Science of the Total Environment 690 (2019) 85–96

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Water diplomacy and nexus governance in a transboundary context: In the search for complementarities

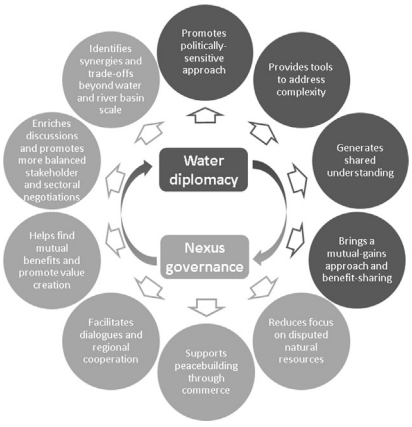
Gloria Salmoral [a,*], Nynke C.E. Schaap [b], Julia Walschebauer [c], Areen Alhajaj [d]

[a] Cranfield Water Science Institute, Cranfield University, Cranfield MK43 0AL, UK
[b] Arcadis – Design and Consultancy for Natural and Built Assets, Beaulieustraat 22, 6814 DV Arnhem, the Netherlands
[c] Independent researcher, Belgium
[d] German Jordanian University, Amman Madaba St., P.O. Box 35247, Amman 11180, Jordan

HIGHLIGHTS

- Nexus governance enriches discussions and balances negotiations in water diplomacy.
- Mutual benefits and regional cooperation can be promoted with nexus governance.
- A political driven approach in nexus research is strengthened through water diplomacy.
- Water diplomacy offers tools to address complexity in water-energy-food systems.
- Shared understanding and mutual gains are generated in water diplomacy.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 13 January 2019
Received in revised form 29 June 2019
Accepted 29 June 2019
Available online 02 July 2019

Keywords:
Water diplomacy
Nexus
Governance
Jordan
As-Samra
Zambezi River Basin

ABSTRACT

Growing evidence within nexus research has highlighted the importance for sustainable governance of considering the interdependencies between water, energy, food and the environment, whereas water diplomacy has provided the necessary tools to address water conflicts of a transboundary nature. This paper therefore identifies and evaluates unrealised complementarities between nexus governance and water diplomacy, and discusses the benefits of integrating both for improved transboundary basin management. Two case studies - a wastewater treatment plant within the Jordan's nexus vision and a research project into management of the transboundary Zambezi River Basin - illustrate the identified complementarities and their contribution towards collaborative transboundary natural resources management. On one hand, the consideration of synergies and trade-offs between water, energy and food systems and beyond the river basin scale within nexus governance engages a larger diversity of stakeholders and can help realise more balanced agreements between sectors and hence complement water diplomacy goals. The enriched negotiations arising from a nexus approach can facilitate benefits-sharing in water diplomacy due to the broader exchange of experiences across several natural resources systems. Likewise, international nexus development projects involving a diverse range of sectors and stakeholders can ultimately facilitate peace building through inter-state cooperation and reduce the focus on disputed natural

* Corresponding author at: Cranfield Water Science Institute, Vincent Building, Cranfield University, Cranfield MK43 0AL, UK.
E-mail addresses: gloria.salmoral@cranfield.ac.uk (G. Salmoral), nynke.schaap@arcadis.com (N.C.E. Schaap), julia.walsche@gmail.com (J. Walschebauer), a.abuqullaalhajaj@gju.edu.jo (A. Alhajaj).

https://doi.org/10.1016/j.scitotenv.2019.06.513
0048-9697/© 2019 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

resources. On the other hand, water diplomacy provides tools to address complexity and capture political contexts that overcome the traditional technical and 'most-rational-solution' methods. With the application of joint fact finding, value creation and collaborative adaptive management, the added value includes the generation of a shared understanding that embeds politics in decision-making and promotes mutual gains. Further collaboration and on-the-ground experiences between researchers, policy makers and the private sector are needed, to acknowledge and act upon the complementarities of nexus governance and water diplomacy, with the final outcome of promoting cooperation in the management of transboundary resources.

© 2019 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

1. Introduction

Worldwide there are 263 transboundary river basins, approximately 300 transboundary aquifers (UN-Water, 2018a) and 153 countries with transboundary water bodies (UN-Water, 2018b). These figures mean that over 90% of the world's population lives in countries that share basins, and about 40% of the world's population is found in transboundary basins (UN-Water, 2008). Since 1948, 37 incidents of acute conflict over water have happened, 295 international water agreements have been signed, including the UNECE Water Convention (UN-Water, 2018a), and 116 river basin organisations have been established reflecting differing levels of transboundary cooperation (Schmeier, 2013). Although the number of transboundary water disputes in the last 70 years can be seen as low (ibid), much work is needed in order to reach peaceful and operational agreements (Cooley and Gleick, 2011; UN-Water, 2018a, 2018b).

Addressing transboundary water conflicts is a core purpose in water diplomacy, rooted in international relations. Water diplomacy supports the achievement of identified foreign policy objectives by facilitating the containment, prevention and resolution of conflicts (He, 2015) to harness transboundary water cooperation and promote regional integration (Pohl et al., 2014). From academics and organisations there is a common understanding in water diplomacy of the relevance of including the interests of the multiple dimensions and actors in cooperation processes (Huntjens et al., 2016). Gaining an understanding of the socio-political and environmental context in transboundary basins becomes key for water diplomacy practitioners to work towards inclusive and constructive cooperation. The widely applied Water Diplomacy Framework developed by Islam and Susskind (2012), which has inspired many other works on water diplomacy (e.g., van Rees and Reed (2015); Zandvoort et al. (2018)), will constitute the main water diplomacy reference in our study. The Water Diplomacy Framework diagnoses water problems, highlights intervention points, and proposes sustainable actions able to incorporate diverse viewpoints, uncertainty and changing competing demands to overcome the complexity of actors and challenges in the water sector (Islam and Repella, 2015). While the value of a water diplomacy framework in addressing water conflicts has been recognised in the literature, there is still a need to identify and promote additional initiatives on the ground (Yasuda et al., 2018).

To move beyond a water management focus, there is currently a growing need to better acknowledge the interdependencies between water, energy and food systems, where changes in their demand, policies and management inevitably have effects on the other systems and the broader environment - under what has been called the water-energy-food (WEF) nexus (Hoff, 2011; World Economic Forum, 2011) (Fig. 1). Since the conception of the WEF nexus concept, the diversity of approaches e.g., Howells et al. (2013); Bleischwitz et al. (2018); McGrane et al. (2018), has led to the deduction that the notion of a nexus can be represented as a 'system-of-systems' that interlinks economic, environmental and social systems (Little et al., 2016). Such a nexus approach could be defined as a systematic process for both analysis and policy-making to unpack the interdependencies between water, energy, food and other linked systems (Keskinen et al. 2016), with the final aim of promoting cross-sectoral integration, sustainability, synergies and resource use efficiency (Pahl-Wostl, 2017). From a governance point of view, a nexus approach presents a method to deal with the integration (Al-Saidi and Elagib, 2017) and interdependencies of the management of natural resources across sectors and actors; which this paper refers to as 'nexus governance', in line with its use in the assessment of multi-level sectors (Pahl-Wostl, 2017) and interconnected actors (White et al., 2017)

Nevertheless, nexus governance faces the difficult task of transforming theoretical approaches and research (Allouche et al., 2015) into practical and applicable knowledge to support its successful implementation in policy processes for the purpose of improving natural resource management (Wichelns, 2017). This could be the outcome of a nexus literature that has an idealised depiction, but with an apolitical nature, of integration and trade-offs between sectors in nexus governance based on discourse (Cairns and Krzywoszynska, 2016) and technical rationality (Pahl-Wostl, 2017). There has been a tendency of excluding pragmatic local, national and regional procedures (Benson et al., 2015), as well as the consideration of political and cognitive factors as determinants of change in policy decisions (Weitz et al., 2017), relevant also for dealing with conflicts. As a result, there are characteristics in water diplomacy that can enrich existing nexus approaches, including an inherently political nature, as a result of the conventional understanding in water diplomacy of managing mainly international relationships (Grech-Madin et al., 2018).

Understanding the synergies and trade-offs between water, food and energy is also needed in water diplomacy for a more coherent and integrated natural resources management, due to the general lack of transboundary sectoral agreements. For instance, in the history of transboundary water relations in the Euphrates-Tigris River Basin, sectoral agreements at the transboundary level do not take place for energy production and distribution (Kibaroglu and Gürsoy, 2015). Another example is the Nile River Basin, where land and energy use issues are seen in the scientific literature as increasingly important for future transboundary negotiations (Al-Saidi and Hefny, 2018), but are not currently being addressed in diplomatic negotiations. Nexus governance could help transboundary water diplomacy processes by shifting the focus further away from water issues (ibid) and by addressing the interdependent policies, institutions and actors who are often not involved in the (water-centric) water diplomacy.

This paper therefore reviews the existing literature on nexus governance and water diplomacy to identify and evaluate unrealised complementarities, and discusses the benefits of integrating nexus governance and water diplomacy for improved transboundary basin management. Two case studies - a wastewater treatment plant (As-Samra) within the context of existing nexus initiatives in Jordan and a nexus research project on the management of the transboundary Zambezi River Basin - are analysed through the lens of the identified complementarities. As-Samra was selected because of its relevance for Jordan's environmental needs and economic development; and the Zambezi River Basin due to the need for further promoting sustainable natural resources management, peace and security in south African countries. The case studies demonstrate how the complementarities between nexus governance and water diplomacy exist to some degree, and how the joint (and sometimes unintentional) use of nexus governance

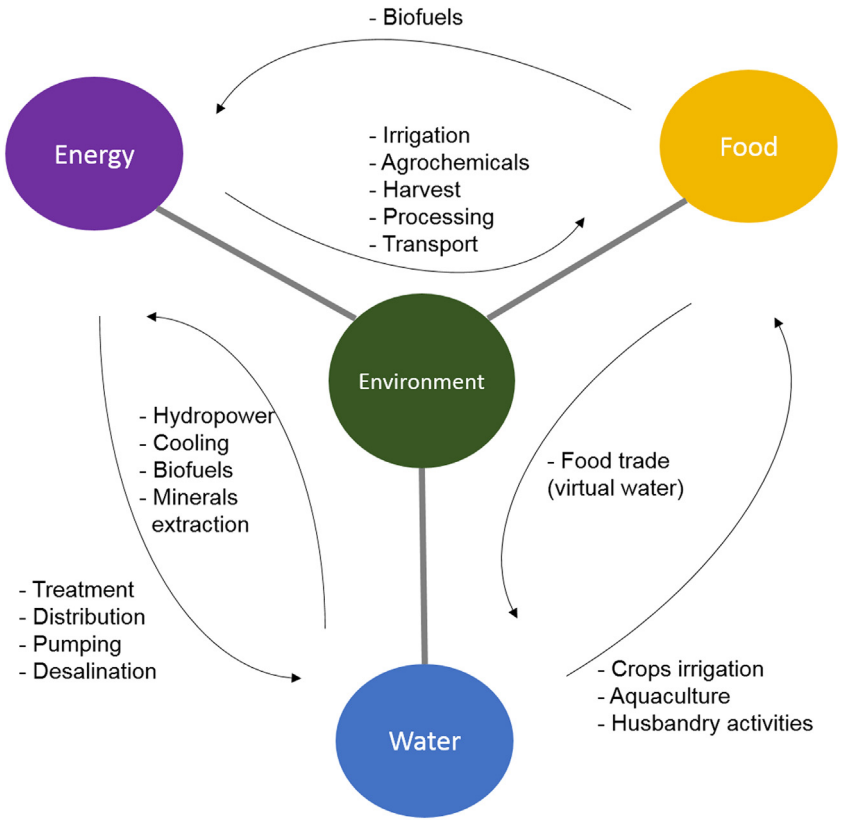


Fig. 1. Schematic diagram of water, energy and food interdependencies.

and water diplomacy practices can promote cross-sectoral collaboration, regional economic development and contribute towards improved transboundary natural resources management.

2. How does nexus governance contribute to the objectives of water diplomacy?

A nexus approach to governance enhances water diplomacy due to several reasons, all relating to the additional scales, socio-economic interactions and multiple actor perspectives that it can provide (Fig. 2). In a transboundary context, nexus governance addresses cooperation issues for key natural resources not only at the basin scale, but also at national and regional scales (Al-Saidi and Hefny, 2018). This approach goes beyond the traditional transboundary basin scale in water diplomacy. Beyond a 'water centric' thinking, key sectors, actors and institutions across water, energy and food systems can be identified, their synergies exploited and trade-offs evaluated to maintain overall environmental sustainability goals (Kibaroglu and Gürsoy, 2015). Involving

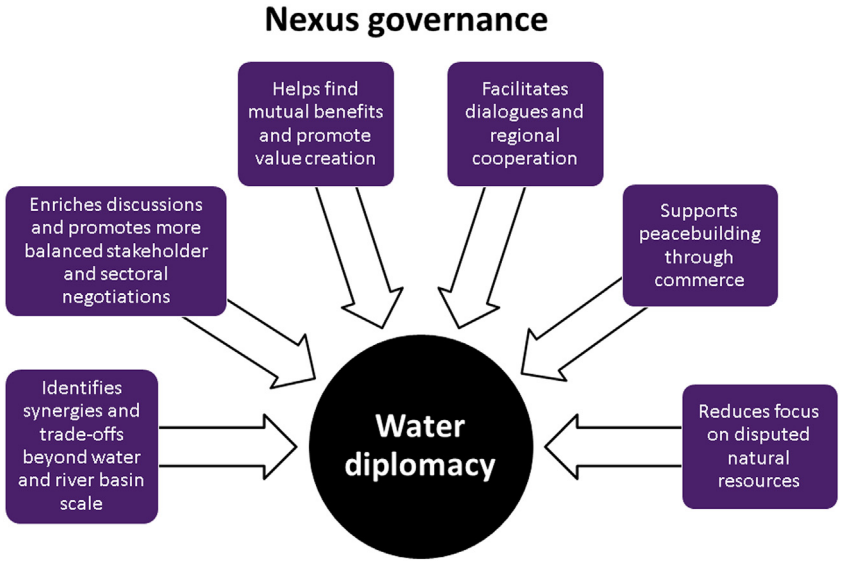


Fig. 2. Added value of nexus governance to water diplomacy.

a larger array of sectors in water diplomacy negotiations helps actors to engage in discussions outside the traditional silo-ed thinking (de Strasser et al., 2016) and support more balanced stakeholder and sectoral negotiations (Pahl-Wostl, 2017). In such negotiations sectoral plans are jointly developed and implemented, accounting for trade-offs, synergies and feedbacks across actors and sectors.

Discussions and negotiations from a nexus perspective include core topics related to worldwide challenges, such as provisioning ecosystem services (e.g., water (Karabulut et al., 2015) and food (Bell et al., 2016)), natural resource use efficiency (Ringler et al., 2013; Al-Ansari et al., 2015) and climate change adaptation (Rasul and Sharma, 2016). As a result, by increasing the scope of related environmental and socioeconomic issues, while enlarging the water, food and energy resources involved, it becomes easier to promote benefits-sharing (Al-Saidi and Hefny, 2018) and value-creation (Islam and Susskind, 2012). This diversifying and enlarging procedure helps, for all involved stakeholders with numerous and often conflicting interests, to reach a win-win situation in transboundary natural resources management. In this way, a nexus approach to governance plays a key role in supporting the exchange of experiences and identification of synergies under what has been called a nexus space (Harwood, 2018) - to facilitate the negotiation of new cross-state agreements and alliances, which may ultimately open political deadlocks and catalyse regional cooperation.

As the initial WEF nexus formulation was primarily driven by international private actors seeking to reduce environmental risks and ecological scarcities in their businesses (Allouche et al., 2015), a nexus approach to governance can also be connected to the field of business with the aim of facilitating peacebuilding in water diplomacy. Peacebuilding through commerce is performed through the provision of economic opportunities, international relations and communication through informal channels, and comprises one (Track 3 Peacebuilding) of nine diplomacy tracks (McDonald, 2012). The development of commercial relations is often set as a requirement by external donors when funding the implementation of development projects. Additionally, the funding and technical assistance opportunities offered by international donors are regularly used as an incentive for disputing states to agree on water cooperation, because of the greater net benefits (e.g., irrigation development, hydropower, flood control) that could not have been achieved through state-centric development alone (Grech-Madin et al., 2018; Yang and Wi, 2018). Nexus governance initiatives can reduce the focus on resources under conflict and provide empirical experiences that go beyond inter-state interactions alone, as we show in the Jordanian case study.

3. What are the challenges of implementing nexus governance in a transboundary context?

To date, the most complete nexus approach in a transboundary context identifies and analyses governance and key sectors (energy, water, food, land, climate, environment and ecosystem), explores intersectoral issues, and promotes dialogue to find synergetic solutions (UNECE, 2015), with an application in a number of transboundary basins (ibid; UNECE, 2017). The scientific literature also contains historical analyses of transboundary resources management (Kibaroglu and Gürsoy, 2015; Biba, 2016; Grumbine, 2018), a combined approach for hydrological, livelihood and food security assessments (Keskinen et al., 2015), and the application of qualitative methods for the identification of cooperation challenges on water, energy and food (Al-Saidi and Hefny, 2018), among others.

Despite the emphasis on the importance of cooperation and dialogue in the aforementioned studies, there is a missed opportunity for power asymmetries and political differences to be captured, and an overly technical framing dominates (Fig. 3). Power imbalances among sectors and stakeholders relate to a lack of cross-sectoral collaboration, instead of a lack of appropriate mechanisms and approaches for implementing a nexus approach (Allouche et al., 2015; Foran, 2015).

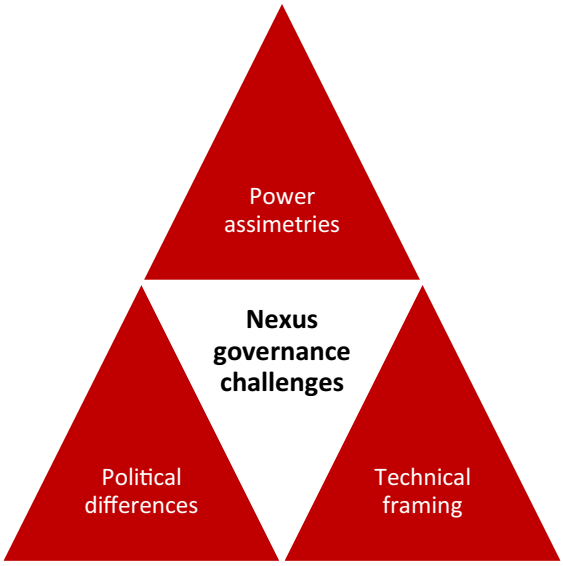


Fig. 3. Challenges to implement nexus governance in a transboundary context.

Examples of power imbalances are the prevailing dominance of agricultural policy over environmental policy, or how economic interests associated with hydropower development have dominated over sustainability (Pahl-Wostl, 2017).

Technical focused management institutions, which will be probably the agencies implementing a nexus approach, can be biased towards an overall optimisation that assumes that all parties involved are equally interested in distinguishing and executing the 'most rational' solution to obtain absolute gains (Pohl et al., 2014). This technically-focussed nexus governance will not fully match the complex reality due to politics, where different trade-offs between benefits and subjective values (e.g. ethics, justice and fairness) exist. Nexus research in the transboundary context helps reveal the resource and economic wins or losses for a riparian state resulting from the unilateral acts of another riparian state. In the case of dams, for example, assessing the impact of different operation modes - based on the national interest of the operating country - gives insights into which choice is most beneficial for the other country's national interest in terms of energy and water security, and hence economic benefits (Jalilov et al., 2016). Yet, such studies have been predominantly technologically applied, based solely on economic premises (e.g., Jalilov et al., 2016; Basheer et al., 2018; Yang and Wi, 2018). In fact, nexus research has been criticised for being framed around efficiency, storage and technology solutions, while putting a 'technical veil' on the bigger debate around the concepts of political economy that deal with inequality in resources allocation and access (Allouche et al., 2015).

These findings highlight that a technical framing of nexus governance can overlook allocation decisions - 'who gets what, where and when' (Lasswell (1936), as cited in Cascao and Zeitoun, 2010) - which ultimately depends on political and cultural considerations (Susskind, 2017). An example of this is given by Pohl et al. (2014) in a water diplomacy context, who pointed out that the technical focus and dominant use of metric tools in transboundary cooperation projects contributes to a self-interest in finishing the water-related projects; irrespective of the extent these projects reflect the politically most appropriate outcomes, such as agreements to manage transboundary natural resources or the promotion of international cooperation and peace building. This technical framing and analysis alone does not address inequality, international political economy and geopolitics (Al-Saidi and Hefny, 2018), so that nexus governance needs to be complemented with plural ways of understanding problems and solutions and with a highly political nature of associated decision-making (Allouche et al., 2015).

4. How does water diplomacy support an appropriate implementation of nexus governance?

Transboundary resources governance is concealed by basin politics and is particularly addressed with a water focus in the water diplomacy literature (Islam and Repella, 2015; Islam and Susskind, 2012; Pohl et al., 2014). In contrast to a nexus approach to governance, the consideration of natural resources within a political context is a key element in water diplomacy, which emerged in response to the traditional technology-focused approach in water management (Islam and Repella, 2015). A nexus approach to governance starts by asking 'how do we do', whereas water diplomacy begins by asking 'how do we think'. By doing so, water diplomacy practitioners are encouraged to examine how values and interests shape the definition of a water problem, and subsequently how this definition influences the ways tools are employed to resolve it. In this water diplomacy process, politics are disclosed. To effectively address (not solve) complex water problems, water diplomacy answers questions such as 'whose water' and 'at what costs' in order to produce normative and ethical options in political decision-making and go beyond the rational once-and-for-all and one-size fits-all.

Approaches for addressing the complexity of nexus governance in a transboundary context is to some degree covered in water diplomacy literature. Pioneers of the Water Diplomacy Framework, Islam and Susskind (2012), show the different types of decision making for different types of problems in transboundary water management (Fig. 4). As Section 3 emphasized, nexus governance tends to address complex issues through 'rational' decision-making. This means that problems - characterised by multiple sectors, stakeholders and spatial boundaries - are addressed as if they were determined by clearly bounded systems and fixed agreements. In other words, complex problems might fail to be adequately addressed.

With the aim of addressing complex problems, water diplomacy encompasses seven key tools: stakeholder representation, joint fact finding, scenario planning, value creation, convening, collaborative adaptive management, and societal learning (Islam and Susskind, 2012). From those key tools, joint fact finding, value creation and collaborative adaptive management, in combination with a mutual gains approach (all explained below), are key to demonstrating how to overcome the challenges of appropriately implementing nexus governance in a transboundary context (Fig. 5).

Joint fact finding, also known as mediated modelling, is the process to jointly collect and interpret technical data and generate a shared understanding of the natural, social, economic and political interactions. It can be used to blend differing interpretations of policy or management options. To illustrate the process of joint fact finding, Islam and Susskind (2012) refer to Werick's (2007) work concerned with the transboundary Ontario Lake. The lake is subject to several conflicting interests related to water levels (e.g. shoreline property protection versus wetland plant diversity). In the joint fact finding process, several groups of experts, decision makers and stakeholders were formed. Several models were built to assess the impacts of certain measures on different environmental elements such as on water availability, flood and erosion conditions. The identified impacts were made accessible to stakeholders as a shared vision model, which provided insights into the main conflicts in the Ontario Lake. As the modelling process was public, results were accessible to all groups and immediately used in the diverse group sessions. Stakeholders were actively involved in the modelling process, resulting in a shared understanding and recognition of tested alternative plans, focusing on the economic benefits related to coastal, recreational, navigation, hydropower, municipal and industrial water uses. As a result, joint fact finding can support practitioners of nexus governance to frame their choices about water, energy and land management beyond an optimisation perspective, that allows the identification of the most desirable options and the best way forward based on joint data gathering and a shared understanding across the diversity of stakeholders.

The second water diplomacy tool relevant for transboundary nexus challenges - value creation - refers to the search for a more efficient water usage that best meets multiple, often conflicting interests. Value creation is usually generated through 'the product of trades' by exploiting differences in stakeholders' priorities and understanding the core interests of each stakeholder. Thinking innovatively, context-specifically and creatively on how to expand the available water supply in order to meet everyone's interests is needed. The process usually involves new technologies or new pathways of economic development such as enabling multiple uses of resources, which expands the list of commodities to trade (Islam and Susskind, 2012). This is in accordance with what was also found with the opportunities for value-creating trades beyond water-related technologies alone in Section 2.

Adaptive management is widely considered to be an appropriate management approach to deal with complex and uncertain natural resource problems (e.g., Cockburn et al., 2018; Ros-Tonen et al., 2018). In water diplomacy, collaborative adaptive management recognises that implementation of decisions usually does not work out on the first try. By acknowledging such implementation barriers, resource managers leave room for continuous adjustments and reconsiderations of previous decisions through an experimental-based process of

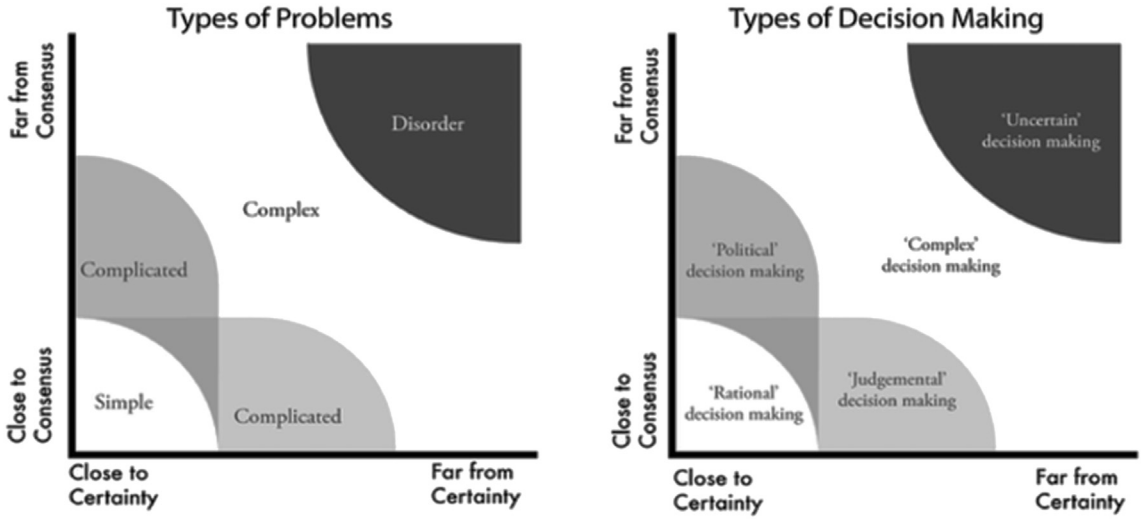


Fig. 4. Degree of certainty and consensus: a lens to describe different types of decision making for different types of problems (Islam and Susskind, 2012, p. 91 and p.95).

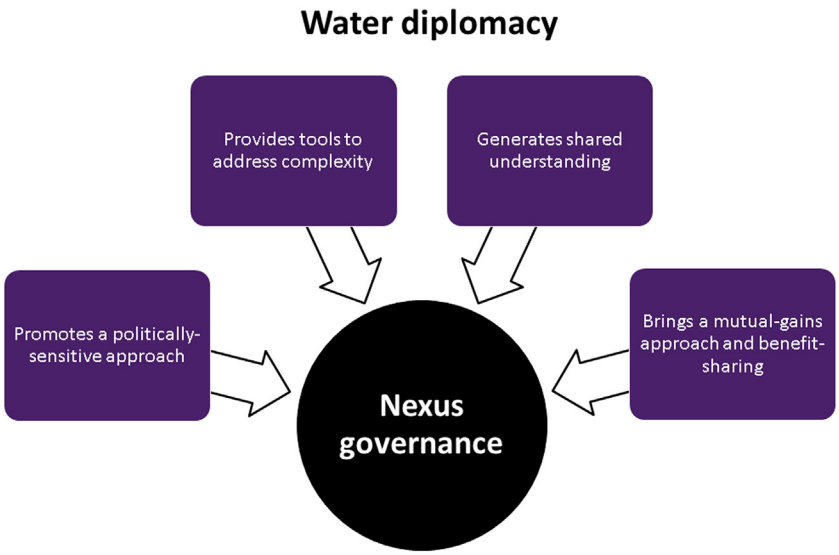


Fig. 5. Added value of water diplomacy to nexus governance in a transboundary context.

gathering new information and insights and by carefully monitoring results and impacts (Islam and Susskind, 2012; Summers et al., 2015). In contrast to conventional approaches to shared resources, collaborative adaptive management includes stakeholders from the start of the research cycle in order to scope analyses and allows stakeholders to complement and inform the conventionally expert-driven decisions (Islam and Susskind, 2012).

Finally, a mutual gains approach is also applied in water diplomacy to negotiate and promote benefits sharing (i.e. win-win outcomes) (Sadoff and Grey, 2005; Islam and Susskind, 2012), as value creation alone does not guarantee that everyone equally benefits from it. A mutual gains approach recognises that negotiations should be based around the benefits derived from the water, rather than the water itself (Sadoff and Grey, 2002). Value creation entails, for example, all the technologies that contribute to the expansion of the amount of resources to trade during the construction of a reservoir. In contrast, a mutual gains approach ensures that the trade generated during the value-creation process reaches a state that all parties can meet their interests in a way that is better than if there were no agreement (Islam and Susskind, 2012). The mutual gains approach ensures that parties look further than individual optimisation, including what benefits other parties. In other words, they are encouraged to look at what is 'great for them, good for others' (Zaerpoor et al., 2017). In that way, it helps overcome the traditionally promoted technical 'rational' and optimisation solutions in nexus governance regardless of who benefits from it.

5. Case studies

Practitioners from the water diplomacy and nexus governance can learn from each other, as this study demonstrates based on a critical review of existing scientific literature. To some extent the complementarities between both fields have been indirectly grasped by authors from water diplomacy (e.g. Islam and Susskind, 2012; Pohl et al., 2014; Susskind, 2017) and nexus research (e.g., Allouche et al., 2015; Pahl-Wostl, 2017; Weitz et al., 2017), but further efforts were needed to provide a sound understanding and acknowledgement. As far as the authors are aware, no empirical study has previously explicitly looked at how both fields complement each other in a transboundary context. As a result, two case studies have been introduced to illustrate, through practical examples, that the identified complementarities exist. The case studies also demonstrate how a joint, and sometimes unintentional, use of nexus governance and water diplomacy practices have promoted cross-sectoral collaboration, regional economic development and contributed towards transboundary natural resources management.

The first case study highlights the potential contributions of a nexus approach to governance to the objectives of water diplomacy, focusing on a Jordanian wastewater treatment plant (As-Samra) located in the transboundary Jordan River Basin and under Jordan's current vision regarding water, energy and food security. The second case study explores how water diplomacy can complement a nexus approach to governance, using the Zambezi River Basin and the related work of the DAFNE (Decision Analytic Framework to explore the water-energy-food NExus in complex transboundary water resource systems of fast developing countries) research project as an example (https://dafne.ethz.ch/) (Fig. 6). The authors would like to stress that the analysis of DAFNE is based on our interpretations from the process and approach followed in the project and that our research is not an outcome from the DAFNE project. DAFNE has been informed of our research and the decision to use their research project as an example.

5.1. Jordan's nexus initiative and its alignment and potential contribution to water diplomacy

Jordan, with a total population of 10 million (Department of Statistics, 2019), has one of the lowest total renewable water resources with 123 m^3/inhabitant/year and 27% of its total water resources coming from shared water resources (FAO, 2018). In addition to water dependency, Jordan's energy sector is strongly reliant on foreign energy sources, with more than 94% its energy needs met by imports (Energy Charter Secretariat, 2010). The abstraction, water treatment and transport of water are also energy intensive, consuming 15% of total energy production (MERM, 2019). The country also has a high dependency on food imports with an annual value of about $3800 million versus the $1235 million in food exports (FAO, 2019). Agriculture consumes 52% of available water resources and only accounts for 4% of GDP (Ministry of Water and Irrigation, 2017), but is an important source of employment for low-income families. Nevertheless, given geopolitical barriers due to the hydro-hegemonic dynamics between the riparian states (Israel, Lebanon, Palestine and Syria) and Jordan's weak power in water diplomacy (Zeitoun and Warner, 2006), the country has little incentive to seek better agreements with riparian states and its most effective role might instead be to act as a diplomatic 'broker' around the Jordan river (WANA Institute, 2016). Improved management of water and energy by upgrading infrastructure and developing new renewable energy projects appears as a way to compensate for the deficiencies in

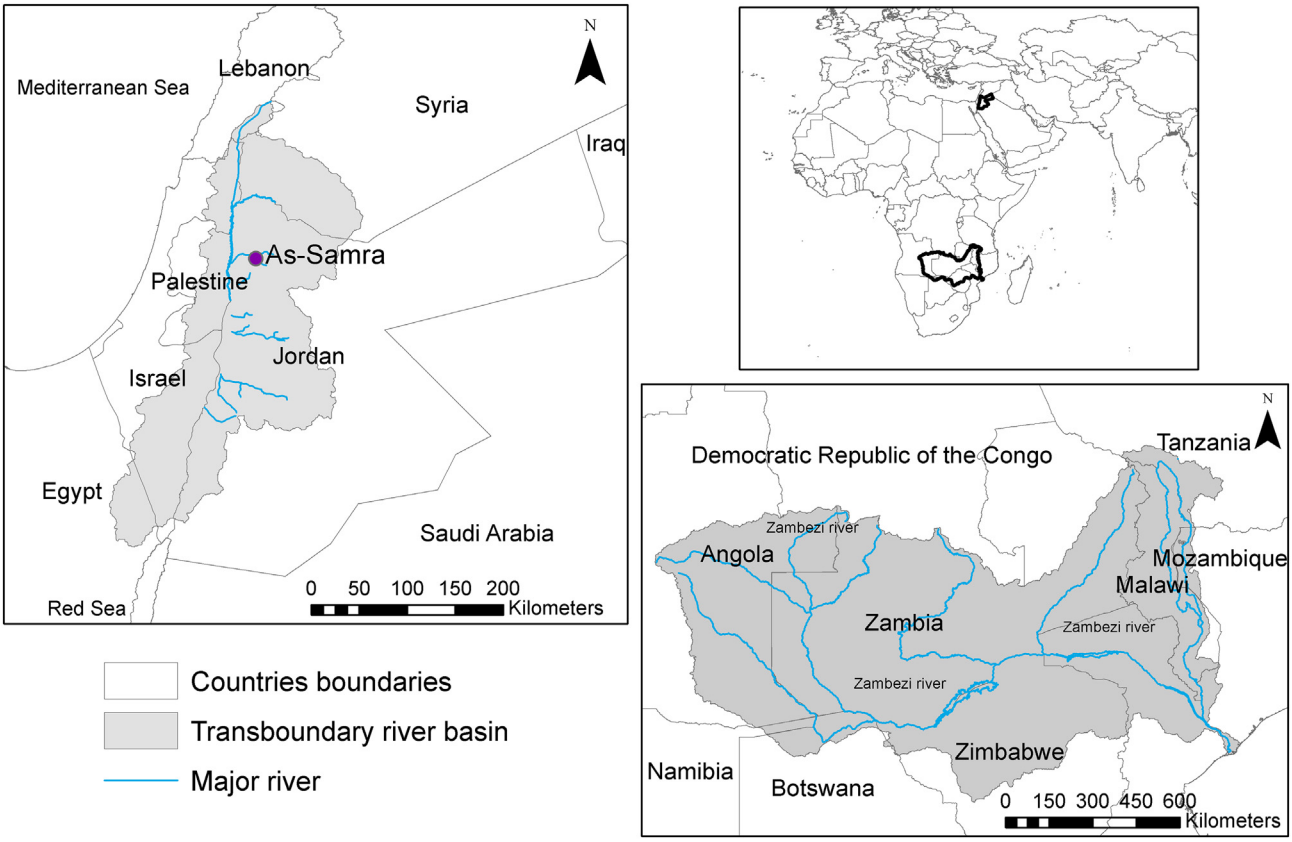


Fig. 6. Case study locations.

existing diplomatic negotiations (WANA Institute, 2016) and thereby reduce the reliance on transboundary water, energy and food.

Technological efforts towards sustainable management of natural resources have focused on seawater and brackish water desalination, wastewater treatment, and water reuse for agriculture with a growing interest to invest in renewable energy (Hoff et al., 2017a). However, in order to materialize the benefits of a nexus approach (without causing negative environmental or socio-economic side effects), technological improvements need to be embedded in appropriate policies, regulations, and monitoring mechanisms (Hoff et al., 2019). In light of the importance given to water, energy and food security aspects in Jordan's Vision 2025 policy framework (Government of Jordan, 2014), coordination mechanisms for the existing policies and institutions have been recommended in order to enhance synergies and reduce negative trade-offs across sectors and resources. Such mechanisms include the establishment of a WEF Nexus Council which is constituted by experts and specialists (including from sector ministries) to advance towards more integrated approaches in a participatory manner and to allow the institutionalization of partnerships between the public and private sector (Hoff et al., 2017b). Moreover, policies have already been put in place in the water and energy sectors to acknowledge the interlinkages between water, energy and food by promoting resource use efficiency.

In that regard, the Ministry of Water and Irrigation has issued the Energy Efficiency and Renewable Energy policy in the water sector as part of its strategy, which intends to improve the energy efficiency in the water sector, reduce water supply costs, ensure a more productive use of energy, and reduce CO_2 emissions, while also contributing to economic growth (Ministry of Water and Irrigation, 2016a). Another policy that focuses on value creation between sectors is the Water Substitution and Reuse Policy, which aims to manage scarce water resources efficiently, maximize the benefits and returns, and reduce pressure on fresh water bodies, by increasing the amount of treated wastewater allocated for irrigation (Ministry of Water and Irrigation, 2016b). A successful implementation of such policies will need to go in hand with an appropriate inter-institutional articulation to overcome the silos in the water sector. For example, as it has been emphasized by the lower levels of communication with institutions outside the water sector in other worldwide water-scarce regions (Daher et al., 2019).

A recent initiative led by the Jordan government, the As-Samra wastewater treatment plant, exemplifies the added value of nexus governance to water diplomacy (Fig. 7). Firstly, As-Samra promotes environmental and socio-economic benefits when dependencies between water, energy and food are acknowledged and exploited. As-Samra discharges into the Zarqa river, the second largest tributary of the transboundary Jordan river with only 4% of Jordan's area and home for about 60% of population (Al-Omari et al., 2009). During 2003–2008, the plant was designed to treat the average wastewater supply of 267,000 m^3/day until 2015 from the population of almost 2.3 million people in Amman and the surrounding areas. During 2009–2016, the capacity of the wastewater treatment plant was expanded by 40% (365,000 m^3/day) to meet the increased volume of wastewater influent for a population of 3.5 million inhabitants (SUEZ, 2018). The plant has an energy potential recovery of 80% of its electricity needs, with only 20% needed from the national grid (Water Technology, 2019). From a water-energy nexus perspective, it treats wastewater with endogenous energy production using hydraulic turbines and biogas generator for power production. With the 230,000 kWh of green energy produced per day, 300,000 tons of CO_2 emissions are saved each year (SUEZ, 2018) and Jordan's dependence on imported fossil fuels is reduced. Moreover, treating 90% of the wastewater discharged into the Zarqa river provides the additional environmental benefit of improving Jordan rivers' water quality, and hence the ability of recycled water to be fully re-used for agriculture purposes (Al-Omari et al., 2013) - emphasising in this case the water for food linkage.

By improving resource use efficiency and sustainability in water infrastructures, initiatives such as As-Samra reduce the focus on water

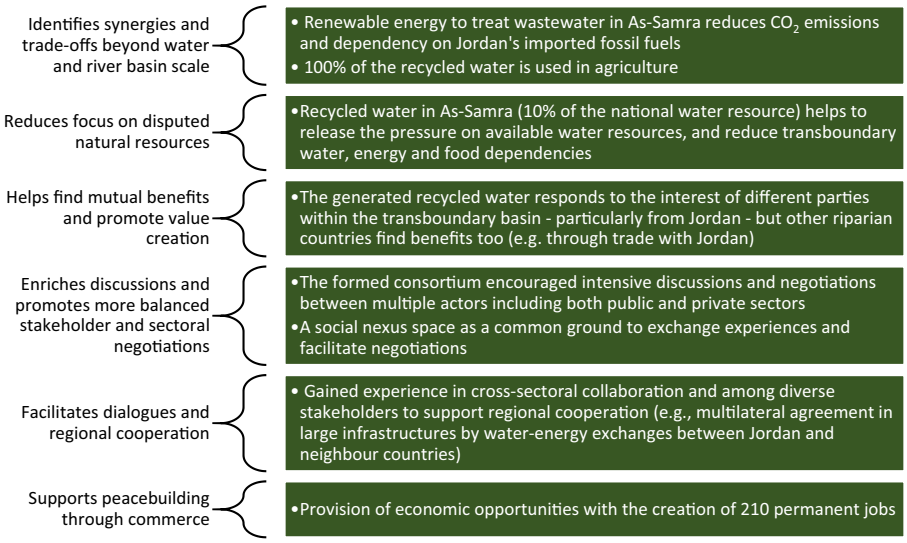


Fig. 7. Added value of nexus governance to water diplomacy (left) and how it is shown in As-Samra wastewater treatment plant in Jordan (right).

and energy resources under dispute with neighbouring countries. In that regard, the 133 million m^3/year of high-quality recycled water represents around 10% of the national water resource (Water World, 2011), which in return is helping to release pressure on freshwater bodies as well as reduce water, energy and food dependencies from neighbouring countries. Similarly as found in desalination projects (Walschot, 2018), by reducing the interdependence between states, large-scale water infrastructure projects influence processes associated with the management of transboundary water resources.

The addition of water resources through reuse of wastewater resources or desalination projects can be seen as a process of value creation in response to the interest of the different parties in conflict over scarce transboundary resources, what can also promote regional cooperation. Recognising the link between water and land for food and energy production can be beneficial for economic development and regional cooperation through mutually beneficial commercial agreements that create value for all sides. In fact, it becomes easier to promote benefits-sharing and create value in relation to the use of resources by conflicting interests by increasing the scope of related issues (Islam and Susskind, 2012; Al-Saidi and Hefny, 2018). In that regard, future large sectoral infrastructures could be considered through multilateral agreement instead of in isolation, as they could promote water-energy exchanges between Jordan and its neighbouring countries through Jordan becoming an energy supplier in exchange for desalinated water from their neighbouring countries (Katz and Shafran, 2019).

From a nexus governance perspective, the As-Samra project provides an example of the involvement of an array of diverse stakeholders and cross-sectoral integration for planning and implementation of infrastructure projects. The project, tendered in 2003 by the Ministry of Water and Irrigation, was awarded to a consortium that encouraged an intensive cooperation between multiple actors including both public and private sectors (Water World, 2011). To have a large diversity of stakeholders in the implementation of governmental projects was a novel initiative because it was not common practice. The decision to involve a diverse array of stakeholders, including banks, politicians, environmentalists and civil society, came from the realisation by the government of the challenges due to diverse interests associated with the complex project structure (de Pazzis, 2014). As-Samra demonstrated the importance of collective action between partners to consider the institutional, financial, and technical aspects of a development project and to exploit all partners' potentials in order to meet the international and domestic expectations (de Pazzis, 2014). The cross-sectoral collaboration in As-Samra (e.g., local farmers, population, As-Samra Wastewater Treatment Plant Company, Ministry of Water & Irrigation and Agriculture, international donors) was achieved through negotiation and trust building between national stakeholders and international funding agencies with uneven perceptions and interests, so as to reach a compromise scenario that suits their goals and objectives, and ultimately supports a space for dialogue. Such space for dialogue is in line to what have been previously called a social nexus space (Harwood, 2018), which allows representatives from multiple economic sectors to find common ground by exchanging experiences and identifying synergies between water, energy and food sectors and promoting more balanced stakeholder and sectoral negotiations (Pahl-Wostl, 2017).

Besides the involvement of several local, national and international partners, the development of As-Samra led to the creation of 2500 jobs during the construction phase and 210 permanent jobs (SUEZ, 2018). This provision of economic opportunities can be considered as an element of peacebuilding through commerce i.e., informal channels as means to provide economic opportunities, international relations and communications. Whether the planning, construction and operation of As-Samra also resulted in (informal) communications between the riparian states (which in turn could facilitate further peacebuilding) cannot be stated from the available literature. However, peacebuilding on the national level turned out to be an incentive for at least two of the international funding agencies, referring to the stress caused by the Syrian refugee crisis as a result of increased water demand and cultural differences in water usage (Proctor, 2014).

5.2. Zambezi River Basin: support of water diplomacy to nexus governance

The Zambezi River Basin, with a population of about 40 million inhabitants (ZAMCOM, 2016), is the fourth-largest river basin in Africa (1.39 million km^2) and represents 4.5% of Africa's continental area. Starting in Zambia, the river flows about 3000 km eastwards, passing through seven other countries (Angola, Namibia, Botswana, Zimbabwe, Tanzania, Malawi and Mozambique) (Fig. 6) (FAO, 1997). The Zambezi River Basin presents a key role in terms of achieving the objectives of the Southern African Development Community (SADC) Treaty (ZAMCOM-SADC-SARDC, 2015), including the sustainable utilisation of natural resources, effective protection of the environment, promotion of peace and security, and achieving development and economic growth to alleviate poverty. In the transboundary river basin, basin-wide and SADC regional targets related to transboundary cooperation are in place, such as the Zambezi Watercourse Commission Agreement (ZAMSEC, 2004), the 4th Regional Strategic Action Plan for

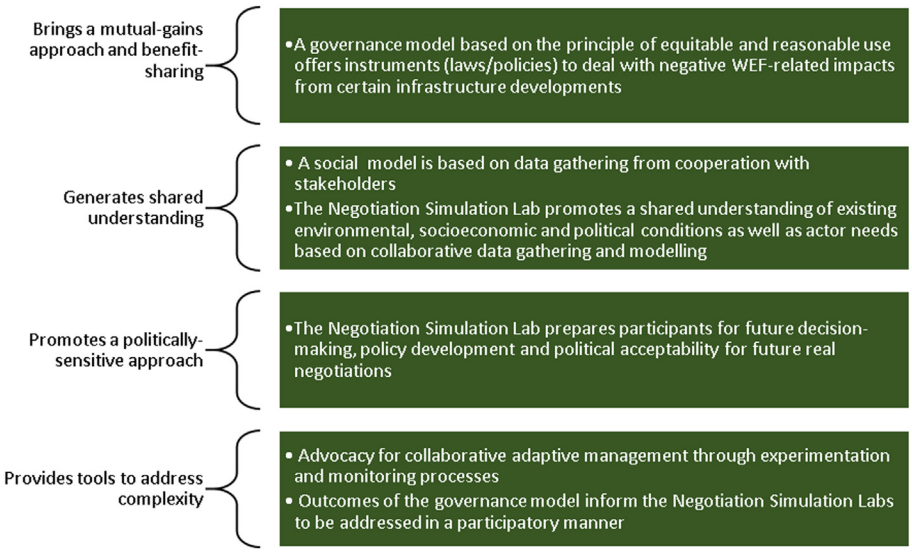


Fig. 8. Added value water diplomacy to nexus governance (left) and how it is shown in the DAFNE Zambezi River Basin project (right).

Integrated Water Resources Development and Management (SADC, 2016) and the SADC Protocol on Shared Watercourses (SADC, 2000).

Besides the necessary transboundary water management, the basin is facing pressures from an increasing population, estimated at 51 million by 2025 (i.e., 27.5% more than in 2008). The population growth will lead to a 60% increase in food demand, with a subsequent 50% increase in energy consumption by 2035 and a 10% increase in irrigation water withdrawals by 2050 (ZAMCOM, 2016). Within the context of addressing water, energy and food challenges in the Zambezi River Basin, the Horizon 2020 DAFNE project is being conducted with the aim of understanding, modelling and managing the WEF nexus in transboundary water resource systems. Although documents outlining the DAFNE project do not explicitly mention water diplomacy as its core element, we found this project in the Zambezi River Basin to be an exemplar of how water diplomacy elements can complement a nexus approach to governance (Fig. 8).

DAFNE has developed a methodological nexus approach that includes a social model (Scholz et al., 2018), a water governance model (Yihdego et al., 2018), and a Decision Analytic Framework (Micotti et al., 2019) (Fig. 9). The social model embeds social, demographic and cultural developments (population growth, access to water and/or food, displacement, urbanisation and agricultural practices) that are used as a starting point to map the links between water, energy and food systems (Scholz et al., 2018). For instance, the model shows how trends in population growth, directly or indirectly, result in impacts across the WEF linkages (e.g., population growth leads to a higher demand for energy, a higher demand for energy causes deforestation). The qualitative data about the WEF links have been obtained in cooperation with stakeholders; increasing the stakeholders' shared understanding of the basin system as well as the perspectives of other stakeholders. At the same time, the identified impacts of certain social, demographic and cultural developments inform the governance model which then offers governance tools (laws and policy) to deal with the impact.

The governance model performs a mutual-gains approach (also known as benefits-sharing approach) based on the water diplomacy work by Sadoff and Grey (2002) to eliminate, mitigate or compensate any harm in the involved states. The conceptual model functions under the theory that economic, social and environmental benefits can be derived from an improved water management, contributing to water, food and energy security and subsequently to the implementation of a number of the UN Sustainable Development Goals. A key principle underlying the model is equitable and reasonable use. The governance model basically asks the questions 'whose water' and 'at what costs', from a legal and policy perspective.

Such mutual gains approach is particularly relevant for the identification of trade-offs and the evaluation of benefit-sharing options. The governance model includes benefit sharing schemes by identifying benefits which arise from the use of water, energy and food resources (Yihdego et al., 2018). It emphasises that a process of value creation in isolation, such as promoting hydropower, does not necessarily lead to mutual-gain outcomes. Accordingly, the model reflects benefits which arise from the river, rather than the water itself, including compensation (cash payment), capacity building and training, land allocation, cheaper

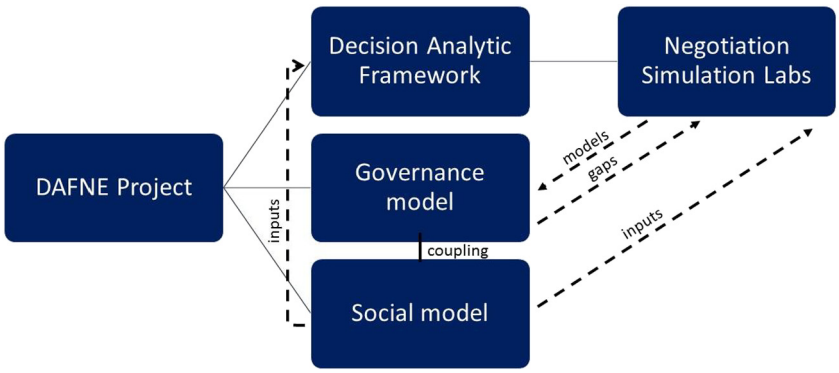


Fig. 9. Developed methodological nexus approach for transboundary basins in DAFNE project with the dashed arrows reflecting adaptive management processes.

energy for local communities, and inter-sectoral water sharing agreements between the riparian countries (e.g. discounted energy in exchange for greater water flow) (Yihdego et al., 2018). The governance model develops and applies modelling in order to reveal legal expectations and to identify gaps and good practices in the WEF nexus. The provided baseline of legal and policy frameworks within the Zambezi River Basin, identified gaps regarding the tensions and mutual benefits between water, energy and food, and potential pathways to overcome them are used as inputs to future stakeholder sessions conducted as part of the Decision Analytic Framework.

The Decision Analytic Framework is built upon an originally conceived methodological procedure for integrated and participative water resources planning (Castelletti and Soncini-Sessa, 2006). It aims to investigate the social, economic and environmental impacts of infrastructural developments and evaluate a set of actions for avoiding or reducing these impacts in complex transboundary river basins (Scholz et al., 2018). The Decision Analytic Framework considers a range of stakeholders such as public bodies, private sector and civil society (Burlando et al., 2018). Development pathways, impact indicators, and solutions for the Zambezi River Basin are collaboratively explored through online interaction with stakeholders and face-to-face workshops, through what are called Negotiation Simulation Labs (Melenhorst et al., 2018). Negotiation Simulation Labs are comparable to the joint fact finding tool in water diplomacy as both aim to examine a situation and carry out collaborative data gathering in order to generate a shared understanding of existing environmental, socioeconomic and political conditions. The Negotiation Simulation Labs prepare stakeholders for negotiation and collaboration with their own adherents and with other (transboundary) parties. This practice allows stakeholders to substantiate their arguments for future real negotiations using scientific evidence, based on impact indicators along the water-energy-food nexus. As a result, the Negotiation Simulation Labs prepare the participants for future decision-making, policy development and political acceptability of options being tested, which reflects a political-sensitivity approach.

While the Decision Analytic Framework has not (explicitly) addressed the degree of certainty (e.g., the complexity due to drivers such as climate change, and political choices) and consensus in the decisions made in the participatory process (as explained in Section 4 and Fig. 4), collaborative adaptive management is underlying the DAFNE project. As explained in Section 4, collaborative adaptive management is an iterative and continuous process of experimentation, careful monitoring of results and impacts and of adjustments (Islam and Susskind, 2012; Yihdego et al., 2018). By making experimentation and monitoring key in the Negotiation Simulation Labs, informing the Decision Analytic Framework with the outcomes of the governance model, and advocating for adaptive management to continue to address nexus in a participatory and multidisciplinary manner, the DAFNE project shows their awareness of the complexity in the Zambezi River Basin, and to act upon that. The sharing of models, data and outcomes, allows stakeholders and decision makers to address the problem at the appropriate level of analysis and leads to informed and adaptive decision making. While long-term outcomes of the DAFNE project for nexus governance in the Zambezi River Basin cannot be foreseen, the approach of the project, characterised by several water diplomacy tools and elements, is valuable for nexus governance.

6. Conclusions

This study discusses how nexus governance in a transboundary context can be improved by drawing upon mediation and negotiation tools in water diplomacy, as well as the benefits that nexus governance can offer in achieving water diplomacy objectives. The consideration of a nexus approach to governance can expand the current scope of water diplomacy practices by exploiting interdependencies between water, energy and food and the related management and policy decisions needed. For example, with the reduction of carbon emissions during water treatment at As-Samra with the use of renewable energy, while reducing pressure on transboundarywater resources through using recycled water to produce food. By applying a natural resource-based focus, water diplomacy negotiations can be enriched beyond the traditional water-centrism and have a greater impact with its value creation trait, for instance by increasing the list of commodities to trade and consideration of cross-sectoral agreements in diplomatic negotiations. As the transboundary context needs cooperative relationships, nexus governance also has potential to facilitate transboundary cooperation due to the larger exchange of understandings and experiences, giving a richer picture of stakeholders' and sectoral relationships. Likewise, peacebuilding could be facilitated in nexus governance with the implementation of nexus development projects that incentivise inter-state cooperation and overcome the state-centrism of water diplomacy by adding intra-state (sectoral, regulatory and institutional) arrangements and practices. An example is the creation of public-private-partnerships in the As-Samra wastewater treatment plant which enhanced stakeholders' engagement towards promoting a better articulation between water, energy and food sectors.

Nevertheless, an appropriate implementation of nexus governance requires further acknowledgment, evaluation and inclusion of evolving socio-political realities, while recognising that there is no single, ideal and 'most rational' solution. Nexus governance in a transboundary context will have to overcome the technical and 'most-rational solution' approaches and broadly capture political contexts and power constellations. By including politics and dealing with normative questions, for example on allocation, peaceful and sustainable (transboundary) natural resource management will more likely be beneficial for all parties involved.

Water diplomacy offers several tools that complement nexus governance, including joint fact finding, value creation and collaborative adaptive management, together with a mutual gains approach. Embedding these tools in nexus governance would set the basis to make environmental and socioeconomic decisions based on a shared understanding of a problem in order to meet all parties' interests and promote shared-benefits by exploiting differences in stakeholders' priorities. As a result, nexus governance practitioners can learn from the water diplomacy field in how to address the complexity of resource systems and their political context. Such challenges in nexus governance are being partially addressed in the ongoing research in the Zambezi River Basin by the DAFNE nexus research project by using experimentation and monitoring processes in engagement processes, informing decisions based on governance analysis and advocating for adaptive management to continue to address transboundary socioeconomic and environmental disputes in a participatory and multidisciplinary manner.

Based on the two case studies, key determinants for transboundary water cooperation that can be generalized to other basins relate to the identified complementarities between nexus governance and water diplomacy (Figs. 7 and 8). Under a political-sensitive approach future transboundary negotiations and discussions will be enriched by considering cross-sectoral WEF agreements and diverse stakeholders' interests. Exploitation of transboundary water, energy, food trade-offs can open economic opportunities in trade agreements and strategic development of future infrastructures in a transboundary context. Nevertheless, water diplomacy and nexus governance research still face challenges related to context-specific political and economic issues for their implementation. From a practitioner's view, water diplomacy needs to overcome barriers related to access to information (Barua, 2018), lack of transparency (Yasuda et al., 2017), short-term thinking in political processes, and uncertainty about the likely results of negotiations (Pohl et al., 2014). This also applies to other resources such as land and energy. Moreover, there are institutional and political barriers to produce the necessary research evidence for transboundary natural resource management due to national interests and existing transboundary water conflicts e.g., water securitization in Jordan

(Wine, 2019). Relevant impact-generation mechanisms in both research disciplines to monitor effective changes in natural resource management and related policy are missing. In that regard, further on-the-ground experiences and collaborations between researchers, policy makers and private sector will be needed to demonstrate and act upon the complementarities of nexus governance and water diplomacy with the final outcome of promoting cooperation in the management of resources at a transboundary level and beyond.

Acknowledgements

The paper was inspired during the authors' participation in the Water Diplomacy Training for Young Professionals (Alexandria - Egypt, 29th October–2nd November 2017) organised and funded by the Swedish Institute Alexandria. We would like to thank Gül Özerol, the initiator of this training, and Ian Holman for the time and insights they provided to improve the research quality and writing of this paper. The authors are also grateful for the comments and recommendations of two anonymous reviewers, which helped to improve the quality of the manuscript. Gloria Salmoral acknowledges the support of the Natural Environment Research Council (NERC) funded project NEXT-AG (NE/R015759/1). No new data were collected in the course of this research.

References

Al-Ansari, T., Korre, A., Nie, Z., Shah, N., 2015. Development of a life cycle assessment tool for the assessment of food production systems within the energy, water and food nexus. Sustainable Production and Consumption 2, 52–66. https://doi.org/10.1016/j.spc.2015.07.005.

Allouche, J., Middleton, C., Gyawali, D., 2015. Technical veil, hidden politics: interrogating the power linkages behind the nexus. Water Alternatives 8, 610–626.

Al-Omari, A., Al-Quraan, S., Al-Salihi, A., Abdulla, F., 2009. A water management support system for Amman Zarqa Basin in Jordan. Water Resour. Manag. 23, 3165–3189. https://doi.org/10.1007/s11269-009-9428-z.

Al-Omari, A., Al-houri, Z., Al-Weshah, R., 2013. Impact of the As Samra wastewater treatment plant upgrade on the water quality (COD, electrical conductivity, TP, TN) of the Zarqa River. Water Sci. Technol. 67, 1455–1464. https://doi.org/10.2166/wst.2013.686.

Al-Saidi, M., Elagib, N.A., 2017. Towards understanding the integrative approach of the water, energy and food nexus. Sci. Total Environ. 574, 1131–1139. https://doi.org/10.1016/j.scitotenv.2016.09.046.

Al-Saidi, M., Hefny, A., 2018. Institutional arrangements for beneficial regional cooperation on water, energy and food priority issues in the Eastern Nile Basin. J. Hydrol. 562, 821–831. https://doi.org/10.1016/j.jhydrol.2018.05.009.

Barua, A., 2018. Water diplomacy as an approach to regional cooperation in South Asia: a case from the Brahmaputra basin. J. Hydrol. 567, 60–70. https://doi.org/10.1016/j.jhydrol.2018.09.056.

Basheer, M., Wheeler, K.G., Ribbe, L., Majdalawi, M., Abdo, G., Zagona, E.A., 2018. Quantifying and evaluating the impacts of cooperation in transboundary river basins on the water-energy-food nexus: the Blue Nile Basin. Sci. Total Environ. 630, 1309–1323. https://doi.org/10.1016/j.scitotenv.2018.02.249.

Bell, A., Matthews, N., Zhang, W., 2016. Opportunities for improved promotion of ecosystem services in agriculture under the water-energy-food nexus. J. Environ. Stud. Sci. https://doi.org/10.1007/s13412-016-0366-9.

Benson, D., Gain, A.K., Rouillard, J.J., 2015. Water governance in a comparative perspective: from IWRM to a "nexus" approach? Water Alternatives 8, 756–773.

Biba, S., 2016. The goals and reality of the water–food–energy security nexus: the case of China and its southern neighbours. Third World Q. 37, 51–70. https://doi.org/10.1080/01436597.2015.1086634.

Bleischwitz, R., Hoff, H., Spataru, C., Voet, E. van der, VanDeveer, S.D. (Eds.), 2018. Handbook of the Resource Nexus. Routledge.

Burlando, P., Nyambe, I., Juizo, D., Odada, E., Zeleke, G., Orshoven, J. Van, Sinclair, S., Koundouri, P., Castelletti, A., Bers, C. van, Novak, J., 2018. DAFNE: a decision analytic framework to explore the water-energy-food nexus in African transboundary river basins. 7th European Bioremediation Conference & 11th ISEB Conference, Chania, Greece, June 25–28, 2018.

Cairns, R., Krzywoszynska, A., 2016. Anatomy of a buzzword: the emergence of the "water-energy food" nexus in UK resource debates. Environ Sci Policy 64, 164–170. https://doi.org/10.1016/j.envsci.2016.07.007.

Cascao, A.E., Zeitoun, M., 2010. Power, hegemony and critical hydropolitics. Transboundary Water Management Principles and Practice, 27–42 https://doi.org/10.4324/9781849776585.

Castelletti, A., Soncini-Sessa, R., 2006. A procedural approach to strengthening integration and participation in water resource planning. Environ. Model. Softw. 21, 1455–1470. https://doi.org/10.1016/j.envsoft.2005.07.013.

Cockburn, J., Palmer, C., Biggs, H., Rosenberg, E., 2018. Navigating multiple tensions for engaged praxis in a complex social-ecological system. Land 7, 129. https://doi.org/10.3390/land7040129.

Cooley, H., Gleick, P.H., 2011. Climate-proofing transboundary water agreements. Hydrol. Sci. J. 56, 711–718. https://doi.org/10.1080/02626667.2011.576651.

Daher, B., Hannibal, B., Portney, K.E., Mohtar, R.H., 2019. Toward creating an environment of cooperation between water, energy, and food stakeholders in San Antonio. Sci. Total Environ. 651, 2913–2926. https://doi.org/10.1016/j.scitotenv.2018.09.395.

de Pazzis, A., 2014. As Samra Wastewater Plant Expansion Continues [WWW Document]. World Finance URL. https://www.worldfinance.com/infrastructure-investment/project-finance/as-samra-wastewater-plant-expansion-continues, Accessed date: 29 June 2019.

de Strasser, L., Lipponen, A., Howells, M., Stec, S., Bréthaut, C., 2016. A methodology to assess the water energy food ecosystems nexus in transboundary river basins. Water 8, 59. https://doi.org/10.3390/w8020059.

Department of Statistics, 2019. Jordan in Figures [WWW Document]. URL. http://dosweb.dos.gov.jo, Accessed date: 26 June 2016.

Energy Charter Secretariat, 2010. Jordan. Regular Review of Energy Efficiency Policies. Part I: Trends in Energy and Energy Efficiency Policies, Instruments and Actors [WWW Document]. https://energycharter.org/who-we-are/members-observers/countries/jordan/, Accessed date: 29 June 2019.

FAO, 1997. The Zambezi Basin [WWW Document]. URL. www.fao.org/docrep/W4347E/w4347e0o.htm, Accessed date: 6 January 2019.

FAO, 2018. AQUASTAT. Food and Agriculture Organization of the United Nations [WWW Document]. URL. http://www.fao.org/nr/water/aquastat/main/indexesp.stm, Accessed date: 22 December 2018.

FAO, 2019. Crops and Livestock Products [WWW Document]. FAOSTAT http://www.fao.org/faostat/en/#home, Accessed date: 24 June 2019.

Foran, T., 2015. Node and regime: interdisciplinary analysis of water-energy-food nexus in the Mekong region. Water Alternatives 8, 655–674.

Government of Jordan, 2014. Jordan 2025 a National Vision and Strategy [WWW Document]. URL. http://www.nationalplanningcycles.org/sites/default/files/planning_cycle_repository/jordan/jo2025part1.pdf, Accessed date: 29 June 2019.

Grech-Madin, C., Döring, S., Kim, K., Swain, A., 2018. Negotiating water across levels: a peace and conflict "toolbox" for water diplomacy. J. Hydrol. 559, 100–109. https://doi.org/10.1016/j.jhydrol.2018.02.008.

Grumbine, R.E., 2018. Using transboundary environmental security to manage the Mekong River: China and South-East Asian countries. International Journal of Water Resources Development 34, 792–811. https://doi.org/10.1080/07900627.2017.1348938.

Harwood, S.A., 2018. In search of a (WEF) nexus approach. Environ Sci Policy 83, 79–85. https://doi.org/10.1016/j.envsci.2018.01.020.

He, Y., 2015. China's practice on the non-navigational uses of transboundary waters: transforming diplomacy through rules of international law. Water Int. 40, 312–327. https://doi.org/10.1080/02508060.2015.1011455.

Hoff, H., 2011. Understanding the Nexus. Background paper for the Bonn2011 Nexus conference. The Water, Energy and Food Security Nexus. Stockholm Environment Institute, Stockholm, pp. 1–52.

Hoff, H., Al-Zubari, W., Mansour, L., Abaza, H., Biad, M., Ouran, N. Al, Ulrich, A., 2017a. Mainstreaming the Water-Energy-Food Security Nexus into Policies and Institutions in the MENA Region: Nexus Evidence Base. GIZ, GFA.

Hoff, H., Mansour, L., Carius, A., Kramer, A., Abaza, H., Ouran, N. Al, Al-Zubari, W., Ulrich, A., 2017b. Mainstreaming the Water-Energy-Food Security Nexus into Policies and Institutions in the MENA Region: National Guidelines on Mainstreaming the Water-Energy-Food (WEF) Security Nexus Into Policies and Institutions in Egypt and Jordan. GIZ, GFA.

Hoff, H., Alrahaife, S.A., El Hajj, R., Lohr, K., Mengoub, F.E., Farajalla, N., Fritzsche, K., Jobbins, G., Özerol, G., Schultz, R., Ulrich, A., 2019. A nexus approach for the MENA region—from concept to knowledge to action. Frontiers in Environmental Science 7, 1–14. https://doi.org/10.3389/fenvs.2019.00048.

Howells, M., Hermann, S., Welsch, M., Bazilian, M., Segerström, R., Alfstad, T., Gielen, D., Rogner, H., Fischer, G., van Velthuizen, H., Wiberg, D., Young, C., Roehrl, R.A., Mueller, A., Steduto, P., Ramma, I., 2013. Integrated analysis of climate change, land-use, energy and water strategies. Nat. Clim. Chang. 3, 621–626. https://doi.org/10.1038/nclimate1789.

Huntjens, P., Yasuda, Y., Swain, A., De Man, R., Magsig, B., Islam, S., 2016. The Multi-track Water Diplomacy Framework Cooperation Over Shared Waters. https://doi.org/10.1080/17429140802160136.

Islam, S., Repella, A.C., 2015. Water diplomacy: a negotiated approach to manage complex water problems. Journal of Contemporary Water Research & Education, 1–10 https://doi.org/10.1111/j.1936-704X.2015.03190.x.

Islam, S., Susskind, L.E., 2012. Water Diplomacy: A Negotiated Approach to Managing Complex Water Networks. Routledge.

Jalilov, S.M., Keskinen, M., Varis, O., Amer, S., Ward, F.A., 2016. Managing the water-energy-food nexus: gains and losses from new water development in Amu Darya River basin. J. Hydrol. 539, 648–661. https://doi.org/10.1016/j.jhydrol.2016.05.071.

Karabulut, A., Egoh, B.N., Lanzanova, D., Grizzetti, B., Bidoglio, G., Pagliero, L., Bouraoui, F., Aloe, A., Reynaud, A., Maes, J., Vandecasteele, I., Mubareka, S., 2015. Mapping water provisioning services to support the ecosystem–water–food–energy nexus in the Danube river basin. Ecosystem Services 17, 1–15. https://doi.org/10.1016/j.ecoser.2015.08.002.

Katz, D., Shafran, A., 2019. Transboundary exchanges of renewable energy and desalinated water in the Middle East. Energies 12, 1455. https://doi.org/10.3390/en12081455.

Keskinen, M., Someth, P., Salmivaara, A., Kummu, M., 2015. Water-energy-food nexus in a transboundary river basin: the case of Tonle Sap Lake, Mekong River basin. Water (Switzerland) 7, 5416–5436. https://doi.org/10.3390/w7105416.

Keskinen, M., Guillaume, J., Kattelus, M., Porkka, M., Räsänen, T., Varis, O., 2016. The water-energy-food nexus and the transboundary context: insights from large Asian Rivers. Water 8, 193. https://doi.org/10.3390/w8050193.

Kibaroglu, A., Gürsoy, S.I., 2015. Water–energy–food nexus in a transboundary context: the Euphrates–Tigris river basin as a case study. Water Int. 40, 824–838. https://doi.org/10.1080/02508060.2015.1078577.
Lasswell, H.D., 1936. Politics: Who Gets What, When, How. McGraw-Hill, New York, NY.
Little, J.C., Hester, E.T., Carey, C.C., 2016. Assessing and enhancing environmental sustainability - a conceptual review. Environmental Science & Technology 50, 6380–6845. https://doi.org/10.1021/acs.est.6b00298.
McDonald, J.W., 2012. The institute for multi-track diplomacy. Journal of Conflictology 3, 66–70. https://doi.org/10.7238/joc.v3i2.1629.
McGrane, S., Acuto, M., Artioli, F., Chen, P., Coomber, R., Cottee, J., Farr-Wharton, G., Helfgott, A., Larcom, S., McCann, J., Salmoral, G., Scott, M., Todman, L.C., van Gevelt, T., Yan, X., 2018. Scaling the nexus: towards integrated frameworks for analysing water, energy and food. Geogr. J., 1–13 https://doi.org/10.1111/geoj.12256.
Melenhorst, M., Bers, C. Van, Lumosi, C., Novak, J., Becker, M., Koroleva, K., 2018. Negotiation simulation laboratory. Technical Implementation Plan. Deliverable D6 (1).
MERM, 2019. Energy 2018 - Facts & Figures [WWW Document]. URL. https://www.memr.gov.jo/EchoBusV3.0/SystemAssets/PDFs/EN/Bruchure2018.pdf, Accessed date: 29 June 2019.
Micotti, M., Bertoni, F., Zaniolo, M., Castelletti, A., Giuliani, M., 2019. Evaluation of Indicators, Value Functions And Pathways [WWW Document]. DAFNE: A Decision-Analytic Framework to Explore the Water-Energy-Food Nexus in Complex and Transboundary Water Resources Systems of Fast Growing Developing Countries. No. 03/2019 (March). The Newsletter of the DAFNE Project (GA no. 690268). URL. https://dafne.ethz.ch/2019/03/20/dafne-newsletter-issue-5/, Accessed date: 19 June 2019.
Ministry of Water & Irrigation, 2016a. Energy Efficiency and Renewable Energy Policy. Ministry of Water & Irrigation.
Ministry of Water & Irrigation, 2016b. Water Substitution and Reuse Policy. Ministry of Water & Irrigation.
Ministry of Water & Irrigation, 2017. Jordan Water Sector Facts and Figures [WWW Document]. URL. http://www.mwi.gov.jo/sites/en-us/HotIssues/JordanWaterSectorFactsandFigures2017.PDF, Accessed date: 29 June 2019.
Pahl-Wostl, C., 2017. Governance of the water-energy-food security nexus: a multi-level coordination challenge. Environ Sci Policy, 1–12 https://doi.org/10.1016/j.envsci.2017.07.017.
Pohl, B., Carius, A., Conca, K., Dabelko, G., Kramer, A., Michel, D., Swain, A., Wolf, A., 2014. The Rise of Hydro-Diplomacy. Strengthening Foreign Policy for Transboundary Waters.
Proctor, K., 2014. Tapped Out: Water Scarcity and Refugee Pressures in Jordan [WWW Document]. URL. https://www.mercycorps.org/research/tapped-out-water-scarcity-and-refugee-pressures-jordan, Accessed date: 29 June 2019.
Rasul, G., Sharma, B., 2016. The nexus approach to water–energy–food security: an option for adaptation to climate change. Clim. Pol. 16, 682–702. https://doi.org/10.1080/14693062.2015.1029865.
Ringler, C., Bhaduri, A., Lawford, R., 2013. The nexus across water, energy, land and food (WELF): potential for improved resource use efficiency? Curr. Opin. Environ. Sustain. 5, 617–624. https://doi.org/10.1016/j.cosust.2013.11.002.
Ros-Tonen, M.A.F., Reed, J., Sunderland, T., 2018. From synergy to complexity: the trend toward integrated value chain and landscape governance. Environ. Manag. 62, 1–14. https://doi.org/10.1007/s00267-018-1055-0.
SADC, 2000. SADC Revised Protocol on Shared Watercourses in the Southern African Development Community [WWW Document]. URL. https://www.internationalwaterlaw.org/documents/regionaldocs/Revised-SADC-SharedWatercourse-Protocol-2000.pdf, Accessed date: 29 June 2019.
SADC, 2016. Regional Strategic Action Plan on Integrated Water Resources Development. Phase IV [WWW Document]. URL. https://www.sadc.int/files/9914/6823/9107/SADC_Water_4th_Regional_Strategic_Action_Plan_English_version.pdf, Accessed date: 29 June 2019.
Sadoff, C., Grey, D., 2002. Beyond the river: the benefits of cooperation on international rivers. Water Sci. Technol. 4, 91–96. https://doi.org/10.1016/s1366-7017(02)00035-1.
Sadoff, C.W., Grey, D., 2005. Cooperation on international rivers: a continuum for securing and sharing benefits. Water Int. 30, 420–427. https://doi.org/10.1080/02508060508691886.
Schmeier, S., 2013. Governing International Watercourses River Basin Organizations and the Sustainable Governance of Internationally Shared Rivers and Lakes. 1st ed. Routledge.
Scholz, G., Knieper, C., Bers, C. van, Sodoge, J., Eikemeier, N., 2018. Models of Demographic, Cultural and Social Developments in the Omo-Turkana and Zambezi River Basins (DAFNE Delevirable 4.3).
SUEZ, 2018. As Samra. Wastewater Treatment Plant: A Major Asset for Jordan [WWW Document]. URL. http://inwrdam.org.jo/wp-content/uploads/2018/10/As-Samra-wastewater-treatment-plant-Jordan-EN.pdf, Accessed date: 29 June 2019.
Summers, M.F., Holman, I.P., Grabowski, R.C., 2015. Adaptive management of river flows in Europe: a transferable framework for implementation. J. Hydrol. 531, 696–705. https://doi.org/10.1016/j.jhydrol.2015.10.057.
Susskind, L.E., 2017. The political and cultural dimensions of water diplomacy in the Middle East. In: Cahan, Jean Axelrad (Ed.), Water Security in the Middle East. Anthem Press.
UNECE, 2015. Reconciling Resource Uses in Transboundary Basins: Assessment of the Water-Food-Energy-Ecosystems Nexus. United Nations Economic Commission for Europe [WWW Document]. URL. https://www.unece.org/fileadmin/DAM/env/water/publications/WAT_Nexus/ece_mp.wat_46_eng.pdf, Accessed date: 29 June 2019.
UNECE, 2017. Assessment of the water-food-energyecosystems nexus and the benefits of transboundary cooperation in the Drina River Basin. United Nations Economic Commission for Europe. [WWW Document] URL. https://www.unece.org/index.php?id=46164, Accessed date: 29 June 2019.
UN-Water, 2008. Transboundary Waters: Sharing Benefits, Sharing Responsibilities [WWW Document]. URL. https://www.unwater.org/publications/transboundary-waters-sharing-benefits-sharing-responsibilities/, Accessed date: 29 June 2019.
UN-Water, 2018a. Transboundary Waters - Water Facts [WWW Document]. URL. http://www.unwater.org/water-facts/transboundary-waters/, Accessed date: 10 December 2018.
UN-Water, 2018b. Progress on Transboundary Water Cooperation 2018: Global Baseline for SDG Indicator 6.5.2 [WWW Document]. URL. https://www.unwater.org/publications/progress-on-transboundary-water-cooperation-652/, Accessed date: 29 June 2019.
van Rees, C., Reed, J.M., 2015. Water diplomacy from a duck's perspective: wildlife as stakeholders in water management. Journal of Contemporary Water Research & Education 155, 28–42. https://doi.org/10.1111/j.1936-704x.2015.03193.x.
Walschot, M., 2018. Desalination, transboundary water desecuritization and cooperation. Desalin. Water Treat. 104, 38–44. https://doi.org/10.5004/dwt.2018.21913.
WANA Institute, 2016. Promoting Water Cooperation in the Wana Region: Widening the Base for Water Diplomacy. West Asia - North Africa Institute. [WWW Document]. URL. http://wanainstitute.org/en/publication/promoting-water-cooperation-wana-region-widening-base-water-diplomacy.
Water Technology, 2019. As-Samra Wastewater Treatment Plant, Jordan [WWW Document]. URL. https://www.water-technology.net/projects/as-samra-wastewater-treatment-plant-jordan/, Accessed date: 2 January 2019.
Water World, 2011. PPPerfect or Problematic? [WWW Document]. Water World URL. https://www.waterworld.com/articles/wwi/print/volume-26/issue-1/editorial-focus/public-private-partnerships/ppperfect-or-problematic.html, Accessed date: 29 June 2019.
Weitz, N., Strambo, C., Kemp-Benedict, E., Nilsson, M., 2017. Closing the governance gaps in the water-energy-food nexus: insights from integrative governance. Glob. Environ. Chang. 45, 165–173. https://doi.org/10.1016/j.gloenvcha.2017.06.006.
Werick, B., 2007. Changing the rules for regulating Lake Ontario levels. Computer Aided Dispute Resolution, pp. 119–128.
White, D.D., Jones, J.L., Maciejewski, R., Aggarwal, R., Mascaro, G., 2017. Stakeholder analysis for the food-energy-water nexus in Phoenix, Arizona: implications for nexus governance. Sustainability (Switzerland) 9. https://doi.org/10.3390/su9122204.
Wichelns, D., 2017. The water-energy-food nexus: is the increasing attention warranted, from either a research or policy perspective? Environ Sci Policy 69, 113–123. https://doi.org/10.1016/j.envsci.2016.12.018.
Wine, M.L., 2019. Under non-stationarity securitization contributes to uncertainty and tragedy of the commons. J. Hydrol. 568, 716–721. https://doi.org/10.1016/j.jhydrol.2018.11.044.
World Economic Forum, 2011. Water Security: The Water-Food-Energy-Climate Nexus. The World Economic Forum Water Initiative. Island Press, Washington, Covelo, London https://doi.org/10.5822/978-1-61091-026-2.
Yang, Y.C.E., Wi, S., 2018. Informing regional water-energy-food nexus with system analysis and interactive visualization – a case study in the Great Ruaha River of Tanzania. Agric. Water Manag. 196, 75–86. https://doi.org/10.1016/j.agwat.2017.10.022.
Yasuda, Y., Schillinger, J., Huntjens, P., Alofs, C., De Man, R., 2017. Transboundary Water Cooperation Over the Lower Part of the Jordan River Basin: Legal Political Economy Analysis of Current and Future Potential Cooperation.
Yasuda, Y., Hill, D., Aich, D., Huntjens, P., Swain, A., 2018. Multi-track water diplomacy: current and potential future cooperation over the Brahmaputra River Basin. Water Int. 43, 642–664. https://doi.org/10.1080/02508060.2018.1503446.
Yihdego, Z., Gibson, J., Hawkins, S., 2018. Models and Principles of Water Governance in the Omo-Turkana and Zambezi Basins (DAFNE deliverable 4.4).
Zaerpoor, Y., Susskind, L., Islam, S., 2017. Value Creation in Transboundary Water Negotiations [WWW Document]. URL. http://blog.waterdiplomacy.org/2017/09/value-creation-in-transboundary-water-negotiations/, Accessed date: 13 January 2019.
ZAMCOM, 2016. Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin: At a Glance. Zambezi Watercourse Commission. Harare [WWW Document]. URL. http://www.zambezicommission.org/publication/integrated-water-resources-management-strategy-and-implementation-plan-zambezi-river-0, Accessed date: 29 June 2019.
ZAMCOM-SADC-SARDC, 2015. Zambezi Environmental Outlook 2015. [WWW Document]. URL. https://www.sardc.net/en/environment/zambezi-environment-outlook-2015-zeo/, Accessed date: 29 June 2019.
ZAMSEC, 2004. Agreement of the Establishment of the Zambezi Watercourse Commision [WWW Document]. URL. http://www.zambezicommission.org/sites/default/files/publication_downloads/zamcom-agreement.pdf, Accessed date: 29 June 2019.
Zandvoort, M., van der Vlist, M.J., van den Brink, A., 2018. Handling uncertainty through adaptiveness in planning approaches: comparing adaptive delta management and the water diplomacy framework. J. Environ. Policy Plan. 20, 183–197. https://doi.org/10.1080/1523908X.2017.1347035.
Zeitoun, M., Warner, J., 2006. Hydro-hegemony - a framework for analysis of transboundary water conflicts. Water Policy 8, 435–460. https://doi.org/10.2166/wp.2006.054.



https://dspace.org/

Water diplomacy and nexus governance in a transboundary context: In the search for complementarities

Salmoral, Gloria; Schaap, Nynke C. E.; Walschebauer, Julia; Alhajaj, Areen

2019-07-02
Elsevier
https://doi.org/10.1016/j.scitotenv.2019.06.513
Salmoral G, Schaap NC, Walschebauer J & Alhajaj A (2019) Water diplomacy and nexus governance in a transboundary context: In the search for complementarities, Science of the Total Environment, Volume 690, Issue November, 2019. pp 85-96.

Downloaded from a DSpace repository. https://dspace.org/