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Towards realization of nexus-doing at the grassroots level: Water-energy-food governance assessment in the Songwe River Basin (Tanzania and Malawi)

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ABSTRACT

The intricate connections between water, land, food, energy, and climate change require a multicentric approach to evaluating the trade-offs and synergies needed to achieve sustainable development. For example, the amount of water required in irrigated agriculture, consumptive water uses, and hydro-power production can potentially lead to water pollution, and negatively affect hydrological regimes. However, Operationalizing Water Energy Food (WEF)-nexus thinking has evolved such that a division between researchers (e.g., academia), political actors (e.g., policymakers), and development partners (e.g., promoters) has formed. This lack of connection can lead to a situation where there is incoherent governance of WEF resources management. In the Southern African Development Community (SADC) context, the WEF nexus approach is at the core of regional sustainable development plans and strategies. This paper analyses the ambitions and the expected outcomes of the Songwe River Basin Development Programme (SRBDP) and reflects on how governance coherence of WEF resources rooted at the grassroots level contributes toward achieving "nexus-doing". The SRBDP exhibits a multi-stakeholder connection of interests geared towards a common target (i.e. stabilisation of the River Songwe flow). The SRBDP creates a multi-centric action system within the water, energy, food, and climate change adaptation role-players to achieve this overarching goal. The connections espoused in this system form the basis for nexus-doing in the Songwe River Basin. The major findings are: (i) there is a significant infrastructural demand in the Southern Africa Development Community (SADC), anchored in the development of water, land, food, and energy resources; (ii) governance coherence in the SADC context can be identified at both vertical and horizontal levels; (iii) the nature of trade-offs and synergies exhibited in SRBDP is valuable for making progress towards the operationalization of integrated WEF-nexus resource management; (iv) governance inconsistencies/ambiguities are better diagnosed and addressed in implementing nexus-doing initiatives such as SRBDP. Based on the findings, the following recommendations are proposed: (i) build upon small wins and support snow-balling successes to upscale promising initiatives-for instance the joint agreement by Tanzanian and Malawian governments to stabilize Songwe River flow by inaugurating the joint cooperation and equitable sharing of the Songwe watercourses (AFDB, 2019); (ii) invest in capacity building and human resources for the Songwe River Basin Commission and associated stakeholders to become more effective;-for posterity of sustainable developments in the Songwe River Basin; both the Tanzanian and Malawian governments in partnership with development partners need to upscale the investment in human capacity development and resource capacity development of the Songwe River Basin Commission (SRBC) as the joint development vehicle for the basin. and (iii) enrich policy assessment tools tailor-made for SADC. This tool will help in policy accounting to help minimize duplication, and ambiguities by fostering cooperation and policy mapping across the WEF-nexus sectors in the SADC region. This work can guide approaches to close the gap between nexus-thinking, and nexus-doing, something that is increasingly called for.

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1. Introduction

The water-energy-food (WEF) nexus is an increasingly discussed concept in global development domains (Wolfe et al., 2016), underpinned by relationships between the production, consumption, and distribution of water, energy, and food (Hoff, 2011). Furthermore, the demands for all are increasing (Kurian and Ardakanian, 2015; Boas et al., 2016; Purwanto et al., 2021). Proponents of the nexus concept argue that the interdependence of these sectors creates opportunities for analyzing and developing synergies resulting in the synchronization of policies across sectors and the improved effectiveness and efficiency of their development and implementation. Meaning, different actors, especially at an international level, have nuanced the "original" WEF nexus framework at an academic, institutional, and research level to fit nexus thinking to their respective interests (Dupar and Oates, 2012; Bizikova et al., 2013; Benson et al., 2015; Boas et al., 2016; Benson et al., 2017; Howlett, 2019). Additionally, key global reports adopted from conferences such as the World Forum gathering in 2011, Bonn WEF Conference in 2011; Rio Conference and World Water Forum in 2012; and the Stockholm Water Week in 2014 situate nexus thinking in the field of environmental planning (Al-Saidi and Elagib, 2017). Therefore, several WEF frameworks, tools, and models have been developed depending on the needs of the users.

At the same time, there is criticism on the analytical usefulness of the nexus concept (Addams et al., 2009; Foran, 2015; Smajgl et al., 2016; Wichelns, 2017). These authors argue, inter alia, against the subjective basis of boundaries employed in different contexts while using the WEF-nexus approach. For instance, there is a need to look into other interrelations that are not covered by the WEF-nexus, such as energy-water-soil-food (Subramanian and Manjunatha, 2014) or water-soil-waste (Kurian and Ardakanian, 2015). Moreover, the WEF nexus has been diversified to incorporate climate change interactions (Purwanto et al., 2021) while others argue that externalities are often missing in nexus analyses (Dupar and Oates, 2012; Hülsmann et al., 2019).

Therefore, the rationale of the nexus approach is to appraise and encourage symbiotic resource interaction between water, energy, land, climate change and food. This interaction discourse has taken two pathways. First, the scientific debate (sustainability science) has focused on using models to understand the pathways of creating sustainable interaction of the sectors. Second, the public debate (environmental policy) has taken a participatory approach to foster equitable utilization of common-pool resources (Bazilian et al., 2011). Interestingly, a universal consensus on how to structure a universal integration mode between these two is still lacking (Bazilian et al., 2011; Macknick et al., 2012; Albrecht et al., 2018).

Moreover, applying the WEF-nexus concept is not entirely new, especially at the grassroots scale level between farmers, fishers, and hydropower companies (Simpson and Jewitt, 2019a). The concept is sometimes criticized as being “nirvanic”, and in certain contexts, settings, and scales can easily result in mis-alignment of policies. For example, mis-alignment between the national water uses, and demands required in the agriculture sector can lead to poor development and implementation of the national water and agriculture policies. Hence, in mobilizing the WEF concept, actors must balance economic, political, social, and ecological demands (Conca and Weinthal, 2018), as well as mediating often contradicting policy objectives at various governance levels.

There is abundant research on the nexus at the ’thinking’ level referred to as the research, development, and promotion of WEF-nexus paradigms and modelling studies, which argues that the core pillars’ situatedness in a nexus framework is dependent on an author’s perspective (Mabhaudhi et al., 2018; Sušnik et al., 2018; Simpson and Jewitt, 2019a, 2019b). While the ‘thinking’ level developments are advancing knowledge of the WEF nexus, there are increasing calls for nexus ‘doing’ (i.e. translating the science into on-the ground actions). Essentially referring to the grassroots level of implementation across resource sectors, considering stakeholders involved in setting a WEF-nexus action arena to actualize regional and national targets and goals in a specific context.

The WEF-nexus approach is slowly starting to be adopted in the developed-nations to meet the growing demand for water, energy, land, and food (Hoff, 2011; Munaretto, Witmer, 2017; Munaretto et al., 2018). Interestingly, lesser-developed nations have increased awareness and regional level policy coherence, and uptake of a WEF nexus governance approach that is arguably stronger compared to the developed countries. For example, in the Southern African Development Community (SADC) region, agriculture is the main livelihood support and economic growth asset (contributing to approx. 20% of the SADC gross domestic product (GDP) relies on the water sector (irrigated farming) (Mabhaudhi et al., 2018; Nhamo et al., 2018). Yet, at the national level, there is competition between water uses and water users ranging from domestic units to industrial levels and across the WEF subsectors (Swatuk, 2003); Swatuk and Wirkus (2009); (Smajgl et al., 2016). A lack of nexus-doing studies and initiatives could also contribute to the perceived lack of nexus-related policy relevance (Brouwer et al., 2018).

Within this context, this paper aims to analyse water-energy-food nexus governance in a global-south context taking the Songwe River Basin (SRB) Development Programme (SRBDP) shared between Tanzania and Malawi as a case study. It aims to explore how policies written on paper are implemented on the ground, with the objective of providing recommendations for more harmonious cross-sectoral policy implementation in the SRB between the two countries to promote resource sharing, human benefit gains, and mutual transboundary cooperation. It also aims to offer recommendations for improved “nexus doing” in similar transboundary and developing country settings. The SRBDP project is used to interrogate policy and governance coherence at three levels: 1) on the ground/grassroots; 2) national; and 3) regional between Tanzania and Malawi. The opportunities and challenges encountered in designing and the initial stages of implementation of the SRBDP presented the chance to map the interactions between WEF-nexus sub-sectors, allowing for the identification of policy synergies to exploit and trade-offs to avoid. The analysis resulting from this work aims to shed light on the state of WEF-nexus “doing” in the SRBDP from the perspectives of the national governments and grassroots actors, and the potential of the project to initiate ‘nexus-doing’ in other lesser-developed countries. Lastly, the paper aims to start filling the knowledge gap related to nexus doing, and therefore contributing to the practical policy relevance of mounting nexus-thinking research.

2. The Songwe River Basin context

The SRB covers an area of 4243 km^2 (Fig. 1) and has a population of 350,000 who rely on rich alluvial soil to sustain livelihoods through agriculture and fishing. Malawi contains 47% and Tanzania 53% of the Songwe catchment area (Swatuk and Wirkus, 2009; Ipyana and Mikova, 2019). The Songwe River runs for 200 km across Tanzania and Malawi. Floods are a major issue in the basin. The river course has naturally shifted over time, directly impacting approximately 60,000 people living in the Songwe. The Songwe has frequently flooded land used for food production, leaving 80% of the population in need of additional food. Furthermore, 35–55% of people have no access to safe water and 75% lack access to electricity. The SRBDP aims to address energy, food and water deficits by developing a multi-purpose reservoir in the lower Songwe with a hydropower capacity of 180.2 MW. The reservoir will support 3050 ha of irrigated agriculture in Malawi and 3150 ha in Tanzania (AWF and NEPAD-IPPF, 2010; SRBDP, 2018).

Approximately 90% of agriculture in SADC is rain fed (Mabhaudhi et al., 2018; Nhamo et al., 2018; SADC, 2020). Current rainfall patterns in the region are highly variable in time and space. Rainfall totals vary from 285 mm yr^{-1} (in Namibia) to 1543 mm yr^{-1} (in DRC) (FAO. n.d). Agriculture is the major livelihood support accounting for 17% of

regional GDP growth (Simpson and Jewitt, 2019a). In this context, the transboundary SRB between Malawi and Tanzania is relatively resource rich, yet struggles to provide resources to the majority of the population. At the same time, climate change is expected to lead to serious detrimental impacts on all three WEF sectors across southern Africa (Conway et al., 2015).

Analysis of policy and strategy documents from SADC show that the WEF-nexus approach has become omnipresent. Five key regional integration themes are highlighted: (i) trade integration; (ii) regional infrastructure; (iii) productive integration; (iv) free movement of people; and (v) financial and macroeconomic integration (AFDB, 2016; ADB, ADF, 2018; AFDB, 2018, 2019). This manifests as proposals for integrated projects and programmes planning to drive water, energy, food security; optimization of investment partnerships for water, energy, and food security through joint infrastructure developments; and sustainable management of resources. Furthermore, major African Union strategic programs such as the Comprehensive African Agricultural Development Program (CAADP), the Regional Indicative Strategic Development Plan (RISDP), and the primary aim of sustained growth and poverty alleviation underpin local or sectoral initiatives. Therefore, the WEF nexus is evident both in resources terms (e.g. reservoir development for hydroelectric generation, water supply, and irrigated agriculture extension) and in policy terms (e.g. SADC regional development plans, including in the SRB). This makes the SRB an ideal case study for WEF-nexus policy and governance assessment.

2.1. Trigger for cooperation: resource dependence and nexus doing

The 2013 *6th multi-stakeholder water dialogue in Lusaka, Zambia,* organized by SADC and Global Water Partnership-South Africa (GWP-SA), was critical to establish WEF nexus thinking in the region (Mabhaudhi et al., 2018). At the SADC level, the trigger for cooperation is centred on infrastructure development focusing on hydropower (energy), mechanized agriculture (food), and international border stabilization (water-related). The SADC region has been prone to many climate risks which have resulted negative socio-economic and environmental impacts. Climate risk in this context referring to the interaction between hazards (e.g. floods), and vulnerability (e.g. poor grassroot communities) such that a risk does not only involve a natural peril (e.g. floods) but also involves socio-ecological setting where the peril occurs (Mabhaudhi et al., 2018; SADC, 2020). For instance, mechanized farming that is driven by the demand for food security could increase greenhouse gas (GHG) emissions that fuel climate change, potential increasing the severity and frequency of flooding. The core climate risks facing the Southern Africa region were identified as rapid population growth, and climate change impacts (AFDB, 2019). In 2016, the SADC energy and water joint ministerial workshop initiated the "nexus journey", setting the foundation for the nexus awareness by developing various regional WEF Master Plans for the SADC region. Primary overarching interests at the early stages included identifying critical stakeholders and analysis of competing interests, major gaps, and the synergies in the SADC context.

While Tanzania, Malawi, and the SADC region have realized that significant socioeconomic and political gains from the SRBDP are possible, there are still substantial rates of poverty, risks, and vulnerabilities facing the SRB. Consequently, most research work done from a WEF context focuses on using scientific models to assess the environmental impacts of proposed developments. These analyses have shown the potential of the SRBDP to deliver benefits in the basin, yet policy, and governance coherence challenges may exist. SRB provides a system of interests that brings together different actors with the assumption/expectation that working together minimizes unhealthy competition on natural resources. Thus, the SRBDP provides a significant opportunity to evaluate the extent of WEF nexus thinking operational in a multi-sectoral, interdisciplinary, and regional setting and whether 'nexus doing' is achieved.

2.2. Songwe River Basin Development Programme context

The SRBDP is designed to give impact to Malawi and Tanzania's Country Strategy Papers (CSPs) for development (AFDB, 2019). In this

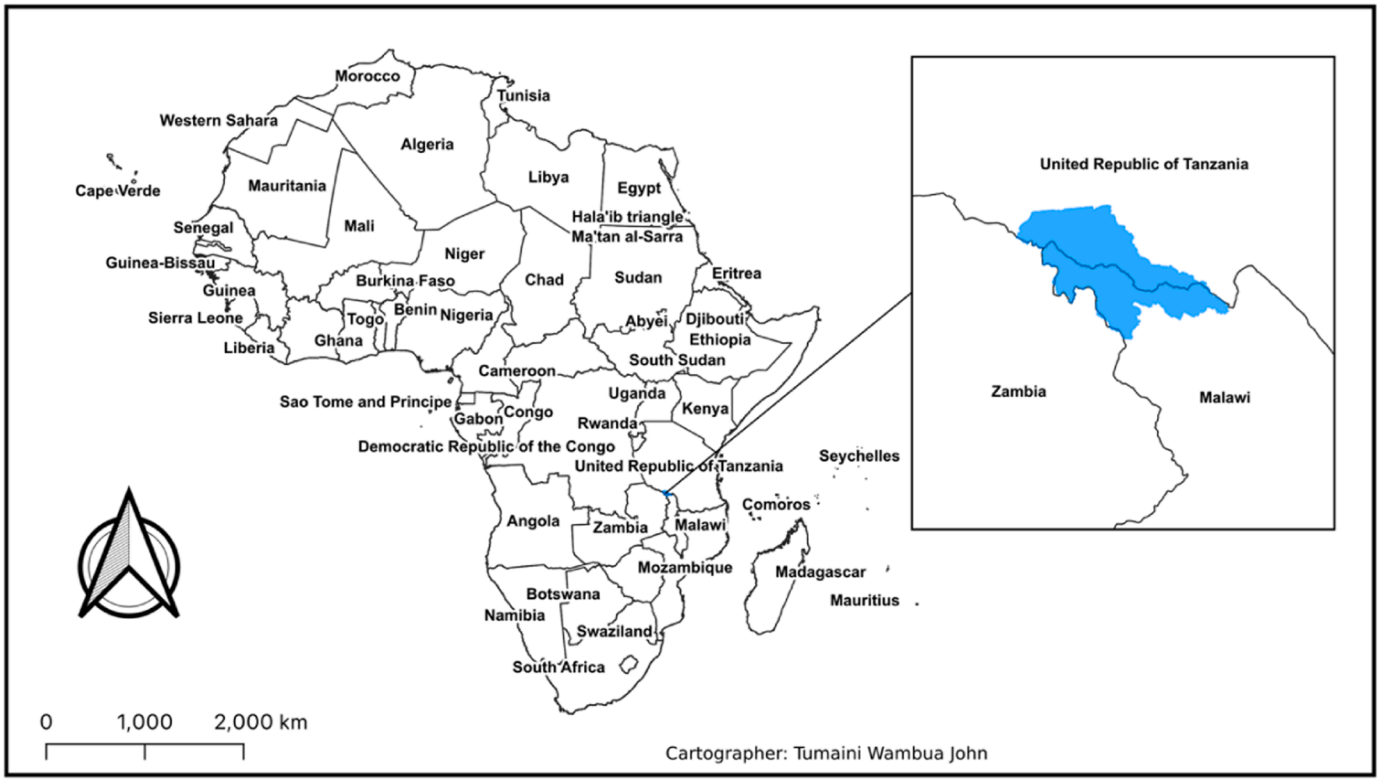

Fig. 1. Map of the Songwe River Basin (blue shaded area).

context, the CSPs are the rules in use. Tanzania's 2016–2020 CSP is built on two pillars: (i) Infrastructure development for green growth; and (ii) strengthening governance and accountability (AFDB, 2016). To achieve green infrastructural growth, focus is granted to rural communities to enhance productivity in terms of income and tackle food insecurity by addressing value addition to farmers on production and management techniques (AFDB, 2016). Malawi's 2018–2022 CSP has three pillars: (i) Investing in infrastructure development through energy and transport to remove bottlenecks; (ii) removing investment constraints that increase the cost of business while improving competitiveness and functioning of the public sector industry, businesses, and households; and (iii) investing in economic transformation by strengthening agricultural value chains and developing water infrastructure to boost economic diversification, build resilience, and to underpin job creation (AFDB, 2018; Mabhaudhi et al., 2018; Simpson and Jewitt, 2019a).

The municipal levels of government in Malawi and Tanzania provide functions such as daily administrative services and primary report response to emergencies such as flooding to the higher governance levels. Municipal levels provide the daily grassroot coordination duties cutting across water, food, and climate change sectors. SRBDP brings together the national governance levels (Tanzania & Malawi) with a vertical governance coherence approach where vertical level is confined within the legal mandates of ministries. On the horizontal level (i.e. across resource sectors at the same level of governance), the intertwined nature of water, land energy, and food sectors in the SRB has created a system of systems spanning economic targets, politics, and social connections across the two countries.

2.3. Why the Songwe River Basin? The rationale

According to the governments of Tanzania and Malawi, despite the broader benefits related to irrigation development and electricity production, the SRBDP is primarily an opportunity to *"develop an idea of stabilizing the river flow" (*SRBDP, 2019*)*. Irrigation and electricity benefits are considered subsidiary gains of the SRBDP. Typically, flooding events occur on approximately seven to nine days between March and April and affect citizens of both countries (Swatuk and Wirkus, 2009; Ipyana and Mikova, 2019). Songwe River floods alter the flow regime, resulting in a three-tier problem:

- Fluidity of the central-longitudinal international border (sovereign territory risk);
- Loss of land rights to locals (land ownership risk);
- Loss of food crops and contaminated water (food and water risk).

Consequently, flooding impacts have attracted the greatest attention from the governments of Malawi and Tanzania, and hence it is the main trigger for cooperation in the SRB. The Songwe Basin has not featured in flood prediction, planning, and adaptation compared to other districts in the larger Zambezi Basin. Synergy in basin development plans/strategies can be argued to have been necessitated by a combination of flood risk, food security needs for the local community, and sovereign border definition. Therefore, while border concerns are a primary motivation for river flow control, the initiatives offer significant opportunities in the water, energy, and food nexus sectors. The potential extent of these gains can be assessed via a policy and governance assessment such as that carried out in this work.

3. Methodological Approach

The methodological approach adopted for this study consists of four steps (Fig. 2), elaborated upon below:

1) Conceptual framework development, -focused on interrogating the institutional arrangements within the SRB between Tanzania and Malawi.
2) Action level analysis, focused on understanding the interactions, and coordination agreed upon in management of SRB with a WEF-nexus angle.
3) Assessment level analysis, focused on interrogating the integration of institutional arrangements with the operational actions in the implementation of SRBDP as joint SRB development initiative in the form of SRBDP.
4) Results and discussion on the institutional arrangements, and interactions (at the action and assessment levels) in the SRBDP.

3.1. Conceptual framework for WEF-nexus analysis in SRB

To assess and analyze WEF-nexus goals in the SADC region, the IAD framework (Ostrom, 2009; McGinnis, 2011) has been adopted to analyze governance level interactions (trade-offs, synergies) at the basin level. The IAD framework is centered on eight design principles that informs management of shared common-resources (Ostrom, 2009; McGinnis, 2011), and is considered a reliable tool for unpacking complex relationships and arrangements that are developed while sharing common pool resources such as water. With a limited availability of natural resources, Ostrom argues that competition is guaranteed. Therefore, the resource level interactions have to be controlled/managed using rules and institutions that are objective. Fig. 3 shows how Songwe basin actions are adapted from the IAD framework.

The institutional arrangements in the Songwe case exhibit a polycentric action arena that can be explained using the IAD framework, which allows analysis of the nature of coherence between different governance levels involved in actualizing WEF-nexus-based development programs to meet targets of both the Tanzanian and Malawian governments (the action situation; Fig. 3). The governance systems level in this case focuses on how different levels of organization interact, act, and achieve outcomes from the different actor interactions (McGinnis et al., 2010; McGinnis, 2011). The application of Ostrom's IAD framework in the SRB is built on three pillars:

a) The 'rules-in-use', which in this context are the specific national policies and strategic documents that form the SRBDP action arena (Fig. 2 & 3);
b) The nexus 'doing' is exhibited in the form of action situations imbedded at the national level (vertical) between government ministerial departments, and regional level (horizontal) in the WEF-subsectors that resulted in the inauguration of the SRBC;
c) Nexus-doing in this case was centered on the common interests of flood management/mitigation (primary goal), food security (secondary goal), and infrastructure development (tertiary goal). As the primary goal is flood management, water naturally forms the focus of subsequent analyses.

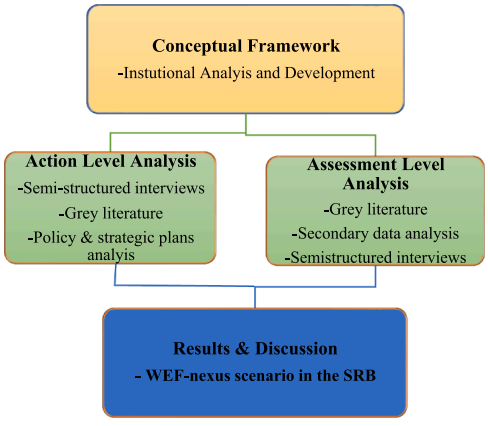

Fig. 2. Methodological approach.

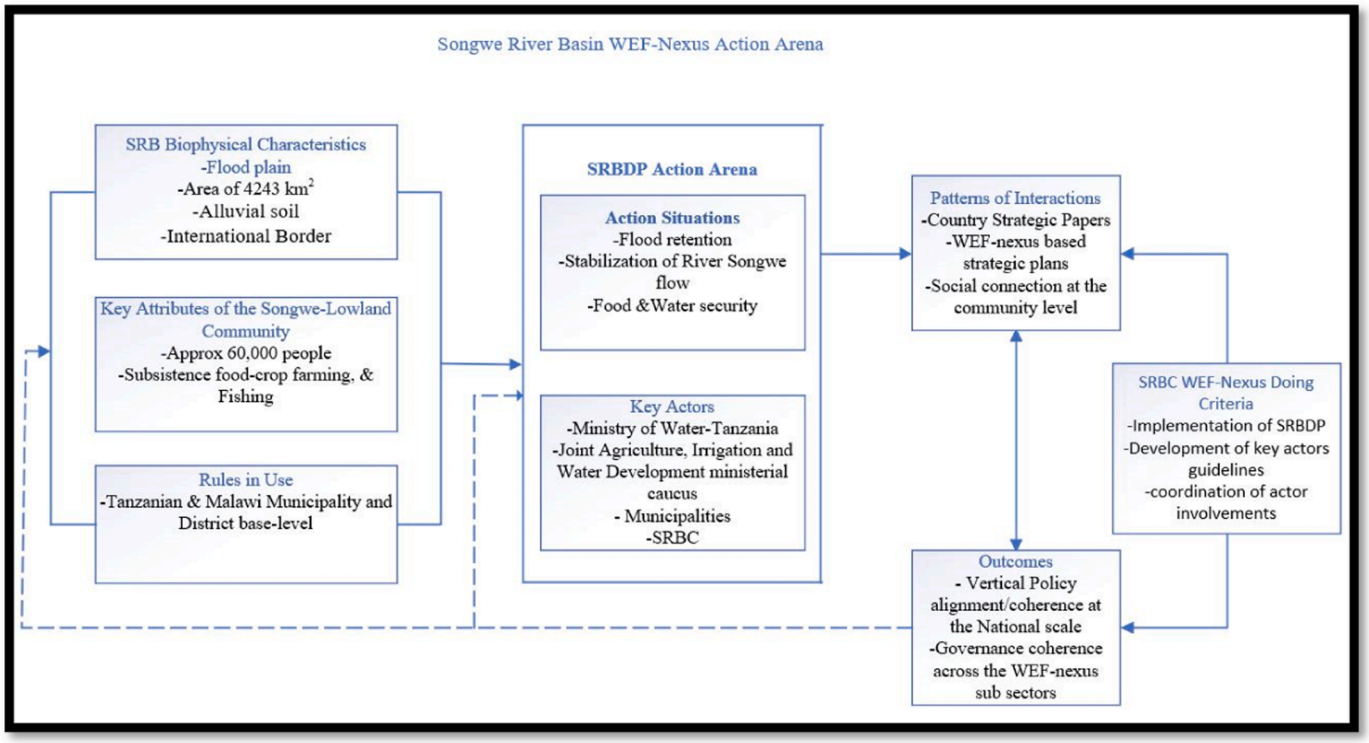

Fig. 3. Songwe River Basin WEF-Nexus .
Action Arena adapted from (Ostrom, 2009).

3.1.1. Action level: action arena and action situation

To interrogate the mobilization of nexus-doing, the focus is on probing the institutional arrangements in practice at the Songwe basin level (Fig. 2 & 3). These arrangements are a combination of formal and informal institutional mandates vested on the municipalities in Malawi and Tanzania, the SRBC, and the local community.

The **action arena** refers to the larger scope covering geographical, developmental and global influences. In the SRBDP case, this means the interactions from the SADC region, and key development partners, along with climate change impacts. In the SRB, the risk of flooding coupled with the food and water needs of the population creates the action arena for the governmental ministry level, municipality level, and the basin level to engage in the WEF-nexus environment. This is classic governance level system that espouses vertical and horizontal interactions/arrangements. This paper combines the policy centric aspect between governance levels in the SRBDP, with the polycentricity of implementation of a multi-actor programme that resulted in the overlapping of governance systems whereby authority and mandates interact to attain certain objectives.

There are two major angles in the SRB action arena: (i) rationality; and (ii) resource dependence. Rationality focuses on the environment for actors' interactions. Both physical and natural environments create the platform for actors to purposefully, and strategically plan, prioritize, and execute actions. Rationality assumes that decisions made by actors are rationally situated to attain specific outcomes/interests - in SRB it was rational to stabilize the flow of River Songwe as a flood mitigation measure (Hermans and Cunningham, 2018). However, rationality does not guarantee achievement of interests due to incomplete decision-making tools, and other unforeseen circumstances such as the Covid-19 pandemic. In developing the action situation, actor rationality is not a perfect combination of knowledge, resources, and preferences. On the contrary, it is a combination of projections, scenarios, information and interests geared towards a common goal. Therefore, actors are assumed to act mutually and consciously and not emotionally or impulsively (Hermans and Cunningham, 2018). Resource dependence builds on rationality, meaning that actors engage mutual interactions because the outcome/s translates into a gain. Distribution of resources is the catalyst for strategic partnerships. For example, in SRB the dependence on the River Songwe is central to the development of a joint-basin cooperation framework. The rationale and resource dependence in the SRB are explained in the following sections.

The **action arena** (Fig. 3) refers to the policy choices that create the foundation for interactions between government departments/levels. In the SRBDP case, this means the national CSP targets for Malawi and Tanzania.

3.2. Assessment level: WEF nexus policy integration and governance coherence

This study employed a combination of semi-structured interviews, grey literature analysis, and secondary data analysis methods to assess WEF sector policy integration and governance coherence (Fig. 2). Semi-structured interviews used predetermined questions (Supplementary Information) while offering opportunities for Key Informant Interviewees (KIIs) to further elaborate on responses. Eleven (11) individuals well acquainted with the WEF-nexus and strategically positioned in terms of the governance, and/or involved in research in the Songwe basin and the wider SADC bloc were identified as key informants to aid with the policy and governance assessment. It is noted here that attempts to contact personnel from the energy and land ministries in Malawi were unsuccessful, and as such only the policy documents were analysed without triangulation. The semi-structured interviews were coded to develop a unique identification key ranging from Key Interview Informant one (KII001) to Key Interview Informant 11 (KII11) and analysed according to the IAD framework described in Fig. 3 and elaborated in the Supplementary Information. Using a snowballing sampling approach, the study engaged with WEF-nexus stakeholders at the Songwe River Basin level to investigate the nuances of policy integration and governance coherence. The snow-balling approach was effective because the KII's voluntarily facilitated

specific recommendations and introductions to government officials, researchers, and development partners in the SRBDP context. By interrogating the nuances of policy integration and governance coherence, the semi-structured interviews specifically looked into the multiplicity of roles between the SRBC, government ministries, and local municipalities in the management of SRB. Additionally, interviews interrogated the operational coordination between the different government levels (at the national scale), and the basin level (SRB). For instance, at the national level (Malawi &Tanzania), municipalities and the SRBC explicitly acknowledged that the daily basin operations activities such as fishing are largely built on mutual agreements (**KII01, KII02, KII04, KII05, KII09, and KII11**).

Grey literature analysis focused on governmental and Songwe River Basin reports such as blueprints and national reports in the WEF-nexus sectors. Secondary data analysis focused on scientific research on WEF-nexus doing by looking into policies at the national and SADC levels. Table 1 summarizes the key policy and strategic documents used in this research.

This combination of methods (assessment of the action arena and action situation, policy document analysis, grey literature review, and key informant semi-structured interviews) allowed for in-depth analysis of policies, plans, and strategies, and semi-structured interviews gave more nuanced information about WEF resources governance.

4. Results

4.1. National level action situations

The SRBDP exhibits governance coherence at both vertical and horizontal levels. At the vertical level, the hierarchical governance arrangements at the national level for Tanzania and Malawi were assessed. The horizontal lens focused on the international cooperation for joint development of the same resource in the SRB. Table 2 summarises the comparisons between the action situations in the two countries, along with summaries comparing the three levels of association (direct, indirect, subsidiary) in each nation.

4.1.1. Tanzania

In Tanzania, governance coherence is based on a centralized ministerial approach. There is a modus-operandi that has identified the Ministry of Water as the central player in advancing Tanzania's interests in the Songwe Basin, hence a default water-centric viewpoint. The Ministry of Water hosts the SRBDP under the National Water Policy (2002) and National Water Resources Management Act (2009). The coordinating ministry scrutinizes any initiative's goals against ministerial level policy goals. In this case, the Ministry of Water probes the goals of SRBDP concerning national water policy, national water development

Table 1
Summary of desk-reviewed key policy and strategy documents.

Policy Document	Country	Specific Policy/ Strategy Document	Target	Reference
Tanzania/Malawi: Strengthening transboundary cooperation and integrated natural resources management in the Songwe River Basin (2019).	Malawi &Tanzania	- Tanzania National Water Policy (2002) - Tanzania Water Resources Management Act (2009) - Tanzania Water Sector development Program (2005–2025) - Tanzania Agriculture Policy (2013) - Growth and Development Strategy II (MGDS II 2017–2022)	- Enhancing transboundary management & institutional capacity - Improvement of early warning, disaster risk management &monitoring - Community-based participation in Integrated Natural Resources Management - Knowledge sharing, monitoring, and evaluation	(ADB, 2019) (AFDB, 2016) (AFDB, 2018) (Tanzania, 2006) (Tanzania, 2002) (Tanzania, 2013) (Ministry of Lands and Housing, 2002)
Tanzania & Malawi Cooperating to harness Songwe River Basin Water Resources for socio-economic development. (2018)	Tanzania & Malawi	- Tanzania National development plan vision-2025) - Growth and Development Strategy II (MGDS II) 2017–2022)	- Community development via infrastructure development - Co-sharing of SRB natural resources and improved land use management practice.	(Tanzania, 2006) (ADB, ADF, 2018)
Tanzania Country Strategic Paper 2016–2020	Tanzania	- Tanzania National development plan vision-2025 - Tanzania Water Sector Development Program (2005–2025)	- Infrastructure development for green growth. - Strengthening governance and accountability	(Tanzania, 2006) (Tanzania, 2015)
The Songwe River Basin Development Programme	Tanzania & Malawi	- Tanzania National Land Policy - Malawi Growth and Development Strategy II (MGDS II))2017–2022) - Malawi Integrated Water Resources Management, and Water Efficiency (IWRM/WE) Plan (2008–2012),	- Implement multi-sectoral solution to capitalise on readily available the basin resources. - Forster cooperation to help mitigate adverse environmental impacts in SRB.	(Global Water Partnership South Africa et al., 2008) (AFDB, 2016)
Malawi Country Strategic Paper 2018–2022	Malawi	- Malawi Integrated Water Resources Management, and Water Efficiency (IWRM/WE) Plan (2008–2012) - Malawi National Land Policy (2002) - Malawi National Energy Policy (2018)	- Investing in infrastructure development through energy and transport. - Investing in economic transformation powered by strengthened agricultural value chains & developing water infrastructure to boost economic diversification.	(Global Water Partnership South Africa et al., 2008) (Ministry of Lands and Housing, 2002)
SADC Climate Change Strategy and Action Plan (2021–2030)	SADC Region	- Regional Strategic Action Plan on Integrated Water Resources Development and Management -Phase IV (2016–2020) - Regional Integration Policy and Strategy (RIPoS) 2014–2023 - SADC Regional Indicative Strategic Development Plan (RISDP) 2020–2030 - Regional Infrastructure Master Plan-Outline of major Mega Projects for SADC (2012) - Energy Sector Policy of the African Development Bank Group (2012) - Protocol on Energy in the Southern African Development Community (2006)	- Enhance cooperation in addressing climate change issues. - Improve local livelihoods. - Promote GHG emissions reduction by developing the green energy infrastructure. - Achieve a resilient and Low carbon regional - Energy as an economic booster to alleviate poverty	(SADC, 2020) (SADC, 2020) (SADC, 2020) (SADC, 2012) (SADC, 2006) (SADC, 2006)

Table 2
Summary of the Action Situations.

COUNTRY	ACTION SITUATION	COMPARISON TO OTHER COUNTRY
TANZANIA	i) National policy level	- Water ministry is solely responsible for advancing the national transboundary management interests
	ii) Ministerial level	- Harmonization of the inter-ministerial department decision tools by different ministry teams (Water, Energy & Agriculture)
	iii) Project administration level	- Implementation duties by the jointly designated offices (SRBC and Local municipalities for SRBDP)
MALAWI	i) National policy level	- Water, Energy & Agriculture ministry's jointly responsible for advancing the national transboundary management interests
	ii) Actualization level	- Combines harmonization processes, mandates, and implementation instruments and mandates

program (2020–2025), and the country-specific paper (AFDB, 2016; ADB, 2019; SRBDP, 2019). "***By probing the objective of a program like SRBDP against the national goals, gives us the facts useful to strategically partner internally with the respective ministries to secure the interests of the peoples' republic of Tanzania***" **(KII05).** At the national level, Tanzania displays vertical governance coherence achieved via hierarchical procedural integration (Fig. 4).

In Tanzania, there are three hierarchical levels providing vertical coherence, based on the national government structure. Six interviewees from Tanzania acknowledged that the flag-bearer ministry has veto powers over all projects within the official territorial boundaries of the republic (**KII01, KII02, KII04, KII05, KII09, and KII11).** This information was triangulated with that acquired from the Tanzania National Policies which highlighted three types of association in the SRBDP case (direct, dependency, subsidiary dependency; see Fig. 4 and Discussion). These associations, shown in Fig. 4, describe the policy relationship levels following the government system analysed in the IAD Framework. The veto powers of the flag-bearer were established as a potential source of ambiguity in the daily operations of the SRBC in the sense that ministerial directives in the event of flooding were supreme and hence the SRBC mandates would be overruled. Essentially, the SRBC would then become a department in a ministry of the Tanzanian government. Such as scenario though not yet experienced, was identified as a major risk in actualizing the 'nexus-doing' in the Songwe river basin. A decision to make SRBC part of the Tanzanian water ministry would essentially lead to a twofold challenge; 1) internal frictions with the energy and agriculture ministries on the basis of competing water demand for different uses. Internal friction at the ministerial level would negatively affect farm inputs specifically by delayed budgetary mobilization for mechanized farming leading to increased food poverty, as well as negatively affecting the energy production capacity hence resulting in a higher cost of power; 2) there could be the potential for transboundary water resources management conflict with Malawi.

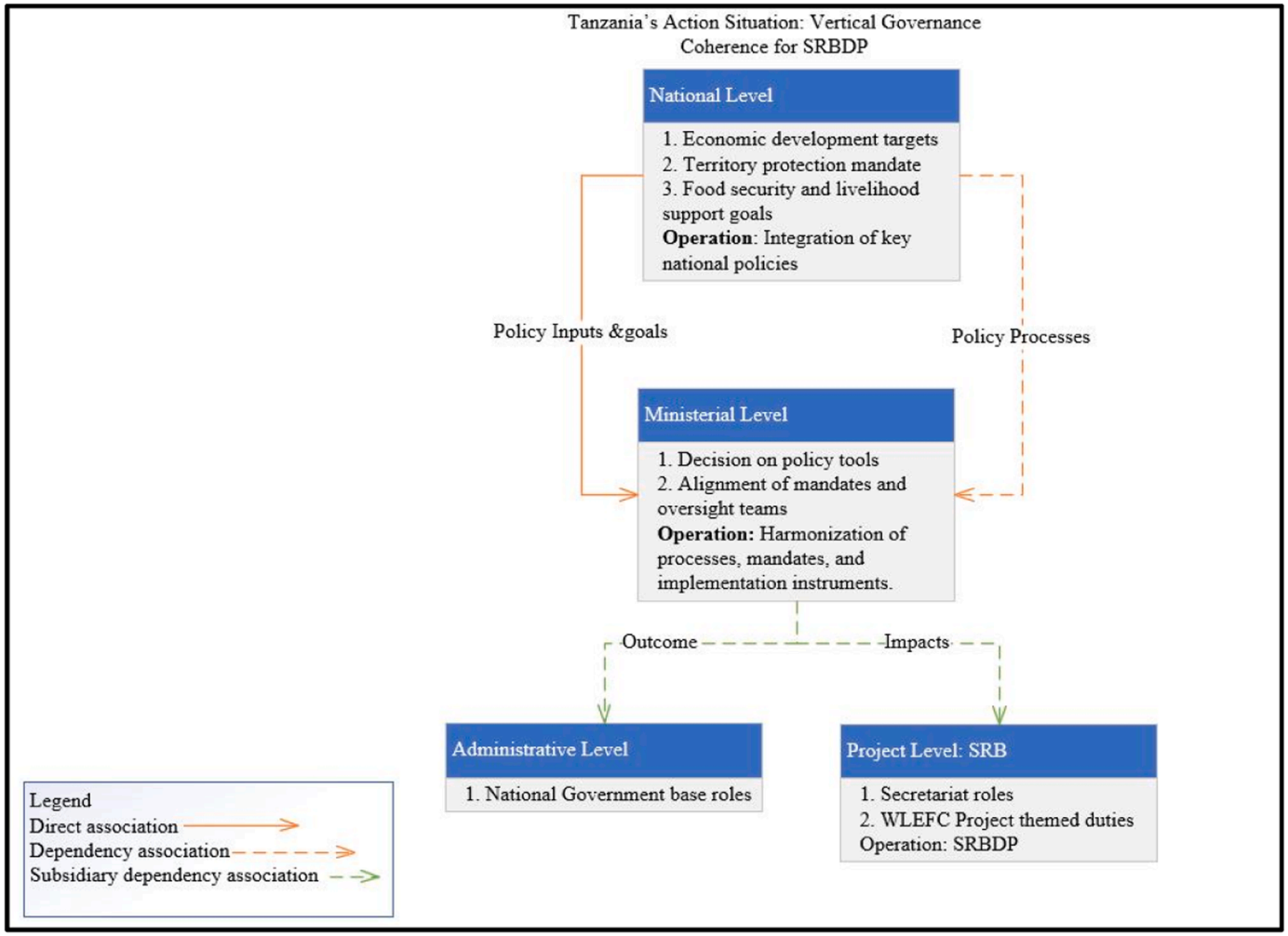

Fig. 4. Tanzania's Action Situation: vertical governance for SRBDP.

4.1.2. Malawi

In Malawi, the national level depicts a two-layered modus operandi. First, national policy is focused on economic targets, territory mandates, and food and livelihood support targets to secure Malawi's interests in the SADC context. The ministerial level was identified as the actualization level where harmonization of processes, mandates, and implementation instruments are mobilized. Vertical coherence in Malawi relied on the Malawi Growth and Development Strategy II (MGDS 2017–2022), Malawi Country Strategy Paper (CSP 2018–2022), Malawi National Water Policy (2005), the Malawi Integrated Water Resources Management and Water Efficiency (IWRM/WE) Plan (2008–2012), Malawi National Land Policy (2002) and Malawi National Energy Policy (2018). Fig. 5 summarizes the governance coherence scenario and dependency interactions at Malawi's national level.

The action situations (Fig. 4 & 5) built on the 'rule-in use' created the enabling environment with three targets: (a) stabilize the flow of the River Songwe (flood management/mitigation); (b) provide food security; and (c) improve the infrastructure by the construction of a mega hydro-power dam to be autonomously managed by the SRBC.

4.2. National governance coherence

4.2.1. Tanzania

Information acquired from Tanzanian KIIs was triangulated against the Tanzania National Policies and three types of vertical coherence association were found (Fig. 4):

4.2.1.1. Direct association. this is the dominant governance level derived from the mandates vested on the Tanzanian Water Ministry as the coordinating government department in the **SRBDP**. Governance inputs (budget allocations, ministerial responsibilities), and goals (strategic targets) are the main means in this association which brings together the executive actors in the government hierarchy. It is important to note that the governance processes (the institutional arrangement & procedures) are subject to changes based on the goals of the present government.

4.2.1.2. Dependency association. at this level are key government departments (the Tanzanian Ministry of Water, Ministry of State in the President's office, regional administration, local government, civil service and good governance, ministry of finance and planning, and ministry of environment). **KII02, KII05, and KII09** established this as the integration and harmonization level where internal government consultations are facilitated to ensure a synchronized government action plan. "***The government agencies have to conduct government business using the official procedures, and shape policy-making to fit the local setting of citizens living in exceptional border regions such as Songwe Basin Area***" **(KII09).**

4.2.1.3. Subsidiary association. "***Since every minister cannot handle all daily administrative responsibilities; we rely highly on the delegation to administrative authorities per ministry***" **(K1105).** To safeguard the mandates and national targets, outcomes at a local level are subject to direct appraisal by base government actors (municipalities and authorities) to safeguard Tanzanian territorial objectives. The impact of the SRBDP is closely coordinated with these government levels to foster coherence. The secretarial level of SRB is important as it sets the daily agenda in actualizing the SRBDP. The Tanzanian CSP (2016–2020) and the Tanzanian Waters Sector Development Program (2005–2025) are the guiding documents that prioritize infrastructure development and strengthening governance and accountability. The National Water Policy (2002) and Water Resources Management Act (2009) provide the basis for governance processes. Nonetheless, interactions are not seamless. There are inconsistencies that emanate from regulatory

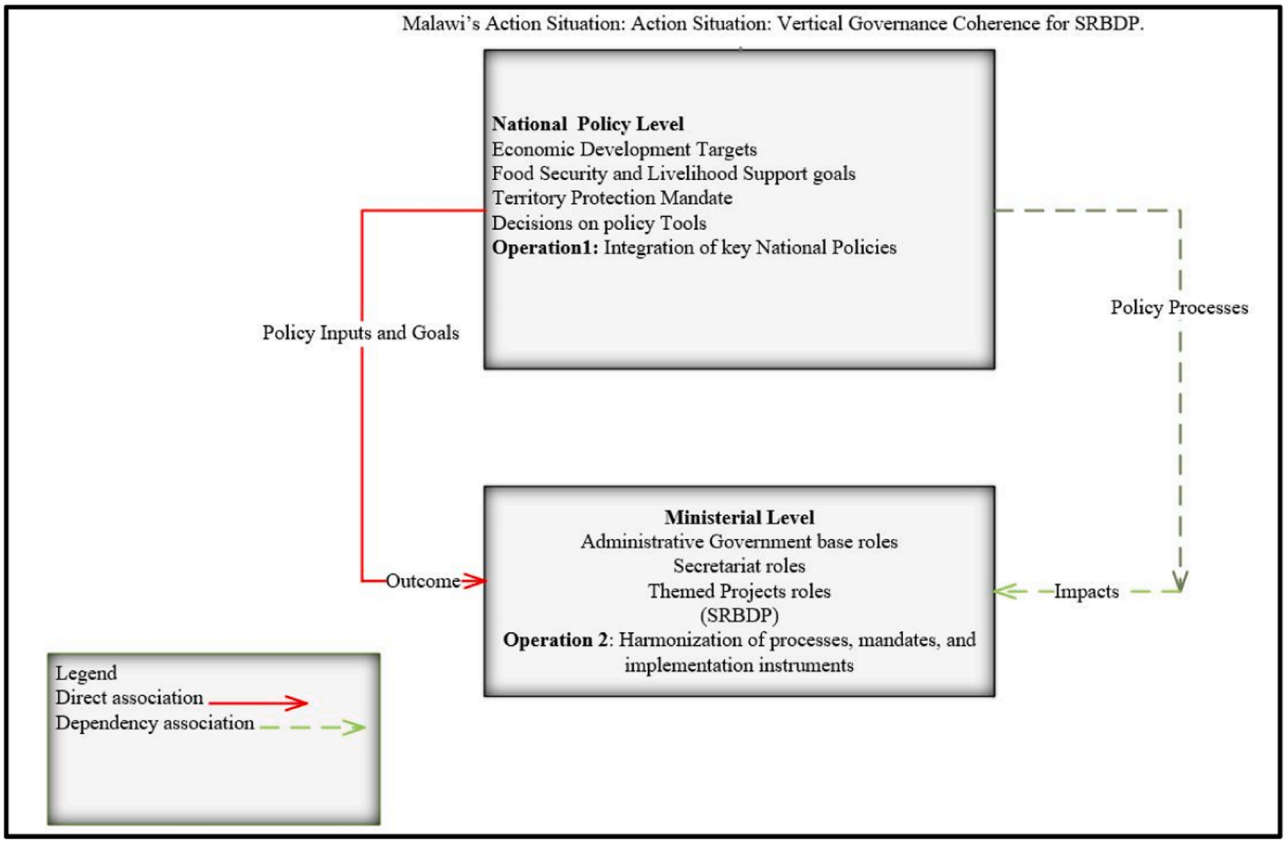

Fig. 5. Malawi's Action Situation: vertical governance coherence for SRBDP.

processes in the nexus-doing ecosystem (Nilsson et al., 2016). For instance, the overlap of mandates between Ministries of Water and Defense in a flooding event was established as a scenario of inconsistency whereby the Ministries of Defense and National Service and Finance and Planning responses can veto planning and mandates of the coordinating department (Ministry of Water), potentially changing the action situation from WEF-nexus coordination to military coordinated operations.

4.2.2. Malawi

Governance coherence in Malawi depicted a 'muddling-through' approach. In this context, jointly executing the MGDS II and CSP goals are geared towards refining key government processes (strategies, budgeting, and implementation). At the national level, the CSP targets are infrastructure development and value addition through improved competition for the public industry sector (CSP 2018–2022) in line with Sustainable Development Goals (SDGs) 7, 9,10,11, and 12. The national water policy is to attain sustainable management and utilization of water resources to attain equitable access to clean water for all (SDGs 2,3,6 and 13). The MGDS II and the national energy policy target renewable energy interventions emphasizing hydro-power. Hence, the national energy policy is to deliver an integrated framework to ensure that the nation has access to affordable, clean, and sustainable energy. Therefore, there is a strong synergy with the water policy goal of access to clean water by investing in the SRBDP to achieve a multi-purpose dam. Malawi's national coherence depicted two types of association (Fig. 5):

Direct Association is the executive level in the Malawi government focused on bringing together the respective ministers to deliberate and align national economic, development, food, security, and territorial mandates. The goal is to agree on the decision-making tools to be employed in different contexts and capacities to safeguard the nation's interests locally, regionally, and globally.

4.2.2.1. Dependency association. This administrative level is made up of ministerial departments centrally supported by the national government inputs (finances, human resources, and mandates). Mandates at this level are project-specific such as the SRBDP. The association is subject to government changes as per the policy goals of the present regime.

The three different types of associations mean that in operationalization of the SRBDP as a nexus-doing intervention, the interests of key actors exhibited a linked nature in the form of strategic national and regional targets aimed at solving a common challenge. The differences in associations are summarized in Table 2, which compares and contrasts the situations in the two countries, while Figs. 4 and 5 show the contrasts in the dependencies between governance levels. In this context, the direct association creates deliberate executive will across the top-most level of decision-making. The dependency association on the other hand is as a result of strategic alignments at the executive level. It is at this level where actual mobilization of resources happen. The subsidiary association is the additional efforts to coordinate activities either nationally or basin-wise. These associations are significant because they empower the interactions between the actors from the bottom-up hence actualizing a nexus doing.

4.3. Governance coherence in the Songwe River Basin Development Programme

At the Songwe Basin level, two levels of horizontal governance coherence were established. First, the executive level is comprised of a joint team of experts drawn from research institutes, development partners, the SADC bloc, and the council of ministers drawn from the sovereign government of Malawi and Tanzania, and across the water, energy, and food sectors. Here the goal is to transform problems into opportunities. The specific problem tied to SRBDP is to deal with the risks of flooding caused by the meandering river and address the fluidity of the international border (linked to the Songwe River, and hence to water focus). The guiding vehicle was an intensive policy campaign anchored within the SADC-RISDP to eradicate poverty by investing in strengthening transboundary cooperation between Tanzania and Malawi. **"*The cooperation between the two sister countries dates the back to early 1970 s trying to answer the question of floods, and meandering of River Songwe*"** (KII05). Savenije and Van der Zaag (2000) argue that in classical thinking of sharing transboundary waters, politicians and technical experts work together in institutions that transcend the values of grassroots communities to help achieve the integrated water resources management goal. Additionally, other key resources such as land and energy resources have significant impact on the governance and management of transboundary basins. For example, land use changes due to increased population will directly impact land ownership and eventually affect the transboundary land management practices and regulations within the SRB.

Secondly, at the secretariat level, both governments deploy government officers to Kyela to oversee transboundary cooperation to stabilize River Songwe flow. The base level at inception was an emergency intervention specifically targeting risks affiliated with extreme weather events. The coordination at this level stemmed from the secretariat, then to the local municipals and district administration level across both nations. At the administrative level, the focus was on implementing and managing daily activities, for example manning domestic water supply points, ensuring equitable distribution of agriculture extension services, and monitoring the daily power shortages. Malawi and Tanzania's governments sought a long-term border solution in this area, as disclosed by the respective government CSPs, national policies, and KIIs. Fig. 6 summarizes horizontal governance coherence in SRBDP.

The SRBDP action arena (Figs. 3 and 6) has led to trade-offs (e.g. both nations conceding not to use the respective military assets to protect the 200 km international boundary), ambiguities in WEF sector management (e.g. possibility of defense departments having veto-powers over the SRBC in the event of an extreme condition, impacting on water, energy, and food objectives), and synergies (e.g. deliberate cooperation to upgrade SRBDP infrastructure to a basin-wide investment framework across nexus sectors – water supply, food production, hydroelectric generation capacity enhancement).

At the same time as the trade-offs, the five focus points of the SRBDP namely: (i) Shared Vision 2050 for Songwe; (ii) Comprehensive design and preparation for priority investment; (iii) Environmental and social safeguarding of SRBDP; (iv) Development of Joint River Basin Commission and affiliated IWRM capacity building at local and national level; and (v) Support to project management and resources mobilization for the implementation of capital investments under SRBDP, have created action situations to jointly develop mutual actor arrangements that scale down national ambitions in favor of SRB resources efficiency (i.e. synergistic opportunities). A good example is the mutual agreement between Tanzania and Malawi to actualize an independent SRBC that will exclusively manage the multi-purpose dam from the inception to supply and pricing of hydro-power from the multi-purpose dam in a way that is fair and equitable for the local population. This means that the five focus points create an enabling environment promoting governance synergy regarding nexus-doing. Therefore, the state of nexus-doing at the SRB is still at the early stages. Nonetheless, it provides a clear case of trade-offs, and synergies cutting across the WEF-nexus sectors as mentioned above through government departments nationally and the SRB basin wide and hence belongs to the "nexus-doing" context rather than an integrated water resource management context, although stemming from a water-centric baseline (river flow regulation and border stabilization).

The governments of Tanzania and Malawi identified SRBDP as a mutually valuable investment in human life over the territorial value. KII05 argued that understanding the problem of Songwe at the executive level could not be explained using the technical principles only. On the

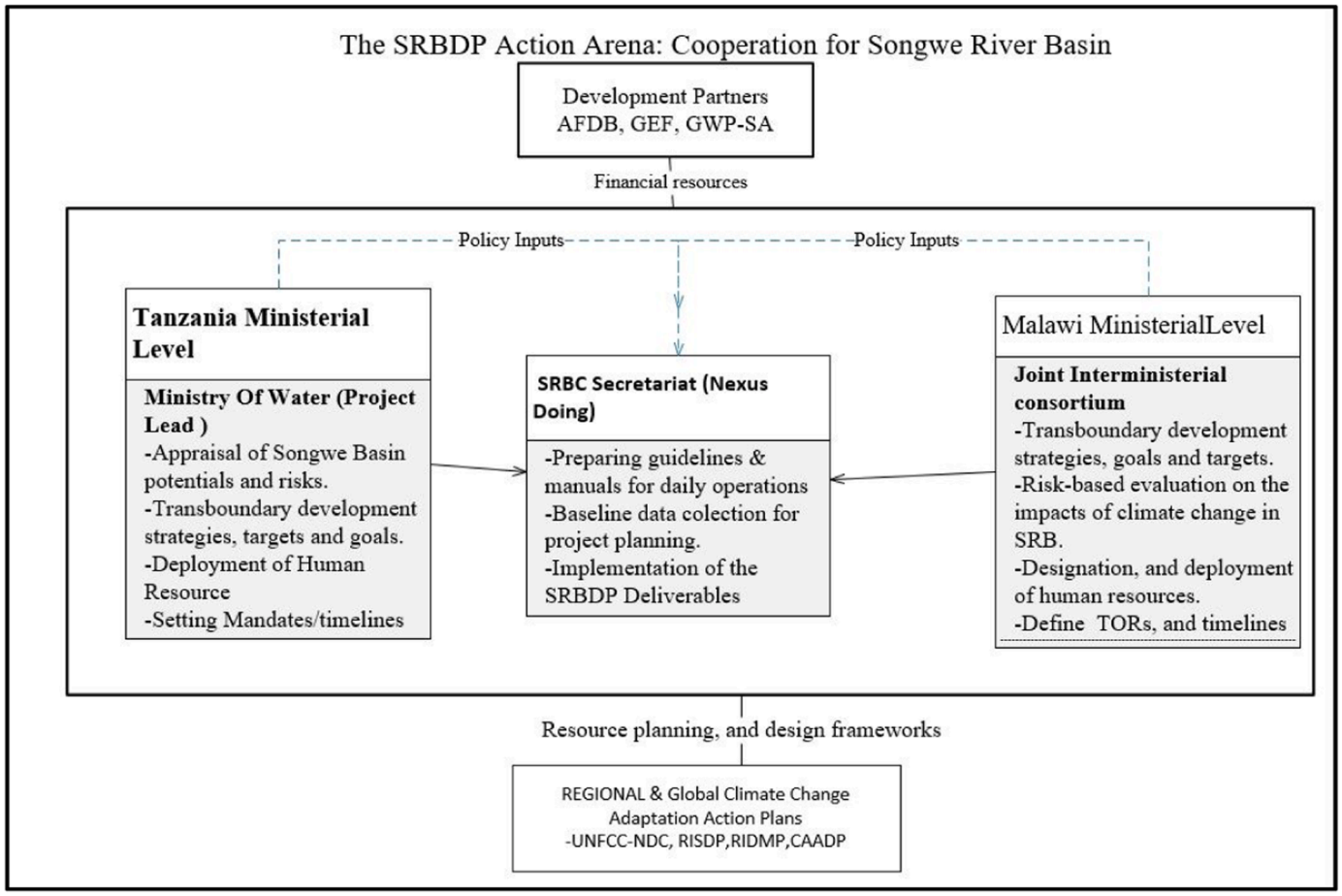

Fig. 6. Horizontal Governance coherence for SRBDP.

contrary, it required a delicate balance between science and politics. KII01 reiterated the same concern arguing that at the grassroots level, what matters is the impacts of the river on the daily lives of the people of Songwe. "***Here, no one understands the engineering principles and language, not the locals or the local administrators. Society is one. We experience floods or droughts together, mourn our loved ones, and build together. After that, we're just normal people relying on the river for farming***" (KII01***).***

5. Discussion

5.1. Horizontal governance coherence: cooperation for the Songwe

Horizontal governance coherence builds on policy coherence practice as argued by (Addams et al., 2009; Nilsson et al., 2012). This means governments rely on their respective national targets to engage on modalities of developing limited resources. In the WEF-nexus, governance coherence is necessary due to connections that bind water, food, land, energy, and climate change (Purwanto et al., 2021; Sušnik and Staddon, 2021). Probing the value proposition of national policies is important in the WEF nexus approach, referring to the expected gain/-goal set to be achieved by executing an international WEF-nexus based development approach. The primary value proposition in the SRB is the mitigation of flood risks associated with the unstable River Songwe flow regime, increased food production locally, and enhanced hydropower generation.

While flood management is the low-lying fruit, the food and energy sectors in SRB can significantly gain through the implementation of SRBDP. For instance, stabilizing River Songwe flow with the proposed multi-purpose dam would not only increase the amount of water for domestic use, but also increase hydro-electric production capacity (Tanzania & Malawi), and water for irrigation purposes. Consequently, these developments create a positive feedback on infrastructural development resulting from economic growth. Thow et al. (2018) argue that coordinated interventions to mitigate flooding could also help address undernutrition and food insecurity. This is achievable through targeted coordination between governments and government departments to achieve food security. However, the coordination is characterized by synergies and ambiguities. For instance, in the case of a South African analysis by Thow et al. (2018), food supply was identified as potential area of ambiguity and incoherence (both policy and governance) specifically between the local food supply and the economic goal of a liberal economy. Therefore, while there is ample opportunity to realise nexus gains, caution must be paid so as to avoid pitfalls and trade-offs.

Bringing out the vulnerability of African urban cities in the wake of climate change, Ahmed et.al (2022) support the need of close coordination between different levels of governance to eliminate duplication of climate change adaptation interventions. The Ghanaian case found a minimal degree of policy coherence but a high degree of collaboration between different governance levels (governance coherence) (Ahmed et. al, 2022). This is similar to the findings presented here for the SRB. Essentially, this means the operational level is characterized by deliberated coordination between actors on-the-ground to achieve a common goal such as food security. These findings strengthen Nilsson et.al (2012) arguments that policy incoherence exists in many settings. This also raises a question: is policy coherence a prerequisite for governance coherence? Studies such as this one, and that of Ahmed et al. (2022) suggest not necessarily.

At the SRBC secretariat level, Tanzanian and Malawian governments

deploy their government officers to the SRBC base office to oversee transboundary cooperation to stabilize River Songwe flows. Malawi and Tanzania's governments sought a long-term border solution, as disclosed by the respective government CSPs, national policies, and KIIs. Fig. 3 summarizes the WEF-nexus action arena exhibited at the SRBDP, Fig. 6 summarises the SRBDP governance coherence analysis, while Table 2 compares and contrasts the two settings, showing that there are differences in resources governance structure between the two countries, potentially leading to mismatches in management approaches despite the mutual desire to stabilize Songwe River flow as a driving motive. In this regard, the SRB setting points to potential problems in horizontal governance stemming from policy coherence (Addams et al., 2009; Nilsson et al., 2012). As there are gaps in policy coherence, it follows that there is likely to be governance incoherence in implementation in the SRB.

As specific examples of potential incoherence in practice, both governments agree to cede the sovereign mandate and responsibility to mobilize national defense assets to protect national boundaries in the SRB, over-riding the mandates of the Ministry of Water (in the Tanzanian case). At the same time, there was a decision to build on the social context of the communities living on the 200 km border for stability, and for the continuation of important activities for the maintenance of livelihoods. These two aspects may be incompatible, at least during times of flood events, which may lead to knock-on impacts on food production and stable energy generation from the proposed hydropower plant. Additionally, national targets on infrastructure development (energy, agriculture and transport) for both Tanzania and Malawi would translate to an unhealthy competition for land (e.g. the reservoir and associated infrastructure vs. high productivity land for food production) and water resources (e.g. water storage to ensure hydroelectric generation vs. water required for the new irrigated land, or water required to ensure the hydrological regime is not significantly altered) at SRB if pursued at the national scale.

5.2. *Implications for Songwe Basin nexus doing and practical recommendations*

Lesser-developed nations development strategies are centered on food security, water, and energy availability (Nhamo et al., 2018; Mabhaudhi et al., 2022). From the SADC-context, these strategies have increased the focus on a WEF nexus approach (Mabhaudhi et al., 2018; Simpson and Jewitt, 2019a) where the WEF Nexus approach has been mobilized as a developmental framework to attain national development as part of achieving SDG goals (Mabhaudhi et al., 2018; Simpson and Jewitt, 2019a). The SRBDP adopts a nexus approach in the sense that it has created a joint resource development and sharing arena for Tanzania and Malawi. For example, the SADC Regional Strategic Action Plan (RSAP IV) advocates for alignment of water resources management with the industrialization ambitions of the SADC bloc. The overall objective at the SADC-level is to identify, develop and support sustainable socio-economic development programmes using a scaling-down approach in basins such as the Songwe.

In this wider SADC WEF nexus context, the nature of actions in SRBC reinforce the enabling environment for cooperation, centered primarily on flow regulation to achieve project goals could mitigate flooding and sovereign border issues. However, these interventions could threaten agrarian livelihoods that depend on seasonal floods, as well as having knock on implications for water provisioning to domestic users, for expanding irrigated agriculture in both countries, and on the stability of energy generation from the proposed hydropower plant. There are therefore wider nexus issues related to the primary drivers of flow and border regulation which may impinge on wider WEF nexus resource security ambitions. The enabling environment to achieve SRDBP targets is based on the alignment of government process at the local level (the municipalities, the local community, the SRBC-secretariat). For instance, in the Ghanaian case argued by Ahmed et al. (2017), the enabling environment that is climate change-induced sea level rise accelerated the alignment of municipalities and local actors to develop climate change adaptive interventions leveraging on the urban policies set by the national government. At the nexus-doing level, SRBDP has espoused a governance coherence approach to exploit the 'low-lying' fruits of coordination. For example, KII05 acknowledged that at the 'doing-level,' the most influential coherence stems from the grassroots administration level at the secretariat's SRBDP case. The SRBC-Secretariat coordinates with local municipalities and the community at an administrative scale and gives the most urgent and feasible national scale recommendations to the governments of Tanzania and Malawi. The active action situation in SRBDP tapping into synergies between municipalities, the SRBC-secretariat, and the local community to minimize competition of roles that results in ambiguities (such as overlapping mandates between departments). This means 'nexus-doing' in SRBDP is still at the primary stage of developing actor arrangements to support the SRBDP action arena, and still has opportunities specifically human capacity development for the SRBC secretariat, financial autonomy, and full transfer SRB management mandates to the secretariat to improve operational efficiency and effectiveness.

Policy gaps, ambiguities and inconsistencies in the SRBDP action arena slow-down nexus doing opportunities. Policy gaps tend to exist in siloed-sections. For instance, government laws (existing in water, agriculture and energy sector policies) were not centrally accounted for, meaning a lack of common regulations on transboundary water resource management in the SRB, potentially leading to conflicting ambitions. Ambiguities and inconsistences mainly stem from the departmentalization of government roles. Essentially, government processes across ministries were identified as a costly and bureaucratic procedure that slowdown actualization of development projects, as in the example of defense ministries taking over the operations in Songwe in the event of flooding. In order to remedy this situation and promote nexus doing, it is suggested that entrusting the SRBC-Secretariat with mandates and resources (financial and human-resource) to spearhead the designing, developing, and executing holistic nexus-doing programmes. The national government departments on the other hand need oversight (monitoring & evaluation) roles across WEF-nexus sectors.

Recommendations stemming from this analysis to improve SRBDP nexus doing include:

1) Invest in capacity building and human resources for SRBC;
2) Celebrate small preliminary wins & support snow-balling successes;
3) Enrich governance coherence assessment tools tailor-made for the SRB;
4) Develop a common policy accountability tool for the SRB to help monitor, and evaluate, the nexus targets, gains, and trends in the region.

While the SRBDP employs a nexus framework, water was identified as the core driver of nexus opportunities stemming from sovereign border concerns. The nexus at the AU level focuses on food security and the SADC level focuses on infrastructure development. Interestingly, the nexus loses "shape" at the national level. Then nexus issues 're-appear' locally almost by default because the approach can be leveraged to exploit energy, climate change, and food opportunities, and improve efficiency of measures. Within the SRB, the synergies, trade-offs, ambiguities, and inconsistencies identified are summarized as:

5.2.1. *Synergies*

a) Deliberate coordination and actualization of the Songwe River Basin Commission as a long-term government-to-government partnership to achieve the ambition stabilizing the River Songwe;
b) Joint mobilization of resources, and granting autonomy to the operations of the commission;

c) Grassroots level coordination between the municipalities, the commission, and local communities.

5.2.2. Trade-offs

a) Ceding of sovereign international border territory under military protection to the SRBC;
b) Agreement to shelve national targets in favor of the five key development components namely: (i) Shared Vision towards 2050 and a 10-year SRDBP; (ii) Comprehensive design and preparation for priority investment as a major task (iii) Environmental and social safeguarding of SRBDP; (iv) Development of Joint River Basin Commission and affiliated IWRM capacity building at local and national level; and (v) Support to project management and resources mobilization for the implementation of capital investments under SRBDP.

5.2.3. Ambiguities

a) Increase of water demands driven by energy and food targets hence precipitating a conflict of interests: irrigation agriculture is the main livelihood support, contributing approximately 17% of the regional GDP yet regional economic growth targets are predominantly anchored on hydroelectric energy. Hence a dilemma of water allocation and appropriation;
b) Risk of land use conflict between reservoir expansion, food crops and energy crops: energy crops and food crops are competing for the same finite arable land area;
c) Environmental degradation from the use of inorganic farm inputs: increased use of inorganic farm inputs (e.g. fertilizers and pesticides) geared toward increasing crop yields eventually ends in rivers and harms aquatic ecosystems;
d) Initial investment cost for high-end technologies in the WEF-nexus subsectors.

5.2.4. Inconsistencies

a) The possibility of mobilizing military assets in the event of extreme weather events especially floods: this is a grey area in that military organizations do not necessarily operate in a socio-political environment. The knock-on effects of military interventions if and when mobilized therefore could impact nexus-doing initiatives in SRB;
b) Control of key internal responsibilities of SRBC (e.g. human resources) using the central government system. Centralized control of resources is inconsistent with the autonomy of the SRBC fostered in the Tanzania and Malawi CSPs targets.

The inconsistencies, ambiguities, and trade-offs are leading to implementation inefficiencies and ineffectiveness in nexus doing. This can be seen at the development projects implementation level through duplication and overlapping mandates of key actors. To mitigate this, and to improve the impact of local-level nexus-doing initiatives, the following measures are proposed:

1. Interpreting the ambitious national targets to tailor-made nexus-doing (actualization) action situations between the municipalities, local communities and SRBC-secretariat;
2. Develop and establish a WEF-nexus tool or utility (the Songwe Basin Action Arena) for quantification of policies (accounting) and assessment of applicability of scenario planning (governance processes) centered on shared resources management for the SRB;
3. Ensuring autonomy of the SRBC in carrying out nexus-doing initiatives, with minimal ministerial involvement;
4. Testing the technical goals of SRBDP at the implementation level in line with the UNFCC- climate change adaptation targets.

6. Conclusions

A number of authors claim that the nexus concept can be better operationalized as an analytical tool, and can be better implemented in practice. Considering the multiplicity of water uses (irrigation, hydropower generation, domestic use), there is potential that a WEF-nexus approach in the Songwe River Basin would contribute to national and regional development target. Nexus-doing at the SRB is happening under the Songwe River Basin Development Programme, in the sense that there is active mobilization of the respective nation national policies and strategies (rules-in-use) joined by a common interest to stabilize the flow of the River Songwe. There is then the subsequent allocations of budgets, human resource, and operational mandates on the SRBC as the act pivot center of projects in the basin (nexus-doing).

This paper has shown how nexus-doing in the Songwe River Basin is hampered by trade-offs, ambiguities, and inconsistencies both at the within-nation level (i.e. conflicting policy objectives across sectors) and at the transboundary level within the SRB itself. While the SRBDP does have the potential to be a truly WEF nexus integrated initiative, at present this is far from being achieved. The paper provides insights to fill the gap between nexus-thinking and nexus-doing, illustrating a concrete example of an ongoing initiative, and suggesting practical opportunities to further improve on this and achieve more robust nexus doing, in particular granting more autonomy to the SRBC to implement nexus activities. The SRB could become a regional exemplar of how to practically 'do' the nexus in a practical sense. Thus, lessons could be applied elsewhere, especially in the lesser-developed nations context, and when a transboundary river basin is considered.

Author statement

Please find attached our updated and revised paper based on the comments on the two reviewers. We trust to have fulfilled the requested changes in a suitable manner.

Ethical statement

All questionnaires and interviews carried out as part of this research were planned and carried out as part of MSc research. As such, they were carried out according to the guidelines and policies of the MSc Degree Programmes, including an internal ethical approval process. The MSc degrees are fully accredited in the Netherlands. All interviewees were approached prior to being interviewed to garner explicit consent to participate in the interviews. All interviewees were sent the full list of questions prior to the interviews. All responses are anonymous to protect identities of staff within each organization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envsci.2023.103596.

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