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Enhancing institutional capacity in a centralized state

The case of industrial water use efficiency in Vietnam

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Abstract

This article uses an institutional capacity framework to assess the interplay between the macro level institutional environment in the form of the centralized Vietnamese state, and the meso level institutional capacity of three different industrial zones to develop technological water use efficiency strategies. Our results show that the relational, knowledge, and mobilization capacities of these industrial zones are constrained by the centralized nature of the Vietnamese state. These industrial zones also show a limited capacity to instigate reform of macro level regulatory institutions. However, we also find instances where industrial zones do demonstrate capacity for implementing water use efficiency technologies because of their capacity to coordinate relations with client firms, universities, and provincial industrial zone authorities. If the institutional capacities of industrial zones are better supported, we argue there remains room for them to influence the macro institutional context to support innovation in water use efficiency. Our results indicate the value of institutional capacity as a framework for assessing processes of technical innovation for industrial ecology, especially in the context of centralized states.

KEYWORDS
governance, industrial ecology, innovation, institutional capacity, Vietnam, water use efficiency

1 | INTRODUCTION

By 2025, industrial zones in Vietnam are estimated to make up 10% of total annual surface and ground water use (Agudelo-Vera et al., 2012; GhaffarianHoseini et al., 2016). At the same time, Vietnam is facing increased rates of surface water pollution and saline intrusion, as well as restrictions on ground water use designed to reduce the risk of subsidence (Ha et al., 2018; MONRE, 2010; Ngo et al., 2015). As a result, industrial zones increasingly compete for water with growing urban populations and the agriculture sector (Giuliani et al., 2019; Ray & Shaw, 2019). To ensure such competition does not lead to the further degradation of surface and ground water, technological innovation to enhance water use efficiency has been prioritized by the Vietnamese government to meet future industrial water demand (Vo, 2007).

Three strategies of technological innovation for water use efficiency show promise for Vietnamese industrial zones (Agudelo-Vera et al., 2012; Leusbrock et al., 2015; Levidow et al., 2016): (1) demand minimization through efficient "end-of-pipe" technologies (Ozturk et al., 2016); (2) "cascading" reclaimed water flows for low quality reuse (Agudelo-Vera et al., 2012; Luckmann et al., 2016); and (3) multi-sourcing from primary ground or surface water sources and secondary water sources such as rain water (Agudelo-Vera et al., 2012; GhaffarianHoseini et al., 2016). These

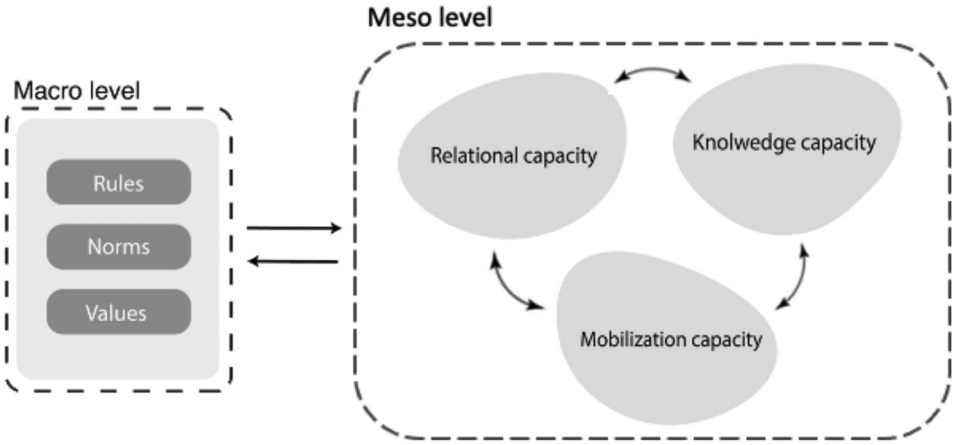

FIGURE 1 The interplay between macro level institutions and meso level institutional capacity

technologically driven strategies are linked to the wider principles of industrial ecology and symbiosis, aimed at enhancing circular resource flows in the processing and manufacturing sectors through cooperative strategies that enable by-product exchange and utility sharing for resource efficiency (Jiao & Boons, 2017; Mol & Dieu, 2006; Spekkink, 2013). Collaboration within and between industries is important to manage environmental and resource issues, for example, water, energy, materials, through industrial symbiosis and industrial ecology (Baldassarre et al., 2019).

Following Boons and Spekkink (2012) and Wang et al. (2017), the extent to which technological strategies for water use efficiency are identified and implemented also depends in part on the *institutional capacity* of key actors such as industrial zones; defined as the ability of private or public actors to work through an existing system of rules, norms, and values to achieve a specified goal (Fuentes & Borreguero, 2018; Johansson et al., 2017; Willems & Baumert, 2003). In particular, meso or organizational level institutional capacities (Willems & Baumert, 2003) are considered key for acquiring resources, accessing knowledge for improving water management techniques, and developing the relations necessary for establishing collective water management strategies (Boons & Spekkink, 2012; Healey et al., 2003; Wang et al., 2017; Wickham et al., 2009).

Successful implementation of technological innovation, however, is also dependent on "macro" national level institutions (Willems & Baumert, 2003) as these rules, norms, and values shape learning, trust ,and collaboration between government, industrial zones, and their client firms (Boons et al., 2017; Chertow, 2007; Gibbs, 2003; Willems & Baumert, 2003). Research on institutional capacity often assumes that industrial ecology policies, such as water use efficiency, fosters and/or positively reinforces relationships between government and industrial zones (Boons & Spekkink, 2012; Wang et al., 2017). While there is evidence that such reinforcement is possible, it is not clear whether this is the case under all political systems—including centralized states, such as Vietnam, with centralized planning and management and hierarchical decision-making and regulation (Garschagen, 2016; Phuong et al., 2018). It is also not clear how the macro institutional environment of centralized states affects the meso level institutional capacity of industrial zones to forge relationships, gain access and expand knowledge, and mobilize other actors, including the government, to support the development and implementation of water use efficiency strategies.

In this article, we explore the interplay between macro level institutions and meso level institutional capacity in Vietnam to understand the conditions under which industrial water symbiosis can emerge. We do so by employing an institutional capacity framework (Dang et al., 2017; Wang et al., 2017) to assess the relational, knowledge, mobilization capacities of three industrial zones and to understand the ways in which this institutional capacity is affected by the hierarchical regulatory and political structure of the centralized Vietnamese state (Boons & Spekkink, 2012).

The following section introduces our institutional capacity framework. We then introduce the methodology used for data collection and analysis before outlining the centralized governance system of Vietnam. We then present our main findings based on data collected from three industrial zones in southern Vietnam. Finally, we discuss the significance of our findings for enhancing industrial ecology and symbiosis in the context of centralized state governance.

2 | INSTITUTIONAL CAPACITY

Macro level institutions constitute the policies, rules, and norms that steer action, either by directly constraining or incentivizing actors to comply with these goals in the short term (Fuentes & Borreguero, 2018; Zhu, 2016), or, as illustrated in Figure 1, by indirectly shaping the capabilities of actors to resolve underlying constraints to comply with these goals and norms over the long term (Cohen-Rosenthal, 2000; Wang et al., 2017). Distinct from the short-term deontic logic underpinning technical compliance to prescriptive rules and norms (Ostrom & Basurto, 2011), systemic problem solving requires institutional capacities that enable the strategic development of collective resolution of complex issues, including knowledge development, material exchange, and utility sharing (Koop et al., 2017; Wang et al., 2017). This includes the ability of a meso level organization

to work through an existing system of rules, norms, and values to implement industrial ecology solutions such as water use efficiency by: (1) participating in decision-making and implementation (Abreu & Ceglia, 2018); (2) complying with governmental policies and regulations (Willems & Baumert, 2003), and/or (3) actively engaging individual or collaborative problem solving and innovation (Boons & Spekkink, 2012).

The three most commonly identified meso level institutional capacities are relational, knowledge, and mobilization capacity (Boons & Spekkink, 2012; Healey et al., 2003) (see Figure 1). These capacities should not be seen as a stock of assets, but instead represent "a force that is emergent, produced in the interactive context of its use" (Healey et al., 2003, p. 64). Relational capacity refers to the ways in which industrial zones affect trust and mutual understanding between themselves and other actors, including government, NGOs, and private firms (Healey et al., 2003; Wang et al., 2017). We assess relational capacity by determining the number and type of actors that industrial zones interact and engage with and the degree to which this engagement translates into support for water use innovation (Wang et al., 2017). We, in particular, examine the morphology of these networks, including the way in which industrial zones develop relations with key actors (Barry, 2012; Healey et al., 2003). We also study how these relations affect collaborative learning and innovation between networked actors. Building on the previous two variables, we explore how these relations foster trust and mutual understanding with actors in developing their water use efficiency strategies (Abreu & Ceglia, 2018).

Knowledge capacity refers to the ability of industrial zones to acquire the knowledge necessary for the adoption of water use efficiency strategies, including the limits and opportunities of how these strategies are able to reduce water use inefficiencies (Boons & Spekkink, 2012; Healey et al., 2003). We assess knowledge capacity by analyzing the ways in which industrial zones identify the type of knowledge necessary for adopting water use efficiency strategies (Barry, 2012; Wang et al., 2017). We then analyze the frames of references, which activities and relations industrial zones employ to access the required knowledge. Lastly, we explore how the extent knowledge is taken up and made accessible, how knowledge is being shared between industrial zones, their client companies as well as governmental actors, including the way in which these key actors are open to taking up new ideas on water use efficiency and learn from experimentation (Abreu & Ceglia, 2018; Healey et al., 2003).

Mobilization capacity assesses the ability of industrial zones to enhance and activate multiple actors to support collective goals like water use efficiency (Boons & Spekkink, 2012; Healey et al., 2003). We first examine the opportunity structures afforded to industrial zones to engage the government or non-government actors (including private universities and NGOs) to use existing rules, norms, and incentives to support the design and adoption of water use efficiency strategies (Boons & Spekkink, 2012). Following Wickham et al. (2009), this includes the extent to which the influence that industrial zones have over public policy and regulation translates into governmental regulation that support operational management decisions to improve water use efficiency. We also examine the extent to which industrial zones take advantage of these opportunity structures to either further opportunities for innovation or develop new opportunity structures that can incentivize client companies, donors, financiers, and NGOs to work toward the realization of collective resource use efficiency goals (Healey et al., 2003).

3 | METHODOLOGY

This study is part of the ENTIRE research project exploring options for optimizing industrial fresh water use in Vietnamese delta areas through technological-cum-institutional innovations (NWO, 2021). Our exploratory analysis is based on a multiple case study approach focusing on three industrial zones in Southern Vietnam: Hiep Phuoc industrial zone and Tan Thuan export processing zone in Ho Chi Minh City, and Long Hau industrial zone in Long An province. We adopt an exploratory case study methodology because it allows for in-depth analysis of a phenomenon and aims at analytical or conceptual generalization (Yin, 2009). Moreover, drawing on multiple case studies allows for a broader basis to develop conceptual insights. The industrial zones used for this analysis were selected in three workshops held prior to the start of the project (in July 2015, March 2016, and July 2017). Selection was based on discussions industrial zones that (1) face different water supply issues, (2) are interested in pursuing technological water efficiency strategies, (3) host different types of industries and sources of investment, (4) are located in different provinces, and (5) were willing to participate in the project (see Table 1).

Primary data was collected between 2015 and 2018 using three methods to allow data to be triangulated for internal consistency (Olsen, 2004; Yin, 2009). First, semi-structured interviews were held with 27 respondents from the three industrial zones and 13 actors representing both government and client companies. Respondents were selected through snow ball sampling; starting from an initial interview with the Saigon Water Company and the directors and vice-directors of the three industrial zone infrastructure companies. All respondents are people who are responsible for or knowledgeable about water use and management in these organizations. Second, observations were made during site visits and attendance at four policy-related meetings to contextualize our interview responses and ground truthing the status of infrastructure and discussions on water use efficiency policy and regulation (Kumar, 2014). Third, we sought out further evidence of water use efficiency strategies through a review of legal and policy documents sourced from the website of law library, websites from governmental departments, and industrial zones. All of these data were then analyzed based on a coding scheme aligned with the variables in our combined relational, knowledge, and mobilization capacity framework. Finally, a final workshop was organized in December 2018 to reflect on and validate information collected from the selected IZs.

TABLE 1 Key characteristics of the three sampled industrial zones

Key characteristic	Hiep Phuoc IZ	Long Hau IZ	Tan Thuan EPZ
Area of industrial zone	348 ha	246 ha	300 ha
Province	Ho Chi Minh	Long An	Ho Chi Minh
Main water issues	Salt water intrusion, raising water demand	Salt water intrusion, raising water demand, restriction on groundwater use	Salt water intrusion, raising water demand
Type of companies	Mechanics, electricity—electronics, rubber—plastics, food processing	Light, clean and un-polluted industry, high value-added industries, bio-tech industry, logistic, trading and services	Food processing, construction material (except cement and steel), logistic and ancillary industries
Number of enterprises (% of foreign investors)	117 (8% foreign investors)	158 (50% foreign investors)	199 (85% foreign investors)
Capacity of wastewater treatment plant	6000 m^3/day	5000 m^3/day	15,000 m^3/day
Water supply system	SAWACO supplies 45,000 m^3/day	Supplied by two water sources: (1) Long Hau underground water plan supplies 10,000 m^3/day and (2) Ho Chi Minh City water supply system supplies 15,000 m^3/day Long Hau IZ also supplies water for the surrounding resident	SAWACO supplies 30,000 m^3/day

4 | MACRO LEVEL INSTITUTIONAL SETTING

The regulatory and political macro level institutions in Vietnam are of a highly hierarchical and top-down nature. Decision-making in Vietnam is based on a system of centralized planning, regulation, and policy supported by judicial enforcement (Benedikter & Nguyen, 2018). Water use efficiency, including reuse and water saving, is governed by both national and provincial level legislation covering issues related to water volume and quality (see Table 2). These documents do not, however, stipulate water use efficiency strategies should be implemented, nor do they offer specific standards for industrial zones to follow as a target to develop these strategies (van Leeuwen et al., 2016). For example, the 2015 Environmental Protection Law sets water reuse and recycling priorities and stipulates the development of reuse and recycle technologies. However, the law provides limited guidance to industrial zones based on their changing water demands—and has not kept pace with the resource efficiency challenges brought about by the rapid expansion of industrial processes within these zones.

Other national policies and regulations (including Laws and Resolutions of National Assembly, Ordinances and Resolutions of National Assembly Standing Committee, Commands and Decisions of President, Decrees of government, Decisions of Prime Minister, and Circulars of a Minister) are "administratively" decentralized (KimDung et al., 2016a). As illustrated in Figure 2, this means that the national government decentralizes responsibility rather than decision-making power for the implementation, enforcement, and communication of various policy domains to the Provincial People's Council—the political branch of the provincial government.

The Ministry of Natural Resources and Environment (MONRE), for instance, is responsible for water management and counsels the central government on water management policy. Their remit extends to devolving responsibility for environmental management to industrial and economic zones (Decree No. 29/2008/ND-CP). The Provincial People's Council then has the power to decide on policies and measures to encourage technical development for environmental improvement, but has to remain within the boundaries set by the Ministry. The Provincial People Committee, the executive body of the Council, is also given the remit to develop a Master Plan for the Economic-Social Development at the provincial level (based on Law No. 11/2003/QH11), including regulation, fees, and incentives for environmental protection (Ngoc, 2017). However, all policy and regulation have to ultimately conform to the national level Master Plan for Industrial and Economic Zone Development in Vietnam controlled by the Ministry of Planning and Investment, the Ministry of Construction, and the City People's Committee, who answer directly to the Office of the Prime Minister.

Within this context the Export Processing and Industrial Zone Authorities (such as those of Ho Chi Minh City and Long An province—HEPZA and LAEZA) are responsible for managing, disseminating, guiding, inspecting, and supervising the implementation of master plans and regulations from the state agencies. They have the right to adjust and approve construction plans without changing the land use function and planning structure. But

TABLE 2 Regulation and policy relevant to water use efficiency in industrial zones of Vietnam

Regulation	Content related to water use efficiency
Law on Water resource 2020	Article 4—Invest in and have mechanism to encourage to invest in research and innovative technology to develop water saving and water use efficiency Article 39—Measures to use water economically and effectively Article 41—Incentives for economical and efficient use of water Article 42—Developing science and technology for economical and efficient use of water
Law on Environmental Protection 2020	Article 4—Increase reuse and recycling of waste Article 5—Strengthen scientific research, develop technology for recycling and waste treatment; prioritize the transfer and application of advanced, high-tech, and environmentally friendly technologies Article 72—Wastewater is encouraged to be reused when it meets the requirements for environmental protection and water use purposes
Law on Technology transfer 2017	Article 9 (section d)—Encourage the transfer of advanced technologies, new technologies that use resources economically and efficiently
Decree 80/2014 on drainage and wastewater treatment	Article 16 (section 10)—The criteria for technology selection, capability of energy saving and recycling wastewater and waste sludge
Decree 54/2015 on incentives for economical and efficient use of water	Article 6—Activities eligible for incentives: reuse, cyclic use of water, collection of rainwater for domestic use, production and import of water-saving products, equipment, technologies Article 7—Incentives for reuse, cyclic use of water Article 8—Incentives for production, import of water-saving products, equipment, technologies Article 9—Incentives for collection of rain water…
Decision 2129/2018 on adjustment of environmental protection fees for industrial wastewater in Ho Chi Minh City	Section I.1—Objective: …encourage economical use of water, reuse treated water, limit discharge and limit environmental pollution…
Bill on National Strategy for Environmental Protection to 2030	The strategy will focus on implementing the tasks of efficient use of natural resources
Decision No. 2502/QD-TTg of the Prime Minister: Approving the Adjustment of Orientation for Development of Urban Water Supply and Industrial Parks in Vietnam to 2025, with a Vision to 2050	Article 1, Section I.4—Encourage the rational and economical use of clean water and reuse it for other purposes Article 2, Section 4—Choose advanced technology and equipment, have high automation, save water, research rainwater reuse technology to support domestic water and other needs

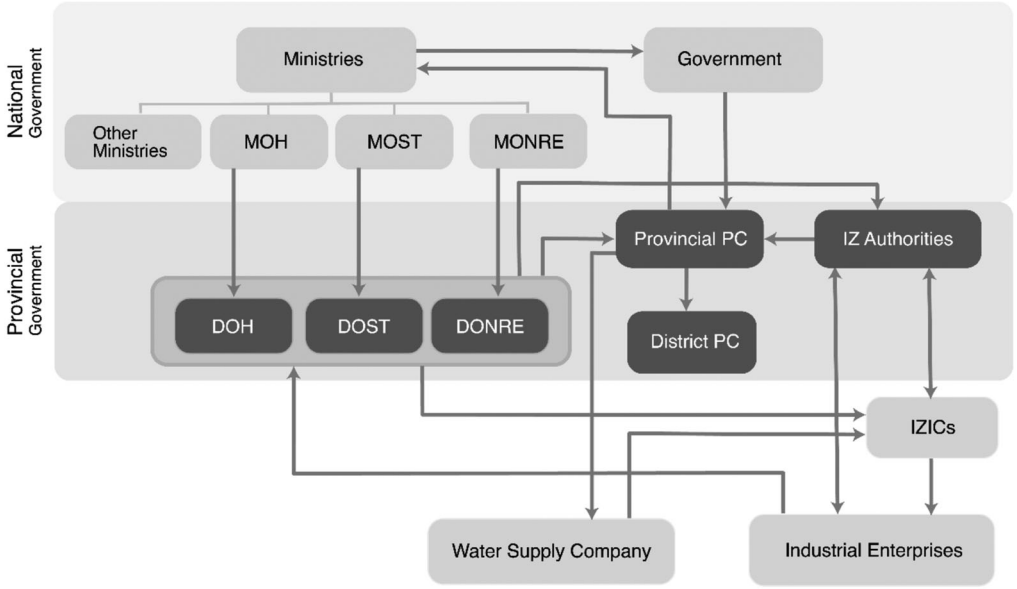

FIGURE 2 Schematic organization of government bodies involved in industrial water policy

they remain obliged to follow all water-related regulations set by the People's Committee in line with national legal documents, policies, and master plans for industrial and economic zone development (Decree No. 29/2008/ND-CP).

A consequence of this hierarchical decision-making is that there is limited interaction between ministries, central committees, departments, scientific institutes, and organizations dealing with the water sector. In addition, there is poor communication between end-users and government officials, and little government transparency and accountability (Grafton et al., 2019). As argued by Van Leeuwen et al. (2016), and demonstrated in the next section, this means that sharing ideas, knowledge, and information between different institutions involved in water use and management is limited and there are difficulties in ensuring the transparency of practices due to lack of commitment, concern, awareness, and participation of relevant stakeholders.

5 | INSTITUTIONAL CAPACITY OF VIETNAMESE INDUSTRIAL ZONES

While differences between institutional capacities are seen between the three industrial zones analyzed in our study, we also observe that there is a low degree of overall variation in these differences (see Table 3). This in part confirms that macro level state institutions in Vietnam have a strong influence over the relational, knowledge, and mobilization capacity of industrial zones. It also indicates that Vietnamese industrial zones do not display the overall capacity to change the macro level institutional environment in which they operate in order to create opportunities for implementing water use efficiency strategies. The following analysis examines each of the institutional capacities placing emphasis on this low variation and overall influence of macro institutions.

5.1 | Relational capacity

All three of the industrial zones demonstrate some capacity to engage with state and non-state actors. However, their ability to use these relations to support experimentation and innovation for developing water use efficiency strategies remains constrained by the hierarchical nature of relations within the centralized Vietnamese state. The industrial zones studied are also, as outlined above, limited in their ability to develop relations within the state that might enable them to influence the macro institutions to which they are subjected. As a consequence, the levels of trust and mutual understanding between industrial zones and key governmental actors are too low to support technological water use efficiency experimentation and innovation.

None of the industrial zones have been able to develop direct relations with the Provincial People's Council and their executive Committee. The weak relation with the Council is consequential because of the central role it plays in coordinating with other parts of government that are relevant to water innovation (Table 3). For example, the Master Plan for Water Demand in Ho Chi Minh city issued by the Prime Minister at the macro level focuses almost exclusively on upgrading the Saigon Water Company facilities to increase overall capacity of water supply as a means to meet future urban demand (Decision 2631/QD-TTG, 2013). Respondents from both Hiep Phuoc industrial zone and Tan Thuan export processing zone argued, if water supply increases and prices are driven lower there may be no incentive for industrial zones to seek out new partners to develop or implement water use and recovery strategies. As a representative from the Saigon Water Company claimed, the focus on supply also means that "the state is disincentivized to set policies that will reduce consumption, because of the consequences this holds for state revenues." Combining these dual disincentives at the macro and meso levels undermine any aspiration of industrial zones to reach out to utility companies and industry bodies that could support experimentation and innovation.

The industrial zones have been successful in overcoming the hierarchical decision-making structure of state policy and regulation (as illustrated in Figure 2) by engaging and working through the Export Processing and Industrial Zone Authorities of Ho Chi Minh City and Long An province (HEPZA and LAEZA). As outlined by two senior industrial zone executives, these provincial authorities have a close working relationship with the People's Committees. The collaboration between HEPZA, LAEZA, industrial zones infrastructure companies (IZICs), and enterprises is described by a web-like pattern in which HEPZA is a clear node. Although positioned within the state, respondents from IZICs and industrial enterprises saw HEPZA and LAEZA as bridging organizations providing industrial zones and their client companies the possibility to access, discuss, and exchange innovative technology knowledge and experience. The direct relations between industrial zones and both industrial zone authorities are perceived by IZIC managers interviewed as indications for high levels of trust—which in turn is thought to enable experimentation with water use efficiency technologies such as water reuse and rain water harvesting. As one of these managers argued when interviewed, "HEPZA has a strong relationship and impact on the enterprises … enterprises will have more trust when they receive the information and request from HEPZA than from the industrial zones infrastructure company."

The interaction between HEPZA and LAEZA and industrial zones is nevertheless infrequent—limited to annual or biannual workshops. Communication between MONRE, People's Council and Committee, and industrial zones happens through official documents. The way the relations are organized and maintained are just administrative and one directional rather than based on dialogue (Carmona et al., 2002). The relations between industrial zones, Ministry of Natural Resource and Environment (MONRE), People's Council and Committee, and Department of Natural Resource

TABLE 3 Variations of institutional capacities of three Vietnamese industrial zones

Capacity	Dimensions	Hiep Phuoc IZ	Long Hau IZ	Tan Thuan EPZ
Relational capacity	*Number and type of actors*	• Weak relations with the Provincial People Council • Close relationship with industrial zone authorities		
		Strong cooperation in research in water use efficiency (DOST/Universities/Institutes/NGOs)	No collaboration with DOST and NGOs	Strong cooperation in research in water use efficiency (DOST/Universities/Institutes/NGOs)
	Morphology of the network	• Hierarchical morphology between PC, MONRE, DONRE and IZICs, enterprises • Web-like morphology between industrial zones authorities, IZICs, and enterprises • Spatial and temporal reach is low		
	Trust and mutual understanding	• High level of trust between industrial zones authorities, IZICs, and enterprises • Low level of trust and understanding between IZs and Ministries, People's Council and Committee		
Knowledge capacity	*Type of knowledge*	• Recognition of the need for water use efficiency improvement and the economic implications of resource degradation		
	Frames of references	• Lack of expertise on water use efficiency • Lack of expertise for establishing more active forms of dissemination		
		New knowledge is provided by industrial zone authority	New knowledge is provided by industrial zone authority, entrepreneurs, and law library	New knowledge is provided by industrial zone authority
	The extent is taken up and made accessible	• Lack of deliberation and sharing of knowledge between IZs, companies, and governmental agencies • Limited uptake of knowledge from industrial zone authority workshops by staff members of IZIC • Limited knowledge sharing among client companies of IZ		
Mobilization capacity	*Opportunity structure*	• Mobilizing support for developing water use efficiency is highly dependent on the system of regulations and laws set by the state • Lack of opportunity to influence provincial or national regulation for water use efficiency development is limited by the openness and timing of publishing new regulations		
	Develop new opportunity structures	Not able to create internal opportunity structure to mobilize industrial enterprises to adopt water use efficiency technologies	Able to create internal opportunity structure to mobilize industrial enterprises to adopt water use efficiency technologies	Able to create internal opportunity structure to mobilize industrial enterprises to adopt water use efficiency technologies

and Environment (DONRE) remain embedded in a highly hierarchical structure, through which water use efficiency continues to be planned and controlled by the macro level regulations of the People's Council and Committee, MONRE, and DONRE, rather than being led by industrial zones and enterprises at the meso level. A lack of trust and mutual understanding exists between industrial zones, People's Council and Committee, MONRE, and DONRE as respondents from both Hiep Phuoc industrial zone and Tan Thuan export processing zone argued that their calls for clearer explanation of regulation specifying when and how wastewater can be reused, as well as their concerns over its effectiveness, have not been effective. In the words of one company operating in Hiep Phuoc industrial zone, they "have no choice, this is policy, enterprise is not able to resist." Industrial zones thus face difficulties in having meaningful engagement with higher level of government preventing them from experimenting with and pursuing reusing treated water for watering the green area or supplying it to industries that require lower quality of water for their operations.

Finally, industrial zones demonstrate capacity to connect with knowledge actors such as universities. For example, Hiep Phuoc industrial zone has a memorandum with Ton Duc Thang University and the University of Technology to cooperate on problems related to odor in wastewater treatment. These knowledge actors provide direct support for industrial zones in calling for macro level regulatory reform. State regulations stipulate that the promulgation or updating of a legal document requires the results and experiences from scientific research and pilot studies. This provides an opportunity for meso level industrial zones to influence macro level regulations by collaborating with experts from universities and/or research institutes in doing scientific research. However, as we now go on to examine, while industrial zones demonstrate the capacity to develop affective relations with some non-state actors, their ability to use these relations for enabling improved macro level regulatory conditions which guides them on how to reuse, exchange, and save to increase water use efficiency remains limited.

5.2 | Knowledge capacity

All three industrial zones acknowledge the need for enhanced efficiency in surface and ground water use. They also recognize that the degradation of these resources will lead to economic implications over the long term—especially when coupled with continued rising demand by both industry and surrounding urban areas. However, their knowledge capacity is constrained by the lack of access to and sharing of knowledge between companies and governmental agencies (Table 3). Industrial zones rely on the limited knowledge shared by the government within existing macro level institutions and regulatory procedures. As a result, industrial zones are not able to acquire the knowledge needed to justify making investments in technological water use efficiency strategies, or promote investment in such technologies by individual companies operating under their remit.

As presented in Table 3, respondents from all three industrial zones recognize the need for developing and implementing water use efficiency strategies. They also identify the need to target expertize that could help improve the quality of treated waste and rain water and assess the costs and benefits of implementing water technologies; such as doing a pilot study on rain water harvesting to assess the requirements for storage and how the quality and quantity of rainwater differs between seasons. As the manager of one company operating in Tan Thuan export processing zone argued when interviewed, "we plan to save water by rain water harvesting, …. we have a high amount of rain water but the investment cost is also high…… we have to invest in two systems of pipes."

Very few respondents across all three industrial zones could identify current activities designed to foster partnerships with the private sector, government, and (national and international) universities to increase the range of knowledge available to them. For example, a manager at the Long Hau industrial zone described how his team had reached out to universities and entrepreneurs to seek out expertise on wastewater reuse and treating water of high salinity. Hiep Phuoc and Tan Thuan could provide no examples of proactive engagement. All three industrial zones do, nevertheless, enroll in workshops led by MONRE, DONRE, and HEPZA aimed at transferring knowledge on international best practices related to water use efficiency strategies (e.g., water reuse, water exchange, water saving). However, these workshops, organized once or twice a year, remain largely performative. It is neither clear whether and how the knowledge presented is taken up by industrial zones nor whether feedback provided by industrial zones during these workshops, while included in the official reporting, influences the design of or support provided by macro level institutions in any way. As a result, all three industrial zones perceive the government as not being open to discussing how challenges with implementing water use efficiency strategies can be overcome.

We also observe that the capacity of three industrial zones to share new knowledge amongst their client companies appears to be limited (Table 3). Managers from all three IZICs stated that they have no clear structure to share information and knowledge amongst their client companies. As one industrial zone manager said, "we do not have any section to inform the knowledge or even have not heard about that…. the staff is provided the knowledge often share and discuss with the director first." This, they went on to argue, is attributable to the lack of expertise on water use efficiency within the industrial zones, making it difficult for managers to discuss any newly acquired knowledge within their office, let alone with their clients. It is also this lack of expertise that these managers argue limits their capacity for establishing more active forms of dissemination, such as piloting new water use efficiency technologies. As illustrated by a representative from Long Hau industrial zone, "we know that … technologies exist. For example, rain water harvesting is a very good idea, but we need pilot studies or pre-feasibility research to say that we should do that or not."

5.3 | Mobilization capacity

Finally, we observe that the mobilization capacity of industrial zones remains dependent on the conditions set by macro level state institutions. Within these conditions, however, industrial zones are able to create opportunity structures by setting internal rules and incentives for their clients to adopt water use efficiency technologies.

The extent to which industrial zones are able to mobilize support for developing and implementing water use efficiency strategies is highly dependent on opportunity structures provided by the state (see Table 3). But even though these opportunity structures exist, engaging the government to support the design and adoption of water use efficiency technology at the level of the industrial zone remains challenging. The representatives from Hiep Phuoc and Tan Thuan industrial zones reported opportunities to apply for financial support for implementing water use efficiency strategies from the state, but also explained that they failed in obtaining this financial support because of "unclear administrative procedures." The resulting lack of financial support from state agencies, such as the Ho Chi Minh City Environmental Protection Fund, has meant that both Hiep Phuoc and Tan Thuan have not upgraded their central wastewater treatment plants. One respondent from Hiep Phuoc IZIC explained that while they applied for financial support, they only received the answer that they will not receive the fund without any further explanation. In rare cases, an industrial zone can be successful in mobilizing support, but only with the specific consent of the government. Long Hau IZIC, for instance, has been able to arrange an exemption from the state to reuse treated waste water within Long Hau industrial zone, but only because the treated waste water is of higher quality than local surface water sources.

In addition, while all industrial zones are interested in water reuse and saving, they do not have the capacity to engage with central and provincial government to translate the current legal system at the macro level into decisions that help to further develop water use efficiency strategies. The "participative" processes developed by the government to communicate policy and regulation has proven largely performative—meaning industrial zones can participate in, but not influence these relations and therefore decisions at the macro level. As illustrated by one industrial zone manager who participated in the design phase of the new Ho Chi Minh wastewater discharge levy in 2019, workshops are "designed to get ideas but in the end those ideas … [are] not incorporated." The industrial zones have, as such, limited opportunities to influence the regulation related to water use efficiency in order to create concrete next steps to develop and apply the technologies (e.g., water reuse) for water use efficiency improvement within industrial zones. According to the respondents from HEPZA and IZICs, there is a lack of specific Circulars (i.e. guidelines) that instruct industrial zones how to implement standards and regulations. For example, representatives from Hiep Phuoc and Tan Thuan IZICs pointed out that Decision 2129 (see Table 3) promotes the use of water reuse, which is a technical solution to enhance water use efficiency by reducing the amount of supplied water and discharged water, but provides no guidance for the industrial zones on the purpose of reuse, or which national technical regulations should be used to assess treated wastewater.

Opportunities to influence provincial or national regulation on the use of wastewater is also limited by the weak transparency and timing of new regulations. While industrial zones regularly communicate with the industrial zone authorities, they are unable to establish direct lines of communication with either central or local government. This limits their capacity to understand the reasoning for new regulation and/or give feedback on the practicalities of translating regulation into action. As one respondent explains, "in principle, there is a survey for industrial zones and enterprises on related legal documents, but this is only administrative, opinions are not accepted." The unpredictable timing between receiving notice of new regulations to their implementation, ranging from the next day to as long as 6 months, further undermines any opportunity for open communication. As pointed out by the manager of Long Hau IZIC, these delays mean that they need to sometimes gather information on updated regulations and policies from a law library rather than in dialogue with regulators. This again emphasizes the limited impact of meso level institutional capacity (of industrial zones) on the macro level institutional environment and vice versa. Industrial zones strongly rely on national legal documents to develop and implement strategies or solutions for water use efficiency, such as, water reuse or water cascading, but the slow time for promulgating new or updated central regulations prevent them from implementing any water use efficiency innovation to meet their demand and interest in time.

Despite the lack of external mobilization, the industrial zones do demonstrate some capacity for creating *internal* opportunity structures that mobilize client firms to set rules and incentives for the adoption of water use efficiency technologies. Long Hau and Tan Thuan both demonstrate a capacity to create internal incentives for their client companies to develop or adopt water use efficiency strategies (see Table 3). For example, Long Hau IZIC uses the waste water treatment fee to incentivize firms to engage in the implementation of water use efficiency and treatment. If an enterprise discharges a higher quality wastewater to the central waste water treatment plant, that is, compliant with "column A" of the National Technical Standard No. 40 (QCVN 40:2011/BTNMT), they will get a 50% reduction on the IZIC's wastewater treatment fee. With this regulation, several enterprises are mobilized to apply innovative technologies (such as reuse for cooling, washing, and watering). A respondent from an enterprise mentioned that with the regulations "affecting the costs, enterprises automatically save water…and reaching column A for a 50% discount on price encourages enterprises to treat wastewater to get it to a better quality."

6 | DISCUSSION

The three industrial zones analyzed all have limited institutional capacity for identifying, collaborating around, and resolving collective problems related to water use efficiency. This limited capacity to develop trusted relations, access knowledge, and mobilize resources necessary for problem

solving and the strategic development of water use efficiency (Cohen-Rosenthal, 2000; Koop et al., 2017; Wang et al., 2017) undermines their efforts to either shape or comply with macro level rules and norms governing the development of water reuse. The findings in particular show that (1) the meso level institutional capacity in Vietnam remains dependent on, and is in fact constrained by, the hierarchical institutional environment of the Vietnamese state, and (2) the interplay between meso level capacities further amplifies these constraints. In light of these findings, we argue that opportunities still remain for industrial zones to expand their institutional capacity for developing water use efficiency strategies with non-state actors and client firms.

First, our results demonstrate that the centralized structure of the Vietnamese state constrains all three institutional capacities of industrial zones. The high reliance of industrial zones on macro level provincial and national level executive institutions, notably DONRE and MONRE, in addition to macro level political institutions through the Provincial People's Committee, limits the extent to which industrial zones can foster relations (both in and outside the state) that might help them with technological innovation, regulatory compliance, and/or greater efficiency in dealing with high levels of state bureaucracy. Faced with this system of centralized planning, regulation, and policy supported by judicial enforcement (Benedikter & Nguyen, 2018), industrial zones are provided a set of goals for water use efficiency, and industrial symbiosis more broadly, but are not afforded the means to develop the meso level institutional capacities necessary for achieving these goals. In line with KimDung et al. (2018), the industrial zones we examined are faced with a form of administrative decentralization or "captured collaboration" (Bruun & Rubin, 2022) that gives them legislated responsibility to innovate, but does not provide them support for gaining the necessary knowledge, relations, or mobilization capacity for innovation. Furthermore, the lack of support by macro-institutions to foster meso level institutional capacity undermines the influence of industrial zones over policy and/or regulation that could enable the adoption of water efficiency technologies. Despite the multiple branches of government and different levels of decision-making in Vietnam, any form of deliberation related to policy and/or regulatory reform still relies on the tacit support of the central government (Dieu et al., 2020). These results indicate that the development of institutional capacities are not only functional—in terms of raising awareness, coordinating, and organizing industrial ecology and symbiosis (see Mortensen & Kørnøv, 2019; Pham et al., 2022)—but also fundamentally political. Without a shift from planning, regulation, and policy supported by judicial enforcement to facilitating policies to build the institutional capacities needed for context specific innovation, innovation in industrial zones (e.g., water use efficiency) may continue to be tenuous.

Second, the results show that the interplay between meso level institutional capacities reinforces the way in which the macro level institutional environment constrains the institutional capacity of the studied industrial zones. As a result, we observe a reinforcing dynamic (building on Boons & Spekkink 2012; Healey et al. 2003) that further undermines the institutional capacity of industrial zones to act without consent of the state or influence the macro level institutional environment to support their efforts in water efficiency innovation. Reaffirming the observations of others (Gibbs, 2003; van Leeuwen et al., 2016; Yoon & Nadvi, 2018), this reinforcing dynamic in turn undermines the development of trust and cooperation needed by industrial zones for developing shared water use efficiency strategies. For example, because relational capacity is limited to fostering trust and mutual understanding with lower levels of government, access to knowledge is limited as well, which in turn limits the knowledge base to act upon. Similarly, the results show how the weak capacity to build trust and mutual understanding and share knowledge with non-state actors is restricting opportunities to mobilize actors beyond the government. This weak relational and knowledge capacity reduces the possibility to engage and/or create (i.e., mobilize) opportunity structures, including legal and/or financial instruments that might assist industrial zones in incentivizing client firms to work toward water use efficiency strategies. This also means that focusing on enhancing one capacity, for example, knowledge capacity, is not enough to overcome the constraining influence of the macro level institutional environment. Enhancing the institutional capacity of industrial zones in a centralized political setting therefore requires fundamental change at the macro level as well.

These findings open up the debate over how the institutional capacity of Vietnamese industrial zones can be enhanced to foster the level of innovation needed for achieving goals like water use efficiency. We argue there are at least three possible, albeit speculative, approaches for doing so.

First, drawing on lessons from other sectors in Vietnam (KimDung et al., 2016b; Tariq et al., 2018), co-innovation, and co-management of water use efficiency strategies could be pursued that expand the institutional capacity of industrial zones. Both co-innovation and co-management would require the state actors to enable industrial zones to improve their relational capacity with a view to accessing new knowledge and technologies. It would also enable them to not only exploit opportunity structures related to planning and regulation, but also engage in their formulation and design. Enhancing the institutional capacities of industrial zones through co-innovation and co-management are, however, only likely to be effective if central government supported greater devolution of control over industrial water use to industrial zones and local authorities. Interestingly, *such* reforms have been taken in the wider Vietnamese water sector at national and water basin scales leading to improved coordination, decision-making, and improved water quality (Grafton et al., 2019). Integrating industrial water use in these reforms, with a focus on enhancing institutional capacities for enhanced deliberation (see Bruun & Rubin, 2022), may be a promising first step to improving industrial water use efficiency.

Second, taking inspiration from Benedikter (2016), opportunities for change do still exist in the Vietnamese state for initiating more decentralized collaboration with non-state actors. All three of the industrial zones we analyzed could be more effective in shaping their institutional context if they could develop their relational, knowledge, and mobilization capacity to engage with the motivations, norms, and abilities of actors operating in non-state networks (Korbee et al., 2019; Phuong et al., 2018). This could mean getting involved in networks of domestic and national universities,

networks of international firms (Truong & Rowley, 2017), and/or create links with international regulatory networks including influential norm setting bodies such as voluntary environmental certifications and/or the International Standards Organization (Daddi et al., 2016; Geng et al., 2009). While these relations may not deliver much support in the short term, they are likely to offer a greater set of opportunities for innovation over the long term.

Finally, despite the lack of capacity to shape their macro-institutional setting, our results do demonstrate that industrial zones have some capacity to coordinate relations with client firms and the lowest level of government to instigate change. There is also some indication, as seen in the cases of Long Hau and Tan Thuan, that industrial zones can internally mobilize their client companies to develop or adopt water use efficiency strategies through their own regulatory and economic incentives (in line with Lüdeke-Freund et al., 2019). This influence exists in spite of not having (as we outline above) the capacity to influence the wider (macro level) institutional context in which this remit is shaped. While still highly speculative, recognizing these strengths highlight the potential of greater decentralization and even devolution of industrial zones for co-producing and implementing new water use efficiency strategies (Moretto et al., 2018). As outlined above, however, such devolution is likely to still rely to some degree on macro institutional support for new forms of co-innovation and co-management of water use efficiency strategies.

7 | CONCLUSION

Our analysis highlights how innovation processes go far beyond the deontic logic of assessing the effectiveness of prescriptive rules and norms aimed at fostering industrial ecology. Instead, we show that industrial ecology goals, such as water use efficiency, requires explicit attention to the way in which macro level institutions shape the institutional capacity of industrial zones. This is especially the case in centralized states like Vietnam where macro institutions focused on centralized planning and management and hierarchical decision-making constrain meso level institutional capacities necessary for achieving industrial ecology outcomes. We also show that centralized macro-institutions affect relational, knowledge, and mobilization capacities more or less equally, and in doing so constrain the range of innovation strategies industrial zones can take. To overcome these constraints, political and institutional change such as greater devolution through more deliberative approaches to industrial ecology are required that both enhance institutional capacities of industrial zones and local level government to engage in water use efficiency innovation—including the possible mobilization of non-state actors and client firms within industrial zones.

Our results contribute to debate on the interaction between macro level institutions and meso level institutional capacity within the field of industrial ecology and symbiosis. Further application of the institutional capacity framework is needed to better understand the relative role of macro level institutions and meso level capacities and how their interaction affects the design and uptake of processes in support of industrial symbiosis goals like water use efficiency. The framework could be used to better understand how actors, like industrial zones, can engage in the design of rules, regulation, or codes of conduct. It could also be used to assess what capabilities are needed in order to respond to both public policy and regulation as well as private regulation such as standards and certification. In either application a deeper understanding of how macro level institutions, institutional capacity, and their interplay in furthering the goals of industrial ecology, is central.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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