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Capacity development for water reuse in in-formal partnerships in northern Namibia

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In central northern Namibia, challenges in water governance related to scarcity meet needs in capacity development on municipal levels. Reuse of treated water in agriculture forms a technical innovation in urbanizing arid regions, because it potentially contributes to both improving water availability and reducing pollution from waste water in arid regions. Governing this transformative approach entails a complexity of processes and actors at different levels and in a range of sectors. The aim of this research is to assess the potential of an informal municipal partnership to (a) support capacity development in implementation of innovation in urban water systems (here: water reuse), and (b) compensate for lack of coordination in governance. Establishing a municipal partnership for wastewater treatment was part of a living lab approach analyzing the potential for water reuse, in collaboration of an interdisciplinary team of researchers, municipal decision-makers, engineers and farmers. Findings show the potential and limitations in capacity development in municipal water governance by means of an informal partnership. The lessons learnt on establishing an informal municipal partnership for learning and capacity development in water governance provide valuable insights for water governance in both research and practice, in particular but not limited to the field of water reuse as means of transforming socio-hydrological relations toward sustainability. The research thus contributes to research on water reuse governance, and to transformative research on water in social-ecological systems.

KEYWORDS

municipal partnerships, water governance, transdisciplinary research and methods, social-ecological transformations, adaptive governance

Introduction

In the face of growing water challenges, in urbanizing arid regions and under the impacts of climate change in particular, capacity needs in water management are high. The 2020 status report on the progress toward meeting the SDGs highlights the urgent need for accelerated action on implementing sanitation services and integrated water resource management, or else the SDG 6: to ensure availability and sustainable management of water and sanitation for all will not be met by 2030 (United Nations, 2020). In the same year, the UN[1] have singled out capacity development as one out of five accelerators to achieve the SDG 6 by 2030 (UN Water, 2020). At municipal level in regions experiencing population growth in particular, management capacities are lacking and governance challenges are stark.

Water reuse is both a transformative approach in integrated water resource management, and an illustrative case of the complexities entailed in developing capacities in water governance across modes, levels and sectors. The urgency of enhancing reuse and wastewater treatment capacity is recognized in the Global Target 6.a under the SDG on water, explicitly highlighting the importance of North-South collaboration in technology development (United Nations General Assembly, 2017 7/10/2017)[2]. Water reuse can be considered transformative in arid regions with drainless areas in particular. Such conditions prevail in Northern Central Namibia. Here evaporation and transpiration are the only mechanisms by which water unsuitable for infiltration can be disposed of, as discharge into rivers after treatment (preflooder) is no option. Waste waters are collected and left to evaporate in waste stabilization ponds (WSP)—an approach to waste water management where hydrological conditions prevent discharging or infiltrating waste water into existing water bodies. Overflowing of WSP during the rainy season leads to flooding of inhabited areas with untreated water and associated health risks. In (semi-)arid regions, and especially in sub-Saharan African countries, water supply is also an issue. Rapid population growth increases the need for alternative water resources due to drivers such as increasing domestic, agricultural and industrial consumption, as well as climate change and climate variability. In combination, the particularities of water use in drainless areas in semi-arid and arid regions imply costs and benefits in water management that differ considerably from those in most parts of the world. Against this background, water reuse is the only option to reduce the pressure on wastewater ponds while also reducing freshwater supply needs (Zimmermann et al., 2019).

At the same time, reusing water at municipal level involves a range of capacities to be developed. Firstly, reusing water (in agriculture) requires new forms of knowledge and collaboration at different levels and across sectors. Key to sustainable water reuse systems is that technological solutions are based on a holistic scientific, economic and social understanding of the entire (urban) water system (Bahri, 2009). Technical expertise to fully understand hydrological information is needed, which many decision-makers lack (Hofste et al., 2019). Cross-scale and cross-sectoral collaboration is a prerequisite for successful water reuse in agriculture (Bahri, 2009). Secondly, implementation of water reuse systems in drainless areas requires an alternative calculation of costs and benefits. Generating resources from wastewater is often not profitable in economic terms when the alternative environmental costs of not treating water and overexploitation of freshwater resources are not factored in (Di Mario et al., 2018). Collaborative approaches may enable economies of scale. Thirdly, open questions remain as to how to change deeply embedded reservations toward reusing water. Moreover, the politics and power asymmetries involved in water reuse governance have barely been explored (Beveridge et al., 2017). This results in both a research gap and a capacity need to create political alliances for reuse (Kjellén, 2018).

Research on water reuse governance has largely focused on economic and awareness aspects, leaving the complexity of institutional arrangements for reuse under-researched (Beveridge et al., 2017). Meanwhile, practical examples of municipal cooperation in the water sector suggest the potential of partnerships in supporting capacity development. This potential is substantiated by literature on water and adaptive governance that teases out the role of informal and bottom up arrangements (Kemerink-Seyoum et al., 2019; Pahl-Wostl, 2019). However, while case studies exist, little is known about the effectiveness of such partnerships (Boag and McDonald, 2010), and their contribution to developing capacity, particularly in the global South (Moodley, 2019).

The present research seeks to explore the potential of municipal partnerships in developing capacity for water reuse. Given the role of semi-formal networks in both compensating a weak governance coordination and in developing capacities, we conceptualize informal municipal networks as cooperative arrangements between local governments where learning takes place and capacities are developed and leveraged. This may include technical, regulatory, adaptive as well as integrative capacities. In bringing together the capacities of multiple municipal actors, such partnerships have the potential for enhancing capacities by combining resources, for instance in the acquisition of technical equipment (economies of scale). A flexible set-up allows for capacity development in

1 Through the coordinating body on water and sanitation, UN-Water.

2 "6.A By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies".

various, changing constellations according to needs in an adaptive manner. This conceptualization situates informal municipal networks at the interface of (1) bottom-up processes of collaboration in the socio-technical tinkering in water management (Kemerink-Seyoum et al., 2019) and (2) formalized collaborative arrangements with the specific objective of enhancing capacities in water governance (Boag and McDonald, 2010). Thus defined informal public partnerships potentially strengthen water governance capacities in local governments, regulatory water governance capacities in networks, and create capacities strengthening meta-governance. Here we study this potential in the context of an innovation in the water sector (water reuse) that is designed to support the social-ecological transformation (Hummel et al., 2017) of municipal water supply in central northern Namibia.

We understand 'wastewater treatment plant partnerships' as semi-formal networks of knowledge exchange and for sharing special technical equipment. The research question addressed here is therefore: What is the potential for municipal partnerships in water reuse, and how can they be designed and implemented to improve capacity development for water reuse in the Namibian context? The research seeks to contribute to research on water (reuse) governance by (1) specifying types of capacity needs for reuse governance in Northern Namibia, and (2) deriving lessons learnt for implementation of wastewater treatment plant partnerships (wwtpps) in support of capacity development and governance.

Conceptual framework

The conceptual framework of our research draws on three main concepts, namely (a) meta-governance, (b) informal networks and municipal cooperation, and (c) learning in adaptive water governance. We consider these concepts cornerstones in a governance framework supporting the social-ecological transformation of water systems toward sustainability (Hummel et al., 2017). Here the innovation of a water reuse concept is taken as an example of a social-ecological transformation in the water sector.

Water governance can be understood as a societal function regulating the management, flow and distribution of water in social-ecological systems (Pahl-Wostl, 2019), given the dynamics and uncertainties of social-ecological interactions around water, the concept of adaptive governance has gained grounds to describe the ability of governance approaches to adjust to change (Koontz et al., 2015). Water governance research has increasingly emphasized the complexity and plurality of what can be described as "modes" of governance (Pahl-Wostl, 2019). For instance, different norms from international conventions, statutory law and traditional law may intersect in "legal pluralism" (see for instance Boelens, 2009). Accordingly, water governance is often shaped by different entities that are not related in a hierarchical order but rather stem from different organizational systems (polycentrism), and that operate at different scales (multi-level governance) (Koontz et al., 2015; Pahl-Wostl, 2019). While polycentrism and multi-level governance conceptualize the complexity and plurality of water governance, research on understanding the interlinkages between modes of governance remains limited. Drawing on the distinction of hierarchy, network and market systems as modes of governance, Pahl-Wostl (2019) has compared water governance arrangements in multiple cases across the globe. She has identified both a need for, and a general lack of a mediating governance mode steering the interaction of these three modes of governance; she calls this "meta-governance".

Especially where governmental capacities are low, bottom up strategies may compensate lack of coordination among different modes of governance (meta-governance). Different institutional and socio-technical arrangements in water governance shape everyday water governance. Local stakeholders may for instance take a leading role in contesting prevailing governance modes and establishing cooperative modes in a rather informal way (Cleaver and Whaley, 2018; Kemerink-Seyoum et al., 2019). Formalized contractual collaborations among public or between public and non-profit entities in the water sector may be designed to improve infrastructure, water delivery services or develop capacities in local governments (Boag and McDonald, 2010; Sanz, 2013). However, a supportive environment is needed in order to (a) avoid the undermining of network governance and partnerships by higher level powers, and (b) ensure that priorities set in informal networks do not run counter to legal provisions in pursuit of meeting the SDG 6 targets (Pahl-Wostl, 2019).

Learning and governmental capacities are key factors for enabling a supportive meta-governance. Learning in institutions can take multiple forms from technical learning to social learning and transformative co-production of knowledge. For adaptive water governance in particular, these different forms of learning are key. While formal learning in fixed institutions tends to replicate routines and focus on technical capacity development, flexible networks where diverse actors can move in and out of processes of knowledge co-production facilitate adaptive governance (Pelling et al., 2008; Bos and Brown, 2012; Pahl-Wostl et al., 2013; Koontz et al., 2015). At the same time, technical learning is an important element of adaptive water governance (Bos and Brown, 2012) that is particularly relevant in the context of infrastructure innovations such as water reuse. Learning in water governance furthermore requires a supportive, experimental and reflexive governance context that enables bringing together multiple forms of knowledge (Bos and Brown, 2012; van der Molen, 2018).

Research design and method

In order to address the research question, we conducted a generic analysis of the emergence and performance of a wastewater treatment plant partnership (wwtpp) in Northern Namibia. The case is one where capacity development in wastewater management is urgently needed, given the challenging social-ecological conditions that are particular to Central Northern Namibia. Here a wwtpp has been set up within a transdisciplinary research project on water reuse. The formation and establishment of the wwtpp unfolded concomitant to the construction of a pilot site for the technical treatment of municipal wastewaters at a WSP for water reuse in Outapi. The pilot site consists of water treatment facilities, the pre-existing wastewater ponds, as well as a plot for plant and irrigation experiments. On-site research involved technical experiments and continued measurements by engineers and scientists in close collaboration with Outapi town council. The transdisciplinary research partnership is a continuation of longstanding collaboration on water reuse (Zimmermann et al., 2015, 2019).

The establishment of a partnership for wastewater treatment among neighboring municipalities and regional authorities in Northern Namibia was part of a transdisciplinary research project using an approach inspired by so-called real-world laboratories. Real-world interventions are the core of real-world laboratories and are framed by co-design, co-production and co-evaluation. The three steps are in a flexible order and usually repeated several times (Wanner et al., 2018). Real world laboratories bear similarities with 'living lab' initiatives which—particularly in the African context—place an emphasis on facilitating learning (Hooli et al., 2016). The real world laboratory approach was operationalized in the EPoNa project by developing and piloting both the improved WSP system in Outapi and the wwtpp in close cooperation with the town council. The continuous exchange of scientific and practical knowledge among the authors as well as with decision-makers and technicians overlooking WSP in the case study area complemented this methodological approach. Figure 1 shows the improved WSP system and set up of different treatment steps for research purposes in form of a flow chart. Construction of the system began in 2017. However, the technical component of the wastewater treatment plant and resource recovery technology is not scope of this research paper and has been presented in detail by one of the authors and further members of the EpoNa project consortium elsewhere (Lackner et al., 2017; Zimmermann et al., 2021).

In a genealogical analysis of the wwtpp's formation, inner and outer perspectives are combined by looking at the partnership formed in Namibia based on project documents (protocols of meetings and site visits to WSP), field notes from the transdisciplinary research process, and semi-structured interviews with key stakeholders and experts ($N = 24$). In the initial phase, one of the authors visited several municipalities in order get an overview on their situations and challenges. His reports served as a basis for identification of potential benefits of the wwtpp.

Three principles for measuring collaborative governance success (see Silva et al., 2018) guided the analysis of the wwtpp's emergence, namely drivers for collaboration, scope of cooperation (motives, for instance economies of scale) and nature of institutional structures (namely degree of formality/integration). The question "What are the capacity needs?" was addressed in the first two meetings of the wwtpp as well as in interviews and site visits by the transdisciplinary research team. Topics and formats of knowledge exchange were identified and addressed in continued exchange between the authors of the paper, the wwtpp members, further participants at the workshops, and other members of the research consortium. Reflections on the learning process were collected in interviews. The potential of a wwtpp for strengthening capacities for water reuse through collaborative governance was assessed through a combined analysis of meeting minutes, field notes and interview material on the effectiveness of the wwtpp. Key lessons learned were derived from the combined analysis of the wwtpp's emergence, capacity development and collaborative governance potential.

Background to the case

Treatment of wastewater is gaining municipal attention in Northern Namibia as the environmental costs of discharging water untreated are rising and new regulations enforced. The southern African Water Act 54 from 1956 (Republic of South Africa, 1956) was the first policy to mandate purification of wastewater and other effluents from industrial water use. Based on the "need to reform" Namibia's water policy, the National Water Policy White Paper (Ministry of Agriculture, Water and Rural Development, 2000) advises the country to "adopt a systematic approach to water resources management, using an integrated, multisector framework that considers issues of decentralization, social equity, ecological protection, and economic growth". As a reaction, a new Water Act was published in 2004. It declares that disposal of effluent requires permission from state authorities, as a measure to protect existing water resources (Government Gazette of the Republic of Namibia, 2004). Due to trending changes in water resources management, the newest reform of the Water Resources Management Act fosters integrated water resource management approaches by including conservation measures as water infrastructure, promoting participation and devolution of decision-making on water to the lowest levels of government. Operating systems for wastewater discharge are to be provided by local authorities and water services providers (Government Gazette of the Republic of Namibia, 2013).

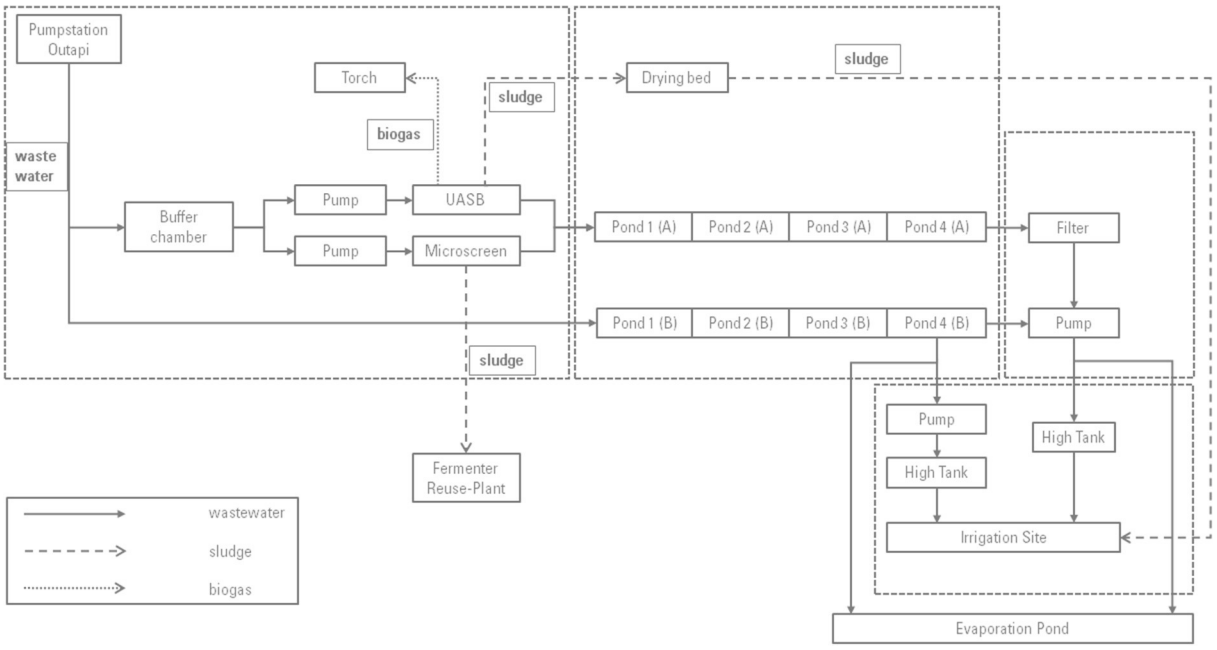

FIGURE 1
Flow chart of the improved waste stabilization pond system. Own design based on Sinn et al. (2019).

Results

In the following sections we present the characteristics of the wwtpp established in Central Northern Namibia, needs and processes of capacity development in the partnership, and its role in relation to meta-governance in the water sector in the region. We discuss the relation of informal and formal moments in the partnership, the role of knowledge co-production in capacity development and the potential of the partnership in enhancing meta-governance in the water sector.

Establishing an informal partnership for municipal water governance in Central Northern Namibia

The establishment of the wwtpp is best understood against the background of the drivers that led to its formation, its scope, and its organizational structure.

Drivers for and scope of setting up a partnership

The special challenges in wastewater management in northern Namibia are exacerbated by limited capacities at municipal authority levels. The rapid growth of the population—as in many other African small and medium-sized towns—quickly leads to overloading of the wastewater treatment facilities, which are often implemented as WSP. Perennial overflowing of the ponds is a consequence of their overloading, with serious impacts on environmental health as untreated waters enter ecosystems and livestock drinks from it (Figure 2). In many cases, the municipalities are unable to cope with the combination of urbanization effects and climate-related events such as heavy rainfall. What comes on top is the low availability of water in the arid region, combined with the absence of rivers or tributaries. Here wastewater could be an important resource for producing water for irrigation agriculture, e.g., for animal fodder production, while at the same time using nutrients.

The WSP in the Cuvelai-Etosha Basin are exemplary for numerous WSP of many African municipalities. Problems such as overloading and inadequate management lead to the fact that their discharge quality is only marginally better than the inflow quality. One goal of the research project[3] was to support the development of solutions such as water reuse in fodder production through capacity development and strengthening governance structures in inter-municipal cooperation. This is because the limited capacity in local authorities for dealing with these challenges is linked to insufficient availability of resources and skills. Through cooperation, resources could be used more efficiently and competencies built up. Against this background, a wwtpp was established in northern Namibia as part of the research project EPoNa.

The overall objective of the wwtpp is to address challenges in wastewater management through capacity development. The network intends to facilitate the exchange of information and

3 EPoNa stands for Enhancement of Ponds in North-Central Namibia.

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FIGURE 2
Overflowing of untreated wastewater from a Waste Stabilization Pond (WSP) in Eenhana municipality in 2018. Photo: Fanny Frick-Trzebitzky.

experience with regard to questions of strategic decisions in water management, operation and maintenance as well as the procurement of materials and spare parts. In addition, it provides a platform for possible mergers of operators for the joint operation of plants in the region, in special-purpose associations or other forms of municipal cooperation.

Organizational structure and type of partnership

The wwtpp was increasingly formalized over time, as summarized in Figure 3. The first committee of the wwtpp was appointed at the 4th workshop in October 2018. As of 2019, the wwtpp consists of a core of five municipalities and one village that form the steering committee (Outapi, Okahao, Oshikuku, Eenhana, Ruacana, Tsandi). These organize regular meetings for intercommunal exchange on the management of wastewater and WSP and send out invitations. In addition, other municipalities, villages and regional councils participate in the network's meetings.

Due to the efforts of the large cities in northern Namibia to construct conventional wastewater treatment plants in the medium term, the focus of the wwtpp continues to be on medium-sized towns as well as villages and settlements, represented by the Regional Councils. According to the typology of public-public partnerships proposed by Boag and McDonald (2010), the wwtpp is an intra-state public authority-public authority partnership in a weakly formalized form.

Table 1 summarizes key characteristics of the wwtpp regarding drivers, scope and institutional structures.

Informal or semi-formal?

The initiation of the partnership is a response to the dynamic changes in land and water use in Central northern Namibia that are putting municipal water management systems under great pressure, exacerbated by climate and demographic change. Established in the context of a living lab on water reuse, it forms part of an experimental approach to adaptive water governance. Initiated by municipal actors and researchers as an informal network, the wwtpp does not fall clearly under either of the categories "bottom up, informal" (Pahl-Wostl, 2019), "everyday tinkering" (Kemerink-Seyoum et al., 2019) or "contractual collaboration" (Boag and McDonald, 2010). Our conceptualization of semi-formal networks proves helpful in understanding the wwtpp as an evolving network that is partly formalized and may take on different forms in the future.

Capacity development

Capacity development in the wwtpp was addressed by identifying capacity needs, developing respective contents and formats of learning and assessing processes of knowledge co-production in the course of these formats.

Capacity needs

The participating municipalities in the Namibian wwtpp face similar challenges and needs for capacity development, which were identified at the first meeting initiated by the research project in 2017. In particular the lack of cost controlling in the budgets of the municipalities, the overloading and poor operation of the existing WSP and treatment plants, vandalism at the plants, the lack of budget for reinvestments, as well as the improper emptying of private septic tanks by service providers are common challenges. They contribute to the fact that WSP are insufficiently maintained and cleaned, and consequently regularly overflow. In the wwtpp, municipalities address these challenges by holding meetings (in workshop format) on specific issues.

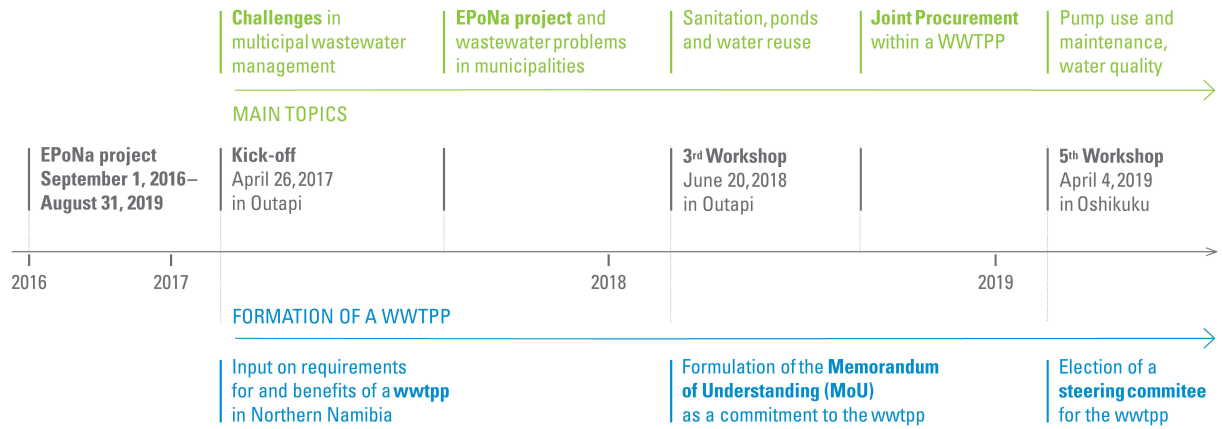

FIGURE 3
Main topics addressed and formalization of the wastewater treatment plant partnership (wwtpp) in Central Northern Namibia.

We have identified the following challenges in the site visits to WSP in the study region in 2017[4] and subsequent discussions in the partnership[5]:

Firstly, general financing problems and insufficient maintenance lead to mismanagement and eventually overflowing of WSP. On average, less than half of the population is connected to municipal wastewater systems. Household costs for wastewater infrastructure and services are a barrier to wider coverage. However, municipalities struggle with lowering the fees as there is no governmental budget to support maintenance of the treatment plants, which would enhance their longevity and capacity.

Secondly, a lack of capacity development and specialized training furthermore lead to mismanagement of the WSP and puts a further constraint on budgeting. In some municipalities, for instance, covering costs for staff trainings burdens the same financial pool as maintenance of the treatment system. Mismanagement of WSP in form of omissions to desilt ponds contributes to blocking of pumps and overflowing, especially in the rainy season.

Thirdly, many citizens are reportedly not aware about what not to dispose through the wastewater systems, nor about reuse potential of treated wastewater. Plastic waste and hygiene articles accumulate in pipes and WSP. Other inflows that affect the water quality are detergents from car wash and fat from restaurants. Reuse of the treated wastewater is difficult to realize in the municipalities, mainly because decision-makers and technicians consider cultural views, societal disapproval and insufficient water quality as hindering factors.

Learning

By combining input from experts and topic-related exchange at eye level, the wwtpp enables learning and creates opportunities for collaboration. At the second meeting, for example, the dimensioning of WSP, a lack of technical know-how in the municipal administrations, problems with pumps and spare parts as well as reuse potentials were discussed. At the third workshop, water reuse and the technical handling of WSP were key topics discussed and illustrated at a visit to the EPoNa pilot plant for wastewater treatment and reuse in feed production. The central theme of the fourth meeting was public and municipal procurement and tendering. The Head of the Procurement Unit of the Namibian Ministry of Finance gave a presentation and was available for questions and discussion. In particular, the options, potentials and prerequisites for joint tenders and contract awards in the wwtpp were identified.

At the fifth meeting, participants discussed questions about spare parts and tools for pumps (e.g., can these be used jointly by neighboring municipalities?), pumping stations (e.g., where are the weak points and how can the regional municipalities support each other?), purchasing and tenders (e.g., what are the advantages of joint tendering for maintenance services?) as well as education and training (e.g., how can corresponding requirements be covered jointly?). Another topic was water quality with regard to wastewater treatment and quality standards for irrigation and drinking water. The input and subsequent discussion addressed the differentiation between different water qualities and associated uses as well as technical, financial and institutional aspects of water use. In subsequent discussion groups, the hurdles and potentials of water reuse were the main topic.

Interviewees state effects of mutual learning and knowledge exchange: "because [the wwtpp] creates a networking platform. We can always assist each other, and we can learn from best

4 The field notes were documented in the form of unpublished operational reports Stegemann (2017).

5 See minutes of the wwtpp's meetings ISOE—Institut für sozial-ökologische Forschung (2017a,b, 2018a,b, 2019).

TABLE 1 Drivers, scopes and institutional structures of wwtpp.

	Characteristics of the wwtpp in central northern Namibia
Incentives/drivers for partnering	Enhanced environmental and public health risk from insufficiently managed wastewater in context of limited capacity at municipal level and dynamic population growth
Scope	Capacity: Enhancing technical, operational and strategic management capacities in municipalities Financial: Joint procurement envisioned; potential for reducing municipal costs by appointing consultants and contractors jointly identified but not yet implemented Socio-political: enhancing bargaining power Infrastructure: improved maintenance and efficiency of WSP and pumps through sharing of technical resources
Nature of institutional structures (Partnership type)	Network of local and regional authorities initially coordinated by research partners; external expert inputs

practices from others and probably emulate the best practices in our own town." (wwtpp member Mr. R.,[6]). They furthermore stress the relevance of capacity development based on expert input: "I think what we need is, as I indicated, a partnership. Once we got a partnership in place, the whole concept will come in from the technical point of view. (…) currently, what I belief we need, is experts or expertise from some areas. The structure which I think is going to work, is that the stakeholders who have to get involved with us, they need to learn from EPoNa and also from other stakeholders, just to have expertise, who are able to inform us (…)" (wwtpp member Mr. S.).

Table 2 summarizes key characteristics of the wwtpp regarding formats and topics of knowledge exchange.

Involving stakeholders for capacity development

Bringing together diverse actors involved in water governance in the case study area at the partnership's workshop enabled social learning in constellations unlikely to be addressed in formal formats (e.g., technicians and CEOs). While partners of the network appreciated this dimension, needs for technical expertise were also high on the agenda (see quote above and list of identified capacity needs). Treating specific technical questions, however, raises questions on whose knowledge to

6 All initials have been changed to maintain anonymity.

TABLE 2 Topics and formats of knowledge exchange.

	Characteristics of the wwtpp in central northern Namibia
Formats of knowledge exchange	Semi-formal meetings (workshops) with expert input and more informal peer-to-peer learning in group discussions
Topics	operational and strategic management topics, e.g., water reuse, joint procurement, pump maintenance and water quality

integrate. Here only those topics were addressed at workshops that a variety of actors could relate to. In particularly at the fourth workshop under the theme of joint procurement several key actors (namely: councilors and financial managers of the collaborating municipalities) were absent and technicians present who could not relate well to the topic discussed. This indicates a potential difficulty in managing a flexible network without losing commitment. It may also hint to a need for strengthening integrative governance capacities (van der Molen, 2018) in municipalities, and for further knowledge-exchange on the multitude of knowledge and competencies needed in adaptive water governance.

Governance capacities

The partnership created in form of the wwtpp established a semi-formal arrangement for governing municipal waters parallel to more hierarchical state authorities and structures. It potentially compensates lacks in meta-governance. At the same time, political interests may also hinder stability and effectiveness of the partnership.

Enhancing negotiation power

Interviewees stress the potential benefit of economies of scale and of enhancing negotiation power of the wwtpp: "when you go as an individual town it won't be heard, but if you come with more towns who have the same conditions and the same problems, the government might listen and fund us. (…) I think when all the towns go to the government with one voice, with one proposal and request of funds to overcome this problem, I think it would work." (wwtpp member Mr. H.). However, during the process, structural limitations to capacity development at municipal level become visible in the course of network establishment. Most importantly, the institutional context of devolution of responsibility for municipal wastewater management in North Central Namibia, where most municipalities and their

governments have only existed for <2 decades, has led to outsourcing of all major planning steps from initial design to technical maintenance. In this context of dependency on consultants, options and opportunities for sharing costs by exchanging tools and machines are barely visible to municipal decision-makers. Further stock-taking and situational analyses are needed to start collaborating on specific technical items and associated tendering. Moreover, council members increasingly raised the issue of political backing needed for a meaningful commitment to the wwtpp. This will involve broad awareness raising in the wider public, as well as among local politicians.

Potential of partnerships under weak meta-governance

The dependency of collaboration in the wwtpp on political support reveals a weakness in government capacities in the hierarchical mode: Here the devolution of competencies under the umbrella of decentralization without respective budget authority appears to create a lock-in. Local authorities are hardly able to establish and maintain water management systems based on the capacities they have. Pertaining to the network governance mode, the wwtpp may serve to compensate deficiencies in the hierarchical mode, for instance by joining resources and enhancing negotiation power, as outlined above. Given its flexible structure and openness to involve higher level authority stakeholders, it potentially also supports a stronger meta-governance of water. In its current mode, this potential is however highly dependent on political backing currently not in place.

Discussion

Key lessons learnt

The potential of wwtpp for capacity development in water reuse lies in the immediacy and flexibility of knowledge exchange and sharing of capacities. Topics addressed at wwtpp meetings ranged from basic technical know-how on the maintenance of pumps, procurement options in financing infrastructure and related services to strategic decisions on water management, namely introducing water reuse as a response to pressing challenges in both water supply and environmental health. An MoU served to formalize and institutionalize participation of various stakeholders and their engagement in dialogues, facilitating knowledge and capacity development as well as creating awareness for the topic beyond the networks. A great potential of wwtpps lies in creating synergies by sharing costs for instance for investment in technical items (e.g., spare parts, machinery) and services, such as consultation of engineers. This flexibility in addressing knowledge gaps as they show to be relevant (needs-based) characterizes the case. It appears particularly appropriate for creating capacity in water reuse, given the limited knowledge on reuse and its governance at the hands of decision makers, operators and technicians.

Differences in knowledge and perceptions became evident between technicians, managers, environmental health officers, amongst others; hence, establishing shared knowledge on water reuse is both a potential and a challenge in the current wwtpp. A positive perception of reuse amongst politicians and wider public was identified as crucial, because they are key stakeholders in budget relevant decisions on how current capacity needs in the water sector are addressed. All of these actors' perceptions are needed for system transformation toward water reuse. The wwtpp has the potential for change in attitudes toward reuse and putting it on the political agenda. However, its existence is at the same time dependent on wider political interests.

The experiences from Namibia have moreover revealed core issues in the design and implementation of wwtpps. There was, first, the consolidation of the network, which required a certain formalization. The clear designation of roles and tasks within the network in the Memorandum of Understanding proved to be an important factor in obtaining an explicit declaration of membership by local administrations (especially the steering committee). The latter is important to ensure the organization of events and related expenses. Thus, the informal exchange is still an important element at the meetings, but the basic structure—contrary to the original conception—has a comparatively formal character. Secondly, a remaining challenge is the networking and organization of the steering committee beyond the meetings. Here it is necessary to develop new routines and lived practices.

Thirdly, it became increasingly apparent that the high dependency of the administrations on external consultants in the planning, procurement and maintenance of WSP impeded the exchange of experience at the technical level: at times, the participants lacked detailed knowledge, for example to specify possibilities for the exchange of technical resources. This shows two things: firstly, that it is reasonable to limit the group of participants to certain functions in order to further deepen the knowledge on individual topics in the wwtpp, and secondly, that there is still a great need to build up competences within the municipalities, which cannot be covered from within the network. With the development of the wwtpp, a format has been created here to enable, for example, training across municipalities.

In sum, the following factors for setting up wwtpps for capacity development can be derived.

Adjusting institutional structures to context specific requirements: The case shows that the degree of formalization and the interaction of more and less formal structures need to be in line with requirements for uncomplicated exchange

of information and participation of relevant stakeholders. Here formalization was a prerequisite to ensure for instance coverage of travel costs.

Maintaining flexibility in formats and topics: As topics emerge in discussions, the need for specific formats of collaboration and knowledge exchange ought to be adjusted. In Namibia, a continued need for expert input on technological know-how was identified by participants.

Matching topics and participants: While initial workshops addressed multiple stakeholders from operational to managing/CEO levels, it soon became clear that peer-to-peer exchange on specific topics (such as maintenance of pumps; joint procurement; introduction of water reuse) requires a selection of participants according to functional group and everyday working environment. Being aware of financial implications of any measure discussed and involving respective stakeholders, however, is a cross-cutting issue.

Principle of proximity: Ensuring manageable travel distances for meetings enhances chances of continued commitment and interaction.

Regular meetings: Because the knowledge exchange is based on personal interaction, meetings need to be held regularly; the rotation of host enhances commitment, ownership of the partnership and spreads the burden of organizational duties.

Political backing: The support by political decision-makers (town and regional councilors) is key to enable changes in management, and to maintain activities in the wwtpp especially given the costs and personnel involved.

Municipal partnerships as a contribution to capacity development in water governance

Establishing a pilot treatment and reuse system at the WSP in Outapi was a core component of the Epona project that demonstrated the effectiveness of reducing environmental health risks (i.e., the level of pathogens in water discharge from WSP and reducing freshwater demand by reusing water in agriculture.). Based on the assessment of E.coli, pathogen reduction was considerable (Mohr et al., 2020). The project results on this technical innovation and its impacts on society and nature have been published elsewhere (Zimmermann and Neu, 2022) and did not form part of the present analysis. However, they underline the potential of developing capacity in water reuse at municipal levels for sustainable water governance. The anticipation of these results were furthermore a core motivation of municipalities' stakeholders to join the partnership. In the remainder of this section, we discuss the core findings on establishing a municipal partnership as a contribution to capacity development in water governance, focusing on municipal water reuse.

Our research has shown that great potential lies in the sharing of costs and equipment through the partnerships. Challenges in implementing capacity development through wwtpp, however, emerged in relation to the calculation of costs and benefits of reusing water. In an alternative calculation of sanitation costs investment in water reuse systems is to be assessed against the avoided environmental health costs for discharging untreated wastewater in an arid area (Di Mario et al., 2018). This involves novel forms of collaborations within and across municipal authorities. However, municipalities rely on the expertise and technological skills of consultants in managing wastewater, and any investment in wastewater management (including in capacity development) is dependent on political interest, given the tight budgets municipalities have.

Outsourcing of public responsibilities in provision of services (here: wastewater treatment and sanitation) has led to outsourcing of both technology and know-how, reinforcing low levels of institutional capacity within the municipalities, and creating dependency on external consultants. Consultants tend to continue the tradition of sectoral knowledge development. Here the case findings substantiate the claim by (Muller, 2018) whereby (international) large consultancies and specialized firms tend to act as knowledge gatekeepers, diminishing local government capacities, a process he terms "recolonization" in the South African water sector. The wwtpp has the potential to counter these structures and promote local level leadership through joint procurement for consultancy services and training, as was identified on the fourth meeting of the wwtpp in Namibia.

The process of implementing a wwtpp in Northern Namibia has revealed specific requirements for the design of a municipal partnership for capacity development, above all the need for formalization of the partnership at an early stage. This mirrors literature on adaptive governance whereby a federal governance frame enables greater flexibility at lower levels of decision-making, whereas a more centralized, hierarchical governance frame (as here in Namibia) calls for more rigid structures at lower levels (Koontz et al., 2015). Intersections with authoritative modes of governance (Pahl-Wostl, 2019) appear to be crucial to the performance of wwtpps, especially as municipalities' and individuals' commitment to participate is dependent on higher level budget decisions. The case suggests that an MoU can embed a municipal partnership as part of a hybrid water governance style (Pahl-Wostl, 2019) and contribute to government backing of capacity development for water reuse (Di Mario et al., 2018). In the present case, this was particularly relevant as municipalities' and individuals' commitment to participate is dependent on higher level budget decisions.

In sum, the experiences from the EPoNa project show an urgent need for creating synergies in capacity development among municipalities that a wwtpp may serve to address. The partnership established created a space for both formal and informal mutual learning. We have identified a great potential for developing and strengthening capacities and reducing municipal costs for wastewater treatment, in particular when combined with technical innovations, such as here a treatment system for water reuse in agriculture. How this potential of the wwtpp can be used will depend on the long-term commitment of town councils to work in partnership for which political backing is key (see also: Beveridge et al., 2017; Muller, 2018).

Conclusion

Our analysis of a newly established informal public partnership on wastewater treatment and reuse (wwtpp) has revealed the potential of municipal partnerships to facilitate capacity development in managing municipal water and sanitation, here by reusing water in agriculture. In transdisciplinary workshop settings we exposed core topics for capacity development, namely: general financing problems and insufficient maintenance that lead to mismanagement and eventually overflowing of WSP, specialized training on management of WSP, and public awareness about what not to dispose through the wastewater systems, as well as about reuse potential of treated wastewater. The capacity needs identified show the culmination of deficiencies in wastewater infrastructure (here: WSP) and its management, rising water demands and sanitation needs in environmental health concerns. In particular the need for more holistic comprehension of wastewater management as part of a vulnerable (urban) water and sanitation system (Bahri, 2009) became apparent in the collection of core challenges in wastewater management in the partnering municipalities. The wwtpp provided a platform for deepening respective knowledge, predominantly through expert inputs from the EPoNa project. It moreover spurred discussion over strategic decisions in water management to overcome current environmental risks resulting from exploitation of freshwater resources and overflowing of WSP. Overall, we identified six key factors to bear in mind when designing a wwtpp for capacity development. These are (1) context-specific institutional set-up, (2) flexibility in formats and topics, (3) matching topics and participants, (4) principle of proximity, (5) regular meetings, and (6) political backing.

To conclude, the research presented expands existing research on water reuse governance on three levels.

(1) On a practice-oriented level, the analysis of the wwtpp has shown that municipal collaboration not only serves to share and disseminate new knowledge effectively. More importantly, the format of wwtpps allows new knowledge to emerge, and for knowledge needs to be identified and addressed immediately. This appears to support social-ecological transformation of municipal water management toward sustainable solutions. A flexible structure of the partnerships is helpful; at the same time, conditions for participation must be clear. Wwtpps moreover have the potential for disrupting disempowering structures (here: dependency on consultants) by generating enhanced capacity for negotiation and alternative financing through partnerships, and by reducing the reliance on external expert knowledge. Political interests and power structures deserve continued attention in future research and implementation of similar arrangements. Future evaluations of the pilot's effectiveness in improving sanitation and contributing to water use efficiency will potentially foster political support for reusing water.

(2) The research presented contributes to a more differentiated understanding of 'implementation barriers' in the water reuse governance debate, primarily by distinguishing between the perceptions and knowledge of researchers, technicians, engineers, consultants, and politicians, in a more differentiated perspective on "awareness". Closing the "implementation gap" involves opening up processes of knowledge production, and re-conceptualizing the process of "implementation" in water reuse debates—moving beyond need for awareness raising and knowledge transfer toward knowledge integration and learning across sectors and levels.

(3) Our findings on capacity development in water reuse governance furthermore add to the field of sustainable water governance more widely. We have demonstrated the potential of such partnerships to compensate for gaps in integration across levels and sectors (meta-governance; Pahl-Wostl, 2019), especially where coordination at regional and national levels is weak. In the case analyzed, the legacy of poor capacity development and limited resources in municipal water management involves a strong reliance on external consultants and political will for implementing transformational change in managing municipal waters. Here or findings raise important questions on dealing with power relations in knowledge production for adaptive governance.

As van der Molen (2018) argues, "building well-informed environmental governance arrangements is not just a matter of managing the interfaces between knowledge and governance; it is also a matter of capacity-building in order to enable the reflexivity of governance arrangements." (p. 24). While the partnership performed as a forum for flexible knowledge exchange and learning in peer to peer,

science experts to practitioners, and policy-makers to policy-implementers constellations, the decisive role of consultants and political decision makers may counteract learning toward transformational change. Demonstrating the potential of technical innovations in the field in a pilot project was a core element in the wwtpp analyzed here. It was central to exposing technical capacity needs and path-dependencies in the distribution of technical know-how (and respective gaps) among key actors. Against this background, incorporating and integrating technical innovations in capacity development not only in local partnerships but across levels and modes of governance is central to actuate capacities along the meta-governance framework. Future research should engage further with the roles of consultancy and political decision-making in order to identify further pathways toward sustainability transformations in municipal water governance.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Institute of Social-Ecological Research (ISOE)'s Ethical Board, ISOE. The patients/participants provided their written informed consent to participate in this study.

Author contributions

Research conception: MZ, TK, and FF–T. Writing: FF–T. Supervision, project administration, and funding acquisition: MZ. Data collection and analysis: All authors.

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Conflict of interest

SS was employed by Emschergenossenschaft.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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