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Integrated Water Resources Management Approaches to Improve Water Resources Governance

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Abstract: The water crisis can alternatively be called a governance crisis. Thus, the demand for good water governance to ensure effective water resources management and to attain specific water goals is growing. Many countries subscribe to the Integrated Water Resources Management (IWRM) approach to achieve this goal. The Integrated Water Resources Management approach aims to ensure a process that promotes the coordinated development and management of water, land, and related resources in a drainage basin to maximise economic and social welfare equitably without compromising the sustainability of vital ecosystems. The design of the Integrated Water Resources Management approach, including its pillars and principles, aspires to good water governance and effective resource management. However, empirical studies examining this hypothesis and analysing the impact of the Integrated Water Resources Management approach on water resources governance are limited, especially in developing countries. Therefore, we characterised and compared the water resources governance aspects of two catchments in Uganda's Lake Albert basin. One of the catchments was exposed to integrated water resources management projects, while the other had no exposure to integrated water resources management projects. Some of the factors that supported the comparability of the two sites included spatial proximity linking into a related hydrological and social-economic setup, common water needs and belonging to the same water administration zone. Comparing both areas led us to analyse whether there was a difference in water resources governance actions, as well as in the quality of water resources governance, under the same overall water management and administrative zone. The data were based on field surveys using questionnaires and information guides in both catchments. The results show that the performance of water resources governance is markedly better in the catchment with Integrated Water Resources Management practices than the base catchment unaffected by these practices. Key themes examined include water resources governance styles, water resources governance systems presence, functionality, the performance of good governance principles, and water resources management effectiveness. The findings contribute to the aspirations for the promotion of integrated water management approaches for improved water resources governance, and the concept that the effectiveness of water resources management measures depends on governance effectiveness. Water governance is significant, as it spells out the power, rights, decisions, and priorities relating to given water resources and communities.

Keywords: IWRM; good water governance; catchment management; effectiveness

1. Introduction

Water forms and also plays a vital role in both the environment and human life [1]. With only 2.5% as freshwater and the rest saline, little water is readily available for the many demands of humankind, testing the illusion of inexhaustibility [2]. Consequently, the global water crisis, which is characterised

by increased water demand, limited access to clean water, ineffective water resources management and uncertainties, can alternatively be called a governance crisis [3].

Water possesses ecological, social-cultural, economic, political, spiritual interests and potential uses. The advancement of integrated resources management and or catchment-based resource management approaches aims at bringing all watershed components, water resource users, managers and respective interests together for holistic consideration [1,4–6]. One such approach is the Integrated Water Resources Management (IWRM) approach, which follows the recommendations of the landmark United Nations Conference on Environment and Development Agenda 21 of 1992, Section 2. These recommendations resulted in the establishment of the Global Water Partnership (GWP) in 1996 to foster an integrated approach to water resources management while advancing governance and management of water resources for sustainable and equitable development [4–6]. Integrated water resources management is defined as a process that promotes the coordinated development and management of water, land and related resources to maximise economic and social welfare equitably without compromising the sustainability of vital ecosystems [7]. The implementation of an integrated water resources management approach requires the establishment of an enabling environment, including appropriate policies, strategies and legislation, institutional framework and management instruments [8], while applying the four water principles of [8,9]:

- *Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment;*
- *Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels;*
- *Women play a central part in the provision, management and safeguarding of water; and*
- *Water has an economic value in all its competing uses and should be recognized as an economic good as well as a social good.*

Although integrated water resources management and water governance concepts are related, they are not mutually exclusive [10–13]. Indeed, the concept of integrated water resources management and or basin approaches result from the desire to transform water governance [14]. The interest in improving water governance, including while implementing integrated water resources management approaches is also indicated in the United Nations Sustainable Development Goal 6 and target reports [15–17]. Possible reasons for focusing on water governance include the documented limitations and challenges of implementing the integrated water resources management concept around the world [9,10]. To others, addressing the symptoms of inadequate provision of water services and dwindling water resources while neglecting the root causes of unequal power balances, unfair patterns between and within countries, and deficits in democratization is questionable [3]. The deficits extend to exclusion of informal and customary systems of water management and governance in developing countries reforms [18,19]. Therefore, water management challenges cannot be exclusively solved through infrastructural means, but also through addressing water resources governance. The integrated water resources management approach deals with water governance and water management, which differ conceptually but are interrelated. Water management refers to the primary mechanism through which actions are implemented to achieve set goals [20] and involves the application of structural interventions like soil erosion, flood control infrastructures as well as non-infrastructural interventions like behavioural change, education, water resources assessment, allocation, pollution monitoring and control, financial management, information management, and planning for human and environmental purposes [12]. Water governance refers to the mechanisms through which rules that guide the water actions and plans are established and enforced [21].

Several countries in Eastern Africa, Mediterranean, Caribbean, Central and Eastern Europe, South Asian among other regions practice or subscribe to the integrated water resources management approach through the Global Water Partnership [22]. In this contribution, we focus on cases from Uganda in Eastern Africa, where integrated water resources management pilot projects were set up in selected catchments to examine the contribution of the approach to improving water resources

governance. The study (a) evaluates whether there was a significant difference in water resources governance in catchments where integrated water resources management practices were implemented, and (b) assesses whether catchments experienced good water governance, and thus, the possibility of water resources management effectiveness. We hope the findings contribute empirical evidence regarding the potential of integrated water resources management approaches in alleviating the water governance crisis for the purpose of scale-up.

1.1. The Concept and Context of Water Resources Governance

Water resources governance is believed to influence water resources management by spelling out power, ownership, boundaries, decision making and course of actions. As such, when governance is ineffective, management is likely to be ineffective, as evidenced by resource quality and quantity deterioration, limited access to operational resources, high costs of service delivery and implementation inefficiency [23]. Water resources governance roles specifically include: (a) supporting the formulation and implementation of water resources related institutions, legislations, and policies; (b) offering clarification on the roles and responsibilities of government, civil society and the private sector water resources and services, enabling inter-sectoral dialogue and co-ordination, stakeholder participation and conflict management; and (c) defining water rights and regulation [24]. Water use systems are, therefore, supported by management and governance components [23,24].

Governance concepts and definitions including water governance vary widely [14,16,25]. The concepts of governance may include varied systems of power and decision making, whether developed and enforced by markets, hierarchies, or networks. Governance may also encompass activities of social, political, and administrative actors seen as purposeful efforts to guide, steer, control, or manage the pursuance of public goods [26,27]. At a higher hierarchical level, governance includes the exercise of economic, political, and administrative authority to manage the country's affairs at all levels and viewed as a composition of the mechanisms, processes and institutions through which citizens and civic groups articulate their interests, exercise their legal rights, meet their obligations, and mediate their differences—a view that adds an element of the functionality of prevailing systems and structures [28]. Water resources governance is also defined variably, as documented in [16], though we particularly relate to the view of water governance as encompassing a range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services in society [29]. The diverse views about water resources governance are reported to often inform divergent policy strategies and decisions. Some of the views mimic political processes, characterised by the confrontation of rival political theories grounded on different values and principles or synonymous to the government [14,25]. Recently, many view water resources governance as a process of pragmatic “pluralism”. The pluralism process envisages different types of interaction resulting from (a) the articulation of the classic forms of authority embodied in the state (hierarchical organisations), (b) the private sector (driven by market competition), and (c) the voluntary sector or “civil society” (characterised by citizens' voluntary action, reciprocity, and solidarity) by water actors. These thus encompass the notions of “public-private partnership” and “tri-partite partnership” [12,14,25]. Other arguments include appreciating water resources governance as a subset of a country's general governance system and consistent with other resources sectors' governance for effective management of water resources [30].

Good governance, a term used about a system that adheres to certain principles in water resources governance, demands representation of various interests in water-related decision-making and the recognition of the role of power and politics as important components [12]. Examples of water governance principles include transparency, accountability, responsiveness, equity and inclusion, stakeholder participation, rule of law, integrity, effectiveness and efficiency in service delivery [31]. Several institutions and stakeholders highlight varying governance principles of interest but underscore accountability, participation that seeks to involve every stakeholder in the decision-making process, and transparency where all relevant information is shared in a timely fashion [11,13,21,29,31,32].

Consequently, good governance is associated with effective water resources governance and leading to effective water resources management. Similarly, poor governance is associated with failing a range of technical solutions for water problems [23].

However, water resources governance status monitoring and studies find measuring descriptive and relative terms such as ‘good’, ‘weak’, ‘bad’ and the compound ‘good governance principles’ challenging [29] when it comes to generalisable consensus. Other considerations in the discussion on governance include the scale and level of water-related actions. Thus, the need to design a governance system fit for the spatial and jurisdictional scale of the resource [26,31,33,34]. Some of the approaches to address scale issues in water governance resulted into (a) the integrated water resources management approach to focus at the different functional, operational, organizational and constitutional levels in water resources management which interlink as decision-making levels [29]; (b) the idea of multilevel governance to facilitate administrative and ecological scales at supranational, national, regional, and local level, including the threefold displacement of state power and control upwards to international actors and organizations, downwards to regions, cities, and communities, and outwards to civil society and non-state actors [26,35]; and (c) adopting flexible governance styles like adaptive governance, network governance and earth system governance to solve scale, flexibility and certainty issues in governance [36–38]. The above-mentioned innovations ensure the adaptation of governance responses to territorial specificities, context-informed design and according to needed solutions [38,39].

The scale and level of action issue in natural resources management possibly influenced some of the conceptual shifts from the monocentric forms of governance [26]. Monocentric governance mainly features the state as the centre of power, authority and control over society, economy, and resources compared to multi-stakeholder approaches in which state authority appreciates mutual interdependences. Accordingly, monocentric governance involves setting the agenda of societal problems, deciding upon policy goals and means, and the top-down implementation of policies unlike polycentric, networking, multilevel, earth system, adaptive governance systems, collaborative governance systems [24,26]. In Table 1, we highlight the water resources governance systems focused on further in the study.

Table 1. A summary description of select resources systems of governance.

Water Resources System of Governance	Operational Meaning
Conventional	Also known as monocentric, “the government perspective”, “hierarchical governance”, “command and control systems of governance”, or the “classical modernist approach of governance”, where government centralises most powers at the top and commands from top-down while governing resources [24,40].
Collaborative	A governance arrangement where one or more public agencies directly engages non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative to make or implement public policy or manage public programs or assets. Collaborative governance involves criteria, actors, and decisions by consensus. The focus of the collaboration is on public policy or public management [41].
Polycentrism	Polycentric governance is characterised by an organisational structure where multiple independent actors mutually order their relationships with one another under a general system of rules. Polycentric governance comprises of multiple decision-making centres each with substantive autonomy and also located at varying levels [42–44]. Emphasis is put on deconcentrating power from political actors and instead keeping it dispersed among organised actors [24,42,45].
New Public Management (NPM)	A reformed public management administration theory or concept bred by the need to bring economics and markets to supplement governance. Easily understood as a Public-Private-Partnership [46–48].
Traditional	In some settings, indigenous, cultural or traditional form a core part of the power and, decision making regarding natural resources and water governance system [18,19].

1.2. Case of Water Resources Governance in Uganda: Trends and Status

Uganda's water resources include an estimated mean annual rainfall of about 1200 mm, the River Nile's annual flow, which exceeds 25 km³, and water storage in the country's broad lake system supplied by various rivers and stream systems, with lakes Victoria, Albert, Edward, and Kyoga as major lakes. However, potential evaporation amounts to up to 75% of the annual rainfall. The predicted average increase in water use ranges between 2.8 to 14.1% in 2030 and groundwater withdraw is estimated to increase up to 15% by 2030—developments that make water resources management an important activity in Uganda [49]. The legal definition of water resources given by the Uganda Water Act (1997) includes 'water flowing or situated upon the surface of any land or contained in any river, stream, watercourse or other natural courses for water like lakes, pans, swamps, marshes or springs, whether or not it has been altered or artificially improved; groundwater; and such other water as the Minister may from time to time declare to be water' [50]. The legislation in the Uganda Water Act (1997) additionally designates the government as the overseer of water resources rights in Section 5. The Uganda Water Act of 1997 is operationalised through the Uganda Water Policy of 1999, recognising the need for the Integrated Water Resources Management (IWRM) approach. The policy actions included reforming the water resources management approach; thus, the Catchment-based Water Resources Management (CbWRM) model, composed of four water management and administration zones, was delineated in 2010 to ably implement integrated water resources management [5,50–54]. The water and environment sector policies reform process included relevant stakeholders experimenting with the integrated water resources management approach through projects since 2006 in select catchments like rivers Mpanga and Rwizi [54]. The process resulted in the gradual establishment of Catchment Management Organisations (CMO) to facilitate stakeholder-driven integrated water resources management and development. Each Catchment Management Organisation (CMO) is composed of the Catchment Stakeholder Forum (CSF), Catchment Management Committee (CMC), Catchment Technical Committee (CTC) and the Catchment Secretariat (CS). The operations of the organisations are guided by the Catchment Management Operations manuals, plans, guidelines, strategies, and the broader water resources governance framework consisting of the Constitution of Uganda and other relevant legislation, mainly the National Wetland Policy (1995), National Environment Management Policy (1994), National Environment Management Act (1995), and Land Act (1998). The 1995 Uganda Constitution specifically commits to taking all practical measures to promote a good water management system, protect the environment, ensure accountability and rules for public officeholding and foreign policy objectives beneficial to transboundary issues. It additionally stipulates the duties of citizens under the national objectives and directive principles of state policy.

Uganda still faces water resources management effectiveness challenges, regardless of sector reforms and subscription to the integrated water resources management approaches. Water management effectiveness challenges relate to institutional financing and capacity, sectors coordination, management approaches, policy implementation, enforcement of legislation. Other challenges include resource conflicts, population growth and related land water demands, conflicting political decisions, climate change and the biophysical limitations from complex and transboundary hydrological systems [13,49,51,54–56]. Therefore, solutions through research are needed.

Similarly, the water crisis progressively documented around the world is characterised by water resources management ineffectiveness due to governance. Consequently, the promotion of integrated water resources management approaches as a solution [4–6,57]. While both integrated water resources management and governance have coverage in literature, no explicit study explains whether integrated water resources management approaches improve the water resources governance. We therefore compare the water resources governance situation of two catchments of the rivers Mpanga and Semliki. The Mpanga river catchment was exposed to substantial integrated water resources management projects while the Semliki river catchment is unexposed. Exposure to integrated water resources management is expected to enhance good water governance possibilities following the conceptual pillars and principles [10,11,58]. To prove this hypothesis, we examined the water resources governance

situation, comparing two catchments, one affected and one unaffected by integrated water resources management measures in the form of projects.

The prevailing water resources governance was evaluated based on the definitions provided by the Global Water Partnership [29] and the United Nations Development Program (1997) view of governance [27], the water governance principles [11,13,21,29,31,32]. Study conceptualization guidance and reference tools used include the user's manual on water governance assessment of the United Nations Development Programme [12].

1.3. Study Area

The study area is in the Lake Albert basin, administered as the Albert Water Management Zone in Uganda. The sampled catchments include that of river Mpanga as a catchment affected by integrated water resource management practices pouring into Lake George and the catchment of river Semliki as the control site unaffected by integrated water resource management practices, pouring into Lake Albert.

The major socio-economic activities in the areas include agriculture, pastoralism, tourism, fisheries and the developing oil and gas industry [56]. Geologically, the area is characterised by the pre-Cambrian Tooro-Buganda rock systems, mainly composed of intrusive rocks. Tectonically, the Albert Water Management Zone belongs to the Cenozoic rift basin system, developed along the Precambrian Mozambique orogenic belt [59,60]. The rifting was initiated during the Late Oligocene or Early Miocene; sandstones, siltstones, clay stones and shales characterize the Cenozoic basin infill [61]. Regional climate corresponds to a tropical savanna climate (as tropical wet and dry or savanna climate after Köppen-Geiger) and tropical monsoon climate (Am) around the Rwenzori Mountain ranges [62]. A spatially sharp variation in rainfall amounts occurs, with the Rift Valley and low-lying landscape of Semliki catchment receiving annual average rainfall amounts of 875 mm, while the elevated mountain ranges of Mt. Rwenzori and Mpanga catchment receive an annual average rainfall of 2500 mm [56]. The average monthly temperature varies between 27 °C and 31 °C, average monthly humidity between 60–80%; due to high evaporation, rates locally negative water balance appears [61]. The land cover consists of well-stocked and low-stocked areas, including forests, bushlands, open waters, aquatic, afro-alpine vegetation, and grasslands and woodlands [61,63,64]. The major land uses include the protected areas (national parks, wildlife reserves and forest reserves), agriculture (crops and livestock) and human settlements [61]. The Albert basin faces several water resources management challenges, especially the increasing water and land demand due to population growth increasing water resources encroachment and land-use changes [65].

The study population was drawn from primary beneficiaries and participants in the integrated water resources management projects areas of Bukuku-Karangura (upstream), Fort-portal urban area (midstream) and Nyabani-Ntara sub-counties (downstream) in river Mpanga Sub catchment. The river Mpanga (Figure 1) delineated to an area of 5203.2 km² sub-catchment flows from Mt. Rwenzori ranges and discharges into Lake George. The integrated water resources management projects were implemented in the sub-catchment starting in 2006 by the Directorate of Water Resources Management of the Ministry of Water and Environment and stakeholders. A range of catchment interventions implemented included research, advocacy, service delivery, information and capacity development [66–70].



Figure 1. The study catchment Mpanga, highlighting the sample study sites. The catchment is exposed to integrated water resources management projects and measures.

The study control site of the river Semliki (Figure 2) is a transboundary catchment located between Uganda and the Democratic Republic of Congo. The river Semliki flows from Lake Edward through the rift valley floor into the Democratic Republic of Congo west of Mt. Rwenzori, having the character of a border river along the international boundary between Uganda and the Democratic Republic of Congo before pouring into Lake Albert. The estimated size of the entire catchment is 8213 km² and it is transboundary. However, for purposes of this study, the part more exclusive to Uganda is delineated and estimated at 833.59 square kilometres, where the study population was drawn from the areas of Rwebisengo, Kanara and Bweramule towards Lake Albert in Ntoroko District. The river Semliki sub-catchment is predominantly known for protected areas like the Tooro-Semliki game reserve, a relatively flat landscape that is rich in biodiversity. Although facilitating agriculture, agro-pastoralism, fishing and small-scale border trading, the Semliki sub-catchment is threatened by deforestation, overgrazing, flooding and deteriorating quality and quantity of water [49,61,64–66]. Watersheds are known to be hydrologically unique elements, so the Mpanga and Semliki relate basing on the interconnected hydrological system, common socio-economic practices that include agriculture, pastoralism, fisheries, tourism, peri-urbanism, cultural system and thus, shared water interests.

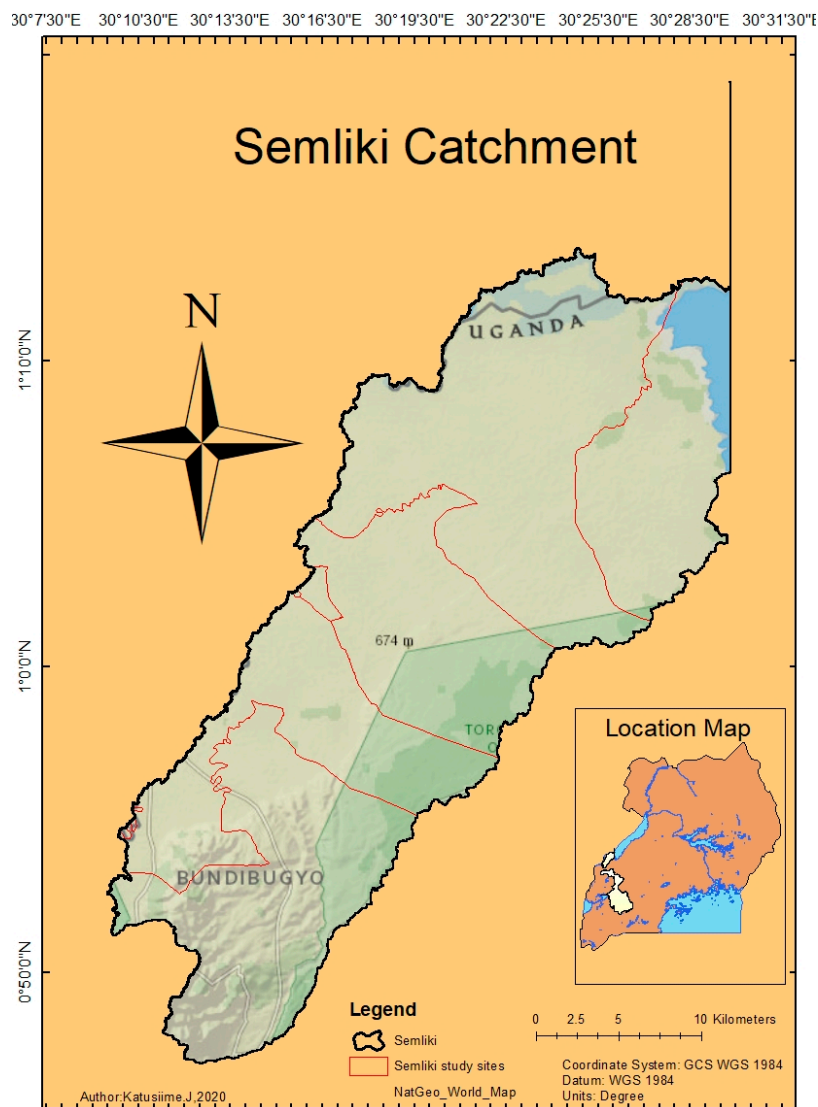


Figure 2. A section of the river Semliki catchment indicating the sample study site's relief topography and a portion of the Uganda-Congo (DRC) Boarder.

2. Materials and Methods

Survey research was conducted to compare the water governance situation in the two purposively selected study catchments. Aware of the limitations when comparing less homogeneous catchments, the Semliki catchment was preferred as the control or base site, given its proximity to the Mpanga catchment, which had been exposed to integrated water resources management projects. The catchment also shares a related hydrological, social-cultural, economic, water administration system, leading to anticipation of a close water resources governance performance. To consistently compare the two catchments, the indicators and characters measured focused on respondent knowledge and capacity, water resources governance styles, the presence and functionality of water resources governance systems, performance of good governance principles, and water resources management effectiveness [29,71]. The assessment was further guided by the water governance definitions and the user's guide for assessing water governance of the United Nations Development Program (2013), which emphasizes actors and institutions, governance principles, and performance as a basic framework for assessing water governance [12]. The estimated sample size of 383 refers to the procedure suggested by Krejcie and Morgan [72], though only 342 questionnaires of the 383 received were fully completed, with 156 questionnaires responding from the Mpanga river catchment and

186 questionnaires responding from the Semliki river catchment. The sample size was drawn from the population data on a sub-county level provided by the government in the study areas, estimated at 139,583 (Mpanga 117,774 residents, Semliki 21,809 residents) [73], and was proportionately distributed between the two study catchments. A simple random sampling of households using target village records as primary respondents to the research questionnaires was performed. Sampling using village-level data increased data collection feasibility and reduced the possibility of bias. The population sampling and selection of target villages targeted the project intervention sites which themselves mainly targeted communities near the main water resources at the upper (hilly or undulating landscape), middle (mostly peri-urban), and lower (relatively flat landscape and some fishing communities) segments of the catchments in Mpanga. A similar arrangement was assumed in Semliki catchment. The survey questionnaire with both open and close-ended questions was used as the main data collection tool, targeting households. The focus group discussions (FDG), key informants guide, and transect walk checklist were used as complimentary data. The data collection exercise took place in July 2015 involving field household interviews, physical and telephone key informant interviews with 15 sector stakeholders (political leaders, cultural leaders, technical resources managers, policymakers, Water User Committee leader, and Civil Society Organisation members). Additionally, six focus group discussions (FGDs), each composed of 10–25 gender-equitable participants, were organised considering upstream, midstream, and downstream catchment zones as much as possible. During transect walks in the catchment, we rapidly evaluated the physical characteristics and validated some of the respondents' information. The focus group discussions and key informant interviews provided information considering issues at community and large spatial scale. The approach involving “multiple-levels and respondents checked for consistency as learned from validation methods relating to environmental governance [74]. Secondary data and information were derived from government reports, plans, strategic papers, and policies. The methodology provided both qualitative and quantitative data from various sources, enabled in-depth exploration of issues while allowing credibility testing of the research findings [75–79].

Qualitative data were numerically coded to allow tabulation and computation of descriptive statistics using the STATA statistical package (StataCorp LLC: College Station, TX, USA). During analysis, the neutral responses were controlled (out) as per variable attributes scale of measurements to generate the site-specific means and t-statistics. Data from Semliki river as the base study catchment was coded zero (0), while data from the Mpanga river catchment affected by integrated water resources management measures was coded one (1). A two paired t-test on the mean proportions (%) from the descriptive statistics was carried out, the interpretation of which made it possible to establish the water resources governance status and whether a significant difference in water resources governance existed between Mpanga and Semliki river catchments. Qualitative data from observation checklists, interviews and focus group discussions notes were analysed, applying content analysis techniques [80].

The catchments maps (Figures 1 and 2) were delineated based on a Digital Elevation Model (DEM) based on Shuttle Rudder Topography Mission (STRM) with 30×30 m resolution (NASA Earth Data accessed: <https://earthdata.nasa.gov/>). DEM data were processed applying QGIS 3.12.2 and Arc Map 10.7 (ESRI, Redlands, CA, USA). Additional spatial datasets used were acquired from arc GIS base maps by National Geographic and Esri, World Resources Institute (Accessed: <https://datasets.wri.org/dataset/waterbodies-in-uganda>) and the United Nations OCHA Humanitarian Data Exchange database (Accessed: <https://data.humdata.org/dataset/uganda-administrative-boundaries-admin-1-admin-3>).

We present the study results in an order that reveals the respondents' knowledge and capacity regarding the research theme, the respective evaluation of the governance situation and resource management effectiveness outcome. We later discuss the findings, offering more information on the studied variables and local context.

3. Results

3.1. Respondents' Water Resources Governance Knowledge and Capacity

Catchment stakeholder's knowledge and capacity are important aspects of integrated water resources management. Therefore, based on the possible implementation of the capacity development strategy of the water and environment sector [81], we evaluated respondents' knowledge and capacity. Variables examined included knowledge of basic water sector issues like the relevant actors and institutions, water resources governance elements like water rights and legislations, individuals' community capacity to contribute to improved water resources management and governance in the community and access to capacity development opportunities. The results show a statistically significant difference in knowledge and capacity between the respondents of the Mpanga river catchment, which was influenced by integrated water resources management projects, and the respondents of the Semliki catchment, which was without any influence of integrated water resources management projects. For instance, the Mpanga catchment respondents' knowledge of the relevant institutions and actors was significantly different ($\alpha < 0.05$), and the same applies to water resources governance issues ($\alpha < 0.01$) and the individuals' community resource management capacity ($\alpha < 0.01$) (Table 3).

3.2. Water Resources Governance in the Catchments

Water sector reforms and the adoption of the integrated water resources management approach promise to transform the water resources systems to those coherent with good water management and governance principles. The water resources systems of governance, also known as styles, are characteristically defined by decision-making procedures and approaches at the local level. The characteristic features were categorised as collaborative, polycentric, new public management (NPM), traditional or customary, and conventional systems. The results indicate the prevalence of the conventional governance system, following the percentage of observations in both catchments, in comparison with other systems of governance (Table 2). Efforts to engage stakeholders through collaborative means like signed Memoranda of Understanding (MOU) while implementing integrated water resources management were observed in the Mpanga catchment.

Table 2. Water resource systems of governance.

System of Governance	Semliki Catchment	Mpanga Catchment
	% of the Total Observations	% of the Total Observations
Conventional	30	28
NPM	24	17
Collaborative	22	23
Polycentrism	7	18
Traditional	17	14

Water governance, defined as a range of political, social, economic, and administrative systems present for managing water resources and subsequent services, is explored. Guided by contextual examples, the results indicate the Mpanga river catchment area, which has been affected by integrated water resources management projects, has markedly more socio-economic, political, and administrative structures than the base catchment of Semliki river. Descriptive statistics of the occurrence of water governance components comparing the two catchments show that the presence of political systems supporting water resource systems occurs significantly more frequent in Mpanga river catchment than in Semliki river catchment ($\alpha < 0.01$). Correspondingly, economic systems present in both catchment areas strongly differ, and are more advance in the Mpanga river catchment than in the Semliki river catchment ($\alpha < 0.01$). In contrast, the locally established administrative systems, as well as traditional resource management systems, do not significantly differ ($\alpha > 0.05$) (Table 3). Although the

political systems and structures were widely reported in both catchments, the traditional systems were less engaged, the administrative systems exhibited enforcement challenges, and multi-stakeholder financing was the prevalent economic system.

Table 3. Water resources governance characters in Mpanga (n = 156) and Semliki catchments (n = 186).

Variable	Semliki Catchment		Mpanga Catchment		Both Catchments		t-Statistics
	Mean	Std	Mean	Std	Mean	Std	
Knowledge and capacity							
Knowledge of water resources stakeholders, institutions	1.432	0.497	1.577	0.496	1.498	0.501	−2.679 *
Capacity building opportunities accessed	2.211	0.409	2.380	0.487	2.287	0.453	−3.423 *
Individual knowledge	1.092	0.339	1.368	0.484	1.227	0.438	−5.279 *
Community resource user' capacity	−0.398	2.091	0.234	2.263	−0.114	2.189	−2.531 **
Water resources governance							
Political systems presence	2.135	0.343	2.618	0.487	2.374	0.485	−10.052 *
Traditional systems presence	2.068	0.254	2.164	0.372	2.110	0.314	−2.665 **
Economic systems presence	2.000	0.000	2.191	0.395	2.085	0.279	−6.435 *
Administrative systems presence	2.989	0.756	3.205	0.649	3.088	0.717	−2.801 **
Functionality of systems							
Systems to report concerns and handle disputes	2.531	0.500	2.600	0.491	2.563	0.496	−1.242
Systems enabling water legal rights	2.150	0.358	2.322	0.468	2.228	0.421	−3.702 *
Systems enabling obligations	2.068	0.253	2.285	0.453	2.175	0.380	−5.286 *
Systems for resource management (Water Committees)	2.367	0.483	2.454	0.501	2.396	0.490	−1.3683
Water resources management							
Water resources management effectiveness	1.622	1.221	2.473	1.506	2.008	1.419	−4.9038 *

Note: ** = Significant at 5%, * = Significant at 1%. Neutral responses were controlled during analysis. The negative means realised at with bi-polar Likert scales. The means of 2.0 in Semliki were a result of the same response in negation by all respondents, thus no variation in the mean, after controlling out the 'neutral' responses.

The functionality of the water governance systems is examined from the resource user perspective as a mechanism or institution through which citizens articulate interests, exercise legal rights, meet obligations, and mediate their differences. The resource governance structures at the lower local government level mostly multi-function with the main objective guided by the establishing institution. Therefore, context-specific system functionality was analysed with respect to practical aspects of handling concerns, mediating conflicts, invoking social obligations, fulfilling water legal rights and local resources management. The functionality of systems differed statistically ($\alpha < 0.01$) between the two catchments, with the realisation of water rights and obligations being more supported in the Mpanga catchment, influenced by integrated water resources management projects. However, systems for handling water-related concerns were rarely present in either catchment, and the occurrence of its

components like users' associations was not statistically different ($\alpha < 0.05$). Similarly, the local resources management committees, which included the water user committees, beach management units and environmental committees' functionality, was not significantly different between Mpanga and Semliki catchments ($\alpha < 0.05$) (Table 3).

3.3. Water Resources Governance Principles

The good water governance principles offered governance quality assessment indicators. Analysis of selected good water resources governance principles indicated a statistically significant difference between integrated water resources management projects catchment and the base catchment ($\alpha < 0.01$), including the principles of participation, responsiveness, equity and inclusion, effectiveness, rule of law, and transparency. However, aspects of integrity and anti-corruption did not show a significant difference ($\alpha < 0.05$; see Table 4). The governance effectiveness principle also showed a significant difference ($\alpha < 0.01$). Integrated water resource management projects established multi-stakeholder forums for participation, local multipurpose water user committees and associations (WUC/A), organised dialogue meetings, facilitated capacity building, carried out policy dissemination, and projects also offered physical solutions to catchment challenges. In return, the differences in water resources governance effectiveness (Table 4) and management effectiveness (Table 3) were statistically significant between the two catchments analysed ($\alpha < 0.01$). The results, therefore, point to the possible relationship between water resources governance quality or status and resource management effectiveness.

Table 4. Water governance principles significance tests in Mpanga and Semliki river catchments.

	Mpanga Catchment (IWRM Pilot Projects Site)		Semliki Catchment (No IWRM Pilot Projects Sites)		Both Catchments		t-statistics
	mean	std.dev.	mean	std.dev.	mean	std.dev.	
Principles							
Participation	1.127	1.109	−0.051	1.295	0.472	1.349	−8.103 *
Accountability	−0.509	1.759	−1.392	1.330	−1.107	1.533	−3.502 *
Equity & Inclusion	0.789	1.309	−0.564	1.302	−0.050	1.458	−7.123 *
Transparency	0.308	1.281	−0.681	1.502	−0.268	1.492	−4.809 *
Rule of law	−0.282	1.495	−100	1.316	−0.723	1.427	−3.418 *
Integrity & anti-corruption	−0.572	1.806	−0.935	1.682	−0.813	1.728	−1.439
Responsiveness	0.910	1.538	−1.020	1.545	−0.169	1.813	−8.266 *
Effectiveness (governance)	0.207	1.507	−1.430	1.046	−0.801	1.474	−7.869 *

Note: * = Significant at 1%: Neutral responses were controlled during analysis. The negative means realised are due to bi-polar Likert scales. The means of 2.0 in Semliki were a result of the same response in negation by all respondents after controlling out the 'neutral' responses.

Overall, the t-test results comparing the water resources governance characters of Mpanga catchment and Semliki river catchments are compiled in Tables 3 and 4; statistics indicate a significant difference in water resources governance between the two study catchments for most variables at least a 5% level ($\alpha < 0.05$). The results hence indicate a significant difference in water resources governance and management effectiveness between areas affected by integrated water resources management projects and areas without integrated water resources management measures.

4. Discussion

4.1. Observations of Respondent's Knowledge and Capacity

Survey responses and findings are dependent on several factors to be aware of, including respondents' knowledge, ignorance, mood, the sensitivity of the matter, opinion, surrounding circumstances, anticipated rewards, and methods [82–85]. Integrated water resources management and water governance are relatively new and complex concepts among natural resources

practitioners and local resource users. Therefore, respondents' basic knowledge about water resources governance and management, relevant sector stakeholders and institutions are important hints for effective participation in water resources management and participatory assessments thereof. Notably, integrated water resources management approaches are characterised by knowledge development, sharing, learning and transfer, including through online toolboxes and sites [86,87]. Implementing partners are, thereafter, expected to apply the knowledge through policies and practice. Such policies and mechanisms include the Uganda Water and Environment Sector Capacity Development Strategy [81].

Capacity may be defined as the capability of a society or a community to identify and understand its development issues, to act and address them, learn from experience, and accumulate knowledge for the future. Knowledge, on the other hand, can be viewed as awareness, acquaintance, skill, and familiarity with the facts surrounding water resources management issue and information. However, knowledge can both be input into capacity development and a product [88,89]. Depending on interests, knowledge and capacity, measurements tend to take diverse approaches [89]. Measuring individuals' basic knowledge of aspects relating to water resources management and governance in the country, actors and institutions were of interest for this study. Respondents' knowledge and capacity regarding water resources governance were more limited in the base catchment than in the catchment influenced by integrated water resources management projects. In addition to the difference in knowledge and capacity-building opportunities, other dynamics such as stakeholder involvement, structuring and related institutional power dynamics are documented [90]. Stakeholders' knowledge and capacity compliments water and related resources management in practice, the participatory monitoring and learning in integrated approaches, as well as ensuring adequate survey evaluations [82,84,91–93]. Community water resource users may have both traditional and conventional knowledge about water resources governance and management and can access adequate information with the advancement in network technologies and multi-stakeholder collaborations to compel action. However, the flow of knowledge and information is patchy and disconnected at the local levels to effectively impact decision making and action [94,95]. As such, water governance and water management knowledge monitoring, organisation and accommodation in integrated water resources management approaches are crucial [96].

4.2. Catchments' Water Resources Governance

The study examines the water resources systems of governance defined as an agreed relational and engagement mechanism of the various stakeholders in a defined framework [27,97]. The stakeholders include government, civil society organisations, resource users and markets (private sector). The 'top-down' governance style dominated in both catchments, and some cases of collaboration and intent to allow multi-stakeholder participation. Despite the top-down mechanism, also known as the conventional governance style, resource users reported holding informal power and decisions about water resources within their community jurisdictions and land. However, the informal power dispersal is less harnessed in existing centralised governance legislation and approaches. Other system de-linkages exhibit when conventional water management systems tend to prioritise professional and scientific "expert" knowledge and views more than indigenous experiences and knowledge [23]. Remediation to informal power and knowledge exclusion includes good governance processes recognising formal and informal power decision-making actors and networks while demanding less centralised systems to accommodate 'down-up' stakeholder-driven interests and approaches [23]. Examples of Stakeholder driven governance styles designed include collaboration among multiple stakeholders and public agencies without necessarily creating independence [41]. Other models such as the public-private partnerships leverage financial resources, the polycentric systems allow issue-based independence and power clusters, while catchments with customary systems present equally use indigenous norms, practices, and knowledge. Water resources systems or styles of governance in Uganda (Table 2) mostly bear characteristics of a centralized system. However, the results pointing to

multiple governance styles affirm the argument that resource governance systems need to be designed while considering interests, biophysical resource scale and function levels [26,31,33,98]. For instance, a transboundary resources governance system and integrated water resources management actions benefit the Semliki catchment. Actions would include transboundary local water committees with participation from Uganda and the Democratic Republic of Congo. The inter-state transboundary catchment committee would enhance the regional Cooperative Framework Agreement (CFA) and the Nile Basin Initiative Act (2002) coordinated by the Nile Basin Initiative (NBI) among other international water instruments aimed at controlling state behaviour and promote cooperation [99]. Governance of transboundary catchment aquifers is also critical, because over-abstraction, contamination and degradation of recharge areas threaten the sustainability of aquifers worldwide according to the International Groundwater Resource Assessment Centre [100,101].

The water resources governance process includes establishing and making functional a range of socio-economic, political, and administrative systems to develop and manage water resources, and the delivery of water services [12,28,29]. Using the integrated water resources management approach pillars for system examples, the social dimensions pillar focuses on equity of access to and use of water resources, equitable distribution of water resources and services among various social and economic groups. The economic dimensions pillar highlights efficiency in water allocation and uses, while the political dimensions pillar focuses on providing stakeholders with equal rights and opportunities to take part in various decision-making processes. The environmental dimensions pillar emphasizes the sustainable use of water and related ecosystem services [10–12,29]. The conventional political systems could include a set of legal institutions that constitute either “government”, “state”, or a set of “processes” or interactions with other non-political sub-systems [102]. Thus, the different pillars offer a basis to define what constitutes the socio-economic, political, and administrative context of each system. A range of examples of political, administrative, and socio-economic systems in the national context were used to guide system presence identification. For example, the elective and non-elective political appointees composed the range of political systems. The relevant state agencies and instruments, like water taxes, permits and fees, policies, bylaws, Acts of Parliament, guidelines, procedures, all mainly administered by a central or local government formed the administrative system. The range of socio-economic systems identified included Payment for Ecosystems Services (PES) schemes like the REDD+ (Reducing Emissions from Deforestation and forest Degradation) program, water, or environmental funds. Other market and non-market schemes like mineral, oil and gas royalties, industrial and domestic water user fees, water extraction and effluent discharge permit fees as well as related project grants were also included. The traditional systems of water resources governance identified with social norms, practices, and cultural leadership involvement. Systems examples were mostly aligned according to the main objective for the establishment to avoid double reporting. The occurrence of water governance systems was more pronounced in the Mpanga catchment, influenced by integrated water resources management projects. However, political systems and structures prevailed more than the administrative, economic, and traditional systems in both study catchments, in addition to multi-purposing especially at the lower administration level. The involvement of political systems in natural resources development and management in developing countries, including Uganda, in particular, is, however, to be regarded with caution, given the possibility of political sabotage from interests and power surpassing scientific knowledge and effective resources management [103–105]. The identified socio-economic-political and administrative water systems need to be capable of serving different purposes. While there are possible variations in the measurement of functionality, the study related functionality to the presence of governance systems as compositions of mechanisms, processes and institutions through which citizens and civic groups articulate their interests, exercise their legal rights, meet their obligations, and mediate their differences [12,20,28,29]. We regard the functionality of systems significantly different with respect to the realisation of water resources use rights and the facilitation of user obligations and exclusive conflict management. Possible reasons observed for limited functionality include the prevalence of a ‘top-down’ style of governance, the limited reach and scale of projects, and the absence

of competent local resources committees in most areas. The findings are related to previously observed gaps in governance systems and challenges during the implementation of policies and enforcement of legislation in the water and environment sector in Uganda [51,54,104–107].

Water governance principles are key measurement indicators of water governance quality [12,29,31,39]. The quality of water resources governance, as indicated by the water governance principles, was significantly different between the two study sites, as was the anti-corruption principle (Table 4). Stakeholders' participation was enhanced, according to the results, while the perceived deficiencies in integrity and fighting graft concurred with earlier studies on transparency, integrity and accountability in the water and sanitation sector in Uganda [13]. The results indicate that the integrated water resources management approach has a high potential to ensure good water governance; this finding is consistent with chances of success documented elsewhere, like the case of Zambia [108,109].

Water challenges persist to varying degrees in both study catchments, independent from already practised integrated water management approaches and the national policy direction. The mixture of successes and challenges observed is to some extent consistent with the successful evidence and approach limitations documented elsewhere [5,11,54,58,108], including the view of Integrated Water Resources Management as a fixed concept rather than understanding it as a flexible and adaptive concept with the capacity to accommodate alternative resource management approaches [110]. The results also point to the possible mutuality in ensuring successful implementation of the integrated water resources management approaches and improving water resources governance. Thus, there is an absence of a very defined linear order of 'cart and horse' [10]. Ineffective water resources governance stifles water resources management effectiveness, as observed in the Semliki catchment, which was unaffected by integrated water resources management projects [23,28,57]. The shortfalls observed in water resources governance in this study equate to policy failure, a possibility also observed in managing interconnected and complex natural systems using approaches incompatible with the broader approaches to governance and public management [109]. It is argued that policy failure (fully or to some degree) is a normal element of natural resources governance, including water resource governance; however, public policymakers fail to contemplate and manage this contingency [25,111]. Policy failure as a constituent of governance failure may be due to the insensitivity of water management institutional (instruments and agencies) and decision-making processes to stakeholder needs at all levels. In consequence, this leads to failure in administration, technical services delivery, financial and economic management and political oversight in the water and related resources sector [112]. Other documented reasons for governance failure are related to state and market failure, given the involvement of the state and the private sector in water resources management and development. The state induced failures might result from over- and or under-regulation, ill-defined rights, nonfulfillment of set resources management goals, corruption, poor leadership, inadequate policy, and legislation responses. The co-existence of formal and informal power structures characterised by political sabotage, power struggles and withholding of useful resources also affects good governance efforts [113]; strategies to overcome policy failure include appropriate instruments to improve institutional credibility and efficiency where markets and regulatory instruments require efficient legal and administrative systems trusted by the community [111]. Additional strategies could include the development of more effective water governance and related land governance regimes designed to overcome government failure, market failure and system failure or a combination of the three [29]. Importantly, water governance regimes are expected to be cognizant of the Dublin water principles and related management approach principles [9,86,87].

The implementation of the integrated water resources management approach in selected watersheds drew lessons about the costs of work at varying scales conducted by multiple stakeholders and institutions [114,115]. As study results indicate the likely effect of unmatched financing for water resources management and governance of catchments, a case in literature demonstrates how

the integrated management approach comes with an increase in governance costs, but a drop in infrastructural costs (Figure 3).

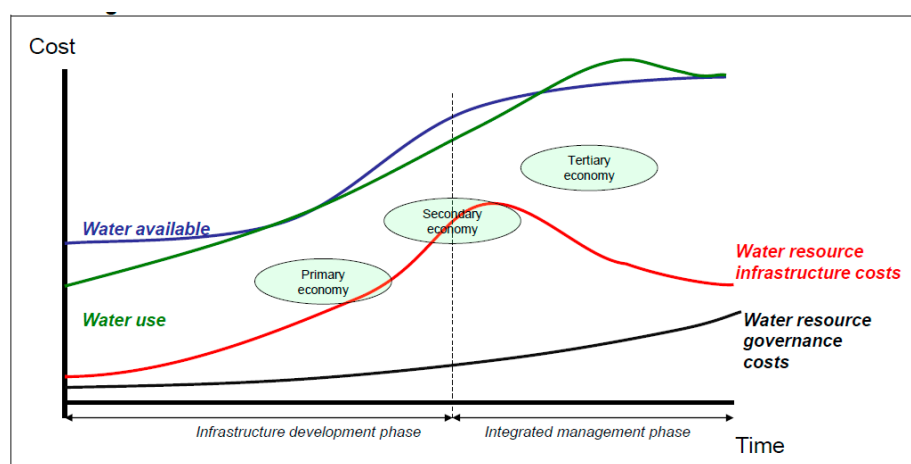


Figure 3. Costs dynamics of water resource governance (black line), water resource infrastructure (red line) and XYZ (green line) as a function of time and related to infrastructure development and implementation of integrated water resource management (graph adapted from EU Water Initiative—Finance Working Group (EUWI-FWG), Report of 2012 on Financing Water Resources Management/Experiences from Sub-Saharan Africa [116]).

5. Conclusions

The water crisis can alternatively be called a water governance crisis. Thus, integrated water resources management approaches and concepts for alleviating both crises have evolved since the 1990s. This study contributes to the increasing consensus regarding the interconnectivity of resources, systems and sustainable development, viewing the integrated water resources management approaches as a key block to successful land and water resources management and governance [15]. The case of the integrated water resources management (IWRM) approach relies on the three cornerstones of establishing an enabling environment, institutional framework, and management instruments. The existing literature indicates the possibility of success or failure of this approach in attaining the desired goals. The adoption of integrated water resources management in Uganda has included water sector reforms and experimental projects implemented in selected catchments since 2006. In this study, the water resources governance situation of two catchments as compared. Both located in the Albert Water Management Zone of the Lake Albert Basin, the river Mpanga catchment has been influenced by the implementation of integrated water resource management projects and was evaluated and compared with a base-catchment that has been unaffected by integrated water resource management projects, that is, the river Semliki catchment (focusing on the Ugandan side). The results show the water resources governance situation to be significantly different between the two catchments under the same water administration. Recognising integrated water resources management as a nationally agreed water management strategy in the water policy, the study findings further demonstrate the effects of differentiated policy translation. Statistical differences in the characteristics of water resources governance and the resulting management effectiveness were highlighted, clearly showing the impact of integrated water resources management on improving water resources governance in the Mpanga river catchment, while water resources governance was largely poor in the Semliki river catchment. Thus, integrated water resources management improves water resources governance and management effectiveness. We observe the integrated water resources management concept to embody both water management and governance tenets; thus, it is double-pronged, ensuring mutual effectiveness. The comparison between both catchments additionally indicates the necessity of

including various aspects such as spatial scale, level of action, policy, and institutionalisation for the successful implementation of the integrated water resources management approach.

Persistent challenges observed in both study catchments include the increasing demand for arable land, leading to riverbank encroachment, catchment deforestation and degradation, in conflict with natural resource rights and tenure. These challenges, coupled with limited enforcement of legislation, threaten resource sustainability and related management objectives in both Semliki and Mpanga catchments. We thus recommend an appreciation of the integrated water resource management approach that is highly cognizant of the local context at the time, to improve water resources governance. The aspirations of integrated water resources management approach include holistic management of land and water resources, which implies future research to consider the examination of water and land resources governance for a holistic view.

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