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Addressing Transboundary Cooperation in the Eastern Nile through the Water-Energy-Food Nexus

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Addressing Transboundary Cooperation in the Eastern Nile through the Water-Energy-Food Nexus

Insights from an E-survey and Key Informant Interviews

Helen Berga, Claudia Ringler, Elizabeth Bryan, Hagar El Didi, Sara Elnasikh

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Abstract

The Nile is the lifeblood of northeastern Africa, and its roles for and interdependency with the national economies it traverses and binds together grow as it moves from source to sea. With rapid economic development—population growth, irrigation development, rural electrification, and overall economic growth—pressures on the Nile's water resources are growing to unprecedented levels. These drivers of change have already contributed to stark changes in the hydropolitical regime, and new forms of cooperation and cross-sectoral collaboration are needed, particularly in the Eastern Nile Basin countries of Egypt, Ethiopia, Sudan, and South Sudan. As direct sharing of water resources is hampered by unilateral developments, the need has increased for broader, cross-sectoral collaboration around the water, energy, and food sectors. This study is conducted to assess and understand the challenges of and opportunities for cooperation across the water-energy-food nexus nationally in Egypt, Ethiopia, and Sudan, as well as regionally across the Eastern Nile. To gather data, the paper uses an e-survey supplemented with key informant interviews geared toward national-level water, energy, and agriculture stakeholders, chiefly government staff and researchers. Findings from the survey tools suggest that most respondents strongly agree that collaboration across the water, energy, and agriculture sectors is essential to improve resource management in the region. At the same time, there is ample scope for improvement in collaboration across the water, energy, and food sectors nationally. Ministries of water, energy, and food were identified as the key nexus actors at national levels; these would also need to be engaged in regional cross-sectoral collaboration. Respondents also identified a wide range of desirable cross-sectoral actions and investments—both national and regional—chiefly, joint planning and operation of multipurpose infrastructure; investment in enhanced irrigation efficiency; joint rehabilitation of upstream catchments to reduce sedimentation and degradation; and investment in alternative renewable energy projects, such as wind and solar energy.

Keywords: water-energy-food nexus, transboundary cooperation, stakeholders, Eastern Nile Basin

1 Introduction

Water, energy, and food (WEF) resources are facing growing stress and conflicts as demand outstrips their supply in many places. As a result of the growing scarcity and variability of resources, interactions between these resources are strengthening, along with the possibility of positive or negative unintended or unanticipated impacts from interventions in one of these resources on others (Ringler, Bhaduri, and Lawford 2013). Although this challenge is global, it is more pronounced in developing regions such as the Eastern Nile economies, where ambitious development plans are putting stress on all of these resources while supply is not keeping up. To strengthen positive synergies across these resources and sectors, and to reduce or avoid negative interactions, developments in the WEF sectors need joint planning and implementation with stakeholder involvement across sectors and riparian countries.

Such cooperation requires appropriate institutions that can facilitate cooperation among stakeholders across sectors nationally as well as across national boundaries. Several developments in the region, such as the energy power pool, food trade, and joint management of water resources, are examples of potentially significant nexus opportunities in the Eastern Nile region. However, the existence of diverse sectoral and national interests, goals, policies, and strategies concerning WEF systems makes taking advantage of such nexus opportunities challenging. From a governance perspective, the nexus concept can be interpreted as a "process to link ideas and actions of different stakeholders under different sectors for achieving sustainable development" (Endo et al. 2016, 3). Meeting the competing needs between uses and users of WEF resources requires understanding the viewpoints of key stakeholders in these resources and understanding the trade-offs related to allocating resources between competing needs (McCartney et al. 2010). Developing such an understanding involves engaging relevant stakeholders in the course of identifying key WEF nexus issues across sectors and scales, in order to build common goals and decide on appropriate response options when potential conflicts of interest arise between sectors (FAO 2014; Endo et al. 2016). Engaging key stakeholders in WEF nexus analysis is also important for understanding the level of regulation in resource use and the extent of harmonization and coherence of policies (FAO 2014).

Usually, policies and actions in WEF sectors lack coordination in both their planning and allocation processes. Weak communication and collaboration between different institutions governing resource allocation leads to inefficiency because single-sector plans can undermine progress in other sectors. In practice, policy and decision makers generally do not follow or even have access to a holistic or inclusive framework that can engage relevant stakeholders and account for the multiscale character (ranging from local to regional, national, or global) as well as the complex and dynamic nature of the WEF nexus. Providing policy makers and practitioners with such a framework could allow them to properly identify and quantify linkages across sectors, and to design inclusive policies and strategies that could result in more efficient allocation of resources. For improved resource use across sectors, however, collaboration between key stakeholders is not an end in itself. There is also a need to properly communicate scientific findings to the relevant parties so they can integrate new knowledge into their plans for evidence-based actions (Mohtar and Daher 2016). Ideally, the WEF nexus approach is expected to offer an opportunity to engage various stakeholders, allowing them to make evidence-based and inclusive decisions in their respective sectors.

Assessing the views of different stakeholders (either through policy dialogues or through conducting surveys or interviews) is important for (1) revealing the diverse plans, targets, interests, and resource uses in different sectors, thus providing information to address potential trade-offs; (2) involving and bringing together different stakeholders from various sectors and levels of governance, thereby building a common understanding of challenges and opportunities at different scales; (3) ensuring that interventions are consistent with the needs and priorities of different sectors at different scales; (4) assessing and making connections with ongoing plans and actions; and (5) creating a feeling of ownership by relevant stakeholders through attaining more favorable outcomes in decision-making

processes. The stakeholders in WEF systems include government bodies, nongovernmental organizations (NGOs), regional organizations, local and international research institutions, universities, civil society, and the private sector (FAO 2014).

This paper describes nexus opportunities and challenges identified by selected stakeholders, with a focus on government agencies at the national and regional levels in the Eastern Nile Basin. The information was collected through an e-survey and key informant interviews (KIIs) conducted in the three Eastern Nile countries of Ethiopia, Sudan, and Egypt.[1] The tools were designed to gather in-depth knowledge and opinions from policymakers and practitioners on challenges and opportunities across the WEF nexus in the region. Particularly, the study attempts to identify the frequency and nature of interactions between key stakeholder organizations in the WEF sectors as well as the most influential organizations operating in the WEF space in the three countries; to understand the relevance of collaboration among the three sectors and among riparian countries, and the main steps needed to improve cooperation between countries in the Eastern Nile; and to discern the investments and actions the three countries should make to ensure adequate supplies of WEF resources to meet current and future demand. The rest of this study is organized as follows. Section 2 discusses the methods used to gather the data and information for this study. The third section presents key findings from the e-survey and the KIIs. The last section discusses the results and concludes.

[1] Activities could not be implemented in South Sudan for various reasons.

2 Methods

The study used an e-survey that was disseminated to key stakeholders in the Eastern Nile countries. Stakeholders surveyed belonged to a range of organizations whose mandate is the development and management of agriculture, water, and energy in the Eastern Nile, mostly with national-level mandates. To expand on views expressed in the e-survey, follow-up KIIs were conducted among respondents to the e-survey who expressed interest in an in-depth interview. The e-survey was designed to gather information on the frequency and nature of interactions across WEF sectors and among countries in the Eastern Nile, such as personal communications between staff, attendance at conferences, and joint work on program design or implementation. In addition, respondents were asked to identify the organizations they perceived as the most influential in the three WEF sectors. The survey also gathered respondents' opinions about the importance of collaboration and coordination across sectors and countries to minimize sectoral and transboundary trade-offs. It asked about the steps needed to improve coordination between sectors and across basin countries for more effective natural resource management. Finally, the instrument elicited opinions on investment, knowledge, and capacity needs in the Eastern Nile region.

The e-survey was geared toward participants working in government agencies, local and international NGOs, research institutions, regional organizations, and other stakeholder organizations involved in the WEF sectors. Participants were identified mainly through previous networks created by the International Food Policy Research Institute and its partners under a nexus project supported by the federal government of Germany. In the e-survey, respondents were asked whether they were interested in participating in a follow-up KII. Those who responded positively were later contacted for an interview. Participation in the e-survey and KIIs was voluntary, and the identity of the respondents was kept confidential.

The e-survey was organized in four sections and consisted of a total of 25 questions. The first section asked for general background information on participants, including the name of the organization they worked in, its type, the country or countries on which the organization focuses, its primary sector, its most relevant area of work, and any additional sectors to which the respondent's organization contributes. Section two inquired about the frequency and type of interactions the respondent's organization has with other organizations across sectors. Section three requested respondents' opinions regarding the adequacy of existing collaboration and coordination across sectors and countries as well as the perceived importance of such collaborations for better resource management in the region. Section four gathered opinions about national and regional investments as well as knowledge and capacity needs required to ensure the supply of WEF resources to meet current and future demands in the Eastern Nile region.

The full e-survey questionnaire is presented in the appendix. The survey contained both closed and open-ended questions and was sent to more than 100 identified stakeholders in each basin country. In all three countries (Egypt, Ethiopia, and Sudan), the response rate was high, at about one-third of all the people who were invited (30 responses from Ethiopia, 31 from Sudan, and 36 from Egypt). Moreover, 15, 17, and 16 individuals from Ethiopia, Sudan, and Egypt, respectively, indicated interest in participating in the KIIs. A total of 14 interviews were completed, 5 in Ethiopia, 3 in Sudan, and 6 in Egypt. The KIIs aimed at gathering in-depth information about the program, projects, and research activities of participants; understanding the type and extent of their collaboration with stakeholders in other sectors; and eliciting their opinions on the need for collaboration between WEF sectors as well as for investments in the three sectors, for each riparian country specifically and for the region as a whole.

3 Results from the E-survey and Key Informant Interviews

This section discusses the results from the e-survey and KIIs, starting with the background of survey respondents.

3.1 Background of E-survey Respondents

In all three countries, the e-survey was sent out to a range of individuals who had participated in previous events focused on the WEF sectors. As a result, the government and academic sectors were overrepresented, and the private sector and representatives of end users, such as farmer organizations, were underrepresented. Thus, although this e-survey does not present the views of all stakeholders in the Eastern Nile Basin, it captures the opinions of key policy and decision makers and of the research community that is generating evidence for these leaders. A summary of respondents' characteristics is provided in Table 3.1. In Ethiopia, slightly more than a third of respondents worked in government agencies (mainly as experts and policy makers), and in Sudan, the share was more than half. In Egypt, on the other hand, the largest share of responses was from the academic community.

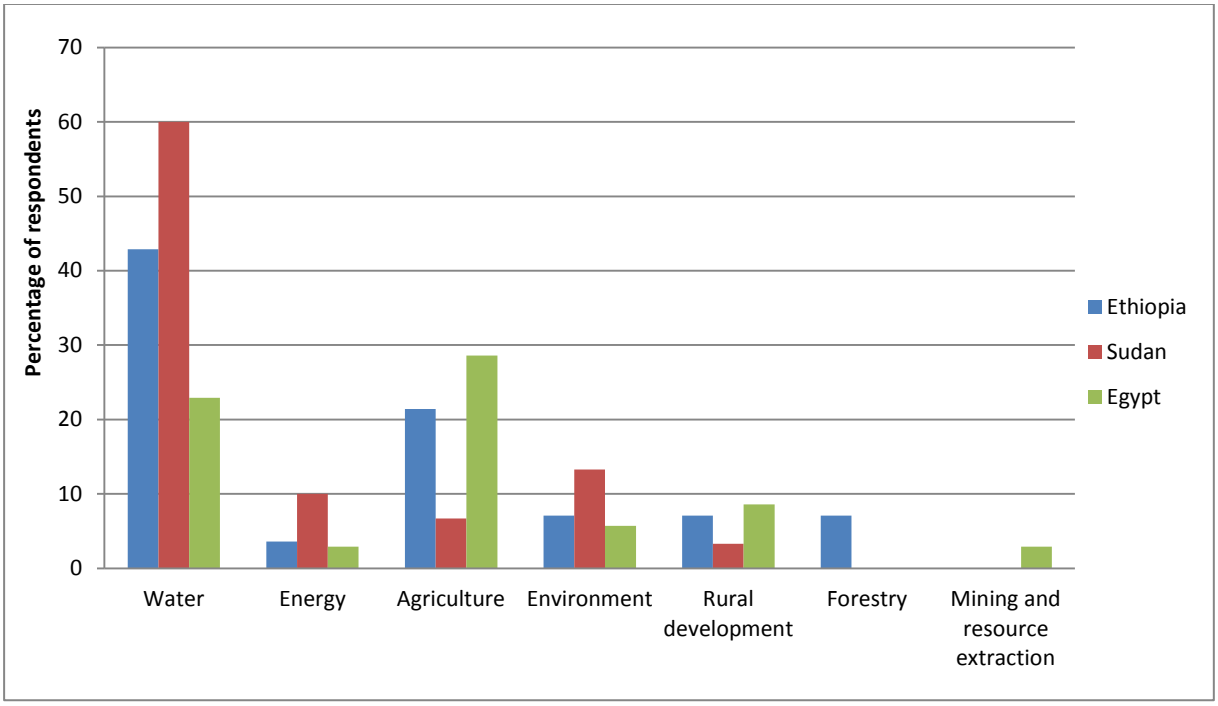
Table 3.1: Survey respondents' organizational types

Organization type	**Ethiopia**		**Sudan**		**Egypt**	
	Freq.	**Percentage**	**Freq.**	**Percentage**	**Freq.**	**Percentage**
Private company	0	0.0%	2	6.9%	1	2.9%
Government agency	11	36.7%	17	58.6%	5	14.7%
National agricultural research institute	1	3.3%	1	3.4%	1	2.9%
Academic or research institution	7	23.3%	5	17.2%	16	47.1%
International NGO	2	6.7%	0	0.0%	2	5.9%
Local NGO	1	3.3%	2	6.9%	0	0.0%
Regional organization	4	13.3%	1	3.4%	0	0.0%
Other (please specify)	4	13.3%	1	3.4%	9	26.5%

Source: Authors' e-survey (2016).
Note: NGO = nongovernmental organization.

Respondents were also asked to state the number of countries their organization focused on. Responses show that 70–80 percent of the organizations represented focused on only one country, with the remainder being regional organizations focused on two to several countries. The e-survey respondents also reported the primary sector their organization focused on. Water was indicated most often in Ethiopia (43 percent) and Sudan (60 percent), agriculture in Egypt (29 percent) (Figure 3.1). Within these sectors, respondents were asked to describe their primary work areas (Figure 3.2). Water (hydrology, hydrodynamics, water management) was the area of work listed most frequently in Ethiopia and Sudan. In Egypt, it was socioeconomic development (including income, welfare, and social protection). Other key areas included environmental conservation and crop production.

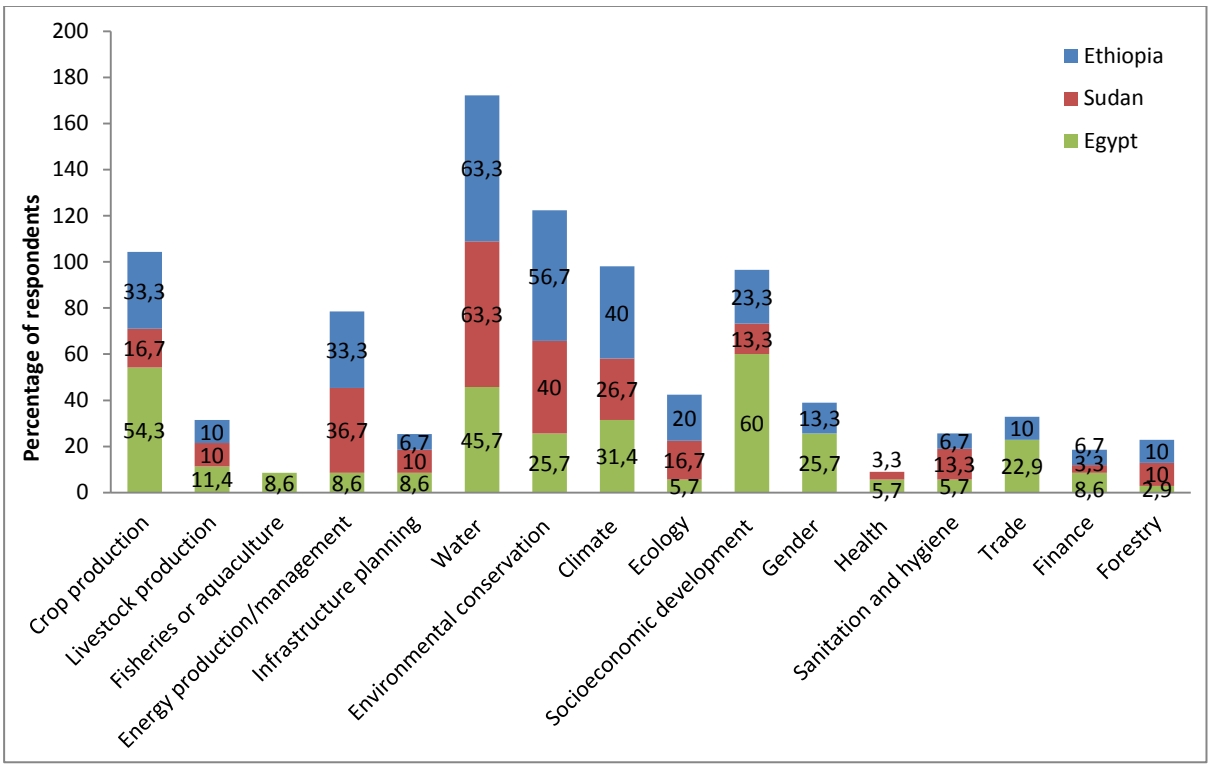
Figure 3.1: Respondent's primary sector



Source: Authors' e-survey (2016).

A further question asked to which additional sectors respondents contributed beyond their primary area of work. More than half of the Ethiopian and Egyptian respondents indicated that they contributed to the environment, agriculture, energy, and water sectors in addition to their primary sector of focus. Responses from Sudan were similar, but several respondents also mentioned forestry as an additional sector they engage in. In both Ethiopia and Sudan, a significant number of respondents whose primary sector of focus was water indicated that they also contribute to energy, agriculture, the environment, and rural development. Specifically, a large number of respondents in these two countries who listed water as their primary sector mentioned linkages to energy. In addition, respondents from Ethiopia primarily focusing on agriculture also linked to water and rural development, whereas responses from Sudan suggested that those working on water and the environment also contributed to the forestry sector. Respondents from Egypt who focused on agriculture indicated that they also contributed to water, the environment, and rural development; those focusing on water mentioned energy, agriculture, and the environment as additional areas they contributed to. Based on these responses, respondents already link across sectors, generally across water-energy-environment and forestry, but no linkages were indicated between the food and energy sectors in the three countries.

Figure 3.2: Areas most relevant to respondent's current work



Source: Authors' e-survey (2016).

The KII participants ranged from executive directors of regional organizations to experts and researchers in government agencies to those working in local and international research organizations. Participants in the KIIs were involved in various areas of work, such as improving agricultural productivity (crop and livestock), watershed management, climate change and risk management, multipurpose water resource development assessment (mainly irrigation and hydropower), renewable energy, natural resource management (such as forestry), enhancing the productivity of marginal resources, clean water supply, livelihood improvement, regional economic integration, and gender issues.

3.2 Cross-sectoral Interactions and Influential Organizations

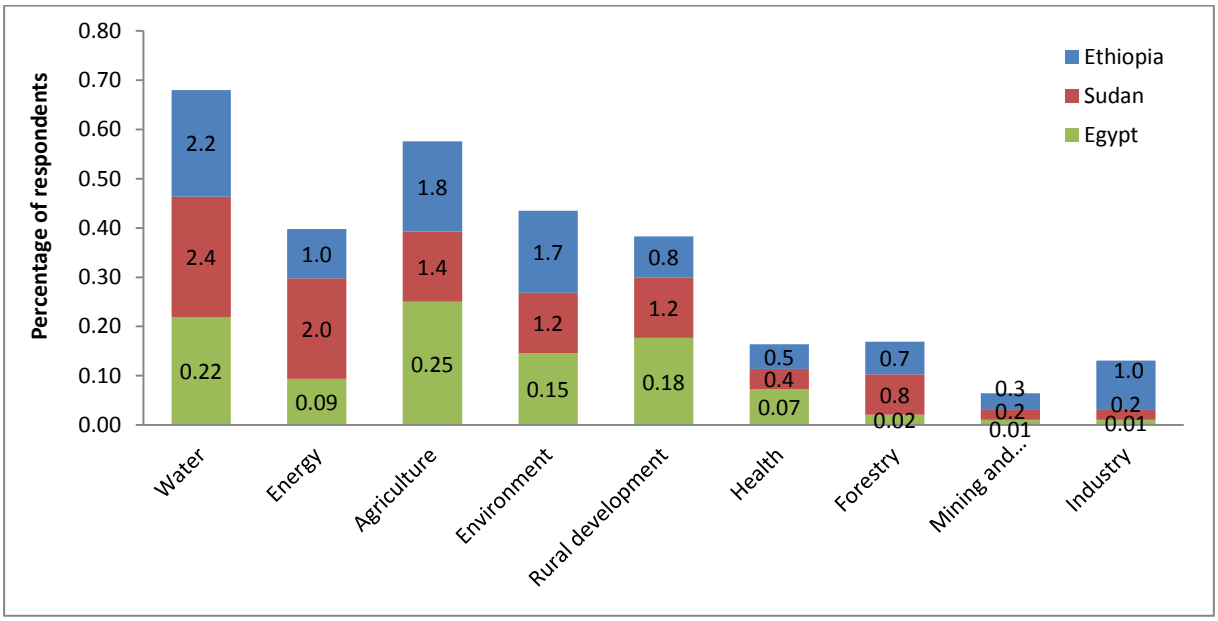
This section discusses the extent and types of interactions between different organizations, based on responses to the e-survey and KIIs as well as the organizations considered to be most influential in the WEF nexus space. Respondents characterized the extent of interactions with organizations in other sectors with responses ranging from "never" to "frequently." Figure 3.3 summarizes responses indicating frequent interactions (five or more times per year).[2] In general, interactions were most frequent with the water and agriculture sectors, followed by interactions with the environment sector. Sudanese respondents additionally reported frequent interactions with the energy sector.

In addition to the number of interactions, respondents were also asked about the types of interactions with other organizations. Table 3.2 presents the number of responses for each type of interaction by sector and country. Most interactions took place within the water sector and between the water and other sectors. The agriculture sector ranks second in terms of interactions, yet there

[2] In all three countries, a large number of interactions were reported with organizations in the same sector (such as water organizations with water organizations), even though the question asked for interactions with organizations in other sectors. These responses can be taken as an indication of significant interactions with other organizations in the same sector.

are few or no linkages between the energy and agriculture sectors. In general, there seems to be limited consultation on planning and decision making in the water sector of Egypt, but the number of responses is too small to draw any conclusions. Responses from most KII participants noted that interactions with government agencies (mainly ministries) were largely in the form of conducting joint projects (research), exchanging data,[3] and communicating findings (and receiving feedback)[4] through workshops and conferences. KII participants also reported that collaboration with various government agencies was important for understanding and following the development agenda of the country.

Figure 3.3: Interactions across sectors, five or more times per year



Source: Authors' e-survey (2016).

One respondent from Ethiopia who was primarily working in the agriculture sector mentioned that his organization had an innovation platform where relevant stakeholders from different sectors could meet and discuss new ideas. Similarly, a respondent from Egypt working primarily in agriculture stated that collaboration with relevant stakeholders from various sectors included planning for future projects, diagnosing and analyzing common problems, and identifying potential solutions. He also mentioned that his organization was gathering the opinions of farmers, the private sector, and NGOs about current and future investment opportunities.

[3]For example, respondents from Ethiopia mentioned that they used input data on climate, hydrology, and water resources from the National Meteorology Agency and the Ministry of Water, Irrigation and Electricity.

[4] Responses from Ethiopia indicated that organizations allow government agencies to give feedback on findings of research work as well as to present relevant research papers from their side. For example, one respondent mentioned working closely with the country's Environmental Protection Authority and allowing the agency to evaluate studies by the respondent's organization.

Table 3.2: Types of interactions with organizations in other sectors and with other stakeholders in the same sector (number of responses)

Panel A. Interactions with water sector

	Primary sector								
	Water			Agriculture			Energy		
Type of interaction	**Eth.**	**Sud.**	**Egy.**	**Eth.**	**Sud.**	**Egy**	**Eth.**	**Sud.**	**Egy.**
Interact through professional conferences	9	8	7	5	2	5	0	0	0
Interact one-on-one with professionals in the sector	6	7	6	3	2	3	0	1	0
Collaborate on planning	6	7	3	0	0	2	0	2	0
Collaborate on project or other implementation	8	7	7	0	1	7	0	1	0
Collaborate on research	8	5	8	1	2	6	0	1	0
Provide policy advice/influence	6	8	5	2	0	1	0	0	0
Consult on planning / decision making	8	6	2	0	1	1	0	0	0

Panel B. Interactions with agriculture sector

	Primary sector								
	Water			Agriculture			Energy		
Type of interaction	**Eth.**	**Sud.**	**Egy.**	**Eth.**	**Sud.**	**Egy.**	**Eth.**	**Sud.**	**Egy.**
Interact through professional conferences	7	7	7	5	2	5	1	1	0
Interact one-on-one with professionals in the sector	4	4	5	4	2	4	0	0	0
Collaborate on planning	6	6	1	3	2	3	0	0	0
Collaborate on project or other implementation	3	3	5	3	2	6	0	0	0
Collaborate on research	3	3	5	5	2	7	0	0	0
Provide policy advice/influence	3	3	3	5	2	4	0	0	0
Consult on planning / decision making	6	6	1	2	2	5	0	0	0

Panel C. Interactions with energy sector

	Primary sectors								
	Water			Agriculture			Energy		
Type of interaction	**Eth.**	**Sud.**	**Egy.**	**Eth.**	**Sud.**	**Egy.**	**Eth.**	**Sud.**	**Egy.**
Interact through professional conferences	7	6	2	0	0	5	0	1	1
Interact one-on-one with professionals in the sector	4	5	1	0	0	1	1	2	0
Collaborate on planning	6	4	0	0	0	1	0	2	0
Collaborate on project or other implementation	3	4	1	0	0	1	1	3	1
Collaborate on research	3	2	2	0	0	1	0	2	1
Provide policy advice/influence	3	4	1	0	0	1	0	3	0
Consult on planning / decision making	6	4	0	0	0	1	0	2	0

Source: Authors' e-survey (2016).

Table 3.3 lists the three most influential organizations in the WEF sectors as identified by respondents. Most respondents indicated that government ministries are the primary and most influential organizations in all WEF sectors, and the most influential agency in each sector was generally clearly identified by a wide margin. In the agriculture sector, in addition to the ministry, Ethiopian and Egyptian respondents identified the Agricultural Transformation Agency and the Food and Agriculture Organization of the United Nations, respectively, as influential organizations. In addition, in all three countries, at least one research organization was among the top three most influential organizations identified in the sector.

Table 3.3: Three most influential organizations in the water, energy, and food sectors as identified by respondents (number of responses)

	Ethiopia		Sudan		Egypt	
Sector	**Name**	**Freq.**	**Name**	**Freq.**	**Name**	**Freq.**
Agriculture	Ministry of Agriculture and Natural Resources	23	Ministry of Agriculture and Forestry	15	Ministry of Agriculture and Land Reclamation	21
Agriculture	Agricultural Transformation Agency	11	Ministry of Water Resources and Electricity	8	Food and Agriculture Organization of the United Nations	14
Agriculture	Ethiopian Institute of Agricultural Research	8	Agricultural Research Corporation	6	Agricultural Research Center	12
Water	Ministry of Water, Irrigation and Electricity	22	Ministry of Water Resources and Electricity	21	Ministry of Water Resources and Irrigation	20
Water	Ministry of Agriculture and Natural Resources	8	Ministry of Agriculture and Forestry	3	National Water Research Center	10
Water	River basin authorities	5	Dams Implementation Unit	3	Ministry of Agriculture and Land Reclamation	3
Energy	Ethiopian Electric Power Corporation	22	Ministry of Water Resources and Electricity	15	Ministry of Electricity and Renewable Energy	10
Energy	Ministry of Water, Irrigation and Electricity	18	Ministry of Energy and Mining; Ministry of Petroleum and Gas	11	Ministry of Petroleum	7
Energy	Ministry of Mines, Petroleum and Natural Gas	7	National Center for Energy Research	4	International companies / private sector	6

Source: Authors' e-survey (2016).

Interestingly, in Sudan, two different ministries were considered to be the most important players in all three sectors. Moreover, one ministry, the Ministry of Water Resources and Electricity, was considered to be among the most important organizations for all three sectors, suggesting substantial potential for intraministerial as well as cross-ministerial collaboration for joint WEF management in the country. In the water sector, responses from Ethiopia and Sudan suggest that, in addition to ministries, river basin authorities and a dams implementation unit, respectively, are important entities, while in Egypt a national research body, the National Water Research Center, is ranked third. For energy, all three countries listed two ministries in addition to a national authority, a research center, and the private sector.

Similarly, responses from the KIIs reveal that most organizations work closely with government bodies at both the federal and regional levels. Almost all respondents from Ethiopia mentioned that they collaborate with the Ministry of Agriculture and Natural Resources; the Ministry of Livestock and Fisheries; the Ministry of Water, Irrigation and Electricity; the Ministry of Foreign Affairs; and the National Meteorology Agency. In addition, CGIAR centers; universities; and regional bureaus of irrigation, agricultural, and natural resources, as well as for livestock and fisheries, were listed as important collaborators. From the private sector, NGOs, private investors, farmers, suppliers, and various service providers and manufacturers were also identified as engaging in WEF sectors in responses from both Ethiopia and Egypt.

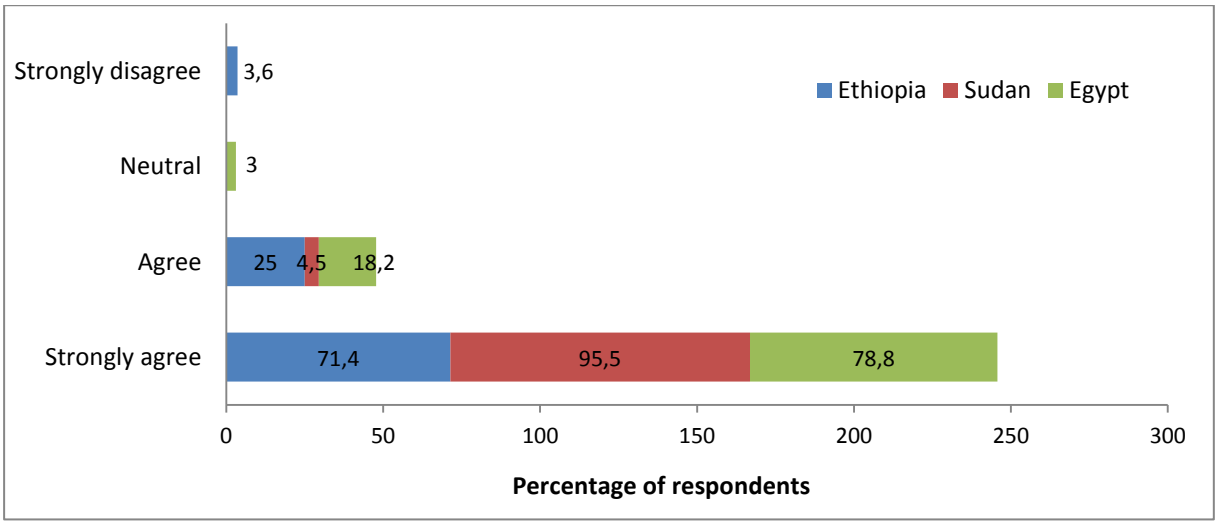
3.3 Collaboration among the Water, Energy, and Food Sectors

This section describes respondents' perceptions about the need for, importance of, and adequacy of cross-sector national and regional collaborations.

3.3.1 National Collaboration

Respondents were asked whether national collaboration across the WEF sectors was essential for resource management in the region and whether national coordination efforts across the WEF sectors were sufficient. Figure 3.4 shows that the majority of respondents in all three Eastern Nile countries strongly agreed that collaboration across the WEF sectors throughout the region is essential for planning and decision making to improve resource management in the region.

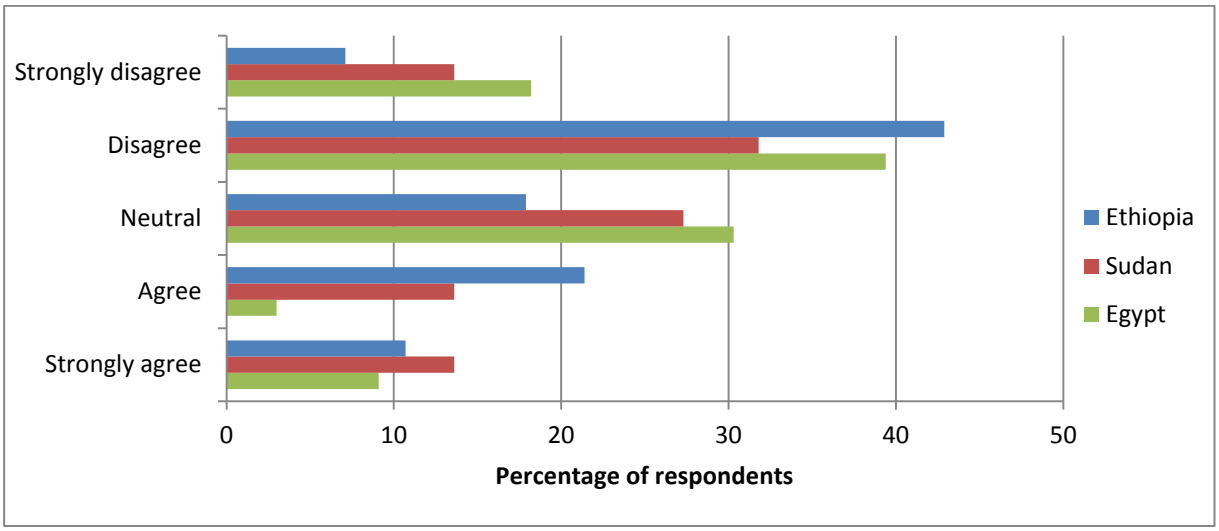
Figure 3.4: Responses to the statement "Collaboration across the water, energy, and food sectors is essential for improved resource management in the region"



Source: Authors' e-survey (2016).

On the question of adequate existing coordination, there was no consensus, but the majority of respondents felt that coordination needs improvement. For example, 43 percent of respondents from Ethiopia, 32 percent from Sudan, and 39 percent from Egypt disagreed that national policies, plans, and decisions are well coordinated across WEF sectors (Figure 3.5). A further 18 percent of respondents from Egypt, 14 percent from Sudan, and 7 percent from Ethiopia strongly disagreed with the notion that policies, plans, and decisions are well coordinated at the national level. A considerable number of respondents did not voice a specific opinion on the question, and several respondents from Egypt (12 percent) and around 30 percent of respondents from both Ethiopia and Sudan agreed or strongly agreed that coordination across the WEF sectors was working well.

Figure 3.5: Responses to the statement "National polices, plans, and decisions across the water, energy, and food sectors are well coordinated"



Source: Authors' e-survey (2016).

Responses from the KIIs provide several examples of weak coordination across the WEF sectors at the national level. A respondent from Egypt summarized the feelings of several Ethiopian and Egyptian respondents:

> Currently there is an ongoing competition on who will be leading an irrigation project planning to cultivate 1.5 million feddan [about 0.63 million ha]. They shift the priorities given back and forth between the Ministry of Agriculture and Land Reclamation and the Ministry of Water Resources and Irrigation. This is not a very good policy, though; a better strategy would be to have an integrated team that has expertise from both ministries working together. Thus, this kind of cooperation is not yet feasible and is not likely to be, in my opinion, unless a newer way of thinking takes the lead. For example, when they designed the water security strategy, there were no people representing the agricultural sector; similarly, there were no people from the water sector represented when the food security strategy was discussed.

The responses obtained from the KIIs also provide some of the reasons for the strong consensuses reached about the need for collaboration across sectors. First, respondents noted that the three sectors are naturally interlinked, making collaboration essential. A respondent from Ethiopia (working in a government agency) mentioned that "basically water, energy, and food are interdependent; one can't stand or operate alone without the other, and hence collaboration or integrated work among them is very important." Integration among sectors was reported to be vital to getting the maximum benefit from investments in all sectors. A respondent from Egypt mentioned that coordination across sectors helps to harmonize planning by reconciling conflicting and overlapping ideas. Respondents also indicated the importance of collaboration for sharing experiences and learning from others.

> To illustrate how lack of integrated work can cause serious problems, I can give the case of the Tana Beles project as an example. The concept of Tana Beles is as follows: the water that goes out from Lake Tana passes through the Chara Chara Weir and goes to the Tis Abay I and II hydropower stations with a capacity of 84 MW. However, instead of staying at 84 MW, a tunnel was built at the back; making it possible to generate more energy (460 MW) with less water (the former uses 100m^3/sec, whereas the tunnel uses only 77m^3/sec). And there are two irrigation projects just downstream: the Upper and Lower Beles projects. Together, up to 140,000 ha can be developed under these projects. However, when the projects were first designed, no mechanism was conceived

> to transfer the water to the irrigation fields in times when the hydropower doesn't operate. So, in the middle of the project it gets redesigned and a bypass tunnel is built at additional cost. In times when the hydropower is not operational, the water will pass through the bypass tunnel for irrigation. If this had not been fortunately discovered in the middle of the project, the irrigation project downstream was going to fail completely. Thus, integration among the three sectors is important to avoid problems like this from the beginning and obtain the maximum possible benefit. -KII response from Ethiopia

Another KII respondent from Egypt emphasized the need for collaboration between WEF sectors because the three resources are highly interdependent in the country. He stressed that irrigation in Egypt is dependent on energy because water abstraction for that purpose often uses diesel for running pumps. The respondent stated that the "situations in Egypt are closely intertwined because at the end of the day in order to produce food, we need water, and in order to get water into the field we need electricity." Accordingly to the respondent, connecting farmers in the delta with electricity (for pumping water) is a challenge limiting irrigation. As a result, solar panels are being considered as an alternative.

> Higher means of cooperation among sectors would solve a lot of problems related to planning, where we happen to have a lot of problems in Egypt. For instance, ideas coming from different ministries might overlap. Thus, more collaboration and connectivity is needed in this regard in order to efficiently manage our limited natural resources. -KII response from Egypt

Improving resource use efficiency is a further important factor reported to support collaboration across WEF sectors. One respondent, from Ethiopia, mentioned that most natural resources are nonrenewable and need to be used in an efficient manner, which requires cooperation across sectors. Another respondent, from Egypt, explained that there is a need to promote efficient use of water by adopting crops with low water requirements. He mentioned that even if efficient natural resource management should primarily be based on the concept of economic efficiency (particularly marginal productivity), social factors should also be given emphasis and need to be integrated into nexus analysis. He presented an example of sugarcane production in Upper Egypt: from an efficiency perspective, sugarcane should not be grown there, but it is difficult to move out of sugarcane due to local traditions and the crop's associated social value. The respondent stated, "Making a change in the cultivation cycle should be preceded by a study of social aspects, but usually decisions on removing crops are made without taking this social aspect into account. Farmers are not going to make changes without having these three questions answered and taken into consideration: First, is it economically wise or profitable? Second, is it socially acceptable? And third, is it environmentally valid?"

> I will address the question of the need for collaboration among different sectors from the perspective of our main work: technology development. I believe any technology produced should take into consideration the available resource potential. For example, let's say we produce a certain crop technology. To be effective, the technology should be able to fit the resource potential available in the area where it is going to be introduced. So we need reliable and appropriate data on resource potential to produce suitable technologies. However, usually the data produced by different ministries are not sufficient for our purposes. One major problem is the difference in spatial scales. Most data are available at an aggregated scale, but the technology we produce is site specific and we need data that are compatible. For example, we need site-specific soil information for different analysis; the data we get are usually aggregated (for a certain region or sub-basin). Also, most of the time we obtain model based data and not observed data. We face the same problem with the National Meteorology Agency. It has only a limited number of stations countrywide, and the data they produce are not representative of Ethiopia (especially given the fact that Ethiopia's topography and

> climate is very diverse). Therefore, information should be planned and produced jointly in a way that everybody can use the information. Otherwise, it will be very difficult for one entity to take and use information or technology that is produced by another party.
> -KII response from Ethiopia

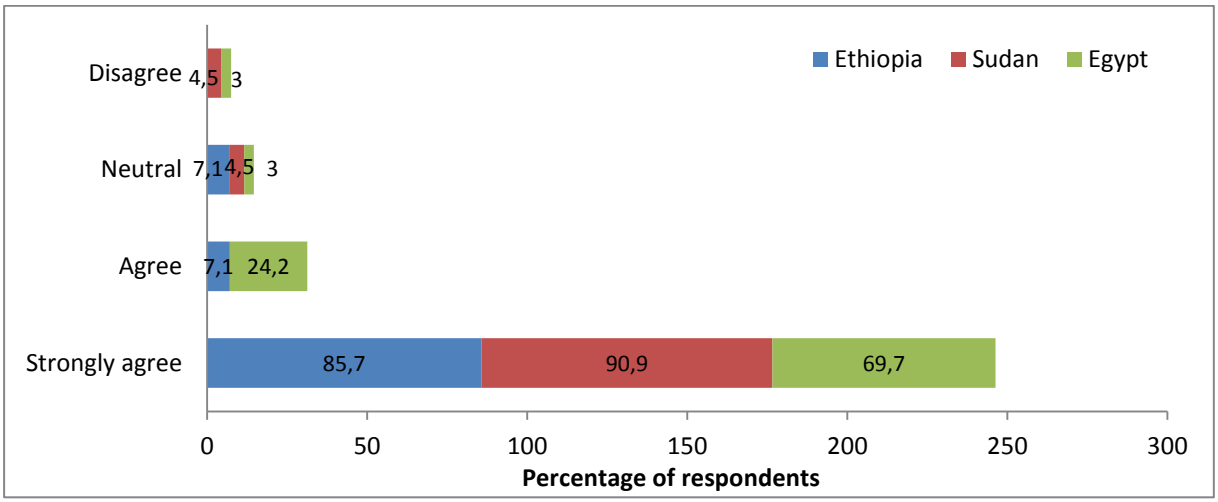
Some KII respondents also reported that collaboration among WEF sectors is not enough in the sense that other factors (such as climate change and basic infrastructure development) should also be integrated into nexus thinking. KII participants also mentioned natural resource degradation and depletion, and the question of sustainability, as a rationale for collaboration among WEF systems. One respondent from an international research organization in Ethiopia pointed out that development activities in any of the three sectors should not adversely affect the natural resource base. Mitigation and rehabilitation efforts are thus needed to ensure that development activities in one sector do not adversely affect outcomes in another.

KII participants also discussed several challenges that hinder collaboration. Respondents reported that even if greater collaboration and integration between sectors is theoretically ideal, in practice it is very challenging. Major challenges include the existence of sector-specific policies, mandates, responsible authorities, and institutional setups, as well as the lack of incentives for cooperation. In many cases, several separate and independent bodies work on what are essentially the same issues, making collaboration difficult because each body has its own goals and institutional setup. As an example, respondents from Ethiopia mentioned the case of irrigation: medium- and large-scale irrigation projects are managed by the Ministry of Water, Irrigation and Electricity, whereas small-scale irrigation is handled by the Ministry of Agriculture and Natural Resources. Such segmentation, respondents indicated, has shortcomings, including difficulty in getting consistent data. Respondents pointed out that in practice, different institutions focus on working per their mandate because in the end, their work will be evaluated based on what they achieved under the mandate. Finally, professional or disciplinary biases were noted to be another obstacle to cross-sectoral, multidisciplinary collaboration.

3.3.2 Regional Collaboration

Next in the survey came questions on the importance of regional cooperation for WEF security. Figure 3.6 shows wide agreement on this topic, with 70–91 percent of respondents, by country, strongly agreeing that collaboration is important to meet WEF needs. Again, respondents from Sudan, the country in some ways in the middle between Ethiopia and Egypt in the Eastern Nile Basin, felt the strongest need for such coordination. Egypt's response on this question was slightly weaker than the country's response about the need for national cross-sectoral collaboration, possibly because the country chose a few years back to leave one of the key regional coordination bodies, the Nile Basin Initiative.

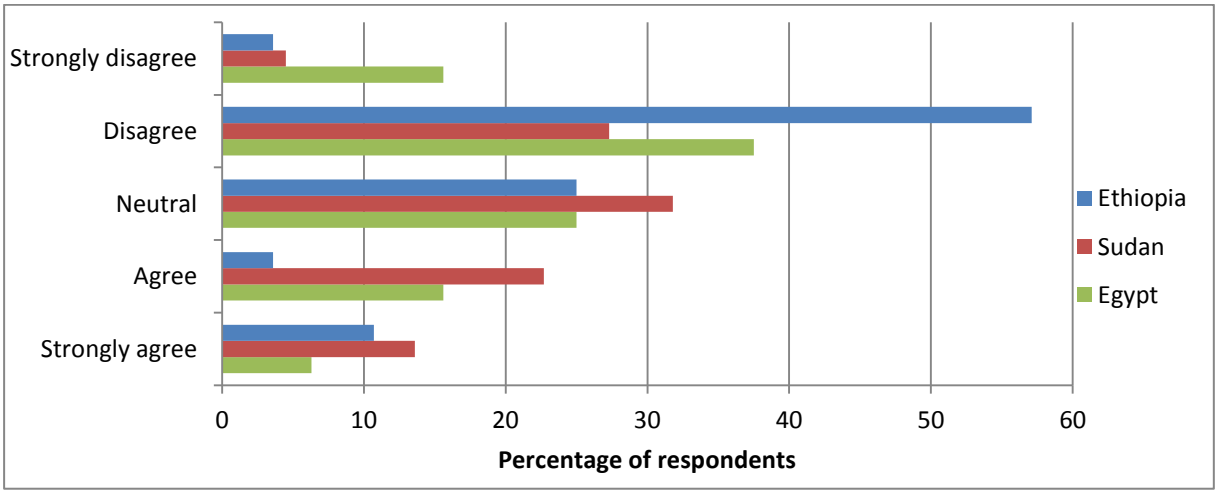
Figure 3.6: Responses to the statement "Collaboration among countries in the Eastern Nile Basin is important for adequate provision of food, energy, and water"



Source: Authors' e-survey (2016).

Similar to the question on adequacy of national collaboration, respondents from the three countries were somewhat divided on the adequacy of current regional cooperation, although most of them characterized it as inadequate (Figure 3.7). More than half of all Egyptian and Ethiopian respondents disagreed or strongly disagreed that cooperation is adequate, and 32 percent of Sudanese respondents disagreed or strongly disagreed. Approximately one-quarter to one-third of respondents felt neutral on this topic, whereas the rest agreed or strongly agreed that cooperation is sufficient. Among the three countries, Sudanese participants in the e-survey felt most strongly that ongoing cooperation is adequate.

Figure 3.7: Responses to the statement "Ongoing regional cooperation between countries in the Eastern Nile Basin is adequate"



Source: Authors' e-survey (2016).

Responses obtained from the KIIs largely support collaboration among countries in the Eastern Nile. Most respondents mentioned that any development in the basin will ultimately have implications for the rest of the basin (which could be either beneficial or harmful) and the benefit could be increased, or damage reduced, through joint planning and actions. A respondent from a regional organization based in Ethiopia gave his take on the importance of collaboration between basin countries: "Unilateral actions usually cause conflicts, and conflict has its own cost. So if we take the cost of conflict into account, collaboration is mostly better than unilateral actions. Collaboration across the

sectors and the basin countries also brings what we call 'benefit beyond the river,' such as increased trade and tourism, better technical cooperation, and improved infrastructure."

> There is no doubt that resources should be used in a coordinated manner by all the four riparian countries [Egypt, Sudan, South Sudan, and Ethiopia]. Each country has its own comparative advantage, and hence a multilateral approach is highly beneficial. I remember a very nice article regarding this. It's by Harry Verhoeven (2011), and he argued that Ethiopia has a comparative advantage in hydropower production, while Sudan has the same in agriculture (oil as well), and Egypt should provide the finance. Then regional trade between the three countries would benefit all the countries. I don't agree with all his arguments, but I think he has a great point. I believe utilizing this difference in comparative advantage between nations is the only way to bring about collaboration across sectors within the basin. In general, though past experiences are not very encouraging, a multilateral approach is the only sustainable option for this basin. -KII response from Ethiopia

Given the fact that downstream countries are largely dependent on water originating from upstream areas, one KII participant suggested joint investment in watershed management upstream as an area in need of collaboration. A respondent from Ethiopia explained that the demographic, environmental, and economic situations in upstream countries are expected to further degrade natural resources, in turn impacting downstream countries:

> In the past, floods and sedimentation have occurred on several occasions, and they could continue in the future if appropriate management of resources is not practiced upstream. There should be strong natural resource conservation upstream. Rapid population growth in the highlands will further reduce the natural resource base for individuals, leading to overutilization and associated degradation. It will be important to find new income opportunities for the highland population outside the agricultural sector to ensure that fragile hillsides are preserved. This will require joint development programs by riparian countries. Because the environmental consequences of upstream natural resource degradation are not local (but stretch to the Mediterranean Sea), joint interventions are needed for the sake of global existence.

In general, KII responses from Ethiopia pointed out that the transboundary nature of the river should be given due emphasis in national plans and that the basin should be managed as one system.

KII responses from Egypt were also in favor of collaboration among riparian countries. For example, respondents identified trade between basin countries as a key form of cooperation. A respondent from a research institute in Egypt mentioned that trade is the right tool for cooperation between Eastern Nile countries and suggested that the private sector, not the government, has to be the main player in this area. He mentioned foreign investment by the Gulf countries in the agricultural sector of Sudan as a good example that can also be practiced by the basin countries through establishing joint agricultural projects between Egypt, Sudan, and Ethiopia.

> I believe we have major areas that we can collaborate on, based on the resource base in each of the [Eastern Nile] countries. For example, livestock has a large amount of virtual water content in comparison with other commodities. Making use of the rainfed agriculture in Ethiopia, we can jointly develop livestock projects (including animal rearing, forage development, slaughterhouses, and processing) there and import the meat, which will allow us to save this high amount of virtual water use in Egypt. The same collaboration can also be made with Sudan. Importing livestock from these two countries will also allow us to utilize the land currently planted with clover (which is used mainly for animal feed) to be planted with wheat instead, which will improve the country's food self-sufficiency/security. We can also collaborate to improve the productivity of rainfed agriculture in Ethiopia and Sudan, such as by promoting

> rainwater harvesting, which could help to increase cropping intensity. -KII response from Egypt

Respondents suggested that because Ethiopia and Sudan possess relatively abundant resources for agricultural production, projects can be established in these two countries with Egypt providing technical assistance (because Egypt possesses better knowledge and experience, especially in irrigated agriculture) (see KII responses for further details).

Another KII respondent from Egypt mentioned that the riparian countries face common problems, such as soil erosion, salinity, and water shortages, which require joint solutions. Moreover, responses from KII participants in Egypt reflected that collaboration between basin countries should center not only on water but also on other sectors. Further, some suggested that integration across countries should include joint operation between the technical and the political realms. One respondent stated, "Even if the technical aspects are well studied and imply the need for more collaboration, at the end of the day the decision maker is the politician and hence the two should work together."

One respondent from Egypt also mentioned that cooperation is needed in the region regarding the operation of water infrastructures that are planned or currently under construction. He gave the Owen Falls Dam on Lake Victoria in Uganda as an example, mentioning that it was partially funded by Egypt. The purpose of the dam is hydropower generation, and its water release is determined through collaboration between Uganda and Egypt. The respondent said, "Over the last 60 years, Egyptian engineers have been engaged in the monitoring and decision making over water releases from the dam. This is an example of the kind of cooperation I would hope to see with other countries in the basin in the future. Inevitably, all the three countries will attempt to maximize control over the water resources, and thus the main issue would be how to do it for the benefit of everyone."

> Water resource developments in the basin are going to proliferate. Currently we have three dams upstream under construction along the Blue Nile main course. At the moment, each country is developing the river unilaterally, but when the infrastructures become operational, a greater degree of coordination is required between countries. If the operation of such developments is not coordinated, it will pose a serious problem to countries. Take the Grand Ethiopian Renaissance Dam as an example. Its operation should be in line with the water use and operation of dams in Sudan and Egypt. If not, the benefit that is expected to be obtained by the three countries from the dam might not materialize at all. Thus, coordinated management of cascade dams is an issue that needs high emphasis. -KII response from Ethiopia

Some KII respondents also reported challenges that hinder collaboration between Eastern Nile countries. One such factor is water politics between upstream and downstream countries. Respondents also listed the lack of common databases, joint analysis tools, and platforms as a challenge that creates mistrust, tension, and conflicts of interest between basin countries. Other barriers that respondents identified include lack of finance and weak existing regional institutions.

3.3.3 Actions and Investment Options

This section discusses national actions, national and regional investments, and steps to enhance cooperation as proposed by the e-survey and KII respondents. Tables 3.4 through 3.7 summarize the responses given by the e-survey respondents. Regarding national steps that need to be taken to improve coordination across WEF sectors (Table 3.4), respondents from all three countries emphasized the need to identify common areas of interest; set clear objectives, policies, and strategies; and then move to joint planning and implementation. Respondents from Sudan and Egypt also mentioned raising the awareness of decision makers on the importance of cooperation as a mechanism to avoid duplication of work and unjustified competition for resources among sectors. Similarly, respondents from both of these countries indicated that involving relevant stakeholders in planning and implementation processes is important to improve coordination across WEF sectors.

Respondents from Ethiopia and Egypt also reported that creating platforms to facilitate multistakeholder dialogue could improve cross-sectoral collaboration.

Table 3.4: National steps needed to improve coordination across the water, energy, and food sectors, respondents' suggestions, by country of respondent

Ethiopia	Sudan	Egypt
Identify common goals and set clear missions and visions	Study areas of common interest and set common objectives as well as clear policy and strategies	Conduct research for providing evidence on the linkages
Form integrated plans and implementation	Perform joint planning and implementation (integrated water resources management)	Perform joint planning and coordination of strategies, interventions, or implementation
	Raise decision makers' awareness of the importance of cooperation for improving sectoral performance	Raise stakeholders' awareness of the importance of coordination among sectors
	Involve relevant stakeholders and empower concerned authorities	Have stakeholders participate in the planning and implementation process
Create a platform for policy debate among policy makers and experts (stakeholders)		Facilitate multistakeholder dialogue
Enhance the capacity of planners, decision makers, and experts working in different sectors	Develop partnerships among sectors with clear roles and responsibilities	Provide incentives for information and data sharing among ministries, and more transparency in decision making
Document and share the potential gains from coordinated efforts		Develop a coordination mechanism between various ministries and regularly monitor its progress
	Give responsibilities to qualified professionals and focus on scientific decisions	

Source: Authors' e-survey (2016).

The survey participants also identified national investments to help ensure that the supply of the three resources meets current and future demands. Respondents from all three countries mentioned investments in water infrastructure (such as dams). Participants from Egypt and Sudan suggested investments in renewable energy as well as in enhancing resource use efficiency (such as improving irrigation systems). Respondents from Egypt and Ethiopia mentioned investments in research and education to facilitate evidence-based decision making. Ethiopia-based respondents pointed to investments in sustainable natural resource management (such as watershed management) as well as in holistic approaches and enhanced institutional setups for the planning and management of resources, taking into consideration all sectoral demands. Respondents from Sudan also mentioned a need to invest in the coordinated management of cascade dams (Table 3.5).

Table 3.5: National investments or actions needed to balance supply with needs along the water, energy, and food sectors, by country of respondent

Ethiopia	Sudan	Egypt
Carry through with planned large-scale investment in water infrastructure	Build multipurpose dams	Develop integrated investments and implementation plans across the water, energy, and food sectors
Pay attention to sustainable natural resource management (such as effective soil and water conservation strategies)	Invest in renewable energy and irrigated agriculture	Invest in renewable energy and irrigation systems
	Improve water management for existing projects (invest in irrigation systems that improve water use efficiency)	Increase resource use efficiency, such as by investing in water-saving technologies and water desalination projects
Institute strong coordination and joint planning among the sectors	Encourage water harvesting	Invest in enhancing water quality
Provide opportunities for private-sector investors	Invest in in-depth study of the benefits of regional power trade	Reduce food waste, especially postharvest losses
Set up institutions in a way that helps avoid conflicts	Develop an optimum operating schedule among existing Sudanese dams in the light of the Grand Ethiopian Renaissance Dam (GERD) operating schedule	Improve agricultural production and marketing
Create public awareness and promote experience sharing	Invest in careful feasibility studies of proposed new dams in Sudan, considering the impact of GERD	
Invest in research (to provide appropriate evidence) and education	Invest in science and technology	Invest in education, research, and capacity building

Source: Authors' e-survey (2016).

In addition to general investment needs for balancing WEF demand and supply, respondents were also asked to state the primary investments that need to be made by each country to ensure WEF security. The responses are very similar to those listed as general investment needs. Respondents from Ethiopia and Sudan mentioned large-scale investments in water and other infrastructure as primary investment needs, those from Ethiopia and Egypt pointed to investments in renewable energy and soil and water conservation, and respondents from Sudan and Egypt recommended investments in enhancing resource use efficiency and rainwater harvesting technologies (Table 3.6).

Table 3.6: Primary national investment needs for ensuring water, energy, and food security, by country of respondent

Ethiopia	Sudan	Egypt
Water storage programs (small and large reservoirs)	New dams for electricity generation and irrigation	
Irrigation	Expansion of irrigated agriculture	Irrigation development
Renewable energy (hydropower, wind, solar, geothermal)		Developing renewable sources of energy
New technologies in all sectors	Science and technology	Increasing water efficiency
	Improvement of water management in existing projects through use of modern technologies	Water desalination projects
	Development of drought-resistant varieties of staple food crops	
Infrastructure (such as roads and telecommunication)	Development and upgrading of infrastructure	
Soil and water conservation (such as afforestation)		Reducing land degradation and improving soil fertility
	Rainwater harvesting technologies	Rainwater harvesting

Source: Authors' e-survey (2016).

The responses obtained from the KIIs largely support the types of national investment needs that were pointed out in the e-survey. KII respondents from Ethiopia mentioned investment in water storage infrastructure (for either hydropower or irrigation) and watershed conservation. Regarding water infrastructure, one respondent explained the following:

> About 86 percent of the Nile flow is contributed by Ethiopia. But when we look at this flow, almost 80 percent of it is generated within three to four months (the rainy season of June, July, August, and September). In the remaining eight months, only 20 percent of the flow will be available. When the flow is at 80 percent, Ethiopia doesn't need the water for agriculture because usually rainfall is enough. If we want to use it for hydropower, it should be generated for the entire year. It is possible to generate hydropower for three to four months as run-of-river, but that is not beneficial at all because it is not sustainable. Thus, there is a great need for water storage infrastructure in Ethiopia that appropriately accounts for downstream impacts.

In addition, respondents indicated investment in watershed management as crucial to ensuring the sustainability of the built water infrastructure.

KII respondents from Ethiopia also emphasized the role of the government in infrastructure development to create a conducive environment for private-sector participation. One respondent mentioned that even though private-sector involvement in all sectors of the economy is very important, such investment is not robust, especially in large infrastructure development, such as hydropower plants, which require a very large capital investment. Infrastructure, such as roads, was also identified as crucial for the development process. Regarding roads, another respondent from Ethiopia indicated their role in making the movement of people, resources, and products (both input and output) cheap and easy: "Better road access gives a farmer an opportunity to easily access additional markets for his products, which will provide him with more income, initiating more investment. It will also give him a chance of being exposed to new ways of thinking and operating." Respondents also underlined that the primary role of government investment should be creating an

enabling environment for the private sector. Investment in research and education was also reported to be essential for successful investments by either the government or the private sector. Respondents suggested that knowledge and science are important prerequisites for appropriate investment choices, and hence schools, universities, and research centers should be formed to develop knowledge and technologies.

Even though KII respondents were supportive of the integrated development of WEF sectors, several respondents pointed out that among the three, food security should be given priority. As stated by one respondent from Ethiopia, "it is always preferable and vital to have integrated development that considers all the sectors in a parallel manner, but it is a fact that [among these] food is most essential for human survival. You can live without electricity but you can't survive many days without food."

Some KII respondents from Ethiopia also discussed the challenges to investment in irrigation in the country. They identified institutions, policies, and geographic features of the country as the main constraints on irrigation development. Another barrier mentioned was the fragmented administration of irrigation (with medium and large irrigation projects administered by one ministry and small-scale irrigation by a different one). In addition, informants identified limited experience with irrigation among policy makers, technical advisors, and farmers as a further hindrance to development. Lack of investments in education and research were also identified as factors limiting the capacity to transform the agricultural sector in Ethiopia. As one participant mentioned, "If we increase irrigation development, we have no agronomists who specialize in irrigated agriculture. This is because in the last 40 years, the focus was on how to become self-sufficient by increasing the productivity of rainfed agriculture, and mainly that of cereal production. As a result, the knowledge that most agronomists have is on rainfed crops. We thus need to invest in educating agronomists who specialize in irrigation."

> Currently Ethiopia is focusing on investments for hydropower production. For example, we are going to use the Grand Ethiopian Renaissance Dam only for hydropower generation and there are limited water infrastructure developments that are intended for irrigation purposes. There are arguments that we have low water use efficiency for irrigation and we will waste water. However, I believe we should invest more in construction of dams for irrigation purposes. We should be able to increase agricultural productivity and become food self-sufficient. Also, given that we are now storing water through the constructed dams, artificial lakes are being formed. Depending on demand, such lakes can be used for tourism, navigation, and fishery. But all of these uses need agreement among countries to avoid potential conflicts and ensure that investments are secured. Benefits and risks from such investments should be distributed (shared) proportionally among countries. Therefore, political will for integration is needed before there can be effective technical cooperation. -KII response from Ethiopia

KII responses from Egypt highlighted the need for investment to improve the productivity of those crops for which Egypt is a net importer, such as fodder, wheat, and oilseeds. Investments in agro-industry and marketing projects were also identified. Respondents also noted the need for investment in renewable energy, including hydropower and other energy alternatives such as solar energy. A respondent from a research center in Egypt mentioned that investment to increase food and agricultural productivity by treating and making use of marginal resources such as saline water and marginal soils is important for Egypt. One respondent described the need to balance investment in human resources with investment in infrastructure: "Comparing investment in infrastructure and investment in human resources, I give priority to the latter because effective utilization of infrastructure requires manpower that can understand, operate, and manage it."

> I believe the potential investment areas for Egypt are improving irrigation systems, reducing agricultural waste, contract farming, and establishing biogas projects. There is a need to improve irrigation efficiency at both the canal and field levels. There is also a need to replace or relocate crops based on their water requirements (that is, crops with

> a high water requirement should be identified and replaced with crops with relatively lower requirements). This will allow us to save water and utilize it in newly reclaimed lands. More water for irrigation can also be obtained by treating and reusing wastewater and water drained from agricultural fields. Food losses at different stages of production are also significant; especially postharvest losses in food crops are substantial. We can reduce such losses by establishing more efficient agroprocessing industries, which we have in limited number currently. Reducing food loss is another mechanism for saving water and land resources. The development of biogas plants is also related to the productive use of waste, which will have an indirect effect on increasing agricultural productivity. -KII response from Egypt

Moreover, KII respondents from Egypt reported investment in science and technology, rural development, open information-sharing systems, and civil society engagement as important ways to improve management of the three resources. These respondents also recommended investment in modern irrigation systems. One of them mentioned that instead of building new physical infrastructure to store water, for Egypt, it would be preferable to invest in improving existing infrastructure, such as irrigation programs, by introducing more efficient water conveyance systems. This respondent also suggested the need for continuous investment in research to assess ways of increasing the efficiency of water use in agriculture. Finally, respondents from Egypt suggested involving local communities in decision-making processes, which has been shown to be effective for more efficient resource allocation than processes whereby decisions are made entirely by some higher central body.

In addition to steps needed to improve cooperation among WEF sectors, e-survey respondents were also asked to suggest steps needed for better cooperation between Eastern Nile countries. There were a lot of interesting similarities among responses obtained across the three countries. Promoting existing regional organizations; creating joint scientific forums for sharing ideas and information; crafting joint policies, strategies, and development plans; and making coordinated investments based on the specific needs of the countries were mentioned by respondents from all three countries as important steps to improve cooperation among riparian countries. Respondents from Ethiopia and Egypt also indicated the need to strengthen existing technical and economic cooperation as well as to build trust and confidence among basin countries. Respondents from Ethiopia and Sudan suggested carrying out in-depth studies to assess the status of WEF resources. Respondents from Egypt and Sudan expressed similar views, noting also the need to rely on evidence and expert opinions when making decisions in the WEF space (Table 3.7).

Table 3.7: Steps needed to improve cooperation between countries in the Eastern Nile, by country of respondent

Ethiopia	Sudan	Egypt
Continue with the current cooperation and promote existing cooperative platforms (such as regional basin organizations)	Promote benefit-sharing regional organizations such as an Eastern Nile power pool	Establish good means of communication such as additional basin management organizations
Strengthen existing technical and economic cooperation		Promote economic integration and interdependence (encourage regional trade, establish free trade areas)
Create a forum to facilitate communication among scientists and experts in the water, energy, and food sectors in the three countries	Establish joint forums and committees	Build a network for scientists in the region
Expedite implementation of investment projects with regional significance	Set joint projects, policies, and strategies	Develop a joint vision and strategy based on facts and evidence, and jointly design large cross-border development projects
Carry out in-depth studies to show the extent of resource scarcity and poverty in the region	Review the status of water, energy, and food in the countries	
	Establish effective follow-up mechanisms to ensure integrated implementation of policies and action plans	Encourage transparency and flexibility among countries in the negotiation and coordination of national plans
Adopt win-win strategies in natural resource development and management	Coordinate to ensure equitable allocations based on actual needs in each country	Make countries consider where they have mutual interests in terms of water, energy, and food
	Allow specialists and experts to decide on management issues	Build the capacities of the countries' professionals and rely on technical advice from experts on mutually beneficial solutions
Build trust and confidence among riparian countries		Build trust and confidence among riparian countries

Source: Authors' e-survey (2016).

Finally, e-survey respondents were asked to report on potential joint investments that can be undertaken by countries in the Eastern Nile. Overall, respondents considered joint investments based on the comparative advantages of countries and enhanced regional trade to be the key elements for transboundary collaboration. Also, responses from all countries indicated that the riparian countries can make joint investments to improve resource use efficiency and sustainability. In addition, respondents from Ethiopia pointed to joint investment in trust building as essential, and respondents from Egypt mentioned the importance of research-based collaboration and investment in renewable energy as well as food security (Table 3.8).

Table 3.8: Potential joint investments across the Eastern Nile, by country of respondent

Ethiopia	Sudan	Egypt
Invest in benefit-sharing projects, such as storage dams for hydropower generation in Ethiopia and large-scale irrigation projects in Sudan: - Virtual water trade programs	Base investment in the three sectors on comparative advantages: - Hydropower in Ethiopia, agriculture in South Sudan and Sudan, industry and marketing in Egypt - Regional trade	Base joint investment in infrastructure on comparative advantages
Adapt efficient water utilization strategies: - Improve irrigation efficiency - Optimize the operational rules of dams in the basin	Focus on sustainability and enhancing the quality of resources	Reduce losses by enhancing resource use efficiency
Practice good watershed management, especially in upstream catchments	Invest in watershed management	Take coordinated action to maintain ecosystem sustainability
Invest in building trust so that stakeholders consider the basin as one unit, irrespective of political boundaries		Launch a major coordinated research effort to assess upstream and downstream costs and benefits of water resource developments
		Invest in renewable energy (solar, wind, and so on)
		Invest in improving food security (such as adapting high-yield crops)

Source: Authors' e-survey (2016).

The question on joint investments by Eastern Nile countries was also posed to KII respondents. Particularly, respondents were asked to elaborate on the joint investment options that they had mentioned in the e-survey. Respondents from Ethiopia emphasized construction of multipurpose dams (either micro or mega) as well as investment in other infrastructure, such as roads and telecommunications, as highly important for attracting further investment to the basin. Investment in environmental protection works, especially in relation to newly constructed water storage infrastructure, was also mentioned, as was the need to carefully study potentially adverse environmental consequences of new infrastructure development and to institute mitigation measures before development starts. Joint investments in watershed conservation in upstream catchments were also mentioned as essential for the sustainable operation of water infrastructure. In explaining this point, one respondent from Ethiopia stated, "If we don't do intensive catchment rehabilitation and watershed management in upstream catchments, any investment we do downstream will not be profitable as well as sustainable. If we take the Grand Ethiopian Renaissance Dam as an example, unless upstream watershed management is done to the extent needed, the dam will become obsolete in a few years."

A KII respondent from Ethiopia also mentioned joint investment in appropriate water resource management, including storage, conveyance, and use, as crucial, for example to reduce water losses to evaporation. Improved irrigation systems, for instance, can greatly reduce water losses in the basin. One respondent stated, "About 70 percent of the Nile water is used for irrigation and hence the irrigation system, which includes conveyance and on-field water use, should be greatly improved. If we see the conveyance system in the basin, it is mostly unlined canals, which lead to a lot of water loss through seepage. The canals are also open, leading to high evaporation losses. On fields, flood

irrigation is usually practiced, which is not efficient at all. More efficient irrigation types, such as sprinkler and drip, should be adopted. In general, a considerable amount of water can be saved through coordinated polices and proper water resource management." KII respondents from Ethiopia also identified virtual water trade schemes based on comparative advantages as a joint area of investment.

> First the issue of integration should be conceptually developed. By integration I am not referring to political integration; my emphasis is more on economic integration. For countries in the Eastern Nile region, separate economic advancement is not possible; they should develop jointly. Economic integration will provide them with bigger markets (because the population of the region is very huge, it has a great potential to create large markets). Especially a landlocked country like Ethiopia should be careful regarding its relations with neighbors. We should be able to integrate our economy in the region. Infrastructure developments that link these countries (railways, roads, and so on) and regional trade agreements that could allow free movement of goods are essential. Investments in alternative energy sources and power trade based on comparative advantages are highly beneficial for all countries. However, such joint development efforts should be appropriately managed to avoid the dominance of one country over the others. Economic integration could also bring about cultural integration, which is important in facilitating cross-border investments and collective development actions. -KII response from Ethiopia

Ethiopian KII respondents also discussed some challenges that hinder countries from making joint investments. Lack of goodwill and trust among countries is one such challenge, hindering trade-based solutions such as growing livestock or crops in relatively cooler Ethiopia for export to Egypt. Financial constraints were mentioned as another key limiting factor for collaborative efforts. Respondents noted that transboundary studies, mostly funded by international donor organizations, have been characterized by a lack of continuity and seldom considered to be of practical use.

> For the Eastern Nile region, increasing agricultural productivity for raising food self-sufficiency levels is one important area of investment. It is important that conditions and plans for agricultural projects not be set by foreign investors. They should be determined in advance by the countries themselves, with clear plans and visions reflecting priority needs in the region. This is very crucial to get optimal results from investments in the region. Investments are also needed in awareness creation and negotiation to ensure a higher level of cooperation across sectors and countries in the basin. Awareness concerning natural resource scarcity is not something required only in ministries; individuals in each country should also be aware of the ongoing and future trends of natural resource scarcity. In this way, efficient utilization of resources and cooperation among different resource users can be achieved. -KII response from Egypt

KII respondents from Egypt recommended joint investments in natural resource management to reduce degradation of resources such as land and shocks such as droughts. They also considered joint investments that balance development and environmental concerns to be vital. One respondent from Egypt described regional needs in this way:

> Investment in research seeking win-win solutions for water management in the Nile basin is important. There have been several research activities since the 1980s that focus especially on dam construction in the basin. There have also been debates, particularly in Ethiopia, over which kind of investment should be pursued for better water resource management. Debates range from whether to build mega dams or many micro dams for storing water or to focus instead on reforestation, which could also serve the purpose of water conservation. Such debates over investment choices should be made at the regional level, and final investment decisions should be undertaken jointly, facilitated by a regional organization such as the Nile Basin Initiative. Joint

decisions are needed not only in terms of where and what kind of dams to build but also regarding their management.

4 Conclusions

With rapid economic development and concomitant growth in natural resource scarcity, enhanced collaboration among the countries sharing Nile waters, particularly those in the Eastern Nile Basin—Egypt, Ethiopia, South Sudan, and Sudan—is urgently needed. Due to a history of hydropolitical tensions, direct cooperation on water resources is challenging. However, a recent concept, that of the WEF nexus, might find wider acceptance because it is not focused solely on sharing one particular, contested resource, but allows for broader discussions, including identifying synergies that can be strengthened across sectors and countries, and trade-offs that can be avoided. This paper used an e-survey and KIIs to elicit insights on the potential of this concept, both nationally in Egypt, Ethiopia, and Sudan, and regionally across these three countries.

Although the responses are not representative of all stakeholders in the WEF sectors in the Eastern Nile Basin, and although the respondents are similarly not representative of all stakeholders in government and research organizations, we believe the responses represent useful insights into the potential for collaboration across the WEF sectors, both nationally and across the Eastern Nile Basin. Assessing the views of different national stakeholders helped identify key constraints and opportunities for collaboration nationally, garner insights on the potential for cross-sectoral collaboration both nationally and regionally, and ensure that regional suggestions are consistent with national needs and priorities.

Even if the objective of the paper and much Nile diplomacy is to move beyond water as the sole topic of discussion, national cross-sectoral interactions clearly indicate that water remains the best-connected sector in the nexus. Both energy and agricultural specialists engage frequently with the water sector, and given the breadth of water specialists' expertise, water-sector experts also frequently engage with other specialists in the sector. Of interest, the energy and agriculture sectors currently do not dialogue much at the national levels, and the potential for cooperation between them is likely similarly limited at the regional scale.

There is a strong consensus that cross-sector collaboration is essential at the national level, but overall, levels of coordination remain unsatisfactory despite the identified benefits of working jointly across sectors, such as these: (1) sectors are naturally linked in important activities such as groundwater pumping, (2) collaboration can conserve natural resources, and (3) harmonizing strategies can reduce the need to retrofit investments later on. These same benefits also apply at the regional level. Respondents proposed a series of measures that can enhance cross-sectoral collaboration at the national level. These steps would also likely support regional collaboration. Key steps identified include raising awareness of the benefits of cooperation, involving relevant cross-sectoral stakeholders in planning processes, and creating institutional frameworks to support cross-sectoral collaboration. Suggested investments to ensure national WEF security could either support or hinder regional cooperation, depending on the cross-sectoral and transboundary connections being made during such investment planning. Key investments proposed include multipurpose dams and food security projects (Ethiopia and Sudan); soil and water conservation and rainwater harvesting (Ethiopia and Sudan); and more efficient irrigation infrastructure, postharvest loss reduction, and renewable energy projects (Egypt). All three countries propose to increase investment in education, research, and capacity building, including building the capacity for better management of infrastructure.

Respondents saw an equally strong need for cross-sectoral collaboration at the transboundary level. Such collaboration is currently being held up due to (1) politics; (2) lack of common databases, joint analysis tools, and platforms; (3) lack of measures to build trust; (4) lack of sustained national financing for regional collaboration; and (5) resulting weak regional institutions. Moreover, most specialist agencies with mandates in water, energy, or food have only national mandates or operate only at the national level. To fruitfully engage national expertise in transboundary nexus collaboration, new networks that integrate these sector specialists will need to be developed.

Specific steps that respondents proposed for enhanced transboundary collaboration on WEF issues were remarkably similar across the three countries and include the following:

1. Strengthen existing technical and economic cooperation (for example, the Eastern Africa Power Pool)
2. Review the status of WEF in the region and carry out in-depth studies to show the extent of resource scarcity and poverty in the region
3. Develop joint projects, policies, and strategies that have common benefits, and implement effective follow-up mechanisms to ensure the implementation of integrated policies and action plans
4. Establish continuous communication and frequent meetings across countries, for example, through a forum to facilitate communication among scientists and experts in the WEF sectors in the three countries, and ensure that technical experts are involved in decision making
5. Share information and data across countries
6. Allow specialists and experts to decide on management issues
7. Continue to develop trust-building mechanisms

Once these measures are established, investments can be taken forward that mirror many of the same investments already identified to meet national WEF security goals, such as joint investments in (1) water storage projects with due consideration of and adjustments for upstream and downstream impacts; (2) catchment rehabilitation, watershed management, and environmental sustainability in general to ensure the sustainability of infrastructure investments; (3) food security projects, including regional trade in agricultural commodities based on the comparative advantage principle, as well as investment in higher-yielding varieties and irrigation efficiency measures; and (4) renewable energy security projects beyond hydropower, such as solar and wind, supported by regional energy trading.

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Background information

This section asks you to provide some background information on your organization and the work you do.

1. Please provide the name of your organization

2. Which of the following best describes the organization for which you work?

- ◯ Private company
- ◯ Government agency
- ◯ National agricultural research institute
- ◯ Academic or research institution
- ◯ International NGO
- ◯ Local NGO
- ◯ Regional organization
- ◯ Other (please specify)

3. Please select the country or countries in which your organization is currently working or is focused

- ☐ Burundi
- ☐ DR Congo
- ☐ Egypt
- ☐ Ethiopia
- ☐ Kenya
- ☐ Rwanda
- ☐ South Sudan
- ☐ The Sudan
- ☐ Tanzania
- ☐ Uganda

4. Please identify the primary sector in which you work.

- ◯ Water
- ◯ Energy
- ◯ Agriculture
- ◯ Environment
- ◯ Rural development
- ◯ Health
- ◯ Forestry
- ◯ Mining and resource extraction
- ◯ Industry
- ◯ Other (please specify)

5. Please identify any additional sectors that you contribute to (check all that apply).

- ☐ Water
- ☐ Energy
- ☐ Agriculture
- ☐ Environment
- ☐ Rural development
- ☐ Health
- ☐ Forestry
- ☐ Mining and resource extraction
- ☐ Industry
- ☐ Other (please specify)

6. Of the following areas, please select the 3 that are most relevant to your current work

- [ ] Crop production
- [ ] Livestock production
- [ ] Fisheries or aquaculture
- [ ] Energy production/management
- [ ] Infrastructure planning
- [ ] Water (e.g. hydrology, hydrodynamics, management)
- [ ] Environmental conservation (e.g. biodiversity, protected areas, watershed management)
- [ ] Climate (e.g. climate information services, forecasting, climate change adaptation)
- [ ] Ecology (e.g. water quality, sedimentation, species protection)
- [ ] Socioeconomic development (e.g. income, welfare, social protection)
- [ ] Gender (research, capacity building, empowerment)
- [ ] Health (e.g. disease management, health education, nutrition education)
- [ ] Sanitation and hygiene
- [ ] Trade
- [ ] Finance
- [ ] Forestry

Connections across water, energy, food and the environment

We would like to understand how frequently your organization interacts with other organizations across sectors and the nature of these interactions. This could include personal communications with staff working in these sectors, attending conferences with experts from these sectors, and working together on program design and/or implementation, among other things. Please answer the following questions on this topic.

7. How often does your organization interact with organizations in other sectors. (Please consider all organization types within a sector including government agencies, NGOs, research organizations, etc.)

	Never	Seldom (1-2 times per year)	Occasionally (3-4 times per year)	Frequently (5 or more times per year)
Water	○	○	○	○
Energy	○	○	○	○
Agriculture	○	○	○	○
Environment	○	○	○	○
Rural development	○	○	○	○
Health	○	○	○	○
Forestry	○	○	○	○
Mining and resource extraction	○	○	○	○
Industry	○	○	○	○

If you interact occasionally or frequently with other sectors not listed here please write those sectors below:

8. For each sector with which you interact occasionally or frequently, please describe the nature of this interaction (select all that apply)

	Interact through professional conferences	One-on-one interactions with professionals in the sector	Collaborate on planning	Collaborate on project or other implementation	Collaborate on research	Provide policy advice/influence	Consult on planning/decision-making
Water	☐	☐	☐	☐	☐	☐	☐
Energy	☐	☐	☐	☐	☐	☐	☐
Agriculture	☐	☐	☐	☐	☐	☐	☐
Environment	☐	☐	☐	☐	☐	☐	☐
Rural development	☐	☐	☐	☐	☐	☐	☐
Health	☐	☐	☐	☐	☐	☐	☐
Forestry	☐	☐	☐	☐	☐	☐	☐
Mining and resource extraction	☐	☐	☐	☐	☐	☐	☐
Industry	☐	☐	☐	☐	☐	☐	☐

Please briefly list any other sectors with which you interact and briefly describe the nature of these interactions

9. Please list the 3 most influential organizations in Ethiopia in the agriculture sector:

Most influential

Second most influential

Third most influential

10. Please list the 3 most influential organizations in Ethiopia in the water sector:

Most influential

Second most influential

Third most influential

11. Please list the 3 most influential organizations in Ethiopia in the energy sector:

Most influential	
Second most influential	
Third most influential	

Opinions about water, energy, food and environmental linkages

This section asks for your opinions regarding the importance of collaboration and coordination across sectors and countries to minimize tradeoffs across the water-energy-food nexus. Please provide your opinion regarding the statements in questions 14-17.

12. Collaboration across the water, energy and agriculture sectors is essential for planning and decision-making to improve resource management in the region.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

13. Policies, plans and decisions are well coordinated across the water, energy and agricultural sectors in Ethiopia.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

14. Collaboration among countries in the Eastern Nile Basin (Egypt, Ethiopia, South Sudan and Sudan) is important to ensure adequate provision of food, energy, and water for the basin's expanding population and wealth.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

15. Ongoing cooperation between countries in the Eastern Nile Basin (Egypt, Ethiopia, South Sudan and Sudan) is adequate to minimize the tradeoffs and exploit the synergies across demands for water, energy and food.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

Follow up on coordination across sectors

16. What steps are needed to improve coordination across the water, energy and food sectors in Ethiopia?

Follow up on coordination across countries

17. What steps are needed to improve cooperation between countries in the Eastern Nile Region to more effectively manage natural resources?

Investment, Knowledge and Capacity Needs

Please give your opinion on the investment, knowledge and capacity needs in Ethiopia and the Eastern Nile Region in the following questions.

18. What investments and/or actions can Ethiopia make to ensure that the supply of water, energy, and food meets current and future demand for these resources?

19. What investments can countries in the Eastern Nile Region make jointly to ensure that the supply of water, energy, and food meets current and future demand for these resources?

20. What are Ethiopia's primary investment needs to ensure adequate supply of water, energy and food? (list 3 most important)

Most important

Second most important

Third most important

21. What are Ethiopia's primary knowledge, data and/or capacity needs to ensure that investments, policies and institutions focusing on water, energy and food management take into account linkages across the three sectors? (list 3 most important)

Most important

Second most important

Third most important

22. Would you be willing to take part in a follow up interview to expand on the views expressed in this e-survey?

23. Please provide your email address

24. Please provide your name

25. Please provide your job title

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