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Quantifying the Process and Performance of River Basin Water Management Decentralisation in Sub-Saharan Africa

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Abstract

This article identifies determinants of the decentralisation processes and performances of river basin management decentralisation in Sub-Saharan Africa, using an institutional analysis framework applied to primary data from twenty-seven river basins in the region. Main findings suggest that water scarcity is a major stimulus to the reform; that water user associations, if not well prepared and trained, may deter the decentralisation process and being part of an existing treaty over an international basin helps foster the process for domestic basins that are part of an international basin. Conditions improving decentralisation process performance include: scarcity of water resources, longer period of implementation, bottom-up creation and appropriate budgetary support of the river basin organisation. Due to the sample size our findings can be seen as suggestive for decentralisation policy in remaining river basins across the continent and elsewhere.

Key words: decentralisation, water, river basin, Sub-Saharan Africa

JEL classification: Q25, Q34

1. Introduction

Decentralisation is a complex process that was implemented in many countries around the world in recent years in order to create or strengthen local and sub-national governments and to put in place policies in different sectors and with various goals. The underpinning idea about decentralisation is that this process should improve efficiency, governance and equity in order to foster development and reduce poverty (Smoke, 2003).

Decentralisation has been undertaken in various sectors and at the economy-wide level. The literature motivates decentralisation by the expected ability of local governments to

provide public goods and services more efficiently, while promoting growth and economic development. Although certain studies suggest that decentralisation has positive impacts, other studies argue the opposite. The non-water literature suggests a variety of benefits from the participation and the share in decision-making such as improved efficiency, equity and sustainability; increased credibility and legitimacy; better information offering opportunities for innovative solutions more suited to local conditions; joint ownership of results; overall economic benefits; increased share of population covered by water services; equality of access and environmental effects (Cowie and O'Toole, 1998; Narayan, 1995; Lobo and Palghadmal, 1999; Wagley, 1999). The wide-ranging participation benefits of decentralisation create not only short-term gains but also help build capacities, of the local as well as key national agencies, that allow the gains to be sustained and enhanced (USAID, 2009, pp. 55–6). Another angle through which decentralisation can create benefits is in conflict-laden regions or countries (Siegle and O'mahony, 2006). Decentralisation has merits also as a conflict mitigation strategy, although not without risk (Brancati, 2009).

Decentralisation theory (Tiebout, 1956; Besley and Coate, 2003) assumes a political system where individuals can affect public policies, based on their preferences, which may not exist in all developing countries. Therefore, decentralisation processes in some developing countries may not achieve the expected benefits. Lockwood (2002) suggests that the level of decentralisation benefits depends on the extent of the externalities in the provision of the public goods. Other studies found that factors such as technology, human capital and government capacity may make a difference in the decentralisation reform. There have been documented harmful fiscal decentralisation processes such as in both Uganda (Azfar *et al.*, 2001) and the Philippines (Akin *et al.*, 2005), where welfare was negatively affected, mainly due to the decentralisation that diminished local governments incentives to provide public goods.

Development agencies, and in particular the World Bank (2000), promoted decentralisation and devolution of political power in Africa as a means of increasing democracy and enhance the capacity to identify local problems and find the appropriate solution at a lower cost.

According to Conyers (2007), in the African post-independence period, three phases can be identified in terms of transfer of power from the central government to local institutions: (a) centralisation, justified on the ground that central policymaking and planning were necessary to bring about the rapid economic and social transformation required; (b) deconcentration, where powers were transferred to institutions over which the central government retained control and (c) devolution, also known as 'democratic decentralisation', where the aim was to enhance democracy and citizen participation while reducing the role and the expenditure of the central government.

Many experiences of decentralisation took place in Africa as a result of the international effort to promote this pathway as a key for development (World Bank, 1987, 1994; WHO Africa, 1999; United Nations Capital Development Fund, 2003). Several sectors regulated by public policies were concerned, including service delivery (Conyers, 2007), road infrastructures and healthcare (Andrews and Schroeder, 2003).

Despite the good intentions and the enthusiastic starts, decentralisation in the various sectors of African public policies often resulted from the very beginning in a number of shortcomings and difficulties. Several factors such as, among others, the attempt of national politicians to maintain central control over crucial service provision components (Kolehmainen-Aitken and Newbrander, 1997), the competition between the new institutions and the ones existing

before the decentralisation process (Kalumbe, 1997), the limited capacity and skills of the local governments (Hutchinson *et al.*, 1999) have contributed to a limited, if any, positive impact of the decentralisation process on service delivery (Conyers, 2007).

In the field of natural resources, such as forests, pasture lands, wildlife and fisheries, surface and groundwater resources, both researchers and development agencies around the world promoted in the past two decades greater local public participation in order to improve local development and natural resource management (Ostrom, 1990; Rio Declaration on Environment and Development, 1992; World Bank, 2000; Agrawal, 2001; Ribot, 2003). Decentralisation of natural resource management consists of local institutions receiving from the central government powers and management responsibilities in order to increase popular participation to promote more equitable and efficient forms of local management and development (Ribot, 2003).

Ostrom (1990) underlines in particular the importance of local self-governing institutions and the design of sharing rules among the users of common pool resources, such as natural resources, in order to reach sustainable development. Practical implementation of natural resource management decentralisation in Africa suffers from the same problems of decentralisation in the other sectors, namely lack of representation, downward accountability and/or sufficient powers (Ribot, 2003).

Among natural common pool resources, water is a key issue in Africa as many African governments struggle to provide basic water services while global water scarcity increases, though decisions about water allocation and infrastructure have to be made (Lange and Hassan, 2006). As pursuing integrated water resources management (IWRM) at the river basin scale and enhancing stakeholder involvement are two of the most widely repeated recommendations in the water resources literature of the past two decades (Kemper *et al.*, 2007 and the literature they cite), water is at the same time at the heart of both theory of common pool resources management (Ostrom, 1990) and development policies. This combination makes water management a particularly interesting case study for devolution and decentralisation in Africa.

A review of the literature on decentralisation in the water sector (Mody, 2004) suggests that not many analyses of decentralisation of river basin management functions have been undertaken yet, and that this topic is also relatively recent. Since then, not too much was added to the literature. Latest works have focused mainly on surveys of efforts at the national level to implement IWRM (Blomquist *et al.*, 2005; Bateman and Rancier, 2012). Very few studies have been published that attempted at quantifying various aspects of the decentralisation process (Dinar *et al.*, 2007; Gallego-Ayala and Juízo, 2012). Gallego-Ayala and Juízo (2012) use a composite index analysis to assess the performance of three river basin organisations that completed the decentralisation process and implemented the IWRM framework (GWP, 2000). Differences in performance, measured by the various indexes they developed, are attributed to geo-socio-economic conditions in each of the basins. Dinar *et al.* (2007) quantified the process and performance of the decentralisation in eighty-three river basins around the world (not including Sub-Saharan Africa—SSA). Having a global approach provides better ability to generalise compared with the case study approach. Mapedza and Geheb (2010) argue that in Zimbabwe decentralisation was certainly a milestone of the water reform in the country, stating that water reform in Zimbabwe was not simply a technical process, but 'it is clearly linked to issues of power, political connectedness, and gender, with fewer women benefitting from the largely violent fast track land reform process' (p. 525).

SSA countries face a peculiar situation. Water resources are relatively abundant in the region, but due to poor institutions and economic ability physical scarcity and poor quality prevail (Van Koppen, 2003). In addition, agriculture is still the predominant sector, which does consume in many SSA countries the lion share of the available water resources. On-going prolonged and recurring droughts and likely impacts of climate change (Dinar and Keck, 2002; Kurukulasuriya *et al.* 2006; Dinar *et al.*, 2008) suggest that impact of water scarcity, increased variability and misallocation have and will have devastating impacts on many of the SSA countries. In response to global water scarcity, river basins in SSA have undertaken efforts in various directions and to various extents to reform their water sectors, including IWRM and decentralisation of water resource management (Van Koppen, 2003). The 2002 Accra declaration of Africa's regional stakeholders' conference for priority setting includes several action bullets in water reform to shift and decentralise the boundaries of lower-level water management institutions and to stimulate users' participation, especially in basin-level and lower tier water management institutions (Van Koppen 2003, p. 1047). Most SSA countries established their water laws in the past twenty years, as a first step of the decentralisation reform, and restructured their institutional and governance framework accordingly.

Based on our survey of the 121 basins we identified, decentralisation has been initiated in only sixty-six. Motivations for water reforms arose mainly in Southern Africa from the water scarcity situations they faced. It was motivated by several Southern Africa Development Community initiatives (Swatuk, 2005). For example, South Africa voted its National Water Act in 1998 and its National Water Resources Strategy in 2002, Zambia amended in 1994 its Water Act of 1970, while Mozambique and Tanzania approved their National Water Policies, respectively, in 1995 and in 2002, and Namibia adopted its Water Resource Management Act only in 2004. These water laws and policies include a significant component of water management decentralisation (Swatuk, 2005, p. 873).

Water user associations (WUAs) have been considered worldwide a key element for the promotion of local governance and the transfer of water management responsibilities (Karar *et al.*, 2011; Kemerink *et al.*, 2013) to the lowest appropriate level (Kemper *et al.*, 2007) in the spirit of subsidiarity principle. Particularly in Africa, the establishment of WUAs is considered by many national water policies the way to operationalise decentralisation for democratic transformation and to achieve empowerment (Cornwall, 2003) of 'historically disadvantaged groups of individuals' (Faysse and Gumbo, 2004). In South Africa, following the National Water Act no. 36 of 1998, all Irrigation Boards were to be transformed into WUAs, which was expected to be inclusive of all users (Faysse and Gumbo, 2004). Similar dynamics were implemented in Zimbabwe (Dube and Swatuk, 2002; Kujinga, 2002), in Tanzania (Sokile *et al.*, 2003) and elsewhere in Africa. This evolution in terms of participation in the water management at the local level is crucially important, since WUAs include small scale farmers (irrigating and rainfed), rural communities, domestic users, mines, industries, representatives of the administrations, environmentalists, etc. WUAs therefore extend the field of water management at the local level to sectors well beyond irrigated agriculture, and hence is fundamental for development purposes. The literature (e.g., Wester *et al.*, 2003 and the literature they cite) suggests various involvement and representation of stakeholders in river basin management.

While existing research focuses mainly on understanding the relationship between decentralisation of public good provision and economic development as a measure of the success or failure of the decentralisation reform (e.g., Azfar *et al.*, 2001; Besley and Coate 2003;

Cerniglia, 2003; Akin *et al*., 2005), our study tackles the decentralisation process from a different angle and focuses on a cross section of river basins rather than on one or several case studies. We attempt at understanding the determinants of the decentralisation process and its performance, once undertaken in a given basin. In this article, we address the broader question of decentralisation of river basin water management, of which IWRM is an important component. An early global study on the determinants and performances of decentralisation processes in river basins (Dinar *et al*., 2007; Kemper *et al*., 2007; Blomquist *et al*., 2010) did not include basins from SSA, mainly because the decentralisation process just started at the time that study was conducted. Our study of decentralisation in SSA departs from Dinar *et al*. (2007) and Blomquist *et al*. (2010) with several adjustments to the empirical analysis, due to the quality of the data we were able to obtain from SSA basins. While we use the same theory as in Dinar *et al*. (2007) and Blomquist *et al*. (2010), we introduce several adjustments to the empirical specifications to better fit to the situation in SSA.

Our research objective is to quantify the determinants that affect the decentralisation process and its performance. Our analytical framework and testable relationship are detailed in Section 2. Section 3 describes the data collection and variables construction methods we used. Section 4 presents the components of the empirical analysis we applied. Section 5 presents and discusses the results, and Section 6 concludes, addresses some policy implications, suggests direction for future research and highlights some of the caveats of our work.

2. Analytical framework and testable relationships

We follow and slightly modify the analytical framework suggested in Blomquist *et al*. (2010).[1] The framework identifies and focuses primarily on four sets of observable variables and suggests directions by which those sets of variables are associated with the performance of decentralisation of water resource management.

These sets include, for each studied basin: (a) initial conditions and contextual factors; (b) characteristics of the decentralisation process; (c) central government–local government relationships and capacities and (d) resource-level institutional arrangements. All four sets of variables represent factors that jointly provide incentives and enable the stakeholders' participation in the decentralisation. Stakeholder participation is said to improve management decisions that, in turn, lead to increased likelihood of improved resource management in the basin (Pahl-Wostl, 2002; Blomquist *et al*., 2010, p. 14). While specific relationships are discussed at the variable level below, we will say here that there are several initial conditions at the basin that may foster or hamper the decentralisation process; different approaches to the implementation of decentralisation may also lead to more or less effective decentralisation processes; certain interactions between different government levels and the capacity of the government officials affect the decentralisation performance and local institutions for resource management can also act as promoters or suppressors of the decentralisation.

According to Blomquist *et al*. (2010) these four sets of variables are said to increase the capacity and incentivise stakeholder participation; they sustain the stakeholders active involvement in resource management decision-making and they increase the likelihood of improved resource management at the basin-level.

1 This framework has already been applied to assess decentralisation reforms in river basin management, not including SSA (Kemper *et al*., 2006; Dinar *et al*., 2007).

2.1 The variables, and the testable relationships[2]

Following the framework in Blomquist *et al.* (2010), we use a list of empirical variables that were included in a questionnaire that was used to elicit responses from the river basin organisations (RBOs) in SSA, and to obtain information on the decentralisation process and performance.

2.1.1 Impact of contextual factors and initial conditions

The literature on decentralised water resource management indicates that the outcome of decentralisation is partly a function of the initial conditions that prevail at the time a decentralisation initiative is attempted (path dependency). Several variables that could represent such conditions are discussed below.

Level of economic development of the river basin region measures the ability of the basin stakeholders to commit financial and other resources necessary to the decentralisation process in addition to central government provision of support for the decentralisation effort. The literature on decentralised water resource management indicates that successful decentralisation must include some degree of financial autonomy (Musgrave, 1997; Cerniglia, 2003).

Thus, decentralising management to the basin-level, developing and maintaining the institutional arrangements for basin-level management and implementing any form of financial autonomy imply that some financial resources at the basin-level will have to be committed to the decentralisation effort. This in turn implies that basins that have a level of economic development that can sustain those resource commitments are (all other things being equal) more likely to achieve sustainable success in decentralisation.

Initial distribution of resources among basin stakeholders is used in the literature on institutional arrangements at a basin-level to utilise various notions of long-term water availability in order to explain likely impact on the reform process. We also refer to the impact of climate change on the variability of water flows in the basin as a measure of resource availability. However, on the one hand and more obviously, extreme disparities in resource endowments among basin stakeholders can imperil decentralisation success. On the other hand and less obviously, some inequality of initial resource endowments may facilitate action by enabling some stakeholders to bear the costs of taking a leadership role (Ostrom, 1990).

Thus, some inequality of resource endowments is not necessarily lethal to a decentralisation initiative and may even facilitate it if better-situated users are willing to lead (Dinar, 2009). Extreme inequality, however, may be detrimental or even derail the decentralisation effort. This means that the relationship between level of inequality of resource endowments and successful decentralisation is quadratic, with the greatest positive impact at a certain level of inequality, and lower or negative impacts at both lower and higher levels of inequality of resource endowment distribution.

2.1.2 Characteristics of the decentralisation process

Certain conditions or characteristics of the decentralisation process itself may affect the prospects for successful implementation. Two necessary conditions of a decentralisation initiative are (a) a devolution of authority and responsibility from the centre, and (b) an acceptance of

2 This section is based to a large extent on Blomquist *et al.* (2010, pp. 2–13). The interested reader is referred to this source.

that authority and responsibility by the regional or local units. Whether (a) and (b) both occur will depend in part upon why and how the decentralisation process takes place.

Top-down, bottom-up or mutually desired devolution are ways of characterising the decentralisation initiative. It could be motivated by need to address internal problems (Simon, 2002) or by need to respond to external pressure (Samad, 2005). In some cases, the decision to decentralise resource management to a lower and more appropriate level may have been the outcome of a process of mutual discussion and agreement between central officials hoping to improve policy outcomes and local stakeholders desiring greater autonomy and/or flexibility.[3]

All other things being equal, it is likely that because decentralisation initiatives require active basin-level stakeholder involvement, they are more likely to be implemented successfully if undertaken under the bottom-up than under the top-down initiative.

Existing local-level governance arrangements contribute to continuation. The literature suggests that decentralisation initiatives are more likely to be accompanied by active involvement of basin stakeholders if existing community governance institutions and practices are recognised by and incorporated in the decentralisation process (see Blomquist *et al*., 2010, p. 626). Thus, all other things being equal, decentralisation initiatives are more likely to succeed in gaining stakeholder acceptance if they are based upon, and constructed from, traditional community governance institutions and practices (i.e., take account of existing social capital).

2.1.3 Characteristics of central government/basin-level relationships and capacities

Because successful decentralisation requires complementary actions at the central and below-central government, and local levels, other aspects of the central–local relationship can be expected to affect that success. Accordingly, our study includes a set of political and institutional variables having to do with the respective capacities of the central government and the basin-level stakeholders, and the relationship between them.

The extent of devolution of responsibilities and decision-making: a decentralisation policy initiative announced by a central government may be only symbolic, while the central government retains in practice control over all significant resource management decisions. Worse still, a decentralisation policy can represent an abandonment of central government responsibility for resource management without a concomitant establishment of local-level authority.

These differences in the extent of actual devolution that occurs can be expected to affect the prospects for successful implementation of the decentralisation policy. Symbolic or abandonment policies are at best unlikely to improve resource management and at worst will undermine stakeholder willingness to commit to and sustain the extent of active involvement necessary for successful decentralisation. All other things being equal, we would expect to see greater prospects for success increasing with level of actual devolution of rights and responsibilities.

Local-level experience with self-governance and service provision: the ability of central government officials to strike a balance between supportiveness and intrusiveness, and the capacity of basin-level stakeholders to organise and sustain institutional arrangements, will in part be a function of their experiences with respect to other public services or

3 As suggested by a reviewer, one can find also elements of both bottom-up and top-down initiation in sequence in the initiation of a reform (Pollitt and Bouckaer, 2011, p. 112).

responsibilities. The ability of central and local participants to perform successfully will depend on the skills and experiences they have developed.

We would expect that water resource management decentralisation initiatives are more likely to be implemented successfully in settings where local participants have experience in governing and managing other resources and/or public services, e.g., land use, schooling and transportation.

Economic, political and social differences among basin users: in many countries, the distribution of political influence will be a function of economic, religious or other social and cultural distinctions. But even if it were not for the connection between these characteristics and political influence, the characteristics themselves can affect successful implementation of decentralisation initiatives through their independent effects on stakeholder communication, trust and extent of experience in interdependent endeavours.

Economic, political and social distinctions among basin-level stakeholders are likely to affect the implementation of decentralised resource management efforts. The greater and more contentious these distinctions, all other things being equal, the more difficult it will be to develop and sustain basin-scale institutional arrangements for governing and managing water resources.

Adequate time for implementation and adaptation: while it is obvious that longevity of water resource management arrangements may reflect their success, it may be less obvious that their success may depend on their longevity. Time is needed to develop basin-scale institutional arrangements, to experiment with alternatives and engage in some trial-and-error learning. Time is needed for trust building, so water users can begin to accept new arrangements and gradually commit to sustaining them. Time is needed also to translate resource management plans into observable and sustained effects on resource conditions.

The relationship between time and success in water resource management is complicated. On the one hand, we have already said that adaptability is important, as water users need to be able to modify institutional arrangements in response to changed conditions. But, patience is important too, because a new approach that has not succeeded can simply erode stakeholders' willingness to commit their time and effort to the next reform. We may observe a curvilinear relationship, in which successful implementation is less likely to be observed among decentralisation initiatives that are very young, but could taper off if central government and basin-level arrangements have proved insufficiently adaptable over long periods.

2.1.4 The internal configuration of basin-level institutional arrangements

Successful implementation of decentralised water resource management may also depend on features of the basin-level arrangements created by stakeholders and/or by the central government.

Presence of basin-level governance institutions may be a prerequisite for successful water resource management. Sustained and effective participation of stakeholders presupposes the existence of arrangements by which stakeholders articulate their interests, share information, communicate and bargain and take collective decisions. Basin-level governance is essential to the ability of water users to operate at multiple levels of action, which is a key to sustained successful resource preservation and efficient use (Ostrom, 1990).

Basin-level water resource management (in other words, a decentralised system) is neither achievable nor sustainable without the establishment and maintenance of basin-level governance arrangements. In the case of SSA, we refer also to situations of rivers that are

international in nature.[4] Thus, having an agreed upon treaty among the various riparians would also fall under this category of sub-basin interests. Because the existence of governance arrangements is a necessary, not sufficient, condition of successful resource management, we should not expect to find success everywhere we find basin-level governance institutions, but we should expect to find failure everywhere they are absent.

Recognition of sub-basin communities of interest: the water management issues in the basin are viewed differently by the stakeholders that share the resource in various parts of the basin, based mainly on the physical conditions and spatial situation of each group. For example, downstream users' perspectives on water quality differ from upstream users. Users with access to groundwater have different views of drought exposure than surface water users. Municipal and industrial water users do not perceive the value of assured water supply reliability in the same fashion that agricultural water users do (Blomquist and Schlager, 1999). Thus, while basin-level governance and management arrangements are essential to decentralised water resource management, the ability of sub-basin stakeholders to address sub-basin issues may be as important.

Level of participation of various groups in basin-level decision-making arrangements explains the direction and extent of the decentralisation process. Of course, transaction costs of the decentralisation process increase as such assurances are institutionalised, since a larger number of stakeholder organisations within the basin will bring greater coordination costs. All other things being equal, we would expect that successful implementation of basin decentralisation has a positive relationship with level of participation of stakeholders in the process. However, with a diverse and large number of stakeholders, high transaction costs may become a constraint. Here too, then, a hill-shaped relation of this variable to successful decentralisation may be expected, with the absence of sub-basin organisations and large numbers of sub-basin organisations negatively associated with lower success and greater prospects for success in between.

Information sharing and communication: the importance of information—more particularly, information symmetry—and opportunities for communication regarding emergence and maintenance of cooperative decision-making is relatively well understood. Because there can be so many indicators describing water resource conditions and performance of management efforts, forums for information sharing are vital to reducing information asymmetries and promoting cooperation.

Since information will not automatically be perceived the same way by all stakeholders, and the implications of information about resource conditions will differ among these groups, it is arguably as important that there are also institutionalised or other regular forums in which basin stakeholders can communicate. All other things being equal, we expect to find successful decentralised water resource management more likely where information sharing and communication among stakeholders are more apparent.

Mechanisms for conflict resolution are needed to prevent disagreements from arising. Resource users can and will disagree about how well their interests are being represented and protected, about how well the resource management programme is working and whether it is time for a change, about the distribution of benefits and costs, and manifold other issues.

4 There are 60 international basins in Africa and 62% of Africa's land area is covered by international river basins (Wolf *et al.*, 1999).

The success and sustainability of decentralised resource management efforts therefore also depend on the presence of forums for addressing conflicts. This leads us to expect that successful implementation of decentralised water resource management would be more likely in settings where forums for conflict resolution exist.

The data collection process and the creation of the workable variables are presented in the next sections.

3. Data and variable construction

A survey instrument in Dinar *et al.* (2005) was modified to collect the data needed for estimating the model equations in SSA river basins. It was first pre-tested on three RBOs prior to being modified, translated from English to French and Portuguese and sent to the identified offices of the RBOs in the various countries. The questionnaire that includes also the definitions of all variables can be found in Supplementary Material and can be obtained from the corresponding author upon request.

3.1 Data collection methodology

Data collection was undertaken by PEGASYS, a consulting firm in South Africa with widely established contacts with water sector agencies in SSA countries. Data collection was completed after several iterative processes of data entry and quality assurance reviews by the authors. Additional rudimentary statistical tests were undertaken to identify, verify and correct outliers in the dataset. The questionnaires were filled by staff from the basin organisations. All questions, especially those related to performance of the decentralisation reform, required objective rather than subjective answers. We intentionally approached local authorities following the reasoning suggested by Alderman (2002), who observed that local authorities appear to have access to information that is not easily captured in official census datasets.

3.1.1 The potential final set of basins included in the study

The basis for the identification of the potential RBOs in SSA was ANBO, AMCOW, and GTZ (2012), which provided a list of ninety-nine basins in Eastern, Western, Southern and Central Africa (Table 1).

This list of basins was assessed by PEGASYS (2013) and revised, based on a set of investigation approaches such as establishing contacts with local NGOs, regional agencies and known water projects. This process yielded a much more detailed list of 121 basins and their decentralisation status (Table 2). As can be seen from Table 2, of the 121 basins, no

Table 1: Initial Set of Identified River Basins in SSA by Region

Region	Number of reported river basins
Southern Africa	34
West Africa	30
Central Africa	14
East Africa	21
Total	99

Source: Compiled by authors from data in ANBO AMCOW and GTZ (2012).

Table 2: Distribution of Decentralisation Efforts in Various Regions of SSA

Country	Basins with decentralisation completed	Basins with decentralisation in progress	Basins with no decentralisation	Basin with no information about decentralisation
Southern Africa region				
Angola			7	
Botswana			4	
Lesotho			1	
Madagascar			4	
Mozambique[1]	13			
Namibia		10		
South Africa	2	17		
Swaziland	1	2		
Zambia			3	
Zimbabwe	7			
Subtotal	23	29	19	0
West Africa Region				
Ivory Coast				1
Benin				1
Liberia				1
Cameroon				2
Ghana			4	
Guinée				1
Mali				1
Mauritania				1
Nigeria				1
Senegal				1
Subtotal	0	0	4	10
Central African Republic				1
DR Congo			4	4
Equatorial Guinea				1
Gabon				2
Subtotal	0	0	4	8
East Africa Region				
Ethiopia				4
Kenya		5		
Malawi			1	
Sudan				4
Tanzania	9			
Uganda			1	
Subtotal	9	5	2	8
Central Africa Region				
Central African Republic				1
Democratic Republic Congo			4	4
Equatorial Guinea				1
Gabon			1	1
Subtotal	0	0	6	8
Total	32	34	29	26

Source: Modified from PEGASYS (2013).

[1]Mozambican respondents to our survey indicated that RBOs in that country are established. Compared with the level of development of the RBOs of other African countries, it would probably be more correct to put Mozambican RBOs in the second column, where the water decentralisation process is 'in progress'. However, to reflect precisely the survey results, we decided to leave the Mozambican RBOs in the first column.

Table 3: Details about the Basins Included in our Analysis

	Basins with decentralisation completed	Basins with decentralisation in progress	Basins in sample	Names of basins included
Mozambique	13		5 (1)	Limpopo, Inkomati, Buzi, Save, Pungwe
Kenya		5	1 (1)	Lake Victoria
South Africa	2	17	10 (1–2)	Breede-Overberg, Incomati, Olifants/Letaba, Middle Vaal, Upper Orange, Crocodile, Usuthu, Thukela, Mvoti, Limpopo
Swaziland	1	2	2 (1)	Komati, Usuthu
Zimbabwe	7		6 (1)	Gwayi, Limpopo, Save, Sanyati, Manyame, Mazowe
Tanzania	9		3 (1–2)	Rufuji, Wami/Ruvu, Internal Drainage
Total in countries in sample	29	24	27	
Total in SSA (Table 2)	32	34	N/A	N/A

Note: While some similar basin names can be found in different countries, each represent a different RBO, with no physical or institutional interaction between these RBOs. In parenthesis is the number RBO staff who were approached to fill in the data (PEGASYS, 2013, Table 3).

decentralisation was initiated in twenty-nine, and the status of decentralisation in twenty-six other basins was impossible to verify. This left us with sixty-six basins that completed the decentralisation process (thirty-two) or that have not yet completed the decentralisation process (thirty-four). Our final sample of twenty-seven basins shows that we obtained a 41% response rate (27/66). This response rate is on the low range of acceptable response rates in the general literature (Nulty, 2008).[5] A description of the twenty-seven basins, the country they belong to, whether or not they are international basins,[6] and their status of decentralisation are presented in Table 3. The list of the twenty-seven RBOs can be found in Table A1, Appendix A.[7]

5 The range of acceptable response rates in mail and Internet surveys are subject to debate in the literature. Nulty (2008) suggests a range between 33 and 75%, depending on the size of the surveyed population. Dinar *et al.* (2007) report a rate of 42% for responses in their analysis.

6 Some of the international river basins may have several RBOs for the domestic portion in a given country, which was controlled for by a variable indicating whether the RBO is part of an international river basin.

7 It can be realised that the sample is not random. Even though it is representative, by the percentage of basins represented in the sample, we might have basins that are better organised and that have been successful in doing their job. In that case, we can expect an upward bias in the data. Nevertheless, we can also expect measurement error and, therefore, attenuation bias. As we had several problems in getting and coding the data, the measurement error can pull toward zero all our estimates. Perhaps, it would be reasonable to say that our estimates can be, at most, considered a lower bound.

3.1.2 The administration of the questionnaires

For the sixty-six basins to whom questionnaires were distributed, the strategy for eliciting responses included: introductory emails followed up by phone calls to identify a focal person; delivery of the questionnaire by email; follow-up on progress by email as well as phone; clarification sessions with some respondents about difficult questions; review of the received questionnaires and follow-up on particular responses as needed and translation of the questionnaire into an electronic dataset in Excel. The data collection work was planned for six months (March 2012–September 2012), but actually lasted much longer (March 2012–September 2013) due to communication difficulties that PEGASYS encountered with the respondents.

3.1.3 Quality assurance procedures

The electronic dataset was shared with the researchers as it was established over time. Overall, the research team provided five rounds of feedback to PEGASYS. Feedback included inconsistencies in recording missing values (99,999) and 0 values, replacement of string values with numerical values and correction of some basic physical information of the basin. Once these inaccuracies were addressed, the dataset was considered complete, even though some variables have not been filled.

Questionnaires in English were translated to French and Portuguese in order to make sure that they were accessible and understood perfectly by all surveyed RBOs in Africa. In order to increase the response rate, a follow-up survey was sent to the respondents if they did not respond to the survey within a month, and then continued by a telephone follow-up, if necessary. To ensure the highest possible quality, the research team constituted an iterative process of data acquisition and quality assurance reviews. The process involved the compilation of qualitative and quantitative data from a questionnaire, which the agency that collects the data, PEGASYS, distributed.

All responses were checked by both PEGASYS and a graduate student at University of California, Riverside (UCR), under the supervision of the principal investigators, for errors that could be critical to the study, such as missing answers to questions, or which respondents for one reason or another did not, or could not, answer. In addition to such a check, a further rudimentary statistical test was conducted on most variables, to identify outliers within the given response range and to ensure that values are justified. In all cases, the seemingly errors were brought to the attention of the respondents and, in the case of actual errors and/or mistakes, efforts were made towards correction.

3.2 Variables construction

Our questionnaire consisted of fifty-six primary questions and 245 primary variables (Annex 2 in Dinar *et al.* 2013; Mutondo *et al.* 2015, and Supplementary Material, Auxiliary Annex). Some of the variables in our dataset are naturally correlated to each other. We conducted several principal component (PC) analyses in order to capture the information in these variables and to prevent possible multicollinearity, by combining a set of primary variables into one inclusive PC variable in our estimated relationships. Unfortunately, due to the quality of some of the variables in the dataset, some of the PC analyses did not yield meaningful results and could not be used in our analysis (see footnote 8). We also used several primary variables to create indices to reflect values that are better expressed on a relative rather than on an

absolute scale, or to create dummy variables that capture key aspects of the decentralisation process. The variables used in our analysis and their measurements appear in Table 6.

4. The empirical framework

We postulate that the characteristics of the decentralisation process ($\boldsymbol{P}$)[8] and the level of the decentralisation success/progress ($\boldsymbol{S}$) can be estimated using a set of variables that include: contextual factors and initial conditions; characteristics of central government/basin-level relationships and capacities; internal configuration of basin-level institutional arrangements and a set of 'other' variables, identified as necessary. These groups of variables and their relationships were discussed in Blomquist *et al.* (2010) and Dinar *et al.* (2007, p. 858) and were used in our study as well. In addition, we use two new variables that have not been explicitly used in Dinar *et al.* (2007). One variable indicates whether or not a basin is governed by an international river basin organisation, under an international treaty. International river basin organisations may include many tributary basins, and all constitute the international basin. The second variable represents the impact of climate change on basin water supply, measured by precipitation or by runoff variability in the basin. The assumptions regarding the behaviour of the various variables are provided in the following sections.

We are interested in two types of relationships. The first is a relationship that explains a certain phenomenon in the basin, such as specifics of the decentralisation process, measured by the levels of $\boldsymbol{P}$. The second is a relationship that explains level of success/progress of the decentralisation process, measured by $\boldsymbol{S}$.

The set of equations used in the estimation of the first relationship takes the following shape:

$$\text{Model 1}: \quad \boldsymbol{P} = g(\boldsymbol{C}, \boldsymbol{R}, \boldsymbol{I} | \boldsymbol{V}, B, \boldsymbol{X}), \tag{1}$$

where $\boldsymbol{P}$ is a vector of characteristics of the decentralisation process; $\boldsymbol{C}$ is a vector of contextual factors and initial conditions; $\boldsymbol{R}$ is a vector of characteristics of central government/basin-level relationships and capacities; $\boldsymbol{I}$ is a vector of internal configuration of basin-level institutional arrangements; $\boldsymbol{V}$ represents the climatic conditions (precipitation or runoff) in the basin; B is a dichotomous variable indicating whether or not the basin is governed under an international river basin treaty/organisation; and $\boldsymbol{X}$ is a vector of 'other' variables, identified as necessary.

A general relationship for decentralisation success/progress, using the theory developed above is as follows:

$$\text{Model 2}: \quad \boldsymbol{S} = f(\boldsymbol{C}, \boldsymbol{P}, \boldsymbol{R}, \boldsymbol{I} | \boldsymbol{V}, B, \boldsymbol{X}), \tag{2}$$

where $\boldsymbol{S}$ is a vector of performance indicators of the decentralisation in the river basin.

All other variables are as defined earlier.

We have several measures of success and several measures for levels of progress of the decentralisation process, as will be discussed in detail in coming sections.

We propose several types of specification of the functional form depending on the nature of the variable $\boldsymbol{S}$. Based on our discussion in previous sections, one possible way to measure success is by using a dichotomous variable that takes the value 1 when decentralisation was initiated and 0 when no decentralisation took place in spite of government intent.

8 Variables represented by a bold italic letter indicate a vector.

A second way of describing success is to measure normatively the extent of achieving several important original goals of the decentralisation reform. The success variable was computed as an aggregation of the success ratings over the different reported decentralisation objectives, because the KMO-statistic[9] of some individual success objective variables was very low.

A third way of measuring progress of decentralisation is by comparing performance between present and the pre-decentralisation period. Performance variables may include: level of participation, local responsibility, financial performance, economic activity, etc. By comparing before and after values, we are just comparing change levels of each of the variables included in the comparison of before and after decentralisation.

4.1 Empirical specifications of the decentralisation process and its performance

The first specification of a relationship we investigate explains whether or not a decentralisation process was initiated (Model 1). We expect that it takes some level of the contextual factors (***C***) as well as characteristics of the central government/basin-level relationships and capacities (***R***) to initiate the decentralisation. However, we are not sure about the direction of the impact of various internal configurations of basin-level institutional arrangements (***I***). Some existing WUA may work in opposite directions. We expect that harsh climatic conditions (***V***) will be associated with higher likelihood of establishing river basin organisation and an existing international treaty or international river basin organisation (*B*) that governs the basin will help also in initiating the decentralisation process in the domestic part of the basin. A domestic portion of an international river basin that is governed by a treaty or an existing international Basin Organization (INBO) is considered a supporting institution to the decentralisation process of the domestic portion of the international basin. Each domestic basin that is part of an international/transboundary basin was treated as a separate observation. However, we used a dummy variable to indicate whether or not such basin is governed by an international treaty ('International treaty').

This approach is valid since the goal of our regression analysis is not to find causal relationships, such as in the context of policy evaluation, but rather to evaluate the intensity of the relationships in a multivariate analysis in the framework presented in the previous section that may provide clues for future research. Several variables could help shed light on the decentralisation process and its performance.[10] The length of the decentralisation process, 'Years decentralisation', the transaction costs of the process, measured by several variables such as 'Institutions dismantled', which is a proxy to the transaction cost, and 'Political cost', which measures the overall political complexity of the decentralisation, and the level of involvement of the organised stakeholders, 'WUA involvement', are included in our analysis. Estimation procedures explaining 'Institutions dismantled', 'Political cost' and 'Years decentralisation' use an OLS procedure as the values of these variables are dummies or continuous. Table 4 summarises the various equations we specified for Model 1, and the expected directions of impact of the independent variables, based on the theory developed earlier.

9 Kaiser–Meyer–Olkin (KMO) statistic predicts if data are likely to factor well, based on correlation and partial correlation. The KMO overall statistic is used to decide whether or not to include a variable in the PC analysis. KMO overall should be 0.60 or higher to proceed with factor analysis. Variables with KMO statistic lower than 0.60 should be dropped from the PC analysis.

10 For definition of the variables, see Annexes 2 and 3 in Dinar *et al.* (2013) and the Supplementary Material, Auxiliary questionnire.

Table 4: Decentralisation Process

Independent variable	Dependent variable		
	WUAs involvement	RBO created	Institutions dismantled
Budget per capita	NI	NI	NI
Creation bottom-up	+	+	+
Disputes over allocation	–	+	NI
Governing body	NI	NI	NI
International treaty	+	+	+
Political cost	+	+	+
Relative water scarcity	NI	+	+
Share of surface water	NI	NI	+
Water flow fluctuates	NI	NI	+
WUA involvement	NI	NI	NI
Years decentralisation	–	NI	NI

NI, not included.

We identified several variables that serve to measure decentralisation performance. We use the variable 'Success over objective' (calculated as an aggregation of the success over all objectives) to reflect achievement of various goals the decentralisation process was aimed to achieve. We applied Linear Probability Model (LPM), TOBIT and OLS procedure to estimate that relationship as well. Because we are not sure that the values measured are distributed normally, we cannot use GLM, as it may provide biased estimates.[11] Thus we use the TOBIT procedure that assumes a Poisson distribution. Finally, we construct the additional variable, 'Problems after', to explain the performance of the decentralisation process. 'Problems before' and 'Problems after' are two variables for which we did use a PC variable (Table A2, Appendix A). Table 5 summarises the estimation procedures of the various equations we specified for estimating relationship 2 (Model 2), and the expected directions of impact, based on the theory developed earlier.

We had to use the LPM approach because of the small number of observations. LPM is not bounded between zero and one, but still captures the intensity of the relationship between the binary dependent variable and the independent variables. We were not been able to administer the PROBIT and LOGIT estimations because the small samples resulted in a few values perfectly predicting either the measure of success (dependent variable equals to 1) or the measure of failure (dependent variable equals to zero). In this situation, the sample did not allow

11 There are three main sources of bias in our work: (a) self-selection bias (the RBO's that decide to participate in the study by answering the questionnaire). This is an upward bias (assuming that only the better-off (in terms of organisation, institutional capacity and social capital) organisations participate in the study and, therefore, they may tend to report better results). (b) Measurement error bias due to selection of the dependent variable (endogenous sample selection), and/or due to missing values, when we cannot include some RBOs because they did not report the information we used to compute the dependent variable. And (c) missing values of independent variables, when the RBOs did not report information on an independent variable (exogenous sample selection). The main sources of bias are (a) and (b). The exogenous sample selection is not as important since we would not be violating any of the assumptions of biasedness and consistency. If anything, we would be reducing the variation of the estimator due to smaller sample size.

Table 5: Decentralisation Performance

Independent variable	Dependent variable	
	Success over objectives	Problems after decentralisation
Budget per capita	NI	+
Creation bottom up		+
Disputes over allocation	NI	NI
Governing body	+	NI
Institutions dismantled	NI	NI
International treaty	+	NI
Political cost	−	−
RBO created	NI	NI
Relative water scarcity	NI	NI
Share of SW	+/−	NI
Water flow fluctuates	−	NI
WUA involvement	NI	NI
Years decentralisation	+	NI

NI, not included.

estimating the variation of the probability of the measure of interest by the different levels of the independent variables included in the model. To show that our results are not sensitive to the estimation procedures used in the analysis, we provide results of TOBIT estimation procedures (Tables A3 and A4) that can be compared with the results of the OLS procedure (Tables 9 and 10, respectively). As can be seen, the results are quite similar both in terms of significance, sign, size of the coefficients and indexes for wellness of fit.

5. Results

Our dataset includes a total of twenty-seven RBOs in six countries distributed over two of the four SSA regions (four RBOs in two Eastern African countries and twenty-three RBOs in four Southern African countries). The basins in the other two regions on the continent, Central Africa and West Africa, do not have decentralisation experiences or information about it (Table 2). Our sample is quite well balanced, representing nearly 30% of the fourteen eastern basins and 44% of the twenty-three southern basins that undertook decentralisation. Therefore, our twenty-seven observations do represent the situation in SSA, even if they include only basins from East and Southern Africa. As for the representation of the basins in the southern and east Africa regions: our sample (85% southern; 15% east, Table 3) represents very closely the distribution of basins with either completed or in-progress decentralisation in the southern and east Africa regions (78% southern; 22% eastern, Table 2). Therefore, our results apply to the entire SSA region reflecting decentralisation of river basin management at this point in time (subject to the within-region self-selection bias we discussed earlier). We start with a report on the descriptive statistics of the variables participating in the analysis.

5.1 Descriptive statistics

While we based our entire analysis in this article on the structure suggested in Dinar *et al.* (2007), due to the reasons indicated in Section 3 we had to revise the measurement of some

of the variables and to eliminate several other variables that were not reported because of difficulties of the respondents in SSA basins to assign values to them. This shrunk the usable variables and reduced the overall number of observations that we could include in the various estimated models. A detailed definition of the variables in our dataset can be found in the Supplementary Material, Auxiliary file with the questionnaire we used. The descriptive statistics of the variables that were included in this article's analysis is presented in Table 6.

Table 6 demonstrates the problems in filling out the questionnaire, as the number of variables with full coverage of the entire set of observations fluctuates between 10 and 27. The descriptive statistics in Table 6 indicates that about 40% of the decentralisation in the sample basins was driven by a bottom-up approach and 60% was driven by a top-down approach. In 80% of the basins where the decentralisation process was initiated, RBOs were created. In 58% of the basins, at least one institution was dismantled during the decentralisation process. It is also clear that disputes over water quality seem to be more critical for RBOs (52%) than disputes over allocation (35%). The decentralisation process, on average, is about one decade old, ranging between two to thirty years. Decentralisation processes in SSA started as early as 1979 and as late as 2009 (according to our sample). Finally, flow fluctuation affects 76% of the basins, and 68% of the basins in our sample are part of a transboundary river, governed by international treaty (all these results are found in Table 6).[12]

5.2 Inference of expectations

Following Dinar *et al.* (2007), we inferred our expectations regarding process and performance of the decentralisation reform in SSA. Given the few countries in our database, we could not include state-level variables such as wealth, regime and others. In addition, we lost several observations due to missing values of some of the variables involved.

We start with a *t*-test analysis of selected performance variables' level in the 'before' and in the 'after' decentralisation periods in Section 5.2.1. Then follow with estimating the determinants of the decentralisation process in Section 5.2.2. We conclude the results section by estimating the determinants of the decentralisation performance in Section 5.2.3.

5.2.1 Performance of decentralisation (comparing level of decentralised and levels of severity of problems responsibility before and after)

We start by comparing several water management responsibility indicator items before and after the decentralisation, using a two-tailed *t*-test. The results of the analysis of four activities (water administration, infrastructure financing, water quality enforcement and setting water quality standards) are presented in Table 7.

As can be seen from Table 7, more water management activities at higher decentralised levels have been reported after the decentralisation process, compared with the situation before the decentralisation. With ranking of water activities varying between 1 and 5 (with 1 indicating centralised and 5 indicating most decentralised activity), one can see that there was a significant move of responsibilities towards basin-level and a significant reduction of responsibility at the central government (increase in local responsibility was not significant, and the same is true for increase in state responsibility). A significant increase of

12 In response to a request from one reviewer, we provide details about the interpretation of the mean values of dichotomous variable (0/1). The mean value of such variables in Table 6 indicates the share of basins that belong to the category defined by that variable.

Table 6: Descriptive Statistics of Variables Included in the Analysis

Variable	Definition	Observations	Mean	Standard deviation	Minimum	Maximum
International treaty	Yes/No	25	0.68	0.4760	0	1
Water flow flactuates	Yes/No	25	0.76	0.4358	0	1
River basin resources equitably distributed	Yes/No	25	0.16	0.3741	0	1
Budget per capita	Basin budget divided by basin population (000$)	17	6.6131	15.7686	0.1785	66.4250
Forums to solve disputes	See Table A2	23	1.0869	0.4170	0	2
Governing body	See Table A2	22	4	1.661	1	6
Method of creation	See Table A2	27	1.5925	0.5007	1	2
Creation bottom-up	Yes/no	27	0.4074	0.5007	0	1
Creation top-down	Yes/no	27	0.5925	0.5007	0	1
Existence of political cost	See Table A2	25	3.56	1.3868	0	5
Relative water scarcity	See Table A2	17	0.5230	0.3308	0.0864	1.5
Share surface water	See Table A2	23	4.4781	0.9472	1	5
WUA involvement	See Table A2	24	1.6666	1.007	1	5
Year of creation	Year	18	1999	7.3163	1979	2009
Years of decentralisation	Number of years (count variable)	23	9.4782	6.4938	2	30
RBO created	Yes/No	25	0.800	0.4082	0	1
Institutions dismantled (during the decentralisation)	Yes/No	17	0.5882	0.5072	0	1
Disputes over quality	Yes/no	23	0.5217	0.5107	0	1
Disputes over allocation	Yes/no	23	0.3478	0.4869	0	1
Problems before decentralisation	See Table A2	15	2.41e – 09	0.9482	−2.3690	2.4236
Problems after the decentralisation	See Table A2	10	−1.34e – 08	0.9765	−1.1872	1.3384
Political cost	See Table A2	11	3.818182	1.778661	0	5
Success over objectives (redefined)	See Table A2	16	5.4375	1.6720	3	9

Note: The two PC variables, problems before decentralisation and problem after decentralisation can yield negative values at the lowest range.

Table 7: Decision-Making in Water Management at Various Levels Before and After Decentralisation

Activity	Before	After	*t*-Statistic
Water administration			
Local	2.235	2.692	0.8785
Basin	1.611	3.733	6.0498***
State	2.875	3.125	0.3369
Central government	3.950	2.533	−2.7947***
Infrastructure financing			
Local	1.917	2.400	0.9659
Basin	1.286	2.714	2.4019**
State	3.222	3.125	−0.1453
Central government	4.714	4.667	−0.1166
Water quality enforcement			
Local	1.500	1.800	0.7069
Basin	1.529	3.273	3.7063***
State	2.750	2.500	−0.4229
Central government	4.000	3.286	−1.8609*
Setting water quality standards			
Local	1.200	1.000	−0.5311
Basin	1.333	2.333	2.3094**
State	2.083	2.714	0.9073
Central government	4.600	4.571	−0.1031

*$P < 0.10$, **$P < 0.05$, ***$P < 0.01$.

responsibilities towards basin-level was also reported in the case of infrastructure financing (increase in responsibility at local level and decrease in responsibility in state and central government levels were not significant). A significant increase in responsibility for water quality enforcement at the basin-level was reported (insignificant increase in local responsibility and insignificant decrease in state and central government responsibilities were also reported). A significant increase in responsibility at the basin-level was reported for setting water quality standards (no significant changes have been reported for local, state and central government). As a whole, our sample RBO moved after the decentralisation process towards more responsibility at the basin-level for all four water management decision-making activities. At the same time, these RBOs show a reduction in the central government responsibility in only water administration and water quality enforcement activities. We found that by 2013 there is still no progress towards increased responsibilities to the local communities (none of the values in Table 7 for local government are significantly different than for the higher levels of governments-basin, state, federal), which suggests difficulty in implementing decentralisation towards local actors. We should indicate that this analysis differs from that in Dinar *et al.* (2007) in that it goes one level lower than the basin-level by addressing decentralisation to the local (sub-basin) level. The findings suggest difficulty in implementing decentralisation below the basin-level to local actors in SSA.

We were also able to get assessments of the severity levels of several issues the RBOs have been facing and to compare the situation before and after the decentralisation. Ranking of

Table 8: Changes in Severity of Various Water Management Issue Between Before and After Decentralisation

Problem item	Before	After	*t*-Statistic
Floods	0.9545	0.7222	1.5396^{+}
Water scarcity	1.0952	0.4705	3.6246***
Environmental quality	1.1052	0.2666	3.5794***
Water conflicts	1.3888	0.2666	4.5825***
Land degradation	1.0500	0.7500	1.6771*
Development issues	1.3333	0.6153	3.5257**

Note: We included also coefficients with level of significance of 15% to accommodate results that are influenced by the small number of observations.
$^{+}P < 0.15$, $*P < 0.10$, $**P < 0.05$, $***P < 0.01$.

values of severity and incremental changes between pre-decentralisation and during and post-decentralisation for each issue are defined in Table A2, Appendix A. Mean values of these assessments for each problem item before and after the decentralisation was undertaken are presented in Table 8.

Table 8 suggests that before decentralisation, except for floods (with mean value of 0.9545), all of the other issues were in the range of 'some problem' to a 'severe problem'. Water conflicts and development issues exhibit the highest level of severity in the sample basins. After decentralisation, all the six issues have been either stable or improving, with floods, land degradation and development issues being closer to 1, indicating that the situation related to these issues tended to improve on average. The situation remains on average the same for water scarcity, environmental problems and water conflicts.

5.2.2 Determinants of the decentralisation process

We use three decentralisation process variables that allowed us to use most of the observations in the dataset. The results of the estimated equations are presented in Table 9.

The results in Table 9 indicate very significantly that, regardless of the inclusion of the international treaty and the flow variation over time, all contextual factors included in the model as well as the variables that measure the internal configuration of basin-level institutional arrangements were significant and follow the expected sign, except the 'Creation bottom up' variable. The coefficient of the 'Political cost' variable is positive and highly significant in all five estimated relationships in Table 9. This suggests that a higher political cost increases the involvement of the WUA (estimations 1–2), increases the likelihood of creation of an RBO (estimations 3–4) and increases the likelihood of dismantling existing institutions in the basin (estimation 5). The negative sign of the coefficient on 'Creation bottom up', while opposite to our initial expectations and previous findings (Dinar *et al.*, 2007) is in line with the discussion in the introduction section and in Mutondo *et al.* (2015), suggesting that the WUAs that have been established in the RBOs were not technically ready to take off the decentralisation process, lacking organisational, legal and technical skills. In other words, the technical staff of the WUAs were not yet trained to provide services to the members, which affected the performance of the WUA, impacting the decentralisation process. This result may indicate that some central government involvement is still needed in SSA basins as a way to transfer not

Table 9: Estimated Features of the Decentralisation Process

Estimation procedure	OLS	OLS	LPM	LPM	LPM
Estimation #	(1)	(2)	(3)	(4)	(5)
Explanatory variable	WUAs involvement	WUAs involvement	RBO created	RBO created	Institutions dismantled
Political cost	1.1071	1.1068	0.4717	0.5731	0.2062
	(4.41)***	(5.00)***	(3.32)**	(4.79)***	(4.04)**
Creation bottom-up	−1.0336	−1.1089	−0.2495	−0.3075	−0.0859
	(2.19)*	(2.61)**	(3.36)**	(4.90)***	(7.99)**
Years decentralisation	−0.3671	−0.36361			
	(5.11)***	(5.73)***			
Disputes over allocation	−1.0308	−0.8469	0.4499	0.7309	
	(2.23)**	(1.98)*	(3.22)**	(4.67)***	
Relative water scarcity			0.9017	1.1600	0.9306
			(3.16)**	(4.84)***	(14.08)***
Share of surface water					0.1589
					(13.30)***
International treaty		0.7457		0.2751	0.1759
		(1.78)+		(1.99)+	(5.20)**
Water flow fluctuates					0.7785
					(11.71)***
Constant	1.6701	1.0635	0.8078	0.5119	−0.7899
	(3.03)	(1.75)+	(2.97)**	(2.15)*	(9.10)**
Number of observations	16	14	11	10	9
F-test	7.42	6.83	5.18	8.4	285.08
Prob > *F*	0.0038	0.0091	0.0377	0.0302	0.0035
R^2	0.7295	0.8103	0.7754	0.9131	0.9988
Adj. R^2	0.6312	0.6918	0.6257	0.8045	0.9953

Note: Absolute value of *t*-statistics in parenthesis.
+Significant at 15%,*significant at 10%, **significant at 5%, ***significant at 1%.

only responsibilities, but also skills to manage the resources under the decentralised arrangement. This support of the central government is needed so that the WUA's creation and implementation process is not 'manipulated' by dominant groups and therefore is neither equitable nor sustainable. More generally, this finding suggests that 'Creation bottom up' is a necessary but not sufficient condition for institutional decentralisation.

Being governed by an 'International treaty' improves cooperation and raises the likelihood of an RBO being created and institutions (a water-related ministry) dismantled. At this point, it may seem that an international treaty that coordinates the various parts of the basin located in different countries may serve as a roadmap for a more effective decentralisation, and a support tool for users to take the reins of the water resources management in a more stable and accountable setting.

The variable 'Disputes over allocation' has a negative and significant coefficient in the equation explaining 'WUA involvement', and a positive and significant coefficient in the equation explaining 'RBO created'. These results follow our expectations. They suggest that having insufficient dispute resolution mechanisms leads to disengagement of WUAs; however, it does provide impetus to the creation of the RBO. Indeed having water conflicts before the decentralisation was indicated (Table 8) as the most severe problem.

Results for several water-scarcity variables are worth mentioning. 'Relative water scarcity', 'Share of surface water' and 'Water flow fluctuates' all are significant and have a positive sign. This suggests that water scarcity in the range observed in our sample leads towards more involvement of the WUAs, more likelihood of creation of the RBO, and dismantling of existing institutions in the process of decentralisation.

5.2.3 Determinants of the decentralisation performance

We were somehow limited in our ability to use the data on all variables that are expected to measure and explain decentralisation performance. We remained with only two variables that measure performance, 'Success over objectives' and 'Problems after decentralisation'. The results of our regression analyses are presented in Table 10.

Scrutiny of the results suggests that in spite of having a small number of observations, our model is of high explanatory level and significance. All coefficients are significant and with the expected sign, except for 'Water flow fluctuates' and 'International treaty', which are not significant. Adjusted R^2 ranges between 0.964 and 0.998, and F-test values are significant at 1% and less. The results indicate that higher 'Share of surface water' as well as a longer experience with the decentralisation process ('Years decentralisation') enhance the success over the basin's objectives. Lower levels of water scarcity, up to a point, may allow for an easier cooperation and coordination of the users, and for a faster accommodation of the decentralisation arrangements. In other words, the absence of an acute problem around water availability facilitates conditions for coordination and a common approach towards basin solutions. A longer decentralisation process may indicate the possibility of the establishment and learning of a cooperative behaviour, and the stability of the mechanisms to solve disputes. All of that translates into a higher social capital accumulation. In contrast to the previous table, the political cost is highly significant and of a negative sign. It could be entirely possible that sharing the benefits of the decentralisation process will result in an excessive level of political costs (through the changes of institutions or the imposition of new duties), which may offset any possible short-term gain. Also, it is not because RBOs are created that problems are solved.

Table 10: Estimated Decentralisation Performance Equations

Estimation procedure	OLS	OLS	OLS	OLS
Estimation #	(1)	(2)	(3)	(4)
Dependent variable	Success over objectives	Success over objectives	Success over objectives	Problems after decentralisation
Share of surface water	0.5967	0.5868	0.5931	
	(3.39)**	(10.37)***	(9.74)***	
Years decentralisation	0.1928	0.1395	0.1450	
	(3.18)**	(6.31)***	(6.21)***	
Political cost	−1.1042	−1.0192	−1.0093	−1.0715
	(7.38)***	(20.25)***	(16.80)***	(8.50)***
Governing body	0.9838	0.9541	0.9483	
	(6.18)***	(18.72)***	(15.83)***	
Creation bottom up				7.2967
				(8.04)***
Budget per capita				0.9797
				(7.79)***
Water flow fluctuates		−0.1080		
		(0.75)		
International treaty			−0.0120	
			(0.10)	
Constant	1.6087 (1.2)	2.1236	1.9694	−3.6314
		(4.37)**	(4.02)**	(5.31)***
Number of observations	10	9	9	7
F-test	33.71	276.39	233.62	26.84
Prob > *F*	0.0008	0.0003	0.0004	0.0114
R^2	0.9642	0.9978	0.9974	0.9641
Adj. R^2	0.9356	0.9942	0.9932	0.9282

Note: Absolute value of *t*-statistics in parenthesis.
**significant at 5%, ***significant at 1%.

Unlike the equations estimating the decentralisation process characteristics, 'Creation bottom up' has a positive impact on the performance of the decentralisation. The fact that a higher-level 'Governing body' fosters the accomplishment of the objectives may be an indication of the need of the higher government levels to be active and supportive during the decentralisation process. Having a higher 'Budget per capita' is an important factor in having less 'Problems after decentralisation', which is an important finding with policy implications. Some other coefficients deserve additional discussion because their signs are different in the decentralisation process equation (Table 9) and in the decentralisation performance equations (Table 10), which was expected, based on our theoretical framework (Tables 4 and 5). 'Political cost' has a positive sign in the process equations, and a negative sign in the performance equation; 'Creation bottom up' has a (surprising, but justifiable) negative sign in the process equation, and a positive sign in the performance equation; and 'Years decentralisation' has a negative sign in the process equation and a positive sign in the performance equation.

6. Conclusion, policy implications, additional research needs and caveats

Decentralisation efforts in river basins have been seen around the world under various political and institutional situations. African river basins have been joining the decentralisation process of river basins relatively late, initiating the process somewhere in early 1990s. We modified and applied an analytical framework that was originally used in a previous study outside of SSA. The dataset we were able to collect consists of about 40% of the river basins in SSA that initiated decentralisation. We conclude that the analytical framework of water management decentralisation we used is robust enough to explain the decentralisation process and progress even in the presence of a limited sample. It seems that this framework, when used with a richer dataset and over a longer period of time, can be informative to policy-makers when designing and evaluating decentralisation processes in Africa and other parts of the world.

Some of the variables in our analysis have interesting implications. It appears that the success and stability of the decentralisation process depends on the way the new decentralised framework distributes the 'Political cost' (that measures transaction cost associated with the decentralisation) among the winners and losers in the basin and how are the losers being compensated. As for the 'Method of creation', it seems that a grass-root initiative, despite all the benefits it may capture in terms of legitimacy and use of pre-existing community arrangements, is insufficient if not properly supported by government transfers of skills, or know-how, budget responsibilities and technical knowledge. The similar impact of 'WUAs involvement' amplifies that conclusion. For SSA, this conclusion is probably the most relevant one, with policy implications. Training the WUAs prior to the initiation of the decentralisation process is essential for high efficacy of the decentralisation. Otherwise the social investment in institutional reforms in the water sector would be wasted. It should be mentioned here that the results of the variables 'Method of creation', 'Creation bottom-up' and 'WUAs involvement', in a previous study with similar analytical framework applied to regions other than SSA were the opposite, suggesting that in SSA grass-root efforts have to still be nourished.

Interpreting the opposite signs of the coefficients of major variables that are included in estimates of decentralisation process and performance equations ('Creation bottom-up',

'Political cost, 'Years decentralisation') could mean that while the implementation of decentralisation processes in the water sector in SSA does not guarantee success, on the other hand, factors that improve the performance of decentralisation do not necessarily facilitate its implementation. For example, decentralisation processes with newly created and adjusted institutions can have better results than established RBOs suffering from untrained staff and mal-performance of infrastructure as well as being disconnected from the stakeholders.

It also appears that the best performances of decentralised basins in our sample seem to refer to solutions for infrastructural issues (irrigation, floods and land degradation control projects), while the socio-economic problems, perceived before decentralisation (conflicts, development), have been addressed less frequently. This result could be a consequence of the fact that hardware solutions (infrastructure, engineering) are easier to implement than software solutions (stakeholders' participation, dispute resolution forums, etc.). Another interpretation of this last observation is associated with the previously mentioned context that infrastructure could be built by international companies, but when completed and left with local operators, may not function well due to inadequate institutions and preparedness. Proper reforms including decentralisation may be useful in setting well-functioning infrastructure. This was discussed by Estache (2006) for Africa's infrastructure in several sectors, including the water sector, and providing estimates of effectiveness of water infrastructure for growth and poverty alleviation.

Training the WUAs prior to the initiation of the decentralisation process is essential for high efficacy of the decentralisation. Otherwise the social investment in institutional reforms in the water sector would be wasted. In addition, a particular attention needs to be addressed in the question of inclusion and representation of the different stakeholders within a WUA. In fact, as pointed out by Kemerink *et al.* (2013) particularly for South Africa, despite the government's aim to redress the inequities of the past by the inclusion and representation of historically disadvantaged individuals, WUA are still dominated by commercial farmers. Similar considerations were put forward a decade before by Kujinga (2002) for Zimbabwe, where effective stakeholder participation is being hampered by lack of proper representation of stakeholders on catchment and subcatchment councils, lack of stakeholder involvement in catchment planning and inadequate financial resources for catchment and subcatchment councils for use in water management. These reflections indicate clearly that the efforts made so far by the Sub-Saharan African governments in terms of real transformation of the local water governance are insufficient. More worrying, observers have very similar views overtime and show that no real progress took place in more than a decade in terms of WUA establishment in SSA. An important policy implication of this fact is that probably the institutional set-up itself of WUA in SSA may need to be changed in order to provide a more inclusive and representative forum for all stakeholders involved in the water management process.

Given the importance of water resource management in SSA for development and sustainability and the concern with future water availability due to climate change, population growth and other constraints, more work is needed. We can suggest new directions and expansions for research on decentralisation in water resource management in SSA and elsewhere.

Our work in SSA that is summarised in this article departs from a framework and a data collection questionnaire in Dinar *et al.* (2005, 2007) and in Blomquist *et al.* (2010). The data collected and analysed in both Dinar *et al.* (2005) (eighty-five observations) and this article (twenty-seven observations) is an original data that was collected for these particular

studies. The total of 112 observations in the two studies can be merged and analysed, using the same analytical framework that was developed for the two datasets, following the two models that were estimated separately in the two articles. This will provide a good inference for the robustness of the models and allow an analysis of global decentralisation trends.

While our analysis in both this article and in the article by Dinar *et al.* (2007) refers to basins that either completed decentralisation or are still in the decentralisation process. One important aspect that has not been addressed in our article is the quantification of the likelihood of a basin to initiate the decentralisation process. This kind of analysis is very important for policy and could reveal ways to increase decentralisation success. However, for such analysis one would need to include in the dataset the entire population of river basins. In the case of SSA (see Table 2), this means that additional fifty-five basins should be included in the data collection effort.

We would like to also highlight some of the caveats of our work and results. First, we were able to approach twenty-seven RBOs that have been in the process of decentralisation. While we claim that we have a representative sample, it is still considered a small one with self-selection bias (within each of the two sub-regions). This is also reflected in the relatively high number of variables with missing values, as shown in the estimated regressions, which could not include all twenty-seven observations. Another weakness of our work is associated with our inability to get endogeneity-'clean' models in that it seems that the dependent variable (decentralisation process characteristics or decentralisation performance) are affected by variables other than those we identified in our analytical framework, but which are correlated with these explanatory variables. The reason for our inability to capture these additional variables was part of the data collection procedure we were able to use in the region. As such our results should be viewed mainly as descriptive or suggestive rather than well-identified causal relationships.

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Supplementary material

Supplementary material is available at the *JAFECO* online version of the manuscript.

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Appendix A

Table A1: The Final RBOs Included in the Analysis

River basin organisation	Country
Lake Victoria	Kenya
Ara Sul Limpopo	Mozambique
Ara Centro Buzi	Mozambique
Ara Centor Pungue	Mozambique
Ara Centro Save	Mozambique
Ara Sul Inkomati	Mozambique
Komati River Basin Authority	Swaziland
Usuthu River Basin Authority	Swaziland
Breede Overberg Catchment Management Agency	South Africa
Inkomati Usuthu Catchment Management Agency	South Africa
Crocodile West Marico Proto Catchment Management Agency	South Africa
Upper Orange Proto Catchment Management Agency	South Africa
Mvoti to Umzimkulu Proto Catchment Management Agency	South Africa
Middle Vaal Proto Catchment Management Agency	South Africa
Tukela Proto Catchment Management Agency	South Africa
Usutu to Mhaltuze Proto Catchment Management Agency	South Africa
Olifants Proto Catchment Management Agency	South Africa
Limpopo Proto Catchment Management Agency	South Africa
Rufiji Basin Water Board	Tanzania
Wami Ruvu Basin Water Board	Tanzania
Internal Drainage Basin Water Board	Tanzania
Gwayi Catchment Council	Zimbabwe
Manyame Catchment Council	Zimbabwe
Mazowe Catchment Council	Zimbabwe
Mzingwana Catchment Council	Zimbabwe
Sanyati Catchment Council	Zimbabwe
Save Catchment Council	Zimbabwe

Source: PEGASYS (2013, p. 33).

Table A2: Detailed Definition of Variables Included in the Analysis

Variable	Definition
Forum to solve disputes	0 = no forums, 1 = one forum, 2 = several forums
Governing body	Higher values express more centralisation: 5 = federal, 4 = state authority, 3 = state owned company, 2 = regional authority and 1 = regional board/council/committee
Method of creation	N/A = 0, bottom up = 1, and top down = 2
Existence of political cost (in decentralisation)	0 = none, 1 = low, 2 = medium low, 3 = medium, 4 = medium high, 5 = high
Relative water scarcity	Ratio between rainfall and evapotranspiration
Share surface water	The share of surface water in the available water resources in the basin 1 = insignificant, 2 = low, 3 = high, 4 = very high; 5 = sole source
WUA involvement	The degree of WUA involvement and participation 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75%, 5 = 100%
Problems before decentralisation	A principal component variable of responses to the following issues: flood, scarcity, environmental quality, water conflicts, land degradation. Development issues, other issues, measured as: 1 = no response, 2 = no problem, 3 = some problem, 4 = severe problem
Problems after the decentralisation	
Success over objectives (redefined)	Scale of success reported by RBO over flood, scarcity, environmental quality, water conflicts, land degradation, other objective1 (open ended) and other objective2 (open ended) values range between 0 and 10.

Table A3: TOBIT Estimations of the Decentralisation Process

Estimation procedure	TOBIT	TOBIT
Estimation #	(1A)	(2A)
Explanatory variable	WUAs involvement	WUAs involvement
Political cost	1.18	1.169
	(5.12)***	(6.19)***
Creation bottom-up	−1.081	−1.131
	(−2.60)**	(−3.29)***
Years decentralisation	−0.3925	−0.385
	(−5.83)***	(−6.95)***
Disputes over allocation	−1.173	−0.9261
	(−2.75)**	(−2.61)**
International treaty		0.8032
		(2.34)**
Constant	1.717	1.050
	(3.55)***	(2.14)***
Number of observations	14	14
Log likelihood	−15.283	−10.020
LR χ^2	23.14	23.14
Prob > χ^2	0.0003	0.0003

Note: Absolute value of *t*-statistics in parenthesis.
**significant at 5%, ***significant at 1%.

Table A4: TOBIT Estimations of the Decentralisation Performance

Estimation procedure	TOBIT	TOBIT	TOBIT	TOBIT
Estimation #	(1A)	(2A)	(3A)	(4A)
Explanatory variable	Success over objectives	Success over objectives	Success over objectives	Problems after decentralisation
Share of surface water	0.646	0.599	0.606	
	(4.68)***	(15.46)***	(14.82)***	
Years decentralisation	0.219	0.1470	0.153	
	(4.43)***	(9.35)***	(9.35)***	
Political cost	−1.205	−1.040	−1.040	−1.071
	(−9.12)***	(−28.30)***	(−23.17)***	(−12.99)***
Governing body	1.129	0.984	0.989	
	(7.32)***	(24.49)***	(20.50)***	
Creation bottom up				7.296
				(12.28)***
Budget per capita				0.979
				(11.91)***
Water flow fluctuates		−0.082		
		(−0.84)		
International treaty			0.007	
			(0.09)	
Constant	0.908	1.930	1.764	−3.631
	(0.81)	(5.49)***	(5.03)***	(−8.11)***
Number of observations	10	9	9	7
Log likelihood	−2.0529	−6.8077	−6.4901	−3.8306
LR χ^2	32.38	47.03	46.40	23.29
Prob > χ^2	0	0	0	0

Note: Absolute value of *t*-statistics in parenthesis.
**significant at 5%, ***significant at 1%.