



Unravelling hidden factors explaining competition for and overuse of groundwater in Azraq, Jordan: digging deeper into a network of action situations

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Abstract

In Azraq in Eastern Jordan, farmers, domestic users, and a wetland ecosystem compete for and overexploit limited groundwater resources. Current studies explain parts of the problem, but do not take a comprehensive social–ecological systems perspective and tend to miss underlying hidden factors. To explain decision-making in this complex social–ecological system, we combine the concept of networks of action situations (NAS) with the political economy concept of the social contract. While the NAS allows a systematic exploration of the system, the concept of the social contract allows a deeper understanding of how informal institutions and power influence the system. Besides a comprehensive literature review, we draw on social network mapping and 67 semi-structured interviews with relevant stakeholders. We find that the main conflict arises between a heterogeneous group of farmers, who use groundwater for irrigation agriculture supported by a strong political lobby, and the water authorities, which rely on the aquifer for domestic water supply at national level. The original wetland with its diverse ecosystem services has largely disappeared and its remainder is maintained artificially. Our analysis reveals that a diversity of action situations, including water, agricultural, environmental, energy, and land governance, but also the monarchy’s underlying social contract and the informal concept of *wasta*, influence outcomes on the ground. We show that no panacea exists, but that systems thinking may help identify a range of intervention points, some more sensitive than others, that could support a social–ecological transformation towards sustainability.

Keywords Social–ecological system · Network of action situations · Groundwater · Power · Social contract · *Wasta*

Introduction

This paper analyses groundwater overuse around Azraq in the eastern desert of Jordan. Azraq resembles the stereotypical tragedy of the commons (Hardin 1968): its groundwater resources are exploited at a rate of at least 260 per cent of the estimated safe yield, because there is high competition

for the resource between irrigation agriculture, domestic use and “environmental use” (MWI 2020).

Given the importance of water security in Jordan, there is a wealth of academic literature on the case. Natural science analyses have described the groundwater resources of Jordan including Azraq (Salameh et al. 2018), the complex hydrogeology of Azraq (MWI and BGR 2019), agricultural groundwater abstraction in the area (USAID 2020), the biodiversity in the Ramsar-protected Azraq Oasis (Haddad 2018), and climate change impacts on the Azraq Basin (Al Qatarneh et al. 2018). Social science has researched the historic development of agriculture in Azraq (Demilecamps and Sartawi 2010), the “Azraq melting pot’s” challenges of land tenure and illegal wells (Mesnil and Habjoka, 2012), and the role of water as a relational medium between the state and Azraq’s inhabitants (Janssens and Thill 2013). Further work has provided important analyses of the economics of

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groundwater use for agriculture in Azraq, the role of land governance for agricultural water use and of farmers' tactics to circumvent the enforcement of water policies and regulations (Al Naber 2016; Al Naber and Molle 2016, 2017a; b). However, to our knowledge, the dynamics of competition among the different water-using sectors in Azraq have so far not been studied in a systematic manner. Beyond Azraq, and of great importance for this study, a strand of literature on the power dynamics of groundwater governance in Jordan describes how a "shadow state" of informal neo-patrimonial networks, once crafted to stabilise the monarchy, cements rent seeking in water policy and allocation (Yorke 2013, 2016). Hussein (2016, 2018) further unpacks the mechanisms of the shadow state, including changes in its participants, and shows how it leads to inefficient use of the resource. However, both authors stop short of analysing farmers' perceptions and of applying methods from research on common pool resource governance to analyse the case. Finally, Mustafa and Talazi (2018) extend the analysis of formal versus informal structures to the field of domestic water supply.

Drawing together the individual angles taken by the above-mentioned literatures, we set out to undertake a systematic and rigorous investigation of inter-sectoral competition for water in Azraq and its place in the wider social–ecological system of Jordan, asking what factors explain the resulting groundwater overuse and if these factors could point to transition-pathways towards a more sustainable future. We take the social–ecological system as the unit of analysis, understanding human societies and ecological systems as inseparably intertwined (Ostrom 2007, 2009; Thiel 2016; Partelow 2018). Often, the complexity of social–ecological systems makes it difficult to identify feasible transition pathways to sustainability (Sachs et al. 2019). While theoretical advances such as leverage points (Abson et al. 2017) or sensitive intervention points in complex social–ecological systems (Farmer et al. 2019) address this challenge, systematically identifying such triggers remains difficult.

An emerging tool to capture the complexity of social–ecological systems is Networks of Action Situations (NAS) (McGinnis 2011; Pahl-Wostl et al. 2010). The concept builds on the Institutional Analysis and Development (IAD) framework (Ostrom 2005) and has particularly been applied with a focus on water governance. Kimmich (2013) uses a game theory approach to explore NAS of electricity governance for irrigation in India. Lubell (2013) analyses polycentricity as an ecology of interlinked games in watershed management in the San Francisco Bay Area. Villamayor et al. (2015) study NAS following a value chain approach in case studies on the water–energy–food nexus in Germany, Kenya, and Spain. McCord et al. (2017) use NAS to explain institutional change in water governance in Kenya. Möck et al. (2019) explore a layered NAS in a combined water and food

system in Germany. Kimmich and Villamayor (2019) analyse irrigation in Spain and India using a centrality measure to identify the most relevant elements in the respective NAS. Srigiri and Dombrowsky (2022) suggest NAS and a polycentricity lens to analyse governance of the water–energy–food nexus.

The progress in applying NAS notwithstanding, institutional analysis of social–ecological systems continues to face methodological challenges (Clement 2010; Hall et al. 2014). The most frequently reported limitations of approaches such as the IAD and NAS are difficulties in capturing informal institutions and power dynamics in social–ecological systems as well as their temporal dynamics (Cole et al. 2019; Cumming et al. 2020; Epstein et al. 2020; Morrison et al. 2019). To address this shortcoming, we combine the NAS approach with the concept of the "social contract" well known from state theory and political economy. The concept, understood as the "implicit agreements between all relevant societal groups and the sovereign, defining their rights and obligations toward each other" (Loewe et al. 2020, p. 3), has repeatedly been applied to analyse power relations in Jordan (Beck and Hüser 2015; Loewe et al. 2019; Melián 2018).

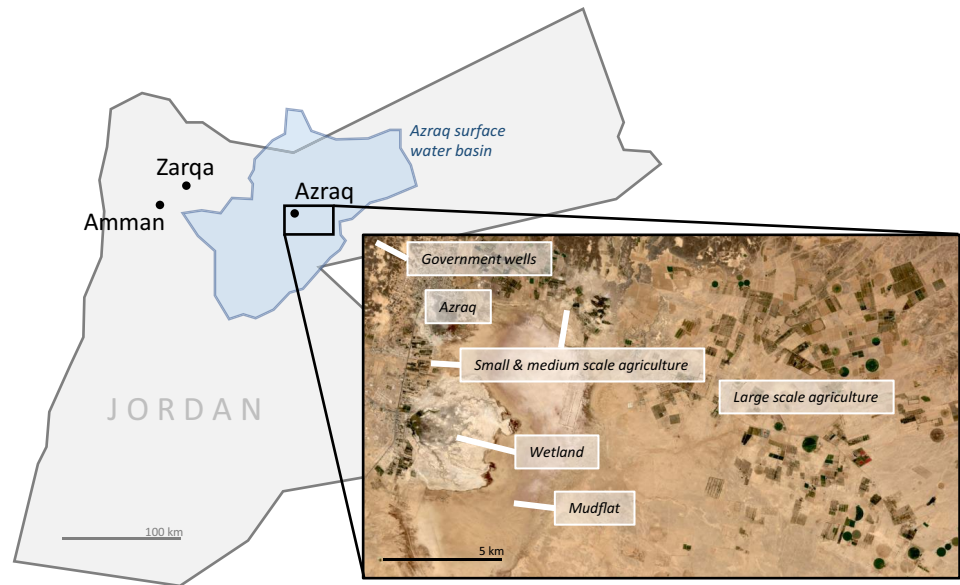
In sum, the research for this paper follows an inductive approach. Our starting point is the case study of groundwater overexploitation by competing sectors in Azraq (Fig. 1). To explore the wider social–ecological system of which Azraq is part, we apply the NAS framework, which we combine with the political economy concept of the social contract to account for power dynamics. By linking the two analytical concepts, we aim at a better understanding of the case study and want to contribute to mid-range theory building about the prospects of sustainable governance of common pool resources in political systems that rely on rent-seeking for their stability.

Materials and methods

Case study: groundwater use in the Azraq Basin, Jordan

The case study is the social–ecological system of Azraq in eastern Jordan (Fig. 1). Azraq is a desert town with 14,000 inhabitants, 40 per cent of whom live below the poverty line (DoS 2010). Around Azraq, the groundwater table is shallow, because the town lies at the lowest point of a large surface water basin. The total groundwater abstraction (61.2 million cubic meters (MCM) in 2018) exceeds the estimated annual safe yield of the Azraq groundwater basin (24 MCM) by at least 260 per cent (MWI 2020). The different user groups competing for groundwater include irrigation agriculture (38.6 MCM in 2018), domestic water supply for the

Fig. 1 Azraq surface water basin in eastern Jordan (left) and the spatial pattern of agricultural, environmental, and domestic groundwater abstraction around the town of Azraq (right). Source: Authors, contains modified ESA Copernicus Sentinel data (2020)



national grid (19.05 MCM in 2018), and a Ramsar-protected wetland, the Azraq Oasis, which was once fed by natural springs and the remainder of which is nowadays maintained artificially (0.65 MCM in 2018), as well as other private wells (2.9 MCM in 2018) (MWI 2020, Fig. 2). The town of Azraq and its older small-scale agriculture surround the historic wetland and an adjacent mudflat. Large-scale farms are scattered in the desert to the east of Azraq. The governmental well field, which supplies water to the national grid, is located northwest of Azraq.

Analytical framework: networks of action situations and social contracts

This section briefly explains NAS and how we extend the concept with elements from political economy. An action situation is the analytical unit at the heart of Ostrom's (2005) IAD (Fig. 3). An action situation emerges "whenever two or more individuals [participants] are faced with a set of potential actions that jointly produce outcomes" (Ostrom 2005, p. 32). For example,

farmers who jointly abstract groundwater from a shared aquifer or government officials negotiating a new groundwater policy are in an action situation.

Action situations are structured by a range of variables (Fig. 3): biophysical/material conditions such as properties of the resource system or technology, attributes of community like its socio-economic structure or heterogeneity, and rules, that is, the social institutions that define how an action situation unfolds (Ostrom 2005; Polski and Ostrom 2017). There are seven types of rules and rules can be formal (e.g., laws) or informal (e.g., shared beliefs about what is right or wrong) (Fig. 3). Participants in action situations interact and produce outcomes, which in turn feed back into the system. For instance, farmers jointly abstract groundwater, thereby lowering the groundwater table, a biophysical condition.

In complex social–ecological systems, action situations hardly exist in isolation but rather in NAS in which they influence one another (McGinnis 2011; Pahl-Wostl et al. 2010). Multiple action situations are connected through the outcomes they produce. For instance, a policy-making action

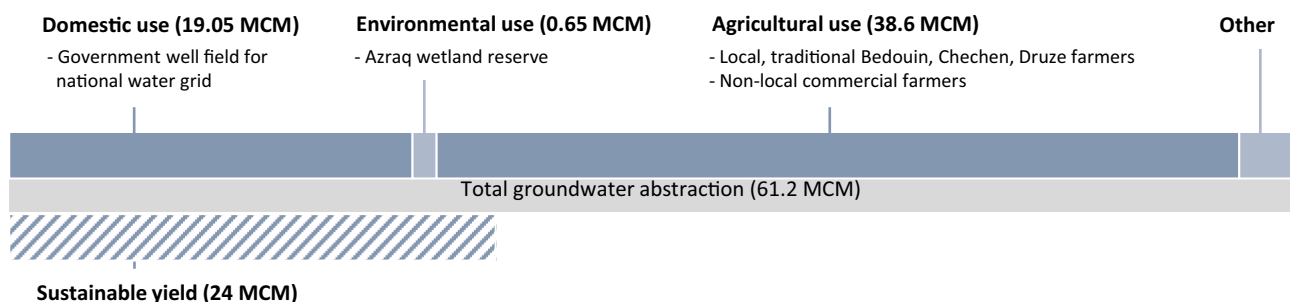


Fig. 2 Groundwater user groups in Azraq, total annual groundwater abstraction, and sustainable yield. Source: Authors, based on MWI (2020)

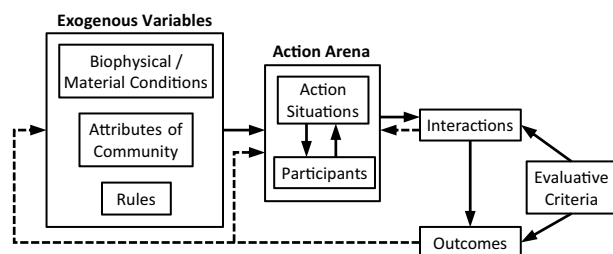
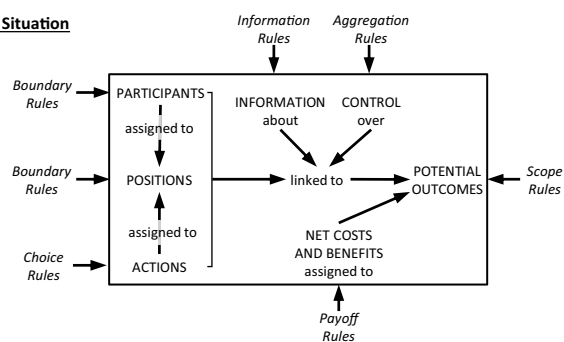
Institutional Development and Analysis Framework**Action Situation**

Fig. 3 Institutional analysis and development (IAD) framework (left) and the inner structure of an action situation (right). Source: Ostrom, 2005 (p. 15 and p. 189)

situation produces a water law, which becomes a rule for an action situation of farmers abstracting groundwater.

To address the above-mentioned shortcoming of institutional analysis concerning power and institutional dynamics (Clement 2010; Cole et al. 2019; Cumming et al. 2020; Epstein et al. 2020; Morrison et al. 2019), we combine NAS with the political–economic concept of the “social contract”, which in Jordan describes the informal and implicit societal agreement between the king, members of the elite including powerful tribes and influential families, and the wider public. It cements the power of the king by guaranteeing rents and privileges for the elites and by providing the wider public with security and basic services to compensate for a lack of political participation (Beck and Hüser 2015; Loewe et al. 2020). In Jordan, an important aspect of the social contract is the concept of *wasta*. *Wasta*, deeply rooted in Jordanian society, describes a mutually felt obligation to provide favourable treatment to members of the same tribe or family and can, therefore, be seen as a local form of nepotism (Barnett et al. 2013; Brahm and Schmitt 2017). People “have *wasta*” if they can use their link to patrons in positions of power to obtain benefits such as bending formal rules in their favour (Cunningham and Sarayrah 1993; Loewe et al. 2008). Because rents and privileges are passed on along these informal networks, tribes and family clans hold a mediating function between the elite and the population (Melián 2018).

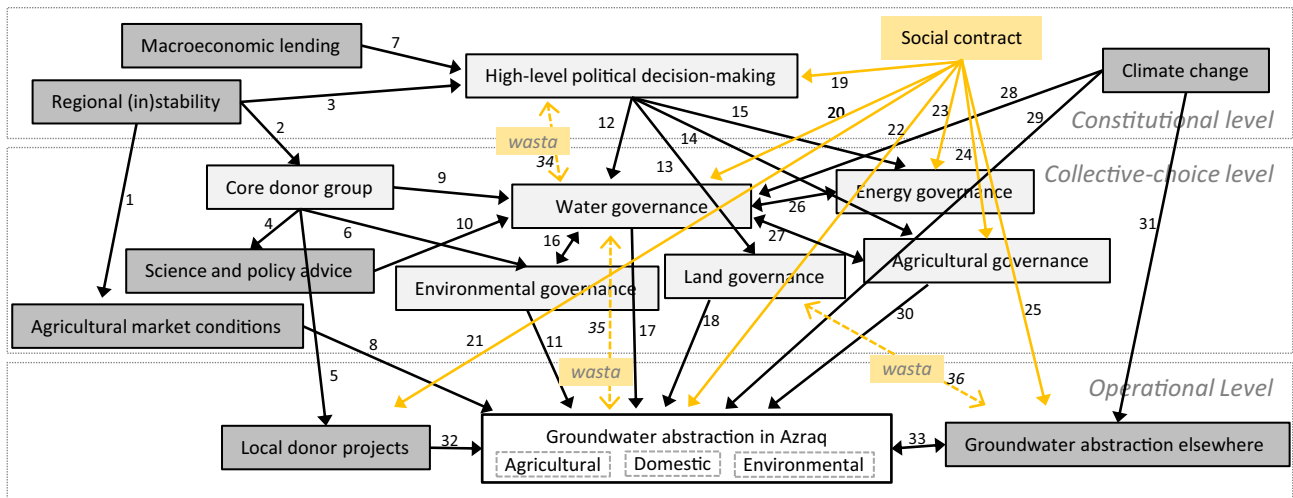
Methods: exploring the network of action situations

First, we compiled a preliminary network of action situations of the Azraq social–ecological system. We analysed academic literature, grey literature, and policy documents relevant to the case study following an explorative approach. To complement the literature review and to identify interviewees, we conducted social network mapping with our research partners from Jordan (see acknowledgements) following the net-map method (Schiffer and Hauck 2010).

Based on this initial overview of the NAS, we explored its details in semi-structured interviews. We conducted 67 semi-structured interviews between February and April 2020 with 24 farmers; 15 experts from academia, consulting, and the private sector; 10 policymakers; eight mediating political actors; six donors; three local administrators from Azraq; and one industrial user. We developed broadly similar questionnaires for each group along the elements of the IAD (see questionnaire for farmers in supplementary materials). We sampled farmers according to farm size while accounting for the diverse ethnic groups. Farm sizes of the interviewed farmers were seven small-scale (< 5 ha), five medium-scale (< 20 ha), eight large-scale (< 100 ha) and four very large-scale (≥ 100 ha). Interviews were numbered consecutively and findings from interviews are referenced throughout the text (“Int-number”).

Results

This section presents the NAS of the Azraq social–ecological system derived from literature analysis and semi-structured interviews. Figure 4 shows an attempt to structure the NAS according to the three levels of nested rules—operational, collective-choice, and constitutional rules—commonly distinguished in institutional analysis (Ostrom 2005). While the figure might give the impression that the three levels of rules match with different levels of governance, this is not necessarily the case, but all three types might exist at all levels of governance (e.g., constitutional rules might be in use at operational level). The remainder of the chapter describes the most important action situations in detail. It pays most attention to the focal action situation of groundwater abstraction in Azraq and summarises findings on others. A detailed account of all action situations in the network will be published in a monograph analysing the Azraq social–ecological system in light of the 2030 Agenda (Dombrowsky et al. 2022).



Legend: The white box marks the focal action situation. Light grey boxes mark important adjacent action situations. Dark grey boxes mark less important peripheral action situations. Yellow boxes mark informal institutions such as the social contract and selected examples of ad-hoc *wasta* action situations that emerge between actors from different formal action situations as described in section 3.9.

1	Regional (in)stability adds to the volatility of agricultural market conditions and reduces export opportunities.	21	Social contract determines beneficiaries of local donor projects.
2	Regional (in)stability makes donors prioritise regime-stabilising interventions.	22	Social contract influences power dynamics in groundwater abstraction in Azraq.
3	Regional (in)stability makes high-level political decision-makers prioritise regime-stabilising measures.	23	Social contract currently inhibits fact-based energy governance.
4	Core donors sponsor science and policy advice to strengthen fact-based governance.	24	Social contract brings conservative momentum to agricultural governance.
5	Core donors support local donor projects at operational choice level.	25	Social contract enable large-scale groundwater abstraction elsewhere as a form of rent-distribution.
6	Core donors are a main advocate and supporter of good environmental governance.	26	Inter-sectoral coordination between water and energy governance recently increased because of mutual dependency.
7	Macroeconomic lending requests structural reform from high-level political decision-makers.	27	Inter-sectoral coordination between water and agricultural governance is weak, resulting in perverse incentives.
8	Agricultural market conditions affect incentives for groundwater abstraction in Azraq in multiple ways.	28	Climate change affects water resources and increases pressure on water governance.
9	Core donors push for fact-based, sustainable water governance.	29	Climate change negatively affects biophysical conditions for groundwater abstraction in Azraq.
10	Science and policy advice supports fact-based water governance.	30	Agricultural governance sets incentives for groundwater abstraction in Azraq that are not always sustainable.
11	Environmental governance backs groundwater abstraction for environmental purposes in Azraq.	31	Climate change negatively affects the biophysical conditions of groundwater abstraction elsewhere.
12-15	For high-level political decision-making, sectoral governance is part of the wider social contract including rent distribution.	32	Local donor projects aim to improve the efficiency of groundwater use in Azraq.
16	Inter-sectoral coordination between water and environmental governance is said to function relatively well.	33	Groundwater abstraction elsewhere negatively affects water resources in Azraq.
17	Water governance sets rules for groundwater abstraction in Azraq.	34	Wasta enables exchange of political support for favours like position in the water administration
18	Land governance affects material conditions of groundwater abstraction in Azraq and provides incentives for tree planting.	35	Wasta enables bending of formal rules due to tribal or family relations
19	Social contract determines personnel for high-level decision-making.	36	Wasta enables influential businessmen to obtain land for commercial farming, e.g. in the northern desert
20	Social contract contributes to rent-seeking in water governance.		

Fig. 4 Network of action situations (NAS) of groundwater abstraction in the Azraq social–ecological system and interrelations explored in the paper. Source: Authors

Groundwater abstraction in Azraq

This section describes the focal action situation of groundwater abstraction in Azraq with its main actors (Fig. 2). Following the IAD, it first describes the exogenous variables “attributes of community” and “biophysical conditions”. It then turns to a more detailed analysis of agricultural groundwater abstraction including “material conditions” and “rules”, followed by brief overviews of domestic and environmental groundwater abstraction. It closes by describing “interactions” in and “outcomes” of the action situation.

Attributes of community

Azraq’s attributes of community are diverse. Druze and Chechens came from abroad in the early twentieth century (Int-05, Int-38, Int-48). Nomadic Bedouins, who have been living in eastern Jordan for a long time, have claimed large parts of the land and settled around Azraq, as encouraged by the government between 1970 and 1990 (Int-42, Int-49, Janssens and Thill 2013). Originally, all three groups relied on small-scale farming, animal husbandry, and pastoralism, as well as fishing and hunting in the oasis for their livelihoods (Int-05, Int-38, Int-49, Int-60). Up until the early 2000s, a considerable part of the community worked in salt production by tapping a lens of saline groundwater underneath the Azraq mudflat (Int-26, Int-30). Since the 1980s and encouraged by the government, commercial farmers and agricultural investors from outside became part of the Azraq community (Int-50, Int-42, Int-62; Al Naber 2018), a development that is viewed critically by many locals (Int-43).

Biophysical conditions

The unique biophysical condition of Azraq is the unusually high groundwater table (Al Naber 2016, 2018). Azraq lies at the lowest surface point of a large hydrogeological formation in which groundwater flows radially towards Azraq. Below Azraq, the groundwater accumulates and stands so close to the surface that it used to feed a natural wetland, the Azraq Oasis. Groundwater in Azraq is a typical common pool resource (CPR): it is easy to access with shallow wells (low excludability) and its consumption is rivalrous. It is currently overexploited at a rate of at least 260 per cent according to government figures. According to scientists, actual water use is significantly higher and safe yield might be considerably lower (Int-01, Int-59, Int-65; Al Naber 2018; USAID 2020).

This overexploitation drastically affects the original biophysical conditions of Azraq. The wetland has shrunk and degraded significantly as groundwater levels have on average dropped by 10 m since the 1990s (MWI and BGR 2019). Wells in adjacent groundwater basins north of Azraq now cause an inversion of the original groundwater flow

away from Azraq (Int-62, Int-65; Margane et al. 2017; MWI and BGR 2019). As a result, the saline groundwater bubble underneath the Azraq mudflat is expanding, which slowly increases the salinity of the aquifer (Int-29, Int-39, Int-45, Int-62, Int-65). The natural springs that once fed the Azraq wetland have dried up and what remains of the wetland is now maintained artificially (Int-48; Int-62).

Agricultural groundwater abstraction

According to official figures, agricultural groundwater abstraction accounts for almost 40 MCM per year (MWI 2020), but it could be as high as 56 MCM (USAID 2020).

The most important material conditions for farming in Azraq are land, energy, and irrigation technology. Land is a production factor, object of speculation and a central part of identity (Int-24). Energy in the form of electricity from the grid, from solar panels, or from diesel generators is needed to pump groundwater from wells. Irrigation technology determines the efficiency of water use in agricultural production.

Boundary rules determine who can enter (and exit) the action situation of groundwater abstraction. Regarding farming, they mainly concern access to land and to well licences. Farmers in Azraq either own land (inherited, given as tribal land, bought as investment) (Int-59), rent land (Int-35), or illegally occupy land (Int-8). Only farmers who legally own land can have a legal well license to legally abstract groundwater, but there are countless farmers without land titles or well licenses (Int-7).

Position rules define the role of being a farmer in Azraq. In a crude attempt to simplify Azraq’s diverse farming community, “traditional” farmers can be distinguished from “commercial” investment farmers. The latter tend to be more powerful than the former and, therefore, have a larger set of potential actions.

Choice rules characterise what farmers in Azraq can and cannot do regarding groundwater abstraction, that is, allowable actions from a regulatory point of view. Historically, farmers in Azraq could basically abstract groundwater no matter the legal status of their well. In 1992, the government issued a well drilling ban that was never enforced (Al Naber and Molle 2017b). Following 2013, however, the government enforced a differentiated pricing system based on well status and the closing of about 1,300 illegal (often unproductive) agricultural wells in Jordan (Int-11). Both caused significant conflict and well-closing has since slowed down (Int-63). Officials also confiscated about 160 drilling rigs (Int-11). As a result, some farmers now say that the government wants to “get rid of agriculture in Azraq” (Int-54).

Aggregation rules determine the degree of cooperation with which farmers must make decisions about groundwater abstraction, for example, as part of a joint management

system. Strikingly, we could not identify any such cooperation among farmers in Azraq. One farmer pointed out that a “sense of responsibility does not exist – everybody works for their own benefit” (Int-46).

Information rules determine the information channels that exist regarding groundwater abstraction in Azraq. Interestingly, little hydrogeological information is available to some farmers, who think that there are “rivers” or “seas” of freshwater underground (Int-09, Int-20), who believe in conspiracies about foreign forces meddling with the resource (Int-22, Int-46, Int-53), or who are largely unaware of recent hydrogeological developments, such as the flow inversion. Vice versa, there seems to be limited flow of information from the farmers to the government, particularly so from small- and medium-scale farmers (Int-46, Int-49).

Payoff rules determine the benefits and costs that follow from actions taken to pursue a certain outcome. The main benefit of farming in Azraq is growing agricultural products that are either used at home or sold in local, regional or export markets (Int-05, Int-25, Int-52). The main costs associated with agricultural production are energy costs for pumping water, accounting for up to 50 per cent of the overall costs (Int-46; Al Naber 2016), labour costs and water costs. Water prices differ depending on the legal status of the well: water from legal wells is very cheap, water from illegal wells that are known to the authorities is expensive, and water from illegal wells unknown to the authorities is free, but there are high fines. Because many farmers did not pay their water bills in the past, the government amended the law in 2014 so it can now estimate the water use of farms using remote sensing. On this basis, the government forces farmers to pay their bills by refusing governmental services, such as electricity supply, labour permits or passport renewals (Int-09, Int-11, Int-15, Int-39, Int-42, Int-51; Al Naber 2016; Molle et al. 2017). Energy prices are also directly related to the legal status of the farm, because only plots with a land title can get electricity from the grid, while others must rely on diesel or solar pumps (Int-44, Int-50). Other than for agricultural production, farming is also used to claim land, which is often subject to land speculation (Int-22).

Scope rules determine allowable outcomes regarding the groundwater resource. As of today, the government has not enacted such regulation. Most strikingly, there are no caps on groundwater abstraction, neither at the individual well level nor at the aggregated aquifer level.

Domestic groundwater abstraction

Domestic groundwater abstraction from Azraq is the second most significant use (20 MCM in 2018), accounting for 87 per cent of the safe yield and 32 per cent of the total abstraction (MWI 2020). The governmental well field north–west of

Azraq (material condition) abstracts water from the shallow aquifer, the majority of which is then conveyed through a pipeline system to the urban agglomerations of Zarqa and Amman (Int-09, Int-41, Int-62). Local staff of the well field have no agency in deciding how much water is abstracted as they receive instructions from the national level (Int-41).

Environmental groundwater abstraction

Groundwater abstraction for environmental purposes artificially sustains the Azraq wetland reserve. The wetland has been protected under the Ramsar Convention since 1978 and managed by the Royal Society for the Conservation of Nature (position rule) (Disi et al. 2004). It is heavily supported by donors (Int-56). Due to groundwater overexploitation, the natural springs that once fed the wetland dried up in the 1990s, which had devastating effects for the biodiversity of the wetland and the livelihoods it once provided to the local people of Azraq (Disi et al. 2004). A political decision was made to artificially sustain a fraction of the wetland with 1.5–2.5 MCM per year but it receives only about 0.65 MCM, which is considered sufficient to maintain the status quo (Int-54). The wetland, including the mudflat, has recently been fenced to exclude agricultural activities within the area (scope rule for agriculture) (Int-04, Int-33, Int-54). The wetland is one of the few tourist attractions in the region (Int-54).

Interactions

There are two dominant patterns of interaction that emerge in the action situation of groundwater abstraction in Azraq. First, there is an overall trend towards stricter law enforcement by the authorities as evidenced by the enforcement of water tariffs and well drilling bans.

Second, among farmers, the enforcement efforts cause resistance against authorities rather than cooperative action towards more sustainable groundwater use. To coordinate action against the government, farmers engage in a social media group with about 130 members and repeatedly organise protest marches to the ministry in Amman (Int-20, Int-30, Int-40). The resistance is partly rooted in a belief that it is not the farmers but the government wells pumping water to Amman that cause the overexploitation and degradation of groundwater (Int-27, Int-35, Int-43, Int-45, Int-49).

Outcomes

Two interrelated outcomes result from the action situation of groundwater abstraction in Azraq. First, authorities partly give in to some farmers’ protests and give discounts of up to 70 per

cent on water bills (Int-42, Int-47), which makes some farmers say that “the government started listening to us” (Int-30).

Second, farmers change their behaviour in multiple ways. Some farmers adopt more efficient irrigation technology to save water and, thus, costs (Int-9, Int-21, Int-42, Int-61). Some try to save on electricity using solar energy (Int-44, Int-50). Some drill illegal wells (Int-11). In addition, several farmers have quit farming, which often left them in despair (Int-16, Int-17, Int-43, Int-42, Int-50, Int-52). Even some farmers from influential families quit farming (Int-42). Still, large-scale commercial farmers and investors have more favourable choices as they can bend the rules. For instance, influential farmers supposedly still manage to obtain new well licenses, which is against the official policy of the government (Int-01, Int-02, Int-07).

Water governance

In Jordan, reliable water supply for the entire country is a constant challenge given that overall water demand exceeds supply (biophysical condition). This has motivated centralised decision-making at the national level. Groundwater is exploited at a rate of 70–80 per cent above the aggregated safe yield nationally (Int-02; MWI 2017) and relies on aquifers such as the Azraq, which covers about 6 per cent of the national domestic demand (Int-20, Int-23; MWI 2020). The public water sector is understaffed and underfinanced, while energy costs for pumping water are high (Int-05, Int-18, Int-57). Consequences are dilapidated infrastructure (Int-01), high rates of leakages and water theft (Int-06, Int-10), a focus on supply-side oriented solutions, such as desalination, as well as reliance on international donor funding to sustain operations (material condition) and augment supply (Int-57). The influx of about 1.3 million Syrian refugees since 2011 has increased domestic water demand by 20 per cent (attributes of community) (Int-17; DoS 2016).

There are two opposing ends in the action situation of water governance. On one hand, there are ambitious policies that clearly prioritise domestic water supply over agricultural water use (Int-02, Int-08; MWI 2015). The initiative to strengthen law enforcement based on remote sensing in the years following 2013 by the then powerful minister pursued that goal (Int-11). Donors also support this goal and their funding is often conditional on progressive water policies and implementation (Int-57).

On the other hand, there is a strong pro-farming lobby, because not only many parliamentarians, but also some (high-level) ministry staff are farmers themselves (Int-01, Int-03, Int-17). As a result, authorities struggle to hold powerful individual farmers accountable (Int-09, Int-17) and water officials clash with farmers at the operational level, sometimes violently (Int-11, Int-60).

Coordination and cooperation in the water sector is sub-optimal. Inter-sectoral coordination between the water sector

and other relevant sectors, such as agriculture, is sporadic (Int-02, Int-03, Int-06, Int-55, Int-60). Intra-sectoral coordination between the water ministry and its agencies is challenging, because responsibilities are unclear and partly overlap (Int-07). An influential donor recently initiated structural reforms, which have met resistance (Int-06, Int-57, Int-60). A key factor undermining long-term strategic coordination is the high turnover of ministers (Int-10).

A past attempt to improve coordination between authorities and farmers, the donor-funded “Highland Water Forum”, brought stakeholders together and resulted in a joint action plan for Azraq (Mesnil and Habjoka, 2012). The plan, however, was never implemented, because new leadership of the water ministry abandoned the participatory approach when the Arab Spring unfolded (Int-14, Int-17, Int-18, Int-57, Int-67).

Agricultural governance

Jordan is an arid country (biophysical condition) importing about 80 per cent of its food (material condition). Although water resources are scarce, agricultural governance aims to improve self-reliance and food security (GoJ 2015; MoA 2016). Securing water availability for the agricultural sector as well as increasing water efficiency are priorities of agricultural governance (payoff rules) (Int-15; Al Naber et al. 2019).

In practice, however, interviewees described agricultural governance as weak inter alia, because a systematic implementation is missing and recommendations are not always fact based (Int-11, Int-24, Int-58, Int-60; Al Naber et al. 2019). Farmers in Azraq expressed low trust in agricultural extension services, partly because they reported to have been ill advised in the past (Int-24, Int-29, Int-42, Int-44).

Coordination between agricultural and water governance is insufficient, and according to interviewees from both sectors, regular exchange at the working level does not exist (aggregation rules) (Int-15, Int-18, Int-60). An employee of the Ministry of Agriculture emphasised that “we are interested in the farmers, but [the Ministry of Water and Irrigation] is only going with the water” (Int-15). These diverging foci result in perverse incentives (outcomes) for farmers in Azraq. For instance, in the past, the Ministry of Agriculture encouraged the planting of olive trees in Azraq despite their relatively high water demand and low economic returns (Int-42, Int-51).

Environmental governance

Environmental governance in Jordan aims at “protecting the environment and maintaining all of its components including air, water, soil and ecosystems and its sustainability”

(MoEnv 2017, p. 20). It is, therefore, tasked with maintaining the biodiversity of Jordan at large (biophysical condition). The Ministry of Environment sees itself as playing an important facilitative role (choice rule), because it works on many inter-sectoral topics (Int-10). The cooperation with other ministries is generally described as good and bilateral or multilateral committees exist with various other governance sectors including water, agriculture, interior, and tourism, as well as with local stakeholders and the private sector (aggregation rules) (Int-02, Int-04, Int-10). However, the ministry's enforcement capacity is considered weak (Int-10). The environmental and the water sectors cooperate to supply the Azraq wetland with a limited amount of water (outcome) (Int-04, Int-10).

Land governance

In Jordan, a government tenure system (formal rules) and an informal tenure system (informal rules) coexist (Al Naber 2016). In the eastern desert, land claims by Jordanian tribes (attribute of community) often collide with formal land tenure (Int-38, Int-59). For some farmers, their ancestors took land and started farming it based on documents signed by the community leader, which is legal in tribal law, but not for the government (Int-14).

For those farmers in Azraq who own tribal land and have no official land titles, the discrepancy of rules (outcome) makes them ineligible for well licenses or connections to the electricity grid (Int-14; Al Naber 2016). Planting (olive) trees is one strategy towards the legalisation of land, which is used for land speculation, and affects groundwater resources negatively (Al Naber and Molle 2016).

Energy governance

Jordan has no exploitable fossil fuel resources (biophysical condition) but imports fossil fuel from abroad (MEMR 2017). The government currently faces a costly oversupply because of long-term natural gas import contracts (payoff rule) (Int-55). The water sector consumes about 15 per cent of the electricity generated in Jordan, which accounts for 50 per cent of the water sector's costs and makes it dependant on donor funding. Regarding Azraq, water and energy authorities jointly decided (aggregation rule) that illegal well owners would be denied connections to the electricity grid (outcome), forcing them to use diesel or solar systems (Int-50; Al Naber and Molle 2017a). Farmers can obtain subsidies for solar systems (Int-55), which mitigates climate change but makes overexploitation of groundwater more likely, because such systems reduce costs for pumping, a perverse incentive in terms of water conservation.

Core donor group

The most important donors in the water sector are Germany, the US and France, who meet regularly as the "core donor group" (aggregation rule) (Int-18, Int-66). The overarching rationale for donors to engage in the water sector is to contribute to the stability of the state in a volatile region and to reduce migration pressure to Europe (payoff rule) (Int-01, Int-66). Donors primarily aim to provide technical support (choice rule), such as improving the financial sustainability of the water sector, irrigation efficiency and wastewater treatment (Int-01, Int-57, Int-67). They also substantially invest in creating scientific knowledge about the water situation to form the basis for fact-based governance (Int-01). All three core donors make their support conditional on improved "governance" of the water sector (outcome) (Int-01, Int-07, Int-57, Int-59, Int-66). However, donors said that they are not welcome to interfere in delicate political issues such as the allocation of groundwater resources (scope rule) (Int-01; see 3.8, 3.9) and acknowledged that they have been pressing for a reform of the domestic water tariffs for the past 30 years without much success (Int-07). As one donor summed it up, "Jordan's stability, that is the big issue in all government negotiations... It is about keeping Jordan as a model, a good example in the Arab region. Because the question is also on the agenda: should we now play harder?" (Int-01). The Jordanian government seeks to convince donors to support seawater desalination in Aqaba and its conveyance to Amman, which would be costly in terms of investment and operational expenses with unknown social and environmental consequences (Int-66).

High-level political decision-making

Participants in this action situation are the king, the royal court, and the security and intelligence services, as well as the highest levels of government, including the cabinet and to a limited extent the parliament (positions rules). The king appoints the cabinet, the senate and the heads of the security service (choice rule). He chooses from the elite, including powerful tribes and families as well as influential businesspeople (attributes of community, boundary rules) (Int-56).

The action situation is strongly influenced by rent seeking (interaction) as part of the social contract (Barnett et al. 2013; Melián 2018). Besides the formal rules that structure this action situation, that is, predominantly the constitution, there is a strong set of informal rules regarding the distribution of power between the participants in this action situation (position and aggregation rules). For instance, cabinet posts are distributed along unofficial quotas among the powerful tribes and influential families, but also across ethnicities and religious groups (Int-56). These informal agreements

(payoff rules) determine how the rents and privileges that are so important to the Jordanian political system are initially split up into large portions, which are then distributed along the informal networks of the individual actors (payoff rules, material conditions).

The action situation affects water governance in several ways. First, as participants in this action situation must secure sufficient rents to maintain their networks, they must convince international donors to continuously provide aid funding. Regarding the water sector, this means making it look as if formal institutions are strengthened (“law enforcement”) and strategic planning is improved (Int-56). At the same time, participants in this action situation are also interested in securing the continuous supply of water—also a type of rent—to the benefit of themselves and their networks (Int-08, Int-37, Int-54). As a result, law enforcement targets small farmers, while those with connections to the higher level are spared. That said, an interesting recent development saw the king dismiss a draft bill that aimed to legalise all illegal wells (Int-59).

Second, the structure of the action situation usually results in a high turnover of ministers, which undermines strategic planning in the water sector (Int-04, Int-10, Int-55, Int-56; Beck and Hüser 2015). Because the government is appointed by the king, public protest often results in the king replacing ministers (Int-56). New appointees are predominantly selected along the previously mentioned quotas (not necessarily for their qualifications) and must satisfy their own clientelist networks, which often results in incoherent governing (Int-56). An interviewee summarised: “If you put plans, somebody comes and cancels your plans, because the prime minister is not elected...he changes and everything is changing” (Int-04).

Social contract

The social contract and its integral element “wasta” underpin power relations in Jordanian society. The social contract grants power to the king, rents and privileges to the elites, and basic services and security to the general public. In this arrangement, tribes and influential family clans serve as important informal structures within which rents and privileges trickle down from the elites to parts of the wider public through the mechanism of wasta (Mélian 2018). Wasta is the mutually felt obligation to provide favourable treatment to members of the same tribe or family, a locally established form of nepotism (Barnett et al. 2013; Brahm and Schmitt, 2017). Within our analytical framework, we understand the “hierarchy of clientelistic relations” (Loewe et al. 2008) of wasta as a hierarchy of ad-hoc action situations that emerge spontaneously between the more permanent action situations of the NAS (Fig. 4). In these ad-hoc wasta action situations a participant (member of a tribe or an influential family clan,

boundary rule) can use wasta to ask a higher up patron to intervene in their favour, thereby bending the rules of their action situations (choice rule) and improving their own benefit (payoff rule, outcome). The extent of this mechanism is virtually unlimited (scope rule): it ranges from farmers using wasta to obtain discounts on water bills from water officials to politicians obtaining cabinet posts from the king. The foundation for wasta is a set of centuries-old socio-cultural norms (attributes of community) of loyalty within the family group, the clan, and the tribe (Barnett et al. 2013).

Wasta was a dominant topic in our interviews. One farmer claimed to have access to the king (Int-25) and others mentioned having access to the royal court, the prime minister, relatives in the secret service, the military and high-level positions in ministries (Int-14, Int-37, Int-42, Int-56, Int-60). Wasta is said to allow some farmers to influence operational matters, such as preventing the closing of illegal wells, or to influence policy reforms at collective-choice level, such as changes in water tariff structure (Int-09, Int-14, Int-17). Additional examples farmers mentioned were the circumvention of import or export bans for agricultural products (Int-08, Int-29, Int-37) and securing discounts on high water bills (Int-30, Int-40, Int-47, Int-50, Int-52). Interviewees stated that former ministers, ministerial staff, and other powerful people have farms in Azraq and, therefore, use wasta to resist stronger legislation and law enforcement (Int-08, Int-37, Int-54). A key pool of farmers’ wasta seems to be parliament, of which many members are farmers themselves and where the agricultural lobby is strong (Int-07, Int-09, Int-17, Int-57, Int-59, Int-66). An interviewee stated that “the culture, the tribes over there, the friendship between the high-level decision-makers in the ministry and the businessmen over there, all this is a political game” (Int-60).

While the patron-client mechanism of wasta brings benefits to some, it disadvantages those without, resulting in social and economic inequality among farmers. Large-scale farmers are generally very strong, whereas farmers without connections get their (illegal) wells closed, cannot compete, have no means of participation, and sometimes lose their livelihoods (Int-07, Int-09, Int-14, Int-17, Int-44, Int-46, Int-54, Int-57).

The informal institutions around the social contract including wasta notwithstanding, several interviewees suggested that a stricter enforcement of formal rules has been taking place in the past years, regardless of farmers’ status and influence (Int-14, Int-37, Int-38, Int-42). For instance, farmers that normally have wasta because they belong to a certain tribe or elite or because of (former) high positions in the government or military, reportedly also received high water bills and conditionality measures were also applied against them (Int-37, Int-42). These empirical findings confirm a certain shift in the Jordanian social contract with respect to water, not only in terms of participants (Hussein

2018), but also in terms of substance, as scholars have observed for other policy fields as well (Bouziane 2010; Loewe et al. 2019).

Other peripheral action situations

Additional peripheral action situations affect the NAS of the Azraq social–ecological system (Fig. 4) but were not explored in detail in this study. The AS “groundwater abstraction elsewhere”, predominantly in the northern highlands, restricts groundwater flows towards Azraq, thereby reducing aquifer recharge in the area and causing an inversion of groundwater flow. “Local donor projects” largely aim at improving irrigation efficiency by providing technology, thereby affecting the material conditions in Azraq. The AS “Science and policy advice” has—with substantial donor funding—recently advanced water use estimations based on remote sensing methods supporting law enforcement. “Macroeconomic lending” by financial institutions such as the IMF imposes structural reform on high-level political decision-making (e.g., concerning domestic water tariffs) in exchange for bailing out the state. Payoff rules for agriculture in Azraq are affected by the AS “agricultural market conditions” at the national and international level. “Regional (in) stability”, a geopolitical action situation between regional and global powers, has resulted in an influx of refugees that altered the attributes of community in Jordan and increased pressure on domestic and agricultural water supply. Finally, climate change, an action situation at global scale, negatively affects the biophysical conditions of Azraq. This shows that the analysed social–ecological system is only a snippet of a larger network of actions situations, in which various Jordanian actors have differing degrees of agency.

Discussion

Advancing the analysis of the case study

This paper analyses the social–ecological system of groundwater abstraction in Azraq in a wider societal context. The results show that the pattern of unsustainable groundwater use is not just a local phenomenon, but that local realities are rooted in the fundamental pillars of Jordanian society. The analysis thereby bridges the existing literature on the case study, which has so far either focussed on individual elements at the local level or at broader analyses of the shadow state without a detailed account of the local level.

A novelty for the analysis of the case study, we systematically apply established tools from institutional analysis of common pool resource governance, namely, the IAD and NAS. Thereby, we shed light on elements that theory

on CPR governance deems important but that have so far been overlooked in the case study. For instance, we discover that there are no caps on individual or aggregate groundwater abstraction—a potentially viable policy option (scope rule); that there is no mechanism for providing farmers with novel information about the resource, such as the flow inversion (information rule); or that farmers do not maintain a decentralised management system (aggregation rules), because they believe that their water is stolen for domestic use by the central government anyways (no excludability). Overall, the case shows how constitutional-level rules may limit the sustainable use of CPRs, as such also informing CPR theory.

Furthermore, going beyond analyses on controlling agricultural groundwater abstraction in Azraq only (Al Naber and Molle 2017a), our analysis of the broader picture of competing water users and underlying socio-cultural factors (e.g., Janssens and Thill 2013) shows that interventions at the farm level might alleviate the situation somewhat but will not lead to sustainable groundwater use. That is partly because water scarcity at the national level results in groundwater abstraction for domestic supply from Azraq that alone uses almost 80 per cent of the estimated safe yield of the aquifer.

Third, the NAS approach shows that weak policies and perverse incentives at the operational level partly result from insufficient inter-sectoral coordination. This, however, does not just follow from limited state capacity and a lack of resources or political will but rather from the fact that there are conflicts of interest between the different sectors and that the public sector was not exactly set up as an efficient tool for fact-based governance but also as a mechanism for distributing rents (e.g., Yorke 2016). Fourth, our analysis explains how protecting the unique biodiversity of the Azraq wetland ecosystem and the variety of ecosystem services that it once provided to the people of Azraq (e.g., Disi et al. 2004) is not a priority in the power-laden scramble for resources in the case study.

Building on the case study, we advance the analysis of the wider social–ecological system by combining the systematic rigour of NAS with the political–economic concepts of the social contract including *wasta*. The underlying pattern that emerges from this analysis is a clash of two social subsystems. On one hand, there is the formal subsystem as written down in Jordan’s constitution, establishing formal relations among the king, the government, the parliament, economic actors such as farmers, and the general population. On the other hand, there is the informal subsystem as captured in an informal and implicit social contract, including the king, a powerful elite, tribes and family clans as intermediaries, and the general population—an informal network also referred to as the “shadow state” (Hussein 2018). Each subsystem questions the legitimacy of the other and yet both are intricately

intertwined and rely on each other, as Brahm and Schmitt (2017) also show for the private sector more generally.

This political–economic analysis of the case study points to inherent tensions within water governance and that king and government need to strike a difficult balance. On one hand, a sufficient provision of rents to the elite, including access to groundwater for farming, is necessary to fulfil the social contract, thereby stabilising the system overall (Yorke 2016). That said, the elites’ rent seeking increasingly clashes with another part of the social contract, that is, the need to provide the wider population with an affordable and somewhat reliable water supply (Loewe et al. 2019). This tension often goes unnoticed in the literature and overly technocratic policy advice. As a result of this tension and as shown by our interviews with farmers, the social contract is not only changing in terms of participants (Hussein 2018) but also in terms of substance, leaving influential farmers in a somewhat more ambiguous situation than in the past.

In addition, to secure vital rent income from Western donors, the regime needs to show willingness to improve “good (formal) governance” (Beck and Hüser 2015), creating another tension in water governance. This also implies, as water and time are running out, that the future role of core donors in the rent-game will be crucial, especially concerning their potential support for expensive seawater desalination (cf. Hussein and Eichholz 2020).

Finally, the broader network of peripheral AS points at important influencing factors, in which Jordanian actors have differing degrees of agency, which should not be overlooked.

Advancing the analytical framework: NAS and power

Beyond the case study of Azraq, our research shows how the NAS approach can be operationalised to analyse power dynamics in natural resource governance. The IAD framework and with it NAS have long been criticised for their inability to address power dynamics (Clement 2010; Cole et al. 2019). For us, NAS is an analytical framework rather than a theory. Therefore, combining NAS with a theoretical concept of power proved essential. Without it, the framework can only capture snapshots of emergent configurations of complex systems but cannot explain how the configuration came about, a phenomenon Morrison et al. (2019) term “the black box of power in polycentric environmental governance”. Combined with the theoretical consideration of power, however, the framework serves to systematically identify use and abuse of power and to explain why current configurations of systems emerged and—perhaps most importantly—how they might evolve in the future. Our study further shows that as much as the NAS approach benefits from combining it with power, political economy approaches

can benefit from combining them with the IAD and NAS, which allows systematic identification of relevant variables and structures. In sum, combining the two approaches allowed us to draw a more comprehensive picture of the case study than before.

Our study is in line with what has recently been demanded for advancing institutional analysis in a post-Ostrom research agenda: it provides a middle-range theory that allows for the “contextualised generalisation of phenomena” (Cumming et al. 2020, p. 31). Such middle-range theories can infuse empirical observation with the necessary explanatory power to make sense of outcomes, to make predictions about the future and to identify meaningful intervention points for sustainability transitions. Concretely, our analysis suggests that where strong informal institutions, such as a social contract and nepotism, cement rent seeking that involves the natural resource at stake, approaches of performance-oriented “good” (i.e., sustainable) natural resource governance are unlikely to succeed. That is because powerful and organised interests from higher levels are likely to significantly constrain the scope of action for local people at the operational level to form collaborative institutions for collective sustainable resource management. This raises interesting questions about sustainability transitions in non-democratic social–ecological systems.

Methodological challenges

While we believe that combining the NAS framework with the concepts of the social contract and nepotism provided insightful results, we also faced methodological challenges. Above all, it became clear that it is much easier for the outside researcher to use NAS to explore formal institutions rather than informal ones. That is because it is easier to identify formal institutions in literature and policy documents and because interviewees tend to be more aware of formal institutions, while they often take informal institutions for granted (Epstein et al. 2020). Our study is, therefore, biased towards formal institutions. We were able to make some observations about the mechanisms of the Jordanian social contract and *wasta*, but we do not explore in detail the action situations and nuances that exist within the informal system. Future research could attempt to extend the detailed picture of primarily formal institutions presented in Fig. 4 by an equally detailed picture of the individual AS of informal institutions of the case study.

We further found it challenging to identify which parts of the NAS mattered the most to our case study. When exploring the NAS beginning from the focal action situation, we quickly encountered a variety of threads to be followed. The task of digging through the NAS can easily become quite overwhelming, particularly if limited time and resources

(and a pandemic) constrain fieldwork. This challenge of keeping a NAS concise yet sufficiently broad to explain outcomes has also been identified by previous work (Kimmich and Villamayor 2019). However, starting from the focal AS helped and limitations regarding the overwhelming character of the NAS could be partly addressed by our introduction of peripheral AS.

Finally, covering a large NAS always results in trade-offs regarding the level of detail. It was, therefore, essential for our case study that individual elements of the NAS were already profoundly covered by literature, which served as a solid base for our research.

Conclusions

This paper investigates groundwater abstraction in Azraq and puts it into the wider political economic context of the power relations underpinning the state of Jordan. The continued overexploitation of groundwater in Azraq is not sustainable. If current trends continue, groundwater tables will drop further and the aquifer will become more saline. Groundwater users will continue to bear the consequences, be it small-scale farmers, the supply of water from Azraq to the domestic grid, the artificial upkeep of the wetland reserve, or large investment farmers who for now have the resources to drill deeper wells. What is now still a renewable resource of freshwater may deteriorate to a point where it is not useable anymore.

To avoid such a scenario and to make groundwater use more sustainable, the structured approach of our study suggests that interventions are conceivable at the different levels of governance outlined in the results section. First, interventions at the operational level would usually target technical aspects, such as irrigation efficiency, cropping patterns or improvements of water infrastructure. In fact, such measures are already applied in the case study, often with donor support. However, despite small gains in efficiency, they are unlikely to alter the general pattern of overexploitation. Second, interventions at the collective choice level could aim at improving the enforcement of the water policy reforms introduced in 2013/14 and at stepping up inter-sectoral coordination with other sectors, e.g., geared at the removal of counterproductive subsidies. While such interventions are likely to have greater potential than interventions at the operational level as they would affect the system as a whole, our research suggests that they have lesser prospects as they would face opposition from those who benefit from the current situation. Third, interventions at the constitutional level could address the fundamental allocation of groundwater in Jordan and have—at least theoretically—the potential to become real leverage points (Abson et al. 2017). Such interventions could alter the taken-for-grantedness of access to groundwater for influential parts of the society. Of course,

interventions like that are highly sensitive as they address the fundamental allocation of resources and rents underpinning the Jordanian social contract and, therefore, are most likely to succeed if they come from within. However, at some point, the allocation of rent, too, will need to become sustainable if the system is to be stabilised in the long term. The recent rejection of a proposition of parliament, which would have legalised all illegal wells, might be seen as a careful step in that direction.

The future of the groundwater situation in Azraq is difficult to predict. Currently, the quantity and quality of the resource deteriorates. It is unlikely that the measures currently taken by the government will be sufficient to reverse the trend. While the situation poses significant challenges for many locals, it remains to be seen if Azraq is enough of a stake for the system at large to address the fundamental question of groundwater allocation.

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