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WATER-ENERGY NEXUS OF WATER AND WASTEWATER SERVICES IN LEBANON

Volume II: SOCIAL NETWORK ANALYSIS



WATER-ENERGY NEXUS OF WATER AND WASTEWATER SERVICES IN LEBANON

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List of Acronyms

ACF	Action Against Hunger
ACTED	Agency for Technical Cooperation and Development
ADRA	Adventist Development and Relief Agency International
AFD	Agence Française de Développement
AFESD	Arab Fund for Economic and Social Development
BDL	Bank du Liban
BFZ	Bavarian economy (bfz) gGmbH
BMLWE	Beirut Mount Lebanon Water Establishment
BUS	BUTEC Utility Services
BWE	Bekaa Water Establishment
CDR	Council for Development and Reconstruction
CESBIO	Centre d'Etudes Spatiales de la Biosphère
CISP	International Committee for the Development of People
CNRS	Centre National de la Recherche Scientifique
DAI	Development Alternatives Incorporated
DAR	Dar Al-Handasah
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EDL	Electricite de Liban
EDZ	Electricite de Zahle
EIB	European Investment Bank
EKF	El Khalil Foundation
ELARD	Earth Link & Advanced Resources Development
ESCWA	United Nations Economic and Social Commission for Western Asia
ESFD	Economic and Social Fund for Development
EU	European Union
FAO	Food and Agriculture Organization
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GVC	WeWorld-GVC Ngo

ICRC	International Committee of the Red Cross
IOCC	International Orthodox Christian Charities
IRI	Industrial Research Institute
ISDB	Islamic Development Bank
KFAED	Kuwait Fund for Arab Economic Development
KfW	KfW Bankengruppe
LARI	Lebanese Agricultural Research Institute
LCEC	Lebanese Center for Energy Conservation
LRA	Litani River Authority
LRI	Lebanese Reforestation Initiative
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPWT	Ministry of Public Works and Transportation
NLWE	North Lebanon Water Establishment
NRC	Norwegian Refugee Council
SLWE	South Lebanon Water Establishment
UNDP	United Nations Development Programme
UNHCR	UN Refugee Agency
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WB	World Bank
WV	World Vision International

Introduction

Social network analysis (SNA) is comprised of a set of methods used to visualize and examine the structure of social relationships in any given group (Tucker, 2017; Ehrlich & Carboni, 2005). It provides a matrix that shows the existence, type and/or quality of interactions between pairs of people or nodes (Ehrlich & Carboni, 2005). An analysis of social networks looks beyond the attributes of individuals to examine more the relations amongst actors in general; how actors/organizations are positioned within a network; and how they fit in the grander pattern scheme. Unlike other forms of analysis in the social sciences, SNA assumes that actors in a network are all-interdependent and, as such, provides unique insights to the interactions between actors in a system and how that would affect their relationships.

Social network analysis draws its importance from the concept of social capital. Defined in Ehrlich and Carboni (2005) as social capital is the “the total sum of potential or actual resources that a person accrues as a result of interpersonal relationships.” By taking this concept into consideration, SNA draws attention to the importance of considering the human ecosystem, or network, when attempting to successfully improve efficiency or allocate resources in a given sector.

Use of SNA in Natural Resource Management

Recent works have stressed the value of SNA as a valuable tool for stakeholder analysis in natural resource management (Kurian, Portney, Rappold, Hannibal, & Gebrechorkos, 2018; Paletto, Hamunen, & De Meo, 2015; Prell, Hubaceck, & Reed, 2009). As Prell et al. (2009) argue, social network analysis in environmental applications is just beginning to emerge; it provides social insights that “increase the likelihood of collective action and successful natural resource management.” Kurian et al. (2018), similarly, point towards the value of SNA to inform how decisions regarding natural resource management are made and how decisions in one domain affect decisions in others. They argue that SNA in this sector shows promise in improving efficiency and advancing governance research. Their argument is increasingly being echoed in the literature (Zedan & Miller, 2017; Siddiqi, Kajenthira, & Anadon, 2013; Prell et al., 2009). So far, SNA interventions into natural resource management have largely been in relation to stakeholder analysis. As Paletto et al. (2015) observed, given the many stakeholders that are involved in natural resource management, successful identification of stakeholders is imperative (see also, Kurian et al. 2018).

SNA for Improved WEF Integrated Policy and Planning

As argued by Siddiqi et al. (2013), integrated policy and planning, in both the energy and water sector is needed to effectively meet the challenges of growing interdependencies between these two sectors. A joint consideration of both water and energy domains, they argue, can identify new options for increasing overall resource efficiencies. As such, precisely because the water-energy-food nexus treats each resource as embedded and relational, SNA has become an appropriate tool to divulge and highlight the relational complexities that exist within these sectors, and their individual stakeholders (Kurian et al., 2018). Using SNA, followed by an analysis of possible strategies for linking decision-makers and enabling the design and implementation of integrated resource policies; one could facilitate collective action, ensure key groups are not marginalized, improve flow of information, maximize the potential of each stakeholder and result in whole-system innovative solutions that benefit the system, rather than the “nodes” as a whole (Prell et al., 2009; Siddiqi et al., 2013; Paletto et al., 2015).

There are tools within the SNA analysis that provide measures of interdependence that, coupled with qualitative analysis, are useful to uncover and address the following questions:

- What are the communication linkages between W-E-relevant stakeholders?
- What are the knowledge flows?
- Which actors are central, isolated, or a conduit of information and influence?

These SNA measures offer opportunities for unique insights into interventions and policy implementation for a given population of nexus actors. Without structural analysis and the accompanying visualization, it is difficult to capture and identify the construct of interconnections, which may be necessary to determine an overall network of interaction.

Study Rationale and Aim

This water-energy nexus study echoes Siddiqi et al.’s (2013) call for a holistic assessment of the major stakeholders in the water and energy sectors through the acquisition of detailed knowledge of key actors and agencies working in the water-energy sectors, the development of an understanding of their interrelationships, and how they influence each other in a decision-making capacity.

The most important part of SNA analysis is studying the ties connecting stakeholders. Granovetter (1973) stated that strong and weak ties are equally important because they both, in some form or another, connect individuals to valuable resources. The utility of strong and weak ties varies, however, as a function of the particular situational context in which it is utilized. In this study, the focus is on the advantages of weak and strong ties in a network focused

on resource management. Strong ties can enhance mutual learning, sharing of resources, and advice, regarding policies planning and management. However, that does not mean that weak ties should be disregarded or ignored. Granovetter (1973) stated that weak ties could play an equally important role in a network. Weak ties are crucial in binding groups of strong ties together; they bring circles of network into contact with each other, strengthening relationships and forming new bonds between existing relationship circles.

Considering, that integrated resource policy and planning is limited in Lebanon, and that effective integrated planning requires an institutional framework with clearly defined roles and communication mechanisms; a social network analysis at the water-energy interface can help shed light on the complex existing interactions. It can illuminate existing relations among stakeholders, and provide the basis for targeted recommendations for a more coordinated and integrated water and energy sector.

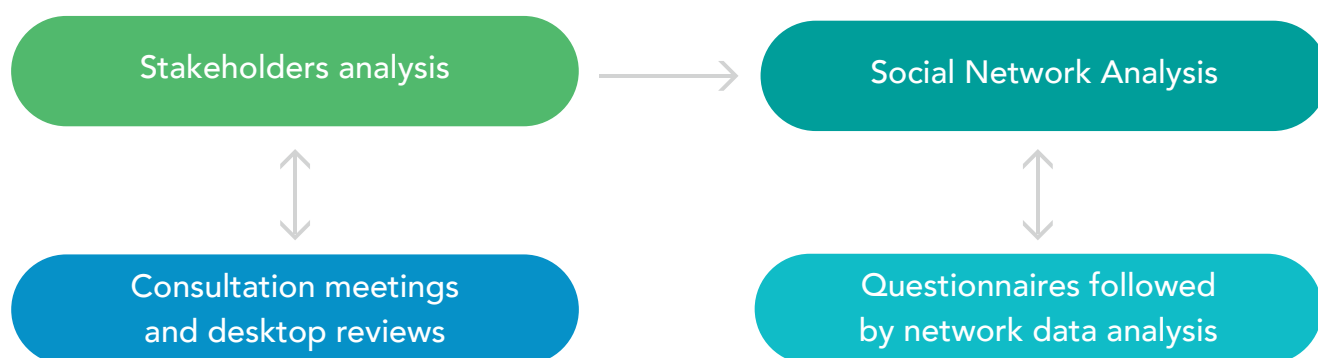
- In order to better develop water-energy efficiency, it is important to identify how stakeholders that work in both sectors influence each other's decisions, and how that may impact project and policy development, and its outcomes. The first step necessary is to define which aspect of the system needs to be analyzed and the issues at hand. In this study, the aim is to assess the relations among stakeholders in the water and energy sectors, by undertaking a stakeholder analysis coupled with a social network analysis (SNA). The most common approach, which will be followed, is to assess the urgency, legitimacy, and the potential power of the stakeholders in question. Both exercises will attempt to answer the research questions below:
- Who are the stakeholders that play a role in water and energy nexus?
- What is the role of these identified stakeholders in the water-energy nexus?
- Are there established connections between key stakeholders in place? And if so, are these connections strong or weak?
- How coordinated are energy and water decisions, planning and projects?

Once the key stakeholders are identified, SNA will focus on gauging relations between key actors in the energy and water sectors.

Methodology

The methodology is divided into two components, a stakeholder analysis where key players in both the energy and water sector will be identified; and a social network analysis where different interactions between those stakeholders will be gauged and analyzed (Figure 1).

Figure 1. Methodology steps



Stakeholder Analysis

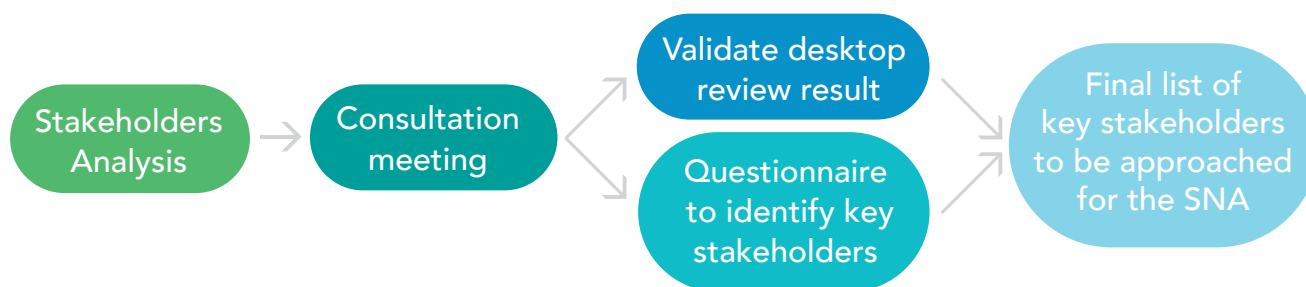
Identify Key Stakeholders at Water-Energy Interface

A desktop review was undertaken to identify all stakeholders involved in those sectors. Based on the results of the desktop review, a consultation meeting was conducted to validate the identified stakeholders (Figure 2). Those deemed to have influence or importance in policy and planning were asked to fill out a questionnaire.

The questionnaire served to validate key stakeholders in the water and energy sectors, the centrality of their interest to both sectors, and the extent to which they impact or are impacted by water and energy policy-making, planning, and projects. The meetings also aimed to address the following questions through an interactive discussion:

- Are institutions aware of energy efficiency opportunities, their costs, and their benefits, particularly in the water sector?
- Does the institutional framework in place encourage the adoption of energy efficiency measures?
- What are the financial mechanisms, which pertain to energy efficiency in the water sector and how efficient are they?

Figure 2. Stakeholder analysis steps



The stakeholder analysis questionnaire and the summary of the stakeholder consultation meetings are further detailed in Appendix A and B, respectively.

A review of the roles and responsibilities of the identified stakeholders allowed for a short list of key stakeholders considered within the water-energy nexus interface.

Social Network Analysis

Once the key stakeholders at the water-energy interface were identified, key individuals were asked to fill a questionnaire for the SNA, in order to identify relationships and the nature of those relationships with other stakeholders at the W-E interface. The design of the questionnaire followed a roster format, whereby predetermined stakeholders, based on the results of the stakeholder analysis, were approached to fill the questionnaire. Particularly, the information from the questionnaire aimed to assess the frequency of contact among stakeholders regarding (a) financial exchange, (b) knowledge, information, and technical exchange, and (c) policymaking, strategies, and plans. The SNA questionnaire is detailed in Appendix A.

A timeframe starting February 2018, up until the time of the interview (approximately two years), was set aside for the analysis. The reason behind the selected timeframe is that this SNA aims to look at the current landscape, especially after the appointment of the new director generals of the four RWEs, and the election of parliament. The “financial exchange” component took into consideration contracts and projects that had been signed, and were ongoing since February 2018. One question was set outside of this timeframe because it aims to measure the overall length of the relationship between actors.

While social network theory can be readily applied in theoretical research and qualitative empirical studies, there is a general emphasis on the use of software to analyze and visualize network data, once they have been collected. RStudio is an integrated development environment for R that provides several useful features for social network analysis (<https://www.rstudio.com/>). A package within RStudio was used to plot the networks and analyze the data. “igraph” was used as a tool to calculate the metrics for the networks that will be plotted.



Understanding an SNA map

SNA is used for investigating the degree of influence of each actor within a network, how they can impact each other's behaviors, and the level of connectedness, cohesion, and clustering within the network. The analysis of the network structure is done following graph theory and social network notions, such as the ones defined in (Table 1). Centralization measures, such as degree, betweenness, closeness, and Eigenvector are a good way to express the idea that there are very powerful and important stakeholders in the network. Stakeholders with high centrality aspects are more likely to influence others, and have higher power within the network (Table 2).

Map Interpretation

It is important to note that the lengths and positions of the edges do not hold any significance, as the analysis and visualization tool that were used chose distance at random.

Table 1 Network Notions and Definition

Notion	Definition	Description	Symbol of the notion in the maps
Node (Vertex)	A unit of a network (e.g. a stakeholder is the node of the stakeholders' network)	The size of the node in the map is dependent on its weight, which is defined by the variable each node is representing. Different types of maps highlight different centrality measures, and the size of the node will vary according to the centrality measure it is portraying.	
Edges	The line connecting two nodes representing the presence of a relationship	Each edge could have a weight-value represented by the thickness of the arrow. Each edge could be directed* or undirected*. The thickness of the arrows either highlights the frequency of communication or its weight.	

*Directed networks: mostly an interaction from one stakeholder to another, as in the case of the first theme, where one actor is a funder and another is a beneficiary, so the network is directed from one actor to another; directed networks are represented by an arrow.

*Undirected networks: highlight the different interactions between actors, where said interactions flow back and forth between stakeholders, such as data sharing or knowledge exchange.

Table 2 Network Centralization Measures

Notion	Definition	Description
Density	<p>Density is defined as the number of connections a participant has, divided by the total possible connections a participant could have.</p> <p>Each stakeholder that maximizing its connection-potential elevates the density scores for the entire network.</p>	Normally the density of a network is a maximum of 1 in a reciprocated network, and a minimum of 0 in a disconnected network.
Degree centrality	The number of edges pertaining to a certain node.	Stakeholders with high degree centrality (more connections with others) are more likely to have access to information, funding, and data sharing.
Closeness centrality	The path with the least number of intermediary nodes between a node and every other node in the network.	Closeness represents the ease of passing/ accessing information between stakeholders. Stakeholders with high closeness can have faster and easier access to/spread of information, and communication with other stakeholders.
Betweenness centrality	The number of other vertices that must pass through a specific node to reach their final path.	Stakeholders with high betweenness centrality act as 'pivot points of knowledge flow in the network'. They connect different stakeholders together, and usually have multidisciplinary knowledge.
Eigenvector centrality	The degree of connection to other important vertices.	Stakeholders linked to other influential stakeholders in the network (such as stakeholders with high authority or power, and are more likely to influence project outcomes, policy reforms, or implementation). The Eigenvector centrality shows the degree of connection to other important vertices or nodes; stakeholders linked to other influential stakeholders in the network for example stakeholders with high authority or power, are more likely to influence project outcomes, policy reforms, or implementation.

Results

Key Stakeholders Analysis Results

Based on desktop review, consultation meetings, and a review of the roles and responsibilities, a total of 25 key stakeholders were currently identified (in 2020) for policy and planning at the interface of the W-E nexus (Table 3). The key stakeholders were categorized into three groups:

Table 3 Stakeholders Identified that Work in the Water and Energy Sectors

Site Location	International Organizations	Private Sector
Ministry of Energy and Water	Agence Française pour le Développement (AFD)	Debbas International SAL
South Lebanon Water Establishment*	UNDP	Mrad Utility Services
North Lebanon Water Establishment*	World Bank	Sustainable Akkar
Beirut and Mount Lebanon Water Establishment*	European Investment Bank (EIB)	KVA SAL
Bekaa Water Establishment*	European Union (EU)	BUTEC utility services (BUS)
Litani River Authority*	USAID	Litani River Authority*
Ministry of Environment		
Ministry of Agriculture		
Ministry of Interior and Municipalities		
Municipalities		
Council of the South		
Council for Development and Reconstruction (CDR)		
Electricité du Liban*		
Electricité du Zahle		
Lebanese Center for Energy Conservation (LCEC)		
Lebanese Agricultural Research Institute (LARI)		
National Center for Scientific Research (CNRS)		
Banque du Liban		
Green Plan		
Higher Relief Commission		

*The review of the roles and responsibilities helped to validate the selected key stakeholders that play an influential role in either the energy or water sectors, or interfacing both (Table 4).

Information regarding roles and responsibilities were compiled, categorized, and illustrated in Table 5, along with the following main aspects:

- Policymaking.
- Planning and implementation.
- Conservation and resource management.
- Implementation and enforcement of regulations and standards/codes.
- Operation and distribution.
- Control and monitoring.

Stakeholders identified as having roles in both the water and energy sectors were contacted to take part in the social network analysis study. A questionnaire was sent, and one-on-one interviews followed, to gather all the required information.

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface

Stakeholders	Roles and responsibilities		Source of information
Governmental Institutions			
Ministry of Energy and water	Water Sector <ul style="list-style-type: none">• Set the necessary policies, regulations, strategies, and decrees for the water sector.• Oversee and monitor the RWEs and LRA.• License wells and all waterextractions.• Oversee, on a national basis, the allocation and distribution of surface and ground water for drinking and irrigation.• Draft general directive for water and sanitation, updating it continuously.• Control the quality of surface water and groundwater.	Energy Sector <ul style="list-style-type: none">• Set the necessary policies, regulations, decrees, and the needed mechanisms in the energy sector (electricity, oil and gas, fuel procurement, etc.).• Support the implementation of the approved plans for the electricity sector, and oversee the ongoing projects in generation, transmission, and distribution.• Set the strategic path and targets for the development of RE in Lebanon	www.energyandwater.gov.lb www.pcm.gov.lb
	Water Establishments (NLWE, BMLWE, BWE, SLWE)	Water Sector <ul style="list-style-type: none">• Manage and distribute water resources within their respective areas of jurisdiction.• Operate and maintain the water systems, from generation to distribution, and collect subscription fees.• Manage, operate, and maintain wastewater treatment plants executed by the CDR, and others.	
Litani River Authority (LRA)	Water Sector <ul style="list-style-type: none">• Implement the Litani irrigation, drying, drinking water, and electricity projects.• Ensure water monitoring in all Lebanese rivers.• Examine, manage, and exploit the irrigation water in Central and Northern Bekaa.	Energy Sector <ul style="list-style-type: none">• Establish a network linking up power stations in Lebanon.• Establish electrical substations and distribution lines in all the Lebanese regions.• Invest in the different parts of the project at both the technical and administrative levels.	www.litani.gov.lb

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface (continued)

Stakeholders	Roles and responsibilities		Source of information
Ministry of Environment	<p>Water Sector</p> <ul style="list-style-type: none"> • Monitor drinking water quality and make sure it is up to international standards. • Monitor the disposal of wastewater in dry wells, rivers, streams, or along the beach. • Develop detailed studies of plans to be followed to combat pollution, regardless of its source, especially waste, wastewater, air pollutants, leaks into groundwater, drinking water, and irrigation; after conducting a comprehensive survey of all the facilities on-shore or indoors, whose waste poses a potential threat to the environment. 	<p>Energy Sector</p> <ul style="list-style-type: none"> • Coordinate all efforts in order to implement the approved RE and EE targets in the NDCs. • Supervise and monitor all Strategic Environmental Assessments (SEA) and Environmental Impact Assessments (EIA) related to RE projects' implementation from wind, solar, etc. • Develop specific regulations for RE project development, for example, minimal separation distances of wind farms from various land use and features. • Organize awareness campaign and workshops to educate developers, other ministries, and the public about RE, its environmental and social impacts, and legal requirements. • Follow up with the MoEW on the integration of environmental components into the RE strategy. 	<p>www.moe.gov.lb - www.pcm.gov.lb</p>
Ministry of Agriculture	<p>Water Sector</p> <ul style="list-style-type: none"> • Involved in the development of irrigated lands. • Promotion of water-saving management and technology in irrigation. • Address climate change challenges—namely droughts. • Support the Green Plan to increase water harvesting. 	<p>Energy Sector</p> <ul style="list-style-type: none"> • Rules and regulations concerning transportation, refrigeration, importing, and exporting (potato for consumption, potatoes seeds, wheat, seedlings and seeds, wooden materials, forage, and mango). 	<p>www.agriculture.gov.lb www.pcm.gov.lb</p>
Ministry of Interior and Municipalities	<p>Water Sector</p> <ul style="list-style-type: none"> • Ensure that municipalities construct, clean, and maintain storm-water drainage networks. 	<p>Energy Sector</p> <ul style="list-style-type: none"> • Support and acknowledge the municipalities' work in their mission to transform their regions into a low carbon economy, and create more sustainable communities. 	<p>www.interior.gov.lb www.pcm.gov.lb</p>

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface (continued)

Stakeholders	Roles and responsibilities		Source of information
Ministry of Finance (MoF)	Both Sectors <ul style="list-style-type: none"> • Finances projects in both the water and energy sectors based on the MoEW/CDR yearly-allocated budgets. • On the RE side, MoF is a co-signatory with MoEW in awarding licenses for independent power producers from RE sources, until the Electricity Regulatory Authority (ERA) is formed. • MoF also has a role at the beginning of technical and financial offers for any energy- or water-related bid. 		www.finance.gov.lb www.pcm.gov.lb
Municipalities	Water Sector <ul style="list-style-type: none"> • Provide services such as maintaining potable water networks and roads. <p>The operation and maintenance of sewer systems.</p> <ul style="list-style-type: none"> • Public programs for works, aesthetics, cleaning, health affairs, water projects, and lighting. • Authorizing the excavation of public streets, in order to lay water, electricity, telephone and wastewater pipes, and others, in return for a guarantee to return the premises to its previous state, at the expense of the license applicant; the public institutions, the independent services, and the state administrations are not excluded from said authorization. 	Energy Sector <ul style="list-style-type: none"> • Implement RE projects and initiatives within their area of jurisdiction, with the support of donors. 	www.localiban.org www.lebarmy.gov.lb
Council of the South (South Province and West Bekaa)	Water Sector <ul style="list-style-type: none"> • Development of water supply networks (pumping, pipes, reservoir, etc.). 	Energy Sector <ul style="list-style-type: none"> • Providing electricity networks (poles, cables, generators, etc.). 	www.councilforsouth.gov.lb
Council for Development and Reconstruction (CDR)	Both sectors <ul style="list-style-type: none"> • Producing a plan and a time schedule for the resumption of reconstruction and development. • Guaranteeing the funding of projects presented, and supervising their execution. • Utilization by contributing to the process of rehabilitation of public institutions, thus enabling them to assume responsibility for the execution of a number of projects under the supervision of the Council of Ministers. • Mobilize international funds and support the MoEW and WEs, as approved by the Council of Ministers. • Execute water and energy projects handed to the CDR by the Council of Ministers. 		www.cdr.gov.lb

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface (continued)

Stakeholders	Roles and responsibilities	Source of information
Electricite de Liban (EDL)	<p>Energy Sector</p> <ul style="list-style-type: none"> • Generate, transmit, and distribute electricity to all Lebanese territories, to the highest possible quality and standards, and comply with the laws and regulations of the Lebanese Republic. • Follow-up on the execution of the MoEW's plans and projects for the electricity sector. • On the RE side, monitor the implement the Net-metering process. EDL receives the applications from subscribers with renewable energy production, and is willing to be part of the net-metering process. It studies the applications and it complies with the parameters set, and issues the approval before installing bi-directional meters. 	www.edl.gov.lb
Electricite de Zahlé (EDZ)	<p>Energy Sector</p> <ul style="list-style-type: none"> • Electricité De Zahlé operates and develops electricity distribution networks to anticipate and meet the needs of its customers in the Zahlé area, by providing quality products and optimal services, while utilizing new technology and maintaining value. • Following a decree issued in the late 1960s by the Lebanese government and Electricité du Liban (EDL), EDZ turned into an electrical distribution utility that develops, operates, and maintains the electric power networks in Zahlé, and 15 surrounding regions. 	www.edz.com.lb
Lebanese Center for Energy Conservation (LCEC)	<p>Energy Sector</p> <ul style="list-style-type: none"> • Act as the technical arm of the Ministry of Energy and Water in all issues related to EE, RE, and green buildings. • The center works on setting-up national action plans to reach the goals announced by MoEW, issues licenses, and closely follows the technical implementation of several projects and initiatives. 	www.lcec.org.lb
Lebanese Agricultural Research Institute (LARI)	<p>Water Sector</p> <ul style="list-style-type: none"> • Research and promote sustainable use of water resources in Lebanon. • Support in providing farmers with chemical and microbiological analysis of water used for irrigation, as well as potable water. 	www.lari.gov.lb

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface (continued)

Stakeholders	Roles and responsibilities		Source of information
National Center for Scientific Research (CNRS)	<p>Water Sector</p> <ul style="list-style-type: none"> • National Center for Remote Sensing: Emphasise environmental concerns, Remote Sensing, and GIS to produce reports and studies on land and water resources in Lebanon. • They work on water projects such as WATER DROP, which focuses on developing an integrated water cycle management approach at the Mediterranean Sea Basin level for managing related cross-sector issues through the enforcement of multi-stakeholder partnerships, in particular with public and private actors. 	<p>Energy Sector</p> <ul style="list-style-type: none"> • Conduct studies on land suitable for RE projects (solar, wind). 	<p>www.cnrs.edu.lb</p>
Banque du Liban	<p>Water Sector</p> <ul style="list-style-type: none"> • Provide financial support/loans to SMEs working in the water sector to implement and launch their startups. • Provide RWEs with foreign currency at the official exchange rate for procurement and diesel supply 	<p>Energy Sector</p> <ul style="list-style-type: none"> • Provide subsidized loans and green financing mechanisms for big energy projects, as well as setting the necessary initiatives for it; most commonly known is NEEREA, a national financing mechanism initiated in collaboration with MoEW, MoF, UNDP, the EU, and the LCEC, which provides "Green Loans" for any type of EE and/or RE project to private sector entities. • Study the application submissions for any Lebanese commercial bank, and coordinates with the LCEC on technical terms, prior to giving its approval/rejection. 	<p>www.bdl.gov.lb www.climatechange.moe.gov.lb</p>
Green Plan	<p>Water Sector</p> <ul style="list-style-type: none"> • Green Plan works on projects developing water-harvesting strategies. • Promote agricultural livelihoods and employment through investment in land reclamation and water reservoirs. • Executes irrigation infrastructure and takes part in sustainable water management projects, funded by ARDB. 		<p>www.greenplan.gov.lb</p>

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface (continued)

Stakeholders	Roles and responsibilities		Source of information
Higher Relief Commission (HRC)	Water Sector <ul style="list-style-type: none"> • Implementation of Agenda 2030 for Sustainable Development. • Focus on shared water resources management. • Monitor water supply and sanitation services. • Focus on projects related to the water-energy-food security nexus. • Climate change assessment and adaptation. • Capacity-building, technical assistance, and institutional strengthening. 	Energy Sector <ul style="list-style-type: none"> • HRC focus on the improvement in energy efficiency. • Ensures access to modern energy services. 	www.eliktisad.com www.dawlati.gov.lb www.elnashra.com www.general-security.gov.lb
	Non-Governmental Institutions		
Agence Francaise pour le Development (AFD)	Both sectors <ul style="list-style-type: none"> • Fund, support, and accelerate the transition to a fairer and more sustainable world. • Focuses on climate, biodiversity, peace, education, urban development, health and governance, and implementing SDGs. 		
UNDP	UNDP currently works with around 25 Lebanese ministries:		
	Water Sector <ul style="list-style-type: none"> • Sustainable development and the achievement of SDG goals. • Adapt to climate change and water management, which includes the promotion of water management and conservation, protection of vulnerable water resources, and raising awareness. 	Energy Sector <ul style="list-style-type: none"> • Mitigating Climate Change and Sustainable Energy is one of the largest thematic areas under implementation. The program supports the government of Lebanon to meet its target of 12% renewable energy by 2020, while promoting demand-side energy management and energy conservation. • Implement projects related to energy efficiency and renewable energy. • Provide policy advice, technical assistance, finance, and programs to the MoEW to overcome legal and technical bottlenecks in energy planning. 	www.lb.undp.org

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface (continued)

Stakeholders	Roles and responsibilities			Source of information
European Union	Both sectors <ul style="list-style-type: none">• Represent EU interests.• Promote cooperation with and among EU Member States in Lebanon.• Support the reform agenda of the Lebanese government.• Ensure that the EU cooperation benefits those mostly in need.			www.eeas.europa.eu .
World Bank	Both sectors <ul style="list-style-type: none">• Provide a wide array of financial products and technical assistance, and help apply innovative knowledge and solutions to challenges in both energy and water sectors.	Water Sector <ul style="list-style-type: none">• Improve urban and rural water-supply service delivery and sector performance by proposing appropriate policies and incentives, and to facilitate access to financial support.• Provide subsidized loans to strategic water projects that have completed technical, environmental, and social impact assessments.	Energy Sector <ul style="list-style-type: none">• Support MoEW in setting plans and policies to reduce the energy sector's financial burden, and to implement needed reforms.	www.worldbank.org
European Investment Bank (EIB)	Both sectors <ul style="list-style-type: none">• Mobilize the needed finance for water and energy projects submitted to the EIB board, more specifically, in renewable energy projects.			www.eib.org
Private Sector				
KVA (SAL)	Energy Sector <ul style="list-style-type: none">• KVA is the electric Distribution Service Provider (DSP) for Beirut Municipality and Bekaa Valley service areas.• The main goals of KVA is to:<ul style="list-style-type: none">- Provide customer service to EDL customers.- Rehabilitate the electric network in Lebanon.- Install electric meters.- Increase the capacity of the network.- Perform maintenance and operations on behalf of EDL.- Collect of subscription fees.			www.kvasal.com

Table 4 Roles and Responsibilities of Identified Stakeholders at the Water-Energy Interface (continued)

Stakeholders	Roles and responsibilities	Source of information
BUTECH Utility Services (BUS)	<p>Energy Sector</p> <ul style="list-style-type: none"> BUTECH Utility Services (BUS) is one of three Distribution Service Providers commissioned by EDL to maintain and operate the electricity distribution grid in Northern Mount Lebanon and North Lebanon. 	www.bus.com.lb
Lebanon Green Building Council (LGBC)	<p>Energy Sector</p> <ul style="list-style-type: none"> Provide a Lebanese certification system for buildings that adopt environmental parameters, and to transform the way buildings and communities are designed into a prosperous environment. 	www.lebanon-gbc.org
Debbas International SAL (NEU Company)	<p>Energy Sector</p> <ul style="list-style-type: none"> The National Electrical Utility Company (NEU), part of Debbas Group, is one of the companies operating as Distribution Services Providers in Mount Lebanon and Southern Lebanon with a main goal to rehabilitate and modernize the electricity power grid. Its scope of work covers: customer services, management of feeders and substations, operation and maintenance of all assets, meter-reading and bill collection, etc. 	www.debbas.com.lb
Sustainable Akkar	<p>Energy Sector</p> <ul style="list-style-type: none"> Specializes in initiation, development, financing, and the implementation of renewable energy projects, one of which is the Akkar wind-farm project. 	www.sustainableleakkar.com

Table 5 Sectoral Responsibilities of Key Institutions in Water and Energy

Description of responsibilities		MoEW	RWEs	MoA	MoE	MoPH	MoIM	LRA	CDR	MoI	EDL	LCEC	* DSPs	** RECs	Green Plan	Council of the South	BDL	Municipalities	IPTEC	*** IDFA	Lebanon Green Building Council
Policymaking	Definition of sector policy, institutional roles, and structures.	⚡			⚡							⚡								⚡	
	Enactment of legislation and regulations.	⚡	💧		⚡			⚡				⚡									
	Development of investment and subsidy policies.	⚡										⚡									
Planning and Implementation	Establishment of long-term consolidated planning of resources.	⚡	💧	⚡		💧		⚡	⚡		⚡	⚡	⚡		💧		⚡			⚡	⚡
	Evaluation of infrastructure and investment requirements.	⚡	💧	⚡		⚡		⚡	⚡		⚡	⚡	⚡		💧	⚡	⚡	⚡		⚡	⚡
	Resources rationalization.	⚡	💧	⚡		💧		⚡			⚡	⚡	⚡		💧			⚡			
	Design, oversight of construction, and operation of major infrastructure.	⚡	💧	⚡		💧		⚡	⚡		⚡	⚡	⚡	⚡		⚡		⚡		⚡	
	Funding and execution of investment programs.	⚡	💧	⚡		⚡		⚡	⚡		⚡	⚡	⚡	⚡			⚡			⚡	
Conservation and Resource Management	Allocation of resources across regions.	⚡	💧	⚡	⚡			⚡	⚡		⚡	⚡				⚡					
	Identification and promotion, resources conservation, and awareness campaigns	⚡	💧	⚡	⚡						⚡	⚡			💧				⚡		
Implementation and Enforcement of Regulations and Standards/Codes	Issuance of regulations	⚡	💧			⚡		⚡			⚡				💧						
	Enforcement of regulations and standards for cost recovery, service quality, resource quality, and customer relation	⚡	💧			⚡		⚡	⚡		⚡										
Operation and Distribution	Billing and collection of tariffs		💧					⚡			⚡		⚡	⚡				⚡			
	Maintenance and rehabilitation of infrastructure		💧				⚡	⚡			⚡		⚡	⚡		⚡		⚡			
Control and Monitoring	Management of all information including data collection, analysis and reporting	⚡	💧					⚡			⚡	⚡									
	Implementation of service quality and contingency planning	⚡	💧					⚡			⚡	⚡		⚡							

*Distribution Service Providers (DSPs): KVA, BUTEC, Debbas International SAL (NEU Company)

** Regional Electricity Concessions (RECs): Electricité de Zahle, Sustainable Akkar

*** International Development and Funding Agencies (IDFAs): World Bank, European Investment Bank (EIB), Agence Française du Développement (AFD)

💧 : Refers to an actor's work in the water sector
⚡ : Refers to an actor's work in the energy sector

Social Network Analysis Results

The results are represented in a series of stakeholder maps that are grouped into three main themes, as illustrated in Figure 3, and described in detail below.

Figure 3. SNA maps produced for all three themes



Theme 1: W-E stakeholders financial network relationships

Financial exchanges between stakeholders are a funder/source-beneficiary/recipient relationship. Hence the generated maps for financial exchange are directed maps (towards beneficiary/recipient). The first map (Figure 5) exhibits the connections between all the stakeholders, where the node size is a function of the number of connections it has; meaning that the largest nodes would be the ones with the highest degree (highest number of connections).

This map also reflects the density¹ of the network. In the second map (Figure 6), the node size is a function of betweenness centrality scores; meaning that the largest nodes would be the ones with the highest number of vertices that pass through them towards their final path. These nodes act as pivot points. Other metric scores such as closeness and Eigenvector centrality cannot be calculated for directed networks.

Theme 2: Knowledge, information and technical exchange

These forms of exchange can be better seen through undirected networks, where the exchange flows in both directions. Four maps were developed for knowledge exchange; an initial map (Figure 7), showing all the connections between the stakeholders; a map where node size is a function of degree scores (Figure 8); one where node size is a function of betweenness scores (Figure 9); and one where node size is function of the eigenvector scores (Figure 10), which represents stakeholders that are linked to other influential stakeholders in the network. In all the maps, the largest nodes are those that are connected to the highest number of other important vertices or nodes.

Theme 3: Policymaking, strategies, and plans

Two aspects were explored for this type of relationship: the enforcement and implementation of policies, and drafting policies and strategies. Four maps were developed for each type: an original map highlighting the connections, and another showing the degree, betweenness, and Eigenvector centralities.

Figure 4. Red-Blue gradient marking the score spectrum for the centrality metrics (red being the highest)



¹ Density is defined as the number of connections a participant has, divided by the total possible connections a participant could have.
Each stakeholder maximizes its connection potential, elevating the density score for the entire network.

Network Maps

W-E stakeholders financial network relationships

Financial relationships in this study were defined by the frequency of financial exchanges. By financial exchange, we refer to anything with a monetary value such as equipment, implementation agreement with other organizations, and any transactions with monetary values, disregarding the amount. Financial exchange also covers current contracts between two stakeholders in relation to the water and energy sectors. The network relationships (edges) are “directed”, since in “financial exchanges” there are stakeholders that are “funders/sources” and others that are “beneficiaries/recipients”.

Degree centrality of the network

Figure 5 shows all existing relationships between the key stakeholders and other stakeholders that they may have referred to in their questionnaire responses (a list of stakeholders is available in Appendices C and D). The density of the financial network is 0.025, which is very low, means the network is sparsely connected. In the case of financial exchange, the low-density score shows that funding is directed towards certain organizations, rather than providing for equal funding opportunities to all eligible stakeholders. Hence beneficiaries are minimally connected instead of maximally connected to all funders, thereby limiting their opportunity for increased and varied funding. Looking at Figure 5, it can be seen that the BWE is a perfect example of such a connection. The BWE is connected to a minimum of 15 stakeholders. The EU for example is a major funder, but funding may occur through local or international NGOs. However, the presence of links, based on the responses of the stakeholders, was the purpose of this activity, not the amount or the specificity of the transactions or project agreements amongst the actors. Hence the BWE may be receiving funding from one or two major organizations, such as the EU and USAID, but the connections mentioned by the BWE connects them with NGOs as implementers as well as funding agencies.

When a network is directed, such as in this case, there are in-degrees and out-degrees, which count the number of edges going into and coming out of a node. Stakeholders with the highest in-degree values are those that are receiving funds from the largest “number” of sources (not necessarily the highest value, since the amount is not part of the study), while stakeholders with highest-out degree values are those that provide funding for the highest number of recipients. Table 6 and Table 7 show the top five stakeholders with the highest in- (recipients) or out- (funder) degree values.

Table 6 Stakeholders with the Highest In-Degree Score (Recipient)

Stakeholder	In-Degree
BWE	20
SLWE	9
BMLWE	9
CDR	6
LRA	5

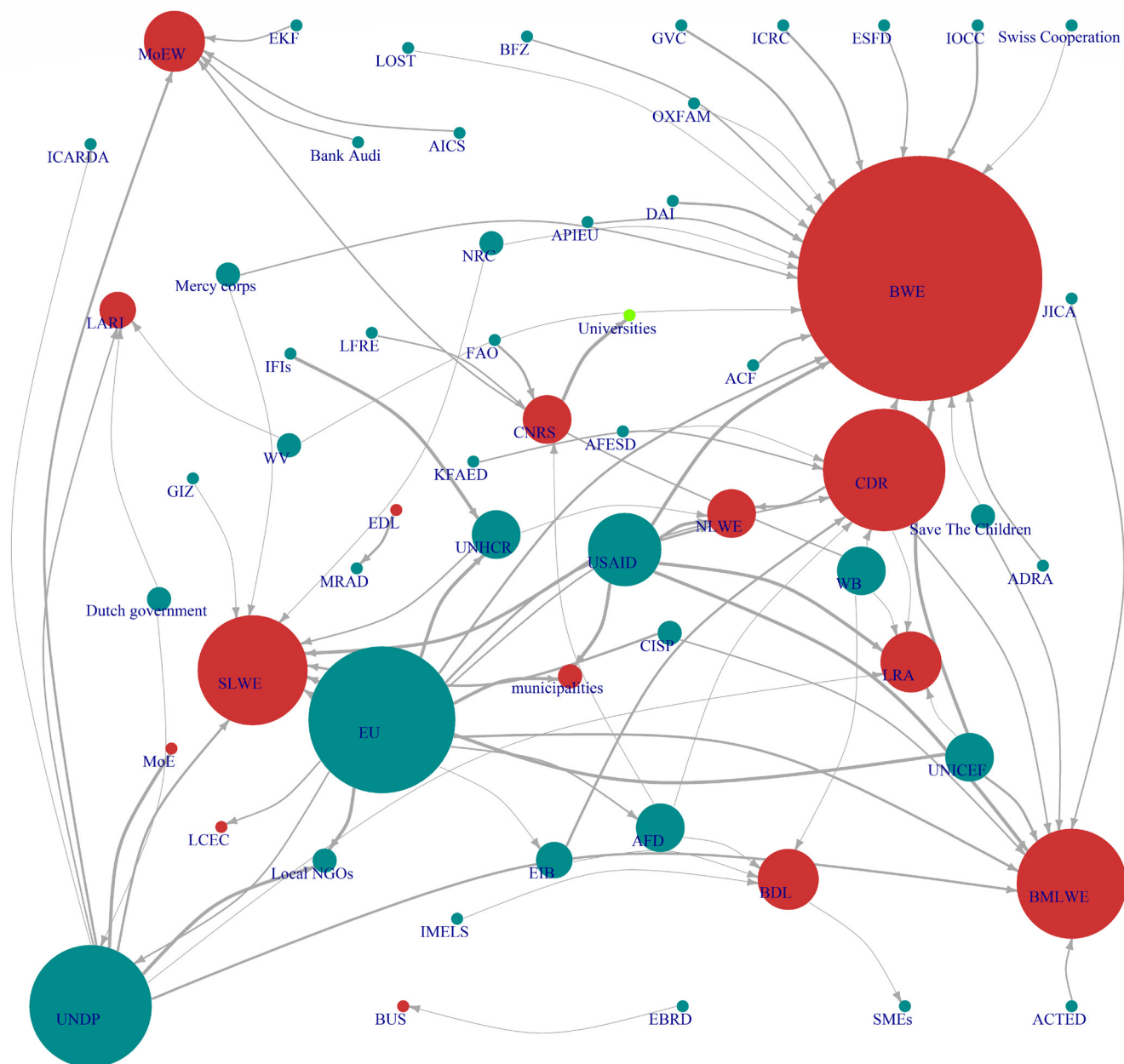
Table 7 Stakeholders with the Highest Out-Degree Score (Funders)

Stakeholder	Out-Degree
EU	13
UNDP	8
USAID	6
WB	4
CDR	4

The direction of the arrows in Figure 5 shows organizations which are funders (source) and which ones are recipients. The BWE is a recipient from multiple sources, which indicates high resilience, while other WEs and municipalities are not connected to major funders (deduced by the size of the node). The EU, having the highest out-degree score, provides funding to the highest number of stakeholders in the water and energy sectors. CDR appears in both the highest in-degree and out-degree scorers, clearly demonstrating the role it plays in channeling funds from funders to recipients in the water and energy sectors.

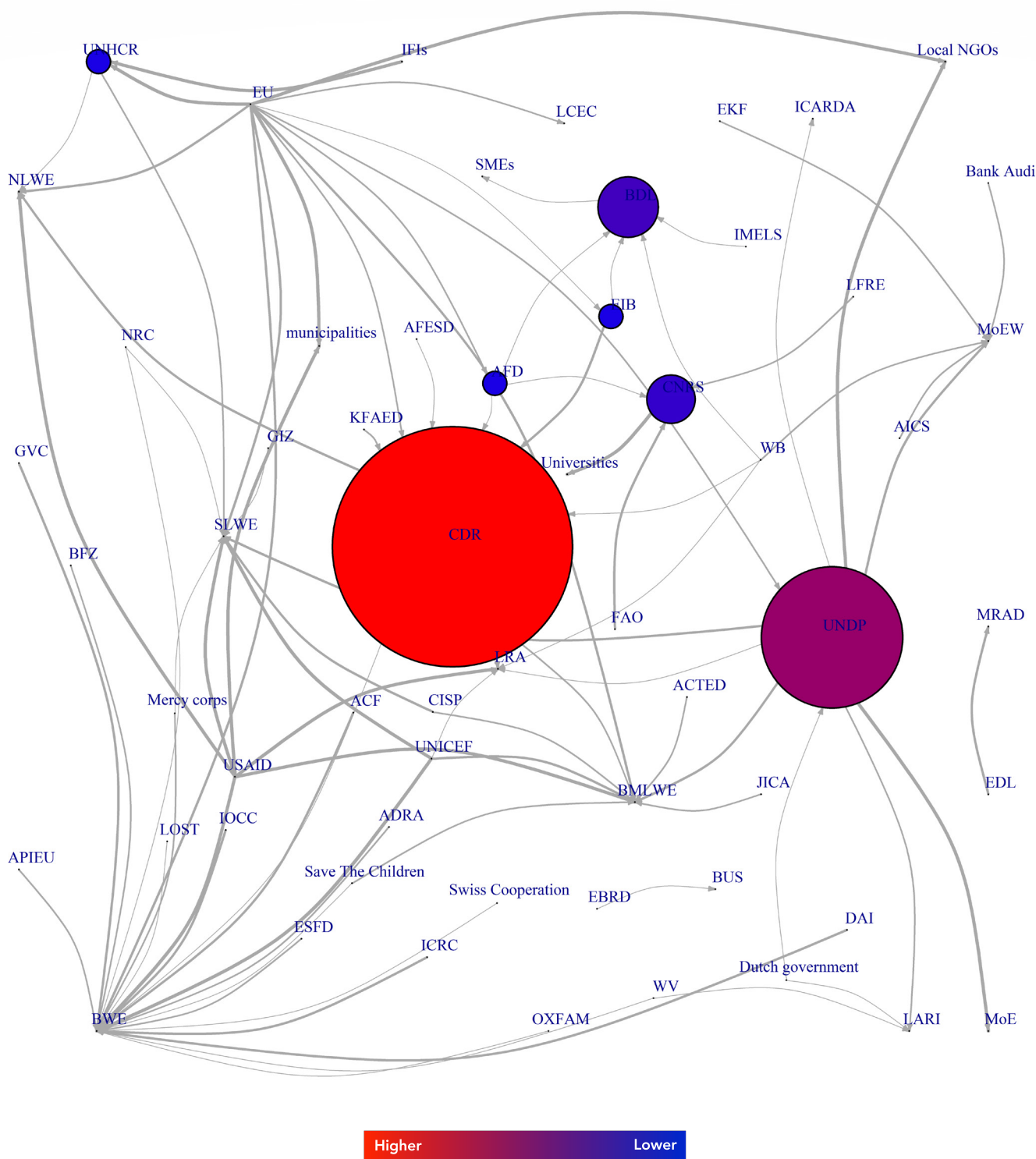
Figure 6 shows the actors with the highest betweenness centrality regarding financial exchange. It can be seen from Figure 6 that the CDR has the highest betweenness value connecting financial exchange between multiple stakeholders, putting it in a perfect position to mainstream W-E Nexus projects through funding, providing or facilitating national organizations. The UNDP has a high betweenness score, meaning that it covers a wide spectrum of organizations, and deals with a large number of influencers, such as Oxfam, GVC, ACTE, DAI, and Save the Children, conveying funds from one actor to another, making it an actor more influential in the diversity of its connections.

Figure 5. Network map highlighting financial exchanges amongst all stakeholder - Node size is based on each stakeholders' degree score



The blue nodes are the non-public organizations, the red nodes are public institutions, and the green nodes represent educational institutions. The thickness of the arrow shows the frequency of contact. The largest nodes are those that are connected to the highest number of other important vertices or nodes.

Figure 6 Actors with the highest betweenness centrality regarding financial exchange



Actors with the highest betweenness degree will have the brightest red color, and the color will shift to purple then to blue as the degree value decreases.

After identifying and mapping the stakeholders with the highest degree and betweenness-centrality scores, a step further was taken. The nodes connected to these stakeholders were identified in order to see if these connections are purely sectoral, or if there is an overlap between stakeholders working in the energy and water sectors.

In terms of financial relationships, the network shows that the interaction between water establishments and energy providers are very weak (Appendix C). Even though public institutions of both sectors are connected to various common international organizations, there is no direct interaction between them when it comes to financial exchanges². On the other hand, the stakeholders identified as funders are focused on funding WEs, the LRA, local NGOs, and municipalities. Most of the organizations funded focus more on water than on energy (Table 4).

Taking an in-depth analysis of their projects, and which sector they are directed towards, was not part of the questionnaire, and their mandates/roles and responsibilities do not specify which sector they provide funding for. However, the analysis identified which stakeholders can be influential, and which play a key role in integrating the W-E Nexus. In the first theme, focused on financial exchange, the main stakeholders that can influence fund distribution, and the topics they should focus on are EU, UNDP, and CDR.

Knowledge, information, and technical exchange among stakeholders in the water and energy sectors

The knowledge, information, and technical exchange relationship among identified stakeholders were defined by the “frequency of exchange” of data and information, expertise, and technical assistance (see Figure 7). The stakeholders in red are non-public institutions, while the stakeholders in blue are public. The map was generated as an undirected graph highlighting the exchanges/sharing between the stakeholders. The network density³ for this map is 0.085, which is considered very low, meaning that not all stakeholders are connected to each other directly. The density shows that there is a lack of trust or transparency amongst organizations working in the same sector in Lebanon.

Stakeholders with the highest degree⁴ centrality are ranked in Table 8, and can be identified as those with the largest nodes in Figure 8.

² Financial exchanges between electricity providers, such as EDL and WEs, do not mean standard billing processes but a shared interest in working at the interface with water and energy, and developing projects and initiatives within the W-E Nexus framework.

³ Normally the density of a network is a maximum of 1 in a reciprocated network, and a minimum of 0 in a disconnected network.

⁴ Number of connections a node is linked to.

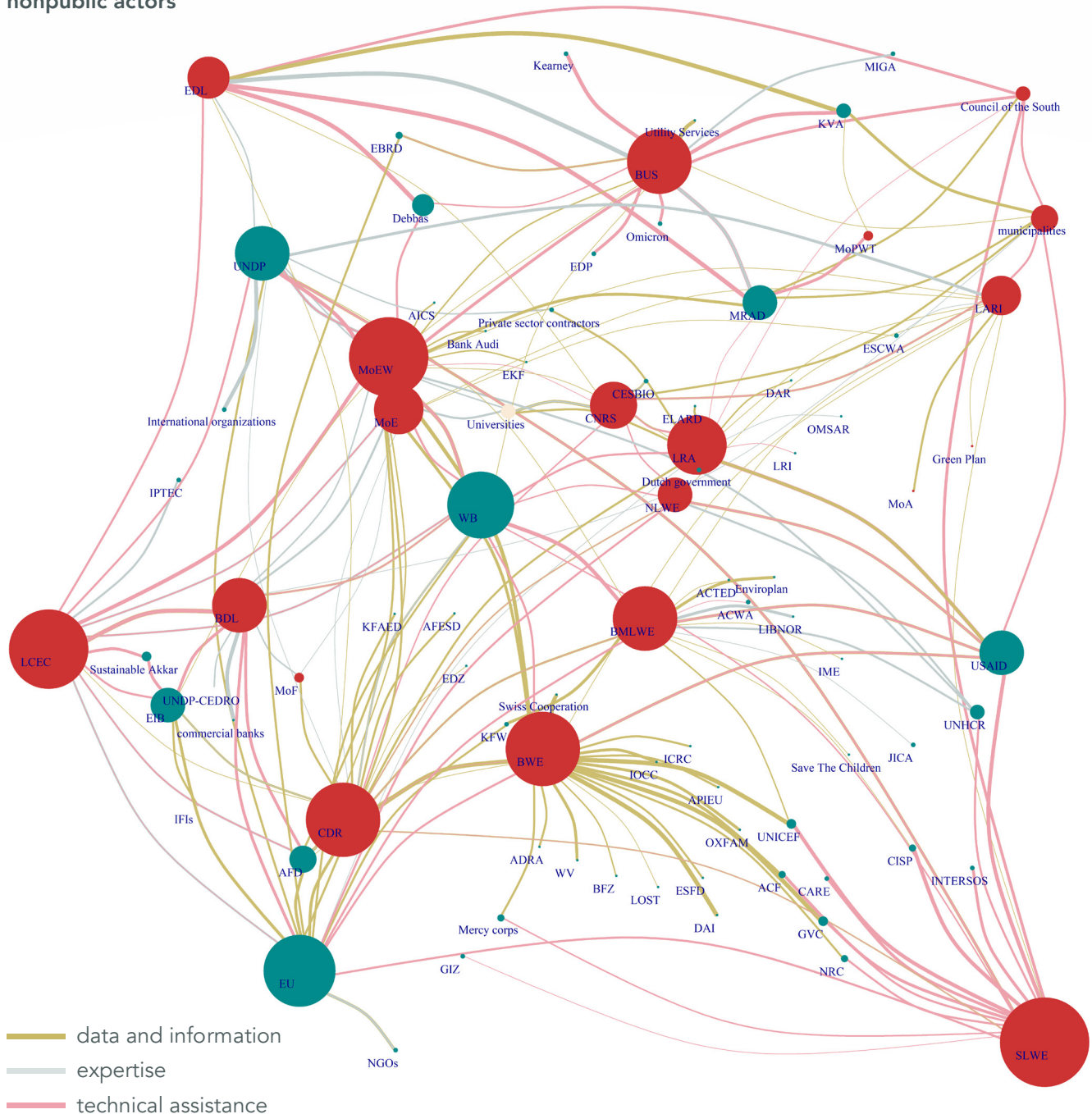
Table 8 Stakeholders with the Highest Degree Centrality

Stakeholder	Degree
SLWE	36
LCEC	32
MoEW	32
BWE	30
CDR	30
EU	29
WB	27
BMLWE	26
BUS	26
LRA	24

According to responses from stakeholders, LCEC, MoEW, SLWE, and the BWE have the highest connection numbers, showing an initiative for data and expertise sharing. SLWE⁵ has the highest connection number, 36.

⁵ A red-blue palette was used, and it can be seen in Figure 8 where the actors with the highest degree centrality will have the brightest red color, and the color shifts to purple then to blue as the degree value decreases.

Figure 7. Network plotting the knowledge, data and information, and technical sharing among stakeholders in the water and energy sectors. Circles in red represent public actors while circles in blue represent nonpublic actors



Stakeholders with the highest degree centrality⁶ can be seen with the brightest red color, and largest size. Organizations such as MoEW, LCEC, and the SLWE have a high capacity for sharing information within their networks. Their numerous connections and accessibility allow for better information collection, and a more informative database. It is noticeable that there is not one institution that prominently stands out in terms of exchange of knowledge, information and data, and technical exchange compared with the SLWE. However, the top ten stakeholders with the highest degree centrality are predominantly public institutions, with the exception of EU and WB. All of the public institutions with the highest degree scores are commonly connected to international funding bodies, such as the EU, UNDP, UNICEF, USAID, GIZ, EBRD, Swiss Cooperation, and NRC (Appendix D).

⁶ The number of edges pertaining to a certain node.

Legend:

- data and information (gold line)
- expertise (grey line)
- technical assistance (pink line)

Color scale: Higher (red) to Lower (blue)

Stakeholders with the highest betweenness centrality values can be seen in Table 9. The CDR and LARI are the institutions that act as hubs for funneling shared information between all the remaining stakeholders. The different betweenness centrality values can be visualized in Figure 9, where the network was plotted based on the betweenness values of the stakeholders highlighting the actors with the highest betweenness centrality values.

Table 9 Top Ten Stakeholders with the Highest Betweenness Centrality Values

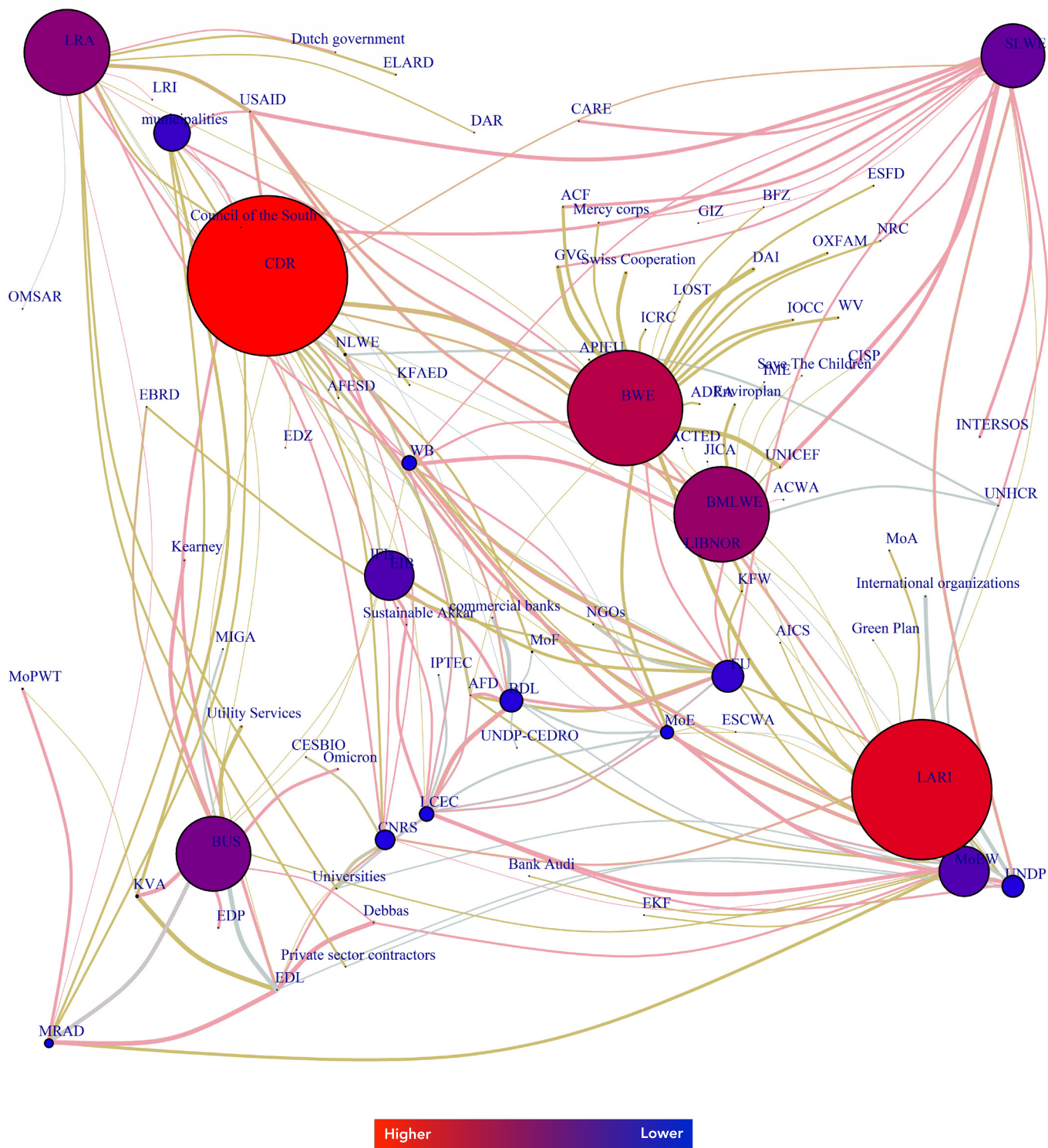
Stakeholders	Betweenness
CDR	1292.60
LARI	1130.48
BWE	929.82
BMLWE	768.31
LRA	690.82
BUS	602.80
SLWE	513.87
MoEW	403.64
EIB	397.21
Municipalities	292.28

Table 10 Stakeholders with the Highest Eigenvector Centrality

Stakeholders	Eigenvector
LCEC	1
MoEW	0.867
WB	0.840
EU	0.733
UNDP	0.691
BDL	0.683
MoE	0.656
BWE	0.567
SLWE	0.549
EDL	0.513

In the case of sharing data, information, and expertise, the LCEC has the highest Eigenvector centrality value. Table 10 shows the stakeholders with the highest Eigenvector centrality values, and those are illustrated in Figure 10.

Figure 9. Network plotting knowledge, data, and technical sharing of stakeholders, based on their betweenness centrality values



Results have shown that water sector institutions, such as the WEs and the LRA, are only dealing with international organizations and the MoEW, while there are no connections with energy-related establishments. The same can be said about the energy sector, organizations such as EDL, the LCEC and BUS share data with international and local agencies, as well as amongst themselves, but there are no linkages to the water sector beyond their connection to the MoEW, and the fact that sometimes they are funded by the same organizations (Appendix D). It can also be stated, based on the results, that they share data with international organizations more than they share data amongst each other. International organizations and NGOs play a major role in providing expertise and technical assistance to the WEs, LRA, LCEC, BUS, and EDL (Appendix D). Expertise and technical assistance are also generally passed on from international organizations to local governmental institutions. However, there is no exchange of expertise amongst local organizations. WEs, for example, commonly share expertise with the EU, WB, USAID, and GVC. The LRA, LCEC, and BUS also share expertise and technical assistance with the EU, WB, USAID, and GVC, but there are no connections, at any level, between these energy and water organizations.

The LCEC has a high Eigenvector score, meaning it is well connected to organizations that are highly connected themselves in the network, meaning it provides a steady flow of information to numerous stakeholders and has influence in the network, or at least in its own sub-network cluster.

The CDR and LARI have the highest betweenness degree scores giving them major intermediary roles in the network about data sharing, technical assistance, and providing expertise. Most connections are channeled through these two stakeholders, giving them an influential role in the network.

Policymaking, strategies, and plans - interactions among stakeholders in the water and energy sectors

Network relationship with regards to policymaking was defined in two aspects: frequency of communication related to implementation, and frequency of implementation related to drafting new regulations in both water and energy sectors. The actors were questioned regarding the enforcement of regulations in the water and energy sectors, as well as drafting policies, strategies and plans in both sectors. The maps were produced according to the responses from the following questions separately:

- How often have you communicated regarding enforcement of regulations in the water or energy sector, since February 2018?
- How often have you communicated regarding drafting policies, strategies, and plans in energy and/or water, since February 2018?

Frequency of communication regarding enforcement of regulations in the water or energy sectors. The first map produced visualizes stakeholders' responses regarding enforcement of regulations in the water and energy sectors. The network density for this map is 0.19, which is relatively higher than the two previous themes, meaning that a larger number of the stakeholders are directly connected to each other, maximizing their edge-node capacity. The stakeholders in question have a stronger frequency of communication regarding enforcement of regulations than they do when data sharing.

Actors with the highest degree centrality scores can be seen in Table 11. A map visualizing the network based on degree scores can be seen in Figure 12. The MoEW has the most connections when it comes to enforcing policy, as it should be; considering its mandate and how big a role it plays in enforcing policies and strategies. Multiple responders stated the WB as their link to enforcing policy, whether in an implementation capacity, which does fall within their mandate, or as a liaison to the MoEW, which was not identified.

Table 11 Actors with the Highest Degree Centrality for Communications Regarding Enforcement of Regulations in the Water or Energy Sectors

Stakeholders	Degree
MoEW	12
WB	9
LRA	8
SLWE	7
CDR	7
LCEC	7
MoE	6
EDL	5
BMLWE	5
CNRS	5

Table 12 Top Ten Stakeholders with the Highest Betweenness Centrality

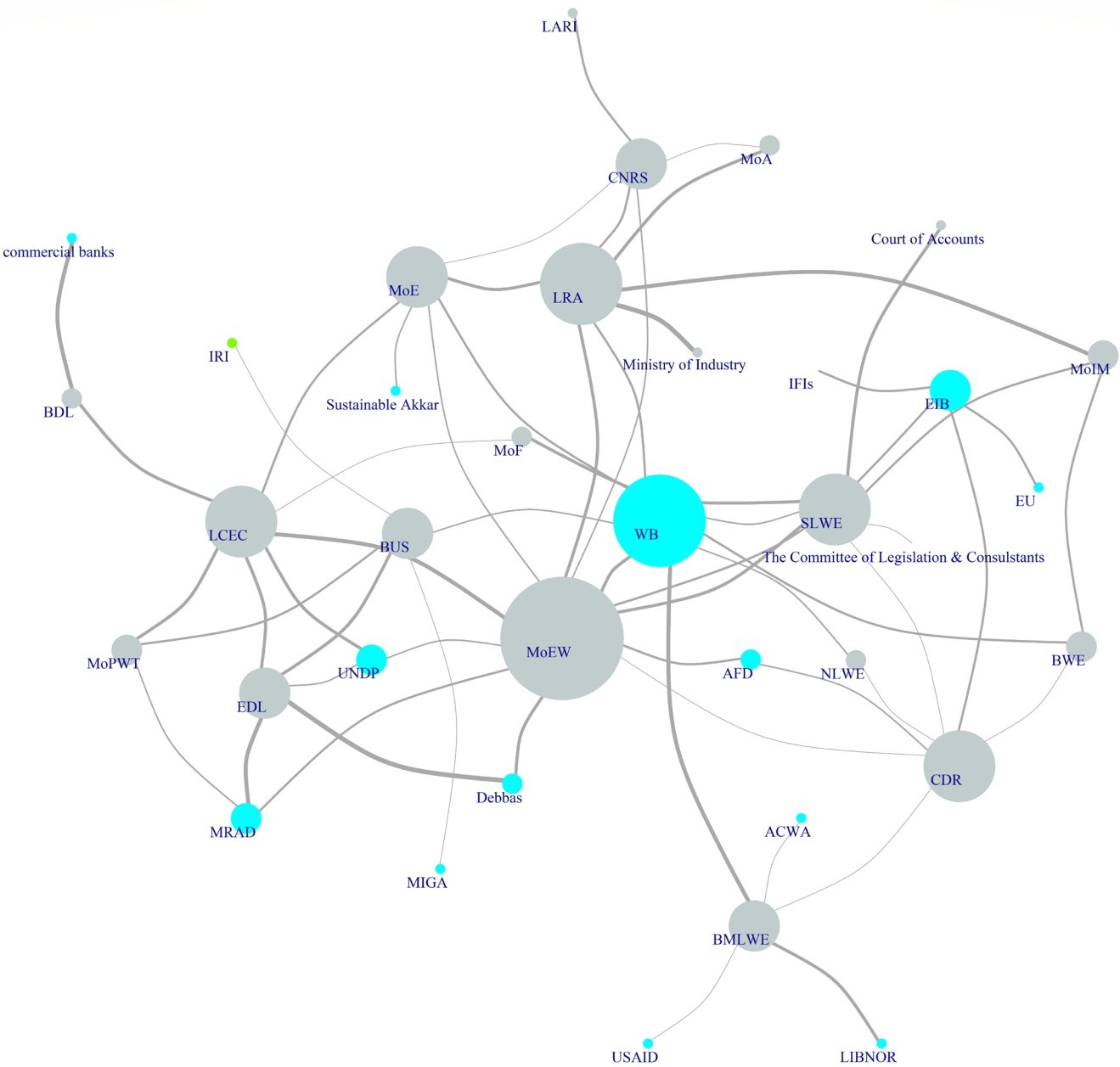
Stakeholders	Betweenness
CDR	266.13
MoEW	228.40
SLWE	132.93
BMLWE	99.00
WB	96.42
MoE	84.70
LCEC	80.17
BUS	75.08
CNRS	71.76
EIB	67.00

Table 13 Top Ten Stakeholders with the Highest Eigenvector Centrality

Stakeholders	Eigenvector
MoEW	1.00
LRA	0.870
WB	0.754
LCEC	0.645
MoE	0.572
EDL	0.451
SLWE	0.435
Debbas	0.379
MoIM	0.353
MRAD	0.322

Stakeholders with the highest betweenness centrality values can be seen in Table 12. The MoEW and CDR are the actors with the highest betweenness centrality scores. The different betweenness centrality scores can be visualized in Figure 13, where the network was plotted based on the betweenness scores of the stakeholders highlighting the actors with the highest scores.

Figure 11. Network plotting the communication regarding enforcement of regulations in the water or energy sector. Actors in grey are public institutions, and actors in turquoise are non-public institutions



It can be seen from Figure 12 that the stakeholder with the highest degree centrality is the MoEW⁷. The MoEW and the WB are both highly connected when it comes to aiding organizations in enforcing policies, and passing along a need for enforcement of policies. Financing institutions such as BDL, WB, AFD, and EIB are connected to the MoEW. The WB, as a connector between MoEW and other organizations, can influence enforcement of policies regarding W-E nexus, and work towards better water energy integration at the policy level. The CDR appears to play an intermediary role in communication regarding implementation of policies (Figure 13). According to its mandate, the CDR does not delve into policy related issues, or the enforcement of regulation at the policy level, meaning that as an organization, the CDR’s role within the entire network appears to be overreaching.

⁷ Blue nodes represent actors in the non-public sector, while grey nodes represent actors in the public sector.

Figure 12. Network plotting the communication regarding regulations enforcement in the water or energy sector by stakeholders based on their degree centrality values

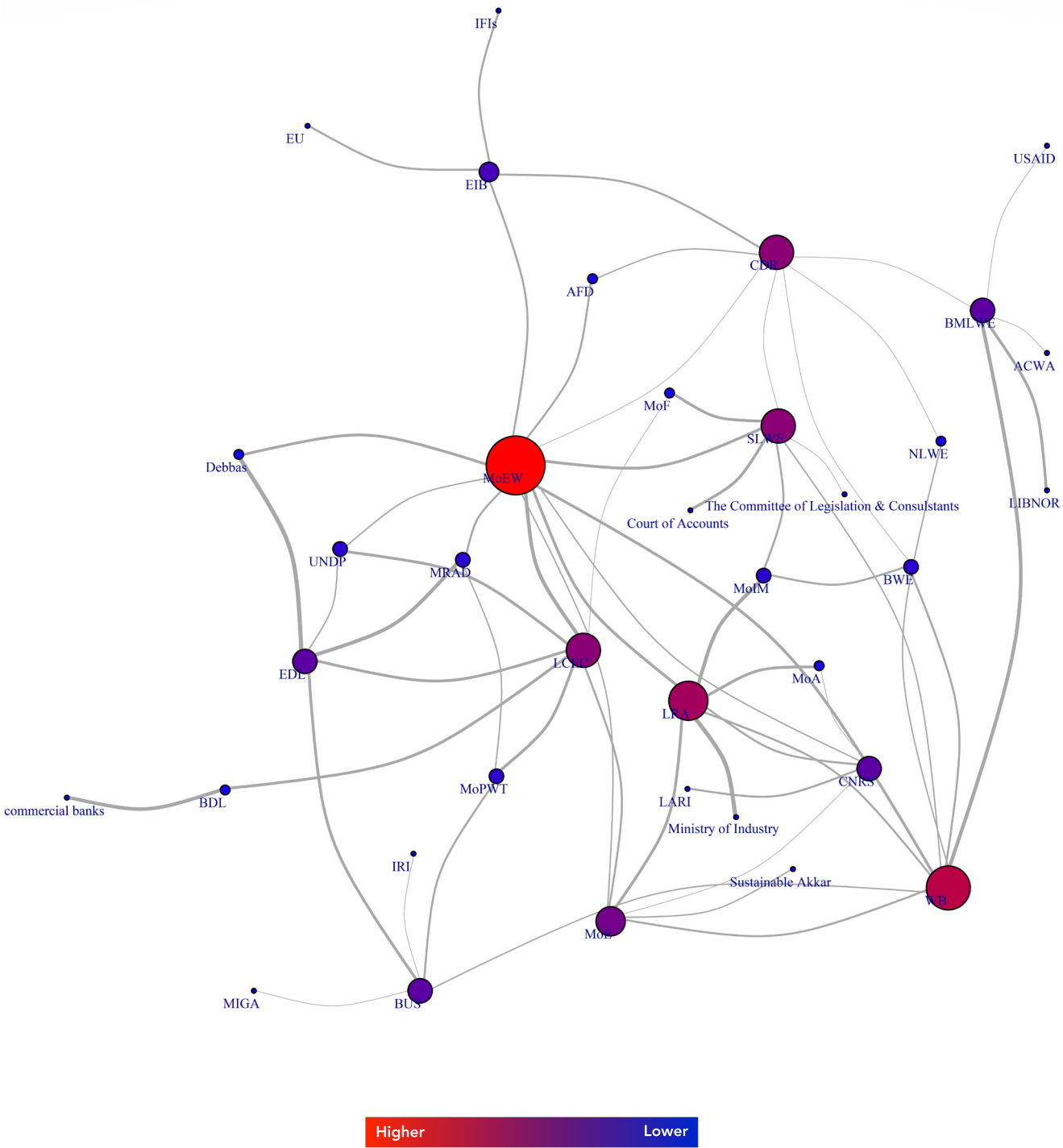


Figure 13. Network plotting communication regarding enforcement of regulations in the water or energy sectors based on stakeholders' betweenness centrality

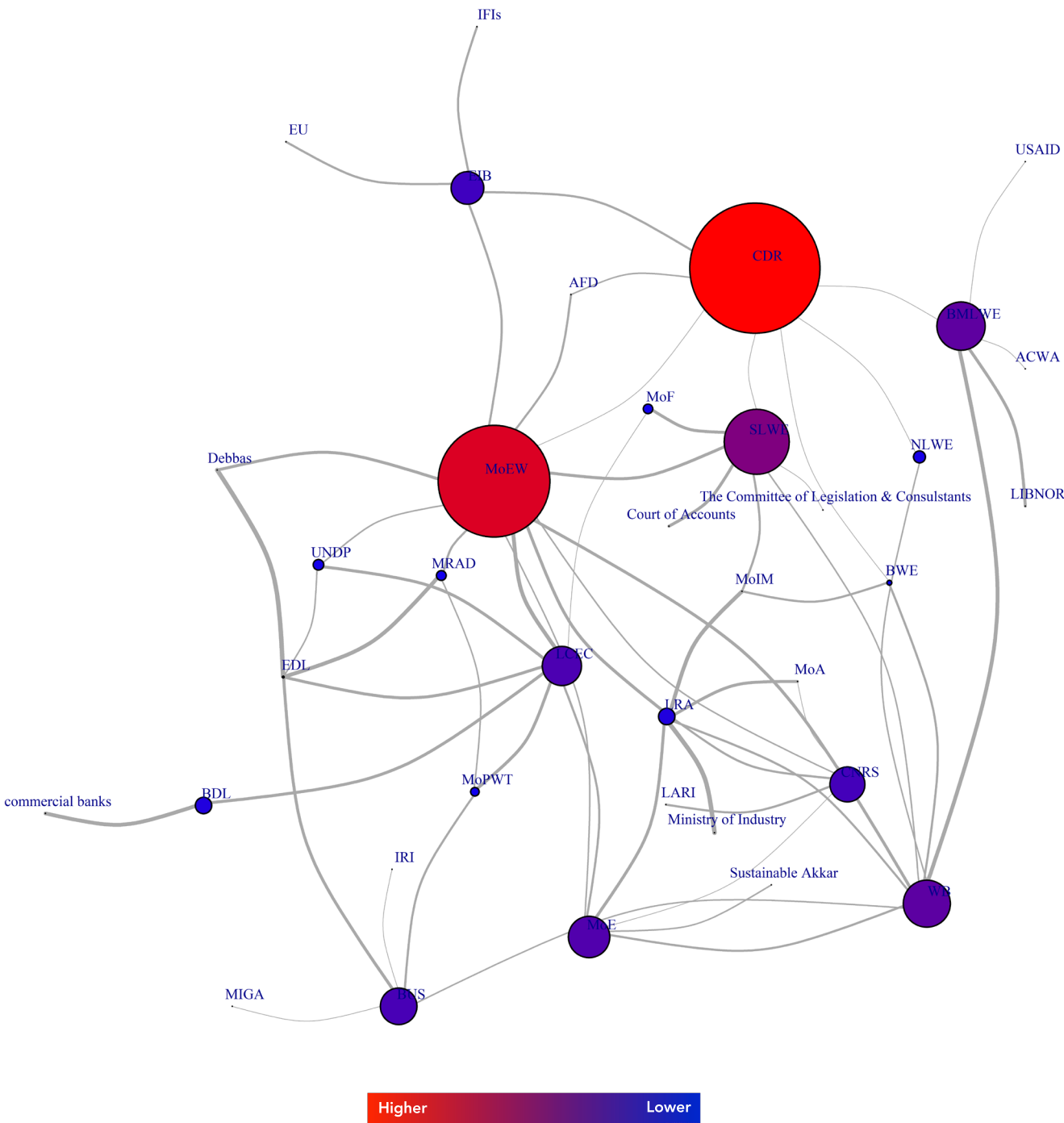
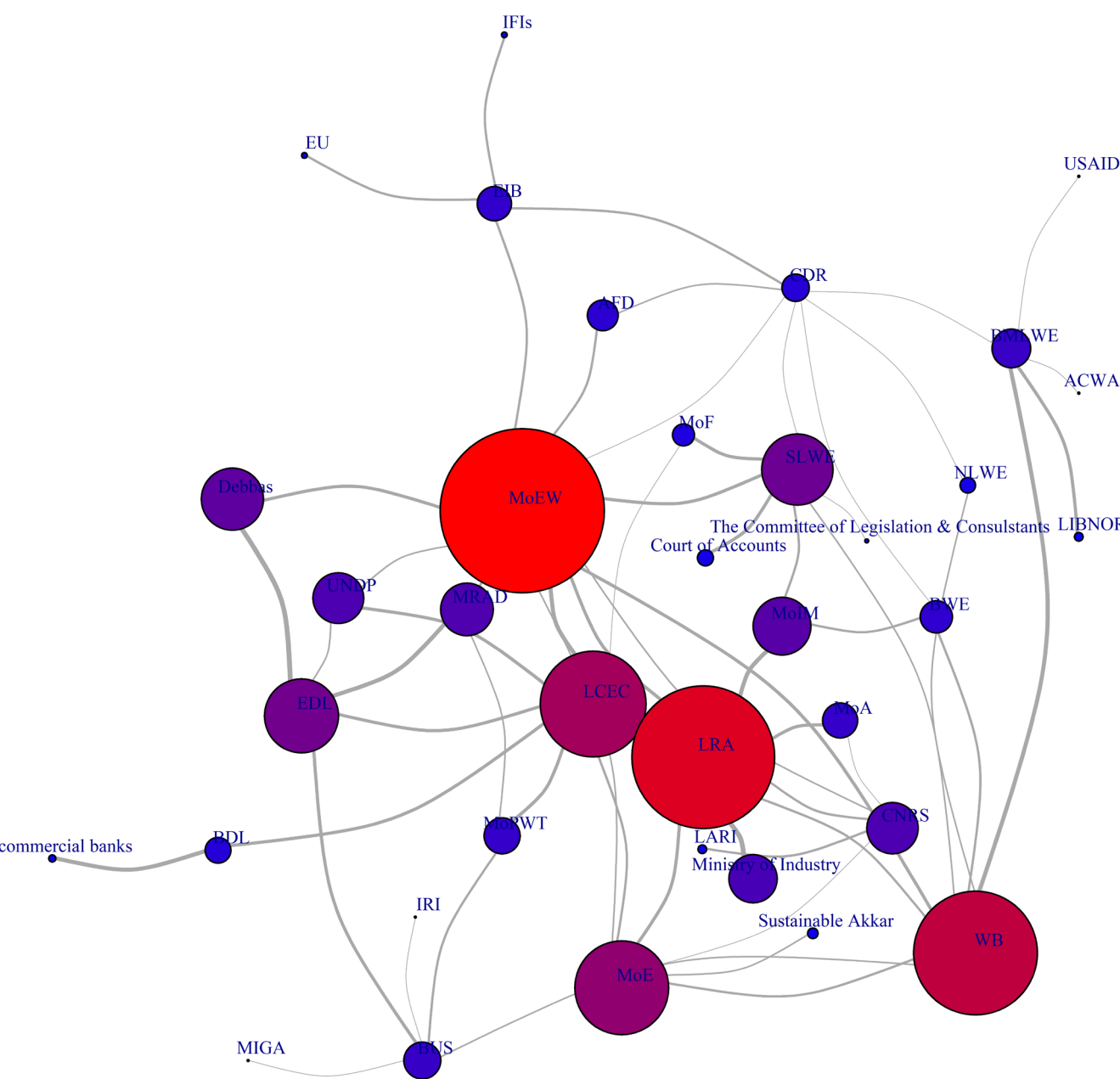


Figure 14. Network plotting the communication regarding enforcement of regulations in the water or energy sector by the stakeholders based on their Eigenvector centrality values



The Eigenvector scores, in the case of sharing data, information and expertise of the MoEW, has the highest Eigenvector centrality value, which reflects its mandate and role in policymaking and implementation, in both water and energy. LRA also has a high Eigenvector centrality value, which also reflects its role and mandate along the Litani river. Table 13 shows the stakeholders with the highest Eigenvector centrality values, and those can also be visualized in Figure 14.

At the policy level, the top ten stakeholders that have the highest number of connections, or highest degrees, can be seen in Appendix E.

Communications regarding drafting policies, strategies, and plans in the water or energy sectors. The network density for this map is 0.18, which is considerably low for these kinds of policymaking networks. Stakeholders at the policymaking level, especially when it comes to developing and drafting new strategies, need to be working on maximizing their edge-node capacity. Instead of having a sparse network, one such as this, theirs should be more interlinked and heavily convoluted.

Table 14 Actors With the Highest Degree Centrality for Communications Regarding Drafting Policies, Strategies, and Plans in the Water or Energy Sectors

Stakeholders	Degree
MoEW	10
BDL	10
CDR	6
BUS	5
MoE	4
LRA	4
WB	4
MRAD	3
EDL	3
EU	2

Table 15 Top Ten Stakeholders with the Highest Betweenness Centrality

Stakeholders	Betweenness
MoEW	109.83
CDR	98.67
WB	80.50
BDL	71.16
BUS	54.00
LRA	51.50
BMLWE	28.00
MoE	25.30
USAID	24.00
Debbas	14.50

Table 16 Top Ten Stakeholders with the Highest Eigenvector Centrality

Stakeholders	Eigenvector
MoEW	1.00
BDL	0.963
AFD	0.562
EIB	0.49
MoE	0.399
MRAD	0.394
WB	0.384
SLWE	0.369
LCEC	0.276
Commercial banks	0.276

Stakeholders with the highest degree centrality are the nodes with the highest number of edges linking them to other stakeholders; these can be seen in Table 14. Another graph was plotted based on the degree-values of the stakeholders highlighting the actors with the highest degrees (Figure 16).

It can be seen from Figure 16 that the stakeholders with the highest degree centrality are the MoEW and BDL. For MoEW, this reflects well the expected role and its mandate, in terms of drafting policies and strategies. Furthermore, the MoEW acts as a hub for developing strategies in a participatory approach in which it is clear that they communicate frequently with various international and national stakeholders. BDL on the other hand, stores most of the national finances for these projects, hence their recurrence in this theme, since beneficiaries have to deposit the money with BDL, or have to get some kind of fiscal clearance for their policies/strategies/plans. It's important to note that it is not in BDL's mandate to act as fiscal clearance for organizations' projects.

Stakeholders with the highest betweenness centrality values can be seen in Table 15. The MoEW is the actor with the highest betweenness centrality value since all strategies, policies,

and planning regarding water or energy comes through it. The different betweenness centrality values can be visualized in Figure 17, where the network was plotted based on the betweenness values of the stakeholders highlighting the actors with the highest betweenness centrality values.

Eigenvector centrality shows the degree of connection to other important vertices or nodes. Stakeholders that are linked to other influential stakeholders in the network, for example, stakeholders with high authority or power, are more likely to influence project outcomes, policy reforms, or implementation. In the case of communications, regarding the drafting of policies, strategies, and plans, the MoEW has the highest Eigenvector centrality value. Table 16 shows the stakeholders with the highest Eigenvector centrality values, and those can also be visualized in Figure 18.

Figure 15. Network plotting the communication regarding drafting policies, strategies, and plans in the water or energy sectors. Grey refers to public institutions and turquoise to non-public

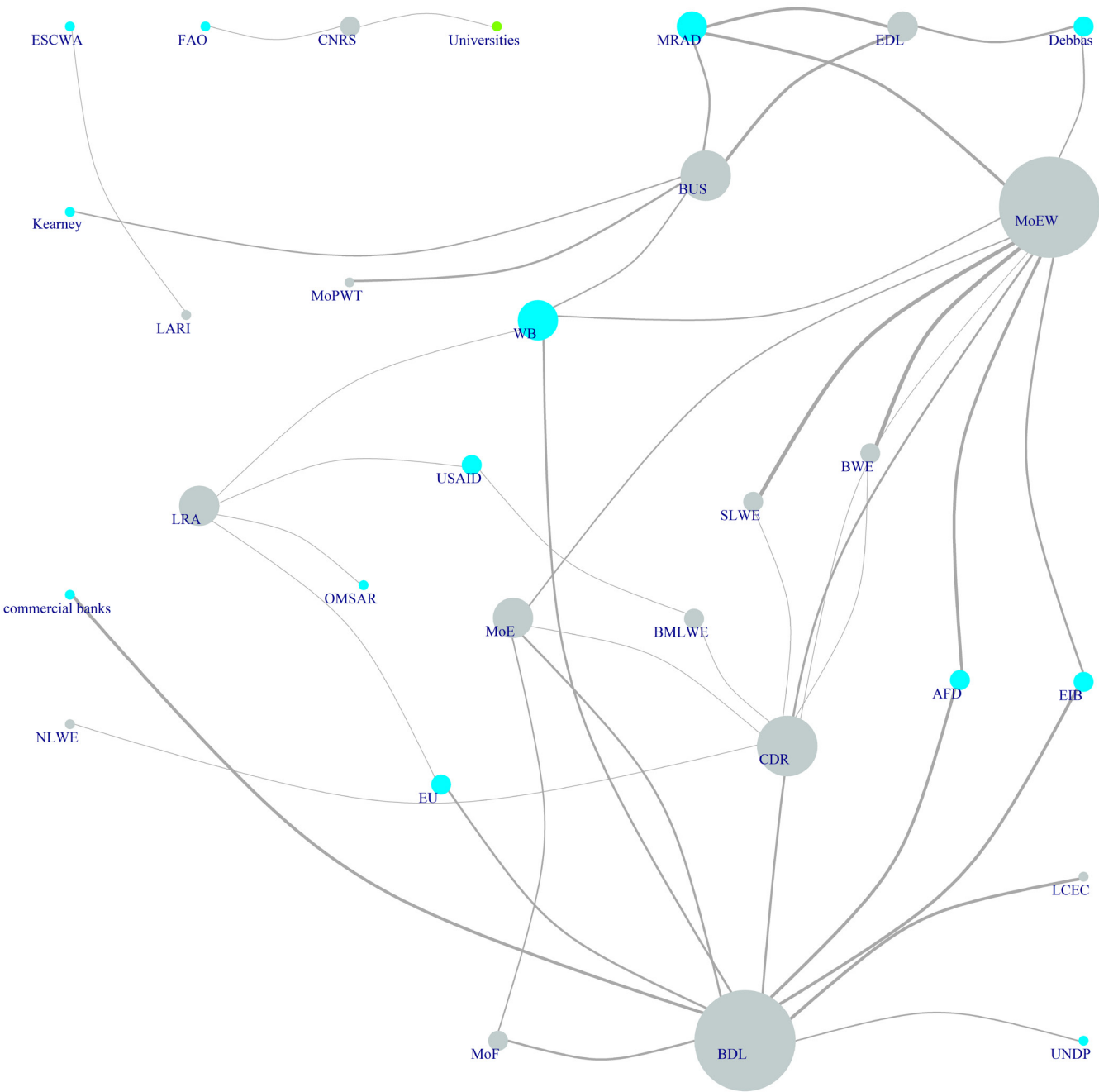


Figure 16. Network plotting the communication regarding drafting policies, strategies, and plans in the water or energy sectors based on stakeholders' degree values

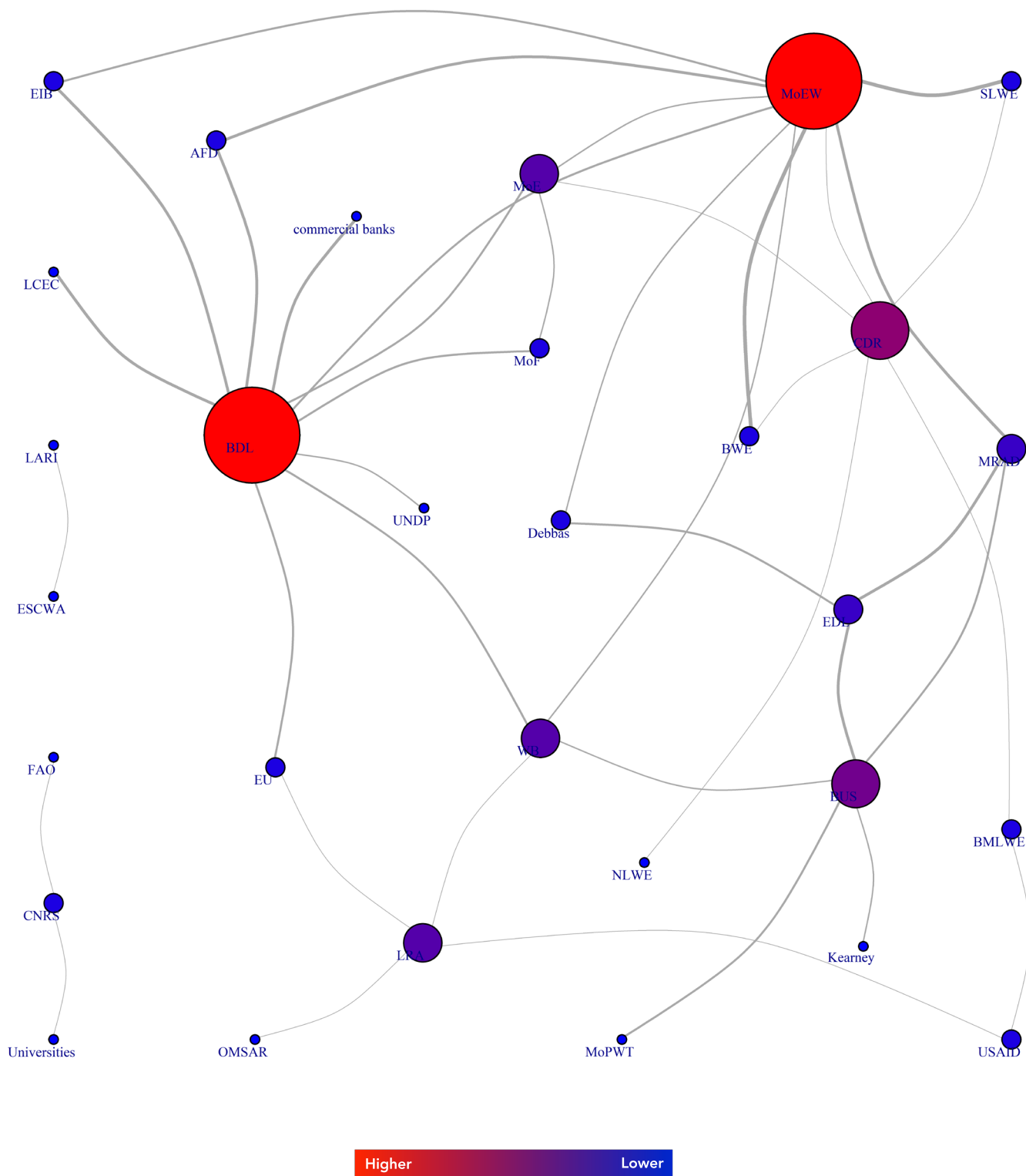


Figure 17. Network plotting the communication regarding drafting policies, strategies, and plans in the water or energy sectors by stakeholders based on their betweenness centrality values

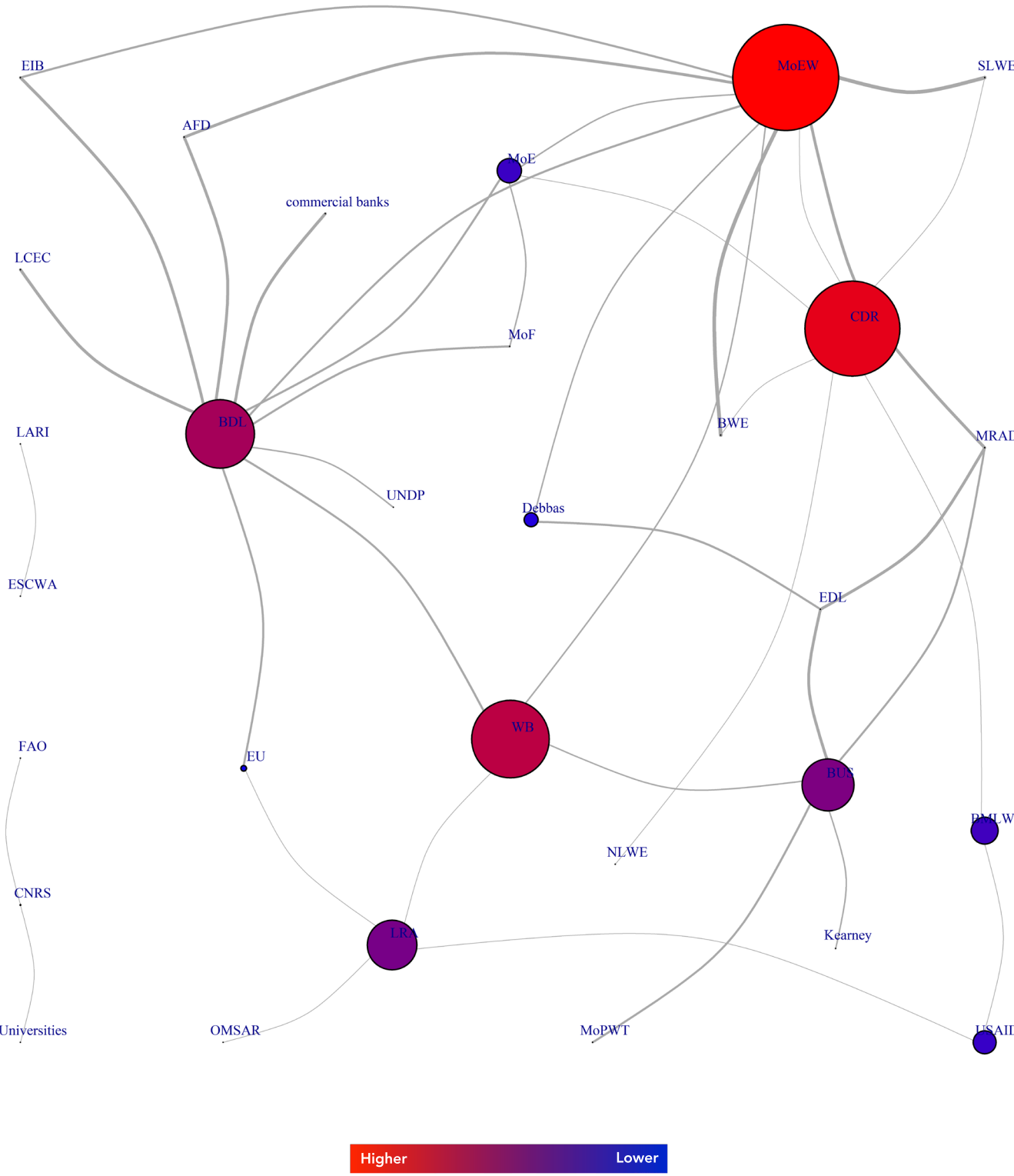
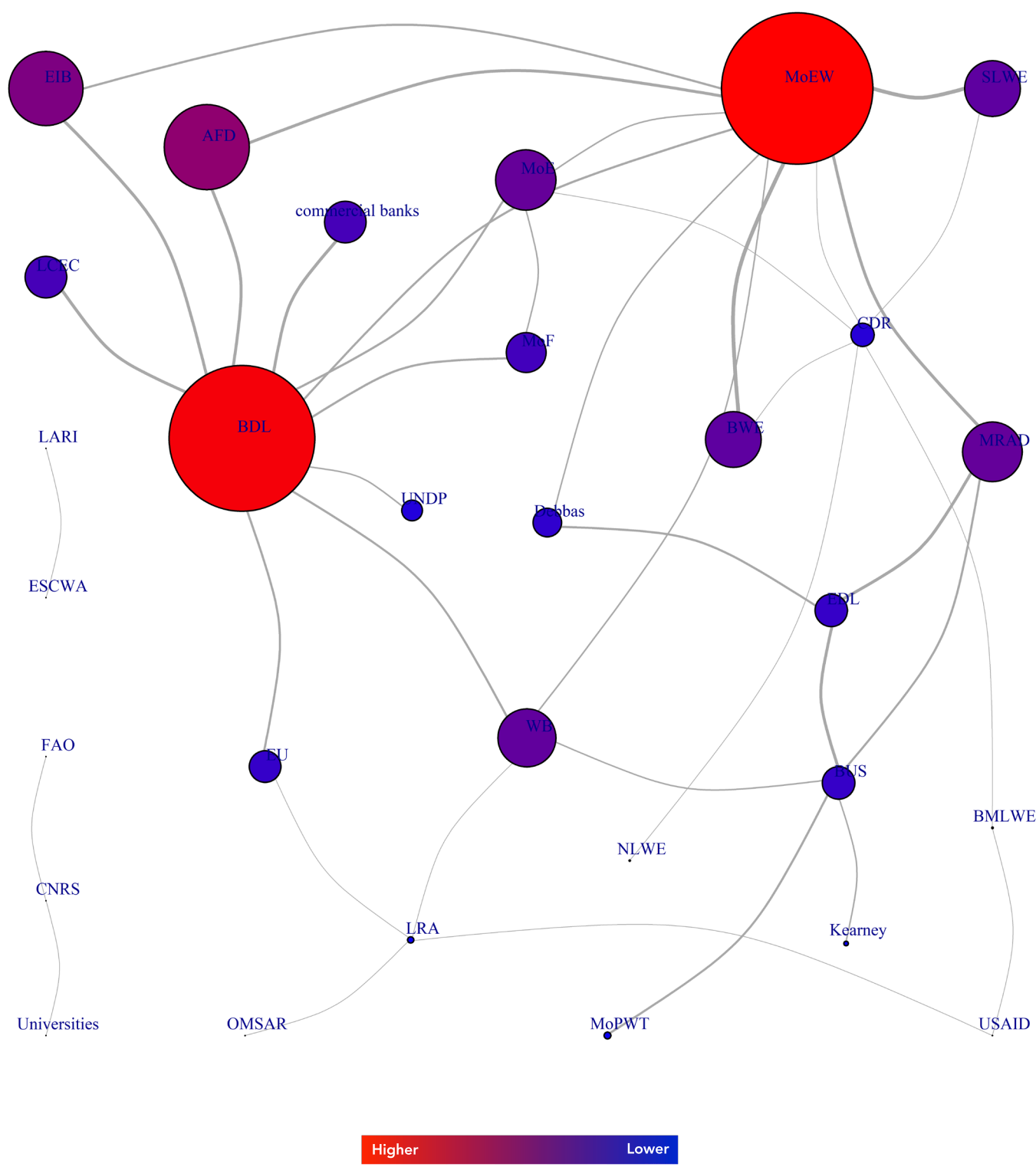


Figure 18. Network plotting the communication regarding drafting policies, strategies, and plans in the water or energy sectors by stakeholders based on their Eigenvector centrality values



At the policy level, the top ten stakeholders that have the highest number of connections, or highest degrees, can be seen in Appendix E. The table shows who these stakeholders are connected to, in terms of drafting new strategies and policies. The MoEW and BDL are both highly connected when it comes to discussing strategy and planning new policies, as it should be. It is important to point out that connections at the policy level are less sectoral. On one hand, the MoEW is connected to organizations, such as EIB, AFD, and the WB, instead of governmental agencies, such as the WEs, and it is connected to electricity providers, such as MRAD and Debbas, showcasing a sectoral approach to policymaking. On the other hand, the CDR is connected to all four WEs at the policy level, which defies its purpose. Even though the policymaking network is denser and better connected than the other two themes, it still shows mismanagement and lack of organizational capacity where no stakeholder is fully implementing its mandate.

Discussion and Recommendations

One of the main challenges facing the much-needed integration of the water and energy sectors is delineating the interface between both sectors, and establishing strong and effective communication and collaboration channels among key stakeholders.

Social network is the metaphoric “glue” that holds organizations and government institutions together. It is characterized by trust, reciprocity, common values, and a structural connection (network) that could foster resilience and facilitate coordinated community action needed for social change.

As seen from the network maps and analysis thus far, the social network comprises two dimensions: (a) bonding within group ties or “strong ties”; and (b) bridging, which is comprised of ties connecting distinct groups together or “weak ties”.

Throughout the networks identified in each theme, several stakeholders with strong ties are observed. BWE, MoEW, CDR, EU, SLWE, and LCEC, for example. Throughout, all three main themes have been identified to have strong ties. However, it is important to point out that stakeholders with strong ties are self-limiting, they can lead to what is sometimes called a filter bubble, where information and new ideas that result from such things as interacting with new stakeholders and breaking the proverbial ‘mold’, are blocked by trying to maintain the same connections within familiar homogenous circles. It is recommended for organizations that focus on natural resource management, to have many weak ties to challenge this vicious cycle and support critical thinking, while bridging new topics such as the water-energy nexus. As observed in the financial connections in theme one (a)—BWE receives frequent funding from multiple stakeholders while other WEs benefit from similar funding to a lesser extent (the study did not include amounts). On the other hand, SLWE has developed strong ties through the expertise they have developed over recent years. Although this is related to performance and the needs of each water establishment, donors and international organizations should ensure impartial and fair access to funds more frequently, and capacity building for all WEs and other public institutions working at the interface of the W-E nexus.

Organizations with high betweenness centrality such as the CDR, BWE, LARI, and the MoEW may have negative impacts on the entire network. Their high betweenness centrality scores makes the network vulnerable to fragmentation, should these actors disappear. The betweenness scores are centralized within these actors, requiring strong links to these stakeholders in order to acquire information, knowledge, or funding, which could lead to perceiving those actors as mandatory bottlenecks. Although, given their mandates, MoEW and CDR could obstruct funding to any RWEs or organizations such as LARI, while the contrary

is not true. The networks show high betweenness centrality, which may give rise to centralized management and thereby fewer experiments and new forms of learning and coordination regarding new projects or concepts on natural resource management, such as the W-E nexus approach.

Following up on the results of the study, it can be deduced that not all stakeholders, especially at the national level, function within the extent of their mandates. Based on the roles and responsibilities identified through the literature review and secondary data collection, which can be seen in Table 5, another table was developed showing which organizations would benefit their networks on all three levels should they focus on the W-E nexus (Table 17). Organizations such as the MoE and the MoA, who were under-represented in all the networks, should focus more on integrating water and energy projects. The CDR should funnel funds to organization more focused on the W-E nexus, creating a certain motivation and ripple effect, allowing other governmental institutions to follow when shifting focus from water and energy separately to W-E nexus projects.

Decentralized networks are, in general, suitable for long-term environmental planning and complex problem solving, due to the need for multiple stakeholders (across the disciplines) to contribute to the solution of a problem, providing different knowledge and perspectives. In the case of the networks analyzed in the study, the networks are centralized. Hence, it would be recommended to decentralize the networks by:

Prioritizing the development of weak ties amongst stakeholders, to promote new concepts such as the W-E nexus at the funding level, as well as at the data-sharing and expertise level.

Weak ties are exploited best when organizations expand their strategies or priorities. The integration of the W-E nexus at the level of all three themes discussed in the study is a perfect example of that. The study showed that there is a lack of communication/ties between stakeholders at all levels, and when there are, the ties are only focused on one sector, either energy or water. An integration of these sectors would give room for more discussion and provide a wider spread of interest amongst stakeholders, which could put stakeholders in touch that normally would not have the same priorities or goals. The MoEW's connections when communicating on drafting policies and strategies would be a perfect example, where a hub such as the MoEW focuses on the big NGOs and donors, instead of communicating with the organization whose strategies and policies would be impacted by stakeholders such as the LRA and WEs.

Review the allocation of funds for W-E projects within the annual governmental budget, and develop a strategy integrating the water and energy sectors, which would attract international funds from organizations, such as the EU, WB, EBRD, ADB, and others, to develop projects within that new W-E nexus theme.

Review the role of institutions, such as the CDR, who throughout the study manifested in capacities that do not fall within its mandate, especially in theme three when discussing drafting policies and strategies.

Organizations such as the MoE and the MoF (as seen in Table 17) should focus more on implementing their roles as per their mandates (Table 5).




















































































































































Results showed that CDR plays a role in policymaking, which goes beyond its original mandate (Table 5). This calls for a review into its reach and role as a financial funnel for water and energy projects. However, recent discussions amongst policymakers have limited the mandate of the CDR and similar councils under the prime ministry's office, as a first step towards abolishing them. Given the CDR's degree of betweenness scores, shown earlier, it would be crucial to decentralize its position within the network, to avoid any power vacuum, fragmentation, and negative impacts on the network. A scenario without CDR presents a power vacuum within the financial network mostly, but also in the other two themes as well, hence the importance of breaking down the network to avoid such power vacuums.

It is important to clarify the role of organizations such as LCEC and LARI, in both water and energy, and to solidify their connections with all relevant stakeholders, such as the MoEW and WEs.

It can be deduced from the SNA that the system has a bias towards strong actors, which is highlighted in their presence throughout all three themes. Actors such as CDR, MoEW, LCEC, and the BWE are all identified by their peers as the main players in themes, which do not relate to their original mandates. For example, CDR has been identified as an impactful stakeholder in policymaking, and the LCEC has been identified as a major stakeholder in data sharing and expertise, regarding energy issues.

There is a need to decentralize the web of stakeholder networks and re-assess the role and responsibility of public and private institutions, relative to the water and energy sector. The betterment in integration would help to mainstream W-E nexus projects and facilitate their implementation.

Table 17 Organizations where a nexus approach can improve the fulfillment of their mandates

Description of responsibilities	MoEW	MoE	MoA	MoIM	MoF	Municipalities (under MoIM)	BDL	CDR	LRA	RWEs	Green Plan	LARI	CNRS	EDL	*LCEC	Council of the South	1DSPs	2RECs
Policymak- ing																		
																		
																		
																		
Strategic Planning and Implemen- tation																		
																		
																		
																		
																		
																		
Conserva- tion and Resource Manage- ment																		
Implemen- tation and En- forcement of Regula- tions and Standards/ Codes																		
																		
																		
Operation and Distri- bution																		
																		
Control and Moni- toring																		
																		
																		

*LCEC is not a public institute but works closely with MoEW to mainstream sustainable energy practices in Lebanon.

1 BUTEC, KVA
2 EDZ

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Appendix A

Social Network Analyses Questionnaire

The Issam Fares Institute for Public Policy and International Affairs (IFI) at the American University of Beirut is conducting a study on the interrelations between various key stakeholders in the public and private sector in Lebanon in relation to water and energy. This study is part of the “Water-Energy Nexus of Water Services in Lebanon” project implemented by IFI within the framework of the “Improving access to safe and affordable water to vulnerable communities” project implemented by H2ALL consortium, under the EU Madad Trust Fund programme “Water, Sanitation and Hygiene (WASH)” programme for Syrian refugees and Lebanese host communities”. H2ALL is a WaSH consortium that consists of the Norwegian Refugee Council, Oxfam, World Vision International, and Gruppo di Volontario Civile.

The objective of the study is to shed light on the complex established interactions between organizations on financing, information and technology, and governance in the water and energy sectors. It would shed light on existing relations among stakeholders and provide the basis for targeted recommendations for a more coordinated and integrated water and energy sectors. The methodology that would be followed is a social network analysis (SNA) that examines a complex, vibrant, and open system—in this case, the interactions between the water and energy sectors—and evaluates the processes and interventions that impact it. SNA promotes the exploration of patterns and different kinds of interactions between actors, and provides a visual presentation of them.

As a key stakeholder in the water and/or energy sector we kindly ask you to take some time (an average of 20 minutes) to respond to the following questionnaire. This questionnaire is designed to identify the level of communication that takes place between your organization and other governmental or non-governmental organizations in Lebanon within the interface of the water and energy sectors.

The questionnaire covers:

- Frequency of contact for financial exchange on water and energy related issues.
- Frequency of contact for knowledge, information, and technical exchange on water and energy related issues.
- Frequency of contact for policymaking, strategies, and plans on water and energy related issues.

Key stakeholders that were identified within the work of this project are listed at the beginning of the questionnaire; however, you may add any other stakeholder that you may think is relevant and key within the water and energy interface. Your responses are crucial to the successful continuity of the following assessment towards improved mechanisms for collaboration and coordination between stakeholders in the water and energy sector in an integrated approach.

Please note that all information provided will be kept strictly confidential, and will only be used for the purposes of this study.

Thank you in advance for your cooperation and contribution to this study.

Questionnaire

1. List the organizations with which you have had funding agreements (as beneficiary) in relation to water or/and energy. Check the box that best describes how often you have had funding agreements since February 2018. Funding includes investment contracts, loans, and other types of funds for a project, program, etc. You may use the list of stakeholders in section A for reference, but please feel free to add more if they are not mentioned in the previously mentioned section.

Question 1	How often have you had funding agreements (as beneficiary) since February 2018?			
Organization	Once	2 times	2-6 times	More than 6 times

2. List the organizations with which you have had funding agreements (as funder) in relation to energy or/and water. Check the box that describes how often you have provided funding for each organization since February 2018. Funding includes investments, loans, and other types of funds for a project, program, etc. You may use the list of stakeholders in section A for reference, but please feel free to add more if they are not mentioned in the previously mentioned section.

Question 2	How often have you had funding agreements (as funder) since February 2018?			
Organization	Once	2 times	2-6 times	More than 6 times

3. List the organizations with whom you have shared data and information (information includes raw, and/or analyzed and contextualized data, shared databases, etc.) in relation to energy or/and water. Check the box that describes how often you have shared official information through formal channels, whether through consultation meetings, one-on-one-meetings, or email, since February 2018. You may use the list of stakeholders in section A for reference, but please feel free to add more if they are not mentioned in the previously mentioned section.

[illegible]

7. List the organizations that you communicated with regarding drafting policies, strategies and plans in energy or/and water. Check the box that describes how often you have communicated with each organization since February 2018 regarding drafting policies, strategies and plans.

You may use the list of stakeholders in section A for reference, but please feel free to add more if they are not mentioned in the previously mentioned section.

[illegible]

8. Check the box that describes the type of relationship you have with each organization. The relationship can be informal, where engagements or interactions occur among people outside the established structure of any organization, or formal, due to a mandate or memorandum of understanding between organizations, meaning that an agreement exists between two organizations outlining their working relationship, and signaling the will of both parties on working together.

Question 8	Relationship between your organization and others				
List of organizations	Never work together	Communicate through an informal relation	Communicate through formal channels	Collaborate based on a MoU towards a clear goal or mission	How do you describe the relation (1 bad, 5 good)
General directorate of Hydraulic and electric resources (Ministry of Water and Energy)					
General Directorate of Exploitation (Ministry of Water and Energy)					
General directorate of oil (Ministry of Water and Energy)					
South Lebanon Water Establishment					
North Lebanon Water Establishment					
Beirut and Mount Lebanon Water Establishment					
Bekaa Water Establishment					
Litani River Authority					
Ministry of Finance					
Ministry of Agriculture					
Ministry of Environment					

Question 8	Relationship between your organization and others				
Ministry of Public Works and Transport					
Ministry of Interior and Municipalities					
Municipalities					
Council of the South					
Council for Development and Reconstruction (CDR)					
World Bank					
Electricité du Liban					
Electricité du Zahle					
KVA SAL					
BUTEC utility services (BUS)					
IPTEC					
Lebanese Center for Energy Conservation (LCEC)					
Lebanese Agricultural Research Institute (LARI)					
National Center for Scientific Research (CNRS)					
Green Plan					
Higher Relief Commission					
ArabO (Electrical Utility of Aley)					
Mrad Utility Services					

Question 8	Relationship between your organization and others				
Debbas International SAL					
European Investment Bank (EIB)					
Agence Française pour le développement (AFD)					
UNDP – CEDRO					
Sustainable Akkar					
Banque du Liban					
European Commission					

9. Check the box, which best describes how long you have had relations with each organization.
Relations include any of the above-mentioned relations.

Question 9	Length of relationship with organizations					
Please list the organization	More than 10 years	5-10 years	3-5 years	1-3 years	Less than 1 year	Don't know this Organization
General directorate of Hydraulic and electric resources (Ministry of Water and Energy)						
General Directorate of Exploitation (Ministry of Water and Energy)						
General directorate of oil (Ministry of Water and Energy)						
South Lebanon Water Establishment						
Beirut and Mount Lebanon Water Establishment						
Bekaa Water Establishment						
Litani River Authority						
Ministry of Finance						
Ministry of Agriculture						
Ministry of Environment						
Ministry of Public Works and Transport						
Ministry of Interior and Municipalities						
Municipalities						

Question 9	Length of relationship with organizations					
Council of the South						
Council for Development and Reconstruction (CDR)						
World Bank						
Electricité du Liban						
Electricité du Zahle						
Mrad Utility Services						
KVA SAL						
BUTEC utility services (BUS)						
IPTEC						
Lebanese Center for Energy Conservation (LCEC)						
Lebanese Agricultural Research Institute (LARI)						
National Center for Scientific Research (CNRS)						
Green Plan						
Higher Relief Commission						
ArabO (Electrical Utility of Aley)						
Debbas International SAL						
European Investment Bank (EIB)						

Question 9	Length of relationship with organizations					
Agence Française pour le développement (AFD)						
UNDP – CEDRO						
Sustainable Akkar						
Banque du Liban						
European Commission						

Appendix B

Stakeholder Dialogue Summary

On Monday, June 13, 2019, the Climate Change and Environment program at AUB-IFI held two stakeholder dialogues, one with public institutions, and another with international organizations and the private sector.

The dialogues included, overall, 18 participants from the water and energy sectors, including ministries, public institutions, donors, academics, and the private sector. The discussion aimed to identify the barriers and opportunities to the water-energy nexus in Lebanon, and to identify key stakeholders at the interface of both fields.

The meeting started with an overview of the project, led by AUB-IFI, by framing the water-energy issue in Lebanon, explaining the scope of the project, and outlining the methodology adopted throughout this study. Currently, RWEs in Lebanon suffer significantly from electricity cuts, which forces establishment to rely on expensive and polluting private generators, or interruptions in water services. Overall, Lebanon has yet to implement efforts for a nexused management of water and energy resources, with the exception of hydropower and solar-water pumping. The policy and legal frameworks do not mediate a nexused approach and the current institutional framework—although potentially enabling for an improved governance of both resources—is currently impeded by a lack of staff, and a lack of coordination among different institutions and departments. Thus, there is a great need to better understand the interlinkages between both proposing an integrated approach and managing the water and energy sectors.

After the presentation from IFI was conducted, a discussion was kicked-off and guided by the following questions:

- How do institutions deal with energy efficiency issues in terms of meeting cost and seeking opportunities and benefits, as related to energy efficiency (and RE deployment)?
- How can opportunities be better promoted and coordinated across both water and energy sectors?
- Do the institutional, legal, and policy frameworks in place encourage the adoption of energy efficiency measures in the water and wastewater sector?
- What are the obstacles in this context?
- What opportunities lie within and beyond these obstacles?

- What linkages are required across sectors to improve energy efficiency and RE deployment in the water sector?
- How is the WE nexus reflected in the context of SDGs and NDCs within the Lebanese context?
- What are the existing financial mechanisms, which pertain to energy efficiency in the water and wastewater sector, and how effective are they?
- What are the financial, technological transfers, and capacity building requirements to implement the WE nexus?

Discussion

The discussion identified barriers and opportunities to the water-energy nexus in Lebanon, and touched upon various points summarized below:

- Over 12 wells in the Bekaa were equipped with solar powered pumping through a project funded by the World Bank, in collaboration with LCEC and BWE. At the start of the project, there was very little knowledge about solar PV pumping, and the role of LCEC was to train the farmers, in addition to executing the whole plan. Afterwards, the number of people asking for solar PV pumping funds increased. Continuous metering of water and energy was conducted in order to ensure proper monitoring of both resources.
- The wastewater issue was brought to the discussion later on, where energy was mentioned as a prime cause for the lack of operation of WWTPs, accounting for 70-80% of their cost according to a representative from the SLWE. In order to operationalize these treatment plants, SLWE estimated an additional tariff needed of over USD 200. Unfortunately, they attempted to increase the tariff by 50,000 LL but were unsuccessful due to societal backlash.
- LRA is responsible for irrigation and hydroelectric projects across the Litani River. In this sense, its relation with EDL entails LRA selling and receiving electricity to EDL, as well as for pumping water for irrigation. By mandate, LRA are expected to receive 180,000 LL from farmers, for each 1 m³ provided, however farmers are currently only paying 60,000 LL; electricity sales to EDL has been used to make up for the deficit.
- At the policy level, LCEC mentioned that they have two frameworks, which tackle efficiency. The first is LEA, which addresses water efficiency projects for both the public and private sectors, and NEEREA, which is a green loan, mainly for individuals and real estates, funded by the central government. LEA fund projects related to solar PV pumping, energy-efficiency measures like double wall building, VRF, Variable Frequency Drivers (VFD) for pumping applications, etc. Currently, the main challenge is the banking sector where the interest rates are increasing (it was 1%, and now is at 2.5-3%). Currently, they have established a new project called LEEREF, which is a loan system that covers only 80% of the project; the rest is covered by other loans.

- The regional water establishments do not have the capacity to borrow directly; they are obliged to refer back to the government. Only BMLWE has the right to issue municipal bonds and borrow. This should be the case for all the water establishments; this could be one of the solutions.
- BMLWE's representative said that one of their major issues is the lack of renewable energy resources. As part of their energy efficiency measures, they are trying to decrease their energy cost from pumping, and collaborating with ACWA to use better quality fuels. Another challenge that he highlighted is a maintenance issue, especially meeting standards and measures. He said that there was not enough equipment or resources by the contractors to carry out proper maintenance.
- The representative of the South Water Establishment (SWE) mentioned that as an energy efficiency measure, they are updating their strategy, and now they are focusing on their surface water sources, instead of the groundwater aquifers. SWE are investing more in their surface waters and implementing solar energy projects, which are considered as one the main pillars of their new strategy, while targeting 5 MW production each year. This energy production will reduce reliance on EDL. In addition, SWE are planning to include illegal beneficiaries on their systems, and will encourage them to pay their bills. The representative of SWE suggested that the payments to EDL must be flexible; donors must help them, especially regarding their solar project.
- CDR was mentioned as "low-hanging fruit" in the water sector, which communicates very little with other stakeholders. Projects are implemented with a silo-approach, and then handed over to establishments without proper consultation or coordination.

Challenges and Recommendations

A summary of both sessions is summarized below:

Table B Summary of the Consultation Meeting

Main Challenges	Main Recommendations
No budget allocation from CDR to the water establishments.	Better coordination and communication between CDR and RWEs.
Water establishments are not included in the decision making of the CDR projects.	
Water Establishments are not allowed to borrow directly money or get funds.	Improve RWEs' financial performance and coordination among stakeholders.
Banking sector has high rates.	Introduction of new financial schemes, which benefit the public sector in terms of renewable energy and energy efficiency, at lower interest rates.
Lack of capacity building across the chain (including donors and the communities).	Training and capacity building activities across the chain (including donors and the communities).
Lack of renewable energy technologies.	Collaboration with ACWA for fuels and integrating new renewable energy technologies.
High cost of maintenance on water establishments.	Focus on preventive maintenance.
Water establishments are not aware of their energy consumptions.	Conduct regular energy audits. SCADA system is a successful energy efficiency measure used by the BMLWE, and can be replicated in the remaining water establishments.
Allocated funds have a certain agenda by CDR that do not allow the water establishment to implement their strategies.	Funds should serve the strategies developed by the water establishments.
Lack of key performance indicators for the staff, performance, outcomes, and institutional work.	Use IWA performance indicators to evaluate the staff, ongoing work, and institutions.
Always in chronic financial and administrative crises.	Hire qualified personnel. Focus on operational cost-effectiveness.
Priority is set to for irrigation and drinking water, instead of demand management.	Fix the organizational structure, especially for irrigation and wastewater sectors.
A lot of issues at the identification phase and designing stage because not all the stakeholders are involved.	Improve communications among different departments and stakeholders.
Donors only focus on their procurement checklists.	Involve RWEs in conceptualizing projects that develop proper metrics for impact assessment

Appendix C

Theme One: Stakeholders Connected to the Five Highest-Degree Scoring Organizations with regards to Communication Concerning Financial Exchange

Table C1 Stakeholders Connected to the Top Five Recipients of Funding







































Recipients	Stakeholders they are connected to
BMLWE 	EU, UNICEF, UNDP, CISP, CDR ( ), Save The Children ( ), ACTED, JICA, USAID
BWE 	EU, WV, NRC, Mercy corps, UNICEF, CDR ( ), ICRC, ESFD, OXFAM, ADRA, BFZ, APIEU, Save The Children, LOST
LRA  	DAI, GVC, Swiss Cooperation, IOCC, ACF, USAID, UNICEF, UNDP, WB, CDR, USAID
SLWE 	EU, UNHCR, GIZ, NRC, Mercy corps, UNICEF, UNDP
CDR	EU, AFD, WB, EIB, AFESD, KFAED

Table C2 Stakeholders Connected to the Top Five Funders

Funder	Stakeholders they are connected to
EU	UNHCR, AFD, UNDP ( ), CDR ( ), EIB, LCEC, SLWE, NLWE
UNDP	LARI (), SLWE (), LRA ( ), MoEW ( ), BMLWE (), MoE ( ), ICARDA, Local NGOs
USAID	SLWE (), NLWE (), LRA (), BWE (), BMLWE (), Municipalities
WB	CDR, BDL, LRA ( ), MoEW ( )
CDR	NLWE (), LRA ( ), BWE (), BMLWE ()

Appendix D

Theme Two: Stakeholders Connected to the Ten Highest Degree-Scoring Organizations with regards to Data Sharing, Expertise, and Technical Assistance

Table D1 Stakeholders Connected to the Top Ten Stakeholders with the Highest Degree Scores for Data Sharing

Top Ten Stakeholders	Highest Degree Scores for Data Sharing
MoEW	EU, UNDP, WB, MoE, AFD, LRA, BWE, CDR, LARI, LCEC, Debbas, AICS, EKF, Bank Audi, MRAD, CNRS, BUS
EU	MoEW, UNDP, WB, EIB, AFD, SLWE, BMLWE, BWE, NLWE, CDR, LCEC, EBRD, KFW, NGOs
CDR	EDL, MoEW, EU, WB, EIB, AFD, LRA, SLWE, BMLWE, BWE, NLWE, MoF, LCEC, EDZ, AFESD, AFESD, KFAED, CNRS
WB	MoEW, EU, LRA, BWE, CDR, LCEC, BDL, BUS
SLWE	EU, UNDP, CDR, LARI, GIZ, USAID, NRC, Mercy corps, UNICEF, CISP, UNHCR, ACF, CARE, INTERSOS, GVC
LRA	MoEW, WB, Universities, CDR, LARI, USAID, Private sector contractors, ELARD, DAR, CNRS
BMLWE	EU, UNDP, CDR, LARI, USAID, UNICEF, CISP, ACTED, Save The Children, KFW, Enviroplan, IME, JICA
BWE	MoEW, EU, WB, MoE, AFD, CDR, LARI, USAID, NRC, Mercy corps, UNICEF, ACF, GVC, ICRC, ESFD, OXFAM, ADRA, BFZ, APIEU, LOST, DAI, WV, Swiss Cooperation, IOCC
BUS	EDL, MoEW, WB, EIB, Municipalities, EBRD, KVA, Debbas, EDP, Kearney, Omicron, MIGA, Utility Services
LCEC	EDL, MoEW, EU, UNDP, WB, EIB, MoE, IPTEC, AFD, CDR, BDL

Table D2 Stakeholders Connected to the Top Ten Stakeholders with the Highest Degree Scores for Sharing Expertise

Top Ten Stakeholders	Highest Degree Scores for Sharing Expertise
MoEW	UNDP, WB, MoE, LCEC, Debbas, CNRS, UNHCR, BDL
EU	CDR, LRA, SLWE, NLWE, BMLWE, LCEC, BWE, NGOs, BDL
CDR	EU, UNDP, WB, EIB, MoE, AFD, CNRS
WB	MoEW, MoE, CDR, LRA, SLWE, NLWE, BMLWE, LCEC, BWE, BDL
SLWE	EU, WB, USAID, GVC, UNHCR
LRA	EU, WB, USAID, OMSAR, Dutch government, MRAD, CNRS
BMLWE	EU, WB, USAID, ACWA, JICA, LIBNOR, UNHCR
BWE	EU, WB
BUS	EDL, KVA, Debbas, MIGA, MRAD, EDL
LCEC	EDL, MoEW, EU, UNDP, WB, EIB, MoE, IPTEC, AFD, BDL, Sustainable Akkar

Table D3 Stakeholders Connected to the Top Ten Stakeholders with the Highest Degree Scores for Sharing Technical Assistance

Top Ten Stakeholders	Highest Degree Scores for Sharing Technical Assistance
MoEW	UNDP, WB, MoE, LCEC, Debbas, Council of the South, CNRS
EU	SLWE, NLWE, LCEC, BWE, BMLWE, BDL
CDR	EIB, SLWE, NLWE, BWE, BMLWE, CNRS
WB	MoEW, MoE, SLWE, LRA, NLWE, LCEC, BWE, BMLWE, BDL
SLWE	CDR, EU, UNDP, WB, GIZ, USAID, NRC, Mercy corps, UNICEF, CISP, UNHCR, ACF, CARE, INTERSOS, GVC, Council of the South
LRA	WB, USAID, LRI, Dutch government, Council of the South, MRAD, CNRS
BMLWE	CDR, EU, WB, USAID, ACWA
BWE	CDR, EU, WB, USAID
BUS	KVA, Debbas, EBRD, EDP, Kearney, Omicron, MRAD
LCEC	EDL, MoEW, EU, UNDP, WB, EIB, MoE, AFD, BDL, Sustainable Akkar

Appendix E

Theme Three: Stakeholders Connected to the Ten Highest Degree-Scoring Organizations with regards to Enforcing and Drafting Policies and Strategies

Table E1 Stakeholders Connected to the Top Ten Stakeholders with the Highest Degree Scores for Policy Compliance and Enforcement of Regulation

Top Ten Stakeholders	Highest Degree Scores for Policy Compliance and Enforcement of Regulation
MoEW	EIB, Debbas, MRAD, MoE, SLWE, AFD, BWE, BDL, CDR, WB
WB	LRA, BDL, BUS, MoEW
LRA	EU, OMSAR, USAID, WB
SLWE	CDR, MoEW
CDR	MoE, SLWE, BWE, MoEW, BMLWE, NLWE
LCEC	BDL
MoE	BDL, CDR, MoEW, MoF
EDL	Debbas, MRAD, BUS
BMLWE	CDR, USAID
CNRS	Universities, FAO

Table E2 Stakeholders Connected to the Top Ten Stakeholders with the Highest Degree Scores for Drafting Policies, Strategies, and Plans

Top Ten Stakeholders	Highest Degree Scores for Drafting Policies, Strategies, and Plans
MoEW	EIB, Debbas, MRAD, MoE, SLWE, AFD, BWE, BDL, CDR, WB
BDL	EIB, MoE, AFD, MoEW, MoF, EU, WB, LCEC, UNDP, Commercial banks
CDR	MoE, SLWE, BWE, MoEW, BMLWE, NLWE
BUS	MRAD, EDL, WB, MoPWT, Kearney
MoE	BDL, CDR, MoEW, MoF
LCEC	BDL
MoE	BDL, CDR, MoEW, MoF
LRA	EU, OMSAR, USAID, WB
WB	LRA, BDL, BUS, MoEW
MRAD	BUS, MoEW, EDL
EDL	Debbas, MRAD, BUS
EU	LRA, BDL

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