

RESEARCH ARTICLE

Water resource management: IWRM strategies for improved water management. A systematic review of case studies of East, West and Southern Africa

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Abstract

Objective

The analytical study systematically reviewed the evidence about the IWRM strategy model. The study analysed the IWRM strategy, policy advances and practical implications it had, since inception on effective water management in East, West and Southern Africa.

Methods

The study adopted the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P) and the scoping literature review approach. The study searched selected databases for peer-reviewed articles, books, and grey literature. DistillerSR software was used for article screening. A constructionist thematic analysis was employed to extract recurring themes amongst the regions.

Results

The systematic literature review detailed the adoption, policy revisions and emerging policy trends and issues (or considerations) on IWRM in East, West and Southern Africa. Thematic analysis derived four cross-cutting themes that contributed to IWRM strategy implementation and adoption. The identified four themes were donor effect, water scarcity, transboundary water resources, and policy approach. The output further posited questions on the prospects, including whether IWRM has been a success or failure within the African water resource management fraternity.

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1 Introduction

Integrated Water Resources Management (IWRM) is a concept that is meant to foster effective water resource management. GWP [1] defined it as “the process which promotes the coordinated development and management of water, land and related resources, to maximise the resultant economic and social welfare equitably without compromising the sustainability of vital systems”. A holistic approach, in the form of the Dublin statement on Water and Sustainable Development (DSWSD), emerged and it became the backbone of IWRM principles.

According to Solanes and Gonzalez-Villarreal [2] the Dublin principles are: “(1) *Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment;* (2) *Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels;* (3) *Women play a central part in the provision, management, and safeguarding of water;* and (4) *Water has an economic value in all its competing uses, and should be recognised as an economic good.*” The seamless conflation of the DSWSD and the Agenda 21 at the United Nations Conference on Environment and Development (UNCED) in 1992 further strengthened the IWRM discourse and facilitated the policy approach of IWRM [3,4]. Since its inception the IWRM policy has been the holy grail of water resource management in Africa, Asia, and Europe to mention a few. For policy diffusion, countries were required to develop an IWRM policy blueprints for effective water use [5].

This review sought to unveil the innovative IWRM strategy approach by critically examining its genesis, implementation, adoption and the main drivers in in East, Southern and West Africa. Secondary to this, the study endeavoured to determine whether the IWRM implementation has been a success or failure. The choice of East, West and Southern Africa was influenced by the regional dynamics of Sub-Saharan Africa which have unique problems in water resources management and the hydropolitical diversity in this region. The isolated cases provide a holistic representation of the implementation dynamics of IWRM. In addition, sub-Saharan Africa was the laboratory for IWRM with Zimbabwe and South Africa being the early implementers [6]. Apart from the IWRM strategy being a social experiment in sub-Saharan Africa, there exists a gap on an overarching review on the performance and aggregated outcomes of the IWRM adopters in the continent. The selection of the countries of interest was based on the authors geo-locations and their expert experiences with the IWRM strategy in their respective localities. The study sought to draw trends, similarities, and potential differences in the drivers involved in achieving the desired IWRM outcome.

IWRM strategy approach and implementation are ideally linked to individual country's developmental policies [7]. Southern Africa (Zimbabwe and South Africa) is the biggest adopter of the water resource management strategy and produced differed uptake patterns [8]. In East Africa, Tanzania, Uganda and Kenya also adopted the IWRM strategy, whilst in West Africa, Burkina Faso latently adopted the IWRM strategy in 1992 [4] and in Ghana, customary and traditional water laws transformed into latent IWRM practices [9].

Various initiatives were put in place to aid the adoption of IWRM in sub-Saharan Africa. For example, Tanzania benefited from donor funds and World Bank programmes that sought to alleviate poverty and promote environmental flows. The World Bank radically upscaled and remodelled IWRM in Tanzania through the River Basin Management—Smallholder Irrigation Improvement Programme (RBM-SIIP) [10]. The government of Uganda's efforts of liberalising the markets, opening democratic space and decentralising the country attracted donor funds that drove the IWRM strategy agenda. The long-standing engagement between Uganda and the Nordic Fresh Water initiative helped in the diffusion of IWRM strategy in the country. Finally, in West Africa, Burkina Faso and Ghana made significant strides in operationalising the IWRM strategy by adopting the West Africa Water Resources Policy (WAWRP). A

massive sense of agency coupled with deliberate government efforts drove the adoption status of Burkina Faso.

Total policy diffusion can be achieved when the practice or idea has supporting enablers. Innovation is key in developing policies that alter societal orthodox policy paths that fuel hindrance and consequently in-effective water governance [11]. Acknowledging the political nature of water (water governance and transboundary catchments issues) is the motivation to legislate water-driven and people-driven innovative policy [12]. Water policy reform should acknowledge the differing interests' groups of the water users and its multi-utility nature; thus, diffusion channels should be tailored accordingly, avoiding the 'one size fits all' fallacy. IWRM as an innovative strategy approach diffused from the global stage to Africa and each regional block adopted the approach at different times under different circumstances.

The rest of this paper is outlined as follows; section 2 presents the conceptual framework adopted and the subsequent methodology. Section 3 presents the results and discussion. The discussion is structured around innovation driver in each respective region. Thereafter, subsection 3.4 presents the prospect of IWRM in the East, West and Southern Africa regions. Lastly, the paper presents the conclusion.

2 Methodology

2.1 Conceptual framework and methodology

The analytical framework applied in the study is based on the water innovation frames by the United Nations Department of Economic and Social Affairs (UNDESA) [13]. The UNDESA [13], classified water frames into three distinct categories namely water management strategies (e.g., IWRM), water infrastructure and water services. The former partly involves IWRM strategies and the latter encompasses economic water usage such as agriculture, energy production and industrial applications [12].

The literature review identified research gaps that informed the employed search strategy. The literature that qualified for inclusion was thoroughly analysed and discussed. The aggregated outcomes were used for excerpt extraction in the thematic analysis.

2.2 Literature handling

The study performed a systematic review as guided by the Arksey and O'Malley [14] approach. The approach details methods on how to scope, gather, screen and report literature. The study further employed a constructionist thematic analysis to extract common recurring themes amongst the regions.

2.2.1 Eligibility criteria. Eligibility criteria followed an adapted SPICE (Setting, Perspective, Intervention, Comparison and Evaluation) structure (Table 1). The SPICE structure informed the study's search strategy (Table 2) and the subsequent formulation of the inclusion-exclusion criteria (Table 3). The evidence search was conducted from the following databases: Scopus, Web of Science, Google Scholar, UKZN-EFWE, CABI, JSTOR, African Journals Online (AJOL), Directory of Open Access Journals (DOAJ), J-Gate, SciELO and WorldCat for peer-reviewed articles, books, and grey literature. The study did not emphasize publication date as recommended by Moffa, Cronk [15]. Databases selection was based on their comprehensive and over-arching nature in terms of information archiving. It is worth mentioning that the search strategy was continuously revised by trial and error until the databases yielded the maximum number of articles for screening.

2.2.2 Search strategy. The search strategy or query execution [16] utilised Boolean operators (OR & AND). The dynamic nature of the search strategy required the authors to change the search terms and strategy, for example, if digital databases did not yield the expected search

Table 1. The Adapted SPICE structure for formulating the inclusion and exclusion criteria.

	Criteria	Definitions
Setting	Reviews focusing on the selected geo-locations	The regions of interests were: East, West and Southern Africa
Perspective	Articles on information mining from the supposed IWRM beneficiaries and the subsequent policy drivers (all stakeholders)	The stakeholders include governments, donors and water users in the respective regions
Intervention	Reviews and governments reports on IWRM strategy and water management	IWRM and the resultant policy diffusion chambers
Comparison	Other IWRM related articles and other topics such as water equity water governance	The Dublin principles over- arching aims informed policy that impacted and tackled a wide range of water related affiaris such as water security, water equity and water governance
Evaluation	Reviews on IWRM strategy outcome	Systematic reviews and meta-analyses that have a clearly defined objective around IWRM and containing valid findings. The publication have a clear and easy to reproduce methodology

<https://doi.org/10.1371/journal.pone.0236903.t001>

Table 2. Search strategy employed in the study.

Database	Search terms	Expanded terms
Google scholar UKZN-EFWE CABI JSTOR AJOAL DOAJ J-Gate Scielo Worldcat Web of Science Scopus	Natural Resource Management (NRM) IWRM, East Africa, West Africa, and Southern Africa	“IWRM/NRM” OR/AND “East Africa” OR/AND “West Africa” OR/AND “Southern Africa”
	Dublin principles, water use and agricultural water management, water equity	“Dublin principles” OR “irrigation operation” OR “water use” AND “agricultural water management” OR “water equity AND water use”
	Water governance, irrigation, water policy, and agricultural water management	“water governance” AND “irrigation” OR “water governance” AND “agricultural water management”, “water policy” AND “water use”

<https://doi.org/10.1371/journal.pone.0236903.t002>

items the study would manually search for information sources. The search queries included a string of search terms summarised in Table 2.

2.2.3 Selection process. DistillerSR[®] software was used for article screening. Online data capturing forms were created in the DistillerSR[®] software and two authors performed the article scoring process that eventually led to article screening. The screening was based on the article title, abstract and locality. The study employed a two-phase screening process [17], the first

Table 3. Inclusion-Exclusion criteria.

Inclusion	Exclusion
• Articles published in English	• Article from predatory journals
• Original research in peer reviewed journals	• Articles not published in English
• Articles that described water governance, water use, water management and irrigation	• Full articles that could not be retrieved
• Conference proceedings	• Articles with insufficient and irrelevant results, discussion and conclusions
• MSc and PhD theses/dissertations	
• Article relating to IWRM in Africa	
• Books	
• Government gazettes	

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phase screened according to title and the second phase screened according to abstract and keywords. During the screening process, studies that the matched information in the left column of [Table 3](#) we included in the literature review syntheses, whilst those that matched the exclusion list were discarded.

2.3 Thematic analysis

The review also adopted the thematic analysis approach by Braun and Clarke [18] to extract, code, and select candidate converging themes for the systematic review. The selected literature was subjected to qualitative analysis to capture recurring themes amongst the selected regions (East, West and Southern Africa). Data extracts from the respective regional analysis were formulated into theoretical themes. Thereafter, the extracted data was coded according to the extracted patterns from the information source to constitute a theme. It is worth mentioning that the authors used their discretion to extract and code for themes.

3 Results and discussion

Data charting comprised of the PRISMA flow-chart ([Fig 1](#)). The study utilised 80 out of 183 records (n = 37, 46%) for East Africa, (n = 37, 46%) for Southern Africa, and (n = 6, 8%) for West Africa.

3.1 Case studies

The introduction of IWRM in the East African region was initiated in 1998 by the water ministers in the Nile basin states due to the need for addressing the concerns raised by the riparian states. These water sector reforms revolved around the Dublin principles initiated by the UN in 1992 [20]. In 1999, Kenya developed the national water policy and the enabling legislation, the Water Act 2002 was enacted [21]. The Act was replaced by the Water Act 2016 which established the Water Resources Authority (WRA) as the body mandated to manage water

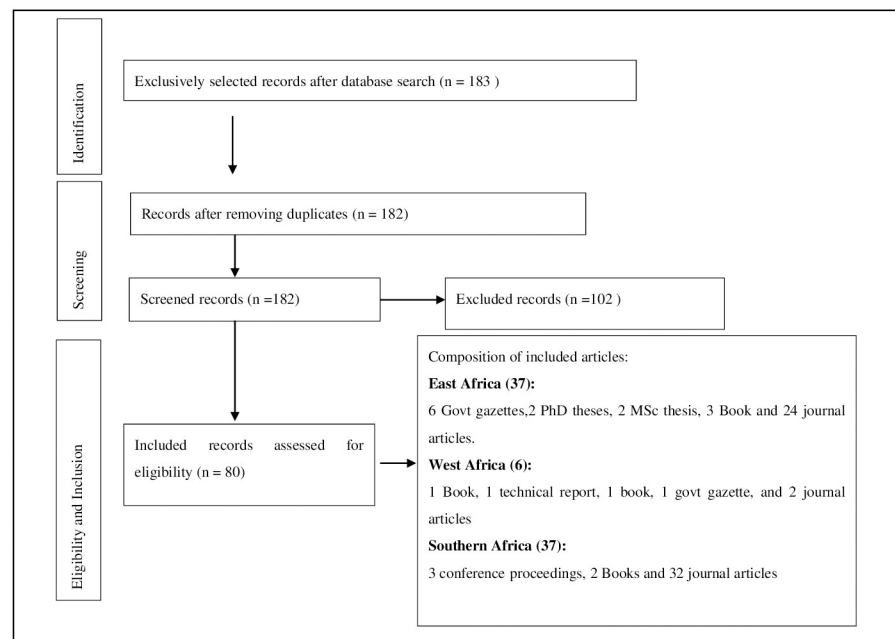


Fig 1. Systematic review flowchart based on PRISMA flowchart [19].

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resources in line with the IWRM principles and Water Resource Users Association (WRUA) as the lowest (local) level of water management [22].

Similarly, Uganda developed the national water policy in 1999 to manage, and develop the available water resources in an integrated and sustainable manner [23]. The National Water Policy further provides for the promotion of water supply for modernized agriculture [24]. Tanzania's water policy of 2002 espouses IWRM principles, and its implementation is based on a raft of legal, economic, administrative, technical, regulatory and participatory instruments [25]. The National Irrigation Policy (NIP), 2010 and the National Irrigation Act, 2013 provides the legal basis for the involvement of different actors on a private-public partnership basis [26].

West Africa possesses an unregistered IWRM strategy that is espoused in the West Africa Water Resources Policy (WAWRP) of 2008. The WAWRP is founded on the following legal principles; (a) "promote, coordinate and ensure the implementation of a regional water resource policy in West Africa, in accordance with the mission and policies of Economic Community of West African States (ECOWAS) and (b) "harmonization and coordination of national policies and the promotion of programmes, projects and activities, especially in the field of agriculture and natural resources". The founding legal basis resonates with the Dublin principles.

The WAWRP design actors were ECOWAS, Union Economique et Monétaire Ouest Africaine (UEMOA), and Comité Permanent Inter-État de Lutte Contre la Sécheresse au Sahel (CILSS). CILSS is the technical arm of ECOWAS and UEMOA. The institutional collaboration was driven by the fact that West Africa needed a sound water policy for improved regional integration and maximised economic gains. ECOWAS established the Water Resources Coordination Centre (WRCC) to (a) oversee and monitor the region's water resources and management activities and (b) to act as an executive organ of the Permanent Framework for Coordination and Monitoring (PFCM) of IWRM [27].

The inception and triggers of IWRM in West Africa can be traced back to the General Act of Berlin in 1885 which, among other things, dictated water resources use of the Congo and Niger rivers [28]. A multiplicity of agreements around shared watercourses in West Africa led to the realisation of the IWRM policy approach. For example, the Senegal River Basin (SRB) Development Mission facilitated collaboration between Senegal and Mauritania in managing the SRB. Another noteworthy agreement was Ruling C/REG.9/7/97, a regional plan to fight floating plants in the ECOWAS countries [28]. GWP (2003) categorised the West African countries according to the level of adoption into three distinct groups namely; (a) Group A comprised of countries with the capacity to develop and adopt the IWRM approach (Burkina Faso and Ghana), (b) Group B comprised of countries needing "light support" to unroll the IWRM plan (Benin, Mali, Nigeria, and Togo), and (3) Group C comprised of laggards which needed significant support to establish an IWRM plan (Cape Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Liberia, Mauritania, Niger, Senegal and Sierra Leone).

Southern African Development Community (SADC) regional bloc has over 15 shared transboundary river basins (For detailed basin and catchment arrangement in SADC see [29]). SADC member states established the Protocol on Shared Water Systems (PSWS) which meant to encourage sustainable water resources utilisation and management. The PSWS was perceived to strengthen regional integration [30]. The regional bloc formulated the Regional Strategic Action Plans (RSAPs) that sought to promote an integrated water resources development plan. The action initiative mimicked IWRM principles and the shared water resources initiatives acted as a catalyst for the genesis of IWRM in Southern Africa [31]. SADC houses the Waternet and the GWP-SA research and innovation hubs upon which SADC's IWRM adoption was anchored on. Besides the availability of trained water experts in the region who were

willing to experiment with the IWRM policy approach, water scarcity fuelled by climate change prompted the region's adoption of the IWRM policy approach at the local level.

3.2 Diffusion drivers of IWRM in East, West and Southern Africa

3.2.1 Water scarcity. The adoption of IWRM in East Africa was necessitated by water scarcity which is experienced by the countries in the region, which formed the need for adoption of prudent water resources management strategies as envisaged under the Dublin principles which was championed indirectly, according to Allouche [5], by the World Bank. Specifically, the need to give incentives and disincentives in water use sectors to encourage water conservation.

Kenya is a water-scarce country with per capita water availability of 586 m³ in 2010 and projected to 393 m³ in 2030 [32]. Uganda is endowed with water resources, however, it is projected that the country will be water-stressed by 2020 which could be compounded by climate variability and change, rapid urbanization, economic and population growth [33].

Using water scarcity was in essence coercing countries to adopt the IWRM principles with the irrigation sector, the contributor of the largest proportion of water withdrawals, becoming the major culprit [5]. The researchers opine that the effects of water scarcity in the region can be countered by adopting IWRM strategy, but adaptively to suit the local context and thus, persuasive rather than coercive, is the appropriate term. Indeed, as put forward by Van der Zaag [34], IWRM is not an option but it is a necessity and therefore, countries need to align their water policies and practices in line with it.

West African climatic conditions pose a threat on the utilisation of the limited water resource. Water resource utilisation is marred by erratic rainfalls and primarily a lack of water resources management know-how [27]. Countries in the Sahelian regions are characterised by semi-arid climatic conditions. Thus, dry climatic conditions account as an IWRM strategy driver to ensure maximised water use efficiency. Although the region acknowledges the need for adopting the IWRM strategy, they have varied adoption statuses (GWP, 2003).

Southern African countries also face serious water scarcity problems. Rainfall in South Africa is low and unevenly distributed with about 9% translating to useful runoff making the country one of the most water scarce countries in the world [35]. Generally, SADC countries experience water scarcity resulting in conflicts due to increasing pressure on the fresh water resources [36]. Thus, the researched opine that water scarcity pushed the region to adopt the IWRM strategy in order to mitigate the looming effects of climate change on surface water availability.

3.2.2 Trans-boundary water resources. Water resources flow downstream indiscriminately across villages, locations, regions and nations/states and therefore necessitates co-operation. The upstream and downstream relationships among communities, people and countries created by the water is asymmetrical in that the actions upstream tend to affect the downstream riparian and not the other way round [34]. In East Africa, the Nile Basin Initiative (NBI) and the Lake Victoria Basin Commission (LVBC) plays a critical component in promoting the IWRM at regional level [20].

The Nile River system is the single largest factor driving the IWRM in the region. Lake Victoria, the source of the Nile River is shared by the three East African states of Kenya, Uganda and Tanzania. Irrigation schemes in Sudan and Egypt rely exclusively on the waters of River Nile and are therefore apprehensive of the actions of upstream states notably Ethiopia, Kenya, Uganda, Tanzania, Rwanda and Burundi. The source of contention is the asymmetrical water needs and allocation which was enshrined in the Sudan–Egypt treaty of 1959 [37]. All the riparian countries in the Nile basin have agricultural-based economies and thus irrigation is

the cornerstone of food security [38]. Therefore, there was the need for the establishment of basin-wide co-operation which led to the formation of NBI in 1999 with a vision to achieve sustainable socio-economic development through the equitable utilisation of the Nile water resources [39].

The Mara River is another trans-boundary river which is shared between Tanzania and Kenya and the basin forms the habitat for the Maasai Mara National Reserve and Serengeti National Park in Kenya and Tanzania, respectively, which is prominent for the annual wildlife migration. Kenya has 65% of the upper part of the basin, any development on the upstream, such as hydropower or water diversion, will reduce the water quantities and therefore affect the Serengeti ecosystem and the livelihoods of people in Tanzania [40]. The LVBC, under the East African Community, developed the Mara River Basin-wide—Water Allocation Plan (MRB-WAP) to help in water demand management and protection of the Mara ecosystem [41]. The mandate of the LVBC is to implement IWRM in Lake Victoria Basin riparian countries [20].

Other shared water basins include the Malakisi-Malaba-Sio River basin shared between Uganda and Kenya and the Kagera River basin traversing Burundi, Rwanda, Tanzania and Uganda. The two river basins form part of the Upper Nile system and are governed through the LVBC and the NBI.

The universal transboundary nature of water creates dynamics that warrant cooperation for improved water use. West Africa has 25 transboundary watercourses and only 6 are under agreed management and regulation. The situation is compounded by the fact that 20 watercourses lack strategic river-basin management instruments [28]. Unregistered rules and the asymmetrical variations associated with watercourses warranted the introduction of the IWRM principle to set equitable water sharing protocols and promote environmental flows (e-flows). The various acts signed represent an evolutionary treaty development that combines the efforts of riparian states to better manage the shared water resources (for detailed basin configuration in West Africa see [42]). Hence, adoption of the IWRM strategy driven WAWRP of 2008 ensured the coordinated and harmonised regional water usage mechanisms.

The SADC region has 13 major transboundary river basins which calls for development of agreements on how to handle the shared water resources with the constraints of varying levels of economic development and priorities among the member states. The multi-lateral and bi-lateral agreements on shared water resources in the SADC is hampered by the hydrogeopolitics where economic power dynamics favour South Africa as in the case of the Orange-Senqu basin [43].

3.2.3 Donor influence. The World Bank has been pushing for IWRM principles in the East Africa through the NBI and by pressurising Egypt to agree to co-operate with the upstream riparian countries in the Nile basin [38]. In the early 1990s, the World Bank had aligned its funding policies to include sustainable water resources management [44].

In Tanzania, Norway, through NORAD, played a key role in implementing IWRM by promoting water projects including hydropower schemes [45]. Indeed the transformation of the agricultural sector in Tanzania through *Kilimo Kwanza* policy of 2009 which emphasised on the commercialization of agriculture including irrigation was driven by foreign donors such as the USAID and UK's DFID [26].

In Uganda, however, the reforms in the water sector were initiated devoid of external influence [46]. However, this assertion is countered by Allouche [5] who pointed that Uganda had become a 'darling' of the donor countries in the early 1990s and that DANIDA helped to develop the Master Water Plan and the country was keen to show a willingness to develop policy instruments favourable to the donor. East African countries are developing economies and therefore most of their development plans are supported by external agencies, which to some

extent come with subtle ‘conditions’ such as free-market economies. In fact imposition of tariffs and other economic instruments used to implement IWRM in water supply and irrigation is a market-based approach which was favoured by the World Bank and other development agencies.

Donor aid cannot be downplayed in pushing for IWRM diffusion in low-income aid-dependent countries of West Africa. GoBF [47] reported that from the period 1996–2001, more than 80% of water-related projects were donor funded. Cherlet and Venot [48] also found that almost 90% of the water investments in Mali were funded outside the government apparatus. It can, therefore, be argued that donor-aid plays a pivotal and central role in diffusing policy and innovation in aid-dependent countries because of the incentive nature it provides for the low-income countries in the sub-Saharan region.

Southern Africa’s experience with western donors including the World Bank in terms of IWRM adoption favoured the urban areas and neglected rural areas (see [8]). The National Water Act drafting process in South Africa was a multi-stakeholder and intersectoral activity that brought in international consultancies. Notable IWRM drivers were Department of International Development—UK (DFID), Danish Danida, and Deutsche Gesellschaft für Zusammenarbeit (GIZ). The DFID was instrumental in water reform allocation law whilst the GIZ and Danida were active in experimental work in the catchments [3]. On the contrary, in Zimbabwe, a lack of access to international funding and fleeting donor aid exacerbated the policy uptake as such the anticipated implementation, operationalisation and continuous feedback mechanism for policy revision and administering process was never realised.

3.2.4 Government intervention and pro-active citizenry. This was predominant in West Africa. For example the Burkinabe government exhibited political goodwill such that in 1995 the government brought together two separate ministries into one ministry of Environment and Water thus enabling coherent policy formulation and giving the ministry one voice to speak on water matters. The dynamic innovation arena (where policy players interact) allows continuous policy revision and redesign thus water policy reform diffusion, and policy frameworks are in a perpetual state of shifting. For example, in the 1990s the Burkinabe government was engaged in several water-related projects and was continuously experimenting with local governance and privatization (from donors) [1]. This policy shift according to Gupta [49] qualifies as an innovation driver.

Burkina Faso and Mali’s adoption story is accentuated by heightened agency, the individual enthusiasm on influencing the outcome facilitated policy diffusion and can be argued to be a potential innovation diffusion driver for the IWRM policy approach in the region. The individual policy diffusion fuelled by an enthusiastic citizenry was a sure method that effectively diffused awareness around the IWRM innovation and acted as a driver of the IWRM practices in the region. Individual strategies were honed in smallholder farming institutions to diffuse the IWRM practice and drawing from the Sabatier and Jenkins-Smith [50] advocacy coalition theory, having individuals with common agendas promoted the transfer and diffusion of water reforms in parts of West Africa.

3.2.5 Legal, political and institutional incoherence. This was a major factor which dictated the pace of IWRM implementation in Southern Africa. For example, the Fast Track Land Reform (FTLR) programme in Zimbabwe disaggregated the large-scale commercial farms and created smallholder farming [51], consequently influencing and dictating IWRM policy path. The FTLR programme had a negative impact on the spread and uptake of IWRM. A series of poor economic performance and poor policy design compounded the limited diffusion and the adoption of IWRM practices at local levels in Zimbabwe. The FTLR programme compounded the innovation diffusion process as the Zimbabwe National Water Authority (ZINWA) lost account of who harvested how much at the newly created

smallholder farms. Thus, water access imbalance ensued, and ecological sustainability was compromised.

Policy incoherence was a major factor in poor IWRM diffusion and adoption, for example, the government did not synchronise the land and water reforms thus it meant at any given point in time there was a budget for one reform agenda [8] and the land reform agenda would take precedence because of political rent-seeking. IWRM in its nature couples growth to the coordinated consumption of finite resources, hence the circular approach cannot be easily realised because finite resources are at the core of the strategy's existence.

South Africa's transition from Integrated Catchment Management (ICM) strategies to the IWRM strategy, hindered the operationalisation and diffusion of the IWRM strategy [52]. Despite acknowledging the "integration", researchers argued that the word lacked a clear-cut definition thus failing to establish a common ground for water's multi-purpose use [53]. For maximised adoption of a practice, incremental innovation is required, which was Danida's agenda in the quest to drive IWRM in South Africa. According to Wehn and Montalvo [54] incremental innovation "is characterised by marginal changes and occurs in mature circumstances",

Land reform in South Africa is characterised by (a) redistribution which seeks to transfer land from the white minority on a willing buyer willing seller basis, (b) restitution which rights the discriminatory 1913 land laws that saw natives evicted from their ancestral land, and (c) land tenure that provides tenure to the occupants of the homelands. This new pattern created a new breed of smallholder farmers that are, more often than not, excluded from diffusion and water governance channels [55]. In addition, researchers argue that a farm once owned by one white farmer is owned by multiple landowners with different cultural backgrounds and, more often than not, IWRM strategy is met with resistance [56]. Another challenge posed by multi-cultural water users is the interpretation and translation of innovations.

To foster water as an economic good aspect of IWRM the licensing system was enacted in South Africa. The phenomenon was described by van Koppen (2012) as paper water precedes water, thus the disadvantaged black smallholder farmers could not afford paper water which consequently limits access to water. The licensing system can be interpreted as stifling the smallholder sector and hence negative attitudes develop and hinder effective policy diffusion. Another issue that negatively impacted adoption was that issuing a license was subject to farmers possessing storage facilities. The smallholder farmers lack resources hence the requirement for obtaining a license excluded the small players in favour of the large-scale commercial farmers. This consequently maintains the historically skewed status-quo, where "big players" keep winning. Van Koppen [57] and Denby, Movik [58] argue the shift from local water rights system to state-based water system have created bottlenecks making it hard for smallholder farmers to obtain "paper water" and subsequently "wet water". The state-based system is characterised by bureaucracies and local norms are in perpetual change, hence denying the IWRM innovation policy approach stability efficiency.

A lack of political will and pragmatism amplified the poor adoption and operationalisation of IWRM, a poorly performing economy and fleeing donor agencies resulted in less funding for water-related project. Political shenanigans created an imbalance that resulted in two forms of water i.e., water as an economic good vs. water as a social good [59]. Manzungu [60] argued post-colonial Zimbabwe continuously failed to develop a peoples-oriented water reform policy. In a bid to correct historical wrongs by availing subsidised water to the vulnerable and support the new social order, the initiative goes against the neo-liberalism approach that defines the "water as an economic good" [61] which is a founding principle of IWRM.

Water redistribution in South Africa has been fraught with political and technical issues, for example, the Water Allocation Reform of 2003 failed to reconcile the apartheid disparity

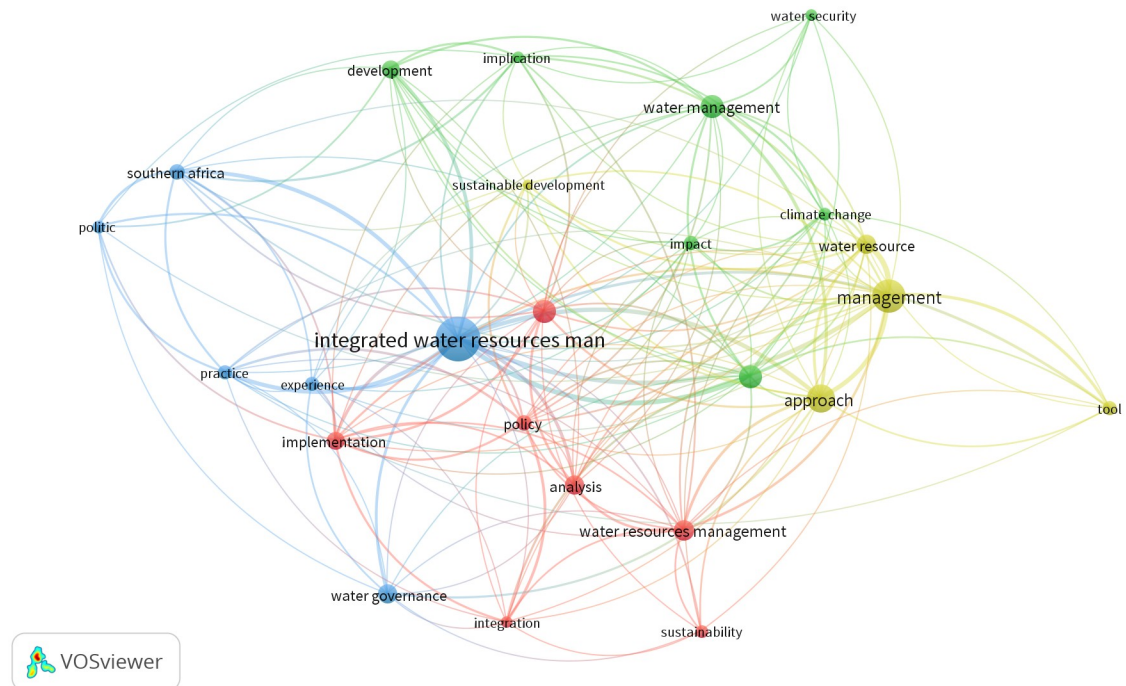


Fig 2. Extracted and converging themes from the coded data excerpts.

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hence the equity component of IWRM was compromised. IWRM suffered another setback caused by the governing party when they introduced radical innovations that sought to shift from the socialist to neoliberal water resource use approach. The radical innovation through the government benefited the large-scale commercial farmers at the expense of the black small-holder farming community [53].

3.3 Systematic comparison of findings on East, West and Southern Africa

Data extracts from the respective regional analysis were formulated into theoretical candidate themes. The thematic analysis extracted recurring themes common to all the three regions. An independent reviewer performed the subjective thematic analysis and the authors performed the review on the blind thematic analysis outcome. The analysis performed a data extraction exercise and formulated codes (Fig 2). Themes were then generated from the coded data extracts to create a thematic map. It is worth mentioning that the data extracts were phrases/statement from within the literature review.

3.3.1 Donor aid and policy approach. Donor activity invariably influenced the policy path that individual countries took. The three regions had significant support from donors to drive the IWRM strategy. Zimbabwe experienced a different fate. The political climate caused an exodus of donor support from the nation, which consequently caused a laggard. The absence of donor support was at the backdrop of the two formulated water acts namely National Water Act [62] and the Zimbabwe National Water Authority Act of 1998 [63], which were meant to promote equitable water provision amongst the population. This highlights the latent adoption of IWRM strategy. The 2008/2009 cholera outbreak raised alarm and facilitated the return of donor activity in Zimbabwe's water sector. The availability of donor support motivated the redrafting of a water clause in the 2013 constitution that espoused the IWRM strategy to water management [64].

Whilst Mehta, Alba [64] argue that South Africa enjoyed minimal donor support it cannot be downplayed how much donor influence impacted the IWRM strategy adoption. For instance, the Water Allocation Reform (WAR) was drafted with the aid of the UK Department of International Development. The WAR fundamentals are informed by IWRM principles. The economic structural programmes spearheaded by The World Bank and the IMF were active in facilitating the diffusion of the IWRM strategy in Kenya and Uganda. Uganda made strides because of a long-standing relationship with donor nations. The Uganda—donor relationship dates back to early 1990 where Uganda was elected to be the NBI secretariat, this in itself evidence of commitment to water policy reform [4,65]. Donor aid acts as an incentive and augments the low African governments' budgets, as such proper accountability and usage of the funds ensures that more funds come in for projected water related projects.

3.3.2 Transboundary water resources. The Nile River system is the single largest factor driving the IWRM in the region since it is shared across several upstream and downstream nations. Irrigation schemes in Sudan and Egypt rely exclusively on the waters of River Nile and are therefore apprehensive of the actions of upstream states notably Ethiopia, Kenya, Uganda, Tanzania, Rwanda and Burundi. The source of contention is the asymmetrical water needs and allocation which was enshrined in the Sudan–Egypt treaty of 1959 [37]. Over time, the upstream countries demanded equitable share of the Nile waters and this led to the establishment of NBI. In Eastern Africa, the Nile Basin Initiative (NBI) and the Lake Victoria Basin Commission (LVBC) plays a critical component in promoting the IWRM at regional level [20]. The LVBC is deeply intertwined with the East African Community (EAC) and thus has more political clout to implement policies regarding utilization of the Lake Victoria waters [66]. This, therefore, implies that for NBI to succeed, it must have a mandate and political goodwill from the member countries.

The conflicts around the utilization of the Nile water resources persists due to the treaty of 1959 which led to the signing of Cooperative Framework Agreement (CFA) by a number of the Nile basin countries, with the notable exceptions of Egypt, Sudan and South Sudan [67]. The CFA was signed between 2010 and 2011 and establishes the principle that each Nile Basin state has the right to use, within its territory, the waters of the Nile River Basin, and lays down some factors for determining equitable and reasonable utilization such as the contribution of each state to the Nile waters and the proportion of the drainage area [68]. The construction of the Grand Ethiopian Renaissance Dam has been a source of concern and conflict among the three riparian countries of Ethiopia, Sudan and Egypt [67]. The asymmetrical power relations (Egypt is the biggest economy) in the Nile Basin is a big hindrance to the co-operation among the riparian countries [69] and thus a threat to IWRM implementation in the shared water-course. While Ethiopia is using its geographical power to negotiate for an equitable share in the Nile water resources, Egypt is utilizing both material, bargaining and idealistic power to dominate the hydro politics in the region and thus the former can only succeed if it reinforces its geographical power with material power [70].

Therefore, IWRM implementation at the multi-national stage is complex but necessary to forestall regional conflicts and war. The necessity of co-operation rather than conflict in the Nile Basin is paramount due to the water availability constraints which is experienced by most countries in the region. The transboundary IWRM revolves around water-food- energy consensus where the needs of the riparian countries are sometimes contrasting, for example, Egypt and Sudan require the Nile waters for irrigation to feed their increasing population while Ethiopia requires the Nile waters for power generation to stimulate her economy. The upstream riparian States could use their bargaining power to foster co-operation and possibly

force the hegemonic downstream riparian States into the equitable and sustainable use of Nile waters [71].

The SADC region has 13 major transboundary river basins (excluding the Nile and Congo) of Orange, Limpopo, Incomati, Okavango, Cunene, Cuvelai, Maputo, Buzi, Pungue, Save-Runde, Umbeluzi, Rovuma and Zambezi [72]. The Revised Protocol on Shared Watercourses was instrumental for managing transboundary water resources in the SADC. The overall aim of the Protocol was to foster co-operation for judicious, sustainable and coordinated management, the protection and utilization of shared water resources [73].

Ashton and Turton [74] argue that the transboundary water issues in Southern Africa revolved around the key roles played by pivotal States and impacted States and their corresponding pivotal basins and impacted basins. In this case, pivotal States are riparian states with a high level of economic development (Botswana, Namibia, South Africa, and Zimbabwe) and a high degree of reliance on shared river basins for strategic sources of water supply while impacted States are riparian states (Angola, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, and Zambia) that have a critical need for access to water from an international river basin that they share with a pivotal state, but appear to be unable to negotiate what they consider to be an equitable allocation of water and therefore, their future development dreams are impeded by the asymmetrical power dynamics with the pivotal states. Pivotal Basins (Orange, Incomati, and Limpopo) are international river basins that face closure but are also strategically important to anyone (or all) of the pivotal states by virtue of the range and magnitude of economic activity that they support. Impacted basins (Cunene, Maputo, Okavango, Cuvelai, Pungué, Save-Runde, and Zambezi) are those international river basins that are not yet approaching a point of closure, and which are strategically important for at least one of the riparian states with at least one pivotal State.

The transboundary co-operation under IWRM in Southern Africa is driven mainly by water scarcity which is predominant in most of the SADC countries which may imply the use of inter-basin transfers schemes [74]. Further, most of the water used for agriculture, industry and domestic are found within the international river basins [75] which calls for collaborative water management strategies. The tricky feature hindering the IWRM is the fact that States are reluctant to transfer power to River Basin Commissions [76]. Indeed most of the River Basin Organizations (RBO) in Southern region such as the Zambezi Commission, the Okavango River Basin Commission, and the Orange-Sengu River Basin Commission have loose links with SADC and therefore lack the political clout to implement the policies governing the shared water resources [66]. Power asymmetry, like in Eastern Africa, is also a bottleneck in achieving equitable sharing of water resources as illustrated by the water transfer scheme involving Lesotho and South Africa [77]. The hydro-hegemonic South Africa is exercising control over any negotiations and agreements in the Orange-Senqu basin [43]. Limited data sharing among the riparian States is another challenge which affects water management in transboundary river basins e.g. in the Orange-Senqu basin [78].

West Africa has 25 transboundary watercourses and only 6 are under agreed management and regulation. The situation is compounded by the fact that 20 watercourses lack strategic river-basin management instruments [28]. Unregistered rules and the asymmetrical variations associated with watercourses warrant the introduction of the IWRM principle to set equitable water sharing protocols and promote environmental flows (e-flows). The various acts signed represent an evolutionary treaty development that combines the efforts of riparian states to better manage the shared water resources. It is important to note that evolutionary treaties are incremental innovation. Water Resources Coordination Centre (WRCC) was established in 2004 to implement an integrated water resource management in West Africa and to ensure regional coordination of water resource related policies and activities [79].

The Niger River basin covers 9 Countries of Benin, Burkina, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria. The Niger River Basin Authority (NBA) was established to promote co-operation among the member countries and to ensure basin-wide integrated development in all fields through the development of its resources, notably in the fields of energy, water resources, agriculture, livestock, forestry exploitation, transport and communication and industry [80]. The Shared Vision and Sustainable Development Action Programme (SDAP) was developed to enhance co-operation and sharing benefits from the resources of River Niger [81]. The Niger Basin Water Charter together with the SDAP are key instruments which set out a general approach to basin development, an approach negotiated and accepted not only by all member states but also by other actors who utilize the basin resources [82].

The main agreement governing the transboundary water resource in River Senegal Basin is the Senegal River Development Organization, OMVS (Organisation pour la mise en valeur du fleuve Sénégal) with its core principle being the equitably shared benefits of the resources of the basin [82]. The IWRM in the Senegal River Basin is hampered by weak institutional structures and lack of protocol on how shared waters among the States as well as conflicting national and regional interests [83,84]. The Senegal River Basin, being situated in the Sudan-Sahelian region, is faced by the threat of climate change which affects water availability [84]. The Senegal River Basin States have high risks of political instability.

3.4 Prospects of IWRM Africa

The countries in the three regions are at different stages of implementation (Table 4). In East Africa, Uganda and Kenya are at medium-high level while Tanzania is medium-low. Majority of the countries in the Southern Africa region are at medium low. Comoros Islands is the only country at low level of implementation in the region. West African countries are evenly spread between low, medium-low and medium-high levels of implementation. Generally, East Africa is ranked as medium-high level with average score of 54% while Southern Africa and West Africa are ranked as medium low-level at 46% and 42% respectively. However if you include, medium low countries of Rwanda, Burundi, Ethiopia and South Sudan and the low-level Somalia, then East Africa's score drops to 39% (medium-low).

The implementation of IWRM in the continent, and more so the inter dependent and multi purpose water use sectors, will continue to evolve amid implementation challenges. The dynamics of water policies, increased competition for finite water resources from rapid urbanization, industrialization and population growth will continue to shape IWRM practices in the region. Trans-boundary water resources management will possibly take centre stage as East African countries move towards full integration and political federation as envisaged in the four pillars of the EAC treaty. Decision support tools such as the Water—Energy—Food (WEF) nexus approach will be very relevant in the trans-boundary water resources such as the Nile system, Mara and Kagera river basins. The approach can potentially ameliorate the after effects of the devolved governance system in Kenya that consequently created a multiplicity of transboundary sectors.

Adoption of the IWRM policy in West Africa is fraught with many challenges. For example, despite having significant water resources, the lack of a collective effort by the governments to train water experts at national level presents a challenge for adoption. Unavailability of trained water experts (who in any case are diffusion media) results in a lack of diffusion channels that facilitate policy interpretation, translation and its subsequent implementation. Helio and Van Ingen [27] pointed out how political instability possesses a threat to current and future implementation initiatives. The future collaboration projects and objective outlined by ECOWAS,

Table 4. Status of IWRM implementation in East, Southern and West Africa regions [85].

Country (Region)	Score	Score	Interpretation of status
Kenya (EA)	53	Medium—high	Most IWRM elements are being implemented under long-term programmes
Uganda (EA)	59	Medium-high	Most IWRM elements are being implemented under long-term programmes
Tanzania (EA)	50	Medium-low	IWRM elements are institutionalized, and implementation is underway
South Africa (SA)	65	Medium—high	Most IWRM elements are being implemented under long-term programmes
Zimbabwe (SA)	61	Medium—high	Most IWRM elements are being implemented under long-term programmes
Zambia (SA)	46	Medium-low	IWRM elements are institutionalized, and implementation is underway
Namibia (SA)	59	Medium—high	Most IWRM elements are being implemented under long-term programmes
Mozambique (SA)	55	Medium—high	Most IWRM elements are being implemented under long-term programmes
Malawi (SA)	40	Medium-low	IWRM elements are institutionalized, and implementation is underway
Angola (SA)	37	Medium-low	IWRM elements are institutionalized, and implementation is underway
Botswana (SA)	41	Medium-low	IWRM elements are institutionalized, and implementation is underway
Eswatini (SA)	53	Medium—high	Most IWRM elements are being implemented under long-term programmes
Lesotho (SA)	33	Medium-low	IWRM elements are institutionalized, and implementation is underway
DRC (SA)	31	Medium-low	IWRM elements are institutionalized, and implementation is underway
Comoros (SA)	26	Low	Some implementation of IWRM elements has begun
Madagascar (SA)	36	Medium-low	IWRM elements are institutionalized, and implementation is underway
Mauritius (SA)	64	Medium—high	Most IWRM elements are being implemented under long-term programmes
Seychelles (SA)	45	Medium-low	IWRM elements are institutionalized, and implementation is underway
Nigeria (WA)	35	Medium-low	IWRM elements are institutionalized, and implementation is underway
Ghana (WA)	49	Medium-low	IWRM elements are institutionalized, and implementation is underway
Togo (WA)	32	Medium-low	IWRM elements are institutionalized, and implementation is underway
Senegal (WA)	53	Medium—high	Most IWRM elements are being implemented under long-term programmes
Benin (WA)	63	Medium—high	Most IWRM elements are being implemented under long-term programmes
Burkina Faso (WA)	63	Medium—high	Most IWRM elements are being implemented under long-term programmes
Cape Verde (WA)	64	Medium—high	Most IWRM elements are being implemented under long-term programmes
Gambia (WA)	30	Low	Some implementation of IWRM elements has begun
Guinea (WA)	24	Low	Some implementation of IWRM elements has begun
Liberia (WA)	15	Low	Some implementation of IWRM elements has begun
Niger (WA)	50	Medium-low	IWRM elements are institutionalized, and implementation is underway
Mali (WA)	53	Medium—high	Most IWRM elements are being implemented under long-term programmes
Sierra Leone (WA)	19	Low	Some implementation of IWRM elements has begun
Côte D'Ivoire (WA)	32	Medium-low	IWRM elements are institutionalized, and implementation is underway

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CILSS, and UEMO highlight a major effort to bring the region to speed with the IWRM policy approach. The WAWRP objectives can potentially set up the region on an effective IWRM trajectory which can be mimicked and upscaled in other regions. Positives drawn from the region are the deliberate institutional collaborations. Burkina Faso and Mali have the potential to operationalise and facilitate policy diffusion to other neighbouring states. Donor driven reform is essential and national ownership is critical in ensuring the water reform policies and innovation diffusion processes are implemented at the national level.

The IWRM policy approach and practice in South Africa was government-driven whereas in Zimbabwe external donors were the main vehicles for diffusion. For both countries, the water and land reform agenda has a multiplicity of overlapping functionaries; however, they are managed by separate government departments. The silo system at national level prevents effective innovation diffusion and distorts policy interpretation and the subsequent dissemination at the local level.

Water affairs are politicised and often, the water reform policy fails to balance the Dublin's principles which form the backbone of the IWRM innovation policy approach. Failure by national governments to address unequal water access created by former segregationist policies is perpetuated by the lack of balance between creating a new social order and recognising the "water as an economic good" principle.

4 Conclusion

Africa as a laboratory of IWRM produced varied aggregated outcomes. The outcomes were directly linked to various national socio-economic development agendas; thus, the IWRM policy took a multiplicity of paths. In East Africa, Kenya is still recovering from the devolved system of government to the County system which created new transboundary sectors with the country. Water scarcity, trans-boundary water resource and donor aid played a critical role in driving the IWRM policy approach in the three regions. Southern Africa's IWRM experience has been fraught with policy clashes between the water and land reforms. Similar to Africa, the transboundary issue in Europe and Asia and the subsequent management is a major buy-in for formulating water resources strategies that are people centric and ecologically friendly. Global water scarcity created fertile grounds for IWRM adoption in Asia, specifically India. Thus, we postulate that some of the drivers that influenced the uptake and diffusion in Africa are not only unique to the continent.

For the future, IWRM policy approach can be implemented in Africa and the continent has the potential to implement and adopt the practice. Endowed with a significant number of water bodies, Africa must adopt a blend of IWRM strategy and the water energy food nexus (WEF) for maximising regional cooperation and subsequent economic gains. WEF nexus will help combat a singular or silo approach to natural resources management. WEF nexus and IWRM is a fertile area for future research as it brings a deeper understanding of the trade-offs and synergies existing in the water sector across and within regions. In addition, the WEF nexus approach can potentially facilitate a shift to a circular approach that decouples over dependence on one finite resource for development.

Supporting information

S1 Checklist.

(DOC)

S1 Table. Data extracts with the applied codes.

(DOCX)

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