TECHNISCHE UNIVERSITÄT DARMSTADT

Global water partnerships for people or performance? Increased access to safe water and the improvement of (sub-)urban water services in Vietnam: strengthening local capacity through global water operators' partnerships

vom Fachbereich Architektur
der Technischen Universität Darmstadt

zur Erlangung des Grades
Doktor-Ingenieur
(Dr.-Ing.)

Dissertation
von Lucía Wright-Contreras

Erstgutachterin: Prof. Dr.-Ing. Annette Rudolph-Cleff, Technische Universität Darmstadt
Zweitgutachterin: Prof. Dr. Miranda Schreurs, Technische Universität München

Darmstadt 2019

Wright-Contreras, Lucía: Global water partnerships for people or performance? Increased access to safe water and the improvement of (sub-)urban water services in Vietnam: strengthening local capacity through global water operators' partnerships
Darmstadt, Technische Universität Darmstadt
Jahr der Veröffentlichung der Dissertation auf TUprints: 2020
Tag der mündlichen Prüfung: 09.12.2019

“Water can be a source, a pathway and a receptor; but for humans it is also a driver for change. Populations must move to find water, societies cannot develop without water, it is non-substitutable, and without it there is no life as we know it.”

—Sarah Hendry, *Frameworks for water law reform*

Acknowledgements

This cumulative dissertation summarizes an important phase of collaboration with scientists and practitioners addressing urban development issues, specifically those related to water provision. As a result, eight publications were produced, informing the following subject areas: Urban Studies, Sociology and Political Science, Water Science and Technology, Business, Management and Accounting, Development, Monitoring, Policy and Law. The richness of this exchange was possible thanks to my first supervisor, Professor Dr.-Ing. Annette Rudolph-Cleff. Her profound belief in my work and abilities to take part in international projects was reflected at the start of the PhD in July 2015. Supported also by Professor Dr.-Ing. habil. Martin Wagner, I was invited to take part of a research stay at Nanyang Technological University in Singapore. I would like to acknowledge the funding received between December 2015 and March 2016 from the German Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*, BMBF), for this purpose, and in the frame of the DAAD Programme Strategic Partnerships and Thematic Network "Clean Water China and Southeast Asia," Programme Line B, Project Number 56268477. As a result of this cooperation, I was actively involved in the Nanyang Environment & Water Research Institute (NEWRI) and had the great pleasure of working with Associate Professor Adrian Wing-Keung Law, Dr. Jie Song and Dr. Tian Li.

The continuation of my work, between April 2016 and May 2019, was possible thanks to the financial support from the German Academic Exchange Service (*Deutscher Akademischer Austauschdienst*, DAAD) "Doctoral Programme in Germany" funding programm number 57214224. I would like to extend my deepest appreciation to my coathors with whom I had the honor to publish with during this time: Dr. Hug March, Dr. Sophie Schramm, Dr. Adrian Wing-Keung Law, Dr. Tian Li, Dr. Jie Song, Julissa Kinyenje, Maria Pascual-Sanz, Julie Perkins and Gerard Soppe. Thank you also to each of the anonymous reviewers who contributed with their expertise during the peer-review processes, and special thanks to the Editors-in-Chief for their invaluable guidance and feedback: Richard G. Little (Public Works Management & Policy), Dr. Eddie Chi-Man Hui (Habitat International), and Dr. Cecilia Tortajada (International Journal of Water Resources Development).

I would like to recognize the valuable input I received during my research stays in Vietnam. Most importantly, I want to thank Dr. Faraj El-Awar and Julie Perkins from the UN-Habitat initiative Global Water Operators's Partnership Alliance (GWOPA) for suggesting the case study during our meeting at the Habitat III Conference in Quito and for initiating the Agreement of Cooperation between TU Darmstadt and GWOPA signed in July 2017. Furthermore, highly relevant were the contributions from Da Nang Water Supply Joint Stock Company's (Dawaco) personnel who responded to all of my inquiries. Special thanks to Mr. Viet

Anh, Mr. Huong Ho, Mr. Phan Thinh, Mr. Bui Tho Ninh, Mr. Le Van Ly, Ms. Duc Hanh Nguyen, Ms. Thao Ngo, and Ms. Ngoc Dao. I extend my gratitude also to Gerard Soppe, Senior Water and Sanitation Expert of the World Bank, Hubert Jenny, Asian Development Bank (ADB) Principal Infrastructure Finance Specialist, and Christopher Moster, Lead Facilitator for ADB Water Operators' Partnerships (WOPs), for their helpful contributions and knowledge on this topic.

I would like to thank DAAD's "International doctorates in Germany for all" (IPID4all) programme for the financial support to cover Open Access fees, allowing me to reach a broader audience and increase the impact of specific publications. I'm deeply indebted to IPID4all, as well as the Association of Friends of TU Darmstadt (*Vereinigung von Freunden der Technischen Universität zu Darmstadt e.V.*), both of which made my participation in international workshops and conferences in Germany, Spain, Singapore and Vietnam possible (e.g. the Impacts World 2017 Conference, in Potsdam; the International Workshop 2017 Towards Urban Resilience, in Barcelona; the Young Water Leaders' Summit of the 2018 Singapore International Water Week; and the Vietnamese International Water Week 2018, in Hanoi).

Thanks to my participation in the Impacts World Conference in Potsdam in October 2017, I had the fortune to connect to my second supervisor, Professor Dr. Miranda Schreurs, Chair of Environmental and Climate Change Policy of the Technical University of Munich. I highly admire her genuine interest in supporting the scientific work of her students, and I especially appreciate her unwavering guidance and encouragement during the last stages of my dissertation.

All of this would not have been possible without the years of constructive advice, wisdom, love, and support from my parents, Professor Dr. David Charles Wright Carr and Yolanda Contreras de Wright. I am extremely grateful for the support of my paternal grandparents, Dr. Kenneth Charles and Grace Katherine Wright—thank you for always being there for me. Equally important has been the guidance and life example of my maternal grandparents, Vicente Contreras (†) and Esperanza Cortez Zea (†). I would also like to extend my appreciation to friends and family who have motivated me during this process in spite of distance. Last but not least, I would like to thank my fiancé and future husband (December 21, 2019), Thomas Geisbüsch, for his clarity, honesty, and unconditional support, every step of the way.

Table of contents

Tables

Abbreviations

ADB	Asian Development Bank
AfT	Aid for Trade
BEWOP	Boosting the Effectiveness of Water Operators' Partnerships
BOO	Build-Own-Operate
BOT	Build-Operate-Transfer
CBO	Community-Based Organization
CCU	Central Control Unit
CKEZ	Central Key Economic Zone
CSR	Corporate Social Responsibility
CTM	Care-Taker Model
CVKER	Central Vietnam Key Economic Region
Dawaco	Da Nang Water Supply Joint Stock Company
DBFO	Design-Build-Finance-Operate
DBO	Design-Build-Operate
DGIS	Directorate-General for International Cooperation
DMA	District Metering Areas
DoC	Department of Construction
EMF	Electromagnetic field
FTA	Free Trade Agreement
GIS	GIS Geographic Information System
GWI	Global Water Intelligence
GWOPA	Global Water Operators' Partnerships Alliance
IWM	Irrigation Water Management
IT	Information Technology
JICA	Japan International Cooperation Agency
JSC	Joint Stock Company
KEZ	Key Economic Zone
KPI	Key Performance Indicator

LLC	Limited Liability Company
MDG	Millennium Development Goal
MIT	Massachusetts Institute of Technology
MoU	Memorandum of Understanding
NEDA	Netherlands Development Assistance
NGO	Non-Governmental Organization
NRW	Non-Revenue Water (unaccounted for water)
OM	Operation-Maintenance
P&C	Planning and Control
PC	People's Committee
PMU	Project Management Unit
PPCP	Public-Private-Community Partnership
PPNP	Public-Private-NGO Partnership
PPP	Public-Private Partnership
PPTA	Project Preparatory Technical Assistance
PUP	Public-Public Partnerships
PUI	Periurban Interface
RBO	River Basin Organization
RNE	Royal Netherlands Embassy
RPM	Resident Project Manager
SCADA	Supervisory Control and Data Acquisition
SCDP	Sustainable City Development Project
SDG	Sustainable Development Goal
SDSN	Sustainable Development Solutions Network
SOE	State-Owned Enterprise
SOP	Standard Operating Procedure
SWRO	Seawater Reverse Osmosis
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UNSGAB	United Nations Secretary General's Advisory Board

USAID	United States Agency for International Development
USD	United States dollar (currency)
USP	Utility Support Programme
VND	Vietnamese dong (currency)
WCED	World Commission on Environment and Development
WEF	World Economic Forum
WHO	World Health Organization
WOP	Water Operators' Partnership
WSUD	Water Sensitive Urban Design
WTP	Water Treatment Plant

Publication list

Publication No.	*Type of publication and reference*
P- I	Journal article **Wright-Contreras, L.,** March, H., & Schramm, S. (2017). Fragmented landscapes of water supply in suburban Hanoi. *Habitat International*, 61, 64-74. DOI: 10.1016/j.habitatint.2017.02.002
P-II	Journal article Schramm, S., & **Wright-Contreras, L.** (2017). Beyond passive consumption: Dis/ordering water supply and sanitation at Hanoi's urban edge. *Geoforum*, 85, 299-310. DOI: 10.1016/j.geoforum.2017.06.016
P- III	Book chapter Schramm, S., **Wright-Contreras, L.** (2019). Suburban constellations of water supply and sanitation in Hanoi, in: Filion, P., Pulver, N. (Eds.), Critical Perspectives on Suburban Infrastructures: Contemporary International Cases. University of Toronto Press, Toronto, pp. 208–230.
P- IV	Journal article **Wright-Contreras, L**. (2019). A Transnational Urban Political Ecology of Water Infrastructures: Global Water Policies and Water Management in Hanoi. *Public Works Management & Policy*, 24(2), 195-212. DOI: 10.1177/1087724X18780045
P-V	Book chapter Pascual-Sanz, M., Perkins, J., Kinyenje, J., & **Wright-Contreras, L.** (2018). Water operators' partnerships for universal and sustainable access to water services. In A. M. Badia Martí & L. Huichi Sancho (Eds.), Agua, recurso natural limitado: entre el desarrollo sostenible y la seguridad internacional (pp. 79–91). Madrid, Spain: Marcial Pons.
P-VI	Technical report **Wright-Contreras, L.** (2018). Water Operators' Partnership Case Study: VEI and Dawaco. Nairobi: UN-Habitat. DOI: 10.13140/RG.2.2.24399.94880
P-VII	Journal article **Wright-Contreras, L.**, Perkins, J., Pascual, M., & Soppe, G. (2019). Water operators' partnerships and their supporting role in the improvement of urban water supply in Da Nang. *International Journal of Water Resources Development*, 1-26. DOI: 10.1080/07900627.2019.1625753
P-VIII	Journal article Song, J., Li, T., **Wright-Contreras, L.,** & Law, A. W. K. (2017). A review of the current status of small-scale seawater reverse osmosis desalination. *Water International*, 1-14. DOI: 10.1080/02508060.2017.1330841

Summary

This cumulative dissertation aims to understand the role of water operators' partnerships (WOPs) in improving urban water supply in developing countries. Through two cases in Vietnam, safe access to water is explored in relation to the place-specific adaptation of decentralized and non-networked infrastructures, as well as the expansion of large-scale (centralized) infrastructures. The case of Hanoi uses the theoretical and conceptual frameworks of urban political ecology and splintering urbanism to understand multilevel water governance and suburbanization trends. The second case compares performance changes of the local water utility in Da Nang, before and after a cooperation with the Dutch organization, VEI (formerly known as Vitens Evides International)—the world's leading non-profit promoter and implementer of WOPs. In this example, supporting institutions include the Asian Development Bank (ADB), the Japanese International Cooperation Agency (JICA), the United States Agenda for International Development (USAID), and the World Bank.

Given the internationalization of strategies toward sustainable development, the research focuses on mechanisms of cooperation that support sustainable water management transitions and resilient urban water supply systems. The research assumes that WOPs sustainably contribute to the improvement of urban water supply in developing countries through the transfer of technical and operational knowledge, and the financial support of local water utilities. Both cases deliver relevant insights regarding:

i) the continuity of utility performance improvements,
ii) sustainable water management transitions, and
iii) the effects of WOPs on poverty reduction.

This work further demonstrates that by supporting urban infrastructure development, WOPs can make an important contribution to Vietnam's integration in the world economy. The findings emphasize the need to adopt a new understanding of transnational urbanism in order to raise accountability of international actors over the management of local resources.

An agenda for future research suggests deepening into the debate of privatization of public water utilities. Given the relatively recent adoption of the United Nations' Resolution A/RES/64/202 on the human right to water, it is necessary to explore the legal frameworks which encourage that international cooperation mechanisms favor cost-effective solutions for affordable and inclusive access to safe water.

Keywords: water infrastructures, transnational urban political ecology, WOPs, water utilities, utility performance, local capacity, suburbanization, Vietnam

Zusammenfassung

*Diese kumulative Dissertation untersucht die Rolle von Partnerschaften zwischen Wasserbetreibern (*water operators' partnerships*, abk. WOPs) mit dem Ziel die städtische Wasserversorgung in Entwicklungsländern zu verbessern. Durch zwei Fälle in Vietnam wird der sichere Zugang zu Wasser im Zusammenhang mit dezentralen und nicht-vernetzten Infrastrukturen, sowie dem Ausbau großer, zentralisierter Infrastrukturen untersucht. Der Fall Hanoi verwendet den theoretischen und konzeptionellen Rahmen der urbanen politischen Ökologie und des „zersplitternden" Urbanismus, um mehrstufige Wasser-Governance und Suburbanisierungstrends darzustellen. Der zweite Fall vergleicht die Performance des lokalen Wasserversorgers von Da Nang, vor und nach der Zusammenarbeit mit der niederländischen Organisation VEI (früher bekannt als Vitens Evides International)—dem weltweit führenden, gemeinnützigen Promotor und Betreiber von WOPs. In diesem Beispiel unterstützen zudem Institutionen wie die Asiatische Entwicklungsbank (ADB), die Japanische Agentur für Internationale Zusammenarbeit (JICA), die Behörde der Vereinigten Staaten für internationale Entwicklung (USAID) und die Weltbank.*

Angesichts der Internationalisierung von Strategien zur nachhaltigen Entwicklung konzentriert sich die Forschung auf Kooperationsmechanismen, die nachhaltige Verbesserung in der Wasserwirtschaft und resiliente städtische Wasserversorgungssysteme fördern. Diese Arbeit geht davon aus, dass die Partnerschaften der Wasserbetreiber zur Verbesserung der städtischen Wasserversorgung in Entwicklungsländern nachhaltig beitragen. Dies geschieht, durch den Transfer von technischem und betrieblichem Wissen, sowie durch finanzielle Unterstützung der lokalen Wasserversorger. Die beiden Fallstudien liefern wichtige Erkenntnisse zu den folgenden Punkten:

i) kontinuierliche Verbesserung von Versorgungsleistungen,
ii) nachhaltiges Veränderungsmanagement in der Wasserwirtschaft und
iii) die Auswirkungen von WOPs auf die Armutsbekämpfung.

Die Arbeit zeigt weiterhin auf, dass WOPs durch die Unterstützung der städtischen Infrastrukturentwicklung einen wichtigen Beitrag bei der Integration Vietnams in die Weltwirtschaft leisten können. Die Ergebnisse betonen die Notwendigkeit, ein neues Verständnis

von transnationalem Urbanismus zu entwickeln, um die Verantwortung der internationalen Akteure in Bezug auf das Management von lokalen Ressourcen zu stärken.

Für zukünftige Forschungen schlägt diese Dissertation vor, die Debatte über die Privatisierung der öffentlichen Wasserversorger zu vertiefen. Ausgehend von der erst kürzlich erfolgten Annahme der Resolution A/RES/64/202 der Vereinten Nationen zum Menschenrecht auf Wasser ist es notwendig, die rechtlichen Rahmenbedingungen zu erörtern. Diese fördern, dass internationale Kooperationsmechanismen kosteneffiziente Lösungen für einen erschwinglichen und integrativen Zugang zu sauberem Wasser ermöglichen.

Stichworte: *Wasserinfrastrukturen, transnationale städtische politische Ökologie, WOPs, Wasserversorgung, Versorgungsleistung, lokale Kapazität, Suburbanisierung, Vietnam*

1. Introduction: theoretical framework and research design

Being that societies are shaped by water, there is a need to deepen our understanding of how water is managed, how individuals have adapted to its availability, what technological developments have facilitated or limited access to water within certain groups of society, and what are the potential mechanisms to alleviate water poverty in the future. In light of the recent internationalization of strategies to improve access to safe water, this work is framed by the United Nations' perspective on sustainable development.

The main interest to carry out this research is to assess the role of water operators' partnerships (henceforward WOPs) in improving urban water supply in developing countries. The investigation parts from the premise that effective technologies and institutional arrangements to develop sustainable urban water supply systems already exist. There is, however, a need to support sustainable water management transitions at a local level.

The first desired result from integrating the hydrological cycle with urban planning is the provision of safe and affordable water in cities. This ideal state, however, is disputed in countries which lag in economic and institutional development. Worsened by the effects of climate change, rapid urbanization, urban-to-rural migration and environmental degradation, the built environment often fails to sustain well-functioning and wholesome infrastructure services which can deliver water to populations in an equitable manner. In other words, there are fully developed urban areas with failing, centralized infrastructures and urbanizing areas displaying a combination of solutions including centralized, decentralized, and non-networked infrastructures. Each system differs in price and offers a variable quality of water, sometimes bypassing customers who are not able to pay for a specific service. While citizens cope with the layering of different technologies and services, the development of modern infrastructure networks is incentivized by different stakeholders through lesson-drawing and transnational problem-solving. Hence, transnational communication and the sharing of technological and managerial know-how is crucial to implement innovative solutions and encourage inclusive access to safe water. To this effect, it is necessary to consider networked and non-networked infrastructures in urban, suburban and rural areas; the role of public and private stakeholders at different levels; and the scaling of strategies to achieve global water targets.

With urban planning as a starting point, the present research uses a transdisciplinary approach to address water accessibility in Vietnam through two case studies. To begin with, the theoretical lens of urban political ecology serves to expand on the challenges and opportunities of suburbanization trends in Hanoi, addressing multilevel water governance and scalar politics in water service provision. The second case study looks specifically at the development of performance changes of the Da Nang Water Supply Joint Stock Company (Dawaco), before and

after a partnership with the world's leading non-profit promoter and implementer of WOPs, the Dutch organization, VEI (formerly known as Vitens Evides International). Through an accumulation of various publications, the work informs on key issues related to suburbanization, water governance, and utility performance. The following sections will start by explains the importance of bridging urban studies with public works management and policy to assess the effect of WOPs on the improvement of urban water supply.

1.1. Bridging urban planning with public water works management and policy

From an urban planning perspective, sustainable urban water management focuses on integrating technical infrastructures with the hydrological cycle for the conversion of raw water resources into services apt for human consumption and use. Calling attention to the challenges of freshwater availability, combined with the effects of rapid urbanization and climate change, Section 1.1.1 illustrates the magnitude of the global crisis and describes the water-sensitive-city approach to achieve sustainable urban water management transitions. By combining a sustainable approach to urban water management, water sensitive urban planning takes into account processes, networks of stakeholders and policy changes. The main weakness of the water-sensitive-city planning vision, however, is that it parts from an ideal 'modern water management' scenario not yet achieved in developing countries.[1] This situation leads us to search for other approaches in the literature which study infrastructure development in the Global South.

In order to explain the uneven access to services reflected in developing areas, the concept of 'splintering networks' was originally used to refer to the multiplicity or layering of networks, derived from the competition of service providers (Guy, Graham, & Marvin, 1997). Section 1.1.2 explores the notion of 'splintering urban waterscapes' through two angles. The first refers to the uneven development of networks, with water service provision tailored toward profitable markets, regarding users as passive consumers. The second refers to a splintering of infrastructures from below, highlighting users' agency to access alternative sources of water. Both angles are relevant to understand policy-driven and needs-driven approaches of water access (Allen, 2012) and to address questions related to water governance.

Section 1.1.3 builds on urban political ecology, and more specifically, a *transnational* urban political ecology of *water infrastructures*, to evidence the influence of transnational

---

[1] The idea of 'leap-frogging' through different stages of the (apparent) linear development, according to the water-sensitive-city urban design framework, has been suggested to adapt alternative technologies in underdeveloped areas (Brown, Rogers, & Werbeloff, 2016, pp. 6, 18, 40) and will be elaborated more throroughly in the next section.

networks in multilevel water governance processes. On the one hand, understanding what is the role of international actors involved in infrastructure development is necessary to redefine transnational urbanism and explore its effects on the management of local resources. On the other hand, the internationalization of strategies towards sustainable development raises a red flag concerning the monitoring of global water targets and the failure of modern infrastructure development, as explored in Section 1.1.4.

Finally, Section 1.1.5 elaborates on the required investment to achieve access to water and sanitation in developing countries and situates WOPs in relation to public-private partnerships (PPP) and public-public partnerships (PUPs). Despite the critique of WOPs being used to favor the private sector, the limited number of studies on the subject shows the need for more evidence to contribute to a well-rounded discussion.

1.1.1. Sustainable transitions in water management

Even though our planet Earth is called a *blue* planet because approximately 1.4 billion cubic kilometers of water are covering 70% of its surface, actually most of this water is salty (UN Water, 2013, p. 18). To be precise, 97.41% of water on Earth is salty (Medeazza, 2008, p. 8; Song, Li, Wright-Contreras, & Law, 2017, p. 1); and the other 2.59% of the total volume corresponds to freshwater sources, such as surface water and groundwater, equivalent to circa 35 million cubic kilometers (UN Water, 2013, p. 18). Subtracting the amount of water in glaciers, 0.592% is groundwater, and only 0.014% is accessible freshwater (Medeazza, 2008, p. 8). UN Water (2013, p. 18) points to 200,000 cubic kilometers as 'usable' freshwater supply, which other sources also refer to as (actual) "blue water" (cf. WEF, 2016, p. 53).[2] That's an equivalent of 560 trillion long-course Olympic-size swimming pools of salt water, 14 trillion pools of freshwater, 3 trillion pools of groundwater, and only 78 billion pools of more easily accessible freshwater.

Considering the natural changes in the hydrological cycle, as well as the changes due population increase, rural-to urban migration, and the rising demands of the agricultural and industrial sector, processing freshwater for consumptive and non-consumptive purposes to sustain human activities has becomes a bigger challenge (Al-Barwani & Purnama, 2008, p. 489; Boberg, 2005, p. xiii; Dawoud, 2008, p. 166; Song et al., 2017, p. 1). To begin with, the World Water Council indicated that 80 to 90% of many of the world's water-scarce river-basins are being depleted, and 70% of major rivers are no longer meeting the sea (WEF, 2016, p. 12).

---

[2] The term "green water" is used when referring to moisture stored in soil (Madrid, Cabello, & Giampietro, 2013, p. 14).

Although cities occupy *only* 2% of the Earth's surface, human activities are becoming increasingly urban and are impacting beyond the limits of the cities themselves, leading to scalar repercussions and global environmental problems (Srinivas, Shaw, & Sharma, 2009, pp. 4–7). In fact, 55% of the global population of 7.5 billion people are concentrated in urban areas, and urbanization is expected to increase to 68% by 2050 with a population of close to 10 billion people (UN DESA, 2015a; World Bank, 2017b). Therefore, not only the demand for water in highly-urbanized areas and megacities will rise, but water resources will become increasingly affected by the effluents of urban settlements if untreated wastewater continues to be discharged into freshwater bodies.

With a higher demand of food production for human consumption and to supply in the human food chain, freshwater is mainly flowing to the agricultural sector, which globally makes up 70% of total water withdrawals (WEF, 2011, p. 9) (or up to 90% in least-developed countries, WEF, 2016, p. 12). This is equivalent of 3,100 billion cubic meters [1.2 billion pools], and is expected to increase to 4,500 billion cubic meters [1.8 billion pools] by 2030 if there is no improvement in efficiency in the irrigation processes (WEF, 2011, p. 6). Due to the development of rapidly-growing regional economies, large volumes of water are needed to support the energy and industrial sectors, which make up 16% of the global freshwater demand, and alike the agricultural sector, are expected to increase to 22% by 2030 (WEF, 2011, pp. 6–9). In contrast, domestic water use makes up 14% of the global freshwater demand and is expected to decrease to 12%, except for specific basins where emerging markets are located (WEF, 2011, p. 6).

The 2030 Water Resources Group (2009, p. 44) forecasted an annual deficit of freshwater supply equivalent to 2,800 billion cubic meters, which would equal a shortfall of 40% to meet the future demand of water. If this trend continues, by 2025 or 2030 water stress will affect two-thirds of the world's population (Jenerette & Larsen, 2006, p. 202). Although UNICEF and WHO (2015, pp. 7–9) stated that the number of people with access to improved drinking water has increased, estimating that 2.6 billion people gained access since 1990, the report specifies that there are still 663 million who don't have access to improved water (cf. United Nations, 2015a, p. 6) (or much less 'safe' water, cf. Wright-Contreras, 2019). On top of that, nearly half of the global population is suffering water shortages during at least one month per year (WEF, 2016, p. 12) and nearly 700 million people are exposed to water-related diseases (Water Health, 2017). According to a WHO report, if water, sanitation, and hygiene were improved, 9.1% of global disease burden and 6.3% of all deaths would be prevented (Prüss-Üstün, Bos, Gore, & Bartram, 2008, p. 10).

Adding to the rising demand of potable water, the increasing pollution of freshwater sources, the decreasing availability of clean water, and the cross-sectoral dependence of water to sustain urban life, cities are also increasingly coping with the effects of climate change. Of the 4 billion people that live in urban areas (World Bank, 2016), an estimate of 1.4 billion people in cities over 1 million inhabitants are exposed to at least one natural hazard per year (Chelleri,

Schuetze, & Salvati, 2015, p. 123). The variations of water availability due to extreme weather events such as storms, floods, droughts, and melting of glaciers (Hendry, 2015, p. 2) also have an impact on water security and the permanence of human settlements. According to the World Economic Forum's 2016 Global Risks Report (WEF, 2016, p. 3), the global water crisis is marked as the largest societal risk in terms of impact.

In response to these challenges, water has become a central concern in urban planning. A Water Sensitive Urban Design (WSUD)[3] approach focuses on achieving an integrated water cycle in cities through sustainable urban water management (including both supply and demand management).[4] Depending on the development and quality of urban water services, a city can transition from a water supply city to a sewered city, drained city, waterways city, water cycle city, and finally, to a water sensitive city (Brown, Keath, & Wong, 2009; Brown, Rogers, & Werbeloff, 2016). This so-called Urban Water Transitions Framework, also known as the Urban Water Continuum, provides a city-scale benchmarking system that measures the shift toward integrated approaches in urban water management (Brown et al., 2016). As shown through the case of Singapore, the island-state is an example of the successful implementation of water-sensitive practices, including flood planning, stormwater filtration, wastewater recycling, and

---

[3] WSUD is a concept proliferated through the work of Rebekah R. Brown and is defined as a "planning and design philosophy […] primarily used to minimize the hydrological impacts of urban development on the surrounding environment" (Morison & Brown, 2011, p. 83).

[4] According to Boberg (2005, pp. xix–xxiii): "The management of water supply and demand can make large differences in water withdrawals, and can influence the quality of water and its impact on human health. Supply management involves the location, development, and exploitation of new sources of water. Demand management involves the reduction of water use through incentives and mechanisms to promote conservation and efficiency." Specifically, *supply management* can be optimized through: dams and water-control structures (despite contextual impacts on the environment and on populations, they can yield benefits in the energy and agricultural sectors, control floods and secure domestic water provision), reforestation (as part of watershed rehabilitation strategies), small-scale irrigation systems (to expand irrigation without recurring to large-scale infrastructure), groundwater (considering over-exploitation of aquifers), inter-basin transfers and water exports (considering the pecuniary and environmental costs), water reallocation (between sectors), desalination (considering the discharge of brine), water harvesting, water reclamation and reuse, and pollution control. And *demand management* can be improved by: governance (including policy instruments), institutional and legal changes (including "water-quality matching," decentralization, and privatization), as well as market-based initiatives (such as water pricing), nonmarket instruments (such as water use restrictions and pollution control through policies and educational programs), and direct intervention (such as leak detection, maintenance, upgrade of infrastructures and water conservation through efficiency standards).

communities engagement through recreational, irrigated green spaces (Brown et al., 2016, p. 35). Essentially, the shift from "exclusively large-scale centralized infrastructure and institutions" to "integrated, distributed and flexible infrastructures and institutions" is the main goal of transitioning to water sensitive cities and building resilience (Brown et al., 2016, p. 12).

While the Urban Water Continuum benchmarking system provides a useful scale to locate the level of sustainable water management experienced in diverse cities, the Transition Dynamics Framework is even more useful in identifying transition phases and domains of change (actors, bridges, knowledge, projects, tools) to assess the feasibility of a system transformation (Brown et al., 2016). More than just a design practice which assesses the physical characteristics of water infrastructures, this second benchmarking tool considers technological path-dependencies due to diverse factors, such as professional agency entrapment, political risk, and dominant governance approaches (Brown, Ashley, & Farrelly, 2011). Both the Urban Water Transitions Framework and the Transition Dynamics Framework are directed at urban planners, strategists and policy makers. They aim at instigating a paradigm shift in water management, by considering human waste and stormwater as resources, responding with cost-effective approaches to demand management, allowing for a diversity of solutions including small and decentralized systems, and by activating engagement and collaboration between stakeholders (Pahl-Wostl et al., 2006).

Contrary to the apparent 'continuum' of the Urban Water Transitions Framework, as shown in the six-step process of becoming a water sensitive city, the Transition Dynamics Framework presents the idea of 'leap-frogging' from one state to another (Brown et al., 2016, pp. 6, 18, 40). A linear pathway to become a water sensitive city in developing countries is hindered by technological path-dependencies which are difficult to overcome through the sole investment in modern infrastructure networks. Therefore, in order to adapt new practices, case studies in Timor Leste, Vanuatu, China, Poland, the Netherlands, and Singapore have shown how different actors (i.e. international experts, international contractors, financial organizations, public authorities and industry practitioners) have negotiated pilot projects, decentralized sanitation systems, decentralized stormwater infrastructures, and a combination of large-scale and small scale solutions (Brown et al., 2016).

1.1.2. Splintering urban waterscapes

Through specific development programs, planning takes economic, social, educational, cultural, and physical aspects of the city into account (Friedmann, 1965, pp. 195–196). Urban development programs rely on measurements of performance goals (which are responsibility of the national government and are linked to policy tools) and achievement goals (in charge of fulfilling

functional areas (e.g. health, education, urban renewal) (Sonenblum & Stern, 1964, p. 111).[5] However, according to John Forester (1989, p. 50), this position of 'rational-comprehensive planning' is "deeply rooted in Western thought" and abstracted from the messy 'real-world,' given that the actual conditions which decision-makers face are often unclear (Forester, 1989, p. 50). While rational-comprehensive planning considers multiple aspects of long-term planning in favor of the public interest, a more "ethical and politically-critical planning theory" (cf. Fischler, 1989) considers practical complications and institutional settings (including competing actors and differences in power) which may limit the impact of a comprehensive approach. The main contributions of these theories are the attention to the nature of urban problems and the connection between planning and policy-making.

Parting from the idea of 'real-world' planning, it is important to understand how technological networks, such as transportation, communications, basic services, and public facilities, reflect both the 'software' and 'hardware' (cf. D. Harvey, 2009) of cities and how they are configured to satisfy the needs of different groups of society. As such, infrastructure networks can function as connectors or disconnectors, reflecting the unequal and fragmented growth of urban areas, or the so-called 'splintering' of the urban (Graham & Marvin, 2001).

The concept of splintering urbanism serves to explain a phenomenon where service provision is shifting to sectors which value revenue over social well-being. The characteristics of splintered networks are: a) multiplicity or 'layering' of networks due to the competition between service providers; b) market-oriented provision of services tailored toward profitable markets; and c) the uneven development of networks shaped by local and regional demands (Guy et al., 1997, pp. 192–193). Opposed to the modern infrastructural ideal, referred to as 'bundled' infrastructure, the splintering of infrastructures leads to a process of 'unbundling' (cf. Coutard, 2008). And as Kooy and Bakker (2008a) point out, splintering does not necessarily occur from 'above,' but also as a result of the broader spectrum of water supply alternatives from 'below.'

To understand the origin of networked systems and their political connotation, it is important to understand Matthew Gandy's (2004) definition of the 'bacteriological city,' a term used to describe how cities were shaped through water in the nineteenth century by elite groups of society with the excuse of creating healthier environments. As awareness of disease-reduction measures and hygiene practices raised, wastewater treatment facilities were built and there was a growing tendency to use privately-owned bathrooms. The introduction of flushing toilets and sewers affected informal economies and agricultural practices, and reduced the value of human

---

[5] Friedmann (1965) based his understanding on economic policy planning, which according to Sonenblum and Stern (1964, p. 111): "[…] is concerned with increasing the efficiency and the use of resources to meet objectives which are considered to be socially desirable."

waste (Gandy, 2004). The higher demand for water and the development of water infrastructure networks as we know them today is also known as 'the water revolution' (cf. Giedion, 1948).

The first centralized water systems (e.g. Paris in 1802, London in 1808, and Berlin in 1856; cf. Gandy, 2004, p. 366) unraveled a series of complex issues, including sociospatial fragmentation and infrastructural failures, which would later spread to other parts of the world through colonialism. Postcolonial literature related to the debate of travelling planning practices (i.e. Healey, 2012; Keil, 2013; Kooy & Bakker, 2008b, 2008a) has illustrated the failure of large-scale infrastructure systems. Empirical studies have echoed Gandy's (2004, p. 363) explanation of an "incomplete modernity" through splintered networks, by describing the "modern ideal of progress" (McGee, 2013: 20); the "modernization myth" (Healey, 2012: 188); the "instance of failed or lapsed modernity" (Kooy & Bakker, 2008a, p. 1845), and an [illusory] "modern integrated ideal" (Zérah, 2008, p. 1923).

A more specific body of literature has built on alternatives to centralized networks of water supply through different means such as wastewater reuse and sustainable sanitation systems (Hofmann, 2013; Kurian, Ratna Reddy, Dietz, & Brdjanovic, 2013; Nguyen, Nguyen, Dinh, Nguyen, & Nguyen, 2011) and a combination of various scales of networked and non-networked systems (J. Monstadt & Schramm, 2013; Schramm, 2011). Others have focused on organizational strategies, such as community-public partnerships and community-run water systems (Adams & Zulu, 2015; Marston, 2014).

Through the cases of *ejido* land in Mexico, and the periurban areas in Bolivia, Ghana, India, Malawi, Nigeria, Tanzania, Venezuela, and Vietnam, scholars (Adams & Zulu, 2015; Allen, 2003; Allen, Dávila, Hofman, & Aref, 2006; Allen, Dávila, & Hofmann, 2006; Allen, Hofmann, Mukherjee, & Walnycki, 2017; Budds, 2008; Karpouzoglou & Vij, 2017; Loftus, 2007; Marston, 2014; Mehta & Karpouzoglou, 2015; Rhodante, Cleaver, Rusca, & Schwartz, 2014; Erik Swyngedouw, 1999) have elaborated on both the challenges and opportunities of the so-called 'periurban interfaces' and 'urban waterscapes.' Adriana Allen's (2005) 'water supply wheel' has been relevant to distinguish between policy-driven and needs-driven practices, and to refer to different forms of interaction between actors (e.g. community cooperation, private competition, public-private cooperation, and public community cooperation; cf. Allen, 2012). Far from 'romanticizing' bottom-up solutions, this wave of research has served to illustrate the spaces defined by splintered networks. The political motivations behind the transformation of land uses through policy reforms has also been questioned (cf. Díaz-Caravantes & Wilder, 2014).

1.1.3. Redefining transnational urbanism

Water sensitive urban planning and splintering urbanism provide useful insights to, first, understand the ideal pathways for adopting integrated water cycles in cities, and second,

recognize exclusionary practices embedded in existing configurations of infrastructural networks. Still, with water being essential for the growth of urban areas, it is important to consider the power relations directing the management and development of water infrastructures, as well as the development of new forms of governance. This is where urban political ecology, and more importantly, a transnational urban political ecology of water infrastructures comes into play.

Urban landscapes cannot be separated from nature. The characteristics inherent to an urban nature encompass economic, political, social and ecological processes which produce inequality (E. Swyngedouw & Heynen, 2003, p. 898). With this in mind, the ultimate goal of urban political ecology is to use contested spaces, born from the production of urban nature and daily life, to create strategies that increase inclusiveness, democracy, and social empowerment, amidst inevitably political urban transformations (E. Swyngedouw & Heynen, 2003, p. 914).

Urban political ecology has been used to reveal power relations embedded in urban processes (Angelo & Wachsmuth, 2015; Heynen, Kaika, & Swyngedouw, 2006), and to position relevant discourses of urban, socio-technological, and socio-ecological aspects of networked infrastructures (including transitions of urban governance, history of urban technologies, and sustainable socio-technical transitions; cf. Jochen Monstadt, 2009, p. 1936). A relevant fusion between urban-metabolic thinking and the urban political ecology of infrastructures is shown in the consideration of water as a material flow embodying the dynamic processes of cities (Bakker, 2012; Gandy, 2004; Kaika, 2005; E. Swyngedouw, 2004, 2009; E. Swyngedouw, Kaika, & Castro, 2002).

At a first glance, 'situating' urban political ecology (looking at urban metabolisms and every-day practices of African cities; cf. Lawhon, Ernstson, & Silver, 2014) does not immediately evidence the communication between local, regional, national, and transnational levels influencing the development of water infrastructures. This is why environmental governance and multilevel governance (Balsiger & Debarbieux, 2011; Bulkeley, 2005; Finger, Tamiotti, & Allouche, 2006; Meadowcroft, 2002; Newig & Fritsch, 2009; Paavola, 2007) are useful to illustrate the complexity of environmental problems which transcend spatial, temporal, jurisdictional, institutional, and management scales (cf. Cash et al., 2006). Even though references have been made to multilevel governance in relation with transnational policy issues (Stephenson, 2013) and regarding the cooperation between subnational and national authorities or between national and supranational organs (Papadopoulos, 2007), a transnational urban political ecology has been rarely applied to empirical studies.[6]

---

[6] Other than the description of development process under the labels of globalization, neoliberal processes, or market-oriented systems, and the occasional reference to projects led by the World Bank, the literature does not clearly depict transnational discourses. While transnational urbanism has been used to shed light

In this research, a transnational urban political ecology of water infrastructures uses multilevel governance to evidence scalar relations of power embedded in urban processes which condition access to safe water (cf. Wright-Contreras, 2019). This theoretical conglomeration can be used to bridge global water policies and local water management. It is used in this research to connect urban planning with public works management and policy. Its aim is to encourage conversations between academics and practitioners on topics related to the development water infrastructures, including frameworks for public and private infrastructure management. It is key to evaluate the sustainability of current trends of water governance and discuss the equitable distribution of safe drinking water according to global targets. This way, the ethnographic perspective of transnational urbanism is widened to a global understanding of the multifaceted and complex arrangements of multi-agency coalitions influencing urban development.

1.1.4. The 'emerging brown agenda'

Although integrated urban planning became popular during the 60s and 70s, projects including integrated strategic concepts did not actually take off until the 90s under the Agenda 21 development model (German Association of Cities, 2013, p. 4).[7] Agenda 21 focuses on means of implementation, such as financing, cost evaluation, capacity building, research, public awareness, human resource development, institutional capacity, collaboration strategies, science and technology. With detailed investments expected from the international community to accelerate sustainable development between 1993 and 2000, Agenda 21 frames urban planning within global, economic and political discussions (United Nations, 1992a).[8]

---

on broader development patterns of global migration (cf. Smith, 2001), there is no specific critique of the ecological threats of developments encouraged by transnational processes. Only a study on transnational urban political ecology in relation to health and infrastructures has illustrated crises in energy provision, health and transportation systems through a new understanding of scale (cf. Keil, 2012).

[7] Agenda 21 is the document emitted after the United Nations Conference on Environment and Development which took place in Rio de Janeiro, Brazil, in 1992 (also known as the Earth Summit or the Rio Summit). The action plan tackles social and economic dimensions of international cooperation and sustainable development addressing issues related to: poverty, health, and the environment; conservation and management of resources; the strengthening of the role of women, children and youth, indigenous people, non-governmental organizations, local authorities, workers and trade unions, businesses and industry, the scientific and technological community, and farmers (United Nations, 1992a).

[8] In order to understand the context behind Agenda 21 and the documents which frame the way we understand sustainable development, it is important to become familiar with the work of Gro Harlem Brundtland, a Norwegian politician who served as the Prime Minister of Norway and as Director General of

During the United Nations' Millennium Summit held in New York, in 2000, representatives of 189 countries endorsed the Millennium Declaration (United Nations, 2000) and, with it, the Millennium Development Goals (or the so-called MDGs). From the eight MDGs, MDG 7c specified to "halve the proportion of people without access to safe drinking water and basic sanitation." According to The Millennium Development Goals Report (United Nations, 2015a), 147 countries met the drinking water target (specified at 88% cf. UNICEF & WHO, 2012). Despite the apparent increase in access to water and sanitation in the last three decades, the World Health Organization (WHO) and UNICEF's Joint Monitoring Programme (JMP) stated that 844 million people, or approximately one out of ten people, still lacked access to basic drinking water services, and only two out of five people used safely managed sanitation services (WHO and UNICEF JMP, 2017b, pp. 3–5). With respect to low- and middle-income countries, a study of over 66,000 healthcare facilities in 54 countries showed that "38% do not have an improved water source, 19% do not have improved sanitation, and 35% do not have water and soap for handwashing" (WHO & UNICEF, 2015). If nearly 40% of people in low- and middle-income countries do not have access to improved water, this means that the scenario for accessing safe water in these areas is at least as bad as the global estimate of people using safely managed sanitation services (in both cases two out of five people), and that a third of their population struggle with access to hygiene.

But what do the terms 'basic services,' 'safely managed services,' and 'improved sources' actually mean? The Multiple Indicator Cluster Survey Manual (UNICEF, 2006) explained that 'improved water' includes "water that is piped into a dwelling, yard or plot; public tap or

---

the World Health Organization. Two important milestones her name precedes in are: the Brundtland Commission and the Brundtland Report. The Brundtland Report built on the 1972 Report of the United Nations Conference on the Human Environment presented in Stockholm; the same year that the United Nations Environment Programme (UNEP) was founded. As the name of the conference indicates, the approaches are human-centered, seeking to "inspire and guide the peoples of the world in the preservation and enhancement of the human environment" (United Nations, 1972, p. 3). The 1972 Report focused on international level actions for the planning and management of human settlements and natural resources management, emphasizing the importance of economic and social development and encouraging international aid for developing countries. It wasn't until the Brundtland Report of 1987 where sustainable development was defined and attention was brought to the needs of the poor. Agenda 21, then, set a clear path for the international community to organize through global partnerships and achieve "a more efficient and equitable world economy" (United Nations, 1992a: II-2.1). Finally, the Rio Declaration called for international agreements to protect the "global environment and developmental system" (United Nations, 1992b), complementing the contemporary understanding of sustainable development and its means of implementation which made progress between 1972 and 1992.

standpipe; tube-well or borehole; protected dug well or protected spring; and rainwater collection." Improved water, in this sense, may or may not be safe, depending on groundwater quality and rainwater quality, and the mediums used to collect the water. In areas where there is an uncontrolled use of privately owned wells, and users do not have the means to test their water, the improved water they are consuming may contain critical levels of heavy metals.[9] Thus, the measurement of the MDGs achievement of target 7c has been questioned.[10] A wave of publications (Bain et al., 2012; Bartram et al., 2009; Brocklehurst, 2017; Schäfer, Werchota, Dölle, & Behnsen, 2007; Tortajada & Biswas, 2015; Yu, Bain, Mansour, & Wright, 2014) has argued that improved water has been used as a surrogate for actual safe water and that the statement on the progress of the MDGs related to water is false.

Since the 90s and the early 2000s, there has been a call for integrated solutions to address many urban issues. Recent studies criticize the politics behind the call for 'integrated approaches to achieve efficiency through technology and create policies open to market-based reforms (J. Williams, Bouzarovski, & Swyngedouw, 2018). Even before the Post-2015 Development Agenda and its 17 Sustainable Development Goals (SDGs) were published,[11] Gandy (2004, p. 369) referred to the *"emerging 'brown agenda,'* focused on the need for global improvements in water

---

[9] In Vietnam, for example, arsenic poisoning may be affecting the health of 7 to 10 million people living near the Red River Delta (M Berg et al., 2007; Michael Berg et al., 2001; Jessen, 2009; Postma et al., 2007; Winkel et al., 2011).

[10] WHO and UNICEF JMP (2017a) reported that access to improved water in Vietnam reached 99% in urban areas and 86% in rural areas, whereas access to piped water reached 82% and 41% respectively; not meeting the target of 88%.

[11] In 2015, the United Nations published the document titled: *Transforming our World, The 2030 Agenda for Sustainable Development* A/RES/70/1 (also known as the Post-2015 Development Agenda, or 2030 Agenda) (United Nations, 2015b). This document contains the Sustainable Development Goals (also known as the SDGs, or Global Goals), including goal number 6 which seeks to "ensure availability and sustainable management of water and sanitation for all." The SDGs aim to engage the United Nations Member States in a plan of action to ensure economic, social and environmental sustainable development (United Nations, 2015b). As reported by the United Nations Development Programme (2018), the Global Goals are "a universal call for action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity." The 2030 Agenda states that its principles and commitments are "grounded in the Universal Declaration of Human Rights, international human rights treaties, the Millennium Declaration, and the 2005 World Summit Outcome" (United Nations, 2015b, p. 8). Under the slogan of "leave no one behind," the SDGs build on collaborative partnerships for the realization of human rights (United Nations, 2015b, 2016).

and sanitation with its rights-based conception of access to water and sanitation."[12] Despite decades of investments in developing countries, cities have still not reached the modern infrastructural ideal and rather display what Gandy (2004, p. 363) described as "a more diffuse, fragmentary and polarized urban technological landscape."

1.1.5. Partnerships for development in the water sector

The United Nations' Sustainable Development Solutions Network (SDSN) pointed out that the investment required to meet the SDGs by 2030 is estimated at USD 1.4 trillion a year, and achieving access to water and sanitation in low- and lower-middle-income countries between 2015 and 2013 would require investments between USD 42 to 45 billion (Schmidt-Traub, 2015, p. 10). This has translated into a massive movement of resources and an alignment of institutional goals to meet the Global Goals, as well as a discussion of the opportunities for private and public shares in these investments.

Various positions regarding private sector participation in basic service provision are disputed in the literature. Despite opposition,[13] public-private partnerships (PPPs)[14] are considered necessary due to government budgetary constraints to invest in public infrastructure and encourage innovation and efficiency (Bayliss & Van Waeyenberge, 2017; Olusola Babatunde, Opawole, & Emmanuel Akinsiku, 2012). With a wide range of possibilities of private sector involvement in the operation, finance, construction and ownership of public services (David Hall, De la Motte, & Davies, 2003), examples of types of PPPs range from operation-maintenance (OM), design-build-operate (DBO), design-build-finance-operate (DBFO), build-operate-transfer (BOT), and build-own-operate (BOO); where, either, the private sector is responsible for specific phases of the life of a project and for a specific period of time, or the private sector retains ownership of the assets (Kwak, Chih, & Ibbs, 2009, p. 54). Factors which influence the success of PPP projects are: a favorable investment environment and manageable risks (nurtured by favorable legal frameworks and political support; e.g. minimum guaranteed revenue and flexibility in tariff structure), economic viability of the project (demand-driven), and effective project management (Kwak et al., 2009, pp. 70–71; Olusola Babatunde et al., 2012, pp. 215–216; Zhang, 2005, p. 5). The challenges of PPP projects are the complex contractual arrangements, the

---

[12] See also: *'The Brown Agenda': Urban Environmental Problems and Policies in the Developing World* (S. W. Williams, 1997).

[13] There are allegations that privatization has been 'repackaged as PPPs' since its failure, demonstrated by water riots and violence in the 1980s and 1990s (Datta, 2015, p. 76).

[14] Also known as private finance initiatives (or PFIs) in the UK (Kwak, Chih, & Ibbs, 2009).

assessment of risks, the profitability of the development of infrastructure, as well as the financial, technical, and managerial competencies of the concessionaire (Kwak et al., 2009, pp. 73–74).

With the rise of worlding cities integrated through a global economy, PPPs have gained popularity in the last three decades. Realistically, it is not a question if PPPs will (or should) occur or not, but how they can be mutually beneficial to both the public and private sectors.[15] In response to the debate of public and private provision of infrastructure facilities and services, decision-making tools (such as MIT's software called CHOICES) have been developed to help governments choose the most suitable combination of public-private involvement through different project delivery and project finance methods (Miller, 1999).

The main issues brought up in reaction to PPPs consider the marginalization of the poor and the need to regulate the private sector (Datta, 2015; Van Dijk, 2008). Adaptations to PPP arrangements have been proposed for the inclusion of local communities and NGOs through public-private-community partnerships (PPCPs) (Bakker, 2012; Van Dijk, 2008) and public-private-NGO partnerships (PPNP) (Baruah, 2007). Alternatives to PPPs are public-public partnerships (or so-called PUPs), which may involve public authorities (e.g. municipal water providers) and non-state entities (e.g. water cooperatives, NGOs or unions) in different arrangements (i.e. intra-state or domestic; inter-state or North-North and South-South; and developmental or North-South) (Boag & McDonald, 2010). A well-rounded definition of a PUP in the water sector is: "A twinning arrangement with a stated non-profit motive that aims to improve water services in one or more of the partner regions and which includes only public partners" (Boag & McDonald, 2010, p. 4).[16]

In 2006, WOPs started to populate the literature related to PUPs in the water sector. However, the literature on WOPs amounts to about 20 documents, a dozen of which are listed in Scopus(*) and less than half of which are both listed in Scopus and have been peer-reviewed(**) (cf. *Batten, 2010; **Beck, 2018; Bélanger Dumontier, McDonald, Spronk, Baron, & Wartchow,

---

[15] According to Miller (1999, p. 193) the public or private debate is empty, useless, hollow and futile. He argues that Information Technology (IT) developments needed for infrastructure improvements are carried out in the private sector and procured by the government (and absolutely necessary to meet world-class infrastructure standards). He elaborates that: "Neither a purely public nor a purely private approach to infrastructure provision has proven to be sustainable in either the developed or the developing world, particularly where financial and environment resources are limited and where innovations in the technology and methods associated with infrastructure continue to occur unpredictably throughout the world."

[16] Alternatives to both public and private models include community-managed water supply schemes (Bakker, 2008; P. A. Harvey & Reed, 2007), acknowledging, nevertheless, their inability to deal with financial and technical management issues at a city-scale.

2016; *Bishop & Kong, 2010; Bjerggaard, 2009; **Boag & McDonald, 2010; **Breeveld, Hermans, & Veenstra, 2013; **Gallego-Ayala, Dimene, Munhequete, & Amos, 2014; **Giesemann, Roche, Austin, & Moulton, 2009; D. Hall et al., 2009; IWA, GWOPA, & VEI, 2009; Mvulirwenande, Wehn, & Alaerts, 2014; **Ndirangu, Ng'ang'a, Chege, de Blois, & Mels, 2013; Pascual-Sanz, 2014; **Pascual-Sanz, Veenstra, Wehn de Montalvo, van Tulder, & Alaerts, 2013; *Patrón-Coppel & Schwartz, 2011; Rusca & Schwartz, 2012; Terhorst, 2012; *Tobon & Yates, 2014; **Tutusaus & Schwartz, 2016; **Wehn & Montalvo, 2016). WOPs are defined as "cooperation between water operators […] for providing support for capacity building of public water operators" with the objective to "strengthen local water services through WOPs while ensuring that WOPs are recognized as important means of achieving internationally agreed targets" (UNSGAB, 2006, p. 3). Other terms that have been used to describe cooperation between water utilities are: "capacity development partnerships (CDP)" (Pascual-Sanz, 2014; Pascual-Sanz et al., 2013); "knowledge and capacity development (KCD) interventions" (Mvulirwenande et al., 2014); "twinning arrangements" (Bjerggaard, 2009; IWA et al., 2009; Tobon & Yates, 2014); and "public-public twinning projects" (Rusca & Schwartz, 2012).[17] WOPs aim to support public utilities, but contrary to PUPs, they don't exclude private sector operators. This has awakened the suspicion that WOPs may be used to favor the private sector and actually cause more confusion than benefits (Boag & McDonald, 2010; D. Hall et al., 2009; Terhorst, 2012).

1.2. Case selection and the relevance of suburbanity

In Southeast Asia, 61 million people don't have access to improved drinking water, and 12 million people use surface water, and only a third of this population has access to piped water on premises (WHO & UNICEF, 2015, p. 7). Southeast Asia is comprised of eleven countries: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Vietnam (UN DESA, 2015b). The United Nations Department of Economic and Social Affairs (UN DESA) specifies that these countries are situated in a 'less developed region,' but are classified as high-, upper-middle-, lower-middle-, and low-income countries as follows: Brunei Darussalam and Singapore, high-income countries; Cambodia and Myanmar, low-income countries; Malaysia and Thailand, upper-middle-income countries; and Indonesia, Laos, Philippines, Timor-Leste, and Vietnam, as lower-middle-income countries (UN DESA, 2015b, pp. xiii–xx).

The most interesting opportunities for investing in infrastructure development are those in countries which have achieved a certain percentage of development, but have not yet rolled out

[17] Wright-Contreras et al. (2019).

their full potential. Countries which are just starting to develop, require investments to bring them up to speed, making them less appealing (due to unreliable investment returns). So, ideally, investors will most likely be interested in lower-middle-income countries which have the potential to develop into upper-middle-income countries.

Taking into account the Human Development Index (HDI), Vietnam and the Philippines are located in the median of Southeast Asian countries with 0.66 HDI (FAO, 2016).[18] Timor-Leste is located in the lower quartile range, and Indonesia and Thailand in the upper quartile range. With the purpose of selecting an in-land country with a medium-to-high development potential, Vietnam has been chosen as the country of focus for this research.

With 95.5 million inhabitants, Vietnam is ranked as the third largest country in Southeast Asia, after Indonesia and the Philippines (World Bank, 2017c). Vietnam's urbanization rate in 1950 was 11.6%, increasing to 33.6% in 2015, and expected to reach 53.8% by 2050 (UN DESA, 2015b, pp. 208–209). The country's population is expected to reach 101.8 million by 2030 and about 104 million by 2050 (UN DESA, 2015b, p. 245). Due to a population density of 308 inhabitants/km^2, Vietnam falls into the higher end of the range of countries in the region, which fluctuate between 81 and 352 inhabitants/km^2 (except for Singapore which has a population density of 7,915 inhabitants/km^2) (World Bank, 2017a).

Vietnam's development has been guided by a process of internationalization and economic liberalization (Bolay, Cartoux, Cunha, Du, & Bassand, 1997). Influenced by marketized systems, the state has combined social and capital principles into a hybrid structure and encouraged urban development through the investment of private capital (Labbé & Musil, 2014). This has raised questions regarding state-owned enterprises (SOEs) acting as profit-oriented organizations, favoring private entrepreneurship and affecting ecological sustainability, public interest and social cohesion (Labbé & Musil, 2014, p. 1148; Sun Sheng & Kim Trang, 2008, p. 1102).

Through the cases of Vietnam's capital, Hanoi, and the coastal city of the Central Vietnam Key Economic Region, Da Nang, this work aligns itself with literature on suburban infrastructure (cf. Filion & Pulver, 2019), showing that the phenomena described in developing areas are not exclusive to the Global South, but rather common to all cities around the globe. In this sense, suburban areas reflect splintering networks regardless of their income. More clearly, suburbanity mirrors the partial transformation of cities in their attempt to modernize.

---

[18] The Human Development Index (HDI) is measured by combining indicators related to health, education and income (GNI, or Gross National Income per capita in USD). The scale is from 1 to 0; 1.0 being the highest and 0 the lowest (UNEP, 2018).

Speaking of water and the modern ideal city, most authors have used the term 'periurban' (Adams & Zulu, 2015; Díaz-Caravantes & Wilder, 2014; Hofmann, 2013; Marston, 2014; Mehta & Karpouzoglou, 2015; Van Ewijk & Ehrhardt, 2016), and not 'suburban' (Gandy, 2008) to refer to developing areas which evidence a stark splintering of infrastructures. For the purpose of this research, situated in Asia, the areas of focus will be suburban areas which encompass both the 'periurban villages' and 'new urban areas' (cf. Wright-Contreras, March, & Schramm, 2017). Both typologies deal with access to water and sanitation services in their own way and are supported by the city to different extents, through pilot projects and public housing cooperatives, or rather by private water suppliers and decentralized water supply systems (Schramm & Wright-Contreras, 2017; Wright-Contreras et al., 2017).

The characteristics of the target areas of this research, Hanoi and Da Nang, reflect the development of Vietnam in two different stages. The first, with water distribution still carried out by an SOE, and the second by a Joint Stock Company (JSC). Considering the country's current national average of water loss determined at 32% (IBP, 2016, p. 54), the local water utility of Hanoi (Hawaco) shows stark problems of losses from the water distribution network fluctuating between 20% and 32% (Hawaco, 2014, p. 17; Owen, 2012, p. 221), while the local water utility in Da Nang (Dawaco) has managed to reduce water losses to 15% (Wright-Contreras, 2018). Both cities are situated in key economic regions of Vietnam, Hanoi as the capital (with nearly 7.5 million inhabitants) and main city of the Northern Key Economic Region, and Da Nang as one of five provinces of the Central Key Economic Region (with 1 million inhabitants) (GSO, 2017).

1.3. Research design

The objective of this research is to assess the effect of WOPs on the improvement of urban water supply in developing countries through the case of Vietnam, and specifically the cities of Hanoi and Da Nang. The country's capital, Hanoi, services to provide the background and state-of-the-art of the development of water infrastructures independent from the influence of WOPs. And the city of Da Nang analyzes the changes in local water services before and after a WOP intervention. The main research questions are: 1) What are the challenges to access safe water in Hanoi and how are they reflected in the built environment? And 2) What are the effects of WOPs on the improvement of urban water supply in Da Nang? Specifically, two broad tendencies of water provision are explored: a) the place-specific adaptation of decentralized infrastructure through public-private partnerships in the real estate market, and b) the expansion of large-scale (centralized) water infrastructure financed by bilateral aid and multilateral funding. Building on the scalar and political nature of the water infrastructure development, this work considers that WOPs sustainably contribute to the improvement of urban water supply in developing countries

by strengthening the capacity of local water utilities to cope with technical, managerial and financial challenges of water service provision.

Auxiliary questions related to the research in Hanoi question include: How is access to water supply splintered between the different suburban typologies (i.e. periurban villages and new urban areas) of Hanoi? How do people access water and sanitation in ways that reach beyond passive consumption of externally provided services, but are at the same time deeply entangled with centralized networks? What are the contradictions between formal policies and actual patterns of service provision shaped by broader suburbanization dynamics and socio-political constellations? And, how can transnational urban political ecology help evaluate the sustainability of the development of local water infrastructures and the equitable distribution of safe drinking water?

Likewise, questions supporting the research in Da Nang are the following: What is the current status and the role of WOPs in the achievement of the global sustainability commitments? How did the VEI-Dawaco WOP influence the sustainability of capacity and performance improvements of the local water utility in Da Nang? And, what were the factors which supported the long-term improvement of water supply services in Da Nang?

The research is based on a mixed-methods approach including observations from field studies; surveys; sampling of water qualities; semi-structured interviews with local and international organizations, government dependencies, water-related enterprises, financial organizations, academic institutions, nonprofit organizations, and community research programs; primary and secondary review of documents, benchmarking of Key Performance Indicators (or KPIs), and analysis of datasets. The findings have contributed to the topics of suburbanization, water governance, and utility performance (see Table 1). The specific focus and contributions of each of the outputs is provided below.

Table 1. Focus of each publication (P) and contribution to key topics.

Note: A = suburbanization, B = water governance, C = utility performance.

(P)	*Focus*	*A*	*B*	*C*
P-I	Water quality and unequal access to safe water	●	●	○
P-II	Place-specific adaptation of water services	●	●	○
P-III	Diversification of water supply and sanitation	●	○	○
P-IV	Multilevel water governance and scalar politics	●	●	○
P-V	Improved local water services through WOPs	○	○	●
P-VI	Case study: the VEI-Dawaco WOP	○	○	●
P-VII	Broader schemes of infrastructure investments	○	○	●

Table 2 summarizes the research objective, and the main research questions and subquestions to be answered cumulatively through publications P-I to P-VII.

Table 2. Research design and publications (P).

Research objective

To assess the effect of water operators' partnerships (WOPs) on the improvement of urban water supply in the case of Vietnam.

Main research questions and subquestions

1. What are the challenges to access safe water in Hanoi and how are they reflected in the built environment?	Case Study Hanoi
1.1. How is access to water supply splintered between the different suburban typologies (i.e. periurban villages and new urban areas) of Hanoi?	P-I
1.2. How do people access water and sanitation in ways that reach beyond passive consumption of externally provided services, but are at the same time deeply entangled with centralized networks?	P-II
1.3. What are the contradictions between formal policies and actual patterns of service provision shaped by broader suburbanization dynamics and socio-political constellations?	P-III
1.4. How can transnational urban political ecology help evaluate the sustainability of the development of local water infrastructures and the equitable distribution of safe drinking water?	P-IV
2. What are the effects of WOPs on the improvement of urban water supply in Da Nang?	Case Study Da Nang
2.1. What is the current status and the role of WOPs in the achievement of the global sustainability commitments?	P-V
2.2. How did the VEI-Dawaco WOP influence the sustainability of capacity and performance improvements of the local water utility in Da Nang?	P-VI
2.3. What were the factors which supported the long-term improvement of water supply services in Da Nang?	P-VII

1.4. Scope and limitations of research

Because of the growing trend of international development cooperation to support economies in transition, this work suggests the need to look at how these dynamics are taking effect. The present dissertation approaches the subject of global water operators' partnerships and their potential to contribute to the sustainable management of water. At the start, the research explored global and regional policies influencing water security in Vietnam. Then, with a closer look at strategies that support the achievement of SDG 6 in developing countries,[19] WOPs became a relevant subject in the discussion of sustainable urban water management transitions. The questions which were answered in this research open new questions about the replicability of international support mechanisms and their long-term effect. Given the potential of WOPs to contribute to the improvement of urban water services, further questions need to be explored. Are WOPs considered legitimate mechanisms by all stakeholders? If so, can the lessons learned from successful WOPs be transferred to areas which could benefit from similar cooperation mechanisms? These questions are necessary to better understand how WOPs can be adapted to development objectives, yet exceed the scope of the present compilation of publications.

The work builds on results from field research carried out in 2014, in Hanoi, focusing on spatial and infrastructure planning; followed by the detailed study of utility performance changes influenced by international cooperation in 2017, in Da Nang.

The main challenge of carrying out research in Vietnam was the language barrier. However, thanks to the continuous support provided by native-speakers, the research profited from insider perspectives on the subject, in combination with well-structured documentation and compilation of data during the interviews. Some presupposed obstacles, such as the researcher's foreign and multicultural background, turned out to be an advantage. In the frame of international conferences, government officials, researchers, and representatives of different types of organizations were keen to share their personal insights and knowledge. Often, interviewees suggested meetings with other experts from their personal and professional networks. In every case, communication was based on trust and long-term contact which ensured the possibility for follow-up questions and the exchange of relevant documents.

---

[19] SDG 6 specifically seeks to *ensure the availability and sustainable management of water and sanitation for all* (United Nations, 2017).

1.5. Outline of dissertation and brief description of methods

The present work is composed by an accumulation of fourteen sections (including the documents listed in the appendix), eight of which are published in the following form: five as peer-reviewed articles, two as book chapters, and one as a technical report published by UN-Habitat. The research focuses on the cities of Hanoi and Da Nang. The case study of Hanoi specifically analyzes access safe water in relation to the built environment, and the challenges and opportunities of (sub-)urban areas. The case study of Da Nang is introduced by a conceptual framework on WOPs, and further elaborates on the developments of Da Nang's water utility (also known as Dawaco) before and after a partnership with the Dutch water operators' company (VEI). The final sections offer a critical summary, discussion, and conclusion regarding the main messages extracted from each of the publications.

In detail, Chapter 2 explains how the layering of different types of infrastructures leads to the splintering of urban waterscapes, and the so-called 'cherry-picking' (cf. Graham & Marvin, 2001) of profitable customers according to their ability to pay for water services. The research describes the splintering of networks of Vietnam's capital through the study of users' perception of water accessibility (including quality, cost and affordability) in 10 suburban districts in the city of Hanoi, together with the sampling of water qualities in two different urban settings, and the expert assessment of (user-related, environmental, technical, institutional, and financial) water provision challenges (see Table 3).

Under the same phenomenon of splintering urbanism, Chapters 3 and 4 elaborate on the reaction of dwellers to the lack of formal water provision, resulting in the coproduction of services combining formal and informal, centralized and decentralized, private and public modes of water supply. The chapters build on information collected through semi-structured interviews to dwellers, local international organizations, government dependencies, water-related enterprises, financial organizations and academic institutions. The added value is the link between water and sanitation governance, showing how users adapt to urban infrastructures through collective action.

Connecting wider political and economic processes of development, this work also consider the influence of global actors over water service provision in developing countries. Using the theoretical lens of urban political ecology, and specifically a transnational urban political ecology of water infrastructures, Chapter 5 analyzes the relationship between global water policies and water management in Hanoi. The findings evidence broader patterns of development which have led to the prioritization of centralized infrastructure systems through foreign investments.

The research on WOPs, revolving around the case study of Da Nang, is based on semi-structured interviews to key informants, primary and secondary data of the partnership, benchmarking of Key Performance Indicators, and a database of global water operators' profiles

and partnerships profiles. The results are published in Chapter 6 (definition and scope of WOPs), Chapter 7 (partnership between VEI and Dawaco), and Chapter 8 (analysis of case study with respect to broader schemes of international and regional funding).

Chapter 9 summarizes the contributions of each publication, Chapter 10 highlights the main methodological approaches and empirical findings derived from the research, and opens discussion on: i) the continuity of utility performance improvements, ii) sustainable water management transitions, and iii) the effects of WOPs on poverty reduction. Finally, Chapter 11 concludes with a critical assessment of the 'cost of failure' of water infrastructures, the adoption of the PPPs and the privatization of public utilities in Vietnam, and the supporting role of WOPs within large-scale infrastructure development projects.

2. Fragmented landscapes of water supply in Suburban Hanoi

Publication No.	**P-I**
Type	Journal article
Journal	*Habitat International*
SJR Score	1.524
Status	Published
Reference	**Wright-Contreras, L.**, March, H., & Schramm, S. (2017). Fragmented landscapes of water supply in suburban Hanoi. *Habitat International*, *61*, 64–74. https://doi.org/10.1016/j.habitatint.2017.02.002
Abstract	Facing the challenges of city planning in the frame of rapid urbanization in the Global South, this study addresses the relationship between the urban development of Hanoi, Vietnam, and water supply including users' perception of water accessibility and satisfaction of coverage, quality, and cost. Because sociospatial disparities are particularly pronounced in suburban areas, these spaces epitomize unequal water access and uneven water quality. Based on the premise that (sub)urban water flows embody and mirror development dynamics and urbanization patterns, the objective is to analyze access to water splintered within the suburban typologies of Hanoi. We analyze the current state of domestic water availability and quality throughout suburban areas and specifically between a new urban area and a periurban village in Hanoi. Through the debates of splintering urbanism and periurban water supply, this paper discusses the differences in water service provision in suburban Hanoi. At the same time, the article considers suburban areas as spaces which reflect a broader spectrum of water supply solutions. Lastly, it informs on how to alleviate the pressure of the increasing demand of water in urbanizing areas by supporting sustainable urban water cycles to improve distributional justice and social equity.

Habitat International 61 (2017) 64–74

Contents lists available at ScienceDirect

Habitat International

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

Fragmented landscapes of water supply in suburban Hanoi

Lucía Wright-Contreras [a, b, *], Hug March [c], Sophie Schramm [d]

[a] Technische Universität Darmstadt, El-Lissitzky-Str. 1, 64287 Darmstadt, Germany
[b] Universitat Internacional de Catalunya, Carrer Inmaculada, 22, 08017 Barcelona, Catalonia, Spain
[c] Internet Interdisciplinary Institute (IN3), Universitat Oberta de Catalunya, Av. Carl Friedrich Gauss, 5, 08860 Castelldefels, Spain
[d] Universität Kassel, Institut für Urbane Entwicklungen, Gottschalkstr. 22, 34127 Kassel, Germany

ARTICLE INFO

Article history:
Received 29 December 2015
Received in revised form
18 December 2016
Accepted 3 February 2017
Available online 14 February 2017

Keywords:
Suburbanization
Splintering urbanism
Periurban waterscapes
Water infrastructures
Sustainable urban water cycles
Vietnam

ABSTRACT

Facing the challenges of city planning in the frame of rapid urbanization in the Global South, this study addresses the relationship between the urban development of Hanoi, Vietnam, and water supply including users' perception of water accessibility and satisfaction of coverage, quality, and cost. Because sociospatial disparities are particularly pronounced in suburban areas, these spaces epitomize unequal water access and uneven water quality. Based on the premise that (sub)urban water flows embody and mirror development dynamics and urbanization patterns, the objective is to analyze access to water splintered within the suburban typologies of Hanoi. We analyze the current state of domestic water availability and quality throughout suburban areas and specifically between a new urban area and a periurban village in Hanoi. Through the debates of splintering urbanism and periurban water supply, this paper discusses the differences in water service provision in suburban Hanoi. At the same time, the article considers suburban areas as spaces which reflect a broader spectrum of water supply solutions. Lastly, it informs on how to alleviate the pressure of the increasing demand of water in urbanizing areas by supporting sustainable urban water cycles to improve distributional justice and social equity.

1. Introduction

Environmental injustices, socioeconomic inequalities, and sociospatial fragmentations are intensifying in scale globally. Societies now face the challenges of rapid urbanization as the urban poverty rate may reach 45 to 50 percent by 2020 (Davis, 2004) and the world's population is expected to double by 2050 (UN DESA, 2008). Rapid urbanization in the Global South is magnifying existing issues such as urban sprawl, urban poverty, rising inequality and environmental degradation, among others (Zhang, 2016). Particularly suburban landscapes transform rapidly, as two thirds of the total inhabitants in the world are projected to populate urban areas by 2030 (UN Habitat, 2012) and the effects of socioeconomic polarization are most evident in these spaces. In the Asian context, the concept of 'suburban' refers to the transitional areas between the rural and the urban which share a mixture of different urban typologies (see Trân et al., 2012; other authors use the concept of 'periurbanization,' see Winarso, Hudalah, & Firman, 2015). These subjoined areas may benefit from higher accessibility to the urban core, but suffer from the complexity of issues that suburbanization entails, including access to basic services, such as water and sanitation. In Hanoi, suburban areas include *new urban areas* and *periurban villages*, the former mirroring the upscaling competition of the city in a global economy (see 'extended metropolitan region; ' Ginsburg & Koppel, 1991), and the latter characterized by a conflicted interface with higher marginalization and lower access to services (Allen, 2010). As water infrastructures in Hanoi are highly differentiated in suburban areas, this research will unveil the current splintered infrastructure systems of centralized piped water schemes, privately owned wells, and additional solutions that users implement to make up for obtaining safe drinking water.

This paper frames the research of water supply in Hanoi within the challenges of urbanization and rapidly transforming urban and rural landscapes, contributing to the debates between water supply and (sub)urbanization of Global South cities (Adams & Zulu, 2015; Allen, 2003; Allen, Dávila, & Hofmann, 2006b; Díaz-Caravantes & Wilder, 2014; Gandy, 2008; Hofmann, 2013; Marston, 2014; Mehta & Karpouzoglou, 2015; Van Ewijk & Ehrhardt, 2016). We

* Corresponding author. Technische Universität Darmstadt, El-Lissitzky-Str. 1, 64287 Darmstadt, Germany.
E-mail addresses: wright@stadt.tu-darmstadt.de (L. Wright-Contreras), hmarch@uoc.edu (H. March), s.schramm@iwar.tu-darmstadt.de (S. Schramm).

http://dx.doi.org/10.1016/j.habitatint.2017.02.002
0197-3975/

ask the question, how is access to water supply splintered between the different suburban typologies of Hanoi? To carry out this study, we analyze the local development of infrastructures, as well as water accessibility and satisfaction of coverage, quality, and cost perceived by residents of different areas in Hanoi, focusing primarily on new urban areas and periurban villages.

The article draws on qualitative and quantitative data from interviews and documentation provided by institutions directly or indirectly linked to water supply in Hanoi. These include the National University of Civil Engineering (NUCE), Hanoi University of Science and Technology (HUST), Hanoi Water Company (HAWACO), Vietnam's General Company of Construction and Export (VINACONEX), Ministry of Construction (MOC), Ministry of Agriculture and Rural Development (MARD), National Target Program (NTP3) of MARD and UN Habitat Vietnam. Additionally, informal interviews and conversations were carried out in the 37th WEDC (Water, Engineering and Development Center) Conference in Hanoi. More specifically, the present study of water supply in Hanoi focuses on: 1) the analysis of users' perception on accessibility, and satisfaction of coverage, quality and cost of water, through 100 questionnaires carried out through cluster sampling of the local population in 10 districts during August and September of 2014, conducted across Hanoi in the suburban districts of Đống Đa, Hai Bà Trưng, Thanh Trì, Hà Đông, Nam Từ Liêm, Hoàng Mai, Long Biên, Gia Lâm; the inner-city district of Hoàn Kiếm; and the rural district of Hoài Đức; and 2) the analysis of water quality which compares piped water and groundwater in two contrasting areas: the new urban area of Linh Đàm, in the urban district of Hoàng Mai, and the periurban village of Triều Khúc, in the rural district of Thanh Trì. The first analysis is based on a survey using 10 questions to obtain information on: a) water accessibility, b) users' knowledge of the source of water, c) type of water supply system and distribution company, d) satisfaction of coverage, e) satisfaction of quality, f) comparison of water supply coverage and quality with neighboring areas, g) cost of water per month, h) family income per month, i) appreciation of cost of water in relation to income, and j) community organization. The second analysis on water quality weighs environmental hazards in Hanoi's piped water and groundwater. These analyses help understand the contrasts between the different urban typologies of Hanoi's suburban areas and water supply schemes. On one hand, the semistructured interviews with local and international organizations, government offices, water-related enterprises, financial organizations, and academic institutions in Vietnam inform the institutional challenges of water provision. On the other hand, the empirical analysis of water supply in suburban areas illustrates direct field research and observations.

The paper is structured as follows. In section two, the article presents an overview of recent scholarship on periurban water access and quality linked to the debate of splintering urbanism. In section three, water infrastructure development in Vietnam and (sub)urbanization in Hanoi is contextualized. The fourth section presents a comparative review based on first-hand information of users' perception of water, discussing accessibility, and satisfaction of coverage, quality and cost of water in Hanoi (100 cluster samples in 10 districts), as well as piped water and groundwater quality (8 water samples in 2 districts). Lastly, the discussion identifies suburban areas as spaces of opportunity in which sustainable urban water cycles can be developed.

2. Splintering of Hanoi's suburban waterscapes

Within Hanoi's continuous expansion, city planners and authorities are under massive pressure to adequately deliver services adequately to urban dwellers and meet the demand of the growing population and rapidly urbanizing suburban areas. Two typologies characterize these spaces. On one hand, so-called *new urban areas*, which house a growing business class as well as resettled former villagers (Labbé & Musil, 2014, p. 1156) and sometimes become "islands of wealth" (Monstadt & Schramm, 2013, p. 90). Here, local infrastructure networks operate as "satellite systems" (Monstadt & Schramm, 2013), exclusively catering to the residents of these estates. On the other hand, *periurban villages* in adjacent areas that remain excluded from external service provision are often stuck in an interface of "sustained poverty, poor infrastructure and a lack of institutional frameworks and governmental support" (Norström, 2007, p. 5). The contrasts between these two typologies can be explained through the concept of 'splintering urbanism' (see Graham & Marvin, 2001), which defines the fragmented growth of cities and the unequal access to services, such as water supply. This concept encompasses the complex, uneven, and intertwined economic, cultural and socio-technical processes behind the production and functioning of urban infrastructures and fragmented urban growth. Briefly, the concept of splintering urbanism aims to shed light on the social disparities and territorial imbalances found in cities around the world (Graham & Marvin, 2001, p. 56). It is through this examination of "space, technology, infrastructure networks and social power" that new (and much needed) mindsets on urban development will be brought forward (Graham & Marvin, 2001, pp. 53–54).

The effects of splintered urbanism are highly visible in cities of the Global South. While the benefits of developing estates equipped with their own water supply systems may be a step towards modernization, the patches of settlements all around suffer from the lack of connectivity to the central water network system and to their neighboring decentralized systems. The concept of 'periurban' areas, or periurbanization, emerges as a critical concept to understand what happens on the fringes of urban areas, in this case concerning water supply. Although there is no clear definition of 'periurban', the discussion amongst scholars tackles the spatially and politically undefined areas. Van Ewijk and Ehrhardt (2016, p. 2) state that: "It is not the proximity to towns, but the linkages and flow of goods, finance, labor and services between rural and urban centers that defines periurban." The challenges which these areas display are rooted in several causes, including the cost of water, which is the driver for most users in poorer areas to seek alternative sources. In most cases, informal practices are not taken into consideration by "formal systems" (Allen, 2003, p. 341). In this case, discussion arises between "policy-driven" and "needs-driven" approaches (Allen et al., 2006b), calling for a more sustainable program of water management. Scholars have specifically focused on urban water provision in these settings. Díaz-Caravantes and Wilder (2014), and Mehta and Karpouzoglou (2015), use the concept of 'periurban waterscape' to show the interconnected social, economic, cultural and political processes embedded in water supply in those areas between the city and the rural areas. In other words, the concept of 'waterscape' encompasses "social, natural, material and discursive processes" (Mehta & Karpouzoglou, 2015, p. 166). Allen (2003) refers to those spaces as "periurban interfaces" and also discusses the main challenges they present concerning water services. Water provision in periurban interfaces has been analyzed by Mehta and Karpouzoglou (2015) in the case of Delhi. Along similar lines, Adams and Zulu (2015) use the concept of 'periurban water supply' in the context of Sub-Saharan Africa. Allen et al. (2006b) specifically focus on the "periurban water poor" lacking adequate water services and water provision in "periurban interfaces" (Allen, 2003; Hofmann, 2013; Mehta & Karpouzoglou, 2015). Periurban waterscapes are implicitly mirrors of power relations (Gandy, 2008) and income inequalities (Mehta & Karpouzoglou, 2015). This gives a distinct importance to the study of water access and water quality in periurban areas, as it is

through the understanding of this material flow (Bakker, 2003) that we can recognize challenges in urbanization and development processes of cities in the Global South. In this paper, we will explore these questions through the case of suburban water supply in Hanoi.

3. Urbanization and the development of water infrastructure in Hanoi

Located in Southeast Asia, bordering China, Laos, and Cambodia, and situated along the coast of the South China Sea, Vietnam is a lower middle income country (World Bank, 2015) with an economic growth raising at a rate of 5.98% with respect to 2013 (GSO, 2014a), and a GINI coefficient of 0.37 which denotes moderate inequality (UNDP, 2010, p. 27). The country's total population is nearly 90 million (World Bank, 2013) with a poverty rate of 20.7% (Badiani et al., 2012, p. 67). Meaning "to renew" or "innovate," the *doi moi* reforms of 1986 embody the shift of Vietnam's transition towards a socialist-oriented market regime (Han & Vu, 2008; Labbé & Musil, 2014; Quang & Kammeier, 2002; Turner, 2009). As result of these reforms, and of the country's insertion in the global economy in the 1990s, the boost of economic growth positioned Vietnam on the map for transnational trade and foreign investment (Labbé, 2013). Urbanization, rated 33% (UN, 2014), is now projected to reach 43.3%, as the total population may rise to 101.48 million by 2030 (Owen, 2012, p. 219).

Within this frame, Hanoi has played an important role as Vietnam's capital and largest city, leading the country through its economic transition (Han & Vu, 2008, p. 1098). Located in the North of Vietnam, the city is inhabited by 7 million people (GSO, 2014b), of which approximately 5% are living in conditions of poverty (Badiani et al., 2012, p. 96). The rapid expansion of Hanoi is fueled by the movement of people to urban areas and the subsequent increase of population, rising 3.35% per year (World Bank, 2011, p. 119), and density, with 2,134 of people per square kilometers of land in the city (GSO, 2014b). Formal and informal urbanization processes (see Minnery et al., 2013) have been largely subject to the availability of land shaped by land-use policies and a market-oriented economy, both consequences of institutional changes.

Adding to the sociospatial challenges of water supply, and despite the efforts of Vietnam's central administration to regulate groundwater extraction, overall overexploitation of aquifers in Hanoi has led to groundwater depletion and soil subsidence (Giao & Ovaskainen, 2000). An alarming 90% of urban sewerage discharges directly into rivers (Le Van, 2012, p. 4), affecting surface water exploitation. Although groundwater extraction became Hanoi's primary raw water source in the 1990s due to pathogenic bacteria found in surface water (Jessen, Jakobsen, Postma, & Larsen, 2009, p. 3), surface water has now become the main source again because of poor groundwater quality in the region (Jessen et al., 2009) and aquifer depletion (see "Hanoi's water supply 2030 master plan and 2050 vision; " HAWACO, 2014a, p. 1).

Rapid urbanization and environmental challenges have affected the supply capacity for basic urban services such as drinking water and sanitation. Concerning the production of potable water in Hanoi, four water enterprises are responsible: VIWASUPCO, HAWACO, Son Tay Company, and Ha Dong Company. To keep up with the demand of water, HAWACO, Son Tay Company, and Ha Dong Company extract approximately 700,000 m^3/day of groundwater; and VIWASUPCO extracts approximately 300,000 m^3/day of surface water (HAWACO, 2014b, p. 17). The companies responsible for the distribution of potable water in Hanoi are: VIWACO, HAWACO, Son Tay Waterworks, and Ha Dong Waterworks. HAWACO is considered the largest water enterprise in Hanoi within the hierarchy of the companies' roles in water provision and has the highest distribution capacity, supplying almost three quarters of the total water supply (with 1,708 km of distribution lines, in comparison to 217, 171, and 627 km of distribution lines from VIWACO, Son Tay Company, and Ha Dong Company, respectively; see HAWACO, 2014b, p. 14).

In order to reduce the 70% of piped water coming from aquifers, two new surface water treatment plants are being built. These are to add to the surface water already extracted from Đà River, as the demand of water was projected to increase to 2.7 million m^3/day in 2015 and 3.3 million m^3/day in 2030 (HAWACO, 2014a, p. 1). The two new surface water treatment plants, to extract water from Hồng River and Đường River, are planned with an initial capacity of 300,000 m^3/day and are expected to expand to a production of 600,000 m^3/day and 900,000 m^3/day in 2050 (HAWACO, 2014b, pp. 1–3, 22). Fig. 1 provides a graphical summary of the existing institutional arrangements and actors who produce and distribute potable water in Hanoi, as well as the quantities and sources of water extraction, and the treatment and distribution processes that ensue.

The Ministry of Construction (MOC) and the Ministry of Agriculture and Rural Development (MARD) face difficulties to service the urban, suburban and rural population in Vietnam with safe water. The first has jurisdiction over urban areas, the second over rural areas. In addition to these two ministries, projects for the development of water supply in Vietnam are coordinated with other government dependencies involving the People's Committees of Provinces, People's Committees of Cities and Towns, and People's Committees of Districts. As People's Committees are part of the local state administration (Parenteau & Thong, 2005, p. 247), decisions concerning water supply mainly follow formal legislation, such as the Clean Water Supply and Environmental Sanitation program launched in 1995 by the National Environmental Agency of the Ministry of Science, Technology and Environment (MOSTE) (Owen, 2012, p. 219). The Ministry of Health (MOH) indicates water quality standards and the Ministry of Planning and Investment (MPI) must approve large-scale projects (Owen, 2012).

As the definition of suburban is jurisdictionally unclear in Vietnam, boundaries between the urban and the rural districts are negotiated between MOC and MARD. In Hanoi, the city develops water supply through master planning, agreed upon by Hanoi People's Committee (HPC) and approved by the Prime Minister. The planning, building, operation and maintenance of piped water supply systems in Hanoi results from a joint effort between urban- and rural-related ministries. Urban planning authorities design and construct water treatment plants through the approval of the central government, and the operation and maintenance of these systems is largely subject to the efforts of state programs that encourage rural households to connect to the piped water distribution network in urbanizing villages. As part of the key strategies lead by MARD, the Information, Education and Communications (IEC) department plays an important role by informing village dwellers on the advantages of the piped water scheme and promoting this technological system, now using "behavior change communication" supported by UNICEF's approach of Communication for Development (C4D) (Interview MARD, 2014). The IEC department assists users in selecting the 'appropriate' technology to ensure the financial sustainability and the operation of water treatment plants and water distribution networks to their maximum capacity (Interview MARD, 2014).

Besides the expansion of the piped scheme network system to supply safe water, maintenance of the existing infrastructure is a challenge. Within the current national average of water loss determined at 32% (IBP, 2016: 54), water losses of the piped distribution networks in Hanoi fluctuate between 20 and 32% (Owen, 2012, p. 221; HAWACO, 2014b, p. 17). Between preventing water

loss, and increasing coverage as needed in Hanoi, the country aims at increasing investment in water infrastructures and implementing a regulated tariff calculation based on water meters and identifying illegal connections (Owen, 2012, pp. 219, 221). In line with the World Bank's 2020 targets, Vietnam would expect to raise the existing 76% safe water coverage, according to the baseline value of 2011, to 85–90% in urban areas and from 37% to 75% (or 85% according to the Ministry of Foreign Affairs in Denmark, 2014) in rural areas (WSP and World Bank, 2014, pp. 5–6).

It is important to keep in mind that the development of water infrastructures in Hanoi faces technical and institutional challenges addressed by government dependencies, international organizations, and financial institutions, with participation of the private sector. At another level, the analysis of the particularities of residents' consumption patterns related to domestic water use is relevant to the aim of this paper. Hence, the next section will explore users' perceptions of water accessibility and satisfaction of coverage, quality, and cost, as well as the monitoring of water quality of piped water and the environmental hazards of groundwater accessed by privately owned wells in Hanoi.

4. Suburban water supply in Hanoi: users' perceptions, water quality and environmental hazards

According to the largest water distribution company in Hanoi, HAWACO (2014b, p. 17), 55% of the city's population, or 3.6 million users have access to piped water. HAWACO specifies that urban districts have full water coverage from the distribution network, while piped water reaches only 41.93% of suburban districts (HAWACO, 2014b, p. 17). At the urban scale, users consume 120–140 l/capita/day, double the national average of 50–70 l/capita/day (Owen, 2012, p. 219). Although piped water in urban districts is accessible, many households still rely on water from private vendors and privately owned wells. In 2010, the sources in urban households were recorded as follows: 70.6% piped water, 0.3% from private vendors, 26.3% from tube wells with pump, and 2.8% as other (UNDP, 2010, p. 80).

Pursuing modernization, MOC and MARD strategize the expansion of centralized piped water networks. MARD pursues the expansion of piped water into rural areas through its National Target Program (NTP) for Rural Water Supply and Sanitation (RWSS) (phase 3 from 2012 to 2015, also called NTP3). The NTP3

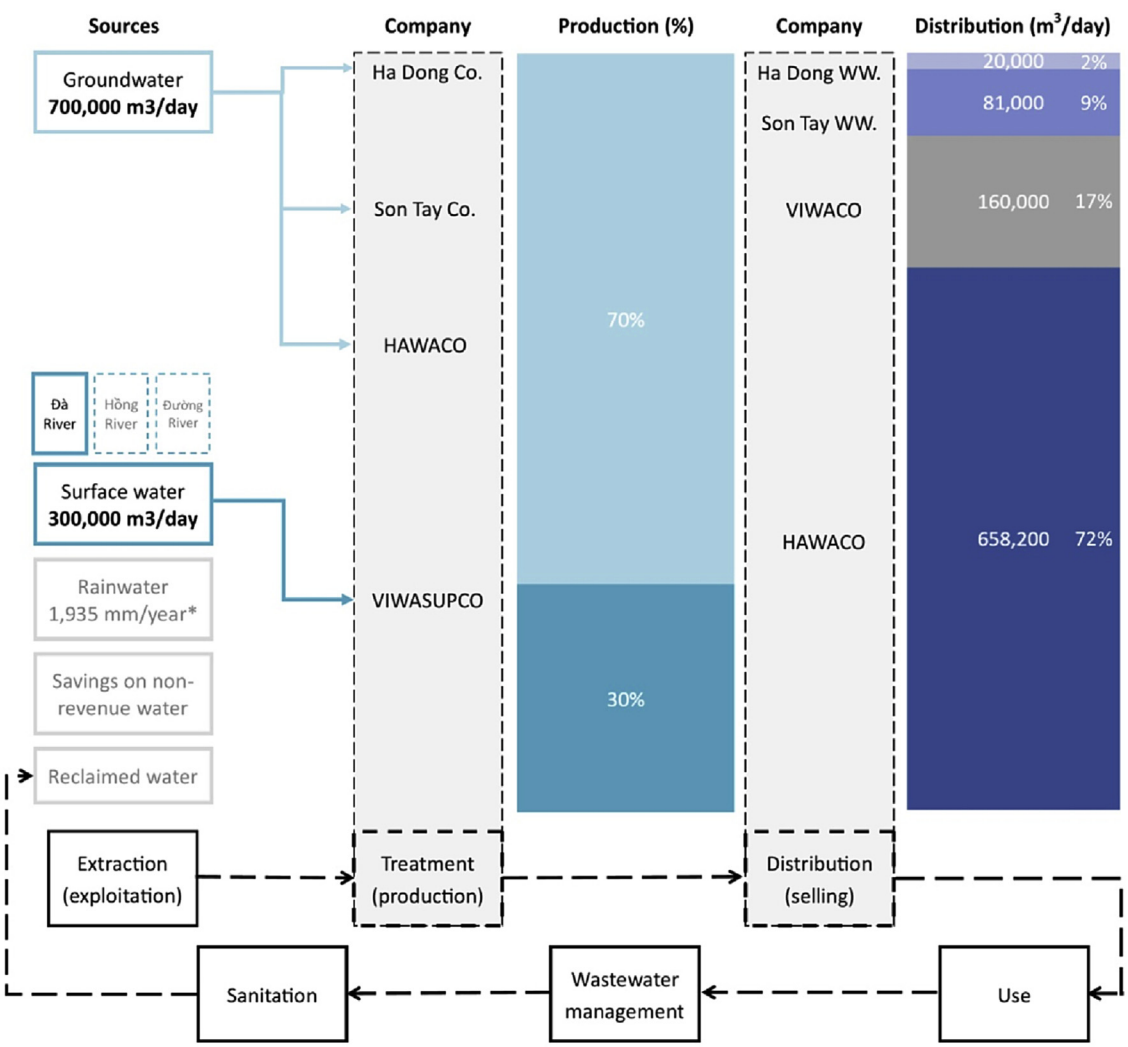


Fig. 1. Hanoi's water cycle and existing production and distribution companies.

program follows a results-based planning and financing approach, which promotes the piped water scheme in rural and suburban areas. At the same time, suburban dwellers attempt to gain control over their water consumption by accessing water through private and decentralized technologies. On one hand, despite the state's efforts to centralize, local managers of new urban areas often operate decentralized, private water treatment facilities. This is because of large distances to Hanoi's centralized piped water network, but also as a result of the competitive stance between construction companies managing infrastructure supply in the new urban areas and the water supply companies (Schramm, 2016). On the other hand, periurban villages rely on independent sources of water, alternating bottled water consumption and filtered well water. Interviewed users state that they complement their intake for drinking water with bottled water and 30% also filtered then boiled well water to drink or cook. The average intake of bottled water per week was 10–20 L, with a difference in cost reflected by the percentage of users complementing their consumption with water from privately owned wells; people who additionally used filtered and boiled well water spent around 0.44 US dollars (USD) per week, equivalent to 10,000.00 Vietnamese Dong (VND) at 22,300.00 VND for 1.00 USD, while people who relied only on bottled water spent up to 3.00 USD per week.

To better understand the overlapping of conditions in suburban areas, the following sections compare water accessibility and satisfaction of coverage, quality, and cost, between suburban districts, focusing primarily on the areas bordering between urban and rural districts, and considering users' perceptions and the effect of built environments on safe water access.

4.1. Accessibility and satisfaction of coverage, quality and cost of water

The following subsection analyzes the results of the 100 questionnaires applied throughout the districts of Hoàn Kiếm, Đống Đa, Hai Bà Trưng, Thanh Trì, Hà Đông, Nam Từ Liêm, Hoàng Mai, Long Biên, Gia Lâm, and Hoài Đức (see Fig. 2). These areas were chosen by selecting 80% of the samples situated in the suburban fringe surrounding the inner city; except for the district of Hoàn Kiếm, which corresponds to the main inner city district, and the district of Hoài Đức which corresponds to a rural district, used as points of comparison to fill the spectrum of the urban-rural range. The results in Table 1 show that access to piped water reaches 100% in 8 of the 10 districts; 90% in the suburban district of Gia Lâm, and 0% in the rural district Hoài Đức, where rainwater was the village's predominant source. It is important to mention that in the urban core district of Hoàn Kiếm, although access to water is 100%, there is an inclination towards water from privately owned wells. One respondent explains: "In 2000, each family had a private well and some families still prefer to use water from their tube or dug wells instead of paying the water tariff" (Interview Resident, Hoàn Kiếm inner-city district, Hanoi, 2014). Additionally, the user states: "Coverage is low, especially during rush hours—between 5 and 6 p.m. it is not enough". Preference to access water independently from the centralized network is observed clearly in Gia Lâm, where, although there is 90% of access to piped water, more than half of the population surveyed uses privately owned wells. The interviewees in Gia Lâm use wells as primary sources of water, but still have a connection to the piped network system. Thus, they pay a water tariff of between 0.70 USD to 3.60 USD per month in comparison to users who do not own wells and pay 0.50 USD to 15.70 USD per month. These expenses refer specifically to bills received according to the water tariff of each area and exclude any personal expenses on purification and filtration methods. In lower income areas, such as in Hà Đông, the cost of piped water is perceived to be more expensive (see relative cost to income in Table 1). Altogether, prices of water range from 2 to 28% of the average income of Hanoi's population, considering 104.00 USD per month (UNDP, 2010, p. 26).

Regarding quality, water was rated lowest in the suburban districts of Đống Đa, Hà Đông, Long Biên, and Gia Lâm. One interviewee in the commune of Vạn Phúc, in Hà Đông, expressed that the water supplied to his household connection is: "Dirty water, a lot of sludge, a lot of detergent [possibly chlorine, comment by authors]; the color of water is yellow or brown. I need to use a water purifier" (Interview Resident, periurban Vạn Phúc commune in Ha Dong district, Hanoi, 2014). In addition to comments regarding the bad appearance or odor of water, other users noted that they are aware of high levels of iron in their water, as indicated in the results of private tests they have conducted. Quality improves significantly when users invest in private water storage systems and treat their own water using additional purification methods. Generally, the interviewees expressed that there was little difference between the water quality in the area they lived in compared to adjacent districts, except in the rural district of Hoài Đức, which rated lower than average due to the lack of connections to the piped water network.

4.2. The relationship between urban typologies and measured water quality

To assess the difference in quality of water supplied in suburban areas, we selected the new urban area of Linh Đàm and the periurban village of Triều Khúc to test 8 water samples for hazardous chemicals that may affect users' health (see Table 2). Facilitated by the School of Environmental Science and Technology of the Hanoi University of Science and Technology in September of 2014, the results show that the quality of piped water remains similar between Linh Đàm and Triều Khúc, equally respecting the QCVN 01: 2009/BYT National Technical Regulation on Drinking Water Quality (SRV, 2009). However, the quality of the groundwater extracted from privately owned wells affects both areas regardless of the urban typology and the users' socioeconomic level. Groundwater in Linh Đàm displays almost twice the tolerated amount of ammonium (NH_4), more than 10 times the permissible level of arsenic (As), and 90 times the standard for iron (Fe). Groundwater in Triều Khúc shows more than twice of the tolerated amount of ammonium (NH_4), up to 30 times more of the permissible level of arsenic (As), and 45 times the standard for iron (Fe).

Considering the comparable risk found in groundwater quality in both Linh Đàm and Triều Khúc, the impact on users' health is rather dependent of the housing typologies and the built environment which limit or permit the use of privately owned wells. Marked by the high-rise buildings and built public space provided in Linh Đàm, privately owned wells are found in peripheral areas of the new urban area, if at all. As the built environment in Triều Khúc is more open to both formal and informal construction, the likelihood of accessing water from privately owned wells is higher. The connection between users' perception and actual water quality issues can be appreciated in the 100 cluster samples. Users stated that there is a general awareness of the presence of heavy metals in groundwater, which is why residents opt for an array of water sources for their different activities. If presented as an option, many will use groundwater for gardening, construction, or for washing. However, even when piped water is technically considered safe to drink, social perceptions show a mistrust of the water source. One resident mentioned: "My family has a water purification system because we are worried about the water source" (Interview Resident, new urban area of Linh Đàm in Hoàng Mai district, Hanoi, 2014). Depending on the level of income of the family, and considering saving on water bills, residents will opt to filter or boil

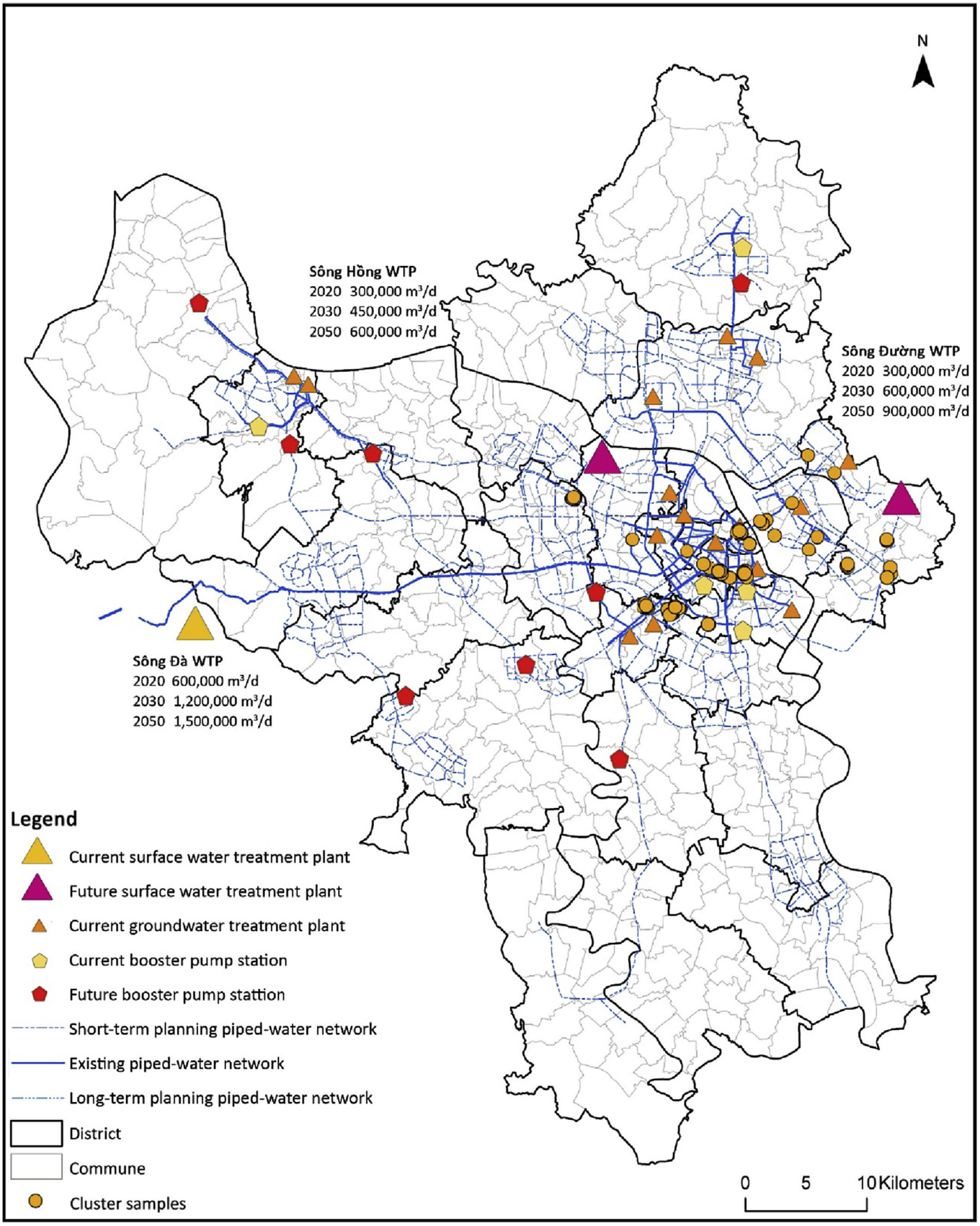


Fig. 2. Hanoi's water supply network, projections of expansion to 2020, 2030 and 2050, and location of cluster sampling.

Table 1
Results of surveys on accessibility and satisfaction of coverage, quality and cost of water.

District	Name Typology	Hoàn Kiếm City-center	Đống Đa Urban	Hai Bà Trưng Urban	Thanh Trì Rural	Hà Đông Urban	Nam Từ Liêm Urban	Hoàng Mai Urban	Long Biên Urban	Gia Lâm Rural	Hoài Đức Rural
			<- Suburban ->								
Case studies	Name Typology				Triều Khúc PUV			Linh Đàm NUA			
Location	Kilometers from city center (Direction)	0	3 (SW)	5 (S)	7 (SW)	8 (SW)	9 (W)	10 (S)	11 (E)	12 (E)	14 (W)
Household size	Number of inhabitants per household	3.9 (2 to 6)	4.1 (2 to 6)	3.8 (2 to 6)	4.7 (2 to 10)	5 (4 to 9)	4.7 (3 to 10)	3.8 (1 to 7)	4.1 (3 to 6)	4.1 (3 to 5)	4 (3 to 5)
Availability of water and sources	Access to piped water supply (%)	100	100	100	100	100	100	100	100	90	0
	Awareness of water source (%)	50	30	20	70	70	40	70	10	70	100
	Type of predominant water supply	Piped water +1 tube well	Piped water	Piped water	Piped water	Piped water	Piped water	Piped water	Piped water	Tube well / Piped water	Rainwater
Satisfaction of coverage and quality of water supply	Coverage [-](1 to 10)[+]	7.4 [s1.65]	7.1 [s2.02]	8.6 [s0.97]	8.4 [s0.84]	7.8 [s1.23]	8.2 [s0.92]	8.4 [s1.07]	6.9 [s3.21]	7.0 [s1.80]	1.7 [s0.67]
	Quality [-](1 to 10)[+]	7.9 [s0.99]	7.0 [s1.54]	7.6 [s1.26]	7.7 [s1.16]	7.0 [s1.41]	7.8 [s1.13]	7.1 [s1.79]	6.0 [s2.58]	5.9 [s1.33]	1 [s0.53]
	Comparison to adjacent areas [-](-2 to 2) [+]	0.6 [s0.71]	0.4 [s0.70]	0.9 [s0.42]	0.5 [s0.53]	0 [s0.46]	0 [s0.47]	0.7 [s0.67]	0.1 [s0.31]	0.1 [s0.73]	-0.4 [s0.52]
Cost and relative cost of water per household	Cost range (VND/month) (x1,000)	40-200	40-140	40-200	100-300	130-350	120-300	70-650	40-175	15-350	n/a
	Cost average (VND/month) (x1,000)	89	72	78	192	214	197	139	103	108	n/a
	Family income (VND/month) (x1,000,000)	> 4,000: 1 4-8,000: 3 8-12,000: 6	> 4,000: 2 4-8,000: 7 8-12,000: 1	> 4,000: 3 4-8,000: 4 8-12,000: 3	> 4,000: 3 4-8,000: 5 8-12,000: 2	> 4,000: 8 4-8,000: ? 8-12,000: ?	> 4,000: 1 4-8,000: 9 8-12,000: 0	> 4,000: 4 4-8,000: 4 8-12,000: 2	> 4,000: 5 4-8,000: 4 8-12,000: 1	> 4,000: 4 4-8,000: 4 8-12,000: 2	> 4,000: 5 4-8,000: 4 8-12,000: ?
	Relative cost to income [-] (1, 2, 3) [+]	1.8 [s0.42]	2 [s0.47]	2.2 [s0.42]	2.3 [s0.50]	2.6 [s0.52]	1.9 [s0.32]	2.3 [s0.67]	2 [s0.66]	1.8 [s0.50]	n/a
Community organization	Neighborhood organization (%)	100	100	100	100	100	100	100	100	100	100

their own groundwater. As a result of our study of hazardous metals found in the groundwater of the region, viewed in line with the built environments of both areas, this analysis shows that monitoring the use of low-quality water sources cannot be viewed separate from the urban form, since it is the latter which conditions the use of small-scale technologies.

Identifying reliable raw water sources, and protecting freshwater bodies from overexploitation and wastewater contamination, are some of the main user-related and environmental challenges to build a sustainable urban water cycle. Several studies (Berg et al., 2008; Jessen et al., 2009; Postma et al., 2007; and Winkel et al., 2010) have raised critical issues in relation to groundwater pollution and have presented evidence that arsenic (As) is affecting lives of between 7 to more than 10 million people living around the Red River Delta. Parting from the World Health Organization's guidelines which establish no more than 10 μg of arsenic (As) per liter in drinking water, some studies have found between 10 and 300 times more arsenic (As) than the established guidelines (Bainbridge, 2013). Being exposed to such amounts of arsenic (As) could cause severe and deadly diseases such as hyperpigmentation, skin cancer, heart attacks and cancer of internal organs due to arsenic poisoning or arsenicosis (Jessen et al., 2009).

5. Discussion

This research has aimed to understand how urban typologies and water accessibility interrelate and affect users in suburban Hanoi. This paper has analyzed: a) water access in suburban areas of Hanoi, and b) the splintered typologies between new urban areas and periurban villages. To do so, it has been important to discuss

Table 2
Results of water samples in districts of the new urban area of Linh Đàm and the peri-urban village of Triều Khúc.

District (NUA/PUV)		Hoàng Mai (Linh Đàm)				Thanh Trì (Triều Khúc)				
Water source		Piped water		Groundwater		Piped water		Groundwater		
Chemical / Sample		LDTP1	LDTP2	LDGW1	LDGW2	TKTW1	TKTW2	TKGW1	TKGW2	QCVN 01:2009
Amonium	NH4	BD	BD	5.68	2.404	BD	0.0321	7.05	0.204	3
Phosphat	PO4	0.23	0.316	2.736	0.758	0.104	0.141	0.835	0.235	?
Arsenic	As	0.0008	0.0055	0.1144	0.0541	0.0012	0.0007	0.276	0.0668	0.01
Lead	Pb	0.0009	0.0008	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0146	0.01
Cadmium	Cd	0.0004	0.0005	0.0005	0.0004	0.0005	0.0005	0.0002	0.0006	0.003
Iron	Fe	0.217	0.258	27.554	22.347	0.239	0.209	13.751	5.161	0.3
Manganese	Mn	0.002	0.011	0.737	0.318	0.016	0.009	0.069	0.13	0.3
Zinc	Zn	0.096	0.152	0.016	0.011	0.003	0.005	0.001	0.118	3
Copper	Cu	0.068	0.045	0.012	0.017	0.013	0.027	0.005	1.138	1

the consequences of rapid urbanization by exposing increasingly blurry boundaries between the urban and the rural, and the contrasts between new urban areas and periurban villages within the city's suburban fabric. Further on, the aim of the following section is to summarize from the analysis of Hanoi's 'splintering suburban waterscapes', users' perception on accessibility, and satisfaction of coverage, quality and cost of piped water, as well as the environmental hazards of groundwater accessed by privately owned wells.

Regarding the empirical analysis of water accessibility and satisfaction of coverage, quality and cost, the results of the surveys shed light on users' preferences for different water sources. The population that was surveyed relies not only on water from large networks, but also from small-scale systems, mainly because the flow of piped water is not always constant and, in some cases, due to their distrust of the quality of water supplied by the piped water network system. This means that, through a "needs-driven" approach (Allen et al., 2006b), in addition to having access to piped water, households maintain privately owned wells for daily-use in gardening, construction, or for washing. For drinking purposes, users will connect supplementary filtering systems to their intake of piped water. Due to the lack of round-the-clock water supply in some areas, as well as cost concerns, users will use alternative sources such as boiled groundwater extracted from privately owned wells or bottled water. However, buying bottled water for drinking highlights the tendency of selling water as a commodity opposed to granting its access as a basic human right. Residents of Hanoi base their choices of water sources on cultural preferences, shaped by social perceptions, and influenced by affordability, rather than just on the existing or available connection to the piped water network system.

The main user-related and environmental challenges that impact Hanoi's population and natural water resources are the high levels of hazardous heavy metals and the overexploitation of groundwater. These two factors affect users with privately owned wells, as the state cannot monitor water quality nor the amount of groundwater that is exploited for domestic use at a small scale. For this reason, due to rapid urbanization and the increasing density in suburban areas, through a "policy-driven" approach (Allen et al., 2006b), the government has encouraged the development of centralized networks. Despite this effort, many users who maintain privately owned wells are aware of groundwater contamination and, in some cases, have no alternative to access safe water sources. As shown in the analysis of water samples, groundwater in the new urban area of Linh Đàm is as contaminated as groundwater in the periurban village of Triều Khúc. Both areas are located in the water supply zone that would receive treated surface water from Đà River (HAWACO, 2011: pp. 52–53). However, the built environment of the first area limits the use the privately owned wells, whereas the built environment of the village favors the use of well water with little or no attention to water quality. Still, in agreement with the city's master planning, the government allows for the supply of groundwater treated by private development companies which monitor and guarantee water quality. The same water served by different means and the contrasting urban typologies of new urban areas and periurban villages expose the discrepancy between the availability of water and the urban form which conditions the

access to safe water sources.

In line with the persistent pursuit of modernity, the hybrid, socialist, yet marketized state has continued to support private investment and welcome the exchange of foreign capital and knowledge to support technological advances. With the growing challenge of supplying fresh water to the rapidly expanding urban population, the central government delegates the implementation of national strategies to different state authorities who combine responsibilities supply water in urbanizing areas. Consequently, Vietnam attempts to expand centralized water supply networks in suburban areas which can hardly keep up with the speed of urbanization. Particularly since the categorization of water as a commercial activity in 2004 (Owen, 2012, p. 219), private entrepreneurship in Vietnam has been encouraged and is expected to raise from the 2% of private sector participation determined in 2012 to 12% in 2025 (Owen, 2012, p. 46).

As water treatment and production technologies advance to keep up with the demand of the water supply, greater access to safe water relies both on the improvement and support of adequate technological systems that correspond to different needs. It is necessary to consider a broader spectrum of combined delivery options, including small-scale and affordable sources (Allen, Dávila, & Hofmann, 2006a), decentralized management techniques to control pollution and hazardous effects on the environment and human health (Allen, 2010), treated wastewater as an alternative source (Kurian et al., 2013), sustainable sanitation systems (Nguyen, 2011), semi-centralized infrastructures (Schramm, 2011), and the combination of various scales of "networked and non-networked" solutions (Monstadt & Schramm, 2013). Funding for water and wastewater systems can also be aided by revenues from water resource recoveries, wastewater fees, and micro-finance programs to support the poor (Nguyen, 2013).

The coordination of actors involved in water supply should aim for a sustainable urban water cycle, defined by an efficient management of freshwater resources, forecast of demand of water use, water supply management including water reuse, wastewater management, sustainability of infrastructures, and maintenance of the systems in order to minimize water losses. Building a sustainable urban water cycle in Hanoi faces user-related, environmental, technological, institutional and economic challenges. The consideration of the users' water-use preferences is fundamental to control the quality of the sources of water that people use and address water coverage and water accessibility. Environmentally, the consideration of freshwater sources is essential as surface water in Hanoi is subject to microbial pollution, the overexploitation of groundwater has led to groundwater depletion and soil subsidence, and both groundwater and wastewater present high levels of heavy metals. Thus, monitoring small-scale systems is as important as the mitigation of pollutants and heavy metals from existing centralized water supply systems to ensure access to safe drinking water. In terms of technical issues, operation and maintenance are crucial to consider the long-term viability of a system, since piped water distribution networks need constant repair, possibly due to the quality of materials that have been used to build water supply networks and because of the lack of maintenance. At an institutional level, the urban/rural dichotomy reflects a complex coordination of the roles of MOC and MARD in urban development and water service provision. Regarding lower income populations who perceive a relatively high cost of water, it is important to recognize that users are active in seeking alternatives of water consumption next to piped water. Altogether, the provision of safe water through a sustainable urban water cycle depends on the capacity of all stakeholders to meet the demand of the population, despite the limitations of the natural resource, challenges of maintenance and operation of the current technological systems, and the cost of water, while considering users' needs and water consumption patterns.

6. Conclusion

New urban areas and periurban villages display unequal access to water following splintering urbanism processes. The contrasting urban typologies and built environments condition access to safe water, while cultural preferences influenced by users' perceptions of water quality and affordability demand a wider array of solutions. This reveals the complexity of urbanization patterns and water governance trends.

As the growing demand of water is not easily met with the current arrangements of large-scale production and distribution of water, recognizing a broader range of environmentally-friendly and cost-effective water sources for consumption and use is imperative to argue in favor of distributional justice and advocate for inclusive decision-making. With the purpose of alleviating the pressure of the existing means of water production, at one level, we argue that it is crucial to prioritize wastewater management and include reclaimed water as a viable source in cities' urban water cycles; and, on another level, it is important to promote water reuse and water conservation practices at household levels to reduce average water consumption rates. As Vietnam's urban household groups and rural villages prove to be effectively organized, involving the community in the earlier stages of design and planning, as well as in the implementation, operation and management of water supply infrastructures, could be essential to increase their sense of ownership and commitment towards promoting and maintaining new technological systems. Parallel to this, experts from civil society organizations and higher education institutions can also represent a great value as their role in facilitating knowledge and resources can help solve national development issues.

Through a call for sustainable development, this study instigates fellow researchers to discuss the direction of planning visions of other cities; create tools to map and visualize the social, environmental, technological, institutional and economic challenges of water provision; re-evaluate processes; and advocate for equitable distribution of resources and services to increase distributional justice and social equity.

Acknowledgements

This research was carried out through the Chair for Spatial Infrastructure Planning of IWAR Institute, Technische Universität Darmstadt, within the frame of the major collaborative research initiative "Global suburbanisms: governance, land, and infrastructure in the 21st century," financed by the Social Sciences and Humanities Research Council of Canada. We would like to acknowledge the professors and students of the Hanoi University of Science and Technology who facilitated the analysis of water samples, with special attention to Dr. Hoang Thi Thu-Huong, and students Nguyen Thị Tam and Nguyen Van Phu; as well as the professors of the National University of Civil Engineering (NUCE) who supported this work: Dr. Nguyen Thi Thanh Mai and especially Dr. Nguyen Viet-Anh who facilitated the 37th WEDC International Conference of *Sustainable Water and Sanitation Services for All in a Fast Changing World*, co-hosted by Loughborough University and the NUCE in Hanoi, from the September 15 to 19 of 2014. We would also like express our gratitude to Nguyen Anh Duong, last-year student of NUCE, who assisted in data collection, conducted surveys in Vietnamese, translated during interviews, and engaged in the discussions concerning the case study. This work was adapted from the master thesis: "The pursuit of modernity through global trends of global water governance in suburban Hanoi", written by

Lucía Wright-Contreras during the Masters of International Cooperation Sustainable Emergency Architecture of the Universitat Internacional de Catalunya (2014–2015), as part of the double degree Masters of Science International Cooperation in Urban Development (Mundus Urbano) in cooperation with the Technische Universität Darmstadt (2013–2014). We thank Dr. Eddie Chi-Man Hui, Editor in Chief, and Dr. Hualou Long, Associate Editor, as well as the anonymous reviewers for their insightful comments and guidance throughout the publication process.

References

Adams, E. A., & Zulu, L. C. (2015). Participants or customers in water governance? Community-public partnerships for peri-urban water supply. *Geoforum, 65*, 112–124.

Allen, A. (2003). Environmental planning and management of the peri-urban interface: Perspectives on an emerging field. *Environment and urbanization, 15*(1), 135–148.

Allen, A. (2010). Neither rural nor urban: Service delivery options that work for the peri-urban poor. In M. Kurian, & P. McCarney (Eds.), *Peri-urban water and sanitation services* (pp. 27–61). Netherlands: Springer.

Allen, A., Dávila, J. D., & Hofmann, P. (2006a). *Governance of water and sanitation services for the peri-urban poor*. London: University College London, Development Planning Unit.

Allen, A., Dávila, J. D., & Hofmann, P. (2006b). The peri-urban water poor: Citizens or consumers? *Environment and Urbanization, 18*(2), 333–351.

Badiani, R., Baulch, B., Brandt, L., Dat, V. H., Giang, N. T., Gibson, J., et al. (2012). *2012 Vietnam poverty assessment: Well begun, not yet done – vietnam's remarkable progress on poverty reduction and the emerging challenges*. Washington DC: World Bank. http://documents.worldbank.org/curated//2013/08/18124050/done-vietnams-remarkable-progress-poverty-reduction-emerging-chall. Updated: 16 August 2013 (Accessed 19 March 2015).

Bainbridge, B. (2013). Arsenic contamination found in Vietnam's water: Study. *Australia Plus*. http://www.abc.net.au/news/2013-10-25/arsenic-poisoning-in-vietnam-wells/5044730http://www.abc.net.au/news/2013-10-25/arsenic-poisoning-in-vietnam-wells/5044730. Updated: 25 October 2013 (Accessed: 21 July 2014).

Bakker, K. J. (2003). A political ecology of water privatization. *Studies in Political Economy, 70*, 35–58.

Berg, M., Trang, P. T. K., Stengel, C., Buschmann, J., Viet, P. H., Van Dan, N., et al. (2008). Hydrological and sedimentary controls leading to arsenic contamination of groundwater in the Hanoi area, Vietnam: The impact of iron-arsenic ratios, peat, river bank deposits, and excessive groundwater abstraction. *Chemical Geology, 249*(1), 91–112.

Davis, M. (2004). Planet of Slums: Urban involution and the informal proletariat. *New Left Review, 26*, 5–34.

Díaz-Caravantes, R. E., & Wilder, M. (2014). Water, cities and peri-urban communities: Geographies of power in the context of drought in northwest Mexico. *Water Alternatives, 7*(3), 417–499.

Gandy, M. (2008). Landscapes of disaster: Water, modernity, and urban fragmentation in Mumbai. *Environment and Planning A, 40*(1), 108–130.

Giao, P. H., & Ovaskainen, E. (2000). Preliminary assessment of Hanoi land subsidence with reference to groundwater development. *Lowland Technology International, 2*(2), 17–29.

Ginsburg, N. S., & Koppel, B. (1991). *The extended metropolis: Settlement transition is Asia*. University of Hawaii Press.

Graham, S., & Marvin, S. (2001). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. Psychology Press.

GSO, General Statistics Office. (2014a). *Economic growth. Month statistical Information: Social and economic situation in 2014*. http://www.gso.gov.vn/default_en.aspx?=622%26ItemID=14195. Updated: 2014 (Accessed: 19 March 2015).

GSO, General Statistics Office. (2014b). *Average population and density. Month statistical Information: Population and employment in 2014*. http://www.gso.gov.vn/default.aspx?tabid=714. Updated: 2014 (Accessed: 25 July 2015).

Han, S. S., & Vu, K. T. (2008). Land acquisition in transitional Hanoi, Vietnam. *Urban Studies, 45*(5–6), 1097–1117.

HAWACO, Hanoi Water Limited Company. (2011). *Construction and development of water supply sector Hanoi. (Original in Vietnamese; Xay dung va phat trien nganh cap nuoc ha noi)*. Hanoi: HAWACO.

HAWACO, Hanoi Water Limited Company. (2014a). *Hanoi water supply system. Unpublished work. Summary distributed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC international Conference: Sustainable water and sanitation services for all in a Fast changing world, co-hosted by Loughborough university and the national university of civil engineering (NUCE)*, 15-19 September 2014 (Date of guided visit: 18 September 2014).

HAWACO, Hanoi Water Limited Company. (2014b). *Hanoi water supply system. Unpublished work. PowerPoint presentation viewed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC international Conference: Sustainable water and sanitation services for all in a Fast changing world, co-hosted by Loughborough university and the national university of civil engineering (NUCE)*, 15-19 September 2014 (Date of guided visit: 18 September 2014).

Hofmann, P. (2013). Wasted waste—disappearing reuse at the peri-urban interface. *Environmental science & policy, 31*, 13–22.

IBP, Inc. (2016). *Vietnam export-import, trade and business directory – strategic, practical information and contacts*. Washington, D.C: International Business Publications.

Jessen, S., Jakobsen, R., Postma, D. J., & Larsen, F. (2009). *Groundwater arsenic in the Red River delta, Vietnam: Regional distribution, release, mobility and mitigation options*. Doctoral dissertation. Technical University of Denmark (Danmarks Tekniske Universitet), Department of Environmental Engineering (Institut for Vand og Miljøteknologi).

Kurian, M., Reddy, V. R., Dietz, T., & Brdjanovic, D. (2013). Wastewater re-use for peri-urban agriculture: A viable option for adaptive water management? *Sustainability science, 8*(1), 47–59.

Labbé, D. (2013). *Land politics and livelihoods on the margins of Hanoi, 1920-2010*. UBC Press.

Labbé, D., & Musil, C. (2014). Periurban land redevelopment in Vietnam under market socialism. *Urban Studies, 51*(6), 1146–1161.

Le Van, D. (2012). *Sanitation of water source and treatment of garbage and wastes in Hanoi city*. Hanoi: East Asian and Middle-South American Conference on Environmental Industry.

Marston, A. (2014). The scale of informality: Community-run water systems in peri-urban Cochabamba, Bolivia. *Water Alternatives, 7*(1), 72–88.

Mehta, L., & Karpouzoglou, T. (2015). Limits of policy and planning in peri-urban waterscapes: The case of Ghaziabad, Delhi, India. *Habitat Int., 48*, 159–168.

Ministry of Foreign Affairs of Denmark. (2014). *Sector program support to water, sanitation and Hygiene promotion (2012-2014). Water and sanitation – Denmark in Vietnam*. http://vietnam.um.dk/en/danida-en/water-and-sanitation/. Updated: 2014 (Accessed: 17 March 2015).

Minnery, J., Argo, T., Winarso, H., Hau, D., Veneracion, C. C., Forbes, D., et al. (2013). Slum upgrading and urban governance: Case studies in three South east asian cities. *Habitat International, 39*, 162–169.

Monstadt, J., & Schramm, S. (2013). Beyond the networked city? Suburban constellations in water and sanitation systems. In R. Keil (Ed.), *Suburban constellations. Governance, land and infrastructure in the 21st century* (pp. 85–94). Berlin: Jovis.

Nguyen, V. A. (2011). Landscape analysis and business model assessment. Final Report. In *Fecal sludge Management: Extraction and transportation models in Vietnam*. Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering.

Nguyen, V. A. (2013). *Wastewater management in vietnamese Cities: Present state and vision for the future* (pp. 1–4). ICUS Newsletter, International Center for Urban Safety Engineering. Institute of Industrial Science, University of Tokyo.

Norström, A. (2007). *Planning for drinking water and sanitation in peri-urban areas*. Swedish Water House Report *21*.

Owen, D. (2012). *Pinsent Masons water yearbook 2012–2013: The essential guide to the water industry from leading infrastructure law firm Pinsent Masons* (14). London: Pinsent Masons.

Parenteau, R., & Thong, N. Q. (2005). The role of civil society in urban environmental rehabilitation: A case study (Thanh Xuan district, Hanoi, Vietnam). *Environment and Urbanization, 17*(1), 237–248.

Postma, D., Larsen, F., Hue, N. T. M., Duc, M. T., Viet, P. H., Nhan, P. Q., et al. (2007). Arsenic in groundwater of the Red River floodplain, Vietnam: Controlling geochemical processes and reactive transport modeling. *Geochimica et Cosmochimica Acta, 71*(21), 5054–5071.

Quang, N., & Kammeier, H. D. (2002). Changes in the political economy of Vietnam and their impacts on the built environment of Hanoi. *Cities, 19*(6), 373–388.

Schramm, S. (2011). Semicentralised water supply and treatment: Options for the dynamic urban area of Hanoi, Vietnam. *Journal of Environmental Assessment Policy and Management, 13*(02), 285–314.

Schramm, S. (2016). Flooding the sanitary City: Planning discourse and materiality of urban sanitation in Hanoi. *In City, 20*(1), 32–51.

SRV, Socialist republic of Vietnam (2009). QCVN 01: 2009/BYT national technical regulation on drinking water quality. Hanoi. Compiled by the Department of Preventive Medicine & Environment and promulgated by MOH's Minister at the Circular No.04/2009/TT-BYT, Updated: 17 June 2009).

Trần, T. N. Q., Quertamp, F., de Miras, C., Quang Vinh, Nguyen, Van Nam, Le, & Hoang Truong, Truong (2012). In *Trends of urbanization and suburbanization in Southeast Asia*. Ho Chi Minh City: Ho Chi Minh City General Publishing House.

Turner, S. (2009). Hanoi's ancient quarter Traders: Resilient livelihoods in a rapidly transforming city. *Urban Studies, 46*(5–6), 1203–1221.

UN. (2014). *World urbanization prospects: Highlights*. New York: Department of Economic and Social Affairs. United Nations.

UN DESA. (2008). *World Urbanization Prospects: The 2007 Revision*. United Nations Department of Economic and Social Affairs (DESA), Population Division. http://www.un.org////_PopDist/Heilig.pdf. Updated: 16 January 2008 (Accessed: 5 December 2014).

UN Habitat. (2012). *Gender and urban planning, issues and trends*. Nairobi: United Nations Human Settlements Program.

UNDP. (2010). *Urban poverty assessment in Hanoi and Ho chi minh city*. www.dl.is.vnu.edu.vn/dspace/bitstream/123456789/94/1/868C8d01.pdf. Updated: September 2010 (Accessed: 9 April 2015).

Van Ewijk, E., & Ehrhardt, C. (2016). *Land governance in the context of urbanisation and climate change: Linking the rural and the urban*. Conference Report Jun. 30-Jul. 1st, 2016. LANDac. Utrecht: Land Governance for Equitable and Sustainable Development (LANDac).

Winarso, H., Hudalah, D., & Firman, T. (2015). Peri-urban transformation in the Jakarta metropolitan area. *Habitat International*, 221–229.
Winkel, L. H., Trang, P. T. K., Lan, V. M., Stengel, C., Amini, M., Ha, N. T., et al. (2010). Arsenic pollution of groundwater in Vietnam exacerbated by deep aquifer exploitation for more than a century. *Proceedings of the National Academy of Sciences, 108*(4), 1246–1251.
World Bank. (2011). *Vietnam urbanization Review: Technical assistance report*. https://openknowledge.worldbank.org/handle/10986/2826. Updated: 2011 (Accessed 9 April 2015).
World Bank. (2013). *Vietnam. Data*. http://data.worldbank.org/country/vietnam. Updated: 2013 (Accessed: 18 March 2015).
World Bank. (2015). *Lower-middle-income economies*. Country and Lending Groups. http://.org//and-lending-groups. Updated: 2015 (Accessed: 18 March 2015).
WSP and World Bank. (2014). *Water and sanitation in Viet Nam: Turning finance into services for the future*. Water and Sanitation Program (WSP) and World Bank Service Delivery Assessment. http://www.mediafire.com//dmncezsw/SDA_Vietnam_full_.df. Updated: June 2014 (Accessed: 25 February 2015).
Zhang, X. Q. (2016). The trends, promises and challenges of urbanisation in the world. *Habitat International, 54*(3), 241–252.

3. Beyond passive consumption: Dis/ordering water supply and sanitation at Hanoi's urban edge

Publication No.	**P-II**
Type	Journal article
Journal	*Geoforum*
SJR Score	1.601
Status	Published
Reference	Schramm, S., & **Wright-Contreras, L.** (2017). Beyond passive consumption: Dis/ordering water supply and sanitation at Hanoi's urban edge. *Geoforum*, *85*, 299–310. https://doi.org/10.1016/j.geoforum.2017.06.016
Abstract	In Hanoi people access, expand and create water and sanitation infrastructures in multiple ways that include, but are not restricted to, external provision of networked services. Urban master planning and the construction of large technological networks aim at integrating the urban region based on circulating 'modern ideals' of ubiquity and standardization of infrastructures. However, centralized infrastructure provision has remained unstable and spatially uneven. We examine differently networked spaces that have emerged at the edge of Hanoi along with rapid urban change and new financing mechanisms in the past thirty years, and the ways in which urban residents engage with the various water and sanitation systems. This engagement is shaped by circulating ideals, place-specific processes of urban re-production, sector-specific dynamics, and individuals. Not only in periurban villages, but also in modern housing estates, people rebut a role as passive receptors of external services. In some instances, they create relatively stable collectives through which they provide, negotiate and complement networked infrastructure connection. Thus, people living at Hanoi's urban edge actively re-produce water and sanitation systems beyond passive consumption of externally provided services.

Geoforum 85 (2017) 299–310

Contents lists available at ScienceDirect

Geoforum

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

Beyond passive consumption: Dis/ordering water supply and sanitation at Hanoi's urban edge

Sophie Schramm[a,*], Lucía Wright-Contreras[b]

[a] Department of Human Geography and Planning, Utrecht University, Utrecht, The Netherlands
[b] URBANgrad, Technical University of Darmstadt, Darmstadt, Germany

ARTICLE INFO

Keywords:
Hanoi
Urban infrastructure systems
Dis/ordering
Urban water and sanitation
Water governance

ABSTRACT

In Hanoi people access, expand and create water and sanitation infrastructures in multiple ways that include, but are not restricted to, external provision of networked services. Urban master planning and the construction of large technological networks aim at integrating the urban region based on circulating 'modern ideals' of ubiquity and standardization of infrastructures. However, centralized infrastructure provision has remained unstable and spatially uneven. We examine differently networked spaces that have emerged at the edge of Hanoi along with rapid urban change and new financing mechanisms in the past thirty years, and the ways in which urban residents engage with the various water and sanitation systems. This engagement is shaped by circulating ideals, place-specific processes of urban re-production, sector-specific dynamics, and individuals. Not only in periurban villages, but also in modern housing estates, people rebut a role as passive receptors of external services. In some instances, they create relatively stable collectives through which they provide, negotiate and complement networked infrastructure connection. Thus, people living at Hanoi's urban edge actively re-produce water and sanitation systems beyond passive consumption of externally provided services.

1. Introduction

Urban space is constituted by flows of finance, water, energy, waste and people. Various sociotechnical networks mediate these flows and thus dis/order cities in manifold ways. Urban studies emphasize the stability of urban socio-spatial configurations, but they also reveal how they have changed over time, particularly in line with the neoliberal project (Graham and Marvin, 2001). In terms of water supply and sanitation, technological standards of large centralized (waste)water treatment plants and networks have been travelling globally since the colonial era and have remained relatively stable (Hommels, 2005; Gandy, 2004). While cities of the Global South are deeply entangled with globally mobile infrastructural models promoting networked (public or commercialized) service provision, their infrastructural landscapes have in fact often remained extremely diverse, with actors accessing services far beyond planning and often beyond the control of central and local governments. In scrutinizing these dynamics, scholars turn toward the every-day practices and linkages of urban dwellers as they access basic services despite failing networked provision (Simone, 2004; Silver, 2014; Lawhon et al., 2013).

The urbanization of Hanoi, the capital of the Socialist Republic of Vietnam, has been shaped by entanglements with circulating ideals and models concerning urban planning and engineering since French colonialization. The 1986 *doi moi* (renewal) reforms toward an opening up of the former communist country to a market economy and its re-positioning within global flows of finance, have had a profound impact on Vietnam's urban development, society and culture as a whole (Han and Vu, 2008; Labbé and Musil, 2014; Quang and Kammeier, 2002). In the past thirty years, Hanoi has experienced massive urban growth and expansion. The development of investor-led real estate projects together with the densification of periurban villages and attempts toward the liberalization and privatization of once formally state-controlled infrastructures have completely transformed the outskirts of the city (cf. Leaf, 2002). They have produced a new "periurban interface" (Allen, 2003, 2010; Hofmann, 2013; Mehta and Karpouzoglou, 2015), where suburban "archipelagos of networks" (Bakker, 2003) emerge together with areas marginalized from external service provision.

Considering these multiple and rapid changes of urban space, we investigate how sociospatial transformations since *doi moi* have dis/ordered water supply and sanitation in Hanoi with and beyond formal service provision. Despite the stated goal to order the rapidly growing and diverse urban region of Hanoi via an expansion of large technological networks, centralized infrastructure provision has remained instable and spatially uneven, with water and sanitation diverging

* Corresponding author.
E-mail addresses: s.schramm@uu.nl (S. Schramm), wright@stadt.tu-darmstadt.de (L. Wright-Contreras).

http://dx.doi.org/10.1016/j.geoforum.2017.06.016
Received 20 June 2016; Received in revised form 13 June 2017; Accepted 20 June 2017

widely in terms of state investments and their insertion into global flows of finance. Centralized water and sanitation provision continue to reflect a 'modern ideal' of ubiquity and standardization of infrastructures. At the same time, they are shaped by a strive toward the attraction of private investments, cost-efficiency, and "cherry-picking" (Graham and Marvin, 2001) of profitable customers through profit-oriented companies. While these approaches differ between water and sanitation with regards to formal management and regulation, they share the idea of citizens as passive consumers of externally provided services. In view of the complex and contradictory dynamics shaping the spatially uneven expansion of water and sanitation networks, we examine the scope and limitations of sub/urban dwellers to appropriate and change the multiple dis/orders produced by centralized infrastructure provision. Studies on Hanoi's urban and periurban water, waste or sanitation services shed light on technical, governance and organizational issues of peoples' access to basic services within these sectors (Parenteau and Thong, 2005; Danière et al., 2016). However, at times their focus is limited to those completely excluded from networked service provision and on decentralized technologies and governance structures (Beauséjour and Nguyen, 2007; Nguyen et al., 2004).

Based on studies scrutinizing urban dwellers' agency in the re-production of Hanoi's space more broadly (Labbé, 2014; Koh, 2006), we aim to contribute to a nuanced understanding of the ways in which sociotechnical infrastructure constellations are shaped by globally circulating ideals as much as by place-specific practices of urban dwellers. We want to illustrate how people access water and sanitation in ways that reach beyond passive consumption of externally provided services, but are at the same time deeply entangled with centralized networks. Therefore they also reach beyond purely situational and functional linkages outside state control as people appropriate and mix different circulating ideals and models of urban service provision.

It is particularly the city's outskirts, which have experienced profound socio-spatial transformations in the past thirty years, and where multiple constellations of infrastructure provision and access far beyond uniform networks emerge (Leaf, 2002). Therefore, we focus our study on the edge of Hanoi, on spaces where centralized networks are expanding and simultaneously stagnating (Fig. 1). A series of 25 semi-structured expert interviews with local residents, local and international organizations, government offices, water-related enterprises, financial organizations, and academic institutions in Vietnam; as well as qualitative analyses of newspaper articles, current and historical planning documents and secondary literature inform our discussion of networked infrastructure provision of Hanoi, its entanglements with globally circulating ideals and models, as well as the scope and limitations of suburban dwellers to appropriate and change these infrastructures.

In the first section, we situate our analysis within research on networked urbanism and the ways in which actors within and beyond the state dis/order urban space and infrastructures. Secondly, we explain the urbanization of Hanoi, an "extrospective city" (McCann, 2013) where changing governments have long striven for the installation of large technological networks in line with globally circulating ideals. Thirdly, we discuss the local and central state's current strategies between the centralization of water and sanitation services and the support of spatially restricted privatization of service delivery. In the fourth section, we focus on suburban dwellers and the multiple ways they actively access water and sanitation, which include, but are not reduced to, externally provided networked services. Finally, we conclude that the expansion of water and sanitation networks and the appropriation of these infrastructures are not only shaped by circulating ideals re-producing a particular urban order, but also by their entanglements with broader urbanization processes. Such dynamics of urban dis/ordering reach far beyond passive acceptance of externally managed exclusion or inclusion. At the same time, they are more than just purely functional and situative linkages emerging between people outside state control.

2. Dis/ordering urban infrastructures beyond the networked city

Standards and ideals of urban infrastructure provision travel around the world. Technological plans of networks and artifacts for the provision of water and sanitation in cities across the globe speak a similar language, use similar calculations and often come to similar conclusions concerning the ideal way to provide services to citizens. As scholars have noted, international agencies enable these convergent processes (Bakker, 2013). Cities worldwide are inserted into global knowledge flows concerning the design, construction and maintenance of urban infrastructure (Monstadt and Schramm, 2017). At the same time, particularly cities of the Global South often display heterogenous technological and organisational constellations of service provision. These are deeply entangled with, but reach far beyond, modern imaginations of networked urbanism (Gandy, 2004). Thus, cities are relational, connected with other cities, and yet they are specific, with particular trajectories and materialities of service provision (cf. McCann, 2011). Starting from this position, we consider the ideal of the networked city as a travelling ideal which influences cities in different ways as urban actors appropriate and mix this ideal with other circulating policies and visions in the re-production of urban space. We argue that it is important for an understanding of (networked) infrastructure access to open the view to broader dynamics of urban development, as the way the modern ideal of the networked city influences urban space is contingent on how urban actors appropriate and combine it with other circulating ideals in very place-specific processes of city-making (cf. Zérah, 2008).

In the following section, we scrutinize urban infrastructure studies regarding their analyses of the modern ideal of networked service provision as a circulating ideal, which positions large-scale infrastructure as a stable, long-lasting basis of urban life and urban dwellers as passive receptors of services. We furthermore introduce recent scholarship on urban actors' agency in the provision of infrastructure beyond this modern ideal, which in contrast often portrays urban dwellers' interactions as extremely provisional, momentary and situational. We mobilize these literatures in order to better understand the ways in which suburban water infrastructures are shaped by the appropriation of circulating ideals and by entanglements with broader dynamics of urban re-production.

2.1. Networking the city: urban infrastructures between stability and change

The networked character of cities, the interconnections and interdependencies of actors and materials, the flows of finance, water, energy, waste and people that constitute urban space, have been of increased interest for scholars of urban studies in recent decades (Graham and Marvin, 2001; Tarr and Dupuy, 1988). Studies reveal and problematize the ways in which infrastructure networks produce and reflect particular urban socio-spatial orders and visions of orderly urbanization (Swyngedouw, 2004). According to Graham and Marvin (2001), urban policy and planning across the globe has been informed by a modern ideal of infrastructure provision. This ideal of a 'networked city' expresses a particular vision of urban sociospatial order, of the relation between the state and its citizens, which is mediated through socio-technical networks providing the urban circulation of people, (waste)water and energy and demarcating national or municipal territories. According to this ideal, public utilities manage the provision of ubiquitous and uniform services to passive consumers via large technological networks, which have been designed and planned through a state agency that furthermore regulates urban land-use through comprehensive planning (Monstadt and Schramm, 2017; Coutard and Rutherford, 2016). The ideal presupposes a population passively consuming reliable, ubiquitous, affordable and uniform services, while the state regulates this provision and thereby controls the population and secures its health (Bakker, 2013). Thus, infrastructure networks become the 'backbone' of cities, the basis of modern urban life, with citizens

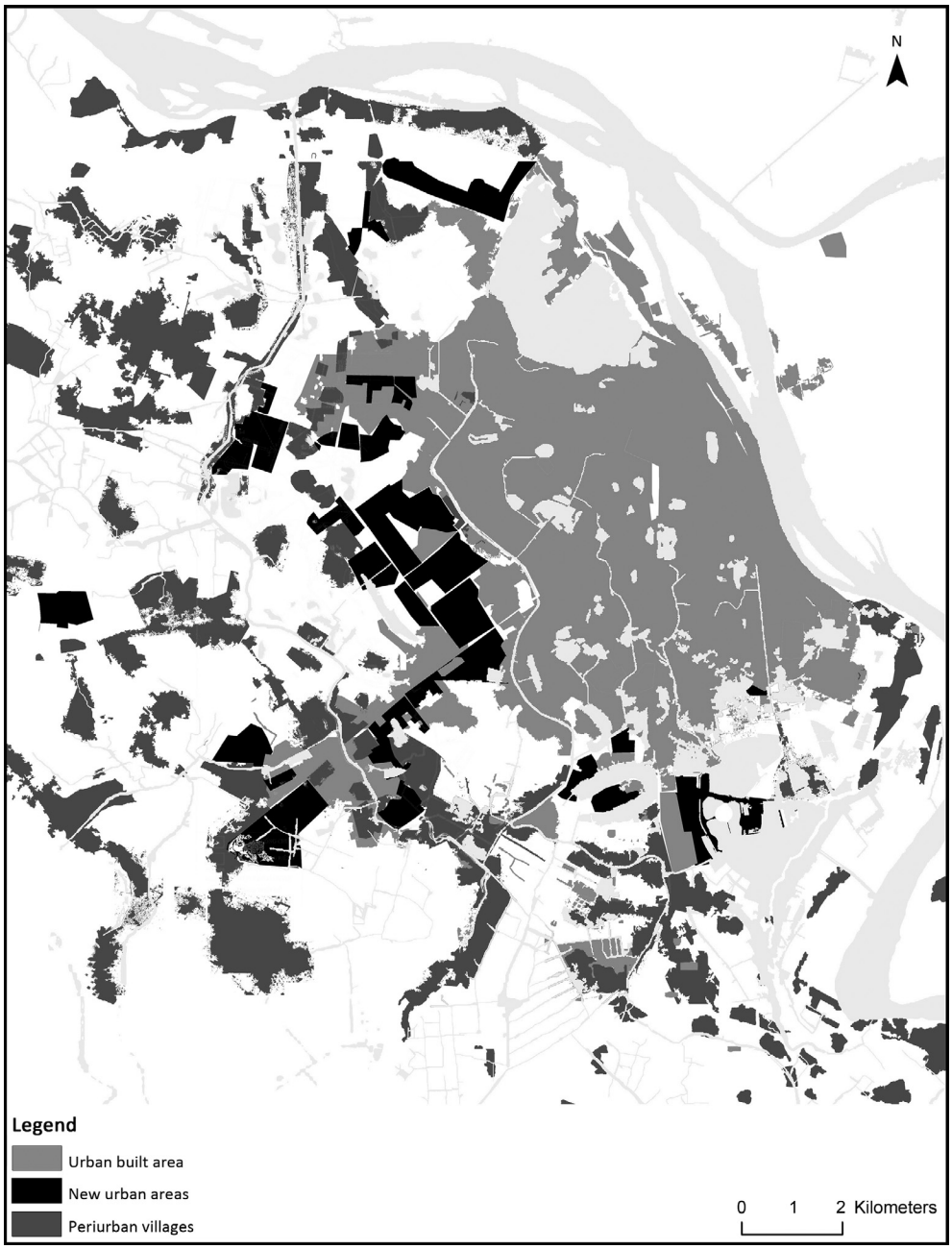


Fig. 1. New urban areas and peri-urban villages at the edge of Hanoi.

receiving stable services that allow them to concentrate on their everyday activities. These networks not only lend stability to urban life, but they appear to be relatively stable themselves, representing concrete material results of past planning decisions.

A core concern of researchers on urban infrastructure systems is their path-dependency and resistance to change. Hommels (2005) and Leigh Star (1999) emphasize that this resistance is rooted in the embeddedness of infrastructure networks and artifacts. These are elements of broader sociotechnical ensembles, closely interconnected with other technologies or social arrangements. This 'inertia' of urban infrastructures increases with the size of the networks, artifacts and institutions and the degree of their embeddedness into broader social and material relations (Hughes, 1987). As Harvey (1985: 16) has observed, "the built environment is long lived, difficult to alter, spatially immobile and often absorbent of large, lumpy investments." Latour (1993: 117) considers urban infrastructure networks as equally fixed and consumers as captives of design and engineering decisions made elsewhere, as we may "die right next to a phone line if we aren't plugged into an outlet and a receiver." This is in line with the position of Graham and Marvin, who diagnose a 'splintering' of urban space, with increasing territorial imbalances and social disparities within cities. They perceive an unequal distribution of goods and services and a fragmented growth of cities in the wake of the neoliberal project. Choosing cost-recovery over the production of equity in urban space, infrastructure utilities "cherry-pick" profitable customers, while other urban dwellers suffer from "infrastructural bypassing" (Graham and Marvin, 2001). According to this conception, consumers appear to be unable to actively resist or change the particular urban orders that large infrastructural systems reproduce. As Graham (2000: 116) points out, a network may "bypass you […] in its line of connection to distant elsewheres" even if you are in direct proximity to it. Thus, these researchers suggest a specific socio-spatial reordering of urban space by infrastructure networks, which urban dwellers are left to passively accept, be they included in or excluded from modern service provision.

2.2. Infrastructural dis/ordering in cities of the Global South

The modern ideal of the networked city has become a model for urban re-constructions across the globe. Speaking with Tsing, its success stems from its "scalability" or apparent ability to expand without limit to any city without ever having to change its elements (Tsing, 2012). However, despite this idea to be scalable, it has undergone very place-specific changes and appropriations by urban actors, rendering it perpetually incomplete. Particularly in cities of the Global South, it has produced considerable frictions and contradictions, which become visible in the often highly unjust distribution of water and sanitation services in cities. With a view to these distortions, scholars of urban infrastructure studies have articulated the need to analyze historic and current dynamics of urbanization and service provision beyond simplistic conceptualizations of splintering networks and infrastructural bypassing of poorer urban areas as part of the neoliberal project (Graham and Marvin, 2001; Coutard, 2008). Large central networks and public institutions ordering urban space in line with the ideal of the networked city remain an anomaly in cities across the globe — as Graham (2000: 115) puts it, networks are "never truly universal". While the contradictions inherent to the ideal of the networked city are by no means restricted to the Global South, they become particularly apparent in post-colonial cities. Here, according to Gandy, the "reconstruction of the underground city [of water pipes and sewerage channels] was only ever partially completed" (Gandy, 2004: 368). Thus, in the massive colonial interventions of urban expansion and restructuring the modern ideal created a system of 'spatial apartheid' via the exclusive provision of networked infrastructure in European urban quarters (Gandy, 2004; Coutard, 2008; McFarlane, 2008). In the colonial city, citizenship was negotiated through the provision or denial of access to water, sanitation and energy, and today, in the post-colonial city, infrastructure networks remain important markers of belonging or exclusion (Fredericks, 2014).

As urban scholars have shown particularly with regards to southern cities, access to services tends to be highly unequal within urban spaces, with regard to technologies, costs, and access to the provision of basic services such as water and electricity (cf. e.g. Jaglin, 2008). Not only public utilities provide services, but a large variety of private entrepreneurs, civil society organizations and individuals operate in the continuum between formality and informality far beyond any pre-designed concept or plan (cf. Mitlin, 2008). Thus, urbanization in the Global South challenges notions of urban systems that are formally envisaged and planned (Lawhon et al., 2013). Moreover, it illustrates that the order incorporated into infrastructure networks and artifacts is not necessarily as fixed as urban studies often imply (Kirsch, 2006). Rather, as urban actors appropriate the built environment they constantly contest, renegotiate and transform these orders (Coutard and Guy, 2007). In the process of transformation of globally circulating ideals a broad variety of ordering practices comes into play. Through these practices actors re-produce urban space and provide infrastructural services (Rakodi, 2008). Accordingly, Lawhon et al. (2013: 16) emphasize the need to study "everyday modalities through which ordinary people link together to provide for their lives" in cities. Simone qualifies these linkages, the ways in which people make use of each other "as infrastructure", as deeply fluid, functional and economic (Simone, 2004). Thus, those excluded from networked service provision find themselves in highly precarious situations having to strategically link up with others in line with emerging needs and opportunities. Accessing basic services beyond centralized provision and often despite being excluded from this provision is not just a means of survival but becomes a political act, as urban dwellers re-define citizenship and demand participation in society (cf. Silver, 2014). The focus on individual actions and on the potentials for improvisations, confrontations and resistances these entail gives some authors hope in this research field, where analyses of broader governance policies often only leave limited space for suggestions toward progressive change (Coutard and Guy, 2007; Lawhon et al., 2013). Appropriations of centralized network provision are highly place-specific. Therefore, analyses of urban infrastructures in the Global South need to consider specific urbanization dynamics and urban morphologies that shape local ways to access infrastructure services through and beyond centralized networks (Zérah, 2008; Coutard, 2008).

Our study of water and sanitation in Hanoi starts from these prerequisites, seeing order not as a state that is complete or final at a specific moment, but as multiple, contradictory and often competing, enacted by people within and outside formal state agencies. We examine the uneven dynamics of network expansion at the outskirts of Hanoi. These are influenced by circulating ideals as well as place-specific urbanization processes. In doing so, we engage with the question of agency in relation to these dynamics, providing a more nuanced understanding of the ways residents in different spaces at the edge of Hanoi actively negotiate their access to service and connection to networks. Our study reveals that these activities oppose the notion of infrastructural bypassing (Graham and Marvin, 2001) of poor areas, which implies a victimization of urban residents excluded from networks, and also go beyond the idea of people using each other 'as infrastructure' in a purely situational and functional way (cf. Simone, 2004). In the diverse suburban areas of Hanoi, centralized networks expand along with spatially-bounded "archipelagos" of networks (Bakker, 2003), creating a highly differentiated landscape of access and exclusion. Yet, residents find ways to engage with and change pre-designed service provision by trying to get connected, by denying exclusive connection, or by changing the conditions of connection. These actions are shaped not only by circulating ideals but also by place-specific processes of city-making; not only by income but also by materialities of built space, the particular characteristics of the sector in question as well as individual actors and social relations.

3. Hanoi: post/colonial planning and suburbanization of an amphibious city

Since the colonial era, Hanoi's planners have intended to install large technological networks of water supply and wastewater disposal to order the city in accord with globally travelling modernist ideals. However, these attempts have been interrupted by the many breaks in the city's turbulent history and they have been complicated by the flat terrain as well as the omnipresence of water in the amphibious city in the delta of the Red River, which is partly lower-lying than the river itself in the rainy season. To date, the impact of infrastructure and urban planning on the sub/urban development of Hanoi has been contradictory. The urbanization of Hanoi's edges is shaped by multiple and competing interests of real estate developers, national and international construction companies, people living in the city and at its outskirts, as well as members of local and central administrations.

3.1. From pre-colonial times till **doi moi**: the management of urban flows of waste and water

In 2010, Hanoi celebrated its millennial anniversary, commemorating the inauguration of the city (then *Thang Long*, "Rising Dragon") as the capital of Vietnam after roughly a millennium of Chinese occupation. With its French-colonial and then socialist past, Hanoi has a tradition of extremely ambitious urban planning led by foreign experts. Urban development plans of Hanoi – from the 1940s French colonial plan and the 1980s "Leningrad Plan" drawn with support from the former Soviet Union, to the current "Hanoi Capital City Masterplan to 2030 and Vision to 2050" – represent globally circulating visions of modernity, symbolized by centralized infrastructure networks, large-scale urban expansion and a sharp distinction between the city and a rural hinterland (cf. Leaf, 1999; Logan, 2000; PPJ, 2010; Chi et al., 2010). However, in the course of the city's history they have never fully reflected, let alone directed, the city's urbanization dynamics.

Since the founding of Hanoi, the question of the fragile 'balance between land and water' has been central to the city's urbanization. This is due to the geographic and climate conditions of the city in the delta of the Red River, with the river's distributaries feeding numerous lakes and ponds of the city and its region only up to 20 m above sea level (WHO, 2010). Hanoi's flat terrain, its low position and its high groundwater levels have challenged the management of the city's water cycle from its foundation on. An ancient system of rivers, dykes, sewerage channels and drains has protected the city from flooding for more than a thousand years (MOC, 1993). This system originally separated household wastes from urban drainage, as people in Hanoi have collected human manure, transported it out of the city and used it as fertilizer in agriculture (Fayet, 1939). The inhabitants of ancient Hanoi have drawn water for drinking and cooking largely from decentralized sources such as wells and surface water.

French colonialization has brought about a break in urbanization, infrastructure provision and planning of the city. The introduction of the networked city ideal to Hanoi was fundamental to colonial water and sanitation planning. In the late nineteenth century, French engineers built the first centralized piped-water distribution networks (Ngo, 2014). They also complemented the ancient urban drainage system with an underground sewerage network combining storm- and household wastewater (Ngo, 2009). This underground system has gradually been extended so that it currently covers about 60–70% of the city's urban districts (Ngo, 2009; Interview Wastewater Expert, 2009).

The Indochina war and the subsequent end of colonial rule (1945–1954) led to a stagnation of urbanization. Also as the American war broke out, construction activities hardly took place (Chi et al., 2010). During the 1970s and 1980s, Hanoi's population nearly tripled, from 480,000 in 1972 to 1.3 million in 1979 (Logan, 2000: 176). Urban planning and infrastructure provision in this period were supported by planners and engineers from the Soviet Union, who promoted the provision of uniform services at extremely low cost by municipal agencies that were to be controlled by the central state (Schramm, 2014). However, Vietnam faced severe economic restraints, which together with a significant loss of knowledge on urban planning and management during the wars rendered the ambitious plans and policies largely irrelevant (Interview Senior Urban Planner, 2011). During this period, Hanoi's growing urban population increasingly handled the provision of water and sanitation itself. It was only in the late 1980s, in the advent of *doi moi*, that the city received funding from the Finnish government to significantly modernize and increase centralized water production (Ngo, 2014). Large-scale interventions into the sanitation system have not been realized to a significant extent to date.

3.2. Suburbanization of Hanoi: shifting passages between the urban and the rural

The planning area of Hanoi's current "Masterplan to 2030 and Vision to 2050" stretches far into the hinterland of the city (PPJ, 2010). This expansion of the planning area has accompanied the inclusion of parts of neighboring provinces into Hanoi in 2008, which enlarged the city's administrative area from approximately 92 hectares and 3.2 million inhabitants in 2007 to 335 hectares and over 7 million inhabitants in urban and rural districts of Hanoi's metropolitan region in 2014 (GSO, 2009, 2014). This institutionalization of Hanoi's metropolitan region is the latest attempt to bring accelerated urban growth since the early 1990s under urban planning control. In the course of the 1990s and 2000s, the government had already created several new urban districts from formerly rural districts to this end (GOV, 2008; Fig. 2). The master plan envisions a centralization of water supply and sanitation ordered by large-scale networks stretching over the urban core and the suburban spaces of Hanoi (PPJ, 2010). Thus, in line with earlier urban plans of Hanoi, the current master plan continues to assume that national and local governments are able to control and plan urbanization. Furthermore, it is based on the idea that pre-designed water and sanitation infrastructures can integrate the urban and suburban spaces of Hanoi into a uniform metropolitan region.

This imagination of urban order underlying current urban planning does not coincide with the actual urbanization dynamics of Hanoi of the past twenty to thirty years. Since the beginning of the 1990s, the city's suburban spaces have been dramatically transformed by people migrating to the city in search of new economic opportunities in the wake of *doi moi* (Quang and Kammeier, 2002). Particularly the western and southern edges of Hanoi have experienced massive urbanization. To a certain degree, the city government has supported and directed urban growth, first with the relaxation of influx controls and later on with the creation of new urban districts and the subsequent development of 'new urban areas' based on master planning. New urban areas are large-scale modern housing estates. These are mostly erected on former farming land and they are designed to provide modern networked underground water and sanitation services (Labbé and Boudreau, 2011). Hanoi's government has promoted these investor-led projects and has benefited from them (Han and Vu, 2008). A senior planning expert shares his view of the planning process:

> "Why is the master plan of interest? Not because it is beautiful or reasonable urban development. The question is: where is my house, my street? You make money, buy a plot, pay compensation, 10 to 20 USD per square meter. You build some roads, drainage and lights, and sell for 300 to 400 USD per square meter. Now you are rich."
>
> Interview Senior Planning Expert, 2011

As the name 'new urban area' indicates, these estates appear in Hanoi's master plans as modern urban spaces inserted into otherwise empty, non-defined and unpopulated spaces, often marked as green in maps (cf. PPJ, 2010). However, they shape the suburban landscape of Hanoi together with periurban villages, which have expanded rapidly since *doi moi* and have partly merged with the urban fabric. These villages urbanize within incremental processes mediated between residents and local administrations. The incremental sub-division of plots in periurban villages leads to densification. Where space becomes rare, former one- or two-story houses and huts are regularly transformed into multi-story houses connected with an intricate system of narrow alleys branching from roads and often ending in cul-de-sacs. These buildings are often 'semi-legal' as individuals legally own plots and subdivide them without formal permission. Local administrations regularly accept this process as they are usually residents themselves and, thus, are deeply involved in the community's activities, including negotiations involving land access and housing construction (Interview Programme Manager, UN-Habitat Office Vietnam, 2009). Koh (2006) elaborates on the agency of urban dwellers in the re-production of Hanoi's urban space in spite of formally strict top-down regulations. As local government officials react more flexibly than formally prescribed to the needs and demands of the people, a "mediation space" (Koh, 2006: 12) emerges that allows for urban dwellers to change urban space beyond formal planning. Particularly, in the course of the 1990s and 2000s, the city government has adopted a tolerant stance toward the incremental growth of urban villages, as it has legalized constructions that are not in line with formal urban planning as long as the owners of these buildings pay land tax (Koh, 2006). Labbé's (2014: 142–143) account of urban dwellers' unsuccessful resistance against the redevelopment of farmland, on the other hand, shows people's limitations in changing top-down policy as the investor-led development of new urban areas proliferate at the edge of the city. Thus, multiple dynamics with and beyond formal urban planning have dramatically altered the suburban fabric of Hanoi in the past decades, where Leaf (2002: 29) observes "[…] a great diversity of intermixed landscapes, including walled residential estates, [and] ad hoc densification of pre-existing villages", which overcomes any fixed urban-rural divide (Fig. 3).

The development of new urban areas as well as the rapid, incremental densification of periurban villages show that master planning dis/orders urbanization processes in specific ways beyond the plans' proposed purpose. These urbanization dynamics and the role of

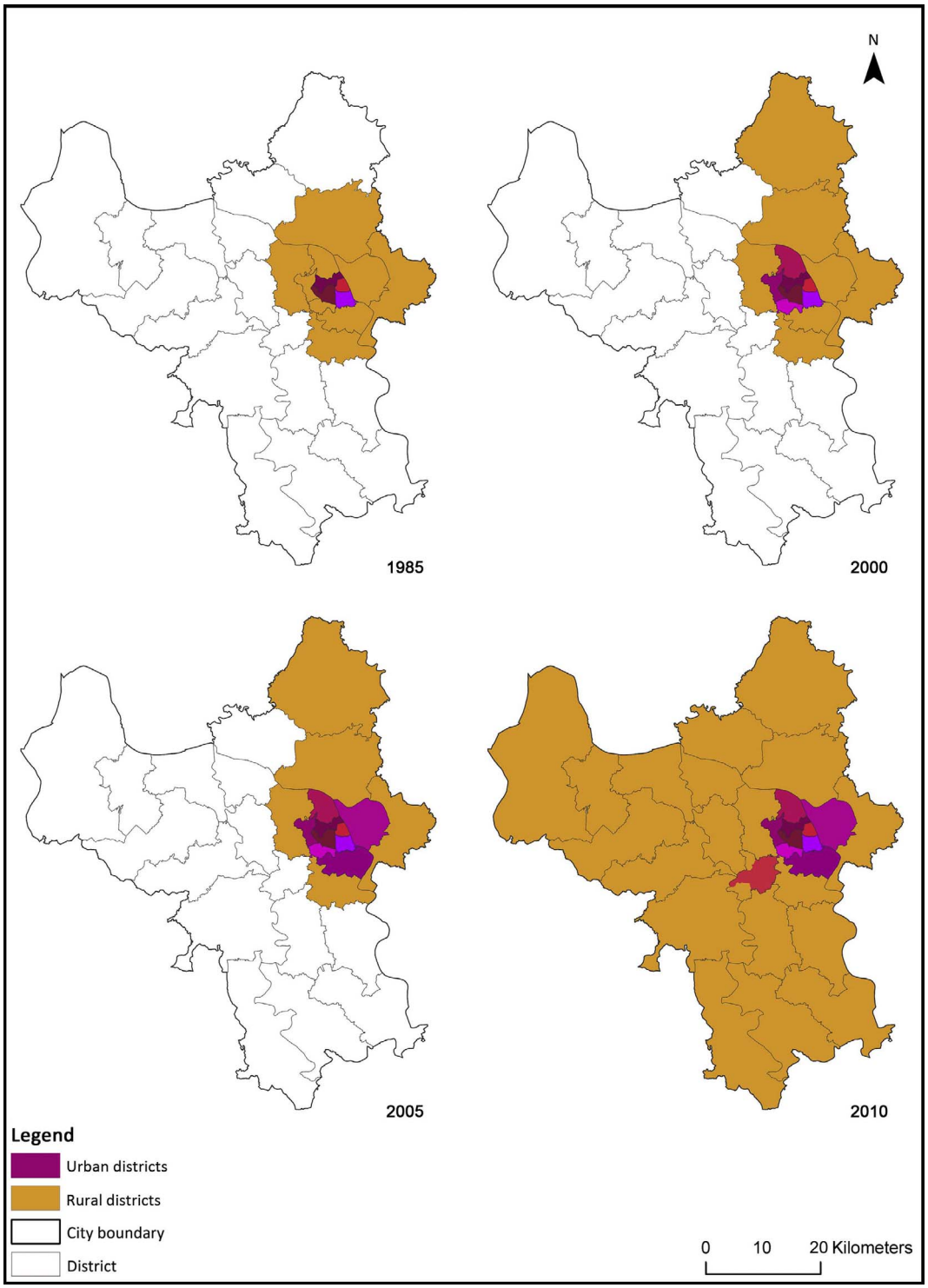


Fig. 2. Urban and rural districts of Hanoi 1985 till 2010.

planning fundamentally challenge the assumption that pre-designed, large-scale water and sanitation networks will actually be able to connect the diverse suburban landscapes of Hanoi and have the integrative effects that formal urban planning ascribes to them.

4. The pursuit of unification and corporatization: central and local networks

Master planning encourages central and unified systems of water and sanitation in Hanoi. Meanwhile, the expansion of large technological networks takes place in a very uneven manner, not least depending on the availability of financing. Since *doi moi*, Vietnam has been experimenting with ways to use private sector money and commercialized models of service provision to finance the roll-out of infrastructural networks (Miras and Quertamp, 2010). The mobilization of resources since the country's transition toward a market economy and its re-insertion in global financial flows does not follow a specific formula. Water and sanitation projects are rather dealt with case by case, resulting in a complicated medley of financing models and infrastructure developments. However, we have identified two broader

Fig. 3. Urbanization of Hanoi's western outskirts, view from the new urban area Ciputra (authors).

tendencies in the provision of networked service: (a) the expansion of centralized networks into suburban or urban spaces financed by loans from bilateral aid or multilateral funding, and (b) the place-specific installation of decentralized networks and treatment plants, along with the construction of residential estates, which are often carried out through public-private partnerships in the real estate market.

4.1. Toward unification: expanding centralized networks

The attempt to order urban Hanoi's region with centralized water supply and sanitation networks is apparent not only in master planning but also in sectoral plans (cf. SRV and HPC, 2009; PPJ, 2010; HAWACO, 2014a, 2011). However, it is hampered by a lack of funds in the city's budget, which results from a reluctance to introduce cost-recovering water and sewerage tariffs in the city. Thus, low profit of the water supply industry, and virtually no profit from sanitation services have made investments directly from the city's budget nearly impossible. This motivates the city to borrow from domestic and foreign companies and organizations to expand centralized networks (Interview Water Engineer, HAWACO, 2014a, 2014b).

In terms of water supply, the Ministry of Agriculture and Rural Development (MARD) is the responsible agency for rural and periurban spaces of Hanoi (cf. Danière et al. 2016). The MARD clearly prioritizes centralized network expansion over decentralized alternatives. A manager of the National Centre for Rural Water Supply and Sanitation Vietnam (NCERWASS) of the MARD explains:

> "[…] If you build a pipe scheme you can get subsidy of the government. But for the individual water supply facilities, such as tube wells, dug wells or rain-water tanks […] we will not subsidize."
>
> Interview General Director MARD, 2014

A municipal engineer states that the goal of network expansions is to decrease the share of the population using groundwater from privately-owned wells below the currently estimated 10% (Interview Environmental Engineer, HUST, 2014). He justifies this pursuit of centralization with health threats related to the uncontrolled use of privately-owned wells. In order to counter the overexploitation of groundwater, The Hanoi Water Company (HAWACO) aims to replace a large percentage of groundwater production with treated surface water (HAWACO, 2014a: 1; HAWACO, 2014b: 1–3, 17). The financing models that Vietnam has experimented with to develop clean water supply projects at national level are diverse, ranging from non-repayable loans over official development assistance to multilateral aid (Miras and Quertamp, 2010: 145).

While Hanoi's urban water supply has become deeply inserted into global flows of finance providing for the exploitation of new water sources far in the hinterland of the city, and the construction of large technological networks, urban sewerage and sanitation have been subject to international investments to a considerably lower degree. The absence of cost-recovery mechanisms considering the low income from tariffs and extremely high construction costs hamper the expansion of centralized networks and treatment plants. These are nevertheless promoted by the Japanese International Cooperation Agency (JICA), which supports the construction of "central large-scaled wastewater treatment plants" as part of the "Hanoi Sewerage and Drainage Environmental Renovation Project" (SRV and HPC, 2009). However, the project, the largest intervention into the sanitation system of Hanoi since French colonization, has so far had hardly any impact on the city's sanitation. This is the case because the urban sewerage utility lacks the funds to operate and maintain the plants constructed within the project (Quoc, 2010).

New financing models and access to multilateral and bilateral aid have transformed water supply networks in and around Hanoi, bringing them closer to centralization in line with the networked city ideal. In contrast, sewerage and sanitation have received much less attention by international donors as well as local and central governments. Despite the stated goal of centralization, the sector remains largely unprofitable and unappealing to investors. These dynamics create a discord between centralized water supply and sanitation of Hanoi. While both sectors are overrun by rapid urbanization, centralized service provision expands at a much faster rate in the water sector than in the sanitation sector.

4.2. Corporatization of services: installing satellite networks

The financing of large-technological water and sanitation systems at the outskirts of Hanoi remains precarious, as the various financial models rely mostly on international and bilateral loans while national and local governments persistently lack funds. At the same time, Hanoi's real estate market offers new possibilities for the implementation of modern infrastructure systems. Public utilities struggle to provide water and sanitation services to new urban areas at Hanoi's urban fringe. As real estate prices in Hanoi were comparable to those in central Paris or Tokyo in 2013 (VietnamNet, 2013), the development of estates at the urban fringe has promised such a profitable investment that companies are ready to provide modern networked services. A variety of companies develop housing estates at the outskirts of Hanoi, which often have a tradition as state-owned companies reaching back to the era of the planned economy. The Housing and Urban Development Company (HUD), for example, is a parastatal corporation, i.e. a corporation that is privately run, but whose majority shares belong to the state, under the Ministry of Construction. There are plans for its privatization in the near future (Vietnam Breaking News, 2016). Another influential actor is Vinaconex, a joint-stock company owned by multiple state-owned and foreign companies. Ownership structures of national and foreign real estate companies as well as financial procedures are complex. A water and sanitation expert of the National University of Civil Engineering in Hanoi explains that "there is no well-designed rule or game for private-public partnerships" (Interview Water and Sanitation Expert, NUCE, 2014). The HUD regularly takes over not only the construction, but also the management of local water supply and wastewater treatment plants (Figs. 4 and 5). Thus, it replaces the urban water and sanitation utilities, which cannot compete with local provision by the corporation itself in terms of costs. Miras and Quertamp (2010: 155) explain the challenge to regulate the quality of the water that real estate companies deliver:

> "[…] firms are inclined to do their own drilling in order to access cheap water, which compounds management of the resource and the problem of verifying groundwater quality."

Fig. 4. Local sewerage system in My Dinh II (authors).

Corporations thus create suburban "archipelagos of networks" (Bakker, 2003) providing services exclusively to housing estates without addressing surrounding spaces and often without considering the wider impacts on the water reticulation system of Hanoi's urban region.

In sum, in light of the re-positioning of Vietnam within globalized markets, the goal to order urban space via large technological networks is transformed by multiple, sector-specific financing mechanisms. Far from having a unifying effect, the piecemeal commercialization, liberalization and corporatization of water and sanitation services bring about a multiplicity of differently networked spaces. Sub/urban spaces of Hanoi display a dissonance between regionally expanded water networks and the lack of a comprehensive sanitation system. Both sectors experience a strive toward centrality and modernity, on the one hand, and a lack of a formula on how to finance respective investments, on the other. While actors in the central and local governments, real estate corporations and construction companies continue to experiment with financing mechanisms, public utilities remain far from being able to close the water loop.

Fig. 5. HUD water supply plant in Linh Dam (authors).

Thus, the dis/ordering of water supply and sanitation at Hanoi's urban edge is shaped as much by the piecemeal centralization of networks as by "cherry-picking" by parastatal or privatized corporations (cf. Graham and Marvin, 2001). This emergence of "archipelagos of networks" (cf. Bakker, 2003) does not depend primarily on the wealth of suburban residents in particular areas. Rather, broader entanglements of urbanization, housing and land markets, infrastructure provision and global finance flows shape developers' decisions toward the investment in infrastructures.

5. Persistent and new practices: beyond passive consumption

Amidst the ongoing attempts to re-order water and sanitation in Hanoi via the roll-out of centralized networks, as well as the commercialization and corporatization of services, suburban dwellers of Hanoi reject the role as passive consumers, which the current top-down interventions into the socio-technical systems of water supply and sanitation formally reserve for them. The ways in which people access water and sanitation depend not only on the sector in question, but they are also highly place-specific.

5.1. Complementing incomplete centralization: active residents in periurban villages

As there is no centralized provision of sanitation outside the formal urban boundaries, villagers and local administrations co-provide drainage and sewerage within periurban villages. They construct sewerage lines incrementally as villages expand. As a party secretary in a village in Gia Lam explains, periurban villagers lend a certain order to sanitation management, as they share the maintenance work of the drainage system:

> "On holidays the women and youths go to work, to open the channels. […This happens] about once every month. Women's union, youth union, everyone has a union, they can take part. After that, the chief of the village controls the activity, prepares a report, gives a critique. The activity is not paid."
>
> Interview Secretary of the Communist Party of Vietnam, Cong Thon village, Gia Lam district, 2011

The communal maintenance of local drainage and sewerage in villages at the outskirts of Hanoi has been influenced by socialist thought, as reflected in the presence of local 'unions' and the local chief criticizing activities. However, as Parenteau and Thong (2010) explain, such practices have been common in villages even before French colonization, when a village code stipulated that people living in a village were to contribute to works of public interest. In many villages, local wastewater drains into lakes and ponds feeding fish and aquatic plants. Furthermore, farmers often use sludges from tanks and latrines as fertilizer in fields or aquacultures, despite the government's formal ban of this practice (GHK, 2005). Septic tank sludge or night soil serves as fertilizer in agriculture or for feeding fish, and residents tend to view sanitation as unproblematic, perceiving it as an integral part of local socio-material cycles rather than waste (Figs. 6 and 7).

However, with the increasing development of housing estates, which replace formerly agricultural or green spaces and discharge their sewage into surrounding areas, the question of drainage becomes pertinent for those who live in villages. According to an urban planning expert, the new urban areas are built on elevated ground, re-directing the suburban flow of water like dams (Interview Senior Planning Expert, 2011). As more and more ground becomes sealed due to the construction of roads and new urban areas on elevated ground, local floods appear increasingly regular. This affects villages because drainage systems direct into the villages not only the discharge accruing from local networks, but also additional wastewater flowing from new

Fig. 6. Farmer using night-soil as fertilizer in the south of Hanoi (authors).

Fig. 7. Periurban fish pond in Lai Xa west of Hanoi (authors).

urban areas. Sanitation unveils the contradictions and contestations inherent to the current suburbanization of Hanoi. The flow of (waste) water overcomes the boundaries between new housing estates and periurban villages, boundaries that planners imagine and that architectural and infrastructural artifacts embody (cf. Schramm, 2016). The stagnation of increasing amounts of (waste)water in periurban villages unveils the problematic effects of the contradictions between planning of sanitation, on the one hand, and water supply, on the other. The dissonance between the two sectors becomes evident as more and more water flows into the suburban spaces of the city via large central networks, while there are no drainage or percolation systems in place that would facilitate a re-direction of the water away from periurban villages. The ways in which centralized networks expand into the suburban areas of Hanoi thus produce particular dis/orders, as they impact on the functionality of place-specific practices in the coproduction of water and sanitation services.

While there is no central-level involvement regarding sanitation of periurban villages, the government does support the extension of networks for water supply to the outskirts of Hanoi. Thus, access of periurban villagers to centralized networks is constantly increasing. However, even where access rates to centralized water provision are high, villagers complement piped water with water from local sources. The persistent practice of using piped water just as one among multiple sources of water illustrates the ability of residents to find alternatives to access water other than that provided through central networks. A study of Hanoi's "splintering urban waterscapes" (cf. Wright-Contreras et al., 2017) confirms the preference of many families to use water from their private well, as was common before, due to economic reasons and low network coverage. Furthermore, residents are not entirely satisfied with the quality of the water from the distribution network. On the one hand, users implement supplementary filter systems or opt for bottled water consumption; and on the other hand, users recur to water from wells, but due to the concentration of heavy metals in ground water they restrict its use to activities other than drinking or cooking (Wright-Contreras et al., 2017: 70–71). When access to water from privately-owned wells is possible, residents differentiate the use of water according to the source for activities such as irrigation, washing of clothes, motorbikes or cars, or construction. This allows them to save up to thirty times the expected charge of the water tariff which may vary from 0.50 USD to 15.70 USD per month (Wright-Contreras et al., 2017: 68). Maintaining decentralized water infrastructures enables dwellers to choose their water source according to their needs and thus attain independence and financial flexibility.

Amidst the rush to expand centralized water supply together with the low priority of central level investments into sanitation, peri-urban villagers actively re-order infrastructure provision. They do so by combining different technologies, such as private wells and septic tanks, with the communal management of local drainage and sewerage networks and with centralized water networks. The roll-out of centralized water networks thus neither excludes villagers, nor does it render them passive recipients of water externally provided to them. Rather, villagers appropriate networked services to include them into the hybrid mix of ways they access water. In terms of sanitation, the lack of networked service provision leaves people little alternative, but to provide for their own access to sanitation. This becomes precarious especially in combination with the development of new urban areas with their own sewage systems, as people in villages receive wastewater from these areas in amounts that overwhelm local drainage systems.

5.2. Residents of new urban areas: between a passive stance and cooperative engagement

While periurban villagers actively engage in their own service provision, residents of new urban areas regularly display a rather passive stance toward the provision of services. This stance is inscribed into the estates' design, with flats in building blocks connected to underground water and sewerage pipes. Also, residents' passivity goes along with satisfaction with service provision. In interviews they express no complaints concerning water coverage or access (Interview Residents, Linh Dam in Hoang Mai district, 2014). In the estate My Dinh II west of Hanoi city, several residents explain that the city's utility for water supply intends to build a second set of pipes in order to compete for this water market with the real estate company (Interview Residents, My Dinh II in Tu Liem district, 2011). This circulating rumor makes apparent the perceived profitability of supplying water to new urban areas, which residents imagine as competitive water markets.

In new urban areas, sanitation is hardly a topic of interest for the estates' local administration or residents. According to a resident and ward representative, "[…] the ward is not interested in sanitation

provision. This is the task of the HUD alone" (Interview Linh Dam Ward Representative, 2011). She goes on to explain that residents' groups discuss local matters regularly with the ward and the HUD, but discussions have focused largely on the use of communal space and other affairs while infrastructure provision has not been an issue (Interview Linh Dam Ward Representative, 2011). This passive attitude of residents in new urban areas toward the supply and management of water and the indifference of local administrations regarding sanitation infrastructures reflect the expectation that living in modern high-rise buildings goes along with the status of consumers of externally provided services.

While these assessments underscore the assumption that people living in new urban areas have little interest and limited scope to actively engage in their own service provision, there is an instance in Hanoi where residents have shown that there is certain space for people to influence service provision in the city's suburban estates. In the new urban area Trung Hoa Nhan Chinh, in the Cau Giay district, local residents formed a housing cooperative, became cooperative owners of the flats and took over local infrastructure service supply from the management board. As the vice president of the cooperative explains:

> "The activities of the cooperative are in the interest of the people. They own the cooperative, while other organizations work for profit. There were many problems, the elevators did not work, and there was no clean water […]".
>
> Interview Vice President Housing Cooperative, 2011

The city had taken over the management of the estate after construction by Vinaconex. However, the management board had continuously neglected the maintenance of water pipes, septic tanks under the buildings, as well as general building repairs despite regular payments by residents. Thus, people living in one housing block formed a cooperative to take over these tasks. As the vice president of the cooperative explains, this was a contested issue because the management companies "do not like the model [of housing cooperatives, comment by author], as they take away their tasks" (Interview Vice President Housing Cooperative, 2011). With the consultation of Swedish experts, the resident of block 17T10 in Trung Hoa Nhan Chinh overcame the opposition by the management board, construction companies, as well as the urban administration of Hanoi, and managed to re/order service provision. Today, residents of the building pay a little less than the amount charged by management boards of the HUD. While there is only marginal financial gain for the block's residents, the maintenance of the building has improved. According to the vice president, this model could work for other new urban areas of Hanoi as well, where service provision is inadequate. It has also gained attention by the media, Vietnamese authorities, and international organizations such as UN-Habitat and the World Bank, sparking a debate on legal changes of the city's housing policy (Reatimes, 2016). However, while housing cooperatives become more and more popular in Hanoi, the success of this cooperative is not least due to the engagement of Pham Dinh Thai, the cooperative's vice president, as well as other individuals (VietBao, 2012; HoanHap, 2016). They were able to negotiate with the city and the construction company and invest time into cooperative activities without being paid.

5.3. Scope and limitations of suburban dwellers' agency

We have elaborated above how suburban dwellers access services through the appropriation of circulating ideals. Suburban residents in Hanoi are neither left to accept "infrastructural bypassing" (Graham and Marvin, 2001), nor do they just consume services provided to them via large networks. At the same time, they do not outright reject to become inserted into a city-wide system of water reticulation, but they carefully navigate and choose among the spectrum of ways to access water and sanitation that is available to them. In doing so, they do not just operate individualistically or through ephemeral sociotechnical linkages. Rather, they furthermore negotiate, complement and change infrastructure access communally through relatively stable collectives. Within these multiple processes, they appropriate, mix and change globally circulating ideals of urban service provision.

Sub/urban dwellers' space of possibility to do so is closely related to their built environment and the degree of its regulation. Periurban villages are more flexible, leaving space for reconstructions by residents. Thus, self-built artifacts, such as tube or dug wells, are more likely to be part of place-specific constellations of water access. While the increasing availability of piped water is a welcome addition to the various ways in which people access water, the absence of city-wide drainage systems puts the residents of villages at risk of floods. Thus, periurban villages not only allow for, but they also require peoples' engagement to different degrees in water and sanitation. Residents of the rather strictly regulated new urban areas depend more strongly on the provision of services by external parastatal or private corporations. However, as the example of the housing cooperative shows, also residents of new urban areas have a room for maneuver, albeit a very limited one, that some of them use to take over their own service provision. Access to services in these areas is not necessarily as fixed as the estates' orderly design might suggest. As a result, not only villagers, but also residents of new urban areas may take an active part in their own service provision.

Our study of both sectors, water and sanitation, illustrates how peoples' individual or collective action and the agency that urban dwellers have in creating and changing infrastructures relates to the provision of external services or the absence thereof. In terms of water supply, centralized networks currently expand relatively rapidly into periurban villages, albeit in ways that do not always comply with residents' standards or financial means. Here, the engagement of people is rather individualistic, such as the use of water from private wells despite a network connection. In terms of sanitation in peri-urban spaces, where centralized service provision and regulation hardly exist, people form collectives in the re-construction and management of local drainage networks. Thus, this collectivization is highly precarious, as it is prompted by a lack of access to externally provided infrastructures. The cooperative management of housing estates is an example of collectivization in a situation where external provision does not comply with residents' standards and where they at the same time have no access to more decentralized and individualistic technologies to balance such shortcomings. Thus, very different forms of collectivization occur, which reflect different degrees of agency. In one case villagers work themselves for basic service access, with close mutual supervision, following ancient codes of communal life. In the other case, urban residents choose to take over the management of basic service provision from the parastatal company that had assigned the provision of this service to itself.

Thus, there might be numerous instances of people using each other as infrastructure (Simone, 2004) according to momentarily emerging needs also in Hanoi's water and sanitation provision. However, our study hints at the existence of more organized, long-lasting forms of collectivization that shape resident's engagement in their own provision of infrastructure. Some of Hanoi's residents engage in prefigurative politics (Silver, 2014), as they negotiate the terms of network connection, be it that they position networked water as just one of several alternatives or that they change the organization of service supply through the creation of cooperatives.

6. Conclusion

Urban planning of Hanoi has been informed by foreign experts since colonization, and it has continually rested on the travelling ideal of the 'networked city,' a particular socio-spatial order realized through large infrastructure networks. These are to integrate urban space and provide external services to urban dwellers, who would consume external services in a passive way. However, far from being stable bases of urban

life, Hanoi's water and sanitation infrastructures undergo perpetual change, reflecting breaks in the city's history, wars, and changes in the political economy. Furthermore, they have been constantly appropriated by people actively negotiating access to networked services. This remains the case after *doi moi*, the re-insertion of Hanoi into global flows of finance and knowledge that has accelerated investor-led as well as incremental urbanization. While the master plan for Hanoi states the goal to unify the expanded metropolitan region with centralized infrastructure networks, the sectoral and spatially uneven roll-out of centralized sanitation and water supply networks as well as the installation of satellite networks in new urban areas have increased the diversity of networked and non-networked service provision at Hanoi's urban edge.

Hanoi's suburban residents engage with this emerging multiplicity of differently networked spaces. Instead of rejecting the external provision of services, they appropriate and use it according to their needs and capacities. These appropriations do not occur in isolation, but again through the adaptation of circulating models, such as that of the housing cooperative. Thus, Hanoi's urbanization is shaped by the place-specific adaptation of various circulating models. Our research has demonstrated that this is not only the case in periurban villages, where a long tradition of residents' active involvement in service provision continues in light of a partial roll-out of centralized networks, but also in new urban areas. In these modern estates with local water and sanitation networks, residents have some, albeit a limited scope to engage in their own service provision. In sum, people's engagement in water and sanitation at Hanoi's urban edge may be an expression of agency as much as of a precarious lack of alternatives. It may be individual or communal, and in some instances collectives are formed. These collectives are deeply entangled with circulating ideals and models of urban infrastructure and housing provision. At times they are far more stable and organized than some of the current literature on the agency of urban dwellers in their provision of services beyond central planning suggests.

Acknowledgement

We would like to thank two anonymous reviewers for their critical and constructive comments. Furthermore, we thank the German Ministry of Education and Research (grant number 02WA0973), the German Research Foundation (DFG, Graduate School of Topology of Technology) and the Social Sciences and Humanities Research Council of Canada (grant number 510134) for their generous support of our research.

References

Allen, A., 2003. Environmental planning and management of the peri-urban interface: perspectives on an emerging field. Environ. Urbanization 15 (1).
Allen, A., 2010. Neither rural nor urban: service delivery options that work for the peri-urban poor. In: Peri-urban Water and Sanitation Services. Springer, Netherlands, pp. 27–61.
Bakker, K., 2003. Archipelagos and networks: urbanization and water privatization in the South. Geographical J. 169 (4), 328–341.
Bakker, K., 2013. Constructing 'public' water: the World Bank, urban water supply, and the biopolitics of development. Environ. Plan. D 31 (2), 280–300.
Beauséjour, J., Nguyen, V.A., 2007. Decentralized sanitation implementation in Vietnam: a peri-urban case study. Water Sci. Technol. 56, 133–139.
Chi, T.T., Luan, N., Luyen, N.T., Thai, N.H., Thong, N.Q., 2010. Half a Century of Vietnamese Architecture. Time Publishing House, Hanoi.
Coutard, O., 2008. Placing splintering urbanism: introduction. Geoforum 39 (6), 1815–1820.
Coutard, O., Guy, S., 2007. STS and the city: politics and practices of hope. Sci. Technol. Human Values 32 (6), 713–734.
Coutard, O., Rutherford, J. (Eds.), 2016. Beyond the Networked City: Infrastructure Reconfigurations and Urban Change in the North and South. Routledge.
Danière, A., Drummond, L., NaRanong, A., van Tran, A.T., 2016. Sustainable flows. J. Environ. Dev. 25 (1), 47–72.
Fayet, L., 1939. Preliminary draft of the sewers of Hanoi. (Original in French; Avant-Projet sur les Égouts de Hanoi). Hanoi: Imprimerie d'extrême Orient, 1939. National Archive Vietnam, Centre I Hanoi, (078692-03).
Fredericks, R., 2014. Vital infrastructures of trash in Dakar. Comp. Stud. South Asia, Afr. Middle East 34 (3), 532–548. http://dx.doi.org/10.1215/1089201X-2826085.
Gandy, M., 2004. Rethinking urban metabolism: water, space and the modern city. City 8 (3), 363–379.
GHK, 2005. Decentralised Wastewater Management in Vietnam—A Hanoi Case Study. GHK, CEEITA, London, Hanoi.
Government of Vietnam (GOV), 2008. 82/BC-CP 2008. Explanatory report on the administrative expansion of Hà Noi capital. Government of Vietnam, Hanoi (Updated: May 29, 2008).
Graham, S., 2000. Introduction: cities and infrastructure. Int. J. Urban Reg. Res. 24 (1), 114–119.
Graham, S., Marvin, S., 2001. Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition. Routledge, London.
General Statistics Office of Vietnam (GSO), 2009. Average population by province. Population Employment. Available: < http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=9880 > (Updated: 2009. Accessed: Apr. 18, 2011).
General Statistics Office of Vietnam (GSO), 2014. Area, population and population density by province by Cities, provinces, Year and Items. Population Employment. Available: < http://www.gso.gov.vn/default_en.aspx?tabid=774 > (Updated: 2014. Accessed: Feb. 15, 2016).
Han, S.S., Vu, K.T., 2008. Land acquisition in transitional Hanoi, Vietnam. Urban Stud. 45 (5–6), 1097–1117.
Harvey, D., 1985. The Urbanization of Capital: Studies in the History and Theory of Capitalist Urbanization. Johns Hopkins University Press, Baltimore.
Hanoi Water Limited Company (HAWACO), 2011. Construction and development of water supply sector Hanoi. (Original in Vietnamese; Xay dung va phat trien nganh cap nuoc ha noi). HAWACO, Hanoi. (Updated: Oct. 2011).
Hanoi Water Limited Company (HAWACO), 2014a. Hanoi Water Supply System. Unpublished work. Summary distributed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC International Conference: Sustainable Water and Sanitation Services for all in a Fast Changing World, co-hosted by Loughborough University and the National University of Civil Engineering (NUCE), Sep. 15–19, 2014 [Date of guided visit: Sep. 18, 2014).
Hanoi Water Limited Company (HAWACO), 2014b. Hanoi Water Supply System. Unpublished work. PowerPoint presentation viewed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC International Conference: Sustainable Water and Sanitation Services for all in a Fast Changing World, co-hosted by Loughborough University and the National University of Civil Engineering (NUCE), Sep. 15–19, 2014 [Date of guided visit: Sep. 18, 2014).
HoanHap, 2016. It is necessary to replicate the Cooperative Management of Housing from Sweden (Original Vietnamese: The Cần nhân rộng mô hình Hợp tác xã quản lý và ung cấp dịch vụ Nhà ở Thụy Điển). Available: < http://hoanhap.vn/bai-viet/ca-n-nhan-rong-mo-hinh-ho-p-tac-xa-quan-ly-va-cung-cap-dich-vu-nha-o–thuy-dien-14164 > (Updated Oct 27, 2016, Accessed: February 2, 2017).
Hofmann, P., 2013. Wasted waste - disappearing reuse at the peri-urban interface. Environ. Sci. Policy 31, 13–22.
Hommels, A., 2005. Studying obduracy in the city: toward a productive fusion between technology studies and urban studies. Sci. Technol. Human Values 30 (3), 323–351.
Hughes, T.P., 1987. The evolution of large technological systems. In: Bijker, W.E., Hughes, T.P., Pinch, T.J. (Eds.), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. MIT Press, Cambridge/Mass, pp. 51–82.
Jaglin, S., 2008. Differentiating networked services in Cape Town: echoes of splintering urbanism? Geoforum 39 (6), 1897–1906.
Kirsch, T.G., 2006. Illegal connections: conflicts over electricity, Soweto. Soziale Welt 16, 193–208.
Koh, D.W.H., 2006. Wards of Hanoi. Institute of Southeast Asian Studies, Singapore.
Labbé, D., 2014. Land Politics and Livelihoods at the Margins of Hanoi. 1920–2010. UBC Press, Vancouver, Toronto.
Labbé, D., Boudreau, J.A., 2011. Understanding the causes of urban fragmentation in Hanoi: the case of new urban areas. Int. Dev. Plan. Rev. 33 (3), 273–291.
Labbé, D., Musil, C., 2014. Periurban land redevelopment in Vietnam under market socialism. Urban Stud. 51 (6), 1146–1161.
Latour, B., 1993. We Have Never Been Modern. Harvard University Press, Cambridge.
Lawhon, M., Ernstson, H., Silver, J., 2013. Provincializing urban political ecology: towards a situated UPE through African urbanism. Antipode 46 (2), 497–516.
Leaf, M., 1999. Vietnam's urban edge. Third World Plan. Rev. 21 (3), 297–315.
Leaf, M., 2002. A tale of two villages: globalization and peri-urban change in China and Vietnam. Cities 19 (1), 23–31.
Leigh Star, S., 1999. The ethnography of infrastructure. Am. Behav. Sci. 43 (3), 377–391.
Logan, W.S., 2000. Hanoi, Bibliography of a City. University of Washington Press, Seattle.
McFarlane, C., 2008. Governing the contaminated city: infrastructure and sanitation in colonial and post-colonial Bombay. Int. J. Urban Reg. Res. 32 (2), 415–435.
McCann, E., 2013. Policy boosterism, policy mobilities, and the extrospective city. Urban Geogr. 34 (1), 5–29.
Mehta, L., Karpouzoglou, T., 2015. Limits of policy and planning in peri-urban waterscapes: the case of Ghaziabad, Delhi, India. Habitat Int. 48.
Ministry of Construction (MOC), 1993. Preserving Hanoi's Architectural and Landscape Heritage. Construction Publishing House, Hanoi.
McCann, E., 2011. Urban policy mobilities and global circuits of knowledge: toward a research agenda. Ann. Assoc. Am. Geogr. 101 (1), 107–130.
Mitlin, D., 2008. With and beyond the state—co-production as a route to political influence, power and transformation for grassroots organizations. Environ. Urbanization 20 (2), 339–360.
Miras, C.D., Quertamp, N.F., 2010. Changes in public water management: transition, compromise, and innovation. In: Gubry, P., Castiglioni, F., Cusset, J., Thieng, N.T.

(Eds.), The Vietnamese City in Transition. Institute of Southeast Asian Studies, Singapore.
Monstadt, J., Schramm, S., 2017. Toward the networked city? Translating technological ideals and planning models in water and sanitation systems in Dar es Salaam. Int. J. Urban Reg. Res. http://dx.doi.org/10.1111/1468-2427.12436.
Ngo, T.T.V., 2009. The existing sewerage and drainage system in Hanoi. TU Int. 63, 18–19. Available: < https://www.alumni.tu-berlin.de/fileadmin/Redaktion/ABZ/PDF/TUI/63/van_ngo_TUI63.pdf > (Updated: Jan. 2009. Accessed: Jun. 22, 2009).
Ngo, H., 2014. Internship report: Yen Phu water treatment plant. (Original in Vietnamese; Noi dung bao cao thuc tap cong nhan nha may nuoc yen phu). Unpublished work. Institute of Environmental Sciences and Technology, National University of Civil Engineering, Hanoi (Updated: Aug. 2014).
Nguyen V.A., Hanh, T.T.H., Thanh, V.T.M., Parkinson, J., Barriero, W., 2004. Decentralized wastewater management – a Hanoi case study. In: Proceedings 30th WEDC International Conference People-Centered Approaches to Water and Environmental Sanitation, Vientiane, Lao P.D.R. pp. 156–159.
Parenteau, R., Thong, N.Q., 2010. The role of civil society in urban environmental management. In: Gubry, P., Castiglioni, F., Cusset, J., Thieng, N.T., Huong, P.T. (Eds.), The Vietnamese City in Transition. Institute of Southeast Asian Studies, Singapore, pp. 167–210.
Parenteau, R., Thong, N.Q., 2005. The role of civil society in urban environmental rehabilitation: a case study (Thanh Xuân district, Hanoi, Vietnam). Environ. Urbanization 17 (1), 237–248.
Perkins Eastman, Posco E & C, Jina (PPJ), 2010. Construction planning of Hanoi capital city to 2030 and vision to 2050 conference report urban development planning Vietnam. (Original in Vietnamese; Quy Hoạch Chung Xây Dựng Thủ Đô Hà Nội đến năm 2030 và tầm nhìn đến năm 2050). Available: < http://hanoi.org.vn/planning/data/ppj_20100402.pdf > (Updated: Apr. 2, 2010; Accessed: May 20, 2010).
Quang, N., Kammeier, H.D., 2002. Changes in the political economy of Vietnam and their impacts on the built environment of Hanoi. Cities 19 (6), 373–388.
Quoc, D., 2010. Re-evaluation of Hanoi drainage project. (Original in Vietnamese; Dự án thoát nước Hà Nội: Phải đánh giá lại). In *Tiền Phong*. Available: < http://www.tienphong.vn/Thoi-Su/189367/Duan-thoat-nuoc-Ha-Noi-Phai-danh-gia-lai.html > (Updated: Mar. 21, 2010. Accessed: May 4, 2010).
Rakodi, C., 2008. Order and disorder in African cities: the social roots and contemporary outcomes of approaches to governance and land management. Paper presented to the UNU-WIDER Project Workshop "Beyond the Tipping Point: Development in an Urban World", Cape Town, 26–28 June, 2008.
Reatimes, 2016. The establishment of apartment building management, Lesson 5: the "thirst" for an effective apartment management model. (Original Vietnamese: Chây ì thành lập ban quản trị chung cư, Bài 5: "Cơn khát" mô hình quản lý chung cư hiệu quả). Available: < http://reatimes.vn/chay-i-thanh-lap-ban-quan-tri-chung-cu-bai-5-con-khat-mo-hinh-quan-ly-chung-cu-hieu-qua-1735.html > (Updated: Nov. 11, 2016).
Schramm, S., 2014. City in flux: Sanitation in Hanoi in the light of social and spatial transformations (Original in German; *Stadt im Fluss: Die Abwasserentsorgung Hanois im Lichte sozialer und räumlicher Transformationen*). Franz Steiner Verlag, Stuttgart.
Schramm, S., 2016. Flooding the sanitary city: planning discourse and materiality of urban sanitation in Hanoi. City 20 (1), 32–51.
Silver, J., 2014. Incremental infrastructures: material improvisation and social collaboration across post-colonial Accra. Urban Geogr. 35 (6), 788–804.
Simone, A., 2004. People as infrastructure: intersecting fragments in Johannesburg. Public Cult. 16 (3). http://dx.doi.org/10.1215/08992363-16-3-407.
Socialist Republic of Vietnam (SRV), 2009. QCVN 01: 2009/BYT. National technical regulation on drinking water quality, Hanoi. Compiled by the Department of Preventive Medicine & Environment and promulgated by MOH's Minister at the Circular No. 04/2009/TT-BYT, Hanoi (Updated: Jun. 17, 2009).
Socialist Republic of Vietnam/People's Committees of Hanoi (SRV/HPC), 2009. Feasibility Study for the Construction Project of central large-scaled wastewater treatment plants for Hanoi environmental improvement - Final report summary. NIPPON KOEI; VIWASE, Hanoi.
Swyngedouw, E., 2004. Social Power and the Urbanization of Water: Flows of Power. Oxford University Press, Oxford, New York.
Tarr, J.A., Dupuy, G., 1988. Technology and the Rise of the Networked City in Europe and America. Temple University Press, Philadelphia.
Tsing, A.L., 2012. On nonscalability: the living world is not amenable to precision-nested scales. Common Knowl. 18 (3), 505–524. http://dx.doi.org/10.1215/0961754X-1630424.
VietBao, 2012. Housing Cooperative Model should be expanded. (Original Vietnamese: Nên mở rộng mô hình hợp tác xã nhà ở). Available: < http://vietbao.vn/vi/Kinh-te/Nen-mo-rong-mo-hinh-hop-tac-xa-nhao/410560193/87/ > (Updated: Sep. 24, 2012. Accessed: May 31, 2016).
Vietnam Breaking News, 2016. Four firms under construction ministry to go public in 2016 – VietNam Breaking News. Vietnam Breaking News.com. Available: < https://www.vietnambreakingnews.com/2016/01/four-firms-under-construction-ministry-to-gopublic-in-2016/ > (Updated: Nov. 16, 2013).
VietnamNet, 2013. Realty woes yet to hit Hanoi's old quarters. Vietnamnet Bridge. Available: < http://english.vietnamnet.vn/fms/business/89094/realty-woes-yet-to-hit-hanoi-s-old-quarters.html > (Updated: Jan. 4, 2016).
World Health Organization (WHO), 2010. International Travel and Health: Situation as on 1 January 2010. World Health Organization, Geneva.
Wright-Contreras, L., March, H., Schramm, S., 2017. Fragmented landscapes of water supply in suburban Hanoi. Habitat Int. 61, 64–74.
Zérah, M.H., 2008. Splintering urbanism in Mumbai: contrasting trends in a multilayered society. Geoforum 39 (6), 1922–1932.

Interviews

Environmental Engineer, HUST, 2014. Interview by authors. Hanoi.
General Director, MARD, 2014. Interview by authors. Hanoi.
Linh Dam Ward Representative, 2011. Interview by authors. Hanoi.
Programme Manager, UN-Habitat Office Vietnam, 2009. Interview by authors. Hanoi.
Residents, Linh Dam in Hoang Mai district, 2014. Interview by authors. Hanoi.
Residents, My Dinh II in Tu Liem district, 2011. Interview by authors. Hanoi.
Secretary of the Communist Party of Vietnam, Cong Thon village, Gia Lam district, 2011. Interview by authors. Hanoi.
Senior Planning Expert, 2011. Interview by authors. Hanoi.
Senior Urban Planner, 2011. Interview by authors. Hanoi.
Vice President Housing Cooperative, 2011. Interview by authors. Hanoi.
Water and Sanitation Expert, NUCE, 2014. Interview by authors. Hanoi.
Wastewater Expert, 2009. Interview by authors. Hanoi.

4. Suburban constellations of water supply and sanitation in Hanoi

Publication No.	**P-III**
Type	Book chapter
Book title	*Critical Perspectives on Suburban Infrastructures: Contemporary International Cases*
Publisher	University of Toronto Press
Status	Published
Reference	Schramm, S., & **Wright-Contreras, L.** (2019). Suburban constellations of water supply and sanitation in Hanoi. In P. Filion & N. Pulver (Eds.), *Critical Perspectives on Suburban Infrastructures: Contemporary International Cases* (pp. 208–230). Toronto: University of Toronto Press.
Abstract	The broader societal change in Vietnam in the past thirty years has become apparent in suburban infrastructure provision, with tendencies toward sociospatial stratification being closely interrelated with a hybrid mix of ways to access sanitation and water supply infrastructures. We argue, that suburban areas are therefore particularly revealing of the contradictions inherent to centralized infrastructure policies insisting on the modern ideal of unitary centralized network provision. At the same time, the relative weakness of centralized infrastructure networks in suburban areas leaves space for creativity and innovative or alternative ways to access basic services for residents). In the first section, we analyze the water cycle of Hanoi and how it has been shaped by technologies for potable water sourcing and distribution, wastewater collection and disposal from the early stages of the city's development on. We then explicate the ways in which central and local governments currently aim to re-shape this water cycle through interventions into infrastructural artefacts and networks as well as organizational structures. In the third section, we focus on suburban dynamics of water supply and sanitation and particularly the place-specific perspectives and practices of suburban residents. Thus, we reveal contradictions between formal policies and actual patterns of service provision shaped by broader suburbanization dynamics and socio-political constellations.

EDITED BY PIERRE FILION
AND NINA M. PULVER

Critical Perspectives on Suburban Infrastructures

Contemporary International Cases

UNIVERSITY OF TORONTO PRESS
Toronto Buffalo London

Toronto Buffalo London
utorontopress.com
Printed in the U.S.A.

ISBN 978-1-4875-0495-3 (cloth) ISBN 978-1-4875-2361-9 (paper)

Printed on acid-free paper with vegetable-based inks.

Global Suburbanisms

Library and Archives Canada Cataloguing in Publication

Title: Critical perspectives on suburban infrastructures : contemporary international cases / edited by Pierre Filion and Nina M. Pulver.
Names: Filion, Pierre, 1952– editor. | Pulver, Nina M., 1978– editor.
Series: Global suburbanisms.
Description: Series statement: Global suburbanisms | Includes bibliographical references and index.
Identifiers: Canadiana 20190049405 | ISBN 9781487523619 (softcover) | ISBN 9781487504953 (hardcover)
Subjects: LCSH: Suburbs – Developed countries – Case studies. | LCSH: Suburbs – Developing countries – Case studies. | LCSH: Infrastructure (Economics) – Developed countries – Case studies. | LCSH: Infrastructure (Economics) – Developing countries – Case studies. | LCGFT: Case studies.
Classification: LCC HT351 .C75 2019 | DDC 307.74—dc23

University of Toronto Press acknowledges the financial assistance to its publishing program of the Canada Council for the Arts and the Ontario Arts Council, an agency of the Government of Ontario.

Canada Council for the Arts Conseil des Arts du Canada

ONTARIO ARTS COUNCIL
CONSEIL DES ARTS DE L'ONTARIO
an Ontario government agency
un organisme du gouvernement de l'Ontario

Funded by the Government of Canada Financé par le gouvernement du Canada

Canada

9 Suburban Constellations of Water Supply and Sanitation in Hanoi

SOPHIE SCHRAMM AND LUCÍA WRIGHT-CONTRERAS

Introduction

Vietnam's transition from a socialist state towards a socialist-oriented market economy roughly thirty years ago, known as *doi moi*, has triggered massive urban growth in the country. National urbanization rates were 33 per cent in 2014 (United Nations [UN], 2014) and are now projected to reach 58.8 per cent by 2049 (General Statistics Office of Vietnam [GSO], 2011: 27). In particular, the capital city of Hanoi has been facing massive urban growth since the beginning of the 1990s (Quang & Kammeier, 2002). This growth has drastically transformed the city's urban edges, where residents, real estate development agencies, international organizations, and urban and national administrations shape the process of urbanization in creative as well as contested ways. The diverse suburban landscapes of Hanoi are particularly representative of the increased social stratification in Vietnam since the introduction of a market economy in the 1990s (Labbé & Musil, 2011; Leaf, 2002). Water and sanitation infrastructures reflect and reinforce these broader sociospatial dynamics.

Urban planning, as well as sectoral plans and projects, continue to promote the expansion of large technological networks in order to centralize and standardize service provision for the entire metropolitan region of Hanoi. However, in the wake of Vietnam's insertion into the global economy after *doi moi*, urbanization dynamics and the organization and governance of infrastructure service provision in water supply and sanitation have resisted the project of unification and centralization. Central and local governments have actively supported massive real estate development at the edges of Hanoi, promising residents access to modern networked services, while urban and peri-urban villages have been incrementally growing and densifying at a rate that is too rapid for formal planning.

Public sanitation utilities have undergone few institutional changes, severely restricting their capacity to serve citizens, despite formal water supply organization and governance reflecting current tendencies towards commercialization and liberalization of service provision. Particularly in the suburban areas of Hanoi, large-scale, path-dependent infrastructure networks are relatively weak and lead to sociospatial diversifications and redundancies of water and sanitation provision, contradicting the current government's plans to roll out uniform water supply and sanitation networks integrating the Hanoi metropolitan region. Multiple technologies to access water and sanitation, such as privately owned wells, decentralized septic tanks, and open sewage drains, as well as central and local water and sewerage networks, are shaping Hanoi's suburban spaces. New actors are emerging and providing services exclusively within residential estates, so-called new urban areas, creating spatially restricted "satellite network systems," which often ignore and at times disturb surrounding topologies of water and sanitation provision. In peri-urban villages, a hybrid mix of self-organized and community-based forms of service provision from wells or through septic tanks and self-organized connections to central water networks or local drainage systems has developed (Schramm, 2014). Thus, the suburban areas of Hanoi are experiencing drastic sociospatial diversifications and decoupling of service provision.

Starting from the perspective of urban infrastructure studies that view flows of water and sewage to be closely intertwined with urbanization patterns and reflective of broader dynamics of urban resource distribution and access (Kooy & Bakker, 2008), we consider Hanoi's "splintered" suburban landscapes of water and sanitation provision as a crucial lens to explain the (sub)urbanization of Hanoi and respective dynamics between sociospatial fragmentation and cohesion. Scholars of urban infrastructure studies have articulated the need to analyse such dynamics beyond simplistic conceptualizations of "splintering" networks and "infrastructural bypassing" of poorer urban areas in the wake of neoliberal projects (Coutard, 2008; Graham & Marvin, 2001), particularly with regards to cities of the global south (Kooy & Bakker, 2008). Such analyses have to take into account specific urbanization dynamics and urban morphologies that shape the local ways to access infrastructure services through and beyond centralized networks (Zérah, 2008).

Furthermore, the diversity of practices in the provision of and access to services in different sectors deserves scholarly attention (Coutard, 2008).

Our study of suburban water supply and sanitation in Hanoi contributes to this endeavour by comparing water and sanitation provision in relation to particular urbanization patterns between centralized urban expansion and incremental growth of peri-urban villages. Our analysis of urban planning, central strategies of infrastructure provision, and users' practices provides a more nuanced picture of place-specific dynamics of infrastructure access throughout and beyond centralized networks. As opposed to notions of "infrastructural bypassing" (Graham & Marvin, 2001) of poorer areas, which imply a certain victimization of urban residents who are left to passively accept their exclusion from modern service provision, our study emphasizes the fact that suburban residents of Hanoi have to access services beyond centralized networks in water supply as well as sanitation. However, this fact does not mean that current dynamics of infrastructural access in Hanoi's suburban areas are unproblematic and free of contestation. It is particularly the focus on both water and sanitation that reveals how the ongoing decoupling of the sectors, with sanitation and wastewater management largely lacking funds and the water supply sector becoming an important arena for investments of national as well as global companies and financial corporations, contributes to very place-specific problems for residents in terms of access to water services, sanitation, and drainage. As we elaborate further on, it is thus the (sub)urban flow of water and sewage that unveils the contradictions and challenges that come along with current spatial planning and housing provision as well as infrastructural management in Hanoi.

The broader societal change in Vietnam in the past thirty years has become apparent in suburban infrastructure provision, with tendencies towards sociospatial stratification being closely interrelated with a hybrid mix of ways to access sanitation and water supply infrastructures. We argue that suburban areas are therefore particularly revealing of the contradictions inherent in centralized infrastructure policies insisting on the modern ideal of unitary centralized network provision. At the same time, the relative weakness of centralized infrastructure networks in suburban areas leaves space for creativity and innovative or alternative ways to access basic services for residents (see Monstadt & Schramm, 2013). In the following sections, we analyse the water cycle of Hanoi and how it has been shaped by technologies for potable water sourcing and distribution and wastewater collection and disposal from the early stages of the city's development onward. We then explicate the ways in which central and local governments currently aim to reshape this water cycle through interventions into infrastructural artefacts and

networks as well as organizational structures. We also focus on suburban dynamics of water supply and sanitation, and particularly the place-specific perspectives and practices of suburban residents. Thus, we reveal contradictions between formal policies and actual patterns of service provision shaped by broader suburbanization dynamics and sociopolitical constellations.

Hanoi's Water Cycle: Technologies of Water Supply and Sanitation

Since the founding of Hanoi more than two thousand years ago, the question of the fragile "balance between land and water" has been central to Hanoi's urbanization. This challenge is due to the geographic and climate conditions of the city situated within the delta of the Red River at a maximum of twenty metres above sea level (World Health Organization [WHO], 2010). Hanoi is an amphibious city with several distributaries of the Red River flowing through the city and its region from north to south, feeding numerous lakes and ponds. Hanoi has a high rainfall, approximately 1,600 millimetres per annum, which replenishes the aquifer below the city (Nguyen & Helm, 1995). Hanoi's flat terrain and low position, its high groundwater levels, its natural occurrences of arsenic in the groundwater, and its increasing pollution with heavy metals are major challenges for the management of the water cycle (Berg et al., 2008; Winkel et al., 2010). Furthermore, high evaporation rates, the sealing of land by construction, and growing consumption of groundwater contribute to a depletion of the aquifer. As groundwater is the major water source for Hanoi's citizens, supply becomes more and more precarious despite the ubiquity of water in the rapidly growing city. This situation affects the health of those residents who access untreated water.

Still, decentralized means of water supply, such as privately owned wells, remain popular. According to a resident of Hanoi, up to the beginning of the twenty-first century nearly every family living in the urban areas of Hanoi owned a tube or dug well (Resident of the inner-city district Hoan Kiem, personal communication, 2015). Today, Hanoi's residents rarely access water through decentralized means exclusively; they mostly use these means to complement water from the city's large technological networks (GHK, 2005). Centralized piped water distribution networks were initially built by French colonists in the late nineteenth century. Since then, Hanoi has continued to increase its capacity for centralized water production (Ngo, 2014).

Hanoi's first water treatment plant, Yen Phu, was built in 1894. After Vietnam's independence from France in 1954, the city expanded the groundwater treatment plant's capacity, and during the period from 1987 to 1997 allowed for funding from the Finnish government to significantly modernize and increase water production to supply the distribution networks (Ngo, 2014). Initially, these networks largely depended on groundwater pumped from centralized treatment plants. The deteriorating groundwater quality presents a challenge to serve the calculated demand of a million cubic metres per day (Hanoi Water Limited Company [HAWACO], 2014a: 17). Despite moderate amounts of non-revenue water, which account for approximately 20 to 30 per cent (Owen, 2012: 221; HAWACO, 2014a: 17), the situation is tense, as water demand is projected to increase to 2.7 million cubic metres per day in 2030 and 3.3 million per day in 2050 (HAWACO, 2014b: 1).

On its way from Hanoi's households into the Red River and the aquifers below the city, water flows through a range of sewage canals, rivers, and drains. Some of these are part of an ancient system that was constructed more than a thousand years ago to protect the city from flooding despite the flat terrain and high levels of rainfall (Ministry of Construction [MOC], 1993). This system was designed to separate household sanitation from urban drainage, because people in Hanoi have traditionally collected human manure, transported it out of the city, and used it as fertilizer in agriculture (Fayet, 1939). French colonial engineers complemented the drainage system with a combined underground sewerage network during the colonial occupation from 1905 to 1945 (Ngo, 2009). This first and to date largest attempt towards the combined sewerage of human wastewaters and storm water has proven to be a failure, as its incomplete conception based on gravitation did not account for the low hydraulic slope. The underground system built by the French covers only part of the inner city, and has gradually been extended so that it currently covers about 60 to 70 per cent of the city's urban districts (Wastewater expert, personal communication, 2009; Ngo, 2009). Today, only roughly 10 per cent of the approximately 760,000 cubic metres of wastewater generated daily in Hanoi's urban core flows through centralized treatment plants, and the share for the metropolitan region is even lower (Chairman, Hanoi Sewerage and Drainage Company, personal communication, 2008; Perkins Eastman, Posco E&C, and Jina [PPJ], 2010a: 115).

Like in the precolonial era, households of Hanoi City and region mostly rely on decentralized sanitation via septic tanks installed under

individual buildings. Septic tanks allow for the separation of human manure from other wastewaters – potentially leading to less contaminated wastewaters in the sewerage system and allowing for the use of human manure as fertilizer in agriculture. However, Hanoi's septic tanks tend to be undersized and emptied too rarely, resulting in the overflow of domestic wastewater directly into the sewerage system. Thus, they hardly contribute to an improvement of the city's rivers, lakes, and ponds, which often have a concentration of dissolved oxygen too low for any microorganism to survive.

Reshaping the Water Cycle: Towards Centralization and Unification

Central and city governments are alerted to the problems concerning water supply as well as sanitation and the deteriorating environmental situation in Hanoi. Planning documents reveal the intent to reshape the water cycle of Hanoi towards the centralization and unification of water supply and wastewater treatment in the city region (Socialist Republic of Vietnam & Hanoi People's Committee [SRV & HPC], 2009; PPJ, 2010a; HAWACO, 2011: 116, 117, 122–7; 2014a: 1–3). With its colonial and then socialist past, Hanoi has a tradition of extremely ambitious urban planning by foreign experts. Its plans are globally fashionable visions of modernity, symbolized by large-scale infrastructure networks and housing development, with a sharp distinction between the city and a rural hinterland. However, they only partially reflect the dynamics of Hanoi.

The current master plan is in line with this tradition. In opposition to its predecessors, the plan does not limit itself to those areas of the city that are urbanized or planned for urbanization. Its planning areas stretch far into the hinterland of the city, and it proposes the conservation of spaces that it represents as non-urbanized, "green," or rural spaces (PPJ, 2010a). The expansion of the planning areas accompanies the inclusion of parts of neighbouring provinces into Hanoi in 2008, which has enlarged the city's administrative area from approximately 92 hectares and 3.2 million inhabitants in 2007 to 335 hectares and over 7 million inhabitants in the urban and rural districts of Hanoi's metropolitan region in 2014 (GSO, 2009; 2014). The master plan envisions water supply as well as wastewater disposal to be organized via large-scale networks that stretch over the urban core as well as the suburban and peri-urban areas of Hanoi and are operated by parastatal water and sanitation utilities (PPJ, 2010a). Thus, the planned water and sanitation

infrastructures are to facilitate the integration of diverse urban and suburban spaces into a uniform metropolitan region under the control of national and local governments. Sectoral plans are in accord with this overall vision of infrastructure provision towards the centralization and unification of sub/urban space in Hanoi. Concerning water supply, it is particularly the hazardous metals found in the water and groundwater depletion that serve as justifications for the planned expansion of the centralized piped water system and the reduction of decentralized privately owned wells (NCERWASS, 2014). The USD $1.2 million National Target Program 3 (NTP3) of the Ministry of Agriculture and Rural Development (MARD) aims to extend the pipe distribution networks in suburban areas of Vietnam and is 90 per cent funded by Australia, Denmark, and the United Kingdom (Ministry of Foreign Affairs of Denmark, 2014). To aid water supply for fast growing areas on the outskirts of Hanoi and ease the overexploitation of groundwater, the city government also plans to build two new water treatment plants that extract water from Hong River and Duong River (HAWACO, 2014a: 1). The initial capacity of the plants will increase the treatment of surface water by 200 per cent and will match the current production of groundwater (HAWACO, 2014b: 1–3, 17). Towards 2050, the Hanoi Water Limited Company (HAWACO) intends to increase the capacity of each water treatment plant in order for surface water to fulfil 80 per cent of the projected demand for water in Hanoi City, while groundwater production is to decrease (HAWACO, 2014b: 23).

The construction and operation of the existing surface water treatment plant from Da River has been aided by private and foreign investments in joint stock companies, while the distribution of water is carried out through one-member limited liability companies such as the HAWACO, which is the biggest distribution company in Hanoi. In general, private sector participation models in water management in Vietnam are expected to increase from 2 per cent estimated in 2012 to 12 per cent in 2025 (Owen, 2012: 46). It is likely that the planned expansion of the city's centralized water supply system will augment the influence of international joint stock companies and the HAWACO over (sub)urban water supply. In terms of wastewater treatment and sanitation, an ongoing project of the Japanese International Cooperation Agency in conjunction with the national and city governments aims to install "central large-scaled wastewater treatment plants" in the metropolitan region of Hanoi. Despite the problems experienced with combined underground sewerage since French colonization, this

project is the proposed technological solution for planned urbanization in the suburban areas of Hanoi (SRV & HPC, 2005). A recent feasibility study of the project qualifies the septic tank system of the city as inefficient and ignores it in the technological design (see SRV & HPC, 2009).

Current interventions towards centralization of water supply and sanitation are an intensely contested issue. The ongoing project towards the installation of centralized wastewater treatment plants meets protests from sanitation experts and public media. A local newspaper deems the project "inappropriate, ridiculously expensive and useless" (24h, 2011; original in Vietnamese), summarizing the criticism by sanitation engineers, planners, and academics. Project costs accrue to USD $800 per person. According to an international water expert from the Asian Development Bank, costs between USD $200 and $600 per person are high already, even for such "heavy engineering" sanitation projects (Urban water supply and sanitation advisor, personal communication, 2011). Despite these costs, the artefacts constructed within the project are largely inoperable or have insufficient capacity to fulfil their designed purpose (Quoc, 2010). The state of sanitation artefacts reflects the situation of the Hanoi Sewerage and Drainage Company (HSDC), the public utility responsible for sanitation. It is owned by the city government and supposed to be financed by public fees. However, today the only fee for public sanitation in Hanoi is a 10 per cent surcharge on the water tariff (SRV & HPC, 2009). Thus, revenues are far too low for the utility to operate efficiently. As opposed to water supply, urban sanitation, sewerage, and drainage are not considered profitable by Vietnam's government, private corporations, or international organizations. While bilateral and international organizations, such as the German Association for International Cooperation (*Gesellschaft für Internationale Zusammenarbeit*, GIZ), promote a "commercialization" of the sector, making the revenues and costs of the utility transparent and raising tariffs in order to achieve "full cost recovery," there are few tendencies towards privatization in the sector. International and national joint stock companies and corporations largely limit their activities to the construction and maintenance of a centralized water supply network.

In the course of Vietnam's integration into the global economy and the drive towards privatization and liberalization since *doi moi*, both the sectors of water supply and sanitation have become increasingly disparate, with the water sector largely dominated by private corporations and firms. In line with the profitability of the water supply, actors

in the water sector are pushing for an expansion of networked water supply into the suburban spaces of Hanoi. There is no public controversy concerning the feasibility of respective interventions, and there are very few investments by international organizations or national governments into decentralized technologies of water supply, with the exception of pilot projects in marginalized areas.

These networks are encouraged largely through community-based management models, and to a lesser extent through cooperatives and private entities (NCERWASS, 2014). Based on the initial commitment to service a minimum of 60 per cent of the inhabitants of a suburban/rural community, MARD will facilitate the extension of the piped water scheme (NCERWASS, 2014). Depending on the capacity of the system, the process includes three months of survey and design and nine to twelve months of construction, or up to twenty months for larger systems. The expansion of the water networks is made possible through a financial mechanism of government subsidies for people living in marginalized areas, which covers up to 60 per cent of investment in capital construction costs. In order to cover the total costs, users contribute financially for the connection and intake from the main pipeline to their household. Thereupon, users in the community are committed to cover 100 per cent of the operation and maintenance costs (MARD representative, personal communication, 2014). As we elaborate further on, users' practices indicate scepticism towards supply from centralized networks, particularly in the suburban areas of Hanoi.

Diversification and Fragmentation: Access to Services in Suburban Hanoi

The contradictions and contestations around the centralization of water supply and sanitation in Hanoi become particularly apparent in the city's suburban spaces, which have experienced massive transformations since the beginning of the 1990s as relaxed influx controls and new economic opportunities in the wake of *doi moi* have motivated people to migrate to the city (Quang & Kammeier, 2002). The government has reacted to this influx with a step-by-step expansion of the city's administrative area through the creation of new urban districts from formerly rural districts in the course of the 1990s and 2000s, and in 2008 with the institutionalization of Hanoi's metropolitan region (Government of Vietnam [GOV], 2008). The creation of new urban districts

has led to massive urbanization, notably in the western and southern edges of Hanoi. Formal urban planning based on master plans has facilitated the development of "new urban areas," large-scale modern housing estates on former farming land designed with provision of networked underground water and sanitation services (figure 9.1; Labbé & Boudreau, 2011). Hanoi's government has promoted these developments and has benefited from them (Han & Vu, 2008). In fact, within "growth coalitions" that are developing these investor-led projects, the boundaries between the state and international and national real estate agencies blur, as individual actors regularly represent several of these entities. The city government's annexation of Ha Tay province in 2008, and thus the massive enlargement of its administrative area, exemplifies the master planning vision of creating a "greater" Hanoi through the development of new satellite cities and urban areas (Labbé & Musil, 2011: 2; PPJ, 2010b).

As the name indicates, such "new urban areas" appear in Hanoi's masterplans as modern urban spaces inserted into an otherwise empty, non-defined, and unpopulated space, often marked as green on maps (see PPJ, 2010a). However, they shape the suburban landscape of Hanoi together with the peri-urban villages on the outskirts of the city, which have expanded rapidly since *doi moi* and have partly merged with the urban fabric (figure 9.2). The urbanization process of these villages is mediated between residents of Hanoi and local administrations. They are often semi-legal, as individuals subdivide the plots they own without formal permission. Local administrations regularly tolerate this process because they are mostly residents themselves and thus deeply involved in village life and respective negotiations and activities around land access and housing construction (UN-Habitat program manager, personal communication, 2009). The incremental subdivision of plots in peri-urban villages leads to densification. Where space becomes rare, former huts are regularly transformed into multistorey houses connected with an intricate system of narrow alleys branching from roads and often ending in cul-de-sacs. "These multiple dynamics dramatically alter the suburban fabric of Hanoi, where a new type of urbanism has emerged ... with a great diversity of intermixed landscapes, including walled residential estates, ad hoc densification of pre-existing villages, and the tight intermingling of small-scale industries with commercial, residential and agricultural activities" (Leaf, 2002: 29). Specific sociotechnical water supply and sanitation arrangements enable and

9.1 The new urban area My Dinh II. Photo: Courtesy of the authors

9.2 Land and water in the peri-urban village Van Phuc. Photo: Courtesy of the authors

are at the same time shaped by these urbanization dynamics at Hanoi's urban edge.

Elite Decentralization: Water and Sanitation in New Urban Areas

While new urban areas are provided with local networks for water and sanitation services in accord with modern standards, there is a lack of connectivity to large-scale networks outside the compounds. As public networks do not reach the new urban areas, the urban utilities lose responsibility. Service provision is managed directly by real estate development companies or by the Ministry of Construction (MOC). These actors supply water through privately owned groundwater wells and treatment plants within the compound (figure 9.3), while wastewater flows from households through a local underground sewerage network directly into the surrounding spaces (figure 9.4). Only in exceptional cases do local plants pretreat sewage before its discharge from the estates (Schramm, 2014). Thus, new service providers come forth, reshaping the spatial and organizational patterns of infrastructure provision in Hanoi as they provide services exclusively within new urban areas. By creating satellite networks, they limit the scope of public utilities in terms of service provision. Such suburban "archipelagos" of networks (Bakker, 2003) at times interfere with surrounding topologies of water and sanitation provision.

Residents and local administrations of new urban areas display a general lack of interest for infrastructure provision in the new urban areas. In the new urban area Linh Dam, 30 per cent of a cluster sample of people interviewed assumed that the water they receive is provided by the real estate development company Housing Development Corporation (HUD), while the remaining 70 per cent simply did not know. In general, the consulted population shows an indifference regarding the technologies and management of water supply, as most of the interviewees didn't know where the water they consume came from and had no particular complaints about the water coverage or access (Survey conducted by the authors in Linh Dam district of Hanoi City, 2014). The perceived profitability of providing services in new urban areas became apparent in the rumour circulating in the estate My Dinh II, where several residents explained that the water supply utility intends to build a second set of pipes in order to compete for this water market with the real estate company (My Dinh II in Tu Liem district residents, personal communications, 2011). Also, sanitation is not

9.3 Water supply plant in the new urban area Linh Dam. Photo: Courtesy of the authors

9.4 Wastewater treatment plant in the new urban area My Dinh II. Photo: Courtesy of the authors

a topic of interest for the estates' local administration or the residents, as one resident and ward representative explained: "The ward is not interested in sanitation provision. This is the task of the HUD alone." (Linh Dam ward representative, personal communication, 2011). The indifference of residents towards water and sanitation infrastructures reflects the expectation that living in modern high-rise buildings goes along with the status of passive consumers of externally provided services.

Hybrid Mixing: Water and Sanitation in Peri-urban Villages

The passive stance of residents in new urban areas is in stark contrast with the active involvement in the provision of sanitation services by inhabitants of peri-urban villages. Here, local administrations and villagers themselves construct sewerage lines incrementally as the village grows, following the typical road patterns of Hanoi's peri-urban villages, where smaller roads branch off the main roads and ultimately end in cul-de-sacs (see Schramm, 2016). As there is no centralized provision of sanitation services, villagers organize the construction as well as operation of the drainage system together with the local administrations. The maintenance of septic tanks, which remain the predominant means of household sanitation, is an individual and private issue (Schramm, 2014). Where farming is still prevalent, farmers use sludge from the tanks as fertilizer in fields or aquacultures (figure 9.5), despite the government's prohibition of these practices (Schramm, 2014). Residents of peri-urban villages are actively involved in sanitation provision and largely consider it to be an unproblematic issue. This attitude is particularly the case where sewage or night soil is reused as fertilizer in agriculture or for feeding fish in aquacultures, which contributes to the perception of these practices as integral parts of local sociomaterial cycles. However, in light of the increasing development of housing estates replacing formerly agricultural spaces and discharging their sewage into surrounding areas, the question of drainage becomes pertinent for those who live in villages. In the absence of unsealed ground or functional drainage systems, they have to deal not only with their locally produced sewage but also with wastewater from surrounding housing estates. A resident from Cau Giay district stated: "Here, we are most interested in wastewater ... Before, there were many fields and vegetables. Now only a few are left. How can we avoid flooding?" (Cau Giay district resident, personal communication, 2011).

9.5 Fishing pond in the peri-urban village Lai Xa. Photo: Courtesy of the authors

Thus, it is the suburban flow of water and sewage that unveils the close and partly conflict-ridden interrelations between new housing estates and peri-urban villages, because it fails to respect the boundaries between these places imagined by planners and represented in architectural and infrastructural artefacts.

The flow of water and its stagnation in peri-urban villages furthermore reveal the contradictions between sanitation and water supply planning, and the problematic effects of the de-coupling of these sectors since *doi moi*, as increasing amounts of water are directed to suburban spaces in the absence of any functional drainage or percolation system. While there is no central-level involvement in the sanitation of peri-urban villages, the central government does support the extension of the existing water supply networks to urbanizing areas and peri-urban villages through the MARD.

Even in those cases where villagers have access to water from large-scale networks, users complement this source with water from shallow wells and, like in new urban areas, with purchased bottled water. Also, they use supplementary filter systems to assure the quality of the piped water. The persistent practice of using piped water just as one among multiple sources of water displays the distrust residents have towards water from central networks. One person in the peri-urban

Van Phuc commune in Ha Dong district conveyed that, at times, the output of the tap water in his house was "dirty water, a lot of sludge, a lot of detergent [possibly chlorine]; the colour of water is yellow or brown. I need to use a water purifier" (Van Phuc commune resident, personal communication, 2011).

Residents in other suburban areas such as Gia Lam reported inconsistent coverage and unreliable quality of the water provided by the distribution network. Thus, they maintain privately owned wells despite a high connection rate to the distribution network. However, concerns about water quality only partially explain the reluctance to fully rely on networked water provision. For example, our own surveys have shown that piped water tested equally positively in both the peri-urban village of Trieu Khuc and the new urban area of Linh Dam, while the quality of groundwater accessed from privately owned wells was poor in both areas, presenting levels of ammonium, arsenic, and iron that exceed the National Technical Regulation on Drinking Water Quality (SRV, 2009). Still, privately owned wells are an important alternative to cover all daily water-consuming activities such as gardening, washing, or construction, even though residents are aware of the presence of heavy metals in groundwater. Maintaining decentralized water infrastructures enables the residents to both have control over the access to water and to gain financial independence and flexibility. Residents may save up to twenty times the expected charge of the water tariff, which may vary from USD $0.70 per month to USD $16 per month (VND 15,000 to VND 350,000 at VND 22,300 for USD $1) (Survey conducted by the authors: 100 cluster samples in ten districts, Hanoi City, 2014).

Suburban residents in Hanoi are not passively consuming services provided to them via large central networks, as these services prove to be too inflexible and costly for their particular needs. At the same time, they do not outright reject their insertion into a city-wide system of water reticulation; rather, they carefully navigate and choose among the broad spectrum of ways to access water available to them. Suburban dwellers' capacity to do so is closely related to their built environment and the degree of regulation of space. For example, tube or dug wells are more likely to be found in the peri-urban villages due to the greater flexibility of the built environment that allows for reconstructions by residents, while residents of the rather strictly regulated new urban areas largely depend on the supply of water from a development company. Thus, residents of peri-urban villages are able to make active decisions and resist the project of unification and centralization of water supply in Hanoi.

Consequently, peri-urban villages display a hybrid mix of ways to access water and sanitation services, ranging from self-organized access through private wells or septic tanks, to community-based management of local drainage and sewerage networks, to centralized networks of water supply (Schramm, 2014). In sum, the multiple technologies of water supply and sanitation in suburban Hanoi beyond centralized network provision reflect patterns of central-level provision favouring corporatization of infrastructure systems in housing estates that operate exclusive, decentralized water supply and sanitation systems, and, paradoxically, the expansion of centralized water supply networks to peri-urban villages. At the same time, these villages remain largely excluded from large sewerage and drainage systems despite central-level projects towards the expansion of these networks. Hence, it is especially the residents of peri-urban villages who suffer from flooding resulting from the decoupling of water and sanitation services, and from sanitation policies based on a modernist dichotomy between urban and rural spaces. As a result, these villagers retain agency by actively taking part in their own provision of sanitation and water supply services. They do so not only in the case of sanitation, where hardly any central-level engagement exists, but also in the case of water supply, where local and central-state actors, together with international and national corporations, push for a centralization and unification of service provision via an aggressive expansion of centralized networks.

Conclusion

Multiple interrelated processes lead to a diversification of water supply and sanitation provision at the edges of Hanoi reflecting wider societal changes: rapid urbanization supported by the central and city governments through the development of modern real estate together with an incremental expansion of villages tolerated by local administrations; the reluctance of central-level administrations to realize the large-scale sanitation systems envisioned in master plans and to equip sanitation utilities with the means to operate such networks; and the expansion of water supply networks together with the insistence of suburban residents on the use of decentralized water sources. These dynamics, the push towards the expansion of large technological networks in the water sector and the preference of residents to use water from the centralized network for some uses only and combine it with water from other sources beyond formal control, clearly contradict conceptualizations of "infrastructural

bypassing" as a process leading to the exclusion of passive populations from centralized network provision (see Graham & Marvin, 2001). The suburban spaces of Hanoi, rather, display very place-specific practices between passive consumption and active involvement in service provision. These practices are shaped by and at the same time shape urbanization patterns and urban morphologies at Hanoi's urban edge, where residents of planned estates have a different capacity to rearrange the built environment compared to peri-urban villagers.

Suburban spaces in Hanoi are thus shaped by and at the same time resist current central-level planning and policies towards the expansion of centralized networks. These policies, projects, and plans are inserted into global flows of knowledge and capital channelled through bilateral and international finance and cooperation agencies. In the case of water as well as sanitation, the concentration on the roll-out of centralized networks displays a lack of respect for place-specific practices, the actual capacities of actors within and outside the state concerning the construction and maintenance of large-scale systems for the transport and treatment of water and the financing of interventions. Contradictions of current attempts to reshape the water cycle of Hanoi play out especially in the suburban areas. Suburban residents' practices, such as the use of night soil in agriculture and the use of water from decentralized wells for certain activities in combination with networked services for other activities, do not conform to any urban–rural dichotomy. This hybridization challenges the urban and infrastructural policies and plans of Hanoi, which continue to be affected by such a divide in their attempt to bring order, via the expansion of large networks, to spaces declared as urban. Suburban areas thus make apparent the need for urban and infrastructure planning in and beyond Hanoi to demonstrate trust in residents and their capability, for example, to differentiate uses of water from different sources in accord with respective water qualities instead of aiming at controlling and oppressing such practices. Suburban infrastructures in Hanoi and beyond thus pose the challenge to imagine ways in which such suburban practices as the use of decentralized water sources and the local reuse of night soil in agriculture may become an integral part of, and no longer a threat to, large infrastructure systems without compromising larger goals of sociospatial cohesion and equity.

The chapter has brought to this volume a consideration of the importance of the scale of infrastructure systems. It has exposed the modernist vision of large integrated water and sanitation systems, conveyed in plans and promoted by international aid agencies. But the Hanoi case

has identified multiple obstacles impeding the implementation of this vision and the adverse health and environmental consequences of fragmented water and sanitation systems. The message of the chapter thus appears to resonate with the modernist perspective on infrastructures and, thereby, promote large-scale, integrated infrastructures. According to this perspective, such infrastructures would be a prerequisite to healthy living conditions, respect for the environment, and coordinated urban and suburban development. The message of the chapter is subtler, however; it considers difficulties in achieving the modernist infrastructure model and alternatives to this model. Hence chapter 9 is of interest because it shows how effective smaller scale water and sanitation systems can be delivered within the prevailing institutional and financial context, while building on local public mobilization.

REFERENCES

Bakker, K. (2003). Archipelagos and networks: Urbanization and water privatization in the South. *The Geographical Journal*, *169*(4), 328–41. https://doi.org/10.1111/j.0016-7398.2003.00097.x

Berg, M., Trang, P.T.K., Stengel, C., Buschmann, J., Viet, P.H., Van Dan, N., Giger, W., & Stüben, D. (2008). Hydrological and sedimentary controls leading to arsenic contamination of groundwater in the Hanoi area, Vietnam: The impact of iron-arsenic ratios, peat, river bank deposits, and excessive groundwater abstraction. *Chemical Geology*, *249*(1–2), 91–112. https://doi.org/10.1016/j.chemgeo.2007.12.007

Coutard, O. (2008). Placing splintering urbanism: Introduction. *Geoforum*, *39*(6), 1815–20. https://doi.org/10.1016/j.geoforum.2008.10.008

Fayet, L. (1939). Preliminary draft of the sewers of Hanoi. (Original in French; Avant-projet sur les égouts de Hanoi). *Hanoi: Imprimerie d'extrême Orient*, *1939*. National Archive Vietnam, Centre I Hanoi (078692–03).

General Statistics Office of Vietnam (GSO). (2009). Average population by province. *Population and Employment.* Retrieved from http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=9880

General Statistics Office of Vietnam (GSO). (2011). Part 2: Projection result tables. *Projected Population for Vietnam 2009–2049.* Retrieved from http://www.gso.gov.vn/default_en.aspx?tabid=617&ItemID=11016

General Statistics Office of Vietnam (GSO). (2014). Area, population and population density by province. *Population and Employment.* Retrieved from http://www.gso.gov.vn/default_en.aspx?tabid=774

GHK International (2005). *Decentralised wastewater management in Vietnam – A Hanoi case study*. London: GHK International, CEEITA.

Government of Vietnam. (2008). *Explanatory report on the administrative expansion of Hà Noi capital*. (82/BC-CP 2008). Hanoi: Author.

Graham, S., & Marvin S. (2001). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. London: Routledge.

Han, S.S., & Vu, K.T. (2008). Land acquisition in transitional Hanoi, Vietnam. *Urban Studies*, *45*(5–6), 1097–1117. https://doi.org/10.1177/0042098008089855

Hanoi Water Limited Company (HAWACO). (2011). Construction and development of water supply sector Hanoi. (Original in Vietnamese; Xay dung va phat trien nganh cap nuoc ha noi). Hanoi: Author.

Hanoi Water Limited Company (HAWACO). (2014a). *Hanoi water supply system*. PowerPoint presentation viewed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC International Conference, "Sustainable Water and Sanitation Services for All in a Fast Changing World," co-hosted by Loughborough University and the National University of Civil Engineering (NUCE), Hanoi, 15–19 September 2014 (Date of guided visit: 18 September 2014).

Hanoi Water Limited Company (HAWACO). (2014b). *Hanoi water supply system*. Summary distributed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC International Conference, "Sustainable Water and Sanitation Services for All in a Fast Changing World," co-hosted by Loughborough University and the National University of Civil Engineering (NUCE), Hanoi, 15–19, September 2014 (Date of guided visit: 18 September 2014).

Kooy, M., & Bakker K. (2008). Technologies of government: Constituting subjectivities, spaces, and infrastructures in colonial and contemporary Jakarta. *International Journal of Urban and Regional Research*, *32*(2), 375–91. https://doi.org/10.1111/j.1468-2427.2008.00791.x

Labbé, D., & Boudreau, J.A. (2011). Understanding the causes of urban fragmentation in Hanoi: The case of new urban areas. *International Development Planning Review*, *33*(3), 273–91. https://doi.org/10.3828/idpr.2011.15

Labbé, D., & Musil, C. (2011). The extension of administrative boundaries of Hanoi: An exercise of recomposition of territories in tension. (Original in French; L'extension des limites administratives de Hanoi: Un exercice de recomposition territoriale en tension). *Cybergeo: European Journal of Geography*. Article 546. Retrieved from https://journals.openedition.org/cybergeo/24179

Leaf, M. (2002). A tale of two villages: Globalization and peri-urban change in China and Vietnam. *Cities*, *19*(1), 23–31. https://doi.org/10.1016/S0264-2751(01)00043-9

Ministry of Construction (MOC). (1993). *Preserving Hanoi's architectural and landscape heritage*. Hanoi: Construction Publishing House.

Ministry of Foreign Affairs of Denmark. (2014). Sector program support to water, sanitation and hygiene promotion (2012–2014). In *Water and Sanitation – Denmark in Vietnam*. Retrieved 17 March 2015 from http://vietnam.um.dk/en/danida-en/water-and-sanitation/

Monstadt, J., & Schramm, S. (2013). Beyond the networked city? Suburban constellations in water and sanitation systems. In R. Keil (Ed.), *Suburban constellations: Governance, land and infrastructure in the 21st century* (pp. 85–94). Berlin: Jovis.

National Centre for Rural Water Supply and Sanitation (NCERWASS). (2014). *Rural water supply in Vietnam: Evolution and opportunities*. PowerPoint presentation viewed during the 37th WEDC International Conference, "Sustainable Water and Sanitation Services for All in a Fast Changing World," co-hosted by Loughborough University and the National University of Civil Engineering (NUCE), Hanoi, 15–19 September 2014. Presented by Le Thieu Son.

Ngo, H. (2014). *Internship report: Yen Phu water treatment plant*. (Original in Vietnamese; Noi dung bao cao thuc tap cong nhan nha may nuoc yen phu). Unpublished work. Hanoi: Institute of Environmental Sciences and Technology, National University of Civil Engineering.

Ngo, T.T.V. (2009). The existing sewerage and drainage system in Hanoi. *TU International*, *63*, 18–19. Retrieved 22 June 2009 from https://www.alumni.tu-Berlin.de/fileadmin/Redaktion/ABZ/PDF/TUI/63/van_ngo_TUI63.pdf

Nguyen, T.Q., & Helm, D.C. (1995). Land subsidence due to groundwater withdrawal in Hanoi, Vietnam. In F.B.J. Barends, F.J.J. Brouwer, & F.H. Schröder (Eds.), *Proceedings of the Fifth International Symposium on Land Subsidence, held at The Hague, The Netherlands, 16–20 October 1995* (pp. 55–60). The Hague: International Association of Hydrological Sciences. Retrieved from http://hydrologie.org/redbooks/a234/iahs_234_0055.pdf

Owen, D. (2012). *Pinsent Masons water yearbook 2012–2013: The essential guide to the water industry from leading infrastructure law firm Pinsent Masons* (14th ed.). London: Pinsent Masons.

Perkins Eastman, Posco E&C, and Jina (PPJ). (2010a). *Construction planning of Hanoi capital city to 2030 and vision to 2050 conference ceport crban development planning Vietnam*. (Original in Vietnamese; Quy Hoạch Chung Xây Dựng Thủ Đô Hà Nội đến năm 2030 và tầm nhìn đến năm 2050). Retrieved from http://hanoi.org.vn/planning/data/ppj_20100402.pdf

Perkins Eastman, Posco E&C, and Jina (PPJ). (2010b). Greater Hanoi: General construction plan deals until 2030 and vision to 2050. (Original in Vietnamese; Uy hoạch chung xây dựng Thủ đô Hà Nội đến năm 2030 và tấm nhìn đến năm 2050). In *Hanoi's Channel, YouTube*. Retrieved from https://www.youtube.com/watch?v=Q9-RErNFhrU

Quang, N., & Kammeier, H.D. (2002). Changes in the political economy of Vietnam and their impacts on the built environment of Hanoi. *Cities*, *19*(6), 373–88. https://doi.org/10.1016/s0264-2751(02)00068-9

Quoc, D. (2010). Re-evaluation of Hanoi drainage project (Original in Vietnamese; Dự án thoát nướ́c Hà Nội: Phải đánh giá lại). *Tiền Phong.* Retrieved from http://www.tienphong.vn/Thoi-Su/189367/Du-an-thoat-nuoc-Ha-Noi-Phai-danh-gia-lai.html

Schramm, S. (2014). *City in flux: Sanitation in Hanoi in the light of social and spatial transformations* (Original in German; *Stadt im Fluss: Die Abwasserentsorgung Hanois im Lichte sozialer und räumlicher Transformationen*). Stuttgart, DE: Franz Steiner Verlag.

Schramm, S. (2016). Flooding the sanitary city: Planning discourse and materiality of urban sanitation in Hanoi. *City*, *20*(1), 32–51. https://doi.org/10.1080/13604813.2015.1125717

Socialist Republic of Vietnam (SRV). (2009). *National Technical regulation on drinking water quality, Hanoi.* (QCVN 01: 2009/BYT). Compiled by the Department of Preventive Medicine & Environment and promulgated by MOH's Minister at the Circular No.04/2009/TT-BYT, Hanoi. Retrieved from http://www.wpro.who.int/vietnam/topics/water_sanitation/wmq_water_standards_technical_regulation_on_clean_drinking_water_quality.pdf

Socialist Republic of Vietnam, & Hanoi People's Committee (SRV & HPC). (2005). *Feasibility study report and program implementation for Hanoi sewerage and drainage environmental renovation project – Phase II Volume I Main report* (Original in Vietnamese; Báo cáo nghiên cứu khả thi (F/S) Và Chương trình thụ́c hiện (I/P) Cho Dự án thoát nướ́c Nhằm cải tạo môi trướ́ng Hà nội – Giai đoạn II). Hanoi: NIPPON KOEI; SRV; HPC.

Socialist Republic of Vietnam, & Hanoi People's Committee (SRV & HPC). (2009). *Feasibility study for the construction project of central large-scaled wastewater treatment plants for Hanoi environmental improvement–Final report summary*. Hanoi: NIPPON KOEI; VIWASE.

24h (2011). Any solution to the problem of pollution of Tô Lịch? (Original in Vietnamese; Lớ́i giải nào cho bài toán ô nhiễm sông Tô Lịch?). In *24h*. Retrieved from http://us.24h.com.vn/tin-tuc-trong-ngay/loi-giai-nao-cho-bai-toan-o-nhiem-song-to-c46a327224.html

United Nations. (2014). *World urbanization prospects: Highlights*. New York: Department of Economic and Social Affairs, United Nations.

Winkel, L.H., Trang, P.T.K., Lan, V.M., Stengel, C., Amini, M., Ha, N.T., & Berg, M. (2010). Arsenic pollution of groundwater in Vietnam exacerbated by deep aquifer exploitation for more than a century. *Proceedings of the National Academy of Sciences*, *108*(4), 1246–51. https://doi.org/10.1073/pnas.1011915108

World Health Organization (WHO). (2010). *International travel and health: Situation as on 1 January 2010.* Geneva: Author.

Zérah, M.-H. (2008). Splintering urbanism in Mumbai: Contrasting trends in a multilayered society. *Geoforum*, *39*(6), 1922–32. https://doi.org/10.1016/j.geoforum.2008.02.001

5. A transnational urban political ecology of water infrastructures: global water policies and water management in Hanoi

Publication No.	**P-IV**
Type	Journal article
Journal	*Public Works Management & Policy*
SJR Score	0.341
Status	Published
Reference	**Wright-Contreras, L.** (2019). A Transnational Urban Political Ecology of Water Infrastructures: Global Water Policies and Water Management in Hanoi. *Public Works Management & Policy*, *24*(2), 195–212. https://doi.org/10.1177/1087724X18780045
Abstract	Using the lens of a transnational urban political ecology of water infrastructures in Vietnam, this article contributes to the understanding of the intersections between urbanization patterns, socioecological problems, financial schemes, and the power relations embedded in Hanoi's urban water supply through politics of scale that aim to ensure safe drinking water. With the analysis of global water policies and their implications in the Southeast-Asian context, the objectives of this work are to (a) reveal the scalar nature of Hanoi's water infrastructures by situating water management processes in a broader context of developmental issues, and (b) review lessons and prospects of past and future global targets of access to safe drinking water. The evidence of multilevel water governance processes and cross-sectoral challenges of safe water provision emphasizes the need for global networks of cooperation to achieve the Sustainable Development Goal 6 and contribute to other sectors aiming to "transform our world."

Public Works Management & Policy
1–18

Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1087724X18780045
journals.sagepub.com/home/pwm

A Transnational Urban Political Ecology of Water Infrastructures: Global Water Policies and Water Management in Hanoi

Lucía Wright-Contreras[1]

Abstract

Using the lens of a transnational urban political ecology of water infrastructures in Vietnam, this article contributes to the understanding of the intersections between urbanization patterns, socioecological problems, financial schemes, and the power relations embedded in Hanoi's urban water supply through politics of scale that aim to ensure safe drinking water. With the analysis of global water policies and their implications in the Southeast-Asian context, the objectives of this work are to (a) reveal the scalar nature of Hanoi's water infrastructures by situating water management processes in a broader context of developmental issues, and (b) review lessons and prospects of past and future global targets of access to safe drinking water. The evidence of multilevel water governance processes and cross-sectoral challenges of safe water provision emphasizes the need for global networks of cooperation to achieve the Sustainable Development Goal 6 and contribute to other sectors aiming to "transform our world."

Keywords

water governance, urban political ecology, safe drinking water, sustainable development goals, Vietnam

[1]Technische Universität Darmstadt, Germany

Corresponding Author:
Lucía Wright-Contreras, Technische Universität Darmstadt, El-Lissitzky-Str.1, Darmstadt 64287, Germany.
Email: wright@stadt.tu-darmstadt.de

Introduction

Water supply, as all infrastructural networks, depends on a web of interrelated actors with weighing political interests to maintain and invest in the systems that support them. Considering water as an urban process, the deconstruction of urban water supply serves to unveil power relationships and understand the origin of socioecological problems. Thus, problematizing the supply of water may explain broader patterns of urbanization, sociospatial fragmentation, and socioecological interactions. In view of the "globalized societal relationships with nature," (Keil, 2012) it is more and more relevant to recognize cross-national networks which shape development at a local and regional level (Armitage, 2007; Balsiger & Debarbieux, 2011; Stephenson, 2013). Based on existing literature of environmental governance and multilevel governance, this study explores the scalar politics and the relationship between environmental problems, scale, and governance (Balsiger & Debarbieux, 2011; Bulkeley, 2005; Meadowcroft, 2002; Newig & Fritsch, 2009; Paavola, 2007). Defined as the "cooperative intergovernmental relations between subnational and national authorities, or between national and supranational organs" (Papadopoulos, 2007, pp. 478-479), multilevel governance aims to "provide a simplified notion of what is pluralistic and highly dispersed policy-making activity, where multiple actors (individuals and institutions) participate, at various political levels, from the supranational to the subnational or local" (Stephenson, 2013, p. 817). Nonetheless, because one of the critiques on multilevel governance is that it has been mistaken for multilevel involvement, failing to explain the differences of power between levels (Stephenson, 2013), the present analysis will be aided by a framework coined as "transnational urban political ecology of water infrastructures."

The "transnational urban political ecology of water infrastructures" framework is used in this article to explain the interaction between water infrastructures in Hanoi, water management in Vietnam, and global water policies. The logic of this framework is built on three theoretical conglomerations. At the core stands urban political ecology (Angelo & Wachsmuth, 2015; Heynen, Kaika, & Swyngedouw, 2006; Swyngedouw & Heynen, 2003), which, in essence, serves to reveal power relations embedded in urban processes. Secondly, this article considers water as a material flow which embodies the dynamic processes of cities (Bakker, 2012; Gandy, 2004; Kaika, 2005). By analyzing infrastructural systems through the lens of urban political ecology, and specifically of those related to water (Monstadt, 2009; Swyngedouw, 2004, 2009; Swyngedouw, Kaika, & Castro, 2002), we are able to trace power relations mediated through water supply in cities. Water, combining the political and economic power of both public and private entities, mirrors the interactions between international, national, regional, and local levels (Swyngedouw, 2004). The relationships between actors at different levels evidences the intertwined political and economic processes which direct water provision. And finally, the multilevel governance approach and the lessons learned from studying the political and ecological characteristics of water supply reveal the complexity of urban water planning and the existing interactions of various scales of organization and management. A transnational urban political ecology (Keil, 2012), and

more specifically, a transnational urban political ecology of water infrastructures will aid the discussion of global trends of water governance and water management in cities where populations face challenges to access safe drinking water.

To begin with, the next section will elaborate on the "transnational urban political ecology of water infrastructures" framework and its application, as well as the current article's hypothesis, objectives, and methodology. The "Urban Water Infrastructures in Hanoi" section will describe the development of water infrastructures in the city of Hanoi and the ownership models of existing water distribution companies. The "Multilevel Water Governance in Vietnam" section analyzes the multilevel water governance processes directing the management of national- and city-level water supply development strategies and their interaction with transnational actors. The "Politics of Scale to Ensure Safe Drinking Water" section discusses global targets of access to safe drinking water and the results in Vietnam, since the measurement of the Millennium Development Goal (MDG) Target 7C and the current prospects for the Sustainable Development Goal (SDG) Target 6.1, as well as the discrepancies in the definition of indicators of water quality. The "Disscussion" section focuses on the issues brought up in each level, from Hanoi's water infrastructure development and the lessons learned regarding Vietnam's national water management strategies, to transnational financing mechanisms and the country's actual progress toward global targets of access to safe drinking water. The understanding of multilevel water governance processes and cross-sectoral challenges of safe water provision will emphasize the need for global networks of cooperation to "transform our world." And more specifically, this case can be used to exemplify the challenges of attaining sustainability, universality, and equity of safe and affordable drinking water to reach global targets by 2030.

Hypothesis, Objectives, and Methodology

The transnational urban political ecology of water infrastructures framework is applied to the case of Hanoi, Vietnam. The research will answer how a transnational urban political ecology lens can help evaluate the sustainability of the development of local water infrastructures and the equitable distribution of safe drinking water. The working hypothesis is that water provision cannot be viewed independently from global trends of water governance. Through the analysis of global water policies and their implications in the Southeast-Asian context, the study of Hanoi's development of urban water infrastructures will achieve the following objectives: (a) reveal the scalar nature of Hanoi's water infrastructures by situating water management processes in a broader context of developmental issues, and (b) review lessons and prospects of past and future global targets that seek to ensure universal and equitable access to safe and affordable drinking water for all. By understanding cities as complex systems, this work will highlight the socioecological problems specific to water provision in Hanoi while evidencing scalar arrangements of power and global urbanization processes. In this process, not only do we locate the opportunities for improvement of decision making and policy-formulation concerning water infrastructure development at different levels, but also justify the role of global frameworks that protect water security.

The empirical analysis referenced in this work is based on primary data collected in 2014 through a project commissioned by the Chair of Spatial and Infrastructure Planning of the Technical University of Darmstadt. The article is informed by interviews to local and international organizations, government offices, water-related enterprises, financial organizations, and academic institutions in Hanoi, Vietnam, including UN Habitat Vietnam Office, the Ministry of Construction (MOC) and the Ministry of Agriculture and Rural Development (MARD) of Vietnam, Hanoi Water Limited Company (HAWACO), Vietnam's General Company of Construction and Export (VINACONEX), the Joint Stock Commercial Bank for Foreign Trade of Vietnam (Vietcombank), the National University of Civil Engineering (NUCE), and the Hanoi University of Science and Technology (HUST). The knowledge gained from the interviewees informs the user-related, environmental, technical, institutional, and financial challenges of water provision in Hanoi.

Urban Water Infrastructures in Hanoi

Located in the Red River Delta, the worlding city (cf. Haila, 2006) of more than 7 million people (General Statistics Office of Vietnam [GSO], 2015) and capital of Vietnam has faced technological, user-related, environmental, financial, and institutional challenges in urban water supply. Hanoi's current centralized systems of piped-water distribution networks started with the construction of the Yên Phụ water treatment plant by French colonists in 1894, under the Hanoi Water Department, now HAWACO (Ngo, 2014). After Vietnam's independence from France in 1954, the city increased the water treatment plant's capacity from 4,000 m^3/day to 11,000 m^3/day (Ngo, 2014). As a result of funding from the government of Finland, from 1987 to 1997, the Yên Phụ water treatment plant was modernized and the existing pipelines were expanded, increasing capacity to 60,000 m^3/day (Ngo, 2014). Currently, Yên Phụ water treatment plant is one of HAWACO's 12 main water treatment plants which supplies residents in the inner-city area with 90,000 m^3/day (HAWACO, 2014b, p. 3; Ngo, 2014). The total demand of water in Hanoi amounts to approximately 1 million m^3/day; officially, piped water is accessed by 100% of the inner-districts and nearly 42% of the suburban and rural districts, and the total percentage of population with water supply is 55% or 3.6 million (HAWACO, 2014a, p. 17).

Previous to 1982, water supply technologies in Vietnam relied mainly on dug-wells and rainwater catchment tanks at household level (National Centre for Rural Water Supply and Sanitation [NCERWASS], 2014). Villagers would also use surface water from ponds for domestic use. From 1982 to 1990, the use of hand-pump tube wells and hand-pump dug wells facilitated access to water (NCERWASS, 2014), aiding the supply to the increasing number of Vietnamese households. During the decade of the 1990s, the introduction of hand-electric pumps for tube-wells and dug-wells increased accessibility, although rainwater continued to be an important source (NCERWASS, 2014). It was also then that the adoption of gravity flow systems and small-size piped-schemes provided households with a direct connection to water from public sources (NCERWASS, 2014).

Due to the overexploitation of groundwater, Hanoi's 2030 plan and 2050 vision conceives surface water as the main natural water resource. Already, there is a surface water treatment plant which extracts water from the Đà River, supplying 300,000 m³/day and projected to supply 600,000 m³/day by 2020 (HAWACO, 2011; see Figure 1a). Two new surface water treatment plants are planned to draw water from the Hồng River and the Đường River, each with an initial capacity of 300,000 m³/day in 2020 (HAWACO, 2011). The construction of these two surface water treatment plants will require the investment of US$273 million and US$450 million, respectively (HAWACO, 2014a, pp. 1-3, 22). The city also plans to expand the drainage network and build new wastewater treatment plants (see Figure 1b). At least (comment by

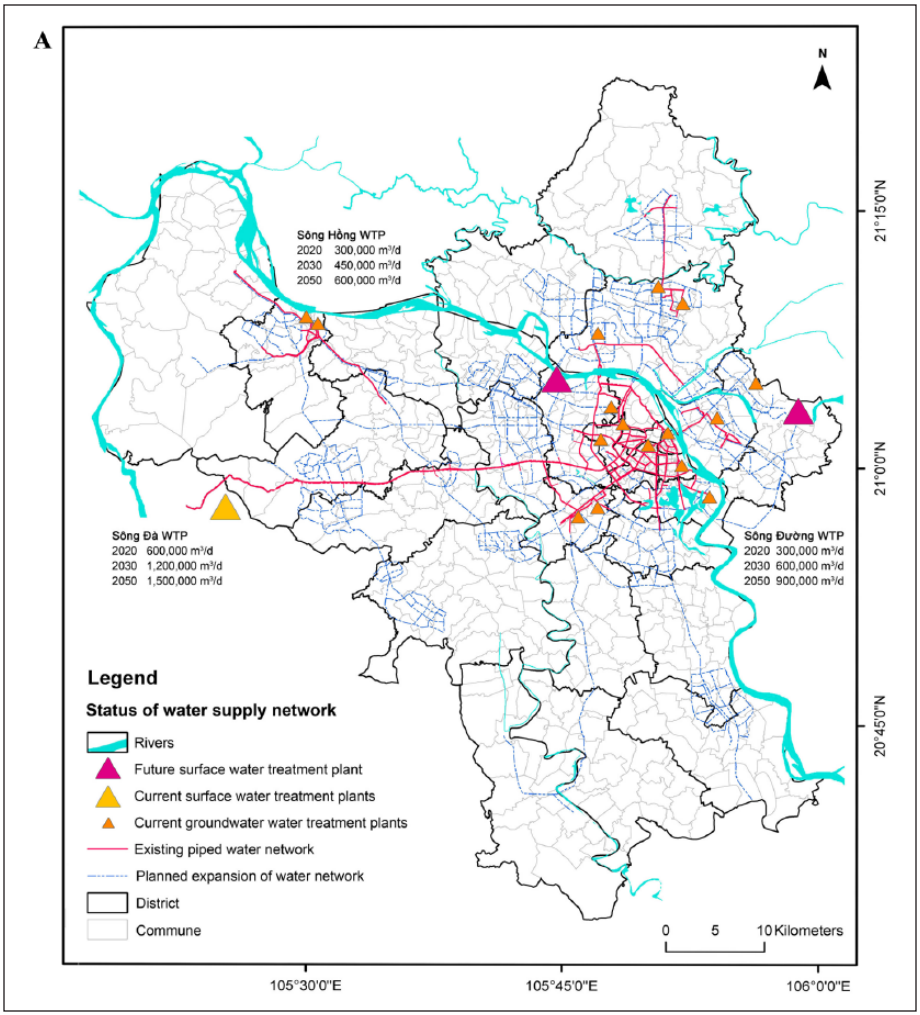


Figure 1. (Continued)

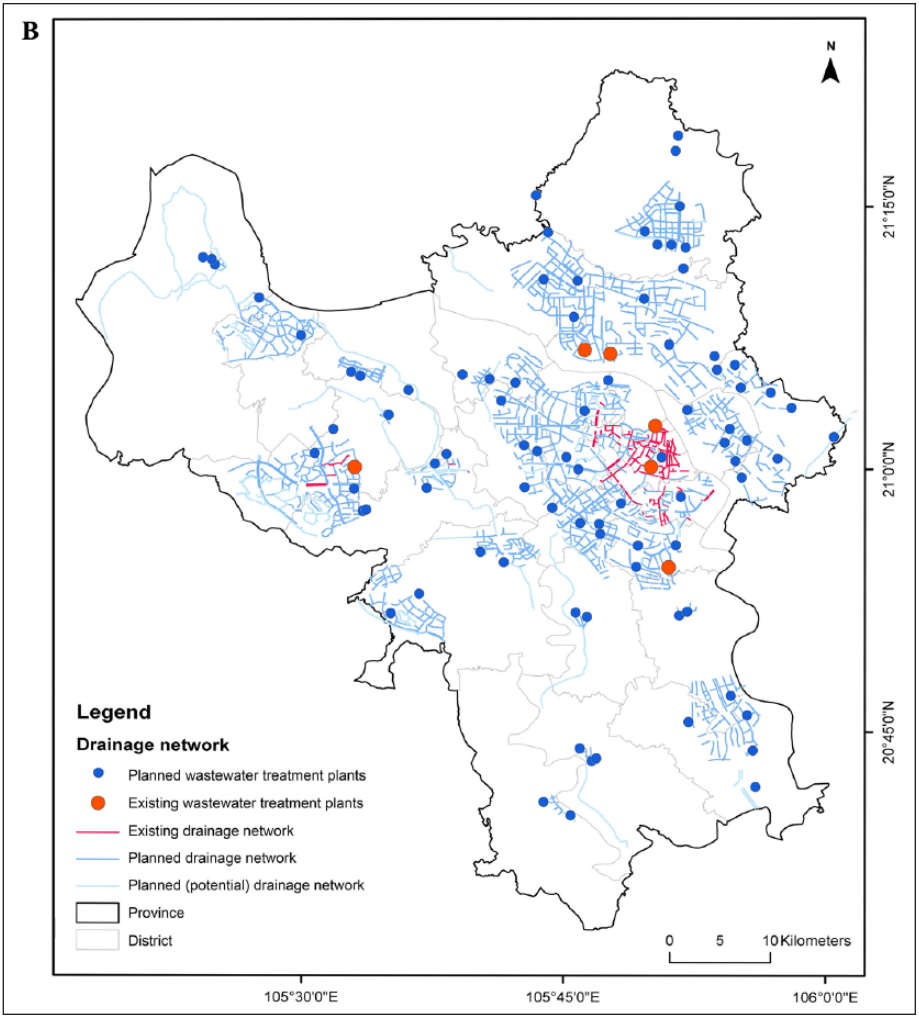


Figure 1. Map of status of Hanoi's water supply network (a), and drainage network (b).
Source. Author's elaboration; base maps courtesy of Thu-Huong Luong, 2015.
Note: color version of the figure is available online.

author) 90% of urban sewerage is discharged into rivers (Le Van, 2012, p. 4), thus affecting the city's urban water cycle and contaminating the primary source of water.

At the city-level, the companies responsible for the production of water for urban and rural areas are VINACONEX Water Corporation (VIWASUPCO), HAWACO, Ha Dong Company, and Son Tay Company (Wright-Contreras, March, & Schramm, 2017). The first is a Joint Stock Company (JSC) and the remaining three are one-member Limited Liability Companies (LLCs). Responsible water distribution are Vietnam's

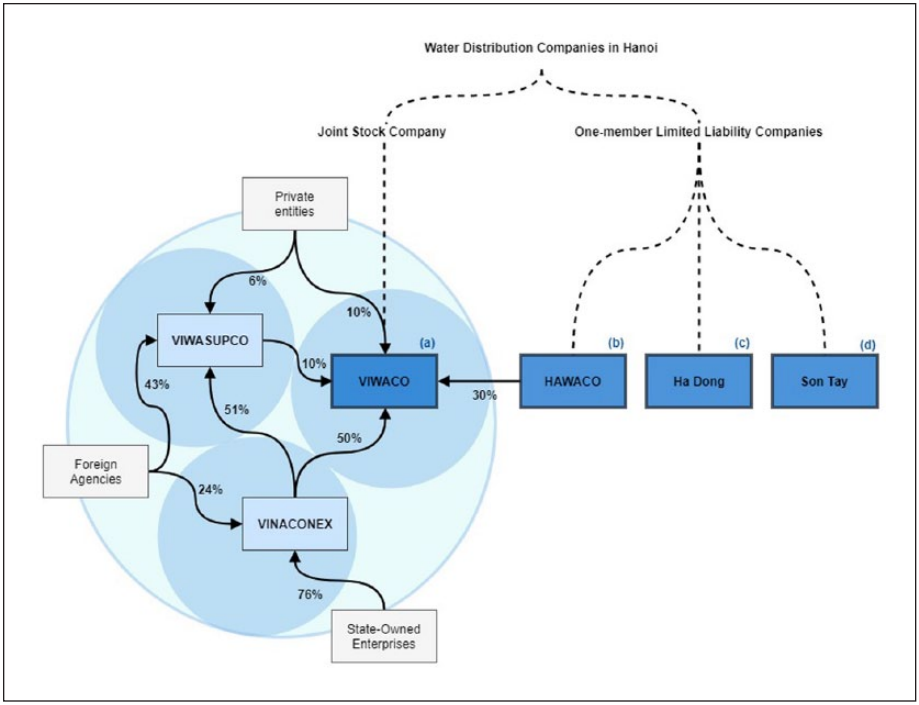


Figure 2. Conceptual diagram of ownership of water distribution companies in Hanoi.
Note. VIWASUPCO = VINACONEX Water Corporation; VIWACO = Vietnam's Freshwater Business and Construction Investment Joint Stock Company; HAWACO = Hanoi Water Limited Company; VINACONEX = Vietnam's General Company of Construction and Export.

Freshwater Business and Construction Investment Joint Stock Company (VIWACO) (Figure 2a), HAWACO (Figure 2b), Ha Dong Waterworks (Figure 2c), and Son Tay Waterworks (Figure 2d). HAWACO and VIWACO distribute most of the water in the inner-city and suburban districts (as shown in Figure 3), accounting for 72% and 17% of the total water supply, respectively (Wright-Contreras et al., 2017, p. 67). Ha Dong Waterworks and Son Tay Waterworks supply the remaining percent of water in the districts they are named after; Ha Dong district is located south-west of the inner-city and Son Tay district is located north-west of the city (not included in Figure 3).

HAWACO is not only considered major distributor, but also plays a larger role in the water supply scene acting as shareholder of VIWACO. Besides the one-member LLC, HAWACO, VIWACO is also owned by VIWASUPCO and VINACONEX. VIWASUPCO is owned by the Singapore-based Acuatico Private Limited Company (Pte Ltd), and VINACONEX is owned by SOEs such as Vietel (a mobile phone company which belongs to the Ministry of National Defense) and the State Capital Investment Corporation (SCIC). All three JSCs, VINACONEX, VIWASUPCO, and

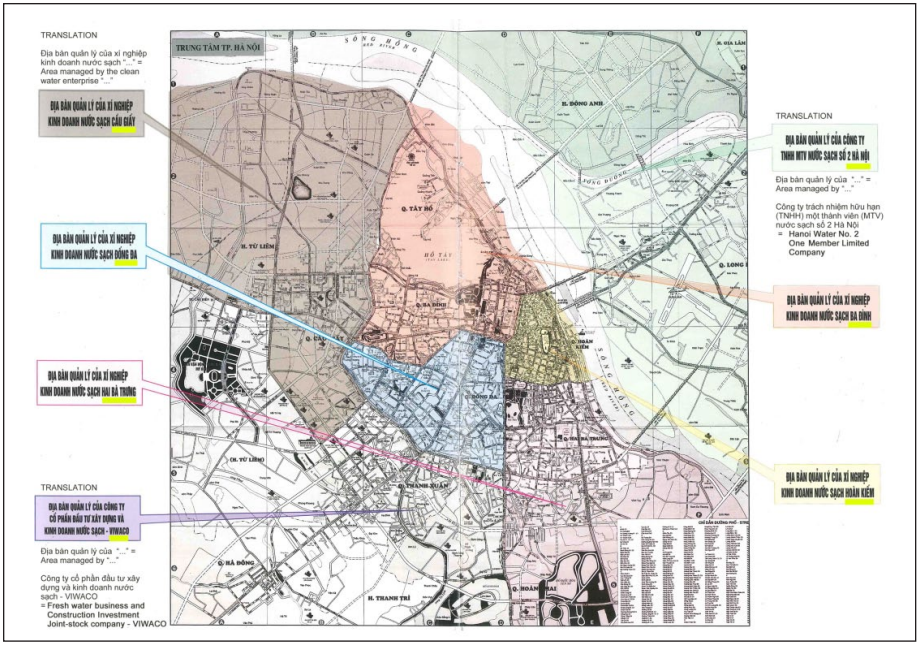


Figure 3. Water supply zones managed by HAWACO and VIWACO.
Source. (HAWACO, 2011, pp. 52-53); translation overlaid by author.
Note. HAWACO = Hanoi Water Limited Company; HAWACO = Hanoi Water Limited Company.

VIWACO, are also owned by private investors and foreign agencies in the ranges of 6% to 43%.

The responsibilities to coordinate the supply of water for urban, suburban, and rural populations in Vietnam are shared mainly by MOC and MARD; the first with jurisdiction over the urban areas, and the second with jurisdiction over the rural areas. In addition, there is increasing development of new urban areas which normally extract groundwater and control privately managed water treatment facilities (cf. Wright-Contreras et al., 2017). In turn, periurban villages caught in between the developing areas and the former rural areas receive water from the piped-distribution network, in some cases managed by cooperatives (cf. Schramm & Wright-Contreras, 2017), and complement their intake of drinking water from private vendors. The technological and administrative challenges to supply urbanizing villages with water are, first, the expansion of water distribution pipes to reach the villages and, second, the organization of users to invest in the subsequent distribution of water from the entrance of villages into each household, which will be addressed in the next section.

Multilevel Water Governance in Vietnam

As 60% of Vietnam's rivers flow originate outside its borders (Asian Development Bank [ADB], 2013, p. 4), water security is difficult to assure within regional and local water resource management plans. On one hand, 80% of Vietnam's surface water is used for agricultural purposes and vast amounts of water are lost through inefficient rural and urban water management (ADB, 2013, p. 4). And on the other hand, water use is expected to increase from 80 billion m^3 in 2008 to 120 billion m^3 in 2020, affecting the productivity of agricultural, industrial, and energy sectors (ADB, 2013, p. 8). Because of the overexploitation of groundwater, at a regional level, aquifer levels have decreased as much as 30 meters (e.g., in Hanoi) (ADB, 2013, p. 5) and, in the Red River Delta, users are exposed to naturally forming arsenic and other heavy metals when accessing water through privately owned tube or dug wells (Le Van, 2012; Wright-Contreras et al., 2017).

Although there is tendency to decentralize the management of water supply in the country (NCERWASS, 2014), there is still a central-level involvement which exercises control over water utilities (Water and Sanitation Program [WSP] & World Bank, 2014). Vietnam's MOC and MARD set the guidelines for urban, rural, and suburban safe water delivery at provincial and city-levels. MARD'S program labeled National Target Program (NTP) for Rural Water Supply and Sanitation (RWSS), from 2012 to 2015, or Phase 3 (NTP3), is carried out through a results-based planning and financing approach which promotes the piped-water scheme. For implementation, at the central level, MARD establishes a Program Steering Committee (PSC) and a Standing Office to aid the project management of the PSC (Socialist Republic of Vietnam [SRV], 2012). At the provincial level, the Provincial People's Committee (PPC) also establishes a PSC (SRV, 2012). Both levels of PSCs include representatives of MARD, the Ministry of Health (MOH), and other ministries and cooperating agencies related to water supply and sanitation (SRV, 2012). In 2013, community-based models made up 55% of Vietnam's piped-water scheme management models (NCERWASS, 2014). Other models managed by the provincial Centre for Rural Water Supply and Sanitation (pCERWASS), cooperatives, private entities, and enterprises, account for another 36% and are steadily increasing; while the remaining 9%, considered the least effective model of piped-water scheme management through Commune People's Committees (CPCs), is decreasing (NCERWASS, 2014).

As People's Committees correspond to the state and are not considered civil society organizations (Parenteau & Thong, 2005, p. 247), decisions concerning water supply mainly rely on government authorities, following the Clean Water Supply and Environmental Sanitation program launched in 1995 by the National Environmental Agency of the Ministry of Science, Technology, and Environment (MOSTE) (Owen, 2012). MOH indicates water quality standards and the Ministry of Planning and Investment (MPI) must approve large-scale projects (Owen, 2012). In addition to MOC, MARD, MOSTE, MOH, and MPI, actors involved in the definition of policies for the implementation of projects related to development of water supply in Vietnam's localities are Ministry of Information and Communication (MOIC), Ministry of

Finance (MOF), Ministry of Education and Training (MOET), Ministry of Natural Resources and Environment (MONRE), Ministry of Science and Technology (MOST), Ministry of National Defense (MOND), Ministry of Public Security (MOPS), Committee for Ethnic Minority Affairs (CEMA), Vietnam's Academy of Science and Technology, Vietnam Women's Union, and Vietnam Farmer's Union (SRV, 2012). In Hanoi, for example, MONRE and the National Board of Water Resources are responsible for the management of water resources, while MOC and the Transport and Urban Public Works Department (TUPWS) decide of the construction of infrastructure in urbanizing areas and the quality of water is regulated by MOC and MOH (Schramm, 2014). This illustrates a parallel process of recentralization of Vietnamese cities within national policies.

Within MARD's NTP3, the central government provides subsidies to water supply projects which prioritize piped-scheme network systems (SRV, 2012). In rural areas, MARD will support the building of the piped-scheme when 60% of the community commits to connecting to the system. To achieve this, MARD's department of Information, Education, and Communication (IEC) assists users in selecting the "appropriate" technology to ensure the financial sustainability and the operation of water treatment plants and water distribution networks to their maximum capacity, using "behavior change communication," modeled from the United Nations Children's Fund (UNICEF) approach of Communication for Development (C4D) (Interview MARD, 2014). Because of the importance of IEC's activities, 5% of the Vietnam's total investment for water supply and sanitation is allocated to this section (Interview MARD, 2014). The total budget of 27.6 billion Vietnamese Dong (VND), equivalent to US$1.2 million, for MARD's NTP3 is made up from central and local budgets, donors' funds, preferential credit, and private investments (SRV, 2012, p. 3). According to the Ministry of Foreign Affairs of Denmark (DANIDA, 2014), Australia, Denmark, and the United Kingdom have contributed to 90% of NTP3's program budget.

Altogether, the development, upgrading, and upkeep of water infrastructures in Vietnam is supported by foreign aid or official development assistance (ODA), bank loans, foreign direct investment (FDI), and private sector participation (PSP) (for the definition of types of foreign capital flows see Chang, 2008, p. 86). International organizations related to the aforementioned are ADB, Australia's Aid Program (AusAID), Danish International Development Agency (DANIDA), Department for International Development of United Kingdom (DFID), German Agency for International Cooperation (*Gesellschaft für Internationale Zusammenarbeit*—GIZ), Japan International Cooperation Agency (JICA), UNICEF, World Health Organization (WHO), World Bank, among others. To exemplify, with a close cooperation between Vietnam's national ministries, operations, and investments in water supply systems are discussed through the Vietnam Water Supply and Sewerage Association (VWSA). VWSA partners with organizations such as the World Bank, ADB, JICA, and GIZ and encourages cooperation among agencies, institutions, and individuals to promote the sustainable development of water supply and sewerage in Vietnam, while encouraging socioeconomic development and modernization (VWSA, 2014). An example of a product of one of VWSA's cooperation efforts is the Development of the Vietnamese

Water Sector (DEVIWAS), supported by the German Water Partnership (GWP) and financed by the German Federal Ministry for Economic Cooperation and Development [*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung*—BMZ] via Sequa (VWSA, 2014), a nonprofit development organization which promotes private sector business development (Sequa, 2015). Furthermore, the Association of Southeast Asian Nations' (ASEAN) Strategic Plan of Action on Water Resources uses a regional approach to formulate the management and coordination of activities based on the United Nations Environment Programme (UNEP) framework (ASEAN, 2005). The document calls for consistent monitoring through a cost-effective national water management to ensure water quality and the management of natural resources (ASEAN, 2005, p. 19). The implementation of projects guided by the technical working body or Asian Working Group on Water Resources Management (AWGWRM) indicates the further development of potential partnerships with the World Bank, ADB, and AusAID to implement the project concepts (ASEAN, 2005, p. 11).

In regard to private and foreign investment, the involvement of the private sector and international organizations has made up for a large percentage of water development projects. Officially, PSP in water management in Vietnam was determined at 2% in 2012 with an expected increase to 12% in 2025 (Owen, 2012, p. 46). In Hanoi, PSP was initiated in 2010 through Acuatico Pte Ltd (joint venture between Pt Recapital Advisors and Pt Glendale Partners based in Singapore) with the construction of water networks in the southwest of the city (Owen, 2012, p. 408). Additionally, the World Bank determined to minimize the current water loss of 160,000 m^3 by half through a regulated tariff calculation based on water meters, and by identifying consumer contracts and illegal connections (Owen, 2012, p. 219, 221). Investments are planned to be recovered in the long term (e.g., 10 years) through tariffs which are monitored and reviewed periodically by the People's Committee of each corresponding district, which is why water tariffs differ slightly from district to district. According to the WSP and the World Bank, the annual investment for water supply and sanitation in Vietnam from the government and donors, between 2009 and 2011, amounted to 0.2% of 2011 Gross domestic product (GDP) and was expected to rise to 0.4% from 2012 to 2014, still insufficient to meet the 2020 targets (WSP & World Bank, 2014, p. V). Although Vietnam has sought to attract US$1 billion to increase access to "safe" water (Owen, 2012, p. 219), the Joint Monitoring Program (JMP), led by WHO and UNICEF, estimated that increasing safe water coverage would require capital expenditures of US$1.562 billion per year (WSP & World Bank, 2014, p. V).

Politics of Scale to Ensure Safe Drinking Water

Derived from the Millennium Summit in New York, in September of 2000, under Secretary-General Kofi Annan, the UN Millennium Declaration set a series of milestones to be met by 2015 known as the MDGs (Millennium Project, 2006). Within MDG 7, Target 7C specifies to *halve the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015* (United Nations Statistics Division, 2017). As the conclusion of the MDGs in 2015, the post-2015

development agenda was issued by the United Nations General Assembly, under Secretary-General Ban Ki-moon's mandate. The document titled *Transforming our World, the 2030 Agenda for Sustainable Development* (United Nations, 2015) lists 17 SDGs. The goal directly related to water is SDG 6 which aims to *ensure availability and sustainable management of water and sanitation for all.* Within SDG 6, the specific target related to drinking water is 6.1 *By 2030, achieve universal and equitable access to safe and affordable drinking water for all.* The document was followed by the *New Urban Agenda* (United Nations Habitat, 2016), adopted in Quito, Ecuador, in October of 2016, serving as a plan for effective implementation, follow-up, and review of the SDGs.

In 2015, WHO and UNICEF's JMP indicated the achievement of the drinking water target (benchmarked at 88%), as the report estimated 91% of the world's population to have access to an improved water source (UNICEF & WHO, 2015, p. 4). Although MDG 7C aimed to halve the proportion of the population without sustainable access to ***safe*** drinking water, the indicator which was actually used to rate the achievement of the MDG target measured *improved* water. The latest report of WHO and UNICEF's JMP (2017b) notes that improved sources include "piped water, boreholes or tube wells, protected dug wells, protected springs, and packaged or delivered water." Comparable with "improved" water is *hygienic* water (cf. Kotsila, 2014, p. 254). Critics have pointed out that "improved" water is a "surrogate for safe water and can lead to substantial overestimates of the population using safe drinking water and, consequently, also overestimates the progress made towards the 2015 MDG target" (Bain et al., 2012; Schäfer, Werchota, Dölle, & Behnsen, 2007). The Millennium Project (2006) itself indicates that "improved drinking water source is a proxy for access to safe drinking water." Furthermore, it specifies that the indicator for MDG 7C "does not take actual drinking water quality into account, nor does it reflect the time spent on getting water from improved sources, which are not on premises" (Millennium Project, 2006). MDG 7C did not actually prove the sustainability of access, nor did it address "safe" water per se. Access to improved water in urban and rural areas in Vietnam was also estimated to have surpassed the 88% target of the MDG (WHO, 2012; WSP & World Bank, 2014, p. 4), reaching 99% in urban areas and 86% in rural areas as of 2015 (WHO & UNICEF JMP, 2017a). For that same year, Vietnam's "safely managed" water coverage was determined at 85% for urban areas and 55% for rural areas; and actual "safe" or piped water reached only 82% in urban areas and 41% in rural areas (WHO & UNICEF JMP, 2017a). As seen in the section on urban infrastructures in Hanoi, just over half of the population of the country's capital had access to piped water (HAWACO, 2014b, p. 17).

Discussion

Considering it was not until the 1990s that gravity flow systems and small-size piped-schemes replaced hand pumps and hand-electric pumps in Vietnam, the country has proven to modernize in a relatively short amount of time. Cities such as Hanoi have

faced the challenge of achieving a "modern ideal of progress" (McGee, 2013, p. 20), framed by competing world cities. In the meantime, the involvement of the private sector has been sought as a solution to reach a modernization of systems which would otherwise seem economically unviable to state governments. Large-scale water infrastructure development plans, including the building of water- and wastewater treatment plants, strive to achieve modernity but also echo the failure of this modern ideal (cf. "incomplete modernity;" Gandy, 2004, p. 363; "modernization myth;" Healey, 2012, p. 188; and "instance of failed or lapsed modernity;" Kooy & Bakker, 2008, p. 1845).

The narrative of the study of water supply in Hanoi reveals the relationships between city- and national-level decision-making bodies, and macro initiatives (such as the New Urban Agenda) embedded in supranational structures; as well as the role of public and private entities contributing to the development of the water sector at different territorial levels and administrative scales (cf. Bon & Kennedy, 2014; Bulkeley, 2005). A few of the lessons learned from the case of Vietnam are that (a) national water management strategies prioritize the piped-scheme network over other technologies; (b) local water infrastructure projects are financed by a web of transnational actors through foreign aid, ODA, bank loans, FDI, and PSP; and (c) global targets of access to safe drinking water do not reflect the actual status of countries' progress toward the MGDs and SDGs.

So far, this article has woven a more complex understanding of water governance, including the multilevel relationships between actors involved in the management of Hanoi's water supply system and the monitoring of Vietnam's past and future global water targets. As Vietnam becomes a growing part of the global agenda, the investment of foreign capital and knowledge to support technological advances becomes more evident. In this sense, cooperative efforts between government dependencies, public and private entities, and transnational actors are illustrated in the supply of water. A closer look on how to improve water utility performance through existing global networks of water operator partnerships may also help ensure the sustainability of these systems. As SDG Target 6A and 6B indicate, by 2030, there is a need to *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*, and *support and strengthen the participation of local communities in improving water and sanitation management* (United Nations, 2015, p. 23).

Based on the lessons learned from the MDG targets on sustainable access to safe drinking water for 2015 and the prospects of the SDGs for 2030, it is important to have a holistic understanding of the country's potentials, the availability of water resources, and how multilevel governance and transnational structures can aid national and regional policy-making. Being that the presence (or lack) of safe water in cities is quite evident, the study of water infrastructures, with emphasis on their management, can contribute to a better reflection of the achievement of parallel SDGs. Due to the cross-sectoral dependence of water to sustain human life, concentrating on Goal Number 6 may undoubtedly contribute to many other sectors aiming to "transform our world."

Conclusion

This article has contributed to the understanding of the intersections between urbanization patterns, socioecological problems, financial flows, and the power relations embedded in Hanoi's urban water supply through politics of scale aiming to ensure access to safe drinking water. The information derived using the transnational urban political ecology of infrastructures framework has informed the article in three ways. First of all, water has been viewed as a material flow that evidences the mediation of power through water supply in cities. In the section of urban water infrastructures of Hanoi, the article describes the evolution of infrastructures and the context-specific technological, user-related, environmental, financial, and institutional challenges in urban water supply. The analysis of the current status of Hanoi's water supply clarifies the roles of the companies responsible for production and distribution of water, their respective water supply zones and ownership structures. The information derived from this section evidences the interplay between different actors at local, regional, national, and transnational levels as well as the cross-scalar political, economic, and institutional processes which direct water provision in Vietnam. Secondly, the combination of the study of water infrastructures through the lens of urban political ecology has provided insights on relations of power embedded in Hanoi's urban water supply. The section of multilevel governance in Vietnam describes the interaction between national ministries and city-level decision-making marked by a combination of decentralized and centralized management influenced by supranational IEC strategies. Also, the expansion of the piped-scheme network and modernization of water infrastructures evidences cross-border financial flows of ODA, loans, FDI, and PSP; highlighting large investments required to increase safe water coverage in Vietnam. This information provides an insight on the roles that public and private entities exercise in the development of Vietnam's water sector, as well as a glimpse of the country's financial shortcomings to reach global water targets. Finally, the transnational approach to an urban political ecology of water infrastructures has been used to explain global trends of water governance and water management in Hanoi. The section which elaborated on politics of scale to ensure safe drinking water clarifies the transition from the MDGs to the SDGs and the differences between "safe," "improved," and "hygienic" water. At the same time, country and city-level records of progress toward access to "improved," "safely-managed," and actual "safe" water are presented to assess the country of Vietnam and its capital. The data suggest an overestimation of the progress made toward the MDGs and leads to the discussion of a failed ideal of modernity. However, with the evidence of the flows of resources and the interplay actors across borders already in place, global networks of cooperation are proposed as means to enhance knowledge sharing and capacity-building in the water sector. Having shown the interdependency of global trends of water governance and the local development of urban water infrastructures, this article has bridged political ecology with public works management and policy in order to contribute to the improvement of water infrastructure development, safe water provision, and the much-needed inclusiveness, and social and environmental justice in cities.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD) funding programm number 57214224.

ORCID iD

Lucía Wright-Contreras https://orcid.org/0000-0003-3879-1744

References

Angelo, H., & Wachsmuth, D. (2015). Urbanizing urban political ecology: A critique of methodological cityism. *International Journal of Urban and Regional Research*, *39*, 16-27. doi:10.1111/1468-2427.12105

Armitage, D. (2007). Governance and the commons in a multi-level world. *International Journal of the Commons*, *2*, 7-32. doi:10.18352/ijc.28

Asian Development Bank (ADB). (2013). *Viet Nam: Environment and climate change assessment*. Mandaluyong City, Philippines: ADB.

Association of Southeast Asian Nations. (2005). *Association of Southeast Asian Nations (ASEAN) strategic plan of action on water resources management*. Jakarta, Indonesia: ASEAN Secretariat. Retreieved from http://environment.asean.org/files/ASEAN%20Strategic%20Plan%20of%20Action%20on%20Water%20Resources%20Management.pdf

Bain, R., Wright, J., Yang, H., Pedley, S., Gundry, S., & Bartram, J. (2012). *Improved but not necessarily safe: Water access and the Millennium Development Goals*. Global Water Forum. Retrieved from http://www.globalwaterforum.org/2012/07/09/improved-but-not-necessarily-safe-water-access-and-the-millennium-development-goals/

Bakker, K. (2012). Water: Political, biopolitical, material. *Social Studies of Science*, *42*, 616-623. doi:10.1177/0306312712441396

Balsiger, J., & Debarbieux, B. (2011). Major challenges in regional environmental governance research and practice. *Procedia-Social and Behavioral Sciences*, *14*, 1-8. doi:10.1016/j.sbspro.2011.03.010

Bon, B., & Kennedy, L. (2014, June 28-20). *Scalar politics in the construction of metropolitan Delhi Shifting patterns of public and private engagement in mass transport and economic development* (Special session 21: Metropolitan governance of metropolitan development. Panel A, The political and economic construction of metropolitan regions). Presented at the City Futures 2014, Paris, France.

Bulkeley, H. (2005). Reconfiguring environmental governance: Towards a politics of scales and networks. *Political Geography*, *24*, 875-902. doi:10.1016/j.polgeo.2005.07.002

Chang, H.-J., 2008. *Bad samaritans: the myth of free trade and the secret history of capitalism*. Bloomsbury Press, New York, NY.

Danish International Development Agency. (2014). *Sector program support to water, sanitation and hygiene promotion* (2012-2014). Ministry of Foreign Affairs of Denmark, Danish International Development Agency.

Gandy, M. (2004). Rethinking urban metabolism: Water, space and the modern city. *City*, *8*, 363-379. doi:10.1080/1360481042000313509

General Statistics Office of Vietnam. (2015). *Area, population and population density by province by cities, provincies, year and items*. Retrieved from http://www.gso.gov.vn/default_en.aspx?tabid=774

Haila, A. (2006). The neglected builder of global cities. In N. Brenner & R. Keil (Eds.), *The global cities reader* (pp. 282-287). New York, NY: Routledge.

Hanoi Water Limited Company (HAWACO). (2011). *Construction and development of water supply sector Hanoi* (original in Vietnamese: Xây đừng và phát triển ngành cấp nước hà nội). Hanoi, Vietnam: HAWACO.

Hanoi Water Limited Company (HAWACO). (2014a, September 18). *Hanoi water supply system*. PowerPoint presentation viewed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC international Conference: Sustainable water and sanitation services for all in a Fast changing world, co-hosted by Loughborough university and the National University of Civil Engineering (NUCE), Hanoi, Vietnam.

Hanoi Water Limited Company. (2014b, September 18). *Hanoi water supply system*. Summary distributed as part of the guided visit to HAWACO's Hoa Binh WTP during the 37th WEDC international Conference: Sustainable water and sanitation services for all in a Fast changing world, co-hosted by Loughborough university and the National University of Civil Engineering (NUCE), Hanoi, Vietnam.

Healey, P. (2012). The universal and the contingent: Some reflections on the transnational flow of planning ideas and practices. *Planning Theory*, *11*, 188-207. doi:10.1177/1473095211419333

Heynen, N., Kaika, M., & Swyngedouw, E. (2006). *In the nature of cities urban political ecology and the politics of urban metabolism*. London, England: Routledge.

Kaika, M. (2005). *City of flows: Modernity, nature, and the city*. New York, NY: Routledge.

Keil, R. (2012). Transnational urban political ecology: Health and infrastructure in the unbounded city. In G. Bridge & S. Watson (Eds.), *The new Blackwell companion to the city* (pp. 713-725). Oxford, UK: Wiley-Blackwell. doi:10.1002/9781444395105.ch62

Kooy, M., & Bakker, K. (2008). Technologies of government: Constituting subjectivities, spaces, and infrastructures in colonial and contemporary Jakarta. *International Journal of Urban and Regional Research*, *32*, 375-391. doi:10.1111/j.1468-2427.2008.00791.x

Kotsila, P. (2014). *Socio-political and cultural determinants of diarrheal disease in the Mekong Delta: From discourse to incidence*. Bonn: Verlag Münster.

Le Van, D. (2012, November). *Sanitation of water source and treatment of garbage and wastes in Hanoi city*. *Presented at the in East Asian and Middle-South American Conference on Environmental Industry*, Hanoi.

McGee, T. G. (2013). Suburbanization in the twenty-first-century world. In R. Keil (Ed.), *Suburban constellations. Governance, land and infrastructure in the 21st century* (pp. 18-25). Berlin, Germany: Jovis.

Meadowcroft, J. (2002). Politics and scale: Some implications for environmental governance. *Landscape and Urban Planning*, *61*, 169-179. doi:10.1016/S0169-2046(02)00111-1

Millennium Project. (2006). *UN millennium project, About the MDGs*. Millennium Project, Commissioned by the UN Secretary General and supported by the UN Development Group. Retrieved from http://www.unmillenniumproject.org/goals/

Monstadt, J. (2009). Conceptualizing the political ecology of urban infrastructures: Insights from technology and urban studies. *Environmental Planning*, *41*, 1924-1942. doi:10.1068/a4145

National Centre for Rural Water Supply and Sanitation (NCERWASS). (2014, September 15-19). *Rural water supply in Vietnam: Evolution and opportunities.* PowerPoint presentation viewed during the 37th WEDC International Conference: Sustainable Water and Sanitation Services for all in a Fast Changing World, co-hosted by Loughborough University and the National University of Civil Engineering (NUCE), Hanoi, Vietnam.

Newig, J., & Fritsch, O. (2009). Environmental governance: Participatory, multi—level—and effective? *Environmental Policy and Governance*, *19*, 197-214. doi:10.1002/eet.509

Ngo, H. (2014). *Internship Report: Yên Phụ water treatment plant*. Hanoi, Vietnam: Institute of Environmental Sciences and Technology, National University of Civil Engineering.

Owen, D. (2012). *Pinsent Masons water yearbook 2012–2013. The essential guide to the water industry from leading infrastructure law firm Pinsent Masons* (14th ed.). London, England: Pinsent Masons.

Paavola, J. (2007). Institutions and environmental governance: A reconceptualization. *Ecological Economics*, *63*, 93-103. doi:10.1016/j.ecolecon.2006.09.026

Papadopoulos, Y. (2007). Problems of democratic accountability in network and multilevel governance. *European Law Journal*, *13*, 469-486. doi:10.1111/j.1468-0386.2007.00379.x

Parenteau, R., & Thong, N. Q. (2005). The role of civil society in urban environmental rehabilitation: A case study (Thanh Xuan district, Hanoi, Vietnam). *Environment & Urbanization*, *17*, 237-248. doi:10.1177/095624780501700113

Schäfer, D., Werchota, R., Dölle, K., & Behnsen, F. (2007). *MDG monitoring for urban water supply and sanitation: Catching up with reality in Sub-Saharan Africa*. Chicago, IL: Deutsche Gesellschaft für Technische Zusammenarbeit.

Schramm, S. (2014). *The comprehensive urban development programme in Hanoi City* (Doctoral thesis). Technische Universität Darmstadt, Germany.

Schramm, S., & Wright-Contreras, L. (2017). Beyond passive consumption: Dis/ordering water supply and sanitation at Hanoi's urban edge. *Geoforum*, *85*, 299-310. doi:10.1016/j.geoforum.2017.06.016

Sequa. (2015). *sequa gGmbH, partner of German business*. Retrieved from http://www.sequa.de/de/

Socialist Republic of Vietnam (SRV). (2012). *Decision No. 366/QD-TTg on the approval of the National Target Program for Rural Water Supply and Sanitation phase 2012-2015*. Retrieved from https://vanbanphapluat.co/decision-no-366-qd-ttg-on-approving-the-national-target-program-on-rural-clean

Stephenson, P. (2013). Twenty years of multi-level governance: "Where does it come from? What is it? Where is it going?" *Journal of European Public Policy*, *20*, 817-837. doi:10.1080/13501763.2013.781818

Swyngedouw, E. (2004). *Social power and the urbanization of water: Flows of power, Oxford geographical and environmental studies*. Oxford, UK: Oxford University Press.

Swyngedouw, E. (2009). The political economy and political ecology of the hydro-social cycle. *Journal of Contemporary Water Research & Education*, *142*, 56-60. doi:10.1111/j.1936-704X.2009.00054.x

Swyngedouw, E., & Heynen, N. C. (2003). Urban political ecology, justice and the politics of scale. *Antipode*, *35*, 898-918. doi:10.1111/j.1467-8330.2003.00364.x

Swyngedouw, E., Kaika, M., & Castro, J. E. (2002). Urban water: A political-ecology perspective. *Built Environment*, *28*, 124-137.

UNICEF & World Health Organization. (2015). *25th progress on sanitation and drinking-water: 2015 update and MDG assessment*. Geneva, Switzerland: World Health Organization.

United Nations. (2015). *Transforming our world, The 2030 agenda for sustainable development*: (A/RES/70/1). New York City: UN.

United Nations Habitat. (2016). *Habitat III. New urban agenda*. Quito, Ecuador: UN Habitat.

United Nations Statistics Division. (2017). *Millennium Development Goals indicators, The official United Nations site for MDG indicators*. Retrieved from http://mdgs.un.org/unsd/mdg/Metadata.aspx

Vietnam Water Supply and Sewerage Association (VWSA). (2014, September 15-19). *Vietnam Water Supply and Sewerage Association*. Brief collected during the 37th WEDC International Conference: Sustainable water and sanitation services for all in a fast changing world, co-hosted by Loughborough University and the National University of Civil Engineering (NUCE), Hanoi, Vietnam.

Water and Sanitation Program & World Bank. (2014). *Water supply and sanitation in Vietnam, turning finance into services for the future*. Retrieved from https://www.wsp.org/sites/wsp.org/files/publications/WSP-Vietnam-WSS-Turning-Finance-into-Service-for-the-Future.pdf

World Health Organization. (2012). *Millennium Development Goal drinking water target met*. Author. Retrieved from http://www.who.int/mediacentre/news/releases/2012/drinking_water_20120306/en/

World Health Organization & UNICEF Joint Monitoring Program. (2017a). *JMP data*. Retrieved from https://washdata.org/data

World Health Organization & UNICEF Joint Monitoring Program. (2017b). *Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines*. New York: UNICEF, Division of Communication.

Wright-Contreras, L., March, H., & Schramm, S. (2017). Fragmented landscapes of water supply in suburban Hanoi. *Habitat International*, *61*, 64-74. doi:10.1016/j.habitatint.2017.02.002

Author Biography

Lucía Wright-Contreras Doctoral Candidate at the Technical University of Darmstadt in Germany. Lucía holds an Erasmus+ double-degree Masters of Science in International Cooperation, Urban Development and Sustainable Emergency Architecture. Her experience includes collaborative research at Nanyang Environment & Water Research Institute (NEWRI) of the Nanyang Technological University (NTU) of Singapore and a current position as research consultant for the Global Water Operators' Partnerships Alliance (GWOPA) / UN-Habitat.

6. Water operators' partnerships for universal and sustainable access to water services

Publication No.	**P-V**
Type	Book chapter
Book title	*Water, limited natural resource: between sustainable development and international security*
Publisher	Marcial Pons
Status	Published
Reference	Pascual-Sanz, M., Perkins, J., Kinyenje, J., & **Wright-Contreras, L.** (2018). Water operators' partnerships for universal and sustainable access to water services. In A. M. Badia Martí & L. Huichi Sancho (Eds.), *Agua, recurso natural limitado: Entre el desarrollo sostenible y la seguridad internacional* (pp. 79–91). Madrid, Spain: Marcial Pons.
Abstract	Summary: 1. Water Operators' Partnerships (WOPs) for the achievement of global sustainability commitments. 2. GWOPA's Secretariat, the Alliance and regional WOP platforms. 3. Basic analysis of WOP numbers. 4. WOPs impact: sustained capacity of water operators to perform. 5. WOPs and funding. 6. Final considerations.

ANA M. BADIA MARTÍ
(Dir.)

LAURA HUICI SANCHO
(Coord.)

AGUA, RECURSO NATURAL LIMITADO

Entre el desarrollo sostenible y la seguridad internacional

Marcial Pons

MADRID | BARCELONA | BUENOS AIRES | SÃO PAULO

2018

EDICIONES JURÍDICAS Y SOCIALES, S. A.
San Sotero, 6 - 28037 MADRID
☎ (91) 304 33 03
www.marcialpons.es

ISBN: 978-84-9123-444-9

Depósito legal: M. -2018

Diseño de la cubierta: ene estudio gráfico

Fotocomposición: Josur Tratamiento de Textos, S. L.

Impresión: Elecé, Industria Gráfica, S. L.
Polígono El Nogal - Río Tiétar, 24 - 28110 Algete (Madrid)
MADRID, 2018

MIXTO
Papel procedente de fuentes responsables
FSC® C122905

Water operators' partnerships for universal and sustainable access to water services

María Pascual-Sanz, Julie Perkins,
Julissa Kiyenje and Lucía Wright-Contreras

SUMMARY: 1. WATER OPERATORS' PARTNERSHIPS (WOPs) FOR THE ACHIEVEMENT OF GLOBAL SUSTAINABILITY COMMITMENTS.—2. GWOPA's SECRETARIAT, THE ALLIANCE AND REGIONAL WOP PLATFORMS.—3. BASIC ANALYSIS OF WOP NUMBERS.—4. WOPs IMPACT: SUSTAINED CAPACITY OF WATER OPERATORS TO PERFORM.—5. WOPs AND FUNDING.—6. FINAL CONSIDERATIONS.

1. WATER OPERATORS' PARTNERSHIPS (WOPs) FOR THE ACHIEVEMENT OF GLOBAL SUSTAINABILITY COMMITMENTS

The urgency to increase access to sustainable water services, the realization that more than 90% of water operators worldwide remained in public hands and the commonality of challenges that they faced set the ground to consider collaboration between water operators as a potentially great mechanism to increase access to water services (UN-Habitat, 2007). In 2006, the United Nations Secretary General's Advisory Board on Water and Sanitation (UNSGAB) led by the ex-prime minister of Japan, Ryutaro Hashimoto, announced the integration of WOPs as a development mechanism to promote access to water supply and sanitation in the Hashimoto Action Plan (HAP), launched during the Fourth World Water Forum (Mexico, 16-23 March 2006). WOPs were defined as "any form of simple or structured partnership aimed at capacity building on a not-for-profit basis. Partnerships can take a multitude of different forms and have various technical, legal and social dimensions, depending on individual circumstances" (IWA et al., 2009) or "a structured programme of cooperation among water operators, based on mutual support and on a not-for-profit basis" (UN-Habitat, 2007). Former UN Secretary-General Kofi Annan endorsed the Hashimoto Action Plan and requested UN-Habitat to lead the development and to host the secretariat of the global WOPs mechanism.

The Sustainable Development Goal (SDG)[1] 6 on water and sanitation emphasizes the continued global demand for these basic services, the need for universality, as well as the sustainability of resources. WOPs can contribute directly to meeting goal 6 commitments by helping operators deliver universal and equitable access to water (6.1) and adequate sanitation (6.2), "halving the proportion of untreated wastewater" (6.3) "increasing water-use efficiency and ensuring sustainable withdrawals" (6.4) and by expanding international cooperation and capacity-building support to developing countries in water- and sanitation-related activities (6.a). WOPs foster solidarity by "implement(ing) integrated water resources management at all levels, including through transboundary cooperation as appropriate" (6.5). Furthermore, WOPs address a number of cross-cutting issues such as encouraging operators to engage in participatory practices (6.b), to tackle matters related to resilient infrastructure systems and disaster preparedness (SDG 11.5) and to improve water quality for all, thereby alleviating deaths associated with water born diseases (SDG 3.9).

The Habitat III New Urban Agenda (NUA) calls for "Equip(ping) public water and sanitation utilities with the capacity to implement sustainable water management systems, sustainable maintenance of urban infrastructure services (...and promote) the universal and equitable access to safe and affordable drinking water, and adequate and equitable sanitation and hygiene for all" (120), objectives to which WOPs directly contribute. Central to GWOPAs mandate, the NUA pledges to support stakeholders typically involved in WOPs "to deliver on capacity development programmes by means of peer-to-peer learning, subject- matter related partnerships, and collaborative actions such as inter-municipal cooperation, on a global, regional, national, sub-national, and local scale" (149).

Spurred on by additional policy documents grounded within the Human Right to Water[2], the explicit reference to GWOPA's efforts to promote "public-public partnerships in water facilities in developing countries" (European Citizens' Initiative Right2Water, 2015)[3] and to "encourage participation and support with partnerships for technical exchanges and action between countries or urban areas sharing similar challenges" (High Level Panel on water Action Plan, 2016)[4] serve as directives to scale up WOP activities.

---

[1] General Assembly resolution 70/1., *Transforming our world: the 2030 Agenda for Sustainable Development*, A/RES/70/L.1 (25 September 2015), available from *http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.*

[2] General Assembly resolution 64/292, *The human right to water and sanitation,* A/RES/64/292 (28 July 2010), available from *http://www.un.org/es/comun/docs/?symbol=A/RES/64/292&lang=E.*

[3] European Parliament resolution, *Follow up to the European citizens' initiative Right2Water*, P8_TA(2015)0294 (8 September 2015), available from *http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2015-0294+0+DOC+PDF+V0//EN.*

[4] High Level Panel on Water, *Action Plan* (September, 2016).

2. GWOPA's SECRETARIAT, THE ALLIANCE AND REGIONAL WOP PLATFORMS

During the annual Stockholm World Water Week in August 2007, the Chair of UNSGAB, Prince Willem-Alexander of Orange, the Netherlands, launched the Global Water Operators Partnerships Alliance (GWOPA) as a global network of partners with a common commitment to helping water utilities help one another. In the Hashimoto Action Plan II, 2010-2012, UNSGAB reiterated its support to GWOPA. "In the three years ahead, we will continue supporting intergovernmental processes on water and sanitation challenges while giving special attention to un-served populations. Our focus on local utilities led to UN Habitat's creation of the Water Operators Partnership Alliance and going forward we will continue supporting and promoting this programm"[5]. In the Hashimoto Action Plan III[6] (2013-2015), UNSGAB recommended that "UN-Habitat expands the scope of GWOPA to encourage partnership among wastewater management operators, with occasional reports to UNSGAB on progress and achievements of the initiative". UNSGAB closed its activities in November 2015 with a final report where GWOPA appears in the list of its main achievements.

To accelerate this transformation the UN Secretary-General Ban Ki-moon and World Bank Group President Jim Yong Kim have convened a High Level Panel on Water (HLPW) to provide the leadership required to champion a comprehensive, inclusive and collaborative way of developing and managing water resources, and improving water and sanitation related services. The Panel was announced by the co-conveners at the World Economic Forum in Davos in January 2016, and officially launched in April 2016 in New York. The Panel issued an Action Plan[7] to help the world to achieve the 2030 agenda in which WOPs again feature prominently. They feature either indirectly i.e. as the cross-cutting theme applicable to each of the five action areas 'Catalyzing Change, Building Partnerships & International Cooperation' (See Figure 1) or as one of the priority actions highlighted "advocate for enhanced capacity building and training, and sharing of good practices, at all levels and across water sectors, and —if relevant— in coordination with other related sectors", or directly "Encourage participation and support with partnerships for technical exchanges and action between countries or urban areas sharing similar challenges (*e. g.* Urban Water Alliance, WOPs)".

---

[5] UNSGAB, *Hashimoto Action Plan II Strategy and Objectives through 2012*, p. 2.
[6] UNSGAB, *Hashimoto Action Plan III Strategy and Objectives through 2015,* p. 8.
[7] High Level Panel on Water, *Action Plan* (September, 2016).

FIGURE 1

GRAPHIC DISPLAY OF MAIN AREAS OF ACTION OF THE HLPW ACTION PLAN

The GWOPA Secretariat is institutionally anchored within the Office of the Executive Director of UN-Habitat. The Secretariat implements its work programme in collaboration with active GWOPA members within the Alliance in the areas of: knowledge management, communications, advocacy, WOP branding and fostering excellence in WOP practice, alliance strengthening, resource mobilization, operational support to WOP regional platforms and specific WOPs. Membership in the Alliance is open to all interested water and sanitation stakeholder organizations (see Figure 8). Membership is obtained by accepting to abide by GWOPA's principles in the implementation of partnership activities. Membership puts members within GWOPA's communication network and allows participation in GWOPA's bi-annual General Assemblies (see Box 6). Alliance Members elect GWOPA's Steering Committee during the biannual General Assemblies from among the Alliance's main constituencies: public water operators and their associations from the various regions, as well as representatives from labour unions, civil society, private operators,

donors and expert organizations. The composition of the Steering Committee reflects the geographical and institutional diversity of the Alliance as established in GWOPA's charter. The Steering Committee currently meets annually and provides overall strategic guidance to the GWOPA activities.

GWOPA has helped establish regional platforms for WOPs in Africa, Asia, the Pacific, South East Europe, and Latin America and the Caribbean. These platforms are not administratively linked to UN-Habitat/GWOPA. Yet, GWOPA helped in activities such as business plan development, raise funds to support WOPs, and provides guidance on WOPs implementation. The type of support depends on the degree of development of the regional platforms. In some regions, GWOPA works with already established platforms. In Asia, GWOPA's regional partner is Waterlinks, founded by the Asian Development Bank (ADB), the International Water Association (IWA), and the United States Agency for International Development (USAID/ECO-Asia). In Africa, considerable effort has been expended in establishing a functional WOP platform with the African Water Association (AfWA). WOP-Africa has received financial support from the African Development Bank (AfDB) and the United States Agency for International Development (USAID). Groundwork has been laid for the establishment of new platforms in Eastern Europe and Central Asia and the Arab Region by 2014. Furthermore, in response to strong demand in Pakistan, Mexico and Brazil, platforms were established at national level to facilitate in-country or international WOPs.

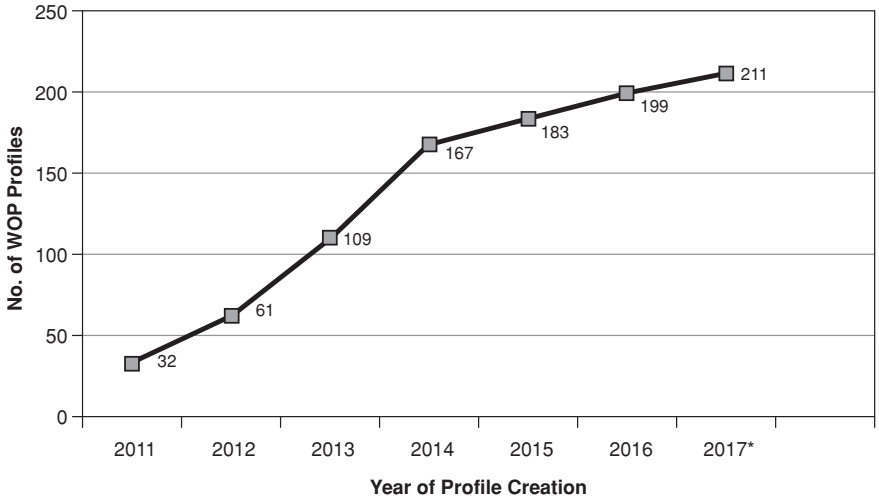
3. BASIC ANALYSIS OF WOP NUMBERS

GWOPA has enabled the possibility for users to contribute information about WOPs on a voluntary basis[8] on their website since 2011. The database is not an exhaustive compendium of WOPs worldwide and one should be aware of the lack of triangulation of data inserted. Yet a first analysis enables the identification of some interesting trends. To date there are 211 WOPs entered in the database. The trend of cumulative number of registered WOPs shows that WOP projects have been starting every year since 2011. The trend shows a steep increase in numbers from 2011 to 2014 and a slower growth the rest of the years till 2017. One of the influencing factors in such a growth during those years was the launch of the call for proposals "Partnership for capacity development in the ACP water and sanitation sector" published in February 2010 EuropeAid/129510/C/ACT/Multi) under the 10th EDF ACP-EU water facility. The ACP-EU water facility awarded grants totalling Euro 23 million to 32 projects, 23 of which were WOPs.

[8] **¡¡¡Falta composición nota 8!!!**

FIGURE 2

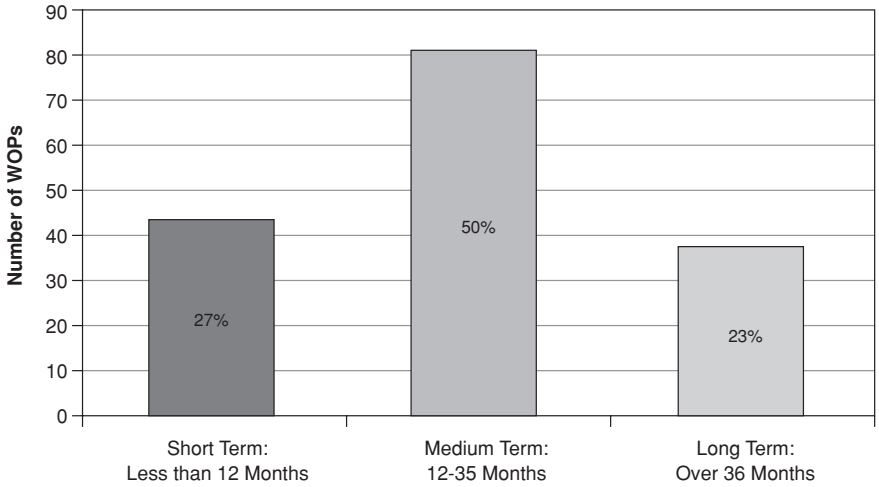
CUMULATIVE NO. OF WOP PROFILES LOGGED ONTO THE GWOPA DATABASE 2011 TO 2017



From the 162 WOP profiles that inform about the duration it can be said that 27% were short term WOPs (less than 12 months), 50% were medium term WOPs (between 12 and 35 months) and 27% were long term WOPs (lasting more than 36 months).

FIGURE 3

DURATION OF WOPS (OF THE 162 WOPS WITH A START AND COMPLETION DATE)

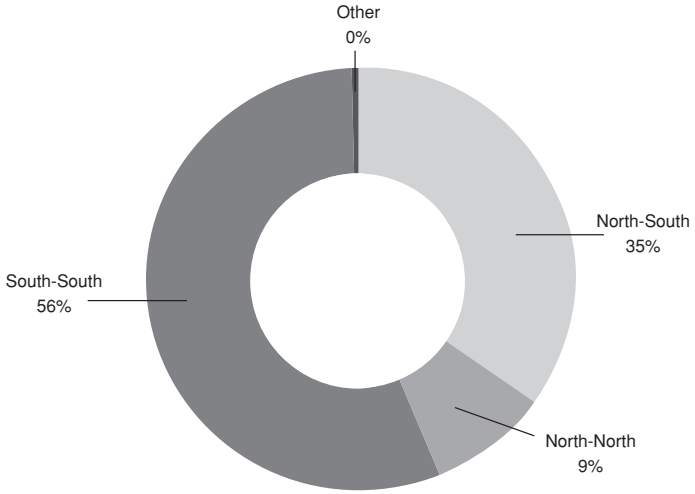


Source: GWOPA Database.

In terms of regional match, most WOPs were South-South (56%), followed by North-South (35%) and lastly, North-North (9%).

FIGURE 4

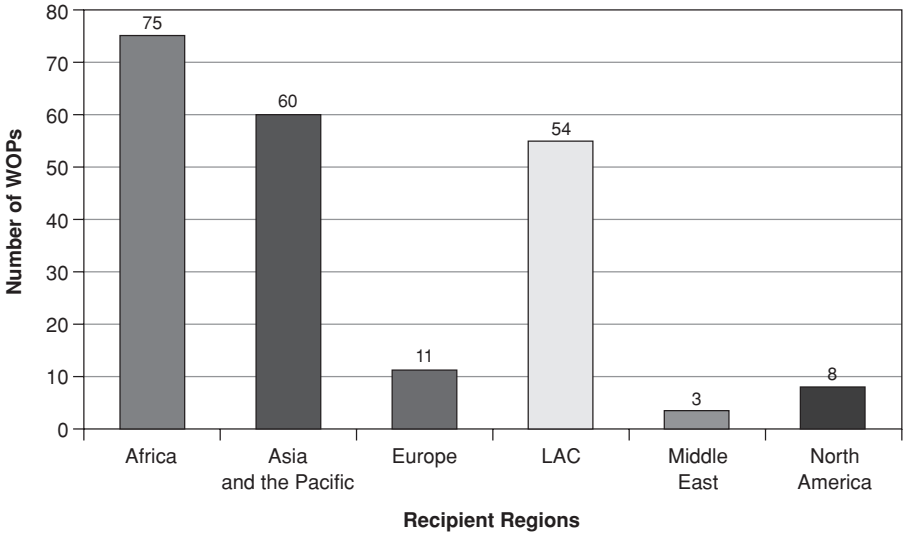
SOUTH AND NORTH MATCH OF PARTNERS IN WOPS (211 WOP PROFILES)



Source: GWOPA Database.

FIGURE 5

REGIONAL DISTRIBUTION OF WOPS. RECIPIENT REGIONS (211 WOP PROFILES)



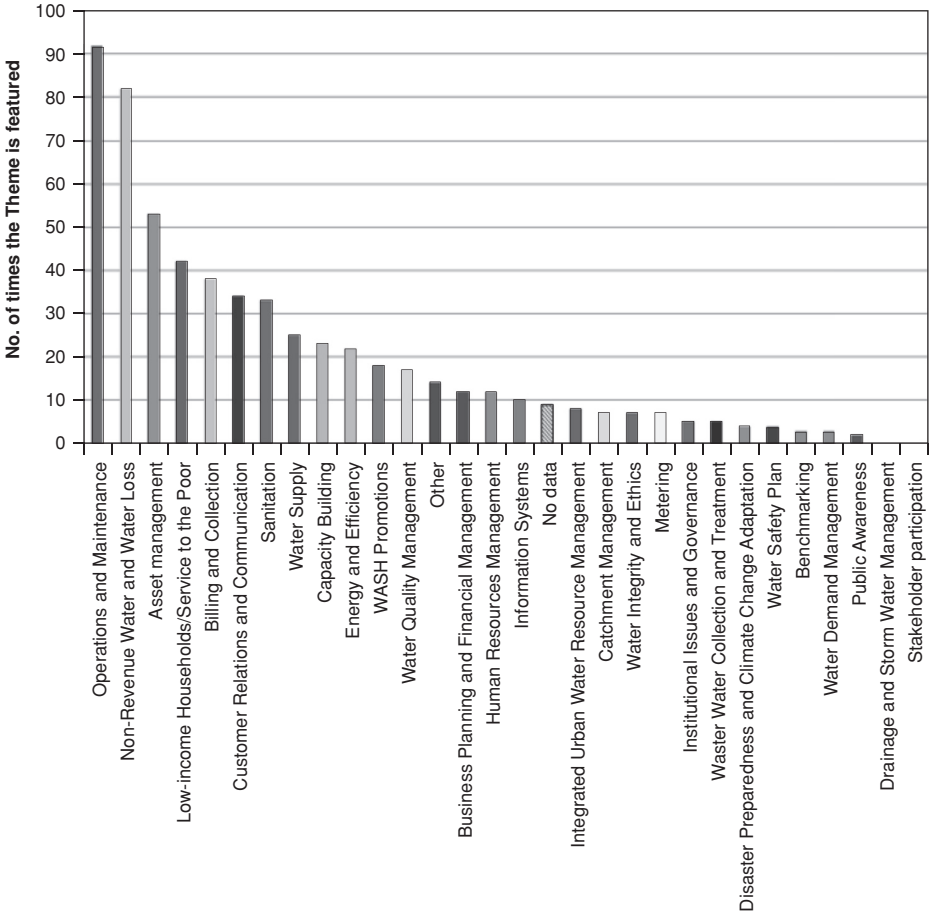
Source: GWOPA Database.

According to the registered WOPs in the database, Africa is the region where most WOPs were implemented followed closely by Asia and the Pacific, and Latin America and the Caribbean. A few cases have been registered also for WOPs in Europe, Middle East and North America.

The registered data also informs about the main improvement themes addressed within WOPs. There are more than 20 improvement areas identified but it can be said that Operation and Maintenance/asset management (O&M) and Non revenue water (NRW) reduction are by far the most frequently tackled with WOPs, followed by low-income areas, billing and collection and customer care. The most common improvement themes that are addressed in WOPs are O&M, NRW, asset management and low-income areas in this order.

FIGURE 6

FREQUENCY OF IMPROVEMENT THEMES FEATURING IN WOPS PROFILES (GWOPA WOP DATABASE - 211 WOPS)



Source: GWOPA Database.

4. WOPs IMPACT: SUSTAINED CAPACITY OF WATER OPERATORS TO PERFORM

Different from other interventions targeting performance enhancement of water operators, WOPs focus on supporting capacity development and not in substituting capacity. Mentors engage in supporting individuals and organizations on the partner organization in their efforts to improve their capacity to perform and sustain performance. This poses a limitation when looking at impact given that enhanced capacity at individual and organizational level escapes generally from the approaches traditionally applied to measure outcomes and impact achieved in water operators. Plenty of evidence can be shown of the impact of WOPs when applying a more comprehensive analytical lens that caters to short-, medium- and long-term evidence that takes into account not only at performance of the utility but also capacity changes at individual and organizational level. Across the diverse WOPs practice globally, distinct impact types emerge. For example, some WOPs target a very specific area of improvement that can be addressed by partners' collaboration in a collaboration of short or medium duration (*e. g.* safety or corporate culture) while others aim at helping a utility with overall operational improvements over a longer-term collaboration. A key factor determining the order of impact achievable is the time in which the impact is measured. Generally, in the short term (0-1 year)[9], WOPs tend to achieve organizational changes related to improvements in staff knowledge, skills, awareness and attitude, in addition to a deeper understanding of the organization's needs and strategies on how to address them. In the medium term (1-3 years)[10], WOP contributions become visible in operational improvements stemming from more efficient organizational routines, improved management practices, more effective organizational structures or management information systems that with time (beyond 3 years)[11] translate into operational, financial and service-related perfor-

---

[9] United Nations Human Settlements Programme, *Water Operators' Partnership Case Study: Companhia de Saneamento de Minas Gerais (COPASA MG) and Empresa Municipal de Saneamiento Básico de Puno Sociedad Anónima (EMSAPUNO S.A.)* (Nairobi: UN-Habitat, 2016), available from *http://www.gwopa.org/en/resources-library/emsapuno-copasa.*

[10] Global Water Operators' Parternship Alliance & UNESCO-IHE, *Factsheet: Water Operators' Partnership between PDAM Tirta Kepri (Tanjung Pinang) Kepulauan Riau Province - Indonesia, PDAM Trita Raharja (Kabupaten Bandung) Bandung Area - Indonesia* (2015) available from *http://gwopa.org/en/resources-library/factsheet-wop-pdam-tirta-kepri-pdam-tirta-raharja.*

[11] United Nations Human Settlements Programme, *Water Operators' Partnership Case Study: Aguas de Norte, Salta, Argentina and Caesb - Brasília, Brazil* (Nairobi: UN-Habitat, 2015) available from *https://issuu.com/gwopa/docs/bewop_1._adn_-_caesb/1.*

United Nations Human Settlements Programme, *Water Operators' Partnership Case Study: SIAAP - Paris, France and ONEE - Rabat, Morocco* (Nairobi: UN-Habitat, 2014) available from *http://gwopa.org/en/resources-library/wop-narrative-case-study-onee-and-siaap.*

United Nations Human Settlements Programme, *Water Operators' Partnership Case Study. HWA - Hunter Water Australia and WAF - Water Authority of Fiji* (Nairobi: UN-Habitat, 2015) available from *http://gwopa.org/en/resources-library/wop-narrative-case-study-water-of-fiji-and-hunter-water-australia.*

mance improvements. In several cases, WOPs have generated broader benefits for the mentee water operators than those initially anticipated, going beyond improved operational efficiency and contributing to the implementation of investment programs[12] or/and governance or regulatory reforms[13].

Overall it can be said that like any other development intervention there are very positive WOP experiences and other less positive ones. Yet, the last decade has seen a steady growth in the experience of key actors (particularly mentors and donors), an increase in knowledge resources and services to foster good WOP practice, and improved approaches to measure capacity enhancement (methodology, currently in testing phase) to inform about WOPs outcomes. Together these factors create increasingly favourable conditions for WOPs' successful implementation.

5. WOPs AND FUNDING

There is no one-size budget for a WOP for two main reasons related to their duration and their association with investments. The collaborative nature of these partnerships makes them an emergent process in which the duration and scope might expand and change as the partnership progresses. The initial duration tends to be defined by the source of funding initially obtained. However, there are cases where once that initial funding ends, or even during the implementation of the initial project, partners search for additional funds to continue and/or expand the collaboration. Available data from GWOPA's database of peer-support show annual budgets that range from a few thousand dollars for a short-term WOP of specific scope between two geographic neighbors (7% of the WOPs database had a budget not higher than US $50,000) to more than 1 million dollars in longterm WOPs of wide scope between distant partners (13% of the WOPs in the database had a budget higher than USD 1 million).

The other reason that there is large variation in reported WOP budgets has to do with whether there are accompanying investments. Irrespective of the duration, a distinction has to be made between the peer-support costs and associated soft or hard investments executed alongside the peer-support. In the case that a WOP takes place without reference to any particular investment funded by the mentee or a third party, the

---

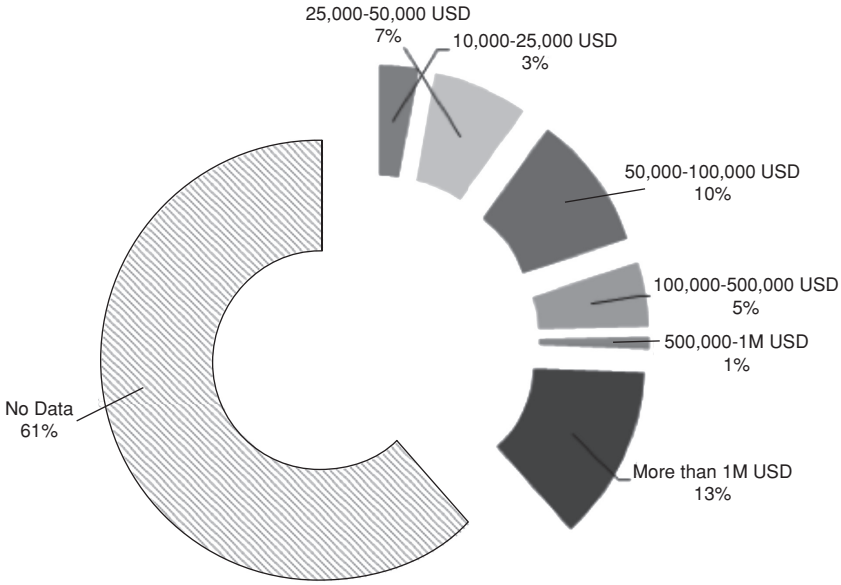
"WOP Analysis between SWDE - Verviers, Belgium and ONEE - Rabat, Morocco" (WOP Profile, 03 February 2016) *http://gwopa.org/en/wop-profiles/wop-swde-and-onee.*

[12] Two year extension of VEI's Water Operator Partnership in Mombassa (Kenya), available from *http://www.vitensevidesinternational.com/two-year-extension-veis-water-operator-partnership-mombasa/.*

[13] United Nations Human Settlements Programme, Water Operator Partnerships in Africa. The case of Vitens Evides International and FIPAG in Mozambique (Nairobi: UN-Habitat, 2013) available from *https://issuu.com/gwopa/docs/case-study-01-mozambique-76.*

FIGURE 7

WOPS BUDGETS (GWOPA WOP DATABASE - 211 WOPS)



basic expenses are travel, accommodation, staff-time and space and materials for visits by staff to their partner utilities' facilities. Staff time and the use of facilities during site visits (*e. g.,* vehicles, conference rooms) are most often contributed in-kind by the partnering operators. However, for new knowledge to translate into operational improvements, water operators frequently require equipment and at times infrastructure rehabilitation and/or further development. As such, the implementation of WOP activities does not occur in isolation from other activities of the recipient water operator, let alone their investments. The evidence from documented WOP cases shows the diversity of scenarios of WOPs associated with investments programs. WOPs can precede an investment program, accompany the implementation of an investment program or follow an investment program implementation:

— *As an initial diagnostic activity with the aim of attracting or preparing larger investments*. Some WOPs help a water operator prepare for future investment. This type of WOP may serve to diagnose needs in advance of a larger investment initiative, or to create an action plan for a broader package of investment in the operator. The WOP may or may not be linked explicitly to a forthcoming investment, but retains a focus on future investment in either case. Fundable Performance Improvement Plans were an outcome of a set of WOPs facilitated by GWOPA in Africa in 2014-2015 with the support of the OPEC Fund for International Development (OFID).

— *As a project that occurs alongside the implementation of an investment program* to increase its likelihood of success and sustainability. WOPs may be undertaken within or alongside other investments by the mentee. Most large hardware investments in water operators already include at least a small element of technical assistance to which WOPs are increasingly able to contribute. WOPs in this context may serve to build capacity around this particular investment and help ensure its success. Example: Investment program associated with an operational support by a strong water operator —through capacity development and support in the implementation of the investment program— in Blantyre and Lilongwe (Malawi). Funded by a loan from European Investment Bank (EIB) and a grant by EU and peer support provided by Vitens Evides International (2009-2014).

— *As an activity that occurs after an investment program to increase its likelihood of sustainability.* WOPs in this context may serve to optimize the operation and maintenance of a given infrastructure to ensure its sustainability. A WOP in Indonesia, conducted with the help of Malaysia's IWK, by increasing the number of sewerage connections helped ensure the viability of a recently constructed wastewater treatment plant.

Most WOPs benefit from a combination of sources of funding. The most frequent have been multilateral agencies, bilateral agencies, regional or local funding for development, Corporate Social Responsibility funds, charities, water associations and in-kind contributions from water operators. To date, bilateral agencies such as AECID, DGIS, AfD, JICA, AusAID, SIDA, NORAD, DFID, BMZ, USAID and multilateral development agencies such as EC, EIB, AfDB, ADB, IDB, OFID, WB have provided the majority of direct funding to support WOPs, GWOPA and regional WOP platforms. Bilateral development agencies generally fund WOPs through grants and tend to use WOPs as means to achieve aid policy objectives. Multilateral development agencies have occasionally used the engagement of a water operator on a not-for profit basis to undertake the technical assistance component of a loan for infrastructure program. However, most public utilities are legally or administratively limited to bid in the competitive international tendering processes used to procure such services. Hence, this avenue for WOPs has not been common.

The substantial in-kind contributions of WOP partners and the non-for- profit nature of these projects generally are a remarkable feature of this type of development projects that translates into lower costs compared with consultant-led technical assistance or other capacity development initiatives. The contrast is even greater when WOPs are compared with standard management or service contracts that tend to entail high transaction costs associated with the long duration and related costs of organizing international competitive bidding process. Water operators, including both mentors and mentees, commonly contribute considerably with in-kind support (usually staff time) and even occasionally with direct funding through social corporate funds. Decentralized solidarity

mechanisms and specialpurpose laws are a notable model of grant funding that is playing an important role for WOPs. Several European countries —in particular France and The Netherlands— have passed laws that allow their local authorities, public water operators and river basin organizations to dedicate voluntarily up to 1% of their water and sanitation turnover toward development cooperation projects abroad. This is a potentially huge amount of money that stands to be leveraged toward WOPs. If every French local authority and water agency committed the full 1%, this figure could rise to between 60 and 120 million Euros per year[14]. In those cases the contribution from water operators has proven instrumental for funding leverage. As an example the leverage of Vitens Evides International's own contribution in 2015 was 86%. The in-kind contribution by partners do not only revert in costs of the project but also in the symbolic bridge and commitment that both partners help building through such contribution.

A recent and innovative initiative that clearly illustrates this type of leverage is the WATERWORX Programme established in the Netherlands. WATERWORX is a 14-year Programmatic Support to WOPs (2017-2030) with a budget of 54 million for the first phase (2017-2021) co-funded by the Netherlands' Ministry of Foreign Affairs (55%), the ten Dutch public water companies (35% levied thanks to their 1% law) and the local partner companies in Africa, Asia and Latin America (10%). This program is also anticipated to have a positive effect on the willingness of financiers to finance (loans for) large-scale investments in water infrastructure in the recipient countries, making it possible to connect large numbers of people to water and sanitation.

6. FINAL CONSIDERATIONS

The number of WOPs being implemented globally has grown steadily since 2011 but is still very low compared with the great potential of public utilities collaborating and the real need for capacity to improve and sustain water services by water operators. The WOP practice and GWOPA as an alliance has developed considerably in the last years and so have done the knowledge and services in place to support WOPs partners. The ambition to upscale the WOP practice now requires, in addition to supporting and capitalizing on ongoing practice, a special emphasis on the advocacy component of the whole alliance's work, to mobilise stronger commitments from donor, National Governments (on recipient and receiving countries), water operators (on recipient and receiving countries).

[14] *http://www.pseau.org/fr/1pourcent.*

7. Water operators' partnerships case study: VEI and Dawaco

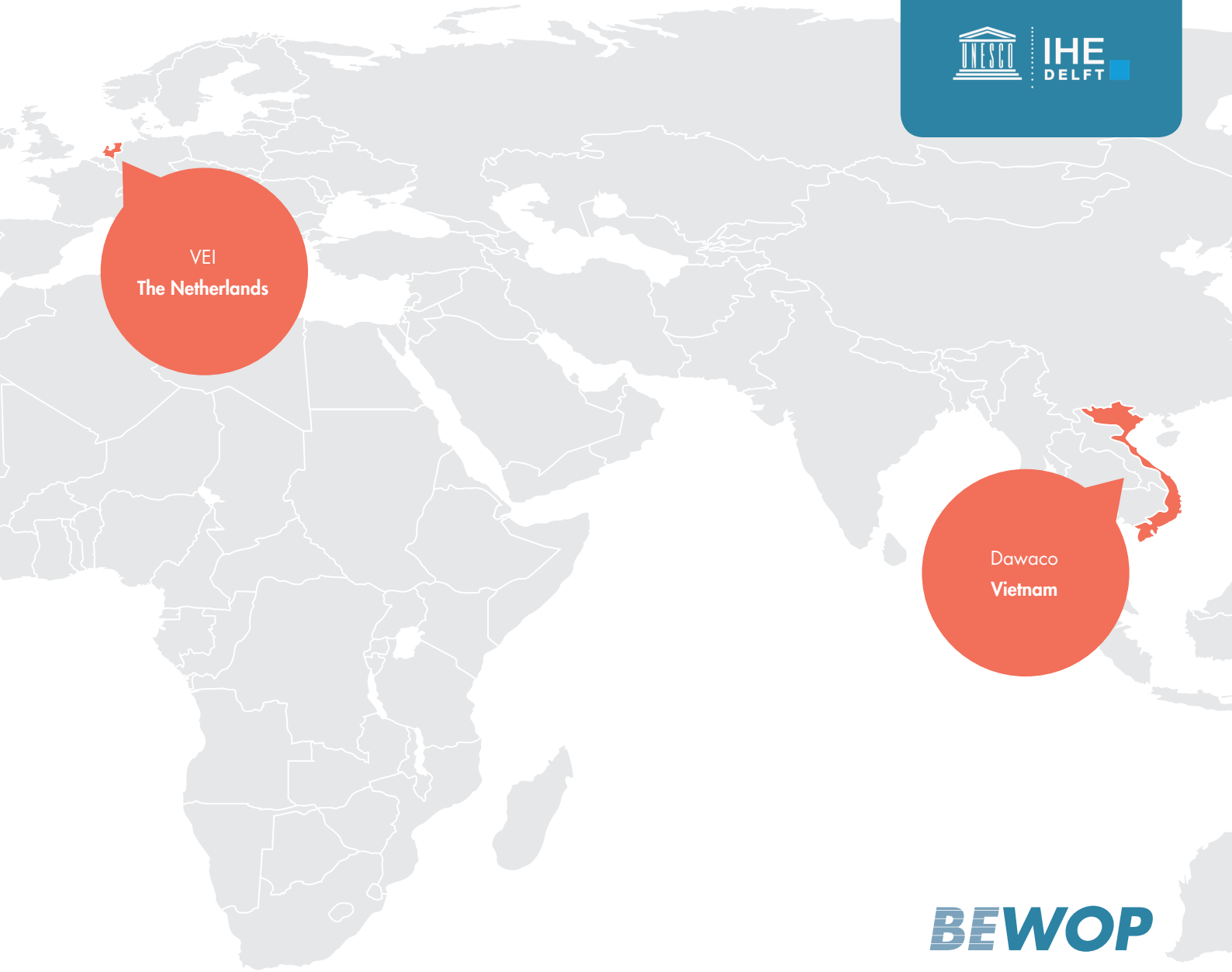
Publication No.	**P-VI**
Type	Technical report
Series title	BEWOP Case Studies
Publisher	UN-Habitat
Status	Published
Reference	**Wright-Contreras, L.** (2018). *Water Operators' Partnership Case Study: VEI and Dawaco* [Case Study]. Retrieved from UN-Habitat website: https://www.vei.nl/IManager/Download/971/88691/21553/1882533/EN/21553_1882533_Qunj_Case-Study-01-VEI-Dawaco-74.pdf
Abstract	The VEI-Dawaco WOP was carried out from 2007 until the end of 2010. The WOP focused on the extension and improvement of water services in Da Nang, while supporting Dawaco in achieving management autonomy and a stronger financial position. Besides the achieved operational, managerial, and financial water utility performance improvements, the WOP was successful in supporting water services for the urban poor. Through improved processes and pro-poor strategies, the WOP's approach allowed for Dawaco to build on its own capacity and contribute to the sustainability of results, including effective, long-term and inclusive water delivery.

Water Operators' Partnership Case Study

GWOPA
Global Water Operators' Partnerships Alliance

UN-HABITAT
FOR A BETTER URBAN FUTURE

UNESCO IHE DELFT



BEWOP

Water Operators' Partnership Case Study
VEI and Dawaco

Published in August 2018

UN-HABITAT, P.O. Box 30030, GPO, Nairobi, 00100, KENYA
Tel: +254 20 762 3120 (Central Office)
www.unhabitat.org

Disclaimer

Acknowledgements

Author: Lucia Wright-Contreras

Reviewer: Maria Pascual, Julissa Kiyenje

Design and layout: Jared Farrell and Anke van Lenteren – www.designi.se

Photos: © Lucia Wright-Contreras

Printer: E Farré

Supported by: Ministry of Foreign Affairs of the Netherlands (co-founder)
Spanish Agency for International Development Cooperation (AECID)

Boosting the Effectiveness of Water Operators' Partnerships (BEWOP)
Initiative | The Global Water Operators' Partnerships Alliance (GWOPA)
& IHE Delft Institute for Water Education

This report was financed by the Agreement of Cooperation between Technische Universität Darmstadt and UN-Habitat number GC/17/026, between July 2017 to August 2018.

VEI and Dawaco

Water Operators' Partnership Case Study


VEI The Netherlands


Dawaco Vietnam

Abbreviations

ADB	Asian Development Bank
CCU	Central Control Unit
CSR	Corporate Social Responsibility
CTM	Care-Taker Model
CKEZ	Central Key Economic Zone
CVKER	Central Vietnam Key Economic Region
Dawaco	Da Nang Water Supply Joint Stock Company
DGIS	Directorate-General for International Cooperation
DMA	District Metering Areas
DoC	Department of Construction
EMF	Electromagnetic field
GIS	Geographic Information System
KEZ	Key Economic Zone
KPI	Key Performance Indicator
LLC	Limited Liability Company
MoU	Memorandum of Understanding
NRW	Non-Revenue Water (unaccounted for water)
JICA	Japan International Cooperation Agency

JSC	Joint Stock Company
P&C	Planning and Control
PC	People's Committee
PMU	Project Management Unit
PPTA	Project Preparatory Technical Assistance
RNE	Royal Netherlands Embassy
RPM	Resident Project Manager
SCADA	Supervisory Control and Data Acquisition
SCDP	Sustainable City Development Project
SDG	Sustainable Development Goal
SOE	State-Owned Enterprise
USD	United States dollar (currency)
USP	Utility Support Programme
VND	Vietnamese dong (currency)
WOP	Water Operators' Partnership
WTP	Water Treatment Plant

Key Facts

Partners

Mentee: *Da Nang Water Supply Joint Stock Company (Dawaco)*

Water utility of Da Nang City. At the moment of the partnership the company was a State-Owned Enterprise (SOE), and since 2016 it has become a Joint Stock Company (JSC), owned 60% by the People's Committee of Da Nang, 35% by a strategic main holder and the remaining 5% of shares are owned by Dawaco staff and are distributed according to their performance and amount of invested time.

Mentor: *VEI – Dutch Water Operators (VEI)*

Not-for-profit, private company registered with the Dutch Chamber of Commerce. Its shares are divided equally between the two largest and publicly-owned water companies in the Netherlands. At the time of the WOP VEI-Dawaco between 2007-2010, VEI represented 3 Dutch water operators. These were Vitens, Evides Waterbedrijf, and WML (Waterleidingmaatschappij Limburg).

Duration

2007–2010

Cost

Total: USD 2.7 million

- USD 1.9 million from the Directorate-General for International Cooperation (DGIS) of the Netherland's Ministry of Foreign Affairs, Royal Netherlands Embassy (RNE).

- USD 550,000 from VEI.
- USD 282,500 from Dawaco (in-kind contribution).

Objectives

Main objectives for the VEI-Dawaco WOP:

1. the extension and improvement of water services in Da Nang,
2. the management autonomy and strengthening of Dawaco's financial position, and
3. the sustainable delivery of water services to the urban poor.

Aim

VEI

Increase Corporate Social Responsibility (CSR) and draw the interest of a workforce that supports VEI's mission.

Dawaco

Enhance the company's capacity and performance, and access parallel funds to improve service provision.

Facilitators

The WOP between VEI and Dawaco was facilitated by the Royal Netherlands Embassy (RNE) in Hanoi and the People's Committee of Da Nang (PC Da Nang). The main incentive for the RNE and the PC of Da Nang to facilitate the WOP between VEI and Dawaco was to deliver water to the poor.

Approach

The VEI-Dawaco WOP was carried out from 2007 until the end of 2010. The WOP focused on the extension and improvement of water services in Da Nang, while supporting Dawaco in achieving management autonomy and a stronger financial position. Besides the achieved operational, managerial, and financial water utility performance improvements, the WOP was successful in supporting water services for the urban poor. Through improved processes and pro-poor strategies, the WOP's approach allowed for Dawaco to build on its own capacity and contribute to the sustainability of results, including effective, long-term and inclusive water delivery.

Results

- Non-Revenue Water has gone down during the years since the start of the WOP from approximately 39% to 26% at the end of the partnership, and 15% by 2017.
- Nearly 49,000 new connections were made, averaging over 16,000 per year.
- Over 7,800 connections for the poor were made, averaging around 2,600 per year and amounting to 16% of the total new connections.
- Water quantity and quality meters were installed at two water treatment plants. With this, 99% of total production was metered. Based on the data collected from these meters the operational processes were improved.
- A Central Control Unit was officially implemented and metering equipment was installed in the network.
- A new tariff structure was approved which made low consumption costs accessible to the poor who generally use a limited amount of water.

- Sustained progress of performance improvements even after the WOP ended, as shown with the increased connectivity rates, current NRW values, and improved creditworthiness of the company evaluated from 1996 to 2017.
- Operational, managerial, and financial water utility performance improvements paved the road for access to other funding opportunities (ADB, JICA, and the World Bank) which further supported the objectives of the WOP.

Success factors

- the expertise of VEI's team, combining a good foundation of Dutch water infrastructure and knowledge management,
- the openness of the VEI team to teach Dawaco everything they know,
- the willingness of Dawaco's management level to change and commit to implement changes,
- the strong motivation by staff at all levels during the WOP, and
- the availability of funds for investments.

Challenges

- Building cultural bridges and overcoming language barriers.

Figure 1: Cau Do Water Treatment Plant

Introduction

This report analyzes the sustainability of Dawaco's improved performance derived from the Water Operators' Partnership (WOP) with the Dutch company VEI from 2007–2010.[1] The initial contact was facilitated by Mr. Gerhardus Nicolaas Albertus Soppe, from the World Bank's Global Water Practice, to formally introduce the key informants to be interviewed for the present case study analysis. The visit took place in Dawaco's headquarters, at 57, Xô Viết Nghệ Tĩnh, Hòa Cường Nam, in Da Nang, Vietnam, from August 4 to August 10, 2017.

The Boosting Effectiveness in Water Operators' Partnerships (BEWOP) analysis framework was applied to understand the operational, managerial, and financial water utility performance improvements achieved during the WOP which contributed to water services for the urban poor. A total of 7 interviews with relevant parties involved in the VEI-Dawaco WOP were carried out.[2] Finally, a visit to the Cau Do water treatment plant proved to be highly valuable, thanks to the exchange with the director, the vice-director, staff, and local engineers.

The following sections will walk the reader through the different phases of the WOP, from the matchmaking process to the inception phase, partnership building phase, and implementation phase, as well as the evidence of progress towards impact and effectiveness of the project, and a final evaluation. The main objective of this report is to understand the succcess factors of the VEI-Dawaco WOP and assess the sustainability of the improved performance of Dawaco after the partnership.

---

1 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International.

2 Interviews included: former VEI-Dawaco Resident Project Manager, former VEI-Dawaco Project Assistant, Dawaco's General Director at the time of the WOP (now Chairman of Management Board), Dawaco's curret General Director, Dawaco's Head of Strategic Planning Department, Dawaco's Head of Technical Department, and Dawaco's Chief Accountant. Communication with staff members from Dawaco's Planning Department, Control Center and Network Management, and Project Management Unit was also key for the elaboration of this report.

Partnership scoping

Contextual Factors

Political factors

Da Nang is a city located in the Southern-central coast of Vietnam, covering 1,285.4 square kilometers, with a population of just over 1 million inhabitants and a population density of 800 people per square kilometer.[3] Throughout the implementation of the national-level *doi moi* reforms, like the country's capital, Hanoi, the city transitioned to a market oriented economy in 1986, leading to rapid industrialization and urbanization.[4] Da Nang is one of 5 provinces, including Thua Thien-Hue, Quang Nam, Quang Ngai, Binh Dinh Province, which form part of the Central Vietnam Key Economic Region (CVKER).[5] Through central government implementation, the CVKER intends to become Vietnam's "growth" nucleus, and boost the dynamic development of Central Vietnam and the West Highlands, while attracting investments from sectors including oil and gas, shipbuilding, logistics, coastal tourism development, and high-tech industries.[6]

---

3 *GSO, General Statistics Office (2015). Area, population and population density by province.* https://tinyurl.com/ybxrrhlc. Updated: 2015. Accessed: May 10, 2017.

4 Nguyen, H. K. L. (2013). *Detecting and Modeling the Changes of Land Use/Cover for Land Use Planning in Da Nang City, Viet Nam* (Dissertation). Georg-August-Universität Göttingen, Göttingen.

5 Vietnam Trade Promotion Agency (2012a). *The Central Vietnam Key Economic Region (CVKER).* https://tinyurl.com/ybwc57rl. Updated: 2011. Accessed: May 11, 2017.

6 Jones, S. and Gu, J. (2012). *Vietnam's Regions and Key Economic Zones.* https://tinyurl.com/ybk5zdqq. Updated: May 29, 2012. Accessed: May 11, 2017.

Socio-economic factors

Based on Decisions No. 145, No. 146, and No. 148/2004/QD-TTg from former Prime Minister Phan Van Khin, the economic development plan which specifies the Key Economic Zones (KEZs) was launched in 2004.[7] Compared to the other two KEZs, the Northern KEZ and the Southern KEZ, the strengths of the areas which constitute the Central KEZ (CKEZ) can be summarized into five points. The first strength is the strategic location of the provinces, which easily provide access to the Central Highlands of Vietnam, the South of Laos, the North of Cambodia, and the key provinces of Thailand and Myanmar, which play an important economic role in the region. The second strength corresponds to the richness in resources found in the region, including the perceived potential for tourism development areas. Third, this area provides a maritime connection to North Asian countries and allows for deep-water seaport construction linked to the national seaport system, and connected to new developments. Fourth, the development of industrial parks and tourist destinations is expected to merge with cross-sectoral economic development zones, boosting the growth of coastal municipalities in Vietnam. Fifth, CKEZ envisions a population with a high capacity of integrating into the market economy, through industry – and technology-oriented livelihoods. Despite the overall positive outlook portrayed in the regional economic development plans, several soft points exist within the region including: "weak socioeconomic foundation, inclement weather, and frequent floods."[8]

---

7 Jones, S. and Gu, J. (2012). *Vietnam's Regions and Key Economic Zones.* https://tinyurl.com/ybk5zdqq. Updated: May 29, 2012. Accessed: May 11, 2017.

8 Vietnam Trade Promotion Agency (2012a). *The Central Vietnam Key Economic Region (CVKER).* https://tinyurl.com/yd3ojqxu. Updated: 2011. Accessed: May 11, 2017.

Water sector characteristics and developments

Technological development of water infrastructures

Before the mid-twentieth century when a formal water supply system in Da Nang was built, the city had relied on wells and small technological networks. However, saltwater intrusion and limited availability of groundwater are some of the main factors that continue to challenge urban water supply. Since the capacity of groundwater exploitation in the central areas of the city cannot exceed 15,000 m^3/day, in the '60s, under the management of the Da Nang Water Bureau, two surface water supply stations were established in Cầu Đỏ and Sân Bay; the first serving the users in the inner city, and the second supplying military zones of the old regime. After the end of the war in Vietnam in 1975, a new water management unit was established supplying about 12,000 m^3/day, later amounting to 22,000 m^3/day through the renovation and expansion of water supply stations. From 1985 until 2005, the capacities of both Cầu Đỏ water treatment plant and Sân Bay water treatment plant were increased to 50,000 m^3/day and 30,000 m^3/day, respectively, and two new water supply stations were built: the Sơn Trà water supply station and the An Trạch saltwater pumping station. Cầu Đỏ water treatment plant would be later renovated through Official Development Assistance (ODA) from the French government in 2002. Da Nang's water supply company improved the management of water provision by establishing water supply branches throughout the city's districts. In 2004, Dawaco was established under the national government Decision No. 01/2004/QD-CTCN and now has a supply capacity of 205,000 m^3/day distributed throughout four units: Cầu Đỏ water treatment plant, Sân Bay water treatment plant, Sơn Trà water supply station, and An Trạch salt water pumping station.[9]

---

9 Dawaco (2017). *Dawaco, Danang Water Supply Joint Stock Company* [original in Vietnamese: Công ty cổ phần cấp thoát nước đà nẵng]. http://dawaco.com.vn/. Updated: 2017. Accessed: May 10, 2017.

Institutional: Legislation and policies

Formally, at the start of the partnership, the production and management of drinking water was regulated by the People's Committee of Da Nang (PC Da Nang). However, Dawaco actually reported directly to the Department of Construction (DoC) and PC Da Nang acted only as asset owner and regulator. The organizational structure of the company was managed by a Director, overlooking eight departments: Administration, Planning and Technology, Finance and Accounting, Business and Materials, Commercial Affairs, Project Management Board, Water Supply Services Consultancy Center, Monitoring Team; and the following enterprises and water supply branches were, in turn, managed by the Vice-director: Water Production Enterprise, Construction Enterprise, Water Supply Branch Hải Châu, Water Supply Branch Thanh Khê, Water Supply Branch – CNCN Sơn Trà, Water Supply Branch Ngũ Hành Sơn, Water Supply Branch Liên Chiểu, Water Supply Branch Liên Chiểu, Mechanic & Electricity Workshop.[10] Since January of 2016, Dawaco is a Joint Stock Company run by a General Meeting of Shareholders, a Board of Directors, a General manager, a Control Board, and three Deputy General Managers.[11]

---

10 Dawaco, VEI, RNE, & PC Da Nang (2008, March 19). *Inception Report, Utility Support Programme Dawaco. Public-Private-Partnership (PPP), Da Nang Water Supply Company (Dawaco), Vitens-Evides International (VEI), the Royal Netherlands Embassy/Government of The Netherlands (RNE), and the People's Committee (PC) of Da Nang City.* Hanoi, Vietnam: Dawaco, VEI, RNE, PC Da Nang.

11 Dawaco (2017). *Dawaco, Danang Water Supply Joint Stock Company* [original in Vietnamese: Công ty cổ phần cấp thoát nước đà nẵng]. http://dawaco.com.vn/. Updated: 2017. Accessed: May 10, 2017.

As a Public Interest Company and Joint Stock Company,[12] Dawaco abides to the following laws: Investment Law No. 67/2014 /QH13; Enterprise Law No. 68/2014 /QH13; Law on Securities and the Stock Market No. 70/2006/QH11; Environmental Protection Law No. 55/2014/QH13. The general rules on planning water supply, water supply development investments, connection points, service contracts, clean water price, rights and obligations of water supply units and customers, and safety and management, are provided in Decree No. 117/2007/ND-CP, whereas concrete objectives and goals targeted to the years 2015, 2020, 2025 and the vision of 2050 are established in Decision No. 1929/QD-TTG

Financial aid and parallel investments

With the economic boost since the *doi moi* reforms in 1986 and the expected development of the area, the infrastructural water supply networks in Da Nang have been under constant expansion.[13] The city's water supply system has been improved and developed with the assistance of foreign expertise which has facilitated technological support and know-how, helping Dawaco increase its capacity of water production and improve water quality, billing, customer relationship management, financial information management, strategic management and overall planning.[14]

---

12 For specific definition on Public Interest Companies and Joint Stock Companies refer to: SRV, Socialist Republic of Vietnam (2017). *Decree No. 71/2017/ND-CP Guidelines on Corporate Governance Applicable to Public Interest Companies.* https://tinyurl.com/ydydhmhx. Updated: May 6, 2017. Accessed: November 1, 2017.

13 Vietnam Trade Promotion Agency (2012b). *Overview of Danang City – Part 1, 2 and 3.* https://tinyurl.com/yd3ojqxu. Updated: 2012. Accessed: May 11, 2017.

14 Dawaco (2017). *Dawaco, Danang Water Supply Joint Stock Company* [original in Vietnamese: Công ty cổ phần cấp thoát nước đà nẵng]. http://dawaco.com.vn/. Updated: 2017. Accessed: May 10, 2017.

From 2008 to 2013, ADB contributed to a project for the expansion of the water distribution network.[15] And since 2013, the Japanese International Cooperation Agency (JICA) has supported Dawaco with the construction of a water treatment plant in Hòa Liên.[16] Also in 2013, the World Bank provided the Vietnamese government a USD 272.2 million loan to carry out the "Da Nang Sustainable City Development Project" (SCDP), implemented by the City People's Committee of Da Nang. These investments have contributed to the objectives set in the partnership with VEI.[17]

Bio-physical factors

The freshwater sources used mainly for household consumption and industrial use in Da Nang come from the Hàn River and the Cu Đê River, two major rivers which cross the province to reach the Da Nang Gulf. They comprise a basin bed surface area of 5,180 and 472 square kilometers, respectively.[18] The Hàn River flows from the following river branches: Cầu Đỏ River, Tuý Loan River, Yên River, and Vu Gia River, while Cu Đê River flows into Đà Nẵng Bay, Nam River and Bắc River (see Figure 2).[19] From this basin, 95%

---

15 ADB, Asian Development Bank (2008). *Da Nang Water Supply Project.* https://www.adb.org/projects/41456-012/main#project-pds. Updated: October 1, 2008. Accessed: May 15, 2018.

16 JICA, Japan International Cooperation Agency (2018). *Da Nang City Hoa Lien Water Supply Project.* https://www.jica.go.jp/english/our_work/social_environmental/id/asia/southeast/vietnam/c8h0vm0000b1q0ar.html. Updated: 2018. Accessed: May 28, 2018.

17 World Bank (2017). *Projects & Operations: Danang Sustainable City Development Project (SCDP).* https://tinyurl.com/yc94olve. Updated: 2017. Accessed: May 11, 2017.

18 Vietnam Trade Promotion Agency (2012b). *Overview of Danang City – Part 1, 2 and 3.* https://tinyurl.com/yd3ojqxu. Updated: 2012. Accessed: May 11, 2017.

19 Da Nang CCCO, Da Nang Climate Change Coordination Office (2014). *The river network of Danang city.* http://ccco.danang.gov.vn/106_121_1203/The_river_network_of_Danang_city.aspx. Updated: August 12, 2014. Accessed: March 29, 2018.

of Da Nang's clean water supply originates from Cầu Đỏ River, and 5% comes from the Lượng Stream and Sơn Trà Mountain.[20]

Figure 2: The river network of Da Nang city **Source: Da Nang CCCO, 2014**

20 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

Partnership creation

The WOP between VEI and Da Nang Water Company was facilitated by the Royal Netherlands Embassy (RNE) in Hanoi and the People's Committee of Da Nang (PC Da Nang) from 2007 to 2010.[21] In order to increase DAWACO's performance, the project focused on the following objectives: a) reducing non-revenue water, b) improving tap water quality, c) improving the consistency of the production operation management, d) creating a financial management system, e) developing a client registration system, f) developing a professional billing and collection system, and g) introducing a programme to provide house connections to the urban poor.[22]

History of collaboration and first contact

At that time, VEI supported Dawaco by transferring its expertise and knowledge to improve the performance of the water utility and contribute to the Millennium Development Goal number 7 on water supply and sanitation. The contact with Dawaco was driven by an opportunity of funding provided by RNE in Hanoi. To find the appropriate partner in Vietnam, former director of VEI, Mr. Jan Hoffer, established communication with a former VEI employee based in Vietnam, Mr. Ngo Xuan Truong, who in turn facilitated the communication with Mr. Nguyen Anh, Dawaco's General

---

21 Dawaco, VEI, RNE, & PC Da Nang (2007, October 19). *Memorandum of Understanding for Public-Private-Partnership (PPP) between the Da Nang Water Supply Company (DWSC) and Vitens-Evides International BV (VEI) and The Royal Netherlands Embassy Embassy (RNE) and The People's Committee (PC) of Da Nang City.* Ho Chi Minh City, Vietnam: PC Da Nang, DWSC, VEI, RNE-Hanoi.

22 VEI (2014). *Da Nang, Vietnam.* https://tinyurl.com/y7l2rbkr. Updated: 2014. Accessed: May 10, 2017.

Director, and Mr. Bui Tho Ninh, Director of the Planning and Technology Department in 2006.[23]

Enabling factors

At the time the partnership was initiated, the Chairman of the People's Committee of Da Nang, Mr. Van Huu Chien, was an active supporter of the cooperation with VEI.[24] This type of support from PC Da Nang, together with the willingness of key people within Dawaco, were both important enabling factors for the start of the partnership.[25]

23 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

24 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

25 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

Partnership formalization

On October 19, 2007, a Memorandum of Understanding (MoU) was signed by the four parties: VEI, Dawaco, RNE, and PC Da Nang.[26]

Following the MoU, the WOP was carried out in three phases:

1. Inception Phase. Planned: November 2007 to January 2008;[27] reported duration: six months in *End Project Report*.[28] VEI and Dawaco carried out a baseline survey, agreed on the improvements to be implemented during the WOP, and produced a work plan for 2008 which served as the basis to carry out the partnership building phase. The baseline survey reported on water production, distribution network, management accounting, billing and collection, Non-Revenue Water (NRW), and financial performance of the company. For implementation, the operational processes were subdivided into: improvement of operational tasks and skills related to organization, implementation of effective monitoring of the processes; implementation of maintenance programmes with related budgeting and planning and control (P&C) methodologies, and capacity building and training, to be

---

26 Dawaco, VEI, RNE, & PC Da Nang (2007, October 19). *Memorandum of Understanding for Public-Private-Partnership (PPP) between the Da Nang Water Supply Company (DWSC) and Vitens-Evides International BV (VEI) and The Royal Netherlands Embassy Embassy (RNE) and The People's Committee (PC) of Da Nang City.* Ho Chi Minh City, Vietnam: PC Da Nang, DWSC, VEI, RNE-Hanoi.

27 Dawaco, VEI, RNE, & PC Da Nang (2008, March 19). *Inception Report, Utility Support Programme Dawaco. Public-Private-Partnership (PPP), Da Nang Water Supply Company (Dawaco), Vitens-Evides International (VEI), the Royal Netherlands Embassy/Government of The Netherlands (RNE), and the People's Committee (PC) of Da Nang City.* Hanoi, Vietnam: Dawaco, VEI, RNE, PC Da Nang; p. 12.

28 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 5.

integrated into abovementioned categories of activities.[29] The Inception Report was prepared in February 2008 and concluded in March 2008.[30]

2. Partnership Building Phase. The guiding documents for this phase are the Strategic Plan, which describes the Utility Support Programme (USP) Action Plan, detailed until October of 2010, and a multi-year investment plan, until 2015. As a comprehensive strategy, the plans guided the company's development and support water supply to the urban poor.[31]

3. Implementation phase. Approval of project by PC Da Nang: July 25, 2008. The implementation of the WOP was led through decisions resulting from a close collaboration between the General Director of Dawaco and a Resident Project Manager (RPM) from VEI, together with a Steering Committee formed by RNE, PC Da Nang, VEI, and Dawaco. Working teams were established and led by a Project Management Unit (PMU) manager, covering the following areas: Production Process, Distribution Process and NRW Reduction, Customer Relation Management, Financial and Management Information System, and Master Planning Human Resource Management. Each team leader from Dawaco reported on a regular basis to the General Director of Dawaco and the RPM of VEI.[32]

---

29 Dawaco, VEI, RNE, & PC Da Nang (2008, March 19). *Inception Report, Utility Support Programme Dawaco. Public-Private-Partnership (PPP), Da Nang Water Supply Company (Dawaco), Vitens-Evides International (VEI), the Royal Netherlands Embassy/Government of The Netherlands (RNE), and the People's Committee (PC) of Da Nang City.* Hanoi, Vietnam: Dawaco, VEI, RNE, PC Da Nang.

30 Soppe, G. (2008b, October 2). *Strategic Plan 2008-2015, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International; p. 8.

31 Soppe, G. (2008b, October 2). *Strategic Plan 2008-2015, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International; pp. 8-9.

32 Soppe, G. (2008b, October 2). *Strategic Plan 2008-2015, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International; p. 10.

The parties: mentor, mentee, facilitators

Mentor (VEI)

VEI is a not-for-profit, private company registered with the Dutch Chamber of Commerce. Its shares are divided equally between the two largest publicly-owned water companies in the Netherlands. At the time of the WOP between VEI and Dawaco from 2007 to 2010, VEI represented 3 Dutch water operators. These were Vitens, Evides Waterbedrijf and WML (Waterleidingmaatschappij Limburg).[33] In line with the mandate outlined in the United National Sustainable Goal 6, VEI's primary commitment is to help ensure access to water and sanitation for all. Through VEI's main expertise areas: Non-Revenue Water, Customer Relations, Operations and Maintenance, Network Design, and Selection of Commercial Systems and Surveys, the organization provides support to water operators in Africa, Asia and South America.

33 VEI (2015a). "Governance." http://www.vitensevidesinternational.com/about-vitens-evides-international/governance/. Updated: 2015. Accessed: October 15, 2017.

Table 1: Size and service indicators of VEI (2016)

Size and Service Indicators	VEI[34]
Population served (in millions)	11 million customers
Number of households (in millions)	6.5
Water supply (millions of m^3)	887
Number of employees	3,602
Number of water treatment plants	n/a
Length of network (in kilometers)	102,000
Unaccounted for water (percent of total)	n/a
Staff per 1000 connections (water supply)	0.55
Staff per 1000 population served (water supply)	18.01
VEI turnover (in millions EUR)	1,000
Average drinking water price per m^3 (EUR)	0.63 (e.g. Vitens)[35]

34 VEI (2017). *Annual Report 2016, Unlocking the Strengths of Dutch Water Companies.* Utrecht, Netherlands: VEI.

35 Vitens (2017). *Vitens makes a difference, Annual Report 2016*. Zwolle, Netherlands: Vitens.

Motivations, interests, opportunities

The underlying motivation behind VEI's interest to form a partnership with Da Nang was mainly driven by Corporate Social Responsibility (CSR) and the will to increase the interest of a younger workforce supportive of VEI's mission. The opportunity, however, was facilitated through the local contacts in Vietnam and their relationship to the local government in Da Nang and Dawaco's staff.[36]

Mentee (Dawaco)

At the time of starting the partnership the company was a State-Owned Enterprise (SOE), and since 2016 it has become a Joint Stock Company (JSC), owned 60% by the People's Committee of Da Nang, 35% by a strategic main holder, the construction and investment Joint Stock Company, Da Nang Mien Trung company (DMT; original in Vietnamese, Cty cổ phần đầu tư xây dựng, Đà Nẵng Miền Trung) of which Mr. Dang Thanh Binh is Chairman. The remaining 5% of shares are owned by Dawaco staff and are distributed according to their performance and amount of invested time.[37]

36 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

37 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

Table 2: Size and service indicators of Dawaco (from 2007 to 2011); (1)[38], (2)[39], (3)[40]

Size and Service Indicators	2007 (Start WOP)	2011 (End WOP)
Population served	421,480 (3)	585,595 (2)
Number of households	91,000 (1)	140,000 (2)
Water supply (m^3)	40,504,000 (3)	53,478 (3)
Number of employees	466 (1)	528 (3)
Number of water treatment plants	3 (1)	4 (1)
Length of network (in kilometers)	2,567 (3)	2,755 (3)
Unaccounted for water (percent of total)	39 (1)	26 (2)
Staff per 1000 connections (water supply)	4.7 (2)	3.6 (2)
Service coverage of water supply (percent)	52% (2)	66% (2)
Net Revenue (x1 million VND)	104,617 (3)	238,090 (3)
Domestic average drinking water price per m^3	VND 2,744 EUR 0.12 (1)	VND 3,700 – 5,400 / EUR 0.14-0.2 (2)

38 Dawaco, VEI, RNE, & PC Da Nang (2008, March 19). *Inception Report, Utility Support Programme Dawaco. Public-Private-Partnership (PPP), Da Nang Water Supply Company (Dawaco), Vitens-Evides International (VEI), the Royal Netherlands Embassy/Government of The Netherlands (RNE), and the People's Committee (PC) of Da Nang City.* Hanoi, Vietnam: Dawaco, VEI, RNE, PC Da Nang.

39 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International.

40 See Table 8. Information received from Dawaco from August 2017 to June 2018.

Financing

The major financial investments in water infrastructure which Dawaco has executed in the past decade have been provided by the Da Nang Investment Development Fund of PC Da Nang (in Vietnamese, *Quỹ Đầu Tư phát triển Đà Nẵng*). This fund financed the building of the Cau Do Water Treatment Plant (WTP) in 2008, which totaled VND 450 billion. The investment was put into the expansion of the piped-network and the purchasing of management software.[41]

Thanks to Dawaco's financial strengthening derived from the improved utility performance since the partnership, the company now has sufficient resources to self-finance the maintenance and improvement of the network. Projects planned for the near future are:

1. Increase capacity of Cau Do WTP for VND 202 billion;
2. Construction of Hoa Trung WTP of 10,000 m^3 for VND 79 billion; and
3. Construction of Hoa Lien WTP of 120,000 m^3 for VND 1,243 billion.[42]

Motivations, interests, opportunities

The reasons for Dawaco to engage in a partnership with VEI can be described as primarily instrumental and networking motives. As a precedent, the strengthening of Hai Phong Water Supply Company with the support of Finland served as positive example.

---

41 Interview with Dawaco's Chief Accountant Phan Thinh. August, 2017.

42 Interview with Dawaco's Chief Accountant Phan Thinh. August, 2017.

In a similar manner, Dawaco was interested in enhancing its capacity, while reaching out to the Dutch water experts.[43] The opportunity was grasped and guided by key people in the management which had the willingness to incubate change in the company. As financial motives, parallel projects financed by country loans and through ODA were also welcomed by Dawaco.[44]

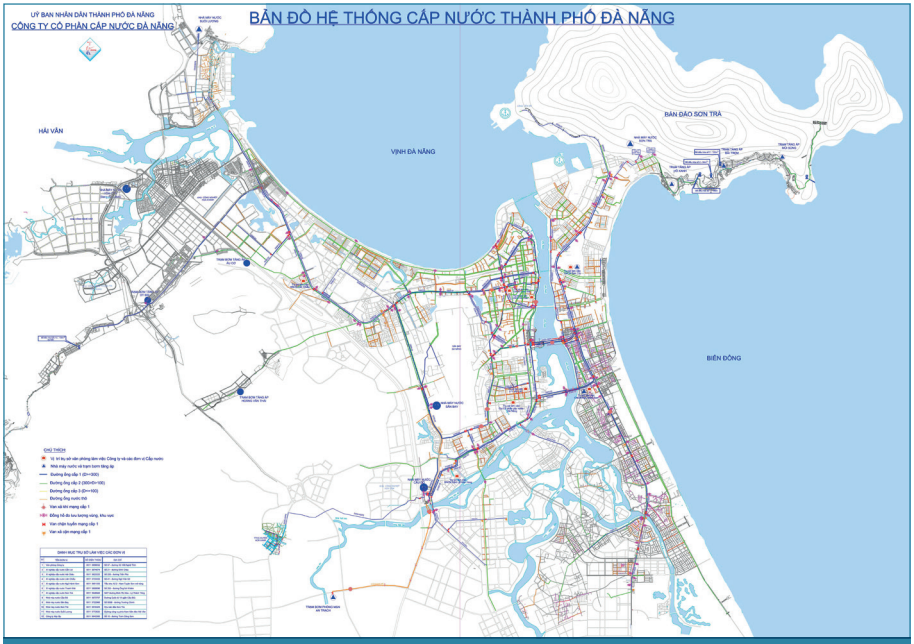


Figure 3: Dawaco's water supply distribution network[47] **Source: Dawaco, 2017**

43 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

44 Interview with former VEI-Dawaco Project Assistant Duc Hanh Nguyen. August, 2017.

45 Received from Dawaco. Da Nang, August, 2017 (see Figure 3).

Facilitators

The Royal Netherlands Embassy (RNE) in Hanoi and the People's Committee of Da Nang (PC Da Nang) both had roles as facilitators in the WOP between VEI and Dawaco. RNE provided financial support on behalf of the Directorate-General for International Cooperation (DGIS) of the Netherland's Ministry of Foreign Affairs, and PC Da Nang acted as a third party to approve policies and regulations.

Motivations, interests, opportunities

The main incentive for the RNE and the PC of Da Nang to facilitate the WOP between VEI and Dawaco was to deliver water to the poor. Providing connections to the peri-urban areas would only prove useful upon the strengthening of the water utility. With a financially viable company, for instance, the connection fees to the poor are no longer charged.[46]

Financing of the WOP

The total amount of the WOP grant was USD 2.7 million. Through DGIS, RNE provided USD 1.9 million and VEI provided USD 550,000. Dawaco, in turn, contributed with human resources and working space equivalent to USD 282,500. Additionally, Dawaco contributed USD 500,000 through investments in the company which contributed to the WOP, such as: installation and improvement of pipelines, network rehabilitation, and installation of quality meters.[47]

---

46 Interview with former VEI-Dawaco Project Assistant Duc Hanh Nguyen. August, 2017.

47 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 25.

Table 3: Total budget allocation of WOP VEI-Dawaco[48]

Description		Subtotals		Total
Cost allocation	**Dawaco**	**DGIS**	**VEI**	
VEI		1,087,580	541,621	1,629,201
Contribution from Dawaco	282,500			282,500
Contribution to Dawaco		810,000		810,000
Total	**282,500**	**1,897,580**	**541,621**	**2,721,701**

Diagnosis of needs and agreement characteristics

Both VEI and Dawaco carried out the diagnosis of needs and together decided which improvement tracks to prioritize.[49] Mr. Ngo Xuan Truong, who was mentioned in the history of collaboration and first contact for the initiation of the WOP, served as a local consultant and mediator between the two parties.[50] The partnership started with the grant decision number 16635, and was originally planned for implementation between September 2007 and August 2010, but was later extended to December

48 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 25.

49 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

50 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

2010. This change did not affect the planned budget and the project was successfully completed and reported through the End Project Report in March of 2011.[51]

The expected outcomes of the WOP are described in the *Inception Report* and focus on the improvement of operational processes to enhancing the efficiency and consistency of:

1. the production of drinking water;
2. the management of the transport and distribution network;
3. the management accounting and financial information; and,
4. the billing and collection.

The implementation of the above-mentioned improvements of the operational processes were subdivided in four categories:

a. improvement of operational tasks and skills and related organization;
b. implementation of effective control and monitoring of the processes;
c. implementation of maintenance programmes with related budgeting and planning and control methodologies; as well as,
d. capacity building and training.[52]

---

51 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 25.

52 Dawaco, VEI, RNE, & PC Da Nang (2008, March 19). *Inception Report, Utility Support Programme Dawaco. Public-Private-Partnership (PPP), Da Nang Water Supply Company (Dawaco), Vitens-Evides International (VEI), the Royal Netherlands Embassy/Government of The Netherlands (RNE), and the People's Committee (PC) of Da Nang City.* Hanoi, Vietnam: Dawaco, VEI, RNE, PC Da Nang; p. 41.

Timeline

2007-2010 DURATION OF THE WOP VEI-DAWACO

2006

- First contact between VEI and Dawaco

2007

- Mou signed between VEI, Dawaco, RNE, and PC Da Nang
- VEI and Dawaco carried out a baseline survey and produced a work plan for 2008

2008

- Approval of project by PC Da Nang
- Tariff study
- Inception Report
- Strategic Plan
- Utility Support Programme Action Plan and multi-year investment plan

MATCHMAKING

INCEPTION PHASE

PARTNER BUILDING PHASE

This timeline is not exhaustive, but highlights some key events in the WOP.

2009

- Customer satisfaction survey
- Implementation of Central Control Unit and metering equipment installed in the network
- Water quality control and cleansing activities
- Registration of visible leakages (Care-Taker Model)

2010

- Project conclusion
- Training on Customer Relations
- Water Asset Management System
- Update of Dawaco's financial system

2011

- Implementation of new tariff structure due to decisions made during the WOP
- Tariff increase

POST-WOP

IMPLEMENTATION PHASE

Project implementation

Management of the partnership and inter-organizational dynamics

The management of the partnership project was led by the General Director of Dawaco, Mr. Nguyen Truong Anh, and the Resident Project Manager (RPM) from VEI, Mr. Gerard Soppe. Working teams reported at least once a month to the Management (General Director of Dawaco and RPM of VEI) and discussed the progress of the project. The responsibilities and interactions of the partners at management and operational level was as follows: all the major decisions were made by the Steering Committee (RNE, PC Da Nang, VEI, and Dawaco); all important decisions were made by the General Director of Dawaco and the RPM of VEI); operational decisions were made by the Project Management Unit (PMU) manager and the RPM; and the working team leaders established and led by the PMU managers would come to an agreement within their teams and make suggestions to the PMU.[53] The PMU consisted of a head, a vice-head, a chief accountant, and team leaders of the five working teams (Production Process, Distribution Process and NRW Reduction, Customer Relation Management, Financial and Management Information System, and Master Planning Human Resource Management).

53 Soppe, G. (2008b, October 2). *Strategic Plan 2008-2015, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International; p. 10.

Furthermore, all interviewees agreed that there were no conflicts throughout the WOP. The General Director at that time, now Chairman of Management Board, Mr. Nguyen Truong Anh, expressed that, thanks to the flexibility of the interaction between the partners at management and operational level, Dawaco would share their opinions and difficulties and VEI would support with problem-solving.[54]

> *In Vietnam, you know, usually people don't want to say what are the bad things to another. But when we worked with VEI, we told them about all the bad things of our company. So they could choose the things that they could support us in. For example, the water loss was very high, nearly 40%. The network was not good. The quality was not stable. And the human resources were not good. So we told VEI everything.*
>
> – Chairman of Management Board, Mr. Nguyen Truong Anh

Improvement tracks

The main objectives for the VEI-Dawaco WOP were: 1) the extension and improvement of water services in Da Nang, 2) the management autonomy and strengthening of Dawaco's financial position, and 3) the sustainable delivery of water services to the urban poor.

54 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

Table 4: Main objectives, outputs and mid-term outcomes for VEI-Dawaco WOP[55]

I. Extension and better water services in Da Nang City
1. The targets for the long term are to have 80% of the population connected and to reduce NRW to 20% in 2020.
2. To protect the mid to long-term interest of drinking water supply to the city of Da Nang the PC and Dawaco will have to compile a plan to reduce the risks of water shortage. An integrated water resources plan is required, in which the selection of different raw water sources, reservoirs for drinking water supply and supply to other sectors are determined.
3. The water treatment plants will deliver 24 hrs per day, 7 days per week within the quality standards.
4. The network covers 80% of the supply area against the minimal required pressure.
5. Maintenance will have a high priority within the company, resulting in an average lifetime of assets according to at least the design specifications.
6. Dawaco will draft an information plan to give more information to other parties and make the company well known within Da Nang.
II. Management autonomy and stronger financial position
7. Dawaco will become a Joint Stock or Asset Holding Company with the PC of Da Nang as sole share holder. The PC will start to implement this.
8. Dawaco and the People's Committee of Da Nang will draft a performance contract in which the standards, authority and means are clear for all parties concerned.
9. Tariff for full cost recovery will be implemented by 2015 and is the objective of all parties.

55 Soppe, G. (2008a, July 15). *Policy Paper 2008-2020, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International; pp. 3-4.

10. The design of a progressive tariff structure, which takes into account the minimum requirements for facilitating programs for urban poor.
11. NRW will be reduced to 20% in 2020. Dawaco is responsible for implementing programs and modifying its organization to achieve and manage the NRW-reduction targets.
12. The PC will support Dawaco through allocating funds for investments to reduce the NRW.

III. Sustainable water services to urban poor

1. In 2015 at least 50% of the urban poor will be supplied with drinking water.
2. The program for the urban poor will be closely conducted with other programs and projects of Da Nang City for this specific group.
3. The provision for the urban poor will be covered in the water tariffs from the time the water tariffs are based on full cost recovery. Until then the PC will supply funding.
4. The financial means of ongoing projects for the urban poor will also be used to improve the water supply.

On behalf of VEI, the inputs used to achieve the objectives of the improvement tracks are both material and non-material. Table 5 and Table 6 show VEI's budgeted contributions and actual investments in time according to each expert, as well as the initial budget for human resources (HR), investments, operational costs, training, and audit in respect to the actual amount spent per year. The breakdown of VEI's input throughout the VEI-Dawaco WOP can be read as follows:

Table 5: VEI's time input for the VEI-Dawaco WOP[56]

	Budgetted days	Actual	2007	2008	2009	2010
Project Director	90	77	6	41	12	18
Resident Project Manager	1,095	1,048	90	229	364	365
Local Advisor	150	136	21	29	46	40
Process engineer	63	153	24	25	50	54
Production Expert	140	252	0	117	112	23
Transport and distribution Expert	119	524	26	125	204	169
Hydraulic Engineer	35	61	0	23	16	22
LIS/GIS Expert	49	23	0	23	0	0
CRM/B&C Expert	77	152	22	40	44	46
Financial Expert	63	100	22	33	20	25
IT Advisor	112	17	0	17	0	0
Stratetic Advisor	21	0	0	0	0	0
Water Engineer	28	0	0	0	0	0
Total	**2,042**	**2,543**	**211**	**702**	**868**	**762**

56 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 9.

Table 6: VEI's input in HR, investments, operational costs, training, and audit for the VEI-Dawaco WOP[57]

	Budget	Remaining	2007	2008	2009	2010
HR	889,660	-131,829	83,641	285,343	348,440	304,065
Investments	625,000	19,982	0	64,282	268,942	271,794
Operational costs	179,920	46,388	11,039	52,512	30,222	39,760
Training	185,000	60,904	0	18,170	64,634	41,292
Technical audit	18,000	18,000	0	0	0	0
Total	**1,897,580**	**13,445**				

The Key Performance Indicators (KPIs) that supported each of VEI-Dawaco's WOP improvement tracks were: I) increased coverage, raw water protection, consistent production, improved supply conditions in network, water quality, asset management; II) corporatization of the company, full-cost recovery, NRW reduction, financial information, financing of investments; III) water supply for the urban poor, urban poor program, and funding for the urban poor. Table 7 provides the partners and description for each KPI and in the next section, Table 7a, 7b, and 7c will provide an assessment on each of the KPIs at the time the WOP was completed in 2010.

57 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 28.

Table 7: Key Performance Indicators[58]

KPI	Partners	Description
I. Extension and better water services		
Increased coverage	Dawaco, PC	Dawaco will target the number of new connections on 16,000 per year of which 2,000 will be for the urban poor. This includes extension of the network.
Raw water protection	PC, Dawaco, VEI	To protect the supply of water to the city of Da Nang a plan for raw water resources will be made.
Consistent production	Dawaco, VEI	Process metering equipment will be installed in 2008. The operational procedures and organization will be reviewed and adjusted.
Improved supply conditions in network	Dawaco, VEI	Implementation of a unit for flow and pressure management in the network. The unit will annually review the investment plan for distribution and transportation.
Water quality	Dawaco, VEI	Plan for quality control and cleansing activities for the transport and distribution network.
Asset management	Dawaco, VEI	A system for asset management is introduced and implemented together with a GIS system.

58 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 6.

KPI	Partners	Description
II. Management autonomy and finances		
Corporatization of Dawaco	PC, Dawaco, VEI	In 2009 steps will be taken to equitize Dawaco. A performance contract will be drafted.
Full cost recovery	PC, Dawaco	Tariff proposal will be drafted in 2008 and be presented to the PC in 2009.
NRW reduction	VEI, Dawaco	A program for the reduction of NRW will be made in 2008, and the organization will be rearranged to the care-taker model.
Financial information	VEI, Dawaco	Functional design for a Management Information System is made and implemented.
Financing of investments	PC, Dawaco	In 2009 Dawaco, supported by the PC, secures funds for financing the planned investments.
III. Sustainable services to the urban poor		
Water supply for urban poor	Dawaco, PC	Annually 2,000 connections will be made for the urban poor. The tariff structure covers the cost for water supply to the urban poor.
Urban poor program	PC, Dawaco, VEI	The partners have in close cooperation made an urban poor program to secure the most effective use of means.
Funding urban poor	PC	The costs for the urban poor are covered by the PC.

Evidence of progress towards impact and effectiveness of the project

Changes in performance and capacity of the mentee (KPIs)

Regarding the extension and improvement of water services, firstly, increased coverage was expected to be reached by establishing 16,000 new connections per year, of which 12.5% would correspond to the urban poor. By the end of the partnership, a total of 48,933 new connections were made, averaging over 16,311 per year, of which 16% were for the urban poor. Secondly, a raw water production assessment was conducted by an ADB consultant with a plan until 2020. Thirdly, the meters installed at both the San Bay and Cau Do water treatment plants served to collect data, monitor, and improve operations of 99% of the total production. Fourthly, the management of flow and pressure in the network through a Central Control Unit was implemented successfully in the third year of the partnership. Next, also in 2009, flushing activities to increase water quality were initiated, however, a recommendation to increase the frequency of this activity is suggested in order to assure the reliability of the water quality. In the final year of the WOP, a GIS/Water Asset Management System was incorporated with the aim of collecting all the network's data in one system. Follow-up on the management of this system is recommended.

Table 7A: KPIs for extension and better water services[59]

KPI	Description	Outputs in 2010
Increased coverage	Dawaco will target the number of new connections on 16,000 per year of which 2,000 will be for the urban poor. This includes extension of the network.	During the three years a total of 48,933 new connections were made. This is 16,311 per year. A total of 7,856 connections for the poor were made. An average of 2,618 per year.
Raw water protection	To protect the supply of water to the city of Da Nang a plan for raw water resources will be made.	The consultant of the ADB has made a plan for water resources as part of their study of how to supply Danang with water in the long term. In that plan an overview until 2020 has been made.
Consistent production	Process metering equipment will be installed in 2008. The operational procedures and organization will be reviewed and adjusted.	Water quantity and quality meters have been installed at both San Bay and Cau Do. With this, 99% of total production is metered. Based on the data collected from these meters the operational processes have been improved.

59 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; pp. 17-18.

KPI	Description	Outputs in 2010
Improved supply conditions in network	Implementation of a unit for flow and pressure management in the network. The unit will review the investment plan for distribution and transportation annually.	The central control unit was officially implemented on May 15 of 2009. To assist the Control Unit metering equipment was installed in the network. At different locations an EMF meter with cello was installed so that data can be transferred to head office real time. Also, an *Epanet* model was built with the information of the network included. This has taken a lot of effort since data had to be checked and then imported in the model.
Water quality	Plan for quality control and cleansing activities for the transport and distribution network.	At the end of 2009 a start was made with flushing activities. However, the total amount of flushing activities should be increased to end up with a network that delivers completely reliable water to the customers.
Asset management	A system for asset management is introduced and implemented together with a GIS system.	The Water Asset Management System has been implemented. This system has a GIS incorporated and in 2010 a start was made to input all data from the network into the system. This will require several years to complete.

Concerning the management autonomy and finances improvement track, the most outstanding indicator has been the reduction of Non-Revenue Water (NRW) which went from nearly 39% at the start of the project to 26% by the end of the partnership. Since then, water loss has continued to decrease. The latest report now shows NRW at 14.79%.[60] The other indicators were achieved in a timely manner. A financial system describing business processes was implemented in the last year of the WOP, as of January of 2010; the full-cost recovery plan with tariff proposals drafted in 2008 were adapted at the end of the WOP in January of 2011; the corporatization of Dawaco advanced with Dawaco becoming a Limited Liability Company in 2010 (and a Joint Stock Company since January of 2016); and as a result of the new tariff structures, Dawaco's finances were significantly strengthened, allowing the company to make bigger investments on its own.

60 See Table 8. Information received from Dawaco between August 2017 and June 2018.

Table 7b: KPIs for management autonomy and finances[61]

KPI	Description	Outputs in 2010
Corporatization of Dawaco	In 2009 steps will be taken to equitize Dawaco. A performance contract will be drafted.	Steps were taken to equitize Dawaco. The company was equitized in June 2010. It has become a limited liability company with the PC of Da Nang as sole share holder. The actual effect of this equitization is still limited as it is not a far reaching chance. For that more has to be done.
Full cost recovery	Tariff proposal will be drafted in 2008 and be presented to the PC in 2009.	In 2008, a tariff study was executed to see the effects of the investment plans on the tariff. The objective of the partnership is to achieve full cost recovery in 2015. During the project several tariff proposals were submitted to the PC. End of 2010 the tariff proposal has been approved. From January 1 of 2011 the new tariffs are implemented.
NRW reduction	A program for the reduction of NRW will be made in 2008, and the organization rearranged to the care-taker model.	In 2008 several pilot projects were carried out. With Dawaco several steps have been made to rearrange the organization according to the care-taker model and was put into place in 2009. The NRW has gone down during the years of the project from 38.9% to 26.1%.

61 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; pp. 21-22.

KPI	Description	Outputs in 2010
Financial information	Functional design for a Management Information System is made and implemented.	The financial system has been tendered, business processes were described and the system was built. It went live in January 1st 2010.
Financing of investments	In 2009 Dawaco, supported by the PC, secured funds for financing the planned investments.	Within the annual budget of Dawaco there is room for small investments. There is not much room for bigger investments. The ADB has had a consultant working on a PPTA for a larger investment in a new treatment plant and work in the network. With the new tariffs implemented there will be more possibilities for Dawaco to make investments.

The third improvement track for water supply for the urban poor was well achieved. Altogether, 30% more connections than planned for reaching the urban poor, together with the implementation of VEI's 'Water for Life' program, with the support of the PC, helped to distribute and track the resources in the areas that needed them most. Finally, with the financial strengthening of the company, Dawaco gained the capacity to cover the connections to the piped-network for the urban poor.

Table 7c: KPIs for the urban poor[62]

KPI	Description	Outputs in 2010
Water supply for urban poor	Annually 2,000 connections are made for the urban poor. The tariff structure covers the cost for water supply to the urban poor.	During the project a total of 7,856 connections were made for the rural poor. The tariff structure approved in 2010 makes the low consumption below costs. This will benefit the poor who generally use a limited amount of water. The rich use more, and in that sense will compensate the poorer communities' consumption.
Urban poor program	The partners made an urban poor program in close cooperation in order to secure the most effective use of resources.	For the different programs for Water for Life close cooperation with the local PCs has been established. With the PC the income and location of different poor households is being recorded. That way the money is spent on the areas that need it most.
Funding urban poor	The costs for the urban poor are covered by the PC.	The costs for the urban poor are now covered by Dawaco themselves. Indirectly it is funded by the PC since at the end of the year Dawaco will request the PC for assistance to be able to meet financial obligations.

62 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; pp. 23-24.

Figure 4: Turbidity Meter at Cau Do Water Treatment Plant

Table 8: Size and service indicators of Dawaco (from 1996 to 2017)[63]

Indicators	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Population served	233,205	240,541	250,292	260,573	276,041	299,078	326,372	358,794	366,794	375,201
Service coverage of water supply (%)	no data	no data	no data	37.09%	38.54%	41.04%	44.03%	47.68%	47.98%	48.16%
Number of water supply connections	22,224	26,466	28,909	31,520	35,029	38,337	44,324	50,726	57,642	66,336
Water supply (m^3) (x1000)	19,093	19,772	18,816	24,369	26,453	27,449	28,127	30,532	32,099	32,931
Number of Employees	195	210	230	250	275	300	315	345	390	410
Number of Water Treatment Plants	3	3	3	3	3	3	3	3	3	3
Length of network (in kilometers)	no data	no data	no data	no data	no data	no data	no data	no data	3,057	3,173
Unaccounted for water (NRW) (percent of total)	31.86%	31.69%	29.72%	46.65%	50.50%	50.48%	45.28%	43.83%	41.30%	38.18%
Staff per 1000 connections (water supply)	8.8	7.9	8.0	7.9	7.9	7.8	7.1	6.8	6.8	6.2

63 Information received from Dawaco between August 2017 and June 2018.

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
383,405	421,480	454,392	523,748	585,595	704,709	732,662	776,121	879,124	915,697	954,262	992,049
48.40%	52.20%	55.30%	63.70%	66.00%	74.10%	75.30%	78.45%	87.26%	89.17%	91.28%	92.98%
78,653	94,044	110,072	30,588	148,028	181,185	198,248	210,667	221,571	234,355	250,396	267,623
37,689	40,554	44,202	48,373	53,478	54,697	60,288	63,802	67,520	73,884	81,173	87,573
442	463	472	496	528	559	696	586	613	703	616	662
3	3	3	3	3	3	4	4	4	4	4	5
3,288	2,567	2,649	2,710	2,755	2,817	2,025	2,138	2,301	2,610	2,746	2,825
40.24%	38.86%	35.53%	31.74%	25.92%	21.18%	19.39%	17.96%	16.82%	16.92%	16.73%	14.79%
5.6	4.9	4.3	3.8	3.6	3.1	3.5	2.8	2.8	3.0	2.5	2.5

Table 8: Size and service indicators of Dawaco (from 1996 to 2017) – continued

Indicators	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Owner's equity (x1 million VND)	18,569	20,212	21,709	81,976	84,169	84,765	87,829	92,316	92,963	101,671
Net revenue from sales and service provision (x1 million VND)	22,910	24,394	25,823	25,328	28,566	29,649	39,889	44,672	48,237	69,271
Operating profit (x1 million VND)	2,668	2,901	3,047	3,240	2,306	1,157	2,288	2,554	942	1,950
Profit after tax (x1 million VND)	1,970	2,174	2,283	2,288	1,653	868	1,556	1,736	678	1,404

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
132,236	191,572	272,829	322,151	373,209	395,140	418,029	437,149	472,832	359,029	601,291	695,775
84,472	104,617	130,719	143,766	150,310	238,090	264,911	289,504	331,976	361,732	397,723	450,560
1,970	2,174	2,501	2,637	3,272	17,059	29,402	24,727	42,983	48,584	94,140	137,832
1,440	1,618	1,896	1,883	2,427	12,161	21,904	17,796	31,343	35,282	72,758	107,092

Results derived from the project targeted improvement tracks

To achieve the main objectives of the WOP, the most relevant strategy for the extension and improvement of water services in Da Nang was the implementation of the Care-Taker Model. **Care-Taker Model (CTM)** (in Vietnamese, *Nhóm nhân viên chăm sóc*) means group of care workers. Da Nang was the first in implementing the Care-Taker Model for a water network management in Vietnam.[64] The CTM is the configuration of the piped-network system by areas called District Metering Areas (DMAs), monitored by a specific team of workers.[65] Water loss is better monitored, and leakages can be fixed. The results are easier to keep track of since each care-taker is responsible for the DMA they're accountable for.[66] Figure 5 shows Dawaco's water distribution network and the current DMAs.

> *Before in our company there was a group of people who took care of all the network. But the Care-Taker Model created a small group to take care of small areas so that they knew everything about the customers, about the network.*
>
> – Chairman of Dawaco Management Board, Mr. Nguyen Truong Anh

64 Interview with Dawaco's Chairman of Management Board Nguyen Truong Anh. August, 2017; VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; p. 15.

65 Interview with Dawaco's Head of Strategic Planning Department Bui Tho Ninh. August, 2017.

66 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

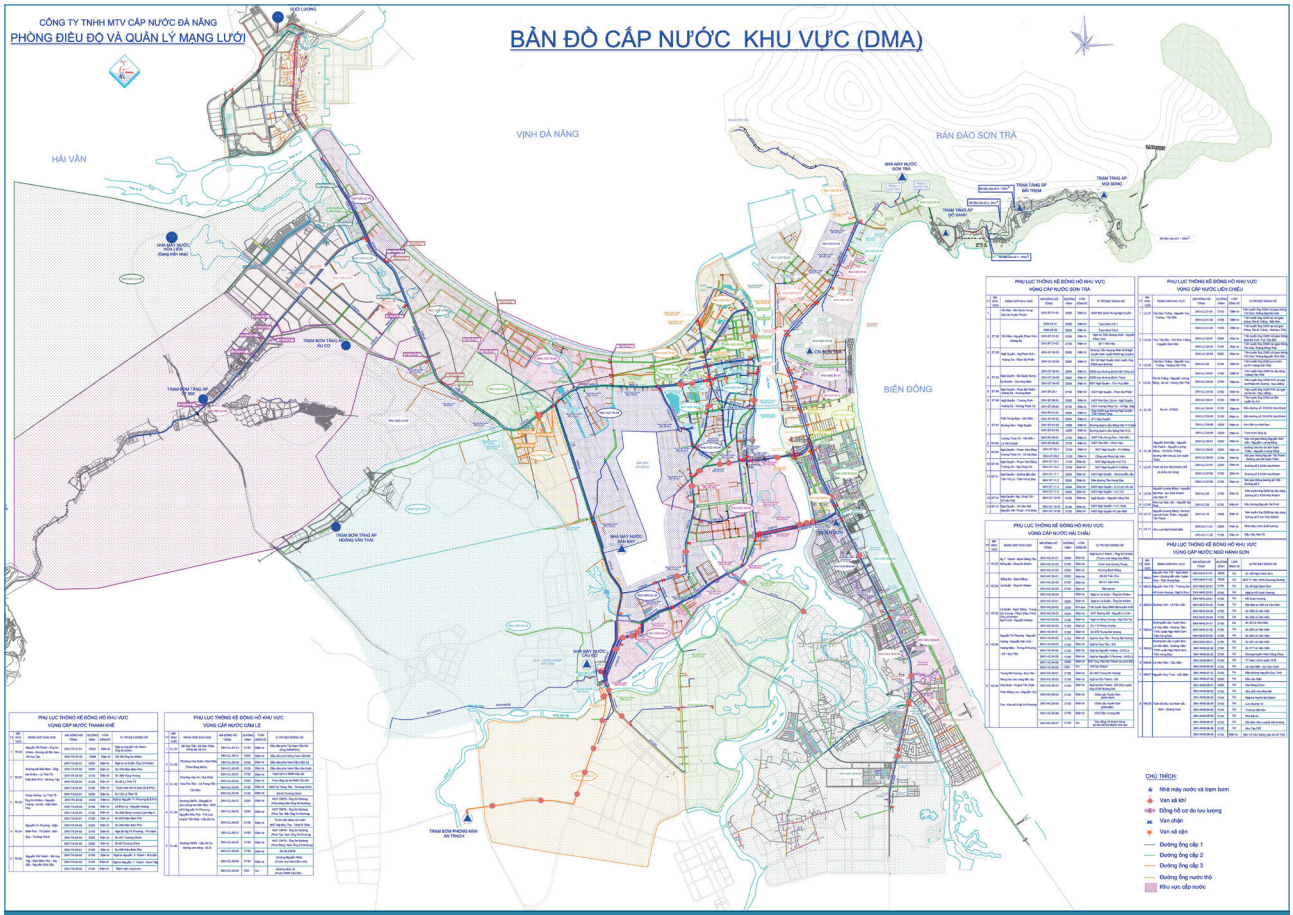


Figure 5: District Metereas (DMAs) [68] **Source: Dawaco, 2017**

67 Received from Dawaco. Da Nang, August, 2017.

Another important procedure was the creation of a **Central Control Unit (CCU)**, specifically accountable for monitoring the pressure and flow of water in the transmission network. Before the CCU, the responsibilities of the head office and the branch offices were not clear. The equipment and information systems used by the CCU are the ***GIS/Water Asset Management System*** and the ***SCADA System***. The GIS/ Water Asset Management System is based on data of the transmission and distribution networks, together with geographical information. This system prioritizes the efficient management of the network by measuring the investment, operational, maintenance, refurbishment, and replacement costs of an infrastructural asset during its life cycle. The SCADA System collects data on pressure and flow through water meters installed throughout the network. With hourly updates and online access, this system allows for the directives of Dawaco to receive notifications of the network status and address issues with the CCU.[68]

Both the CTM and the CCU procedures favored the extension and improvement of water services in Da Nang and worked towards the management autonomy of the company. On one hand, the planned activities which influenced the measurable outputs of the management and operational strategies are described in Tables 7a, 7b, and 7c. All resources invested during the WOP contributed towards: increased coverage, water resources extension planning, consistent production, improved supply conditions in the network, water quality monitoring, collection of data; NRW reduction, full-cost recovery through a new tariff program, the strengthening of the company; and improved water supply for the urban poor through an urban poor program. The planned activities, which

68 VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang.* Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International; pp. 15-16.

supported the sustainable delivery of water services to the urban poor, was the linkage to VEI's foundation: **Water for Life**. Water for Life exists since 2004 and is funded through voluntary contributions from customers in the Netherlands, willing to donate money for improving drinking water for the urban poor in the areas were VEI is working.[69] Water for Life supported the WOP between VEI and Dawaco by sponsoring the installation of 6,632 water meters for the poor, throughout five projects as follows: 486 meters for Tho Quang Ward in Son Tra District; 500 meters for Khue My Ward in Ngu Hanh Son District; 1,450 meters for Hoa Hiep Nam Ward in Lien Chieu District; 2,710 meters for An Khe Ward, Hoa Khe, in Thanh Khe District; and 1,486 meters for Hoa An Ward in Hoa Phat district and Cam Le district.[70] The total amount invested through these five projects was approximately EUR 1,000,000.[71]

> *The poor are really the ones that deserve the connections. But the near-poor are not always able to afford the connection. To be able to take the near-poor into consideration, we chose the wards which had 80% near-poor. This way we would connect everybody.*
>
> – Former VEI-Dawaco Resident Project Manager, Mr. Gerard Soppe

69 VEI (2015b). *Water for life*. https://tinyurl.com/ybbujwcx. Updated: 2015. Accessed: October 15, 2017.

70 Received from Dawaco. Da Nang, August, 2017.

71 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

Project evaluation

Impact in terms of sector targets

To meet the requirements of the city, the *Policy Paper 2008–2020* suggested a step-by-step process to improve drinking water production at a reasonable cost by: 1) supplying clean water to most areas, 2) continuously supplying water to most areas, 3) continuously supplying water to all areas, 4) continuously supplying sufficient, clean water to all areas, and 5) continuously supplying sufficient good quality water to all.[72] As Dawaco was at stage 1 (supplying clean water to most areas) at the time of the document's publication (in 2017), the company may be between step 3 and 4 (continuously supplying water to all areas and continuously supplying sufficient clean water to all areas), with special attention to the improvement of the water quality and reaching all rural districts (including Hoa Vang). Partners showed optimism about reaching step number 5 by 2020.

> *Dawaco already supplies water to the center areas for the districts, and only one rural district is covered only by 75%. The aim for 2020 is to cover the whole city including that rural area. That's the vision. And for the continuous supply, it is almost 24/7, but in case of power cuts or accidents it might not be completely 24/7.*
>
> – Dawaco General Director, Mr. Ho Huong

72 Soppe, G. (2008a, July 15). *Policy Paper 2008-2020, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International; p. 8.

Replicability

Dawaco gained visibility due to their improved performance after the WOP with VEI. Soon after, Dawaco became a mentor itself through twinning programs with companies from other provinces.[73]

> *An unplanned activity for Dawaco was being a peer to neighboring utilities. People that visited the company to witness the SCADA system were impressed by the results. Dawaco got visibility and went to two provinces to train on Non-Revenue Water. That really made them proud of the changes they'd made.*
>
> – Former VEI-Dawaco Resident Project Manager, Mr. Gerard Soppe

Furthermore, other water utilities in the Southeast Asian region approached Dawaco to understand the key to their improvement. Amongst them: Mandalay and Yangon in Myanmar, Davao in Philippines, and Soc Trang in South Vietnam. Dawaco showed and explained the results of the partnership to the interested parties and has facilitated the communication with VEI.[74]

73 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

74 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

Relational capital and satisfaction of partners

Both the mentor and the mentee have agreed that the quality of the relationship between the partners was very good. Not only because there were no conflicts, but due also to the implementation's flexibility and the communication between management and operational levels during the WOP, the KPIs were successfully achieved. While the cultural understanding within the Management team created an enabling atmosphere for both parties to work well together, the connection between the short-term experts and Dawaco's staff created a strong basis for building a good relationship between the partners.[75]

Since the completion of the WOP, VEI has occasionally followed up with Dawaco while carrying out other projects in the country. The last visit VEI paid Dawaco was in early 2017. The unofficial visits show VEI's interest in following up the company's progress, while giving the opportunity to Dawaco to openly discuss the present challenges.[76]

75 Interview with former VEI-Dawaco Resident Project Manager Gerard Soppe. August, 2017.

76 Interview with Dawaco's Chairman of Management Board, Nguyen Truong Anh. August, 2017.

Effectiveness

The main objectives for the VEI-Dawaco WOP were achieved: 1) the extension and improvement of water services in Da Nang, 2) the management autonomy and strengthening of Dawaco's financial position, and 3) the sustainable delivery of water services to the urban poor. For the first improvement track, the KPIs which were exceeded were increased coverage, rising from 52% to 66% during the 2007 to 2010 period, and reaching 93% in 2017. The rest of the targets such as raw water production assessment, current status of the installed water meters, effectiveness of the Central Control Unit (CCU) and its GIS/Water Asset Management and SCADA systems, and water quality, were reached during the WOP. Concerning the second improvement track, the KPI which was exceeded was a reduced Non-Revenue Water (NRW) from 39% in 2007 to 26% in 2010, and 15% in 2017. Dawaco's assets in November 2016 were valued at approximately VND 575 billion or USD 25 million. Including long-term assets and investment properties, the company's assets amount to over VND 1,000 billion or USD 45 million. Dawaco's net cash provided by operating activities between January and October of 2016 was approximately VND 350 billion or USD 15 million. From this amount, roughly 10% was used for investment.[77] Finally, the third improvement track for water supply for the urban poor was also exceeded, surpassing the target of 2,000 connections by 30% with an average of 2,618 connections per year during the partnership.

77 Dawaco (2016). *Da Nang Water Supply Co., LTD. Financial Statements for the period from 01/01/2016 to 31/10/2016.* Hanoi, Vietnam: Dawaco; pp. 6, 9.

Number of water supply connections (including % in change)

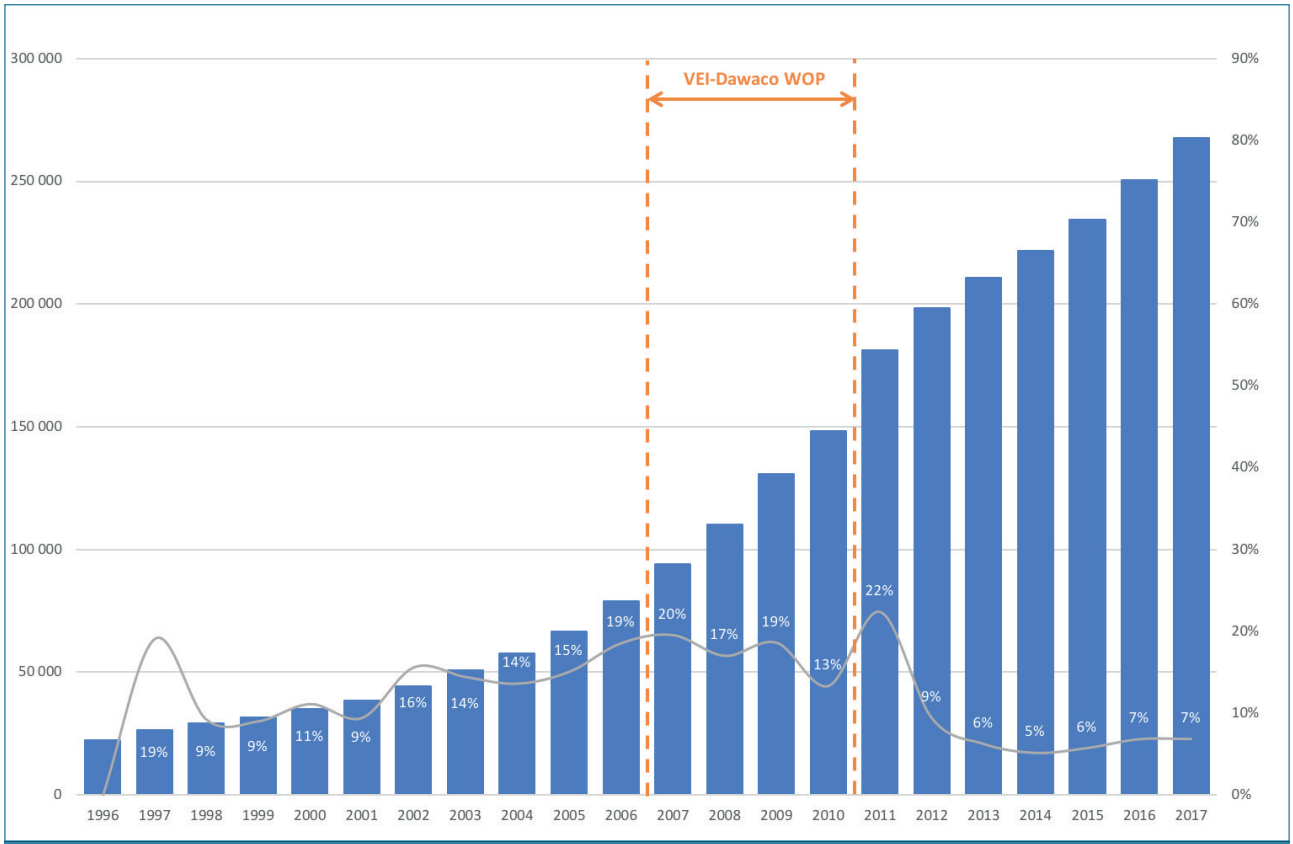


Figure 6: Number of water supply connections (including % in change) Source: Table 8

Service coverage of water supply (including % in change)

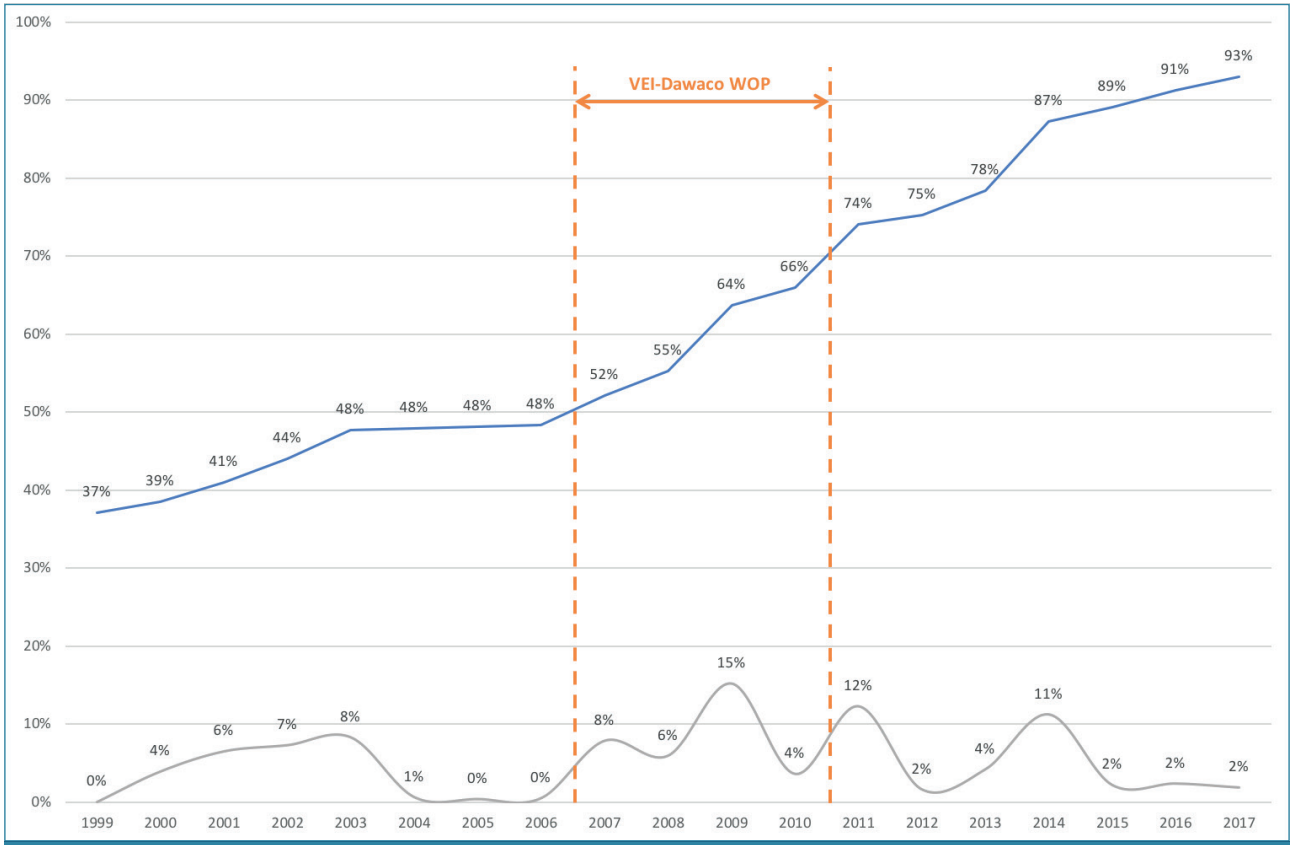


Figure 7: Service coverage of water supply (including % in change) Source: Table 8

Unaccounted for water (NRW) (% of total)

Figure 8: Unaccounted for water (NRW) (% of total) Source: Table 8

Net revenue from sales and service provision (x1 million VND)

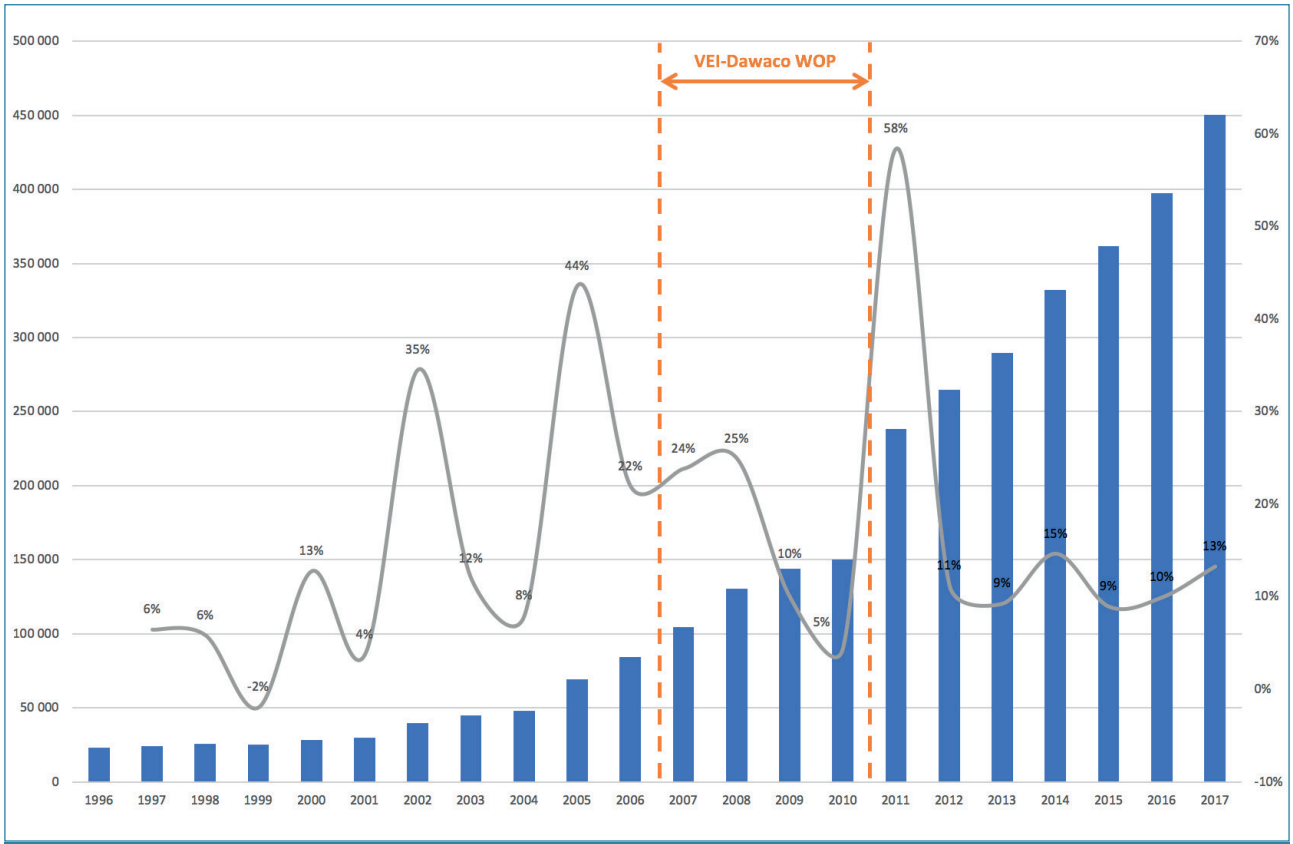


Figure 9: Net revenue from sales and service provision (x1 million VND) Source: Table 8

> *It was building relation, it was building results, and this way Dawaco really had a feeling of accomplishment as well. We did this together. It was not, we were telling them what to do, it was really about how can you achieve a result together. If I were a consultant, it would have been much shorter, and it would have been much more directive. And this was really about building a relationship.*
>
> – Former VEI-Dawaco Resident Project Manager, Mr. Gerard Soppe

Efficiency

All the interviewees involved in the WOP between VEI and Dawaco agreed that the partnership was executed efficiently. Important factors that influenced the efficiency of the partnership were the internal support, through the cooperation between the VEI team and the Dawaco staff, as well as external support from the RNE and PC Da Nang. The combination of the two directions of support allowed for the strategies which were put in place to be carried out efficiently and demonstrate results through the measurement of the KPIs. The improvement of the performance of Dawaco can still be seen today.

> – The Head of Dawaco's Strategic Planning Department also shared that the WOP model is mutually beneficial:
>
> *It's not just about teaching each other, it's about talking; how to manage well and how to build new technologies. It's not just about mentoring, it's about working together.*

Success factors and challenges

The success factors which were critical to achieving the KPIs for each improvement track are those which had the strongest impact during the partnership formation. The start of a good cooperation was cultivated through the first contact facilitated by a bi-cultural mediator (Mr. Ngo Xuan Truong) familiar with the Dutch expertise and language, as well as with the local Vietnamese culture. Hiring a bi-cultural mediator at the start of the partnership and for subsequent follow-ups was highly valuable for informing about the mentee's progress. This role was essential for relaying information about the local culture and about how activities can be carried out most effectively. Another factor that supported the formalization of the partnership between VEI and Dawaco was the support of the Chairman People's Committee of Da Nang (Mr. Van Huu Chien). During the implementation of the WOP, the successes were mostly dependent on the continual receptiveness of the Dawaco's staff as well as the openness of VEI's Management team and short-term experts in transferring their expertise. Practical interventions and changes in routine, such as timely payments to contractors by the RPM can be understood as strategies which increased the efficiency of the activities developed during the WOP. Relying on effective communication between the partners was essential in building and maintaining cultural bridges, which allowed for successful results. Finally, with the completion of the WOP, the sustainability of its results depended on maintaining the activities inherited from the mentor.

Figure 10: Cau Do Water Treatment Plant engineer

What the partners say

"I think that the management of the company now is very good. But if I could learn how the management is done in other companies and realize what can be improved, then I would learn from this and change the management here. The same with new technology. I don't have an idea on which specific technologies can be improved, but if a foreign company has a better proposal I am willing to adopt it."

– Dawaco's General Director, Mr. Ho Huong

People keep talking about the achievements or the results of the KPIs, such as NRW or something that can be easy to measure, talking by figures. But for myself, I think the most important, or the most valuable result is the behaviour and the awareness of the staff of Dawaco; that they could learn from the Dutch and from the experts of the WOP.

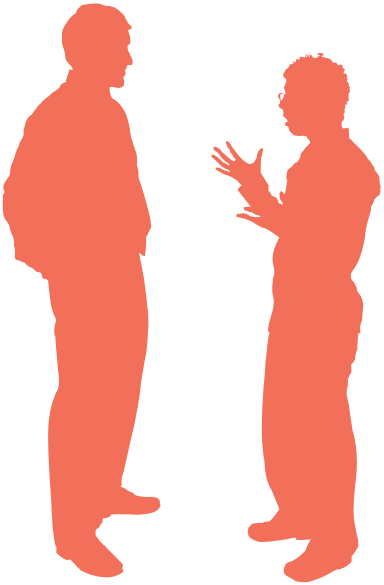
– Former VEI-Dawaco Project Assistant, Ms. Duc Hanh Nguyen

"1 Now we cannot supply for 100% of the population, so we want to be able to supply to the whole population.

2 Now there are not enough water treatment plants performing at their maximum capacity, so in the future, we want to have more water treatment plants.

3 Lastly, I want the company to perform the best in order to decrease the water tariff that people have to pay, i.e. to have the appropriate price for the people."

– Dawaco General Director, Mr. Ho Huong



Conclusion

Sustainability of Dawaco's improved performance

The WOP provided Dawaco with the knowledge and capacity to extend and improve water service delivery in Da Nang, secure the company's management autonomy and strengthen its financial position, while developing sustainable water supply strategies for the urban poor. As the company has increasingly been able to build on its own assets, there is a clear continuity of the performance improvements. The knowledge and expertise gained by Dawaco through the WOP has proven to have sustained the progress and results of the KPIs, as shown with the increased connectivity rates, current NRW values, and improved creditworthiness of the company.

According to the key informants, factors that contributed to this success were:

- Dawaco management's commitment to change,
- the expertise of VEI's team, combining a good foundation of Dutch water infrastructure and knowledge management,
- the openness of the VEI team to teach Dawaco everything they know,
- the strong motivation by staff at all levels during the WOP, and
- the availability of funds for investments.

Moreover, the VEI-Dawaco WOP paved the road for access to other funding opportunities, starting by supporting the involvement of ADB to create a sustainable water resource management plan at the start of the partnership. This prepared Dawaco for receiving further financial support after the WOP, such as an ADB loan for the design, construction, supervision and management assistance for the extension of the water

supply network, and the investment from JICA in the construction of a water treatment plant in Hòa Liên. These funds, and other foreign direct investments have aided the maintenance and up-keep of water infrastructures in Da Nang, thus, being instrumental in keeping up with performance improvements.

Figure 11: Cau Do Water Treatment Plant staff and visiting GWOPA consultant

References

ADB (2008). *Da Nang Water Supply Project.* https://tinyurl.com/y74rg4wp. Updated: October 1, 2008. Accessed: May 15, 2018.

Da Nang CCCO [Climate Change Coordination Office] (2014). *The river network of Danang city.* https://tinyurl.com/y8c9yaya. Updated: August 12, 2014. Accessed: March 29, 2018.

Dawaco (2017). Dawaco, Danang *Water Supply Joint Stock Company* [original in Vietnamese: Công ty cổ phần cấp thoát nước đà nẵng]. http://dawaco.com.vn/. Updated: 2017. Accessed: May 10, 2017.

Dawaco, VEI, RNE, & PC Da Nang (2007, October 19). *Memorandum of Understanding for Public-Private-Partnership (PPP) between the Da Nang Water Supply Company (DWSC) and Vitens-Evides International BV (VEI) and The Royal Netherlands Embassy Embassy (RNE) and The People's Committee (PC) of Da Nang City.* Ho Chi Minh City, Vietnam: PC Da Nang, DWSC, VEI, RNE-Hanoi.

Dawaco, VEI, RNE, & PC Da Nang (2008, March 19). *Inception Report, Utility Support Programme Dawaco. Public-Private-Partnership (PPP), Da Nang Water Supply Company (Dawaco), Vitens-Evides International (VEI), the Royal Netherlands Embassy/Government of The Netherlands (RNE), and the People's Committee (PC) of Da Nang City.* Hanoi, Vietnam: Dawaco, VEI, RNE, PC Da Nang.

Dawaco (2016). *Da Nang Water Supply Co., LTD. Financial Statements for the period from 01/01/2016 to 31/10/2016.* Hanoi, Vietnam: Dawaco.

Evides Waterbedrijf (2016). *Annual Report 2015.* Rotterdam: Evides.

GSO, General Statistics Office (2015). *Area, population and population density by province.* https://tinyurl.com/ybxrrhlc. Updated: 2015. Accessed: May 10, 2017.

Global Water Operators' Partnerships Alliance. *Operator Profiles.* (Wright-Contreras, L. reconstruction of database). http://www.gwopa.org/en/operator-profiles. Updated: 2017. Accessed: May 15, 2017.

JICA, Japan International Cooperation Agency (2018). *Da Nang City Hoa Lien Water Supply Project.* https://tinyurl.com/yaewndym. Updated: 2018. Accessed: May 28, 2018.

Jones, S. and Gu, J. (2012). *Vietnam's Regions and Key Economic Zones.* https://tinyurl.com/ybk5zdqq. Updated: May 29, 2012. Accessed: May 11, 2017.

Nguyen, H. K. L. (2013). *Detecting and Modeling the Changes of Land Use/Cover for Land Use Planning in Da Nang City, Viet Nam* (Dissertation). Georg-August-Universität Göttingen, Göttingen.

Soppe, G. (2008a, July 15). *Policy Paper 2008-2020, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International.

Soppe, G. (2008b, October 2). *Strategic Plan 2008-2015, Partnership Building Phase Dawaco.* Hanoi, Vietnam: Vitens-Evides International.

SRV, Socialist Republic of Vietnam (2017). *Decree No. 71/2017/ND-CP Guidelines on Corporate Governance Applicable to Public Interest Companies.* https://tinyurl.com/ydydhmhx. Updated: May 6, 2017. Accessed: November 1, 2017.

Vietnam Trade Promotion Agency (2012a). *The Central Vietnam Key Economic Region (CVKER).* https://tinyurl.com/ybwc57rl. Updated: 2011. Accessed: May 11, 2017.

Vietnam Trade Promotion Agency (2012b). *Overview of Danang City – Part 1, 2 and 3.* https://tinyurl.com/yd3ojqxu. Updated: 2012. Accessed: May 11, 2017.

Vitens (2017). *Vitens makes a difference, Annual Report 2016*. Zwolle, Netherlands: Vitens.

VEI (2011, March 11). *End Project Report, Public Private Partnership Dawaco, Da Nang*. Compiled and written by: G. N. A. Soppe. Hanoi, Vietnam: Vitens-Evides International.

VEI. (2014). Vitens-Evides International (VEI) Vietnam – Da Nang (Project objectives). Zwolle, Netherlands: VEI.

Governance. https://tinyurl.com/y988keh7. Updated: 2015. Accessed: October 15, 2017.

VEI (2015b). *Water for life*. https://tinyurl.com/ybbujwcx. Updated: 2015. Accessed: October 15, 2017.

VEI (2017). *Annual Report 2016, Unlocking the Strengths of Dutch Water Companies*. Utrecht, Netherlands: VEI.

World Bank (2017). *Projects & Operations: Danang Sustainable City Development Project (SCDP)*. https://tinyurl.com/yc94olve. Updated: 2017. Accessed: May 11, 2017.

GWOPA
Global Water Operators' Partnerships Alliance

United Nations Educational, Scientific and Cultural Organization

IHE DELFT
Institute for Water Education
in partnership with UNESCO

Ministry of Foreign Affairs of the Netherlands

MINISTERIO DE ASUNTOS EXTERIORES Y DE COOPERACIÓN

aecid

TECHNISCHE UNIVERSITÄT DARMSTADT

WOP FACTSHEET

BEWOP

WATER OPERATORS' PARTNERSHIP BETWEEN

Da Nang Water Supply Joint Stock Company

(Dawaco) Vietnam

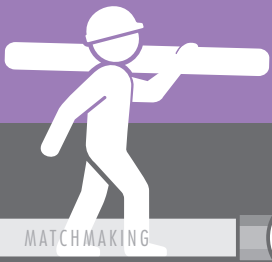
VEI – Dutch Water Operators

(VEI) Netherlands

TARGETED IMPROVEMENTS ON

Non-Revenue Water and Water Loss | Operation and Maintenance | Integrated Urban Water Resource Management | Water Supply | Tariffs | Customer Relations | Asset Management | Financial Management | Service to the Poor

TIMELINE



2006 — MATCHMAKING — 2007

First contact between VEI and Dawaco

Oct MoU signed between VEI, Dawaco, RNE and PC Da Nang
Nov 2007-Jan 2008 VEI and Dawaco carried out a baseline survey and produced a work plan for 2008

INCEPTION & PARTNERSHIP BUILDING

Feb-Mar Inception report
Jul Approval of project by PC Da Nang; Tariff study
Sept Strategic plan
Oct Utility Support Programme (USP) Action Plan and multi-year investment plan
Oct 2008-Oct 2009 Registration of visible leakages (Care-Taker Model)

2008/9 — IMPLEMENTATION — 2009

Customer Satisfaction survey
Water quality control and cleansing activities
May Implementation of Central Control Unit (CCU) and metering equipment installed in the network

IMPLEMENTATION

Training on Customer Relations
Water Asset Management System
New tariff structure approved
Jan Update of Dawaco's financial system
Jun Steps to equitize Dawaco
Dec Project conclusion

2010 — POST-WOP — 2011

Jan Implementation of a new tariff structure

COST

DIRECTORATE-GENERAL FOR INTERNATIONAL COOPERATION **(DGIS)** OF THE NETHERLAND'S MINISTRY OF FOREIGN AFFAIRS, ROYAL NETHERLANDS EMBASSY **(RNE)**	DAWACO	VEI
US$ 1.9 MILLION	US$ 282,500 (IN-KIND CONTRIBUTION)	US$ 550,000

TOTAL COST OF WOP **US$ 2.7 MILLION**

APPROACH

The VEI-Dawaco WOP was carried out from 2007 until the end of 2010. The WOP focused on the extension and improvement of water services in Da Nang, while supporting Dawaco in achieving management autonomy and a stronger financial position. Besides the achieved operational, managerial, and financial water utility performance improvements, the WOP was successful in supporting water services for the urban poor. Through improved processes and pro-poor strategies, the WOP's approach allowed for Dawaco to build on its own capacity and contribute to the sustainability of results, including effective, long-term and inclusive water delivery.

IMPROVEMENT TRACKS

Objective 1: Extension and better water services in Da Nang City

- NRW reduction from approx. 39% to 26% (2007-2010) and 15% by 2017.
- Nearly 49,000 new connections were made, averaging over 16,000 per year.
- Water quantity and quality meters installed at two water treatment plants to monitor 99% of the total production. Water quality control and cleansing activities implemented at the end of 2009.
- Implementation of a Central Control Unit including real-time metering equipment in May 2009.
- Water Asset Management System including GIS incorporated in 2010.
- Water resource management plan led by parallel ADB project.

Objective 2: Management autonomy and stronger financial position

- Steps to equitize Dawaco, becoming a limited liability company in June 2010.
- Tariff study in 2008 and new tariff structure approved at the end of 2010 and implemented in January 2011.
- New financial Management Information System implemented in January 2010.

Objective 3: Sustainable water services to urban poor

- Over 7,800 connections for the poor were made, averaging around 2,600 per year and amounting to 16% of the total new connections.
- Pro-poor strategies through the implementation of VEI's "Water for Life" programme in cooperation with PC Da Nang.
- New tariff structure approved which made low consumption costs accessible to the poor who generally use a limited amount of water.

CHALLENGES

Cultural differences: Building cultural bridges and overcoming language barriers.

SUCCESS FACTORS

- Dawaco management's commitment to change
- The expertise of VEI's team, combining a good foundation of Dutch water infrastructure and knowledge management
- The openness of the VEI team to teach Dawaco everything they know
- The strong motivation by staff at all levels during the WOP
- The availability of funds for investments.

WHAT THEY SAID

"People keep talking about the achievements or the results of the KPIs, such as NRW, or something that can be easy to measure, talking by figures. But for myself, I think the most important, or the most valuable result is regarding the behaviour and the awareness of the staff of Dawaco, that they could learn from the Dutch and from the experts of the WOP."

Former VEI-Dawaco Project Assistant, Ms. Duc Hanh Nguyen

"In Vietnam, you know, usually people don't want to say what are the bad things to another. But when we worked with VEI, we told them about all the bad things of our company. So they could choose the things that they could support us in. For example, the water loss was very high, nearly 40%. The network was not good. The quality was not stable. And the human resources were not good. So we told VEI everything."

Chairman of Management Board, Mr. Nguyen Truong Anh

"An unplanned activity for Dawaco was being a peer to neighboring utilities. People that visited the company to witness the SCADA system were impressed by the results. Dawaco got visibility and went to two provinces to train on Non-Revenue Water. That really made them proud of the changes they'd made."

Former VEI-Dawaco Resident Project Manager, Mr. Gerard Soppe

"1 Now we cannot supply for 100% of the population, so we want to be able to supply to the whole population.

2 Now there are not enough water treatment plants performing at their maximum capacity, so in the future, we want to have more water treatment plants.

3 Lastly, I want the company to perform the best in order to decrease the water tariff that people have to pay, i.e. to have the appropriate price for the people."

Dawaco General Director, Mr. Ho Huong

MENTEE

Da Nang Water Supply Joint Stock Company

(Dawaco) Vietnam

Water utility of Da Nang City – Joint Stock Company (since 2016): 60% The People's Committee of Da Nang, 35% Strategic main holder, 5% Dawaco Staff shares.

MENTOR

VEI – Dutch Water Operators

(VEI) Netherlands

VEI represents a number of Dutch water operators, motivated by Corporate Social Responsibility (CSR) to engage in Water Operator Partnerships.

GENERAL DATA

2,746 km
LENGTH OF NETWORK
(2016)

102,000 km
LENGTH OF NETWORK
(2016)

0.81 millions of m^3
WATER SUPPLY
(2016)

887 millions of m^3
WATER SUPPLY
(2016)

954,262
POPULATION SERVED
(2016)

11,873,000
POPULATION SERVED
(2016)

MOTIVATIONS

Enhance the company's capacity and performance and access funds to improve service provision.

Exercise Corporate Social Responsibility (CSR) and draw the interest of a younger workforce supportive of VEI's mission.

SUPPORTING THIRD PARTY

This WOP was facilitated by the Royal Netherlands Embassy (RNE) in Hanoi and the People's Committee of Da Nang (PC Da Nang). The main incentive for the RNE and the PC of Da Nang to facilitate the WOP between VEI and Dawaco was to deliver water to the poor.

GWOPA
Global Water Operators' Partnerships Alliance

UN-HABITAT
FOR A BETTER URBAN FUTURE

UNESCO IHE DELFT

WATER OPERATORS' PARTNERSHIPS

WOPs are peer-support arrangements between two or more water and sanitation operators, carried out on a not-for-profit basis with the objective of strengthening operator capacity.

BEWOP

Boosting the Effectiveness of Water Operators' Partnerships (BEWOP) is a research, operational support and outreach initiative aimed at boosting the effectiveness of Water Operators' Partnerships around the world.

Launched in September 2013, BEWOP is a collaboration between leading water sector capacity development institute, IHE Delft, and UN-Habitat's Global Water Operators' Partnership Alliance, the organization leading the global WOPs movement.

This project has been made possible with support from the Governments of Netherlands and Spain.

This factsheet is part of a series summarizing WOPs cases being studied in order to draw lessons and guide better practice.

FIND OUT MORE BEWOP.org | #BEWOP | GWOPA.org

Ministry of Foreign Affairs of the Netherlands
MINISTERIO DE ASUNTOS EXTERIORES Y DE COOPERACIÓN aecid
TECHNISCHE UNIVERSITÄT DARMSTADT

8. Water operators' partnerships and their supporting role in the improvement of urban water supply in Da Nang

Publication No.	**P-VII**
Type	Journal article
Journal	*International Journal of Water Resources Development.*
SJR Score	0.701
Status	Published
Reference	**Wright-Contreras, L.**, Perkins, J., Pascual-Sanz, M., & Soppe, G. (2019). Water operators' partnerships and their supporting role in the improvement of urban water supply in Da Nang. *International Journal of Water Resources Development*, 1–26. https://doi.org/10.1080/07900627.2019.1625753
Abstract	This work analyzes the main outcomes and success factors of the water operators' partnership (WOP) between the Dutch water operators' organization, VEI (formerly Vitens Evides International), and the Vietnamese water utility, Da Nang Water Supply Joint Stock Company (Dawaco), which took place from 2007 to 2010. The partnership is considered within broader international and regional funding programmes, including parallel national and regional WOPs. The article presents WOPs as key processes in larger operations of water infrastructure development and considers WOPs as relevant strategies that contribute to the improvement of urban water services at a global scale.

INTERNATIONAL JOURNAL OF WATER RESOURCES DEVELOPMENT
https://doi.org/10.1080/07900627.2019.1625753

Water operators' partnerships and their supporting role in the improvement of urban water supply in Da Nang

Lucía Wright-Contreras[a], Julie Perkins[b], Maria Pascual[b] and Gerard Soppe[c]

[a]URBANgrad, Technical University of Darmstadt, Darmstadt, Germany; [b]Global Water Operators' Partnership Alliance / UN-Habitat, Barcelona, Spain; [c]Former Resident Project Manager of Vitens Evides International for the VEI–Dawaco Water Operator Partnership, Utrecht, Netherlands

ABSTRACT
This work analyzes the main outcomes and success factors of the water operators' partnership (WOP) between the Dutch water operators' organization, VEI (formerly Vitens Evides International), and the Vietnamese water utility, Da Nang Water Supply Joint Stock Company (Dawaco), which took place from 2007 to 2010. The partnership is considered within broader international and regional funding programmes, including parallel national and regional WOPs. The article presents WOPs as key processes in larger operations of water infrastructure development and considers WOPs as relevant strategies that contribute to the improvement of urban water services at a global scale.

ARTICLE HISTORY
Received 8 October 2018
Accepted 26 May 2019

KEYWORDS
water operators' partnership; capacity development; utility performance; sustainable development goals; Da Nang

Introduction

In 2000, the United Nations member states signed the Millennium Declaration, which included Millennium Development Goal 7, Target 7C, to 'halve the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015' (UNICEF, WHO, 2015). After several milestones acknowledging water as a human right, including General Comment 15 (2003), the UN General Assembly adopted Resolution A/RES/64/292 (2010) on the human right to water and sanitation. Now, the post-2015 development agenda, also known as the New Urban Agenda, titled 'Transforming Our World: The 2030 Agenda for Sustainable Development' (United Nations, 2015) lists 17 Sustainable Development Goals (SDGs, or Global Goals) addressing poverty, hunger, inequality, economic growth and infrastructure development, climate change, desertification and land degradation, and loss of biodiversity, as well as diverse pathways to achieve health and well-being, quality education, clean water and sanitation, affordable and clean energy, resilient and sustainable cities, peace, justice, and inclusiveness. SDG 6 specifically seeks to 'ensure the availability and sustainable management of water and sanitation for all' (United Nations, 2017). The complex issues addressed by the SDGs and SDG 6 call for full support from formal and informal institutions across the globe to reduce (if not to eliminate) these problems (Tortajada & Biswas, 2015).

CONTACT Lucía Wright-Contreras wright@stadt.tu-darmstadt.de
Supplemental data for this paper can be accessed at https://doi.org/10.1080/07900627.2019.1625753

Globally, 2.7 billion people suffer from water shortages for at least one month per year (WEF, 2016), and almost 10% of the world's population risk their health because they lack access to clean drinking water (Water Health, 2017). An important shift in the last half century has been to focus on the management of water, rather than just on the physical assets themselves (Hendry, 2015). Based on the observation that 'publicly owned and managed water operators currently provide more than 90% of the world's piped water, and [that] even small managerial improvements could yield major benefits' (UNSGAB, 2006, p. 1), in 2009, the United Nations established the Global Water Operators' Partnerships Alliance (GWOPA) to support not-for-profit, peer-support partnerships between utilities. The objective of the alliance includes raising the capacity and, ultimately, the performance of local water and sanitation service providers around the world.

More than 310 of these water operators' partnerships (WOPs) have been recorded by GWOPA, and over 20 in-depth case studies and factsheets have been produced (GWOPA/UN-Habitat, 2019). GWOPA promotes and guides WOPs' practices on all continents with the support of water utility associations and WOP platforms at national and regional levels (Bjerggaard, 2009; IWA, GWOPA, VEI, 2009). WOPs are supported by a variety of financial institutions (bilateral and multilateral donors and development banks) such as the Asian Development Bank (ADB), the Inter-American Development Bank, the US Agency for International Development (USAID), and the African Development Bank. In Asia and the Pacific, ADB started implementing WOPs in 2007, and has now 77 completed and ongoing partnerships (ADB, 2017; updated number of WOPs provided by C. Moster, personal communication, November 28, 2018). In 2008, ADB signed an agreement with USAID and IWA during the Stockholm World Water Week and established a network called WaterLinks, a non-profit organization aimed at supporting and facilitating WOPs through regional capacity-building programmes and knowledge dissemination (IWA, GWOPA, VEI, 2009; WaterLinks, 2018).

WOPs are defined in the 2006 Hashimoto Action plan as 'cooperation between water operators … for providing support for capacity building of public water operators', with the objective to 'strengthen local water services … while ensuring that WOPs are recognized as important means of achieving internationally agreed targets' (UNSGAB, 2006, p. 3). An important understanding is that partnerships are focused on strengthening capacity, not substituting it (i.e. 'institutional transplantation' in Breeveld, Hermans, Veenstra, 2013).

Since its establishment in 2004, VEI (formerly Vitens Evides International), owned by two of the largest, publicly owned water companies in the Netherlands, is considered the world's leading non-profit promoter and implementer of WOPs (VEI, 2017). VEI's work is encouraged by Dutch national policies, given that the Netherlands recognized safe drinking water and sanitation as a basic human right (in 2008) and resolved that '1% of the annual turnover of Dutch water companies can be used for projects in developing countries' (IRC, 2014, p. 2; Ministry of Foreign Affairs of the Netherlands, 2012, p. 43). VEI now shares the expertise of six Dutch water operators (Vitens, Evides, WML, Waterbedrijf Groningen, Brabant Water and Water Laboratorium Noord) in over 20 countries worldwide, and provides over 300,000 people with improved access to water services in Africa, Asia and Latin America by building the capacity of water utilities in each of these regions (VEI, 2018a).

Through a new collaboration with the Ministry of Foreign Affairs of the Netherlands, and all Dutch water operators (from largest to smallest in terms of population served, these are Vitens, Brabant Water, Evides, PWN, Dunea, WML, Waternet, Oasen, Groningen, and WMD; see Vewin, 2017), VEI has launched a new programme called WaterWorX, aimed at increasing sustainable access to water for 10 million people, facilitating loans for large-scale investments in water infrastructure to over two dozen local partner companies in three continents between 2017 and 2030 (Dutch Water Sector, 2017; VEI, 2018b). According to Adriaan Mels (2018), regional director at VEI, 'WaterWorX will mobilize up to USD 500 million in investments from the private sector for infrastructure expansion, rehabilitation, and improvements in the sector.' Prior to this initiative, a foundation called Water for Life has reached 1.1 million people (through the installation of water pipes, taps, toilets and training related to hygiene) by connecting donations from consumers and non-consumers to invest in VEI's projects and strengthen the resources of the Dutch operators' staff who travel to the recipient operator ('short-termers') (Evides Waterbedrijf, 2018; VEI, 2017; Water for Life, 2018).

A criterion for the start of a WOP is that the recipient water utility clearly expresses the need for a partnership. Depending on their duration, WOPs can be classified into simple partnerships (up to 12 months of formal or informal exchanges between utilities) and structured partnerships (including specific partnerships, up to 12 months); comprehensive partnerships, up to 48 months; and long-term, special-purpose partnerships (IWA, GWOPA, VEI, 2009; see Figure 1). An updated review in 2019 of the recorded duration of WOPs in GWOPA's database showed that 24.2% have lasted up to 12 months, 45.5% between 12 and 36 months, 23.7% between 36 and 48 months, and 6.6% are long-term partnerships of between 4 and 13 years.

Because WOPs are not-for-profit partnerships, there is not an explicit need for financial transfers except where there is a support from a donor to the recipient or to the mentoring operator, or both, in the case of multiple-source funding (cf. IWA, GWOPA, VEI, 2009; see Figure 2). Although nearly two-thirds of the records registered by GWOPA do not have information on funding, from the available data, 7.5% have reported costs under USD 25,000, 14.2% between USD 25,001 and 50,000, 20.1% between USD 50,001 and 100,000, 21.6% between USD 100,001 and 1 million, 32.1% from USD 1 to 10 million, and 4.5% from USD 10 million to over 1 billion. ADB, for example, focuses on WOPs in the third range, between USD 50,001 and 100,000 (interview, ADB, 2018).

The academic literature on WOPs amounts to about 20 documents, a dozen of which are listed in Scopus(*) and less than half of which are both listed in Scopus and have been peer-reviewed(**) (*Batten, 2010; **Beck, 2018; Bélanger Dumontier, McDonald, Spronk, Baron, & Wartchow, 2016; *Bishop & Kong, 2010; Bjerggaard, 2009; **Boag & McDonald, 2010; **Breeveld et al., 2013; **Gallego-Ayala, Dimene, Munhequete, & Amos, 2014; **Giesemann, Roche, Austin, & Moulton, 2009; Hall et al., 2009; IWA, GWOPA, & VEI, 2009; Mvulirwenande, Wehn, & Alaerts, 2014; **Ndirangu, Ng'ang'a, Chege, de Blois, & Mels, 2013; Pascual-Sanz, 2014; **Pascual-Sanz, Veenstra, Wehn de Montalvo, van Tulder, & Alaerts, 2013; *Patrón-Coppel & Schwartz, 2011; Rusca & Schwartz, 2012; Terhorst, 2012; *Tobon & Yates, 2014; **Tutusaus & Schwartz, 2016; **Wehn & Montalvo, 2016). Accompanying terms used to refer to capacity development support between water utilities include 'capacity development partnerships' (Pascual-Sanz, 2014; Pascual-Sanz et al., 2013), 'knowledge and capacity

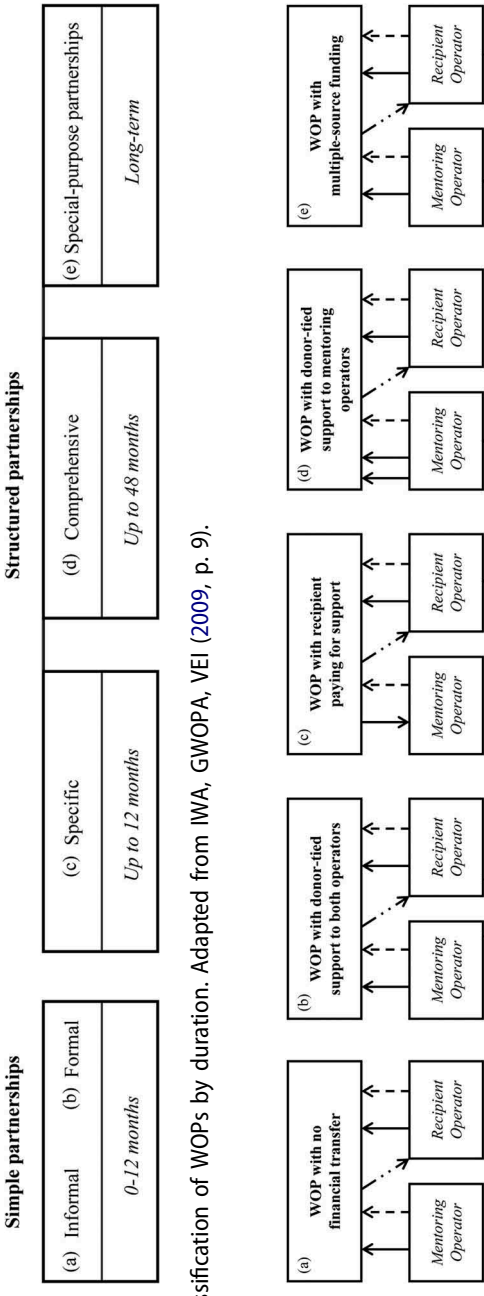


Figure 1. Classification of WOPs by duration. Adapted from IWA, GWOPA, VEI (2009, p. 9).

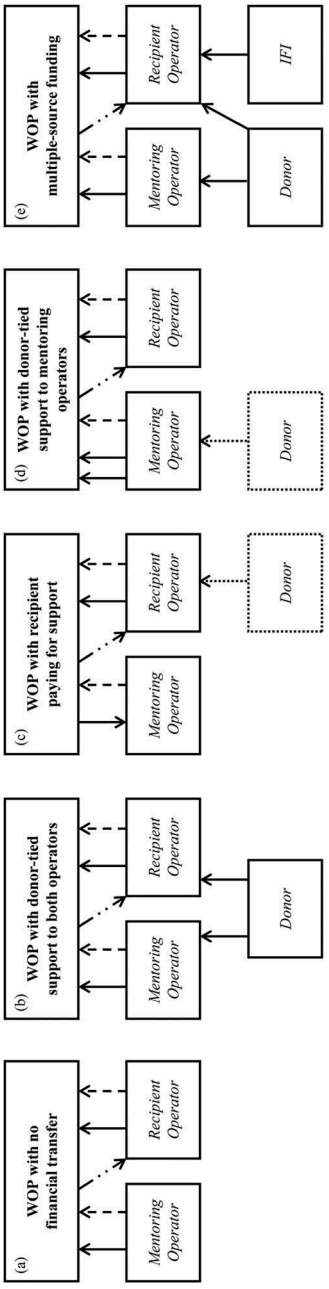


Figure 2. Types of WOPs according to financial flows. Note: IFI = international financial institutions. Adapted from IWA, GWOPA, VEI (2009, p. 8).

development interventions' (Mvulirwenande et al., 2014), 'twinning arrangements' (Bjerggaard, 2009; IWA, GWOPA, & VEI, 2009; Tobon & Yates, 2014), and 'public-public twinning projects' (Rusca & Schwartz, 2012).

The literature has raised critical points regarding the measurability of the effectiveness of WOPs (Breeveld et al., 2013; Gallego-Ayala et al., 2014; Pascual-Sanz & Hoffer, 2009) and the value of knowledge transfer through interaction with external actors (Breeveld et al., 2013; Mvulirwenande et al., 2014; Pascual-Sanz et al., 2013; Wehn & Montalvo, 2016). The present research aims to inform each of these topics and to explore how WOPs work parallel to other forms of technical assistance and financial support from various institutions.

Because VEI is the most active organization promoting North–South development cooperation, this research will zoom in on a WOP with the Vietnamese water utility, Da Nang Water Supply Joint Stock Company (Dawaco). The main question guiding this research is: What were the conditions which supported the long-term improvement of water supply services in Da Nang? The objective is to understand the role of the VEI–Dawaco WOP in the local water utility's performance improvements and its relation to other external forms of assistance.

In the next section, the case study and methods used to assess the changes implemented during the VEI–Dawaco WOP will be explained. The section 'Water Sector Characteristics and Developments in Da Nang' will walk the reader through the city-level developments regarding urban water supply. The details of how the partnership between VEI and Dawaco was initiated, its objectives and its total cost will be described in the section 'Establishment of the VEI–Dawaco WOP'. The following sections build on a multi-layered results framework which lists the organizational changes implemented during the partnership, the changes in performance, and the continuity of results until 2017 (Table A1, in the online supplemental data at https://doi.org/10.1080/07900627.2019.1625753). In the section 'Changes Implemented during the VEI–Dawaco WOP from 2007 to 2010', an analysis of activities supporting the partnership's objectives will be described. The section 'Standard Key Performance Indicators from 1996 to 2017' will discuss the water utility's improvements over a longer period of time. Then, 'Dawaco's Operational Capacity and Financial Sustainability vis-à-vis Other Factors' will debate to what extent the improvements can be attributed to the WOP in light of parallel activities and the mobility of resources from other organizations. And finally, the 'Discussion' and 'Conclusion' will summarize the main lessons of the case study and highlight the factors which may have contributed to the success of this particular WOP and its supporting role in the extension and improvement of urban water supply services.

Methodology

This article studies the activities which influenced changes in the capacity of Dawaco between 2007 and 2010, in the frame of the partnership between VEI and Dawaco, in Da Nang, Vietnam. The main study of the VEI–Dawaco WOP took place through Agreement of Cooperation number GC/17/026 between the Technical University of Darmstadt and GWOPA from August 2017 to August 2018 (cf. Wright-Contreras, 2018). The case was suggested by the World Bank to GWOPA because of its financial results and sustainability, offering insight on the opportunities of scaling up the WOP approach. In

addition, active communication with experts familiar with the VEI–Dawaco WOP and the possibility of accessing information prior and posterior to the cooperation facilitated the discussion on whether the WOP contributed to Dawaco's improvements. Understanding the changes in Dawaco's performance between 1996 to 2017 was crucial to assess the company's progress with respect to the partnership and the development of parallel agreements.

To begin with, information was obtained through a review of secondary data, including the partnership's Memorandum of Understanding, policy paper, strategic plan, inception report, and end project report (Dawaco, 2007; Dawaco, VEI, RNE, PC Da Nang, 2008b; Soppe, 2008a, 2008b, 2011). Field work between 4 and 10 August 2017, in Da Nang, and a remote follow-up in November 2018, enabled the collection of primary data through semi-structured interviews of key informants. Of the nine interviewees, seven were in contact with the activities of the VEI–Dawaco WOP when the partnership took place, including former VEI–Dawaco WOP resident project manager, Dawaco's current general director, Dawaco's general director at the time of the WOP (now chairman of management board), head of the Strategic Planning Department, head of the Technical Department, chief accountant, and former ADB senior urban development specialist and team leader for the Da Nang Water Supply Project. We also interviewed Dawaco's current general director and the current lead facilitator for ADB WOPs.

Following the Boosting Effectiveness in Water Operators' Partnerships analytical framework developed by GWOPA and UNESCO-IHE to analyze over a dozen case studies (cf. GWOPA/UN-Habitat, 2015), circa 100 questions were directed to Dawaco's key informants to understand the scope of the partnership, the partnership creation, the project implementation, the evidence of progress towards the impact and effectiveness of the project, and the evaluation of the WOP. The interviews served to validate the information contained in the reports, and to better understand the influence of WOP activities in the changes detected in capacity and performance. Moreover, they illuminated topics related to Da Nang's context (political, socio-economic, cultural and environmental); first contact and enabling conditions for the collaboration between VEI and Dawaco; motivation of the partners and facilitators to fund the WOP; development and management of the partnership; inter-organizational dynamics; objectives of the partnership; and the evidence of progress towards the impact and effectiveness of the collaboration. Staff members of Dawaco's Planning Department, Control Centre and Network Management, and Project Management Unit also provided information and followed up with the research process until the end of 2018, providing up-to-date data on the company's ongoing programmes and performance indicators (including the number of water supply connections, percentages of increased coverage, water quality results, non-revenue water reduction, and the company's development towards full cost recovery). Lastly, the interviews with ADB's key informants facilitated understanding of the large-scale investments and policy changes which have occurred in Vietnam over the last two decades.

Water sector characteristics and developments in Da Nang

Da Nang is on the southern-central coast of Vietnam. The city is one of five provinces of the Central Vietnam Key Economic Region. In Decision No. 148/2004/QD-TTg, the prime

minister shared the major orientations for socio-economic development of this region, expected to increase its annual GDP growth rate by 1.25 times the national average and contribute 6.5% of the national GDP by 2020 (SRV, 2004). Despite economic growth and the aim to reduce unemployment and the percentage of poor households, in Da Nang's population of just over 1 million inhabitants, poor households still account for over 70% of the housing situation (Quang, 2016).

Da Nang's formal water supply system was developed between 1945 and 1950, drawing water from wells through small piping systems (Dawaco, 2017). The city built its first surface water treatment plant in 1965 and has continuously expanded its water supply network by building new water treatment plants and increasing their capacity (Dawaco, 2017). Da Nang has four water treatment plants: Cầu Đỏ (built in 1965), Sân Bay (1974), Sơn Trà (more accurately, a water treatment station with three catchment points, built in 1985), and An Trạch (2008) (Dawaco, 2017). Most of the water is extracted from the Cầu Đỏ River, and a small percentage from the Lượng Stream and Sơn Trà Mountain (interview, Dawaco, 2017). Two new water treatment plants are planned: Hòa Trung (estimated completion in 2019) and Hoà Liên (estimated completion 2020) (N. H. T. Ngo, personal communication, March 2, 2018).

In 2004, Dawaco was formally established under Decision No. 01/2004/QD-CTCN (Dawaco, 2017). In 2010, the company became a limited liability company with the People's Committee of Da Nang (PC Da Nang) as sole shareholder, and in 2016, it became a joint stock company owned in majority by PC Da Nang (60%), Da Nang Miền Trung Joint Stock Company (*Cty cổ phần đầu tư xây dựng, Đà Nẵng Miền Trung*, 35%), and Dawaco staff (5%) (interview, Dawaco, 2017). As a public interest company

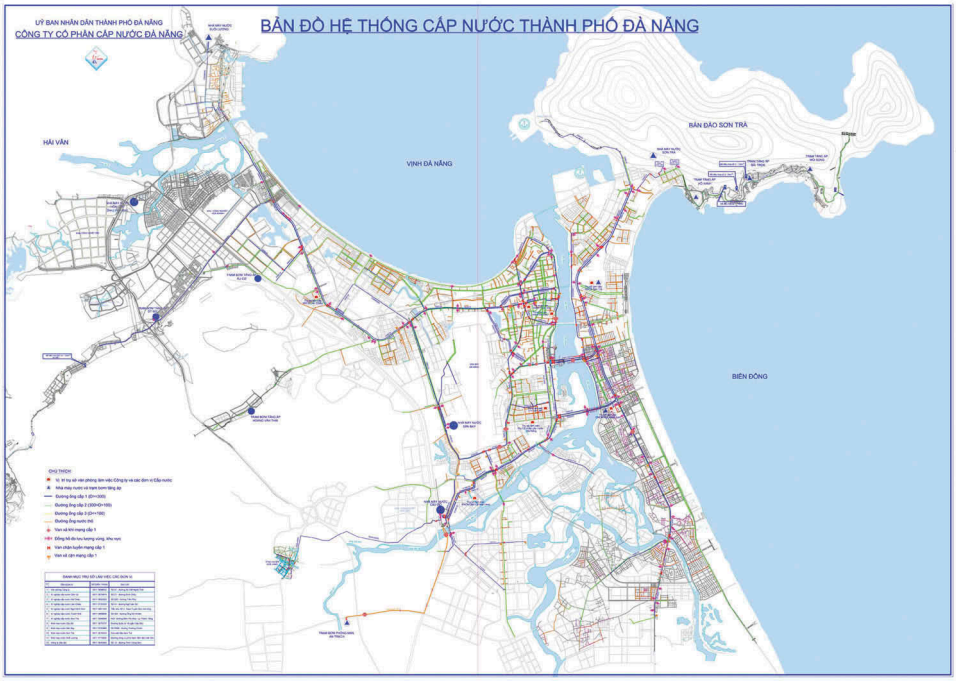


Figure 3. Dawaco's water supply distribution network. Source: Dawaco, Da Nang, Vietnam, 2017.

and joint stock company, Dawaco abides by the Investment Law No. 67/2014/QH13, Enterprise Law No. 68/2014/QH13, Law on Securities and the Stock Market No. 70/2006/QH11, Environmental Protection Law No. 55/2014/QH13, and decrees and decisions related to water, urban water supply and the prevention of loss of clean water, especially Decree No. 117/2007/ND-CP and Decree No. 124/2011/ND-CP on production, supply and consumption of clean water (interview, Dawaco, 2017).

Da Nang's development and management of water infrastructures has been supported by foreign capital and foreign expertise, such as the assistance from the French government in 2002 to renovate the Cầu Đỏ water treatment plant (Dawaco, 2017). Technical assistance has also been facilitated by organizations such as the ADB, the Japanese International Cooperation Agency (JICA) and the World Bank. From 2008, the ADB worked on the preparation of the Da Nang Water Supply Project, including the initial assessment and pre-feasibility study of water resources for future development; the feasibility study and basic design for new water infrastructure projects (with focus also on water service provision for peri-urban areas); the extension of existing water distribution networks (Figure 3); and an institutional development programme to review the organizational structures, regulations and policies of the water sector in Da Nang (ADB, 2008a). This particular project (ID 41,456–012: TA 7144-VIE) was valued at USD 2.45 million and took place between November 2008 and October 2009, financed by a grant from the Multi-Donor Trust Fund (with contributions of the governments of Australia, Austria and Norway) together with in-kind contributions from the Vietnamese government (ADB, 2008a, 2008b).

The implementation of the Da Nang Water Supply Project (ID 41,456–033: Loan 2961-VIE) started in January 2013 and is expected to be completed in December 2019 (ADB, 2012a). The project is part of the second tranche of ADB's Periodic Finance Request Water Sector Investment Program, worth USD 212 million, USD 30 million of which have been allocated to the city of Da Nang for the expansion and rehabilitation of the distribution network; the implementation of an institutional strengthening programme; and the implementation of an operational management contract to improve and upgrade maintenance and operational procedures (ADB, 2012a, 2012b; 2013a). This financing is part of a larger fund of USD 1 billion from the Multitranche Financing Facility approved in February 2011 by the ADB Board of Directors for operational improvements of urban water supply in Vietnam between 2011 and 2020 (ADB, 2012a).

Furthermore, technical assistance facilitated by ADB through the Capacity Development Technical Assistance project (ID 44,002–022: TA 8357-VIE) was made possible through a grant from the Netherlands Trust Fund under the Water Financing Partnership Facility administered by ADB (ADB, 2013b). From May 2013 to December 2014, the project worked with selected water companies on improving performance and accountability, reducing non-revenue water, and supporting monitoring and evaluation mechanisms for water supply services (ADB, 2013c).

With a broader focus on sanitation issues, JICA is currently supporting Da Nang with the Da Nang City Water Environment Improvement Project (JICA, 2018). The project started in April 2013 as an international technical cooperation between Yokohama City and Da Nang for sustainable urban development, with the objective of providing technical advice to Da Nang on becoming an environmentally friendly city, increasing

its capacity to treat wastewater and assisting Dawaco in building new water supply networks (JICA, Kajima Corporation, Hitachi, Ltd., Yokohama Water Company, Original Engineering Consultants Co., Ltd., Global Water Recycling and Reuse System Association, 2016). Within this project, the Da Nang City Hòa Liên Water Supply Project builds on ADB's preparatory study, carried out by Black and Veatch (2010), for project ID 414,456–033 and proposes the construction of a new water treatment plant with an investment of JPY 1.8 billion (USD 16 million, equivalent to 30% of the total cost) and a loan amount of JPY 4.2 billion (USD 37 million, 70%) (Kajima Corporation, Hitachi, Ltd., Yokohama Water Company, Original Engineering Consultants Co., Ltd., Global Water Recycling and Reuse System Association, 2012).

Another project which has influenced the water and sanitation sectors is the Da Nang Sustainable City Development Project (ID P123384) of the World Bank, approved on 26 April 2013 and concluded on 30 June, 2019; consisting of a USD 272.2 million country loan to achieve development objectives which include urban infrastructure, service delivery and water resource management plans (World Bank, 2017).

Establishment of the VEI–Dawaco WOP

The VEI–Dawaco WOP is essentially a comprehensive, (medium-term) structured partnership financed by multiple sources (Figures 1(d), 2(e)), with activities linked to additional funding available for investment in infrastructure through international financial institutions (cf. IWA, GWOPA, VEI, 2009). Initially, the contact between VEI and Dawaco was triggered by a funding opportunity through the Royal Netherlands Embassy (RNE) in Hanoi. A timely factor facilitating the start of the partnership was the good communication and relationship between Dawaco's management level and the chairman of PC Da Nang, who supported the cooperation with VEI (interview, Dawaco, 2017). The support from PC Da Nang and the willingness of Dawaco's managerial staff were both important for starting the WOP.

Facilitated by RNE and PC Da Nang, the WOP between VEI and Dawaco took place from October 2007 to December 2010 (Dawaco, VEI, RNE, PC Da Nang, 2007). VEI aimed to contribute to Target 7C of the Millennium Development Goals, while cultivating the interest of the workforce supporting VEI's mission. RNE and PC Da Nang, in turn, supported the WOP with the aim of delivering water to the poor (Dawaco, VEI, RNE, PC Da Nang, 2007). The main objectives of the VEI–Dawaco WOP were to extend and improve water services in Da Nang, to increase management autonomy and strengthen Dawaco's financial position, and to deliver water services to the urban poor in a sustainable manner (Soppe, 2011).

Table 1. Breakdown of costs from Directorate-General for International Cooperation funds.

Breakdown of costs	Budget	Percentage	2007	2008	2009	2010	Remaining
Human resources	889,660	47%	83,641	285,343	348,440	304,065	−131,829
Investments	625,000	33%	0	64,282	268,942	271,794	19,982
Operational costs	179,920	9%	11,039	52,512	30,222	39,760	46,388
Training	185,000	10%	0	1,817	64,634	41,292	60,904
Technical audit	18,000	1%	0	0	0	0	18,000
Total	**1,897,580**	**100%**					**13,445**

Source: Soppe (2011).

On 19 October 2007, VEI, Dawaco, RNE and PC Da Nang signed a memorandum of understanding (Dawaco, VEI, RNE, PC Da Nang, 2007), which was followed by a baseline survey and the development of a strategic work plan for 2008 (Soppe, 2008b). The WOP facilitators and partners made the following contributions. RNE provided USD 1.9 million on behalf of the Directorate-General for International Cooperation of the Netherlands Ministry of Foreign Affairs; PC Da Nang acted as a third party to approve policies and regulations; VEI provided USD 550,000; and Dawaco contributed with USD 282,500 in kind, for a total cost of approximately USD 2.7 million (Soppe, 2011). Dawaco also invested USD 500,000 in the expansion and improvement of the pipe network, contributing to the objectives of the WOP in the same time frame (Soppe, 2011).

The breakdown of the costs from the Directorate-General for International Cooperation shows that the majority of the funds were allocated to human resources (47%); a third of the budget was used for investments in equipment and software (33%); and the remaining budget was assigned to operational costs (9%), training costs (10%), and technical audit costs (1%) (Table 1).

Changes implemented during the VEI–Dawaco WOP from 2007 to 2010

The activities implemented during the VEI–Dawaco WOP supported all three objectives of the partnership: improving water service provision; increasing the company's management autonomy and strengthening its financial position; and delivering water services to the urban poor. The following subsections list the changes which contributed to each of the

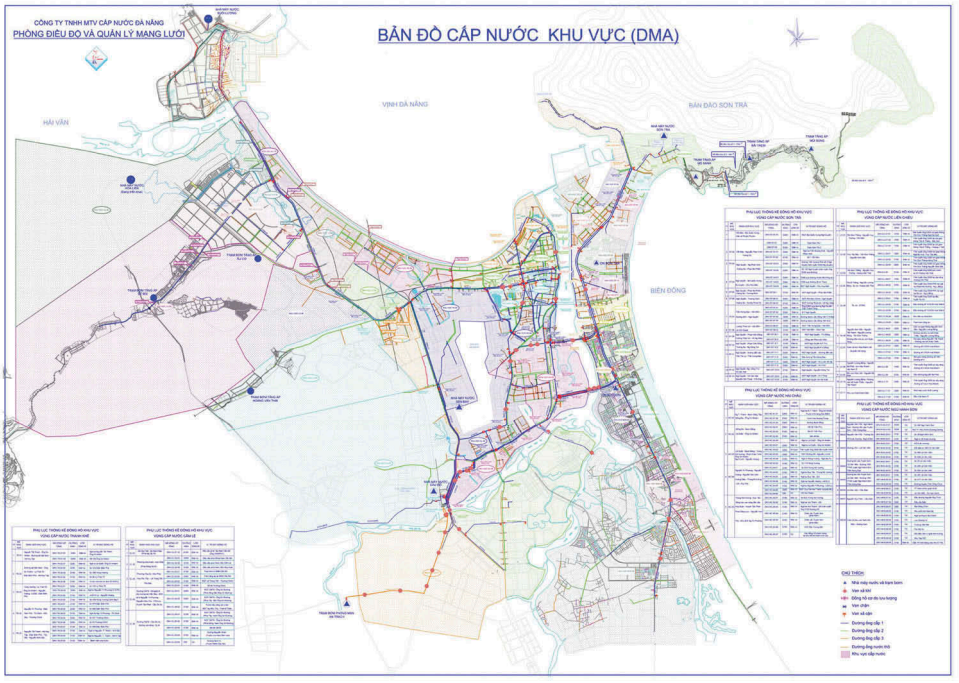


Figure 4. District metering areas. Source: Dawaco, Da Nang, Vietnam, 2017.

WOP's objectives. The multilayered results framework (see Table A1 in the online supplemental data) shows how each of the activities influenced the key performance indicators (KPIs) which are used to evaluate the continuity of results in the next section.

Objective 1: extend and improve water services in Da Nang

Activities related to connectivity and improved coverage (both in the network as a whole and in the areas where poor households are located) included the creation of a Central Control Unit and installation of metering equipment in the network; a study and plan concerning raw water protection and water resources management (as part of ADB's Project ID 41,456; ADB, 2008a); flushing activities for the production of more reliable water; inclusion of a Water Asset Management System to incorporate all data from the network into one system (VidaGIS, 2018); and implementation of a caretaker model.

Although there are often references to the 'caretaker approach' in rural and small-scale, community-managed water supply systems (e.g. Barrington, Fuller, & McMillan, 2013; Greaves & Simmons, 2015; Mahmud et al., 2007; Watsisi, 2017; Whittington et al., 2009), the caretaker model referred to in this case is based on a number of sub-areas (also called district metering areas, see Figure 4) monitored by an assigned team of workers to detect water loss from the pipe network system (cf. McIntosh, 2003). The purpose of the caretaker model is to detect leaks from the network more efficiently and repair them. Da Nang was the first to implement this model for water network management in Vietnam (Soppe, 2011). According to the chairman of Dawaco's Management Board, 'Before [in Dawaco] there was a group of people who took care of all the network. But the caretaker model created a small group to take care of small areas so that they knew everything about the customers, about the network.'

Objective 2: increase management autonomy and strengthen Dawaco's financial position

Dawaco's financial position was strengthened through the implementation of a new financial system and a tariff proposal (Table 2) to achieve full cost recovery and prepare the company to receive larger investments through other organizations. Decree No. 117/2007/ND-CP and its amendments (in Decree No. 124/2011/ND-CP) require water supply companies to operate on full cost recovery, which in essence 'aims to cover the operation and maintenance cost and the higher depreciation or debt service' (ADB, 2012a, p. 1). The amendment and supplement to Clause 1, Article 51 states: 'The price of clean water must be properly calculated, fully covering

Table 2. Dawaco's water tariff structure (VND).

Groups	Purpose of use	1992	1996	1999	2002	2005	2011	2014
1	Households	500	500	1,200	1,486	2,343		
	Zero to 10 m^3						3,524	3,810
	11m^3 to 30 m^3						4,190	4,571
	Over 30 m^3						5,143	5,714
2	Administration	1,000	1,500	1,962	2,343	3,045	5,810	6,476
3	Industry	1,000	2,000	3,010	3,486	3,867	7,714	8,476
4	Business and service	2,000	3,000	4,152	4,629	5,295	11,619	12,857
	Effective from	July 1992	Aug. 1996	Aug. 1999	Jan. 2002	Jan. 2005	Jan. 2011	Feb. 2014

Source: Received from Dawaco. Da Nang, Vietnam, 2017.

reasonable expenses arising in clean water production and distribution (including also expenses to maintain connection) so as to guarantee the rights and lawful interests of water suppliers and users' (SRV, 2011).

At the time of the VEI–Dawaco WOP, Dawaco was a department of the municipality under direct control of the Department of Construction and, in 2010, it became a limited liability company. In 2016, it transformed into a joint stock company, and according to the former resident project manager of the VEI–Dawaco WOP, 'Moving from a department to a limited liability company was the most important step as the company became more autonomous and could take decisions independently, although there was still control of the PC [Da Nang] over budgets and investments.'

Objective 3: deliver water services to the urban poor in a sustainable manner

The implementation of a tariff structure to benefit the urban poor (Table 2) and the link to the Water for Life foundation helped locate the poorest households in Da Nang and subsidize household connections (Soppe, 2011). The former VEI–Dawaco WOP resident project manager explained: 'The poor are really the ones that deserve the connections. But the near-poor are not always able to afford the connection. To be able to take the near-poor into consideration, we chose the wards which had 80% near-poor. This way we would connect everybody.'

Key performance indicators from 1996 to 2017

An effort was made to obtain information regarding each of the KPIs for the period between 1996 and 2017. This section takes a close look at the changes in the data on connections, service coverage, water quality, non-revenue water reduction and cost recovery. Data for the number of connections exists between 1996 and 2017; data for coverage is documented from 1999 to 2017; evidence of water quality tests is available for 2006 to 2015; and financial information regarding Dawaco's equity, operating profit, and profit after tax is provided from 1996 to 2017. The most evident improvements will be discussed starting with the results achieved in the frame of the VEI–Dawaco WOP between 2007 and 2010.

Number of connections

From 2007 to 2010, a total of 48,933 new connections were achieved. The VEI–Dawaco WOP target of connecting 16,000 households per year was surpassed by 2%, with the equivalent of 16,311 connections per year (Soppe, 2011). At the same time, 7856 household connections for the poor were made, surpassing the target of 2000 by nearly 400%, with an average of 2618 connections per year (Soppe, 2011). The peak in percentage change occurred in 2011, the year after the WOP ended, with an increase of 22% and a total of 185,185 connections; and the percentage of increase stayed between 5% and 9% until 2017, reaching 267,623 connections, equivalent to a population of 992,049 (Figure 5).

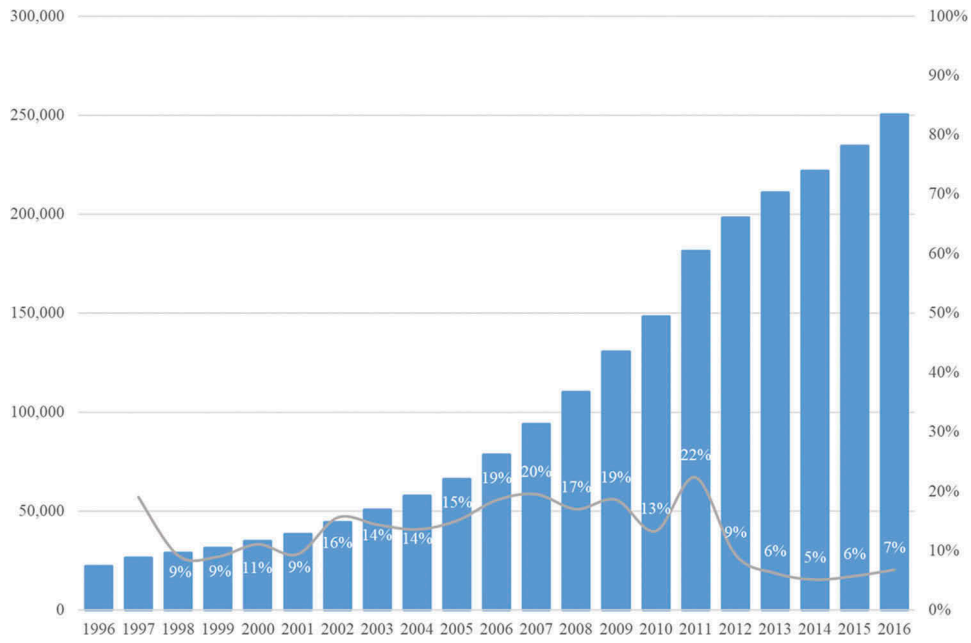


Figure 5. Number of water supply connections (including % change), 1996 to 2017. Data from Dawaco, Da Nang, Vietnam, 2018.

Increased coverage

From 2007 to 2010 service coverage increased from 52% to 66% (Figure 6). The trend of increased coverage continued, including two peaks in percentage of change in 2011, and another time in 2014, reaching 74% and 87%, respectively. In 2017, coverage reached 93%.

Water quality

Records for water quality are available from 2006 to 2015. Between 2006 and 2010 the percentage of tests which passed the quality standards for residual chlorine rose from 72% to 83% (Figure 7), and the percentage of samples which tested other parameters (odour, colour, turbidity, suspended solids, dissolved silicon dioxide, total dissolved solids, total suspended solids acidity, temperature, conductivity, total alkalinity, total hardness, salinity, chemical oxygen demand, organic material, total iron, phosphate, sulphate, nitrate, ammonium, ammonia, chlorine dioxide, manganese, permanganate, lead, arsenic, mercury, cyanogen, alkaloids, residual chlorine, total coliform, alum dose and lime dose) fluctuated between 82% and 88%, registering 87% in 2010 (Figure 8). The tests which did not meet the requirements failed due to turbidity. In 2011, there was a significant increase in the percentage of samples meeting quality standards. The percentage of tests for residual chlorine which passed quality standards was 96% in 2011 and, although the results fluctuated from 90% to 91% between 2012 to 2014, the percentage reached 96% again in 2015 (Figure 7).

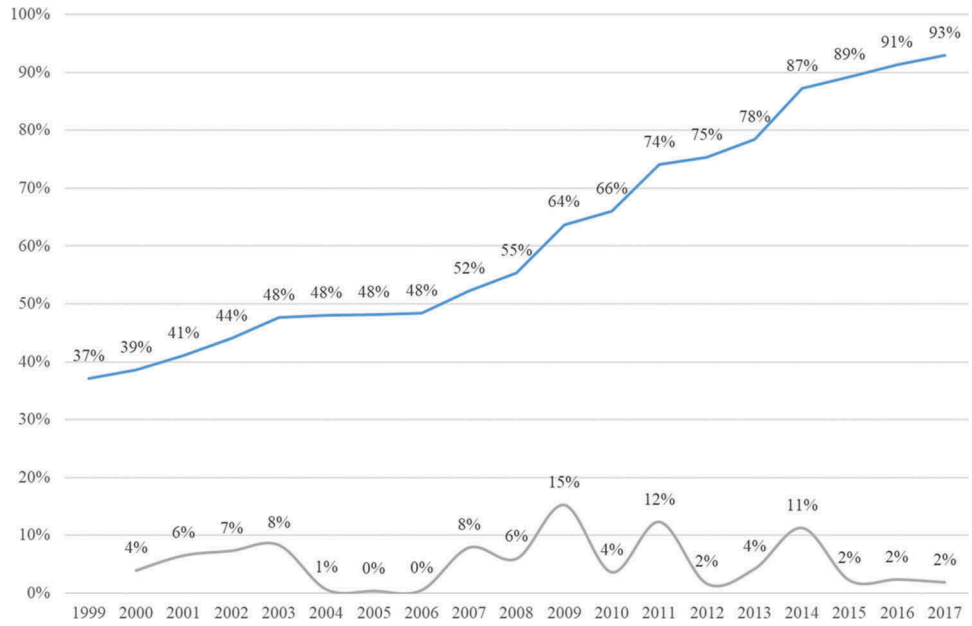


Figure 6. Service coverage of water supply (% and % change), 1999 to 2017. Data from Dawaco, Da Nang, Vietnam, 2018.

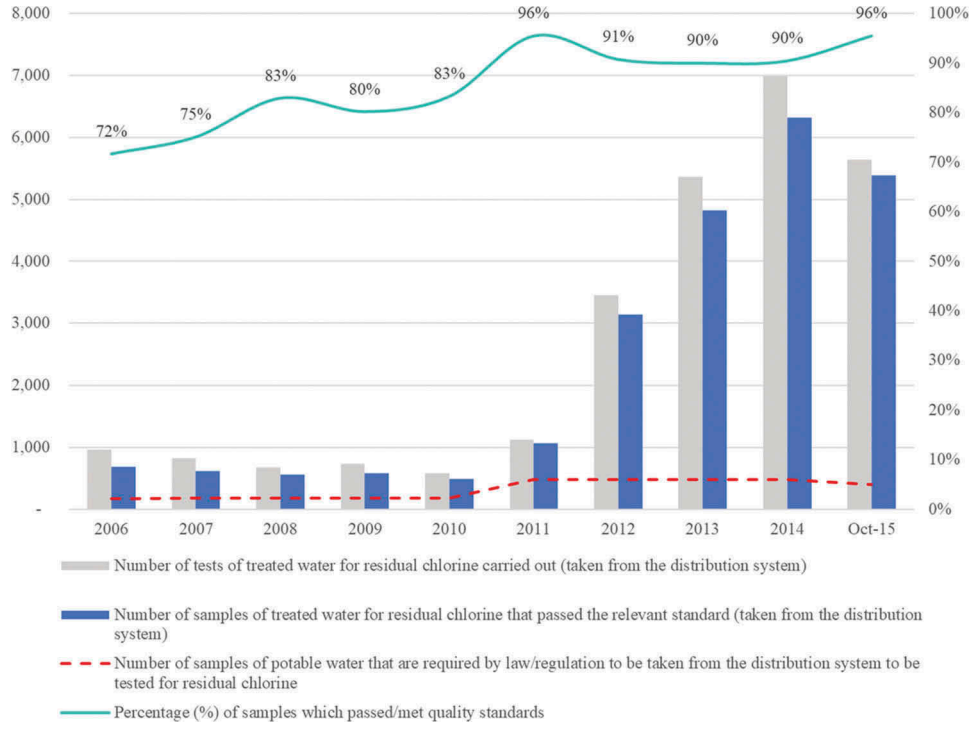


Figure 7. Number of tests of treated water for residual chlorine and percentage of samples which passed quality standards from 2006 to October 2015. Data from Dawaco, Da Nang, Vietnam, 2018.

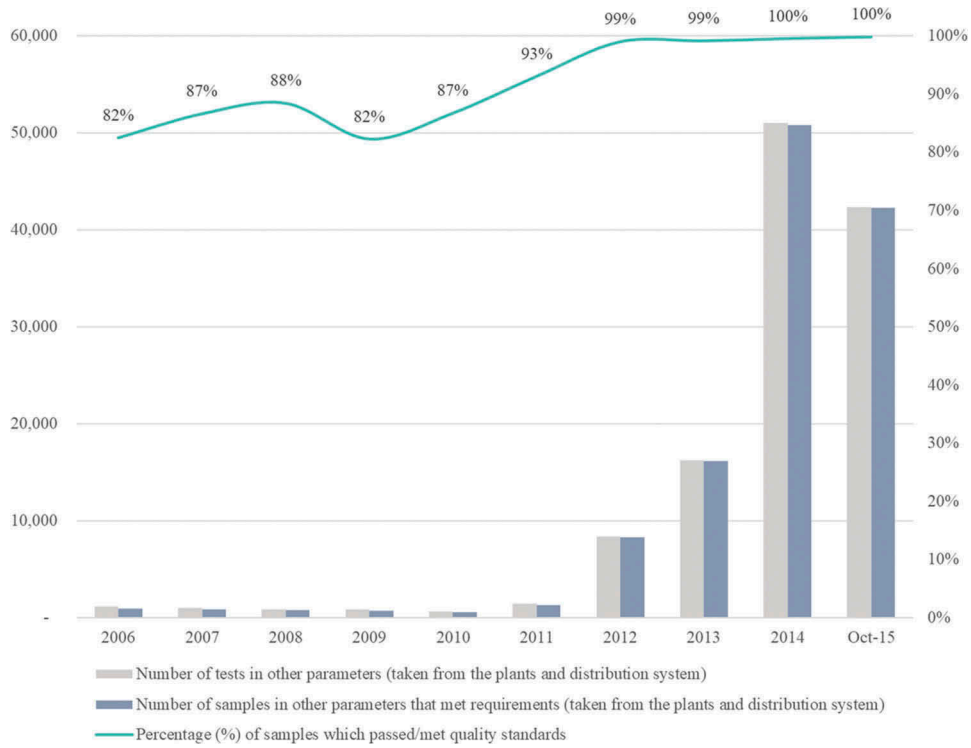


Figure 8. Number and percentage of tests for other parameters and percentage which met requirements from 2006 to October 2015. Data from Dawaco, Da Nang, Vietnam, 2018.

The percentage of tests for other parameters which met requirements increased to 93% in 2011 and to 99% in 2012, reaching 100% by 2014 (Figure 8).

Non-revenue water

The most commonly referred-to KPI is the reduction of non-revenue water, which is the volume of water that is not billed (including unbilled metered and unmetered consumption) or is simply lost (due to unauthorized consumption, metering inaccuracy, or leaks from the network) (see 'IWA Water Balance' in Charalambous & Hamilton, 2011, p. 5). During the time of the VEI–Dawaco WOP, the percentage of unaccounted-for water, or non-revenue water, was successfully lowered from 38.9% to 26.1% (Soppe, 2011). After 2010, non-revenue water dropped to 21% in 2011 and to 17% by 2014. In 2015 and 2016, non-revenue water stabilized at 17% and, in 2017, non-revenue water reached its lowest value with 15% (Figure 9).

Full cost recovery

The percentage change of Dawaco's equity shows a steady increase from 2007 to 2010, a continuing trend which strengthened with the progress the company made since 1999

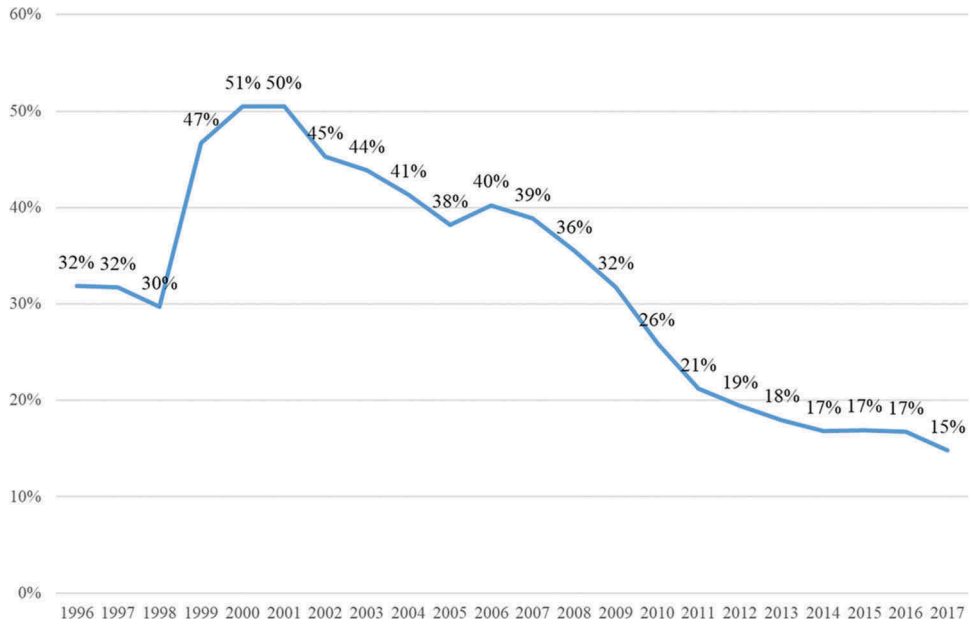


Figure 9. Non-revenue water, % of total, 1996 to 2017. Data from Dawaco, Da Nang, Vietnam, 2018.

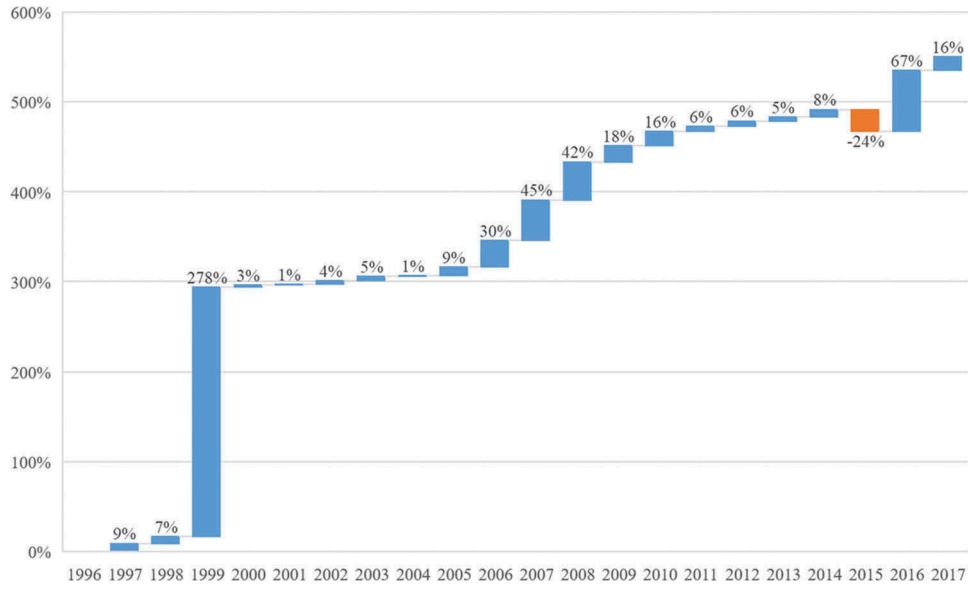


Figure 10. Dawaco's equity (% change), 1996 to 2017. Data from Dawaco, Da Nang, Vietnam, 2018.

(Figure 10). The percentage of change of the company's operating profit also shows a steady growth during the years the VEI–Dawaco WOP took place, a trend which had started in 2006 (Figure 11). As for Dawaco's profit after tax, changes would only be

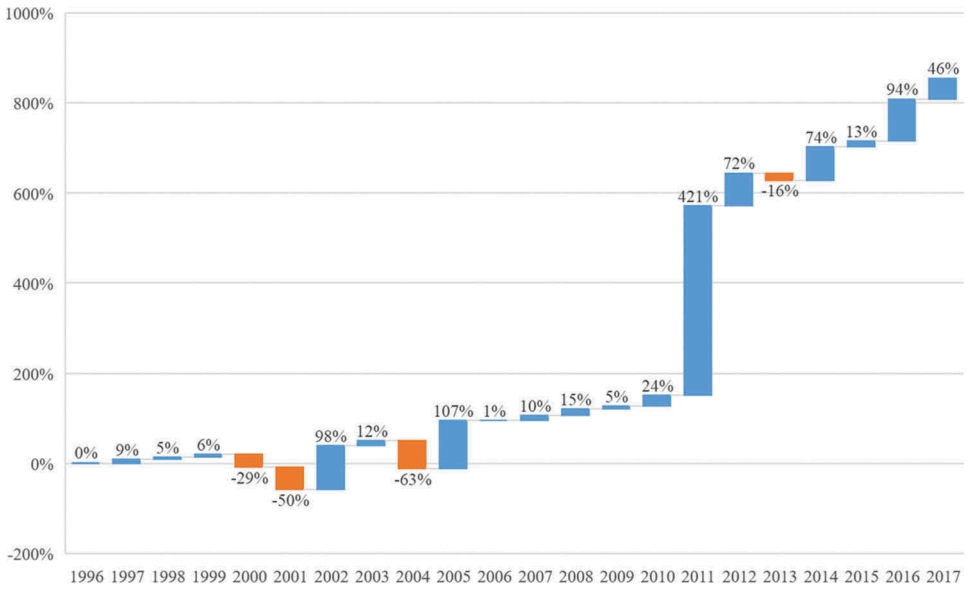


Figure 11. Dawaco's operating profit (% change), 1996 to 2017. Data from Dawaco, Da Nang, Vietnam, 2018.

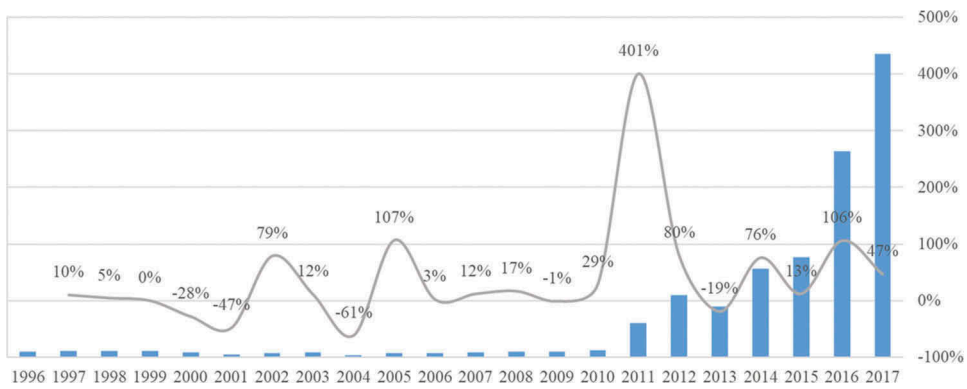


Figure 12. Dawaco's profit after tax (% change), 1996 to 2017. Data from Dawaco, Da Nang, Vietnam, 2018.

apparent with the rapid growth after the partnership ended in 2011, continuing until 2017 (Figure 12).

Structural changes, including the creation of a new tariff structure, the equitization of the company and the changes in its financial system, took place in 2010 and immediately after the WOP ended, in January 2011. The most visible results in the percentage change of Dawaco's operating profit and profit after tax occurred a year after the partnership ended. In 2011, Dawaco's operating profit sky-rocketed 421%, and its profit

after tax increased 401% upon conclusion of the WOP, continuing to increase steadily until 2017 (Figures 11 and 12).

Dawaco's operational capacity and financial sustainability *vis-à-vis* other factors

Not all these improvements can be attributed solely to the VEI–Dawaco WOP. Even though the changes implemented during the partnership seem to have had a permanent effect on the company's performance, parallel projects also played a role in strengthening Dawaco's operational capacity and financial sustainability. From 2008 to 2009, Dawaco worked with Haiphong Water Supply Company (HWSC) and Manila Water Company (MWC) in the frame of two (formal) simple partnerships (Figure 1(b)) (PSIREN, 2009a, 2009b). Between May 2008 and December 2009, the HWSC–Dawaco WOP focused on reducing non-revenue water, increasing productivity by assessing training of personnel for specific tasks, and strengthening management by encouraging cooperation between internal departments (GWOPA/UN-Habitat, 2011a). From December 2008 to April 2009, the MWC–Dawaco WOP concentrated on water quality management, addressing residual chlorine issues and carrying out pipe flushing activities (as specified the VEI–Dawaco WOP as well; see Table A1 in the online supplemental data) (GWOPA/UN-Habitat, 2011b). The HWSC–Dawaco WOP was facilitated by ADB, and the MWC–Dawaco WOP was supported by USAID, under their Environmental Cooperation-Asia project (Dawaco, HWSCO, ADB, 2008a; PSIREN, 2009a; USAID, 2008).

ADB has also played an important role in linking project activities to a larger pool of investment funds through the facilitation of technical assistance (project IDs 41456–012: TA 7144-VIE and 44002–022: TA 8357-VIE) and investments in infrastructure projects (project ID 41456–033: Loan 2961-VIE and the Public-Private-Partnership Infrastructure Project led by JICA) (Figure 13). The activities carried out under the scope of ADB built on the improved operational capacity achieved by the WOPs. In the case of projects with overlapping time frames, there is evidence of a coordination of activities where the partners made efficient use of resources to achieve common goals (see e.g. the overview of the complementary scope of assistance of the government of the Netherlands and the ADB in Dawaco, 2007).

Discussion

The external factors which contributed to the successful implementation of the VEI–Dawaco WOP in Da Nang were the political support from PC Da Nang and the availability of funds from the Netherlands Ministry of Foreign Affairs provided by the RNE in Hanoi. The possibility of allocating a third of these funds to equipment and software, and nearly half to human resources, resulted in a significant investment to build Dawaco's technical and managerial capacity. The internal factors which harnessed the improvement of KPIs during the 27 months that the partnership took place can be attributed to the strong motivation and commitment of Dawaco's management staff to implement changes in the utility, as well as the openness of both VEI and Dawaco to communicate the utility's needs and transfer expertise.

But the factors which contributed to the success of the VEI–Dawaco WOP were not limited to the organizational changes and activities carried out within the frame of the

partnership. Supported by different financial institutions, the parallel WOPs and subsequent support programmes carried out since 2007 contributed to the overall success of the partnership's goals and played an important part in sustaining the results of the WOP. It is possible to infer that the continuity of improvements of the KPI trends was influenced by the technical assistance facilitated by ADB (from 2008 to 2009, and again from 2013 to 2014), accompanied by the funding provided through the Multi-Donor Trust Fund and Water Financing Partnership Facility (from 2013 to 2019), as well as the long-term public–private partnerships supported by JICA and the investments channelled through ADB's Urban Water Supply programme in Vietnam (with planned execution until 2036).

Dawaco's improved operational capacity and stronger financial position prepared the utility to receive and manage larger investments for the modernization of the city's water infrastructure. In other words, the activities carried out during the VEI–Dawaco WOP (including the MWC–Dawaco WOP and HWSC–Dawaco WOP) also improved Dawaco's creditworthiness (cf. Mels, 2018) and allowed the company to draw from a larger pool of funds to sustain its development and ensure safe water provision.

The WOP approach offered the possibility of leveraging the effects of a small budget and build on the company's own capacity, allowing it to subsequently manage larger investments in water infrastructure development projects. Considering that WOPs are relatively inexpensive (cf. Batten, 2010), leveraging funds from other organizations improved the sustainability of the water utility's improvements. Contrary to Patrón-Coppel and Schwartz (2011, pp. 580–581) questions regarding replicability and the unlikeliness that '(external) funding opportunities will frequently exist', we see a high probability of linking WOPs with parallel funding and post-WOP investments, as shown in the representation of WOPs as key processes linking international and regional investments in urban water supply (Figure 13). In the case of ADB, WOPs have supported USD 2.3 billion of investments in water and sanitation provision (ADB, 2017). Furthermore, the WaterWorX programme is set to mobilize loans for large-scale investments in Africa, Asia and Latin America until 2030, making WOPs an integral step in increasing the sustainability of water services.

Contrary to the assumption that WOPs depend on the ability of public mentor utilities to undertake peer-to-peer learning partnerships with their own resources, this study has explored how WOPs can work together with other forms of assistance. However, there is also evidence of where WOPs have differed in other contexts. A critical report from Terhorst (2012) regarding WOPs in Latin America and the Caribbean has raised questions about WOPs being used as 'policy vehicles' to promote an agenda of public–private partnerships and business opportunities. Just as there are failures in public–private partnerships (as demonstrated by the water riots and violence in the 1980s and 1990s; see Datta, 2015), there are bound to be failures in WOPs (e.g. due to poor management or project design, insufficient time investment, lack of data, unrealistic assumptions regarding tariff increases and levying fees, or failure to internalize processes; see EuropeAid, 2017). In such instances, it is important to keep in mind that WOPs are not stand-alone projects. WOPs have a supporting role in the improvement of urban water services and should be understood as a means to an end. The value of a not-for-profit mechanism in an increasingly marketized economy should be highlighted and improved, rather than seen as a threat.

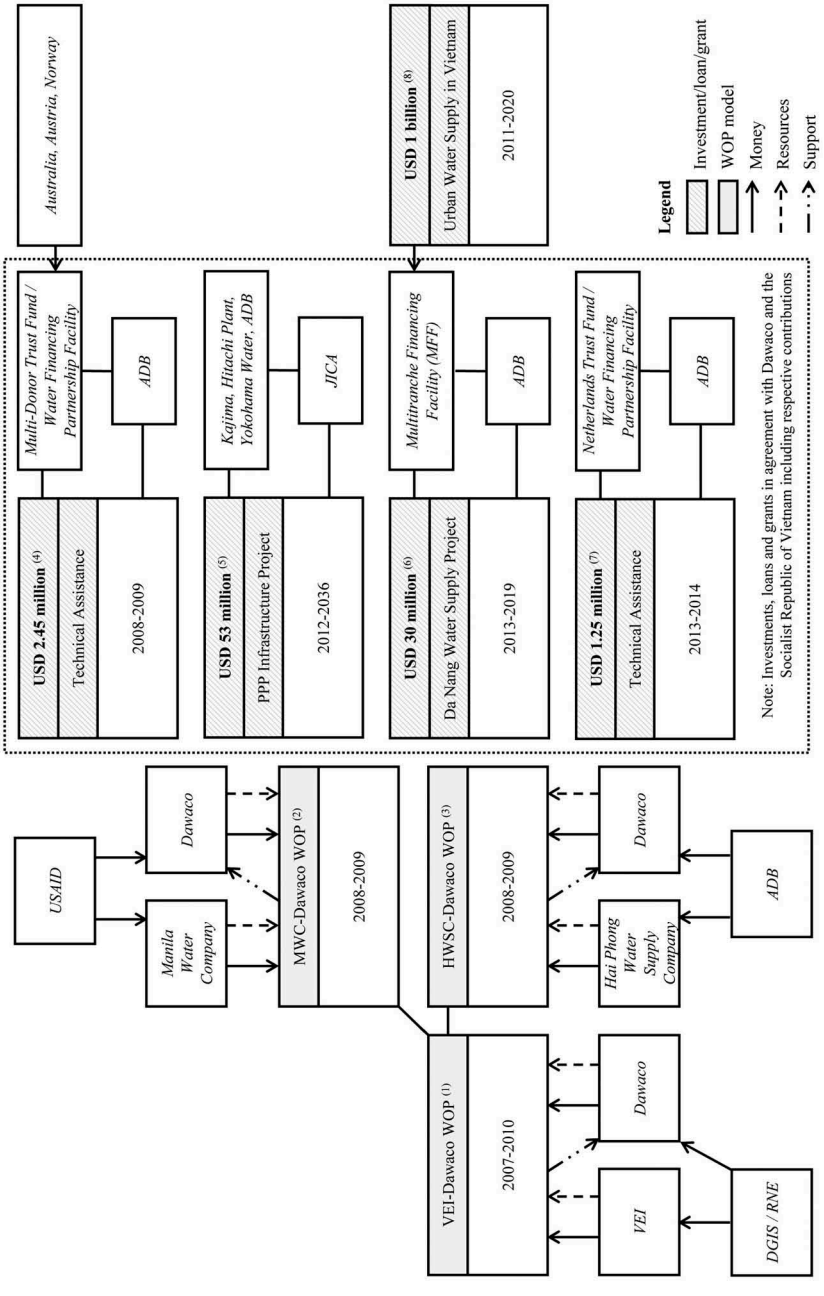


Figure 13. WOPs as key processes of international and regional investments in urban water supply. Sources: (1) This paper and Wright-Contreras (2018); (2) PSIREN (2009a); (3) PSIREN (2009b); (4) ADB (2008a); (5) Kajima Corporation, Hitachi, Ltd., Yokohama Water Company, Original Engineering Consultants Co., Ltd., Global Water Recycling and Reuse System Association (2012); (6) ADB (2013a, 2012a, 2012b); (7) ADB (2013b, 2013c); (8) ADB (2012a).

The case of Da Nang shows the supporting role of WOPs in enhancing utility performance in combination with factors which enabled long-term results. Even though the VEI–Dawaco WOP excelled in capacity building at the project level and paved the road for transnational investment opportunities, some still argue that there is much more work to be done with regard to the institutional development of the water sector (Du, Bui, Buurman, & Quach, 2018; interview, ADB, 2018). This means that socio-technical transitions towards a resilient and sustainable management of water resources depend on the creation of a conducive environment with the political will and the necessary know-how to foster innovation. In this sense, knowledge sharing and capacity building can be achieved through global networks of cooperation (Wright-Contreras, 2019). And WOPs, specifically, have the potential to assist in the implementation of strategies to ensure access to safe water and influence policy making – two WOPs led by ADB, in Nepal and Fiji, have shown that WOP projects on sanitation were first used by utilities, and then elevated to national standards (ADB, 2017).

Conclusion

This article has defined WOPs (in terms of duration and availability of resources) and showed how they function as key processes in larger operations of water infrastructure development. The research has illustrated a comprehensive, (medium-term) structured partnership, integrated within a broader scheme of international and regional funding programmes and external forms of assistance, including parallel, (short-term) national and regional WOPs. The factors which contributed to the successes of the VEI–Dawaco WOP included political support, the availability of funds, and clear communication from both sides of the twinning project. The continuity of results, however, was favoured by the coordination of efforts through simultaneous WOPs which contributed technical know-how (focusing on specific targets such as non-revenue water and water quality), as well as the improvement and the strengthening of the water utility's capacity. The combination of efforts of international financial institutions to promote technical assistance and invest in larger infrastructure development projects also increased the confidence of donors and contributed to the achievement of full cost recovery (also advancing the company's equitization). Regardless of what direction WOPs can be steered towards, this study emphasizes that WOPs are not stand-alone projects. Understanding the nature of WOPs and their supporting role in the improvement of urban water services is necessary to evaluate the direction of development cooperation in the water sector.

Acknowledgments

The authors would like to thank Marco Schouten, CEO of VEI, for authorizing access to documents regarding the VEI–Dawaco WOP, as well the cooperation of Dawaco's current personnel in responding to all queries during the research. Our gratitude is also extended to Hubert Jenny, ADB principal infrastructure finance specialist of the People's Republic of China, and Christopher Moster, lead facilitator for ADB WOPs, for their valuable input during the final writing stage. Thank you also to Cecilia Tortajada, editor-in-chief of the *International Journal of Water Resources Development*, for her guidance and timely feedback, and to the anonymous reviewers for providing valuable comments and suggestions during the peer-review process.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The writing of the manuscript was supported by the Deutscher Akademischer Austauschdienst [57214224].

ORCID

Lucía Wright-Contreras http://orcid.org/0000-0003-3879-1744

References

ADB. (2008a). (41456-012: Technical Assistance Report-VIE, Preparing the Da Nang Water Supply Project (Financed by the Multi-Donor Trust Fund Under the Water Financing Partnership Facility)).

ADB. (2008b). (41456-012: Project data sheet). Da Nang Water Supply Project.

ADB. (2012a). (41456-033: Periodic financing request report-VIE: Water sector investment programme (Tranche 2)).

ADB. (2012b). (41456-033: Project data sheet, loan 2961-VIE, Water sector investment programme (Tranche 2)). Da Nang, Haiphong, Tinh Binh Duong, Tinh Dak Lak, Tinh Thua Thien-Hue.

ADB. (2013a). (41456-033: Loan agreement 2961-VIE, water sector investment programme, project 2, between Socialist Republic of Vietnam and Asian Development Bank).

ADB. (2013b). (44002-022: Project data sheet, TA 8357-VIE, improving operational performance of the water supply sector).

ADB. (2013c). (44002-022: Technical assistance report-VIE, improving operational performance of the water supply sector (financed by the netherlands trust fund under the water financing partnership facility)). Capacity Development Technical Assistance (CDTA).

ADB. (2017). *Forging partnerships among water and wastewater operators*. Manila, Philippines: Asian Development Bank.

Barrington, D., Fuller, K., & McMillan, A. (2013). Water safety planning: Adapting the existing approach to community-managed systems in rural Nepal. *Journal of Water, Sanitation and Hygiene for Development*, *3*, 392–401. doi:10.2166/washdev.2013.120

Batten, J. J. (2010). Building utility partnerships and capacity. *American Water Works Association*, *102*, 36–37. doi:10.1002/j.1551-8833.2010.tb10078.x

Beck, A. (2018). Water operator partnerships: Peer learning and the politics of solidarity in water and sanitation service provision. *Wiley Interdisciplinary Reviews: Water*, e01324. doi:10.1002/wat2.1324

Bélanger Dumontier, M., McDonald, D. A., Spronk, S., Baron, C., & Wartchow, D., 2016. Social efficiency and the future of water operators' partnerships (Occasional Paper No. 29), *Municipal Series Project*.

Bishop, W. J. & Kong, S. (2010). AWWA. IWA water operators partnerships (WOPs) program: Partnering US utilities with developing nation urban utilities. *2010 Awwa Annual Conference (Ace) Proceedings*. Denver, CO: AWWA.

Bjerggaard, S. (2009). *Water operators and their associations supporting WOPs*.

Black and Veatch. (2010). TA No. 7144-VIE: Da Nang water supply project. (*Draft Final Report, Volume VII, Asset Management (Draft Final Report)*). Hong Kong: Author.

Boag, G. & McDonald, D. A. (2010). A critical review of public-public partnerships in water services. *Water Alternatives*, 3(1), 1–25.

Breeveld, R., Hermans, L., & Veenstra, S. (2013). Water operator partnerships and institutional capacity development for urban waster supply. *Water Policy*, *15*, 165. doi:10.2166/wp.2013.018

Charalambous, B. & Hamilton, S. (2011). Water balance - the next stage. *Water Utility Journal*, *1*, 3–10.

Datta, A. (2015). Public-private partnerships in India: A case for reform? *Economic and Political Weekly*, *XLIV*, 73–78.

Dawaco. (2007). *Overview complementary scope of assistance of government of the Netherlands and the ADB*.

Dawaco. (2017). Dawaco, Danang Water Supply and Drainage Joint Stock Company; Công ty cổ phần cấp thoát nước đà nẵng (Original in Vietnamese) [WWW Document]. Retrieved from http://dawaco.com.vn/

Dawaco, HWSCO, ADB. (2008a). *Memorandum agreement between Da Nang water supply company (Dawaco) and Haiphong Water Supply One Member Company, Ltd*. Da Nang: (HPWSCO) and Asian Development Bank (ADB).

Dawaco, VEI, RNE, PC Da Nang. (2007). (Memorandum of Understanding for Public-Private-Partnership (PPP) between the Da Nang Water Supply Company (DWSC) and Vitens-Evides International BV (VEI) and The Royal Netherlands Embassy (RNE), and The People's Committee (PC) of Da Nang City). Ho Chi Minh City: Author.

Dawaco, VEI, RNE, PC Da Nang. (2008b). *Inception report, utility support programme Dawaco*. (Public-Private-Partnership (PPP), Da Nang Water Supply Company (Dawaco), Vitens-Evides International (VEI), the Royal Netherlands Embassy/Government of The Netherlands (RNE), and the People's Committee (PC) of Da Nang City (No. Final)). Da Nang: Author.

Du, T. L. T., Bui, D. D., Buurman, J., & Quach, X. T. (2018). Towards adaptive governance for urban drought resilience: The case of Da Nang, Vietnam. *International Journal of Water Resources Development*, *34*, 597–615. doi:10.1080/07900627.2018.1438886

Dutch Water Sector. (2017). (Dutch water utilities launch WaterWorX programme at celebration of world water day [WWW Document]). Author. Retrieved from https://www.dutchwatersector.com/news-events/news/24309-dutch-water-utilities-launch-waterworx-programme-at-celebration-of-world-water.html

EuropeAid. (2017). *Elaboration of a strategy proposal for strengthening partnership for capacity development in the ACP water and sanitation sector*.

Evides Waterbedrijf. (2018). Water for Life [WWW Document]. www.evides.nl. Retrieved from https://www.evides.nl/drinkwater/water-for-life

Gallego-Ayala, J., Dimene, C., Munhequete, A., & Amos, R. (2014). Assessing the performance of urban water utilities in Mozambique using a water utility performance index. *Water SA*, *40*, 665. doi:10.4314/wsa.v40i4.12

Giesemann, M., Roche, D., Austin, S., & Moulton, T. (2009). Water operator partnerships - A Simple way to help water utilities in developing countries. *Water*, *36*, 42–44.

Greaves, F. & Simmons, C. (2015). *Water safety plans for communities: Guidance for adoption of water safety plans at community level, water safety plans for communities*. Teddington, UK: Tearfund.

GWOPA/UN-Habitat. (2011a). *WOP: Hai Phong water supply company and Da Nang water supply company [WWW Document]*. Retrieved from https://gwopa.org/en/wop-profiles/wop-haiphong-water-supply-one-member-company-da-nang-water-supply-company

GWOPA/UN-Habitat. (2011b). *WOP: Manila water company and Da Nang water supply company [WWW Document]*. GWOPA. Retrieved from https://gwopa.org/en/wop-profiles/wop-manila-water-international-solutions-danang-water-supply-company

GWOPA/UN-Habitat. (2015). *Case studies & factsheets [WWW Document]*. GWOPA. Retrieved from https://gwopa.org/en/gwopa-news/case-studies-factsheets

GWOPA/UN-Habitat. (2019). *WOPs in practice [WWW Document]*. Retrieved from https://gwopa.org/en/wops-in-practice

Hall, D., Lobina, E., Corral, V., Hoedeman, O., Terhorst, P., Pigeon, M., & Kishimoto, S., (2009). *Public-Public Partnerships (PUPs) in water, Financing Water and Sanitation. Public Services International Research Unit (PSIRU), Transnational Institute (TNI), and Public Services International (PSI)*.

Hendry, S. (2015). *Frameworks for water law reform, International hydrology Series*. Cambridge: Cambridge University Press.

IRC. (2014). *Evaluation of The Netherlands government's development assistance for water and sanitation*. The Netherlands: The Hague.

IWA, GWOPA, VEI. (2009). *Water Operators Partnerships Building WOPs for sustainable development in water and sanitation*. International Water Association (IWA), Global Water Operators' Partnerships Alliance (GWOPA)/UN-Habitat, and Vitens-Evides International (VEI).

JICA. (2018). *Danang city water environment improvement project [WWW Document]*. Author. Retrieved from https://www.jica.go.jp/english/our_work/social_environmental/id/asia/southeast/vietnam/c8h0vm00009r4hjo.html

JICA, Kajima Corporation, Hitachi, Ltd., Yokohama Water Company, Original Engineering Consultants Co., Ltd., Global Water Recycling and Reuse System Association. (2016). *Preparatory survey for Da Nang City Hoa Lien Water Supply Project (PPP Infrastructure Project) final report*. Japan International Cooperation Agency.

Kajima Corporation, Hitachi, Ltd., Yokohama Water Company, Original Engineering Consultants Co., Ltd., Global Water Recycling and Reuse System Association. (2012). *Summary of the proposed preparatory survey for Da Nang Hoa Lien new water supply PPP project*.

Mahmud, S. G., Shamsuddin, S., Jafar, A., Ahmed, M. F., Davison, A., Deere, D., & Howard, G. (2007). Development and implementation of water safety plans for small water supplies in Bangladesh: Benefits and lessons learned. *Journal of Water and Health*, *5*, 585–597. doi:10.2166/wh.2007.045

McIntosh, A. C. (2003). *Asian water supplies: Reaching the urban poor: A guide and sourcebook on urban water supplies in Asia for governments, utilities, consultants, development agencies, and nongovernment organizations*. London: Asian Development Bank; International Water Association, Manila, Philippines.

Mels, A. (2018). *VEI: How to support urban water utilities to become creditworthy? [WWW Document]*. SNV. Retrieved from http://www.snv.org/update/vei-how-support-urban-water-utilities-become-creditworthy

Ministry of Foreign Affairs of the Netherlands. (2012). *IOB evaluation. From infrastructure to sustainable impact: Policy review of the dutch contribution to drinking water and sanitation (1990-2011)*. The Hague, The Netherlands: Author.

Mvulirwenande, S., Wehn, U., & Alaerts, G. (2014). Closing the knowing-applying gap in water utilities: Experience from Uganda's NWSC. *Presented at the 37th WEDC International Conference,* Hanoi, Vietman.

Ndirangu, N., Ng'ang'a, J., Chege, A., de Blois, R.-J., & Mels, A. (2013). Local solutions in non-revenue water management through North-South water operator partnerships: The case of Nakuru. *Water Policy*, *15*, 137. doi:10.2166/wp.2013.117

Pascual-Sanz, M. (2014). Capacity development in water operator partnerships: More than just the right methods. *Presented at the 37th WEDC International Conference*, Hanoi.

Pascual-Sanz, M. & Hoffer, J. (2009). Water operator partnership in Mozambique: An assessment of the partnership on autonomy and performance? *Presented at the 10th Waternet/WARFSA/GWP-SA symposium*, Entebbe, Uganda.

Pascual-Sanz, M., Veenstra, S., Wehn de Montalvo, U., van Tulder, R., & Alaerts, G. (2013). What counts as "results" in capacity development partnerships between water operators? A multi-path approach toward accountability, adaptation and learning. *Water Policy*, *15*, 242. doi:10.2166/wp.2013.022

Patrón-Coppel, G. & Schwartz, K. (2011). Water operator partnerships as a model to achieve the Millenium Development Goals for water supply? Lessons from four cities in Mozambique. *Water SA*, *37*. doi:10.4314/wsa.v37i4.17

PSIREN. (2009a). *Manila water international solutions (Philippines) - Danang water supply company (Vietnam) | PSIREN [WWW Document]*. Retrieved from http://isslerhall.org/drupal/content/manila-water-international-solutions-philippines-danang-water-supply-company-vietnam

PSIREN. (2009b). *PUP: Haiphong Water/Vietnam – DAWACO/Vietnam twinning [WWW Document]*. Author. Retrieved from http://isslerhall.org/drupal/content/pup-haiphong-watervietnam-%E2%80%93-dawacovietnam-twinning

Quang, D. N. (2016). *Danang city: City development orientation towards sustainability and resilience*. Hanoi, Vietnam: UN-Habitat.

Rusca, M. & Schwartz, K. (2012). A historical perspective on partnerships in the provision of water supply and sanitation services in developing countries. In T. S. Katko, P. S., Juuti, & K. Schwartz (Eds.), *Water services management and governance: Lessons for a sustainable future. Governance and management for sustainable water systems series* (pp. 113–121). London: IWA Publishing.

Soppe, G. (2008a). Policy paper 2008-2020, partnership building phase Dawaco (No. 0.4). Vitens-Evides International.

Soppe, G. (2008b). Strategic plan 2008-2015, partnership building phase Dawaco (No. 0.4). Vitens-Evides International.

Soppe, G. (2011). End project report, public private partnership Dawaco, Da Nang (No. 0.1). Vitens-Evides International.

SRV. (2004). *Decision No. 148/2004/QD-TTg dated August 13, 2004 of the Prime Minister on major orientations for socio-economic development of the central Vietnam key economic region till 2010, with a vision to 2020*.

SRV. (2011). *Decree No. 124/201l/NDRCP of December 28, 2011, amending and supplementing a number of articles of the Government's Decree No. 117/2007INDRCP of July 11,2007, on clean water production, supply and consumption*.

Terhorst, P. (2012). *Critique of the water operator partnerships in Latin America and the caribbean (WOP-LAC) (Discussion paper)*. Transnational Institute.

Tobon, M. & Yates, D. (2014). Water operator twinning partnership between palm beach county water utilities department and Manila water concessionaires on planning for climate change impacts. *American Society of Civil Engineers*, 101–113. doi:10.1061/9780784478745.010

Tortajada, C. & Biswas, A. K. (2015). Editorial. *International Journal of Water Resources Development*, *31*, 483–485. doi:10.1080/07900627.2015.1094897

Tutusaus, M., & Schwartz, K. (2016). National water operators' partnerships: A promising instrument for capacity development? *Journal of Water Sanitation and Hygiene for Development*, *6*, 500–506. doi:10.2166/washdev.2016.040

UNICEF, WHO. (2015). *25th progress on sanitation and drinking-water: 2015 update and MDG assessment*. Geneva: World Health Organization.

United Nations. (2015). (United nations. Transforming our world, The 2030 Agenda for sustainable development: A/RES/70/1 [WWW Document]). Retrieved from https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

United Nations. (2017). *Sustainable development goal 6: Ensure availability and sustainable management of water and sanitation for all [WWW Document]*. Retrieved from https://sustainabledevelopment.un.org/sdg6

UNSGAB. (2006). *Hashimoto Action Plan (HAP)*. Compendium of Actions. New York: United Nations Secretary-General's Advisory Board on Water and Sanitation.

USAID. (2008). *Environmental Cooperation-Asia (ECO-Asia), water and sanitation/environmental governance (annual report)*. AECOM International Development, Arlington.

VEI. (2017). (Annual Report 2017).

VEI. (2018a). *About us [WWW Document]*. Retrieved from https://www.vei.nl/about-us

VEI. (2018b). *WaterWorX [WWW Document]*. Author. Retrieved from https://www.vei.nl/projects/waterworx

Vewin. (2017). *Dutch drinking water statistics 2017: From source to tap*. The Hague, The Netherlands: Author.

VidaGIS. (2018). *About VidaGIS [WWW Document]*. Author. Retrieved from https://vidagis.com/en/about/About-VidaGIS.html

Water for Life. (2018). *About Water for Life [WWW Document]*. Author. Retrieved from https://www.waterforlife.nl/en/

Water Health. (2017). *Water supply [WWW Document]*. Author. Retrieved from http://www.waterhealth.com/water-supply

WaterLinks. (2018). *WaterLinks: About the organization [WWW Document]*. Author. Retrieved from https://www.waterlinks.org/about

Watsisi, M. 2017. *A sustainability approach for hand pumps in rural areas*. IRC. Retrieved from https://www.ircwash.org/blog/guide-effective-adoption-and-implementation-pay-you-fetch-model-sustainability-approach-hand

WEF. (2016). *The global risks report 2016* (11th ed.). Geneva: World Economic Forum.

Wehn, U. & Montalvo, C. (2016). Knowledge transfer dynamics and innovation: Behaviour, interactions and aggregated outcomes. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2016.09.198

Whittington, D., Davis, J., Prokopy, L., Komives, K., Thorsten, R., Lukacs, H., … Wakeman, W. (2009). How well is the demand-driven, community management model for rural water supply systems doing? Evidence from Bolivia, Peru and Ghana. *Water Policy*, *11*, 696–718. doi:10.2166/wp.2009.310

World Bank. (2017). *Projects: Danang Sustainable City Development Project (SCDP) [WWW Document]*. Retrieved from http://projects.worldbank.org/P123384/danang-sustainable-city-development-project-scdp?lang=en

Wright-Contreras, L., 2018. *Water operators' partnership case study: VEI and Dawaco (Case Study)*. Nairobi: Boosting Effectiveness in Water Operators' Partnerships. UN-Habitat.

Wright-Contreras, L. (2019). A transnational urban political ecology of water infrastructures: Global water policies and water management in Hanoi. *Public Works Management & Policy*, *24*, 195–212. doi:10.1177/1087724X18780045

9. Contribution and summary of publications

The argument which has spearheaded the works of this cumulative dissertation underlines that WOPs sustainably contribute to the improvement of urban water supply in developing countries by strengthening the capacity of local water utilities to cope with technical, managerial and financial challenges of water service provision. The first publication focused on water quality and the unequal access to safe water; the second and third publications referred to place-specific adaptation of water services and the diversification of water supply and sanitation solutions; the fourth article elaborated on multilevel water governance and scalar politics. These four articles focused on the challenges of urban water supply in Hanoi, Vietnam. The fifth defined WOPs; and the sixth and seventh elaborated on a specific cooperation between the Netherlands and Vietnam.

The first publication, P-I, Chapter 2 (Wright-Contreras et al., 2017), elaborated on the layering of infrastructure networks, explaining the broad spectrum of water supply provided by different types of infrastructures with attention to water quality differences and the unequal access to safe water. The study gathered first-hand evidence of groundwater pollution in Hanoi (Red River Delta) and analyzes users' perception of water accessibility and satisfaction of coverage, quality and cost. Using splintering urbanism to show how large technological infrastructure networks fail to supply the growing suburban areas of Hanoi (i.e. splintering from 'above'), the work pointed at the incorporation of various scales of infrastructural solutions, including small-scale and affordable sources, decentralized and semi-centralized infrastructures. Specific contributions included the definition of suburbanization in the Vietnamese context, and the distinction between new urban areas and periurban villages. The article illustrated the city's water cycle, distinguishing the existing and potential raw water sources, and identifying the amounts of water produced and distributed by each company.

The second publication, P-II, Chapter 3 (Schramm and Wright-Contreras, 2017), built on the understanding of layered networks and included the notion of active citizenship by evidencing the agency that dwellers exercise when accessing water services. The article criticized the idea of splintering urbanism through infrastructural bypassing which views residents as victims of exclusion from basic services, and proposed the existence of a rather active engagement of residents in accessing water and organizing collectives to manage water and sanitation provision. An important addition was the study of urban development patterns which shape Hanoi, including the cartographic location of new urban areas and periurban villages and the evolution of the city's urban and rural districts in the last three decades.

The third publication, P-III, Chapter 4 (Schramm and Wright-Contreras, 2019), reinforced the linkage between water and sanitation by summarizing Hanoi's water cycle and the diverse technologies used to provide water and separate or treat wastewater in the city during the different

stages of its formation. The chapter highlighted the tendency of centralization and unification of infrastructures led by master planning and large-scale housing developments. Supporting the argument of active citizenship, it identified, however, the hybrid mixing of access to water and sanitation, from self-organized wells and septic tanks to community-based management of drainage and sewerage networks. The work also contributed with the notion of elite decentralization, explaining the development of networks of water and sanitation services for privately-developed housing compounds.

The fourth publication, P-IV, Chapter 5 (Wright-Contreras, 2019), used the case of Hanoi to understand the prioritization of the pipe-network scheme over other technologies in Vietnam. The article described transnational actors financing local water infrastructure projects and contextualized their work in relation global targets that aim to ensure access to safe drinking water. It also identified the existing and planned extensions of the city's water supply and drainage networks, including the location of current and future water treatment and wastewater treatment plants. It illustrated the water ownership structures of the four main water companies in Hanoi, as well as the water supply zones managed by the two largest water distributors. The empirical material explained the involvement of local, national and transnational actors supported by cross-border financial flows to invest in infrastructure development. It also added to the discussion of the overestimation of progress measured for the MDGs by underlining that, despite the efforts, global targets have not measured the progress made toward safe drinking water.

The fifth publication, P-V, Chapter 6 (Pascual-Sanz et al., 2018), explained the origin of WOPs and the main organizations which promote it, as well as the state-of-the art of WOPs according to UN-Habitat's Global Water Operators' Partnership Alliance (GWOPA), including: cumulative number of WOP profiles, duration of WOPs, types of cooperation (i.e. South-South, North-North, or North-South), regional distribution of WOPs, frequency of improvement themes featured in WOPs, and WOP costs. It makes for a good starting point to clarify the intention of WOPs advocating for universal and sustainable access to water services, per the global agenda led by the United Nations and the existing SDGs.

The sixth publication, P-VI, Chapter 7 (Wright-Contreras, 2018), studied a specific WOP between a Dutch water operators' organization and the water utility of Da Nang. Published as a technical report for UN-Habitat, the study described the results of a cooperation which took place between 2007 and 2010 with the objectives of extending and improving water services in Da Nang, as well as improving the local water utility's management capacity and financial position. The contribution of this report was the first-hand assessment of a transnational cooperation supported by global actors, and the understanding of the potential and replicability of WOPs in other contexts.

The seventh publication, P-VII, Chapter 8 (Wright-Contreras, Perkins, Pascual-Sanz, & Soppe, 2019), was based on a review of the academic literature regarding WOPs, and the field

study results of development cooperation and large-scale infrastructure investments in Da Nang. The article referred to the concept of ‘multiple-funding source partnerships’ to describe the series of relations which gave way to the improvement of water supply services in Da Nang. Having situated the work of UN-Habitat in relation to other organizations, such as the Asian Development Bank (ADB) and Japanese International Cooperation Agency (JICA), it defined the operating strategy of VEI, the world’s leading non-profit promotor and implementer of WOPs. Furthermore, it contributed to the understanding of the conditions which allow WOPs to influence the long-term operational capacity and financial sustainability of water utilities. The paper illustrates, in an on-going revision, how WOPs function as key processes of international and regional investments in urban water supply.

10. Critical discussion

Global trends of water governance are reflected in complex, cross-scale, and multilevel interactions between transnational organizations and local stakeholders working to achieve access to safe water in the Global South. Moving beyond the debates of North-to-South development discourses and ideal visions of progress, we face the reality that cities such as Hanoi and Da Nang are reaching a boost of urban and economic growth, yet still struggle with the increasing demand of basic services. To answer the first main research question regarding what are the challenges to access safe water in Hanoi and how they are reflected in the built environment, four methodological approaches were essential:

a) the analysis of the city's water cycle by identifying existing and potential raw water sources, as well as the volume of water produced and distributed by each company;
b) the study of urban development patterns that characterizes a city, including the cartographic representation of the development of urban and rural areas in recent decades;
c) the identification and location of water and sanitation infrastructures, how they are managed, and the planned expansions, including duration and expected investments; as well as
d) the description of the involvement of local, national and transnational actors in local water infrastructure projects, including the financing of infrastructure development projects in relation to global targets.

The analysis of water infrastructures in Hanoi brought attention to the potential diversification of raw water sources, the broad spectrum of water supply alternatives, and the differences of water quality and affordability in suburban areas. The most critical empirical findings can be summarized in two points:

1) the presence of heavy metals affecting the health of millions of people in the Red River Delta, and
2) the high percentage of water losses (over a third of the treated water) from the pipe network.

In order to address these challenges, and as a means to support public water utilites, the second research question zommed in on the effects of WOPs on the improvement of urban water supply. From the analysis of the VEI-Dawaco WOP in Da Nang, three lessons can be drawn regarding: the continuity of utility performance improvements, sustainable water management transitions, and the effects of WOPs on poverty reduction.

10.1. The continuity of utility performance improvements

The initial findings of the research indicated that knowledge-transfer and capacity-building between water utilities in the form of non-profit, peer-to-peer partnerships, have the potential to contribute to the sustainable improvement of their performance.

In the study of Da Nang, the partnership with VEI paved the road for a secure, and continuous investment in water infrastructures through the cooperation with USAID, ADB and JICA, and through multi-donor trust funds, channeling resources from Australia, Austria, Netherlands, and Norway (Wright-Contreras et al., 2019). In this case, it is important to make a distinction between the effects that WOPs had on the improvement of urban water supply, versus the city-level development strategies linked to international regimes.[20] While there is evidence that WOPs can be used as vehicles to promote public-private partnerships (PPP) and business opportunities (e.g. cases of WOPs in Latin America and the Caribbean; cf. Terhorst, 2012), it is important to acknowledge that WOPs are coping with a reality blended by public and private actors which are constantly changing in the development of water supply in cities. Interestingly, in the process of contributing to the literature on WOPs, there was a strong discussion regarding the development of for-profit activities followed by a WOP intervention, rather than the immediate performance-based improvements triggered by WOPs. Hence, there is a need to differentiate between the supporting institutions and the role of WOPs in the development of urban water supply.

In summary, WOPs are not stand-alone project. Instead, WOPs exercise a supporting role in the improvement of urban water services and should be understood as a means to an end (Wright-Contreras et al., 2019). The continuity of a utility's improvements is influenced by the organizational changes supported during the exchange within a WOP, but is dependant of subsequent investments and technical assistance received from external organizations.

Moreover, some argue that there is much more work be done with regards to the institutional development of the water sector (Interview ADB, 2018). While WOPs make advances in the arena of science-industry collaboration, the science-policy translation is a bit trickier. Two cases of WOPs lead by ADB, in Nepal and Fiji, have shown that WOP projects on

---

[20] For clarity, *international orders* refer to broad governing frameworks arrangements of activities in the international realm (e.g. international economic order), *international regimes* refer to specialized arrangements of social institutions governing specific activities (e.g. international foreign investment regime), *institutions* correspond to social practices governed by rules and conventions (e.g. markets), and *organizations* are legal entities with a physical location (e.g. United Nations) (Young, 1989). This scalar-thinking is a prerequisite for understanding the connections within the international society related to water.

sanitation (i.e. septic tanks and liquid trade waste) were first used by utilities and were then elevated to national standards (by integrating fecal sludge management in the government's water, sanitation, and hygiene policy framework and developing a liquid trade waste policy, respectively) (ADB, 2017). In the case of Vietnam, national urban water supply programs prioritize the expansion of existing pipe networks and large-scale water production (Interview MARD, 2014). This means that socio-technical transitions toward a sustainable management of water resources depend on the creation of a conducive environment with the political will and the necessary know-how to foster innovation.[21]

10.2. Sustainable water management transitions

When speaking of a water-sensitive-city approach, at this stage, WOPs are influencing the first and second of the six transition phases, supporting transitions to a water supply city and sewered city. However, municipal water supply in Vietnam accounted for only 1.5% of the total water usage in 2005 (in comparison to almost 95% for agricultural use and 3.7% for industrial use; cf. FAO, 2016). In order to have a significant impact on supply and demand water management, WOPs would have to focus on irrigation water management (IWM) to achieve a significant shift toward sustainable water management and the creation of resilient urban water supply systems.

---

[21] Instigating a paradigm shift in water management, from potentially unreliable centralized networks to sustainable water supply solutions, requires continuous investment in research and development of innovative water technologies. To illustrate, a collaborative study reviews small-scale reverse osmosis (SWRO) desalination, considering energy requirements and cost constraints, and how the further development of energy-recovery devices could provide cost-effective solutions and benefit a wide range of users, including vulnerable populations in coastal areas. The eighth publication (P-VIII), included in the Appendix, touches on innovation. Through a review of the potential of SWRO desalination, the intention of this article is to raise awareness of the global challenges of providing access to safe drinking water (i.e. water stress and water scarcity). Looking at the growth of the desalination industry, the work proposes the improvement of energy-recovery devices to make small-scale SWRO cost-effective, providing, this way, a more affordable, decentralized, and flexible solution to access safe water. Considering that only 13 SWRO desalination plants have been recorded in Vietnam, as of 2016, with a capacity from 200 m^3 to 22,000 m^3 awarded between 2002 and 2014 (DesalData, 2016), the industry has the potential to develop and adapt to the needs of the Vietnamese market.

10.3. The effects of WOPs on poverty reduction

The VEI-Dawaco WOP delivered impressive results regarding increased coverage, NRW reduction, improved water quality, and full cost-recovery. Although Dawaco's operating profit and profit after tax sky-rocketed upon the adoption of the new water tariff, concerns regarding the equitable distribution of water remain. The number of connections for the urban poor were difficult to follow up on after the partnership ended. During the WOP period, from 2007 to 2010, the planned connections to the poor were surpassed by 30% (i.e. a total of 1,856 connections more than the 6,000 target) (Wright-Contreras, 2018). Afterwards, there was no available information of the monitoring of urban-poor connections to the network, except for a relatively small number of subsidized connections from 2011 to 2017 funded by the Coca-Cola Company (i.e. around 200 household connections per year, mostly in the rural areas) (Interview Dawaco, 2018).

Considering WOPs as non-profit, peer-to-peer support mechanisms between water operators, it is important to separate the improvements achieved through the partnership and the effects of these changes for broader developmental purposes. The findings of this research show that WOPs support pro-poor strategies, but currently lack the necessary benchmarking tools to measure the progress made during and after the partnership. This does not disqualify WOPs, but rather, emphasizes the need to rescue the public-ethos value (i.e. the prioritization of social goals over efficiency goals; cf. Bélanger Dumontier et al., 2016) inherent to WOPs.[22]

[22] Adding to the public-private debate, even PPP-led water service delivery can learn from WOPs' experiences and viceversa. For instance, the success of PPP-supported urban infrastructures in India have been measured based on the effects for poor people and its pro-poor institutional arrangements (e.g. employment/income, merit good and health effect, time-saving factor, achievement toward development goals, and marketing opportunities) (Van Dijk, 2008, p. 228).

11. Conclusion

The Global Water Leaders Group (2017, p. 3) assessed that the operating costs of facilities and services in the developing world amount to USD 396 billion, of which roughly 60% is dedicated to water and wastewater utilities and improved water sources. Besides the direct costs (i.e. payments to utilities and private water solutions), their report estimates time costs, direct and indirect healthcare costs, and deaths (i.e. 'value of life') caused by health risks due to poor water and sanitation systems; summing up to USD 323 billion (also known as the "cost of failure" cf. The Global Water Leaders Group, 2017, p. 14). What is more, the expense of coping with the failure of public water services is comparable to the total capital needed to run these services in developing countries. In other words, the capital and operating expenditures (i.e. capex and opex) of public utilities of USD 124 billion is comparable to the USD 120 billion invested in other sources to secure drinking water (such as packaged water, water from tankers, as well as household filtering and storage systems; expected to rise to USD 458 billion by 2030) (The Global Water Leaders Group, 2017, p. 13).

In the case of Hanoi, the challenges of keeping up with the demand of water are reflected in the required investments of USD 273 million and USD 450 million for the construction of two new water treatment plants (Wright-Contreras, 2019, p. 5). At the same time, the maintenance of a sound water supply system reflects the need for technical know-how and investments to reduce water losses in the piped distribution network which fluctuate between 20% to 32% and deliver safe water (Wright-Contreras et al., 2017, p. 66). Due to the high levels of naturally forming arsenic in the Red River Delta affecting the health of over 10 million people (M Berg et al., 2007; Michael Berg et al., 2001; Postma et al., 2007; Winkel et al., 2011), privately owned wells are discouraged by the government, which insists on projects to unify centralized water supply services. Little hope is set on transitioning (or 'leap-frogging' in the water-sensitive-city model) into a more sustainable water management through alternative means (e.g. rainwater harvesting and wastewater recycling) or through a combination of centralized and (non-elitarian) decentralized infrastructures.

Aiming to close the gap of state budget revenue and expenditure, the privatization of Vietnam's SOEs has been encouraged and is reflected through the country's integration in the global economy and participation in Free Trade Agreements (FTAs) with Australia Chile, China, India, Japan, Korea, and the EU (Do, 2017). With hundreds of enterprises marked for divestment, the state has earned over USD 8.5 billion between 2015 and 2018 (Das, 2018). The Prime Ministers' Decision No. 58/2016/QD-TTg established the criteria for classification of enterprises and a plan to divest state capital in the 2016-2020 period (SRV, 2016). Decision No. 37/2014/QD-TTg was replaced, and with it the minimum percentages of state holdings (e.g. indication to hold

on to at least 50% of the total stocks in the case of enterprises exploiting, producing and supplying urban clean water) (SRV, 2014). Private sector participation in Vietnam was determined at 2% in 2012 and expected to rise to 12% by 2025 (Owen, 2012, p. 46).

Based on the National Assembly's Resolution No. 24/2016/QH14, Resolution No. 25/2016/QH14 and Resolution No. 26/2016/QH14 on the plans to restructure the economy, in May of 2017, Decision No. 707/QD-TTg approved the restructuring of state-owned enterprises (SRV, 2017a), and Decision No. 1232/QD-TTg included minimum capital ratios expected to be withdrawn during the year for each company (e.g. 9.08% for Da Nang Water Supply Joint Stock Company) (SRV, 2017b). The process of privatization (referred to as equitization) of water companies in Vietnam will be completed by 2020. The Global Water Intelligence (GWI) Magazine reported that just 8 of the approximately 70 water utilities (or 79, according to Interview with ADB, 2018) remain 100% state-owned, including the utilities of the country's two largest cities, Hanoi (Hawaco) and Ho Chi Minh City (Sawaco) (GWI, 2018, p. 40).[23]

Given the controversy regarding privatization and the adoption of the PPP scheme (cf. Bayliss & Van Waeyenberge, 2017), WOPs surface as an option to support public water operators. Nevertheless, considering the unavoidable integration of private sector participation (cf. Miller, 1999), unlike PUPs, WOPs don't exclude private sector operators. The Hashimoto Plan of 2006 recommended the creation of WOPs and stated that "urgent water needs must be financed," "local authorities need to attract more funds for water operators," and "governments must develop appropriate finance mechanisms to ensure that necessary systems at the local level are built and maintained […]" (UNSGAB, 2006, p. 1). The document assumed that more than 90% of water operators were state-owned, yet, by May of 2018, almost 90% of water utilities in Vietnam were already partly privatized (GWI, 2018). The question of how many public water and sanitation operators currently exist in the world still remains, considering that the United Nations Secretary General's Advisory Board (UNSGAB) recognized at least 250,000 of them a decade ago (D. Hall et al., 2009, p. 12). This points to the need for an accessible database which contains up-to-date information on the ownership status of water utilities around the globe. Considering the advances made toward the compilation of data of water operators at a global scale and the sharing

[23] As shown through the case of Da Nang, Dawaco became a Joint Stock Company in 2016. The partnership with VEI from 2007 to 2010 proved to be a huge successful case in terms of the technical, managerial and financial performance improvements achieved through non-profit, peer-to-peer capacity-building. Has this particular WOP, then, achieved the overall objective of a WOP? In which case, can WOPs act as stand-alone mechanisms of cooperation that support publicly owned and managed water utilities? Or have are they been used as vehicles to promote PPPs and business opportunities, as Terhorst (2012) signaled with the cases in Latin America and the Caribbean?

of information with other organizations (e.g. GWOPA and ADB), it is imperative that multilateral organizations take responsibility for the coordination and alignment of resources. Private resources, such as the Global Water Intelligence's Project Tracker, also provide a useful starting point, listing global water and wastewater utilities, reuse and desalination facilities, as well as water and wastewater construction projects, and their advances within competitive bidding processes (GWI, 2019).

By acknowledging Vietnam's insertion in a global economy and its efforts to drastically equitize (i.e. privatize) all SOEs by 2020, WOPs and their supporting role within larger operations of water infrastructure development are better understood. The continuity of utility performance improvements can be partly attributed to the organizational and operational changes achieved during a WOP, combined with the strengthening of the company's financial position, and the possibility to leverage larger sums of investments for the development of water infrastructures. There has been little evidence, however, of WOPs being used to break away from technological path dependencies, and in the case of Vietnam, to propose alternatives to the expansion of centralized water infrastructures. The transition toward sustainable urban water supply in developing countries requires the acknowledgement of transnational urbanism and the accountability of international actors over the management of local resources.

Furthermore, despite the achievement of extending water services to low-income households in Da Nang during the VEI-Dawaco WOP, the non-profit character and public-ethos value initially inherent to WOPs should be measured by developing post-WOP assessment tools that measure the benefits attained by low-income households after the partnership ends. In a rapidly privatizing world, WOPs can bond public-private debates and contribute with transparent, trust-based solutions. Given that private water companies are banned from providing drinking water in the Netherlands, an agenda for future research suggests deepening into questions of development cooperation and the backfiring of Aid for Trade (AfT) policies. Also, the need for legally-binding instruments which favor inclusive, cost-effective solutions for affordable and inclusive access to safe water should be explored, parting with questions related to the relatively recent adoption of the United Nations' Resolution A/RES/64/202 on the human right to water and sanitation.

References

2030 Water Resources Group. (2009). *Charting Our Water Future: Economic frameworks to inform decision-making*. Retrieved from The Barilla Group, The Coca-Cola Company, The International Finance Corporation, McKinsey & Company, Nestlé S.A., New Holland Agriculture, SABMiller plc, Standard Chartered Bank, and Syngenta AG website: https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/sustainability/pdfs/charting%20our%20water%20future/charting_our_water_future_full_report_.ashx

Adams, E. A., & Zulu, L. C. (2015). Participants or customers in water governance? Community-public partnerships for peri-urban water supply. *Geoforum*, *65*, 112–124. https://doi.org/10.1016/j.geoforum.2015.07.017

ADB. (2017). *Forging Partnerships Among Water and Wastewater Operators*. https://doi.org/10.22617/TCS178915-2

Al-Barwani, H. H., & Purnama, A. (2008). Brine discharges from two coastal desalination plants. In D. J. Delgado & P. Moreno (Eds.), *Desalination Research Progress* (pp. 489–497). New York: Nova Science Publishers.

Allen, A. (2003). Environmental planning and management of the peri-urban interface: Perspectives on an emerging field. *Environment and Urbanization*, *15*(1), 135–148. https://doi.org/10.1177/095624780301500103

Allen, A. (2005). *Governance Regimes in Peri-Urban Water Supply and Sanitation: Bridging the Gap between Policies and Practices*. London: Development Planning Unit.

Allen, A. (2012). Water provision for and by the peri-urban poor: Public-community partnerships or citizens co-production? In I. Vojnovic (Ed.), *Sustainability: A Global Urban Context* (pp. 309–340). East Lansing, MI: Michigan State University Press.

Allen, A., Dávila, J. D., Hofman, P., & Aref, M. F. (2006). *Governance of water and sanitation services for the peri-urban poor: A framework for understanding and action in Metropolitan regions*. London: University College London, Development Planning Unit.

Allen, A., Dávila, J. D., & Hofmann, P. (2006). The peri-urban water poor: Citizens or consumers? *Environment and Urbanization*, *18*(2), 333–351. https://doi.org/10.1177/0956247806069608

Allen, A., Hofmann, P., Mukherjee, J., & Walnycki, A. (2017). Water trajectories through non-networked infrastructure: Insights from peri-urban Dar es Salaam, Cochabamba and Kolkata. *Urban Research & Practice*, *10*(1), 22–42. https://doi.org/10.1080/17535069.2016.1197306

Angelo, H., & Wachsmuth, D. (2015). Urbanizing Urban Political Ecology: A Critique of Methodological Cityism. *International Journal of Urban and Regional Research*, *39*(1), 16–27. https://doi.org/10.1111/1468-2427.12105

Bain, R., Wright, J., Yang, H., Pedley, S., Gundry, S., & Bartram, J. (2012, July 9). Improved but not necessarily safe: Water access and the Millennium Development Goals. Retrieved March 19, 2015, from Global Water Forum website: http://www.globalwaterforum.org/2012/07/09/improved-but-not-necessarily-safe-water-access-and-the-millennium-development-goals/

Bakker, K. (2008). *The Ambiguity of Community: Debating Alternatives to Private- Sector Provision of Urban Water Supply*. *1*(2), 18.

Bakker, K. (2012). Water: Political, biopolitical, material. *Social Studies of Science*, *42*(4), 616–623. https://doi.org/10.1177/0306312712441396

Balsiger, J., & Debarbieux, B. (2011). Major challenges in regional environmental governance research and practice. *Procedia - Social and Behavioral Sciences*, *14*, 1–8. https://doi.org/10.1016/j.sbspro.2011.03.010

Bartram, J., Corrales, L., Deere, D., Drury, D., Gordon, B., Howard, G., … Stevens, M. (2009). *Water safety plan manual: Step-by-step risk management for drinking-water suppliers*. Retrieved from World Health Organization website: http://apps.who.int/iris/bitstream/10665/75141/1/9789241562638_eng.pdf

Baruah, B. (2007). Assessment of public-private-NGO partnerships: Water and sanitation services in slums. *Natural Resources Forum*, *31*(3), 226–237. https://doi.org/10.1111/j.1477-8947.2007.00153.x

Batten, J. J. (2010). Building utility partnerships and capacity. *American Water Works Association*, *102*(3), 36–37.

Bayliss, K., & Van Waeyenberge, E. (2017). Unpacking the Public Private Partnership Revival. *The Journal of Development Studies*, *54*(4), 577–593. https://doi.org/10.1080/00220388.2017.1303671

Beck, A. (2018). Water operator partnerships: Peer learning and the politics of solidarity in water and sanitation service provision. *Wiley Interdisciplinary Reviews: Water*, e01324. https://doi.org/10.1002/wat2.1324

Bélanger Dumontier, M., McDonald, D. A., Spronk, S., Baron, C., & Wartchow, D. (2016). *Social efficiency and the future of Water Operators' Partnerships* (Occasional Paper No. 29; p. 32). Retrieved from http://bewop.un-ihe.org/sites/bewop.un-ihe.org/files/social_efficiency_and_the_future_of_wops_english.pdf

Berg, M, Stengel, C., Trang, P., Hungviet, P., Sampson, M., Leng, M., … Fredericks, D. (2007). Magnitude of arsenic pollution in the Mekong and Red River Deltas—Cambodia and

Vietnam. *Science of The Total Environment*, *372*(2–3), 413–425. https://doi.org/10.1016/j.scitotenv.2006.09.010

Berg, Michael, Tran, H. C., Nguyen, T. C., Pham, H. V., Schertenleib, R., & Giger, W. (2001). Arsenic Contamination of Groundwater and Drinking Water in Vietnam: A Human Health Threat. *Environmental Science & Technology*, *35*(13), 2621–2626. https://doi.org/10.1021/es010027y

Bishop, W. J., & Kong, S. (2010). *AWWA. IWA water operators partnerships (WOPs) program: Partnering US utilities with developing nation urban utilities*. 21. American Water Works Association Annual Conference and Exposition (ACE).

Bjerggaard, S. (2009, December). *Water operators and their associations supporting WOPs*. Presented at the 1st International Conference of the Global Water Operators' Partnerships Alliance: Raising Awareness and Communicating the Urgency to Act, Zaragoza, Spain. Retrieved from http://www.un.org/waterforlifedecade/pdf/12_water_operators_associations_steen_bjerggaard.pdf

Boag, G., & McDonald, D. A. (2010). A critical review of public-public partnerships in water services. *Water Alternatives*, *3*(1). Retrieved from http://www.municipalservicesproject.org/sites/default/files/A%20critical%20review%20of%20public-public%20partnerships%20in%20water%20services%20-%20Water%20Alternatives%20-%20Issue%203,%20Number%201,%20Feb%202010.pdf

Boberg, J. (2005). *Liquid assets: How demographic changes and water management policies affect freshwater resources*. Santa Monica, CA: RAND Corporation.

Bolay, J.-C., Cartoux, S., Cunha, A., Du, T. T. N., & Bassand, M. (1997). Sustainable development and urban growth, precarious habitat and water management in Ho Chi Minh City, Vietnam. *Habitat International*, *21*(2), 185–197.

Breeveld, R., Hermans, L., & Veenstra, S. (2013). Water operator partnerships and institutional capacity development for urban water supply. *Water Policy*, *15*(S2), 165. https://doi.org/10.2166/wp.2013.018

Brocklehurst, C. (2017). *Water Supply and Sanitation Policy in Developing Countries Part 1: Understanding Complex Problems. Video 1.4. Conversation with Clarissa Brockelhurst* (D. Whittington, Interviewer). Retrieved from https://www.coursera.org/learn/water/lecture/6EVnJ/video-1-4-conversation-with-clarissa-brocklehurst

Brown, R., Ashley, R., & Farrelly, M. (2011). Political and Professional Agency Entrapment: An Agenda for Urban Water Research. *Water Resources Management*, *25*(15), 4037–4050. https://doi.org/10.1007/s11269-011-9886-y

Brown, R., Keath, N., & Wong, T. H. F. (2009). Urban water management in cities: Historical, current and future regimes. *Water Science and Technology*, *59*(5), 847–855. https://doi.org/10.2166/wst.2009.029

Brown, R., Rogers, B., & Werbeloff, L. (2016). *Moving toward Water Sensitive Cities, A guidance manual for strategists and policy makers*. Retrieved from https://watersensitivecities.org.au/wp-content/uploads/2016/05/TMR_A4-1_MovingTowardWSC.pdf

Budds, J. (2008). Whose Scarcity? The Hydrosocial Cycle and the Changing Waterscape of La Ligua River Basin, Chile. In M. K. Goodman, M. Boykoff, & K. Evered (Eds.), *Contentious geographies: Environmental knowledge, meaning, scale* (pp. 59–78). Aldershort, England; Burlington, USA: Ashgate.

Bulkeley, H. (2005). Reconfiguring environmental governance: Towards a politics of scales and networks. *Political Geography*, *24*(8), 875–902. https://doi.org/10.1016/j.polgeo.2005.07.002

Cash, D., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., … Young, O. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology and Society*, *11*(2). Retrieved from http://www.ecologyandsociety.org/vol11/iss2/art8/

Chelleri, L., Schuetze, T., & Salvati, L. (2015). Integrating resilience with urban sustainability in neglected neighborhoods: Challenges and opportunities of transitioning to decentralized water management in Mexico City. *Habitat International*, *48*, 122–130. https://doi.org/10.1016/j.habitatint.2015.03.016

Coutard, O. (2008). Placing splintering urbanism: Introduction. *Geoforum*, *39*(6), 1815–1820. https://doi.org/10.1016/j.geoforum.2008.10.008

Das, K. (2018, October 3). State Divestment: Exciting Opportunities for Investors. *Vietnam Briefing News*. Retrieved from https://www.vietnam-briefing.com/news/state-divestment-exciting-opportunities-investors.html/

Datta, A. (2015). Public-Private Partnerships in India: A Case for Reform? *Economic and Political Weekly*, *XLIV*(33), 73–78.

Dawoud, M. A. (2008). Future Growth in the Desalination Industry in Middle East Region. In D. J. Delgado & P. Moreno (Eds.), *Desalination Research Progress* (pp. 161–185). New York: Nova Science Publishers.

DesalData. (2016). GWI DesalData database. Retrieved from https://www.desaldata.com/

Díaz-Caravantes, & Wilder. (2014). Water, Cities and Peri-urban Communities: Geographies of Power in the Context of Drought in Northwest Mexico. *Water Alternatives*, *7*(3), 19.

Do, H. (2017). *Privatizing SOEs; Implications for Foreign Investors*. Webinar presented at the KPMG Vietnam Webinar, Vietnam.

FAO. (2016). AQUASTAT Main Database, Food and Agriculture Organization of the United Nations (FAO). Retrieved September 7, 2016, from http://www.fao.org/nr/water/aquastat/data/query/results.html

Filion, P., & Pulver, N. (Eds.). (2019). *Critical Perspectives on Suburban Infrastructures: Contemporary International Cases*. Toronto: University of Toronto Press.

Finger, M., Tamiotti, L., & Allouche, J. (Eds.). (2006). *The Multi-Governance of Water: Four Case Studies*. New York: State University of New York Press.

Fischler, R. (1989). Toward an ethical and politically critical planning theory and practice. *Berkeley Planning Journal*, *4*(1), 125–131.

Forester, J. (1989). *Planning in the face of power*. Berkeley: University of California Press.

Friedmann, J. (1965). A Response to Altshuler: Comprehensive Planning As a Process. *Journal of the American Institute of Planners*, *31*(3), 195–197. https://doi.org/10.1080/01944366508978166

Gallego-Ayala, J., Dimene, C., Munhequete, A., & Amos, R. (2014). Assessing the performance of urban water utilities in Mozambique using a water utility performance index. *Water SA*, *40*(4), 665. https://doi.org/10.4314/wsa.v40i4.12

Gandy, M. (2004). Rethinking urban metabolism: Water, space and the modern city. *City*, *8*(3), 363–379. https://doi.org/10.1080/1360481042000313509

Gandy, M. (2008). Landscapes of Disaster: Water, Modernity, and Urban Fragmentation in Mumbai. *Environment and Planning A*, *40*(1), 108–130. https://doi.org/10.1068/a3994

German Association of Cities. (2013). *Integrated Urban Development Planning and Urban Development Management: Strategies and instruments for sustainable urban development*. Retrieved from http://www.staedtetag.de/imperia/md/content/dst/internet/fachinformationen/2013/mat_integrierte_stadtentwicklungsplanung_en_gesamt_korr.pdf

Giedion, S. (1948). *Mechanization takes command: A contribution to anonymous history*. New York: Oxford University Press.

Giesemann, M., Roche, D., Austin, S., & Moulton, T. (2009). Water operator partnerships—A Simple way to help water utilities in developing countries. *Water*, *36*(8), 42–44.

Graham, S., & Marvin, S. (2001). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. London; New York: Routledge.

GSO. (2017). General Statistics Office of Vietnam (GSO). Area, population and population density of Vietnam. Area data as of 31/12/2016 according to Decision No. 2311/QĐ-BTNMT dated September 28th, 2017, Minister of Natural Resources and Environment. Retrieved January 11, 2019, from General Statistics Office of Vietnam (GSO) website: http://www.gso.gov.vn/default_en.aspx?tabid=774

Guy, S., Graham, S., & Marvin, S. (1997). Splintering Networks: Cities and Technical Networks in 1990s Britain. *Urban Studies*, *34*(2), 191–216.

GWI. (2018, May). *Global Water Intelligence Magazine*. (5). Retrieved from https://www.globalwaterintel.com/global-water-intelligence-magazine/19/5

GWI. (2019). GWI Project tracker. Retrieved February 6, 2019, from https://www.globalwaterintel.com/global-water-intelligence-magazine/project-trackers

Hall, D., Lobina, E., Corral, V., Hoedeman, O., Terhorst, P., Pigeon, M., & Kishimoto, S. (2009). *Public-public partnerships (PUPs) in water*. Retrieved from Public Services International Research Unit (PSIRU), Transnational Institute (TNI), and Public Services International (PSI) website: https://www.tni.org/sites/www.tni.org/files/download/pupinwater.pdf

Hall, David, De la Motte, R., & Davies, S. (2003). *Terminology of Public-Private Partnerships (PPPs).* Retrieved from PSIRU University of Greenwich website: http://www.psiru.org/reports/problems-private-water-concessions-review-experience.html

Harvey, D. (2009). *Cosmopolitanism and the geographies of freedom*. New York: Columbia University Press.

Harvey, P. A., & Reed, R. A. (2007). Community-managed water supplies in Africa: Sustainable or dispensable? *Community Development Journal*, *42*(3), 365–378. https://doi.org/10.1093/cdj/bsl001

Hawaco. (2014). *Hanoi water supply system. Unpublished work. Summary distributed as part of the guided visit to Hawaco's Hoa Binh WTP during the 37th WEDC international Conference: Sustainable water and sanitation services for all in a Fast changing world, co-hosted by Loughborough university and the national university of civil engineering (NUCE), Hanoi, Sep. 15-19, 2014 (Date of guided visit: Sep. 18, 2014).* Hanoi Water Limited Company (HAWACO).

Healey, P. (2012). The universal and the contingent: Some reflections on the transnational flow of planning ideas and practices. *Planning Theory*, *11*(2), 188–207. https://doi.org/10.1177/1473095211419333

Hendry, S. (2015). *Frameworks for water law reform*. Cambridge: Cambridge University Press.

Heynen, N., Kaika, M., & Swyngedouw, E. (2006). *In the nature of cities urban political ecology and the politics of urban metabolism*. London: Routledge.

Hofmann, P. (2013). Wasted waste—Disappearing reuse at the peri-urban interface. *Environmental Science & Policy*, *31*, 13–22. https://doi.org/10.1016/j.envsci.2013.03.011

IBP. (2016). *Vietnam export-import, trade and business directory—Strategic, practical information ... And contacts.* Washington, D.C: IBP (International Business Publications).

IWA, GWOPA, & VEI. (2009). *Water Operators Partnerships Building WOPs for Sustainable Development in Water and Sanitation* (p. 36). Retrieved from International Water Association (IWA), Global Water Operators' Partnerships Alliance (GWOPA) / UN-Habitat, and Vitens-Evides International (VEI) website: http://mirror.unhabitat.org/pmss/getElectronicVersion.aspx?nr=2851&alt=1

Jenerette, D. G., & Larsen, L. (2006). A global perspective on changing sustainable urban water supplies. *Global and Planetary Change*, *50*(3–4), 202–211. https://doi.org/10.1016/j.gloplacha.2006.01.004

Jessen, S. (2009). *Groundwater arsenic in the Red River delta, Vietnam: Regional distribution, release, mobility and mitigation options* (PhD, Technical University of Denmark). Retrieved from http://orbit.dtu.dk/en/publications/groundwater-arsenic-in-the-red-river-delta-vietnam(8b4e397c-f7f3-4e2d-88b4-b24ed58d4000).html

Kaika, M. (2005). *City of flows: Modernity, nature, and the city*. Retrieved from https://books.google.de/books?hl=en&lr=&id=srhjfcA5x5sC&oi=fnd&pg=PP2&dq=kaika+water+flow&ots=d9LS1oIf8R&sig=LC0Y7VdxKIRxF_DNvzxr0N9_gRA&redir_esc=y#v=onepage&q=kaika%20water%20flow&f=false

Karpouzoglou, T., & Vij, S. (2017). Waterscape: A perspective for understanding the contested geography of water. *WIREs Water*, *4*(3), e1210. https://doi.org/10.1002/wat2.1210

Keil, R. (2012). Transnational Urban Political Ecology: Health and Infrastructure in the Unbounded City. In G. Bridge & S. Watson (Eds.), *The New Blackwell Companion to the City* (pp. 713–725). https://doi.org/10.1002/9781444395105.ch62

Keil, R. (Ed.). (2013). *Suburban Constellations: Governance, Land and Infrastructure in the 21st Century*. Berlin: Jovis.

Kooy, M., & Bakker, K. (2008a). Splintered networks: The colonial and contemporary waters of Jakarta. *Geoforum*, *39*(6), 1843–1858. https://doi.org/10.1016/j.geoforum.2008.07.012

Kooy, M., & Bakker, K. (2008b). Technologies of Government: Constituting Subjectivities, Spaces, and Infrastructures in Colonial and Contemporary Jakarta. *International Journal of Urban and Regional Research*, *32*(2), 375–391. https://doi.org/10.1111/j.1468-2427.2008.00791.x

Kurian, M., Ratna Reddy, V., Dietz, T., & Brdjanovic, D. (2013). Wastewater re-use for peri-urban agriculture: A viable option for adaptive water management? *Sustainability Science*, *8*(1), 47–59. https://doi.org/10.1007/s11625-012-0178-0

Kwak, Y. H., Chih, Y., & Ibbs, C. W. (2009). Towards a Comprehensive Understanding of Public Private Partnerships for Infrastructure Development. *California Management Review*, *51*(2), 51–78. https://doi.org/10.2307/41166480

Labbé, D., & Musil, C. (2014). Periurban Land Redevelopment in Vietnam under Market Socialism. *Urban Studies*, *51*(6), 1146–1161. https://doi.org/10.1177/0042098013495574

Lawhon, M., Ernstson, H., & Silver, J. (2014). Provincializing Urban Political Ecology: Towards a Situated UPE Through African Urbanism: Provincialising Urban Political Ecology. *Antipode*, *46*(2), 497–516. https://doi.org/10.1111/anti.12051

Loftus, A. (2007). Working the Socio-Natural Relations of the Urban Waterscape in South Africa. *International Journal of Urban and Regional Research*, *31*(1), 41–59. https://doi.org/10.1111/j.1468-2427.2007.00708.x

Madrid, C., Cabello, V., & Giampietro, M. (2013). Water-Use Sustainability in Socioecological Systems: A Multiscale Integrated Approach. *BioScience*, *63*(1), 14–24. https://doi.org/10.1525/bio.2013.63.1.6

Marston, A. J. (2014). *The Scale of Informality: Community-Run Water Systems in Peri-Urban Cochabamba, Bolivia*. *7*(1), 17.

Meadowcroft, J. (2002). Politics and scale: Some implications for environmental governance. *Landscape and Urban Planning*, *61*(2–4), 169–179. https://doi.org/10.1016/S0169-2046(02)00111-1

Medeazza, M. G. (2008). Freshwater Scarcities and Desalination: Evidence from Morrocco, Spain, the Occupied Palestinian Territories and South India. In D. J. Delgado & P. Moreno (Eds.), *Desalination Research Progress.* (pp. 1–66). New York: Nova Science Publishers.

Mehta, L., & Karpouzoglou, T. (2015). Limits of policy and planning in peri-urban waterscapes: The case of Ghaziabad, Delhi, India. *Habitat International*, *48*, 159–168. https://doi.org/10.1016/j.habitatint.2015.03.008

Merme-Darrigrand, V., Pascual Sanz, M., & Schwartz, K. (2015). *BEWOP Framework for analyzing Operator Partnerships: WOP Case Analysis*. Barcelona: GWOPA/UN-Habitat.

Miller, J. B. (1999). Applying multiple project procurement methods to a portfolio of infrastructure projects. In S. Rowlinson & P. McDermott (Eds.), *Procurement Systems: A Guide to Best Practice in Construction* (pp. 109–227). https://doi.org/10.4324/9780203982785

Monstadt, J., & Schramm, S. (2013). Beyond the networked city? Suburban constellations in water and sanitation systems" in Keil, R. (Ed). Suburban Constellations. Governance, Land and Infrastructure in the 21st Century. In R. Keil (Ed.), *Suburban constellations: Governance, land and infrastructure in the 21st century* (pp. 85–94). Berlin: Jovis Verlag.

Monstadt, Jochen. (2009). Conceptualizing the Political Ecology of Urban Infrastructures: Insights from Technology and Urban Studies. *Environment and Planning A*, *41*(8), 1924–1942. https://doi.org/10.1068/a4145

Morison, P. J., & Brown, R. (2011). Understanding the nature of publics and local policy commitment to Water Sensitive Urban Design. *Landscape and Urban Planning*, *99*(2), 83–92. https://doi.org/10.1016/j.landurbplan.2010.08.019

Mvulirwenande, S., Wehn, U., & Alaerts, G. (2014). *Closing the Knowing-Applying Gap in Water Utilities: Experience from Uganda's NWSC*. Presented at the 37th WEDC International

Conference, Hanoi. Retrieved from https://wedc-knowledge.lboro.ac.uk/resources/conference/37/Mvulirwenande-2031.pdf

Ndirangu, N., Ng'ang'a, J., Chege, A., de Blois, R.-J., & Mels, A. (2013). Local solutions in Non-Revenue Water management through North-South Water Operator Partnerships: The case of Nakuru. *Water Policy*, *15*(S2), 137. https://doi.org/10.2166/wp.2013.117

Newig, J., & Fritsch, O. (2009). Environmental governance: Participatory, multi-level - and effective? *Environmental Policy and Governance*, *19*(3), 197–214. https://doi.org/10.1002/eet.509

Nguyen, V. A., Nguyen, H. S., Dinh, D. H., Nguyen, P. D., & Nguyen, X. T. (2011). *Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Vietnam, Final Report* (p. 123). Retrieved from Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering website: http://www.susana.org/_resources/documents/default/2-1673-vietnam-fsm-study.pdf

Olusola Babatunde, S., Opawole, A., & Emmanuel Akinsiku, O. (2012). Critical success factors in public-private partnership (PPP) on infrastructure delivery in Nigeria. *Journal of Facilities Management*, *10*(3), 212–225. https://doi.org/10.1108/14725961211246018

Owen, D. (2012). *Pinsent Masons water yearbook 2012–2013. The essential guide to the water industry from leading infrastructure law firm Pinsent Masons* (14th ed.). London: Pinsent Masons.

Paavola, J. (2007). Institutions and environmental governance: A reconceptualization. *Ecological Economics*, *63*(1), 93–103. https://doi.org/10.1016/j.ecolecon.2006.09.026

Pahl-Wostl, C., Isendahl, N., Möllenkamp, S., Brugnach, M., Jeffrey, P., Medema, W., & Tessa de Vries, T. (2006). *Paradigms in Water Management* (No. D 1.1.2). Retrieved from European Commission website: http://www.newater.uni-osnabrueck.de/deliverables/D112.pdf

Papadopoulos, Y. (2007). Problems of Democratic Accountability in Network and Multilevel Governance. *European Law Journal*, *13*(4), 469–486. https://doi.org/10.1111/j.1468-0386.2007.00379.x

Pascual-Sanz, M. (2014). *Capacity development in Water Operator Partnerships: More than just the right methods*. Presented at the 37th WEDC International Conference, Hanoi.

Pascual-Sanz, M., Perkins, J., Kinyenje, J., & Wright-Contreras, L. (2018). Water operators' partnerships for universal and sustainable access to water services. In A. M. Badia Martí & L. Huichi Sancho (Eds.), *Agua, recurso natural limitado: Entre el desarrollo sostenible y la seguridad internacional* (pp. 79–91). Madrid, Spain: Marcial Pons.

Pascual-Sanz, M., Veenstra, S., Wehn de Montalvo, U., van Tulder, R., & Alaerts, G. (2013). What counts as "results" in capacity development partnerships between water operators?

A multi-path approach toward accountability, adaptation and learning. *Water Policy*, *15*(S2), 242. https://doi.org/10.2166/wp.2013.022

Patrón-Coppel, G., & Schwartz, K. (2011). Water operator partnerships as a model to achieve the Millenium Development Goals for water supply? Lessons from four cities in Mozambique. *Water SA*, *37*(4). https://doi.org/10.4314/wsa.v37i4.17

Postma, D., Larsen, F., Minh Hue, N. T., Duc, M. T., Viet, P. H., Nhan, P. Q., & Jessen, S. (2007). Arsenic in groundwater of the Red River floodplain, Vietnam: Controlling geochemical processes and reactive transport modeling. *Geochimica et Cosmochimica Acta*, *71*(21), 5054–5071. https://doi.org/10.1016/j.gca.2007.08.020

Prüss-Üstün, A., Bos, R., Gore, F., & Bartram, J. (2008). *Safer water, better health: Costs, benefits and sustainability of interventions to protect and promote health*. Retrieved from World Health Organization website: http://apps.who.int/iris/bitstream/handle/10665/43840/9789241596435_eng.pdf;jsessionid=93D647E394527D3F650108821EE25993?sequence=1

Rhodante, A., Cleaver, F., Rusca, M., & Schwartz, K. (2014). Informal Space in the Urban Waterscape: Disaggregation and Co-Production of Water Services. *Water Alternatives*, *7*(1), 1–14.

Rusca, M., & Schwartz, K. (2012). A Historical perspective on partnerships in the provision of water supply and sanitation services in developing countries. In *Water Services Management and Governance* (pp. 113–121).

Schäfer, D., Werchota, R., Dölle, K., & Behnsen, F. (2007). *MDG monitoring for urban water supply and sanitation: Catching up with reality in Sub-Saharan Africa*. Retrieved from Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) website: https://www.sswm.info/sites/default/files/reference_attachments/GTZ%202007%20MDG%20Monitoring%20for%20Urban%20Water%20Supply%20and%20Sanitation.pdf

Schmidt-Traub, G. (2015). *Investment Needs to Achieve the Sustainable Development Goals* (No. Version 2; p. 137). Retrieved from http://unsdsn.org/wp-content/uploads/2015/09/151112-SDG-Financing-Needs.pdf

Schramm, S. (2011). Semicentralised water supply and treatment: Options for the dynamic urban area of Hanoi, Vietnam. *Journal of Environmental Assessment Policy and Management*, *13*(02), 285–314. https://doi.org/10.1142/S1464333211003882

Schramm, S., & Wright-Contreras, L. (2017). Beyond passive consumption: Dis/ordering water supply and sanitation at Hanoi's urban edge. *Geoforum*, *85*, 299–310. https://doi.org/10.1016/j.geoforum.2017.06.016

Schramm, S., & Wright-Contreras, L. (2019). Suburban constellations of water supply and sanitation in Hanoi. In P. Filion & N. Pulver (Eds.), *Critical Perspectives on Suburban*

Infrastructures: Contemporary International Cases (pp. 208–230). Toronto: University of Toronto Press.

Smith, M. P. (2001). *Transnational urbanism: Locating globalization*. Malden, Mass: Blackwell Publishers.

Sonenblum, S., & Stern, L. H. (1964). The Use of Economic Projections in Planning. *Journal of the American Institute of Planners*, *30*(2), 110–123. https://doi.org/10.1080/01944366408978104

Song, J., Li, T., Wright-Contreras, L., & Law, A. W.-K. (2017). A review of the current status of small-scale seawater reverse osmosis desalination. *Water International*, *42*(5), 618–631. https://doi.org/10.1080/02508060.2017.1330841

Srinivas, H., Shaw, R., & Sharma, A. (2009). Introduction to Urban Risk Reduction. In R. Shaw, H. Srinivas, & A. Sharma (Eds.), *Urban risk reduction an Asian perspective* (pp. 3–12). Bingley, UK: Emerald.

SRV. (2014, June 18). *Decision No. 37/2014 /QD-TTg on the list of classification of state-owned enterprises*. Retrieved from https://thuvienphapluat.vn/van-ban/doanh-nghiep/quyet-dinh-37-2014-qd-ttg-tieu-chi-danh-muc-phan-loai-doanh-nghiep-nha-nuoc-236564.aspx

SRV. (2016, December 28). *Decision 58/2016/QD-TTg: Criteria for classification of state-owned enterprises*. Retrieved from https://thuvienphapluat.vn/van-ban/doanh-nghiep/quyet-dinh-58-2016-qd-ttg-tieu-chi-phan-loai-doanh-nghiep-nha-nuoc-336059.aspx

SRV. (2017a). *Decision No. 707/2017/QD-TTg: Restructuring of state-owned enterprises is an economic group*. Retrieved from https://thuvienphapluat.vn/van-ban/doanh-nghiep/quyet-dinh-707-qd-ttg-2017-co-cau-lai-doanh-nghiep-nha-nuoc-trong-tam-la-tap-doan-kinh-te-350452.aspx

SRV. (2017b). *Decision No. 1232/2017/QD-TTg: List of enterprises with state capital divestment of 2017-2020*. Retrieved from https://thuvienphapluat.vn/van-ban/Doanh-nghiep/Quyet-dinh-1232-QD-TTg-2017-Danh-muc-doanh-nghiep-co-von-nha-nuoc-thoai-von-2017-2020-359527.aspx

Stephenson, P. (2013). Twenty years of multi-level governance: 'Where Does It Come From? What Is It? Where Is It Going?' *Journal of European Public Policy*, *20*(6), 817–837. https://doi.org/10.1080/13501763.2013.781818

Sun Sheng, H., & Kim Trang, V. (2008). Land Acquisition in Transitional Hanoi, Vietnam. *Urban Studies*, *45*(5–6), 1097–1117. https://doi.org/10.1177/0042098008089855

Swyngedouw, E. (2004). *Social power and the urbanization of water: Flows of power*. Oxford ; New York: Oxford University Press.

Swyngedouw, E. (2009). The Political Economy and Political Ecology of the Hydro-Social Cycle. *Journal of Contemporary Water Research & Education*, *142*(1), 56–60. https://doi.org/10.1111/j.1936-704X.2009.00054.x

Swyngedouw, E., & Heynen, N. C. (2003). Urban Political Ecology, Justice and the Politics of Scale. *Antipode*, *35*(5), 898–918. https://doi.org/10.1111/j.1467-8330.2003.00364.x

Swyngedouw, E., Kaika, M., & Castro, J. E. (2002). Urban Water: A Political-Ecology Perspective. *Built Environment (1978-)*, *28*, 124–137.

Swyngedouw, Erik. (1999). Modernity and Hybridity: Nature, Regeneracionismo, and the Production of the Spanish Waterscape, 1890–1930. *Annals of the Association of American Geographers*, *89*(3), 443–465.

Terhorst, P. (2012). *Critique of the Water Operator Partnerships in Latin America and the Caribbean (WOP-LAC)* [Discussion paper]. Transnational Institute.

The Global Water Leaders Group. (2017). *A new model for water access: A global blueprint for innovation*. Retrieved from The Global Water Leaders Group website: http://www.globalwaterleaders.org/water_leaders.pdf

Tobon, M., & Yates, D. (2014, November 5). *Water Operator Twinning Partnership between Palm Beach County Water Utilities Department and Manila Water Concessionaires on Planning for Climate Change Impacts*. 101–113. https://doi.org/10.1061/9780784478745.010

Tortajada, C., & Biswas, A. K. (2015). Editorial. *International Journal of Water Resources Development*, *31*(4), 483–485. https://doi.org/10.1080/07900627.2015.1094897

Tutusaus, M., & Schwartz, K. (2016). National water operators' partnerships: A promising instrument for capacity development? *Journal of Water Sanitation and Hygiene for Development*, *6*(3), 500–506.

UN DESA. (2015a). *United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects. The 2015 Revision. Key Findings and Advance Tables* [Working Paper No. ESA/P/WP/241]. Retrieved from United Nations website: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf

UN DESA. (2015b). *World Urbanization Prospects: The 2014 Revision*. Retrieved from United Nations Department of Economic and Social Affairs, Population Division website: https://esa.un.org/unpd/wup/publications/files/wup2014-report.pdf

UN Water. (2013). Water Security & the Global Water Agenda A UN-Water Analytical Brief. Retrieved July 5, 2017, from http://www20.iadb.org/intal/catalogo/PE/2013/12664.pdf

UNEP. (2018). Human Development Reports: Human Development Index (HDI). Retrieved January 21, 2019, from http://hdr.undp.org/en/content/human-development-index-hdi

UNICEF. (2006). *Monitoring the situation of children and women: Multiple Indicator Cluster Survey Manual 2005*. Retrieved from http://mics.unicef.org/files?job=W1siZiIsIjI wMTUvMDQvMDIvMDYvMzcvMDYvMTE5L011bHRpcGxlX0luZGljYXRvcl9DbHV zdGVyX1N1cnZleV9NYW51YWxfMjAwNS5wZGYiXV0&sha=dd2e54d1ddd61cdb

UNICEF, & WHO. (2012). Joint press release: Millennium Development Goal drinking water target met, Sanitation target still lagging far behind. *UNICEF*. Retrieved from https://www.unicef.org/media/media_61922.html

UNICEF, & WHO. (2015). *25th Progress on Sanitation and Drinking-Water: 2015 Update and MDG Assessment*. Retrieved from World Health Organization website: http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf

United Nations. (1972). *Report of the United Nations Conference on the Human Environment A/CONF.48/14/Rev.1*. Retrieved from http://www.un-documents.net/aconf48-14r1.pdf

United Nations. (1992a). *Agenda 21*. Retrieved from https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

United Nations. (1992b). *The Rio Declaration on Environment and Development*. Retrieved from https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf

United Nations. (2000). *The Millennium Development Goals*. Retrieved from http://www.un.org/en/mdg/summit2010/pdf/List%20of%20MDGs%20English.pdf

United Nations. (2015a). *The Millennium Development Goals Report 2015*. Retrieved from United Nations website: https://mdgs.un.org/unsd/mdg/Resources/Static/Products/Progress2015/English2015.pdf

United Nations. (2015b). United Nations. Transforming Our World, The 2030 Agenda for Sustainable Development: A/RES/70/1. Retrieved July 10, 2017, from https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

United Nations. (2016). *The Sustainable Development Goals Report 2016*. Retrieved from United Nations website: http://www.un.org.lb/Library/Assets/The-Sustainable-Development-Goals-Report-2016-Global.pdf

United Nations. (2017). Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all. Retrieved December 18, 2017, from https://sustainabledevelopment.un.org/sdg6

United Nations Development Programme. (2018). Sustainable Development Goals. Retrieved July 27, 2018, from UNDP website: http://www.undp.org/content/undp/en/home/sustainable-development-goals.html

UNSGAB. (2006, March). *Hashimoto Action Plan (HAP), Compendium of Actions*. Retrieved from https://sustainabledevelopment.un.org/content/documents/8749HAP1_en.pdf

Van Dijk, M. P. (2008). Public private partnerships in basic service delivery: Impact on the poor, examples from the water sector in India. *International Journal of Water*, *4*(3/4), 216. https://doi.org/10.1504/IJW.2008.019495

Van Ewijk, E., & Ehrhardt, C. (2016). Land governance in the context of urbanisation and climate change: Linking the rural and the urban. *Conference Report*, 1–12. Retrieved from http://kaleidosresearch.nl/download/2016/09/20160914-LANDac_Report-Conference-08-2016.pdf

Water Health. (2017). Water supply. Retrieved July 7, 2017, from Water Health website: http://www.waterhealth.com/water-supply

WEF. (2016). *The Global Risks Report 2016, 11th Edition*. Retrieved from World Economic Forum website: http://www3.weforum.org/docs/Media/TheGlobalRisksReport2016.pdf

WEF, D. (2011). *Water Security: The Water–Food–Energy–Climate Nexus. World Economic Forum Water Initiative*. Retrieved from World Economic Forum website: http://www3.weforum.org/docs/WEF_WI_WaterSecurity_WaterFoodEnergyClimateNexus_2011.pdf

Wehn, U., & Montalvo, C. (2016). Knowledge transfer dynamics and innovation: Behaviour, interactions and aggregated outcomes. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2016.09.198

WHO and UNICEF JMP. (2017a). JMP Data. Retrieved September 20, 2017, from Wash Data website: https://washdata.org/data

WHO and UNICEF JMP. (2017b). *Progress on Drinking Water, Sanitation and Hygiene 2017. Update and SDG Baselines.* Retrieved from https://washdata.org/report/jmp-2017-report-final

WHO, & UNICEF. (2015). *WHO/UNICEF Report: Water, Sanitation and Hygiene in Health Care Facilities: Status in low-and middle-income countries and way forward, 10 Key Findings*. Retrieved from http://www.who.int/water_sanitation_health/publications/wash-hcf-10things.pdf

Williams, J., Bouzarovski, S., & Swyngedouw, E. (2018). The urban resource nexus: On the politics of relationality, water–energy infrastructure and the fallacy of integration. *Environment and Planning C: Politics and Space*, 0263774X1880337. https://doi.org/10.1177/0263774X18803370

Williams, S. W. (1997). “The Brown Agenda”: Urban Environmental Problems and Policies in the Developing World. *Geography*, *82*(1), 17–26. Retrieved from JSTOR.

Winkel, L. H. E., Trang, P. T. K., Lan, V. M., Stengel, C., Amini, M., Ha, N. T., … Berg, M. (2011). Arsenic pollution of groundwater in Vietnam exacerbated by deep aquifer exploitation for more than a century. *Proceedings of the National Academy of Sciences*, *108*(4), 1246–1251. https://doi.org/10.1073/pnas.1011915108

World Bank. (2016). Data: Urban population. Retrieved June 11, 2018, from The World Bank website: https://data.worldbank.org/indicator/SP.URB.TOTL

World Bank. (2017a). Population density (people per sq. Km of land area). Retrieved January 11, 2019, from World Bank website: https://data.worldbank.org/indicator/EN.POP.DNST?locations=VN-BN-MY-TH-ID-TL-MM

World Bank. (2017b). Urban population (% of total). Retrieved October 6, 2018, from https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

World Bank. (2017c). Vietnam, Total Population. Retrieved July 7, 2017, from World Bank website: http://data.worldbank.org/indicator/SP.POP.TOTL?locations=VN

Wright-Contreras, L. (2018). *Water Operators' Partnership Case Study: VEI and Dawaco* [Case Study]. Retrieved from UN-Habitat website: https://www.vei.nl/IManager/Download/971/88691/21553/1882533/EN/21553_1882533_Qunj_Case-Study-01-VEI-Dawaco-74.pdf

Wright-Contreras, L. (2019). A Transnational Urban Political Ecology of Water Infrastructures: Global Water Policies and Water Management in Hanoi. *Public Works Management & Policy*, *24*(2), 195–212. https://doi.org/10.1177/1087724X18780045

Wright-Contreras, L., March, H., & Schramm, S. (2017). Fragmented landscapes of water supply in suburban Hanoi. *Habitat International*, *61*, 64–74. https://doi.org/10.1016/j.habitatint.2017.02.002

Wright-Contreras, L., Perkins, J., Pascual-Sanz, M., & Soppe, G. (2019). Water operators' partnerships and their supporting role in the improvement of urban water supply in Da Nang. *International Journal of Water Resources Development*, 1–26. https://doi.org/10.1080/07900627.2019.1625753

Young, O. R. (1989). *International cooperation: Building regimes for natural resources and the environment*. Ithaca: Cornell University Press.

Yu, W., Bain, R. E., Mansour, S., & Wright, J. A. (2014). A cross-sectional ecological study of spatial scale and geographic inequality in access to drinking-water and sanitation. *International Journal for Equity in Health*, *13*(1). https://doi.org/10.1186/s12939-014-0113-3

Zérah, M.-H. (2008). Splintering urbanism in Mumbai: Contrasting trends in a multilayered society. *Geoforum*, *39*(6), 1922–1932. https://doi.org/10.1016/j.geoforum.2008.02.001

Zhang, X. (2005). Critical Success Factors for Public–Private Partnerships in Infrastructure Development. *Journal of Construction Engineering and Management*, *131*(1), 3–14. https://doi.org/10.1061/(ASCE)0733-9364(2005)131:1(3)

Appendix 1. Tables

Table 3. Type of methods, data, and collection process for the case study of Hanoi.

Type	*Data*	*Collection method*	*Place, date*
Surveys	Users' perception of water accessibility and satisfaction of water quality, cost, and affordability	100 questionnaires in 8 suburban districts, one inner-district and one rural district. 10 questions obtaining information regarding: a) water accessibility, b) users' knowledge of the source of water, c) type of water supply system and distribution company, d) satisfaction of coverage, e) satisfaction of quality, f) comparison of water supply coverage and quality with neighboring areas, g) cost of water per month, h) family income per month, i) appreciation of cost of water in relation to income, and j) community organization.	Hanoi, 2014
Sampling	Groundwater quality tested for the presence of heavy metals (NH_4, PO_4, As, Pb, Cd, Fe, Mn, Zn, Cu)	8 water samples in 2 districts (corresponding to a new urban area and a peri-urban village) and private tests conducted through the Hanoi University of Science and Technology	Hanoi, 2014
Interviews	Expert assessment of user-related, environmental, technical, institutional, and financial challenges of water provision	Semi-structured interviews with local and international organizations, government dependencies, water-related enterprises, financial organizations, and academic institutions (recordings and full transcripts of interviews between 20-60 minutes, taking notes parallel to the recording)	Hanoi, 2014

Table 4. Type of methods, data, and collection process for the case study of Da Nang.

Type	*Data*	*Collection method*	*Place, date*
Interviews	Political, socio-economic, cultural and environmental context; influence of the water operator partnership's activities in the changes detected in the capacity and performance of the water utility	Semi-structured interviews to actors involved in water operators' partnerships programs, including staff from the Dutch organization, VEI, and from the local water utility of Da Nang, as well as key informants from a supporting international financial institution (recordings and full transcripts of interviews between 20-60 minutes, taking notes parallel to the recording)	Da Nang, 2017
Documents	Information on the partnership development, progress towards established goal, effectiveness of collaboration between institutions, and results	Review of secondary data including the partnership's Memorandum of Understanding, policy paper, strategic plan, inception report, and end project report (facilitated by former VEI-Dawaco WOP Resident Project Manager and former VEI-Dawaco Project Assistant, with prior consent of VEI's CEO).	Da Nang, 2017
Benchmarking	Key Performance Indicators (KPIs) of the water utility's programs for the evaluation of the sustainability of the improved performance of the water utility	Visit to water utility's facilities and exchange with staff members of Dawaco's Planning Department, Control Center and Network Management, and Project Management Unit (provided records with follow-up in 2018)	Da Nang, 2017
Database	Water operators' partnerships profiles and water operator profiles	Self-constructed database of 220+ water operators' partnerships and 500+ operator profiles where (retrieved from GWOPA's website, improved and re-ordered, in order to have better access and to analyze the existing data)	Barcelona, 2015 and 2017

Appendix 2. Interview guidelines: BEWOP Analysis framework[24]

Background

Water operators are critical players in efforts to achieve sustainable, equitable and universal water and sanitation services. But many operators today are not keeping pace with demand. They face a myriad of challenges including rapid urbanization, rising inequity, pressures on water resources, severe resource constraints and ineffective governance frameworks. There is a growing understanding that strong local capacity can provide the foundations to respond to emerging challenges with meaningful and lasting solutions. Supporting water operators in their organizational development efforts to manage effectively over the long-term is the purpose of Water Operators' Partnerships (WOPs). WOPs are peer-support arrangements between water service providers, carried out on a not-for-profit basis with the objective of strengthening operator capacity. They draw on the fact that much of the innovation and expertise to address water operators' challenges resides within utilities, and that a growing number of these successful operators are highly motivated to share their expertise and innovation with others on a not-for-profit basis. WOPs were identified as a high-potential solution by the UN Secretary General's Advisory Board for Water and Sanitation in their 2006 Hashimoto Action Plan.

BEWOP is a 5-year research and outreach initiative aimed at boosting the effectiveness of WOPs around the world. BEWOP, launched in September 2013, is a collaboration between UNESCO-IHE and UN-Habitat's Global Water Operators' Partnership Alliance (GWOPA), the organization leading the global WOPs movement. This project was made possible with the support obtained from the Dutch Ministry of Foreign Affairs (via the Directorate-General for International Cooperation).

BEWOP aims to address a potential obstacle of the WOPs approach: operators are uniquely placed to share their experience and technical expertise with their peers, yet they sometimes lack the didactical capacity to effectively transfer their knowledge and the expertise to manage the partnership process. The goal of BEWOP is to strengthen knowledge transfer and change processes of WOPs in order to maximize the potential for operational improvements of water operators. Over the long run, the BEWOP project should contribute to the enhancement of operators' capacity to cope with emerging technical, financial and institutional issues, leading to

[24] Framework created by Merme-Darrigrand, V., Pascual-Sanz, M., and Schwartz, K. (2015). Revised by: Nabakiibi, W., Perkins, J., and Tusaus Luque, M.

better performance of water utilities and improved water and sanitation services for an estimated 50 million end-users.

The BEWOP initiative is articulated into two major streams: research and operational guidance. Research on WOPs has focused on two main questions: how WOPs function, and the institutional conditions for their wider adoption. Research has involved documenting and analysing WOPs practice and conducting focussed thematic studies in collaboration with water and sanitation operators around the world. The operational component, building upon the knowledge acquired during the research phase, aims at developing supportive tools to overcome bottlenecks to WOPs take-up and specific guidance to address needs at various stages of a WOP: identification of partners, designing agreements, funding, and monitoring and evaluating. Ensuring that BEWOP products are accepted and applied widely in WOPs practice is of primary importance. Throughout the project, communication and outreach work to maximize uptake and is a major component of all activities

Introduction

As part of the BEWOP program, a series of case analyses have been undertaken to obtain a better understanding of the formation, design and functioning of water operator partnerships. In order to ensure a degree of comparability between the different cases it was decided to undertake these case studies following a shared analytical framework. Assessing partnerships is a challenging endeavor for many reasons. Each partnership is unique and the related partnership activities are often complex, shifting and slow in achieving the expected impacts.

This document explains and defines the different building blocks that form this analytical framework. The building blocks essentially follow the chronological flow of a standard partnership. The first block, the water sector context, describes the institutional, organizational, socio-economic and environmental context, in which a particular partnership is being undertaken. The second block focuses on the formation and design of the partnership. The third block essentially concerns the core of the partnership, namely the implementation of improvement tracks to enhance utility capacity and performance. The fourth block focuses on the evaluation and assessment of the WOP.

Use of the framework

Without claiming to be exhaustive, the framework presented here tries to be comprehensive and generic, which allows it to be used to fit almost any Water Operator Partnership. At the same time, the framework allows for flexibility and adaptability to suit different cases. As such, the way

the framework is used depends strongly on the type of partnership that is subject to research. For some partnerships only parts of the framework may hold relevant questions. For more comprehensive partnerships, more questions and dimensions may become applicable.

This analytical framework has also various limitations. Despite trying to be holistic, the set of questions might not cover some important aspects of the WOP. Then, some questions might need rephrasing to ensure a clear understanding by the water professional interviewed. Finally, the analytical framework has drawbacks to be applied in a fully academic context. It is rather descriptive, leaving the analytical part as the main task of the researcher.

In this process of adapting the framework for analyzing a particular case, a crucial role is played by the researcher. The researcher needs to assess which part(s) of the framework fits the specificities of the partnership and which parts are less relevant for the specific case that they are studying. What this means is that the framework guides the broad line of enquiry and provides support for the researcher undertaking the case study. As such, the framework does not provide a blue print that the researcher strictly adheres to. The framework only provides a structured route to pursue in order to produce a meaningful analysis. Thus, the responsibility of the researcher is to create constructive content out of supporting documents and interviews with the stakeholders of the partnership, based on guiding questions of the framework.

The researcher must be aware of complex mechanisms that drive partnerships to be able to draw unbiased and genuine conclusions. His/her main goal is to obtain relevant, authentic and credible evidences. To do so, the researcher must have a basic understanding concerning the particularities and diversities of WOPs. Moreover, the researcher needs to make use of diverse sources of information to cross-check and triangulate the information and data gathered. The diverse source may involve information from key informants outside the two operators involved in the WOP or may concern different sources of data (interviews, reports, different media, etc.).

The resulting report should go beyond the mere description of the partnership and also contain an interpretation of processes, activities, etc., of the partnership. Particular importance should be given to the questions why certain things happened the way they happened (rather than just describing these events). The presentation of findings should be adapted to the audience. Opportunities for discussion are also necessary in order to highlight possible differences in interpretations. The findings should provide a clear understanding of how the partnership can be revised and improved, supported for continuation or expansion and promoted more broadly. In particular, best-practices and lessons learnt identified in the case should be highlighted. The partnership assessment results in learning and action opportunities at different levels (individual, organizational, partnership and wider level).

Extracts from existing cases studies are presented in boxes along the present document to guide the user of the framework in the writing process that follows the collection of data.

I. Partnership scoping

Provisioning of water supply and sanitation services does not happen in a vacuum. Rather service provision takes place within prevailing social, legal, economic, cultural and political conditions. These conditions influence and shape service provisioning in a given location. This block of the analytical framework is overarching in the sense that the other block (partnership design, formation and evaluation) are embedded in this context. This building block can be divided in two main components. The first component concerns general socio-economic, political, cultural conditions that are not specific to the water services sector, but which do influence developments within the sector. The second component relates to the sectoral characteristics and developments within the water services sector.

In applying the questions related to this block, the researcher needs to realize that the social, legal, political, cultural and economic conditions under which partnerships operate are not stable but do change over time. Similarly, the water services sector is subject to institutional reforms and the introduction of new operational and management practices. As such, ideally the researcher would not only describe the current situation, but also present this more dynamic perspective in the context and the water services sector. In providing this more historical perspective, we recommend that it at least would touch upon the latest reforms in the water services sector (highlighting what changes occurred in the sector as a result of these reforms).

Contextual Factors

The context sets the broad setting in which the partnership operates. It includes variables on which the partners have no or very little influence through the direct implementation of the partnership. Conversely, these underlying dimensions can greatly influence the inter-organizational relationship and the functioning of the partnership. In this framework, the contextual factors relate to political, socio-economic, cultural and environmental aspects in which the partnership is embedded. Although these factors are clustered in the context category, the geographical and temporal scales along which these factors manifest themselves may be quite diverse.

Political factors

1. What is the nature of the political system at national and sub-national level?
2. What are the relationship and interactions between the local and national political realm and the utility?

3. To what extent do the differences or similarities with the political context in the mentor country influence the relationship between the partners?

Socio-economic

4. What is the socio-economic status in the country and area of implementation (HDI/GDP)? To what extent is the service coverage area characterized by major socio-economic differences?
5. What are the characteristics in terms of access to basic services (health, water services and education)?
6. What are major economic activities in the vicinity of the partnership location?
7. To what extent these factors affect the operational performances of the mentee?

Cultural

8. What are important cultural factors that affect decision-making/governance?
9. How do these cultural factors relate to water management and water services provision?
10. How does the corporate culture of the mentee affect the relationship with the mentor?

Environmental

11. What are the overall climate and geographical characteristics in the coverage area?
12. What are the main environmental characteristics relating to water (water rainfall, droughts, flooding, water availability, etc.)?

Example extracted from the WOP case study: Aguas del Norte and Caesb

Argentina is a Federal Republic with 23 provinces and a central government located in the capital of Buenos Aires. Argentina is one of the largest economies in South America. According to the World Bank, the country's gross domestic product of US$609.9 billion in 2013 compares with US$2,246 trillion for Brazil. Argentina ranked 45th on the United Nations' Human Development Index in 2013 while Brazil was in 85th position.

The provinces of Argentina are bound by federal laws and the national Constitution but are otherwise autonomous, organising their local governments and managing their own natural resources. The Province of Salta is located in north-western Argentina (borders with Bolivia, Chile and Paraguay) and is composed of 23 departments. Northern departments are relatively poor with mostly indigenous populations, and water and sanitation coverage remains low, at less than 80%. The mountainous western departments are the poorest of Salta and social unrest linked to demands for better services is frequent. Within the capital city of Salta, social inequalities are stark between high – and low-income neighbourhoods. The economy of the province relies mostly on agriculture (tobacco, soy, beans,

sugarcane, vineyards and cotton), the oil and gas industry, mining (e.g. gold, copper), tourism and small-scale factories. It accounts for roughly 1% of the national gross domestic product.

Salta's climate is typical of subtropical highland. The wet season lasts four months (December to March) and brings an average precipitation of 550 mm. The dry season extends through the rest of the year, with an average 150 mm of rain over eight months. The most critical time in terms of water supply is toward the end of this dry period when the resource becomes scarce and leads to supply disruptions. The first rains of the wet season cause important turbidity problems, which directly impact the quality of the service. In 2013, the province recorded the driest year in three decades.

Water sector characteristics and development

The sectoral characteristics and developments provide the specific setting in which the partnership is placed. As such, it focuses specifically on the water sector in the mentee country and with respect to the mentee utility. This setting consists of an institutional dimension and bio-physical characteristics of service provision. The institutional dimensions relate to the legal setup of the sector, policies related to the water services sector, organizations involved in the regulation and operations of water services provision, and financing of investment and operations. In examining the sectoral characteristics and developments, it is crucial to distinguish between different responsibilities within the water services sector: policy formulation and implementation, regulation of service providers, and actual service provision.

Institutional: Legislation and policies

13. Please describe briefly the sectoral setup of the provision of water services: What are the different responsibilities (policy formulation, regulation, service provision) in the water services sector and which organizations are attributed these responsibilities? What is the relationship between these organizations?
14. What are important principles[25] underlying the water services sector as defined in government laws, regulations and policies?
15. What reforms have taken place in recent years? How have they influenced the water sector evolution?

[25] With principle we refer to things like having the utility operate on the basis of cost recovery, viewing water as a public good, having the utility operate as an autonomous entity, etc.

Bio-physical characteristics

16. What water sources are available for water services provision (surface water, groundwater, etc.)?
17. What are the prevailing qualitative and quantitative issues/challenges with respect to these water sources?
18. What are the main characteristics of the topography in the covered area and how do these impact on the water conveyance and distribution system and the wastewater collection and sanitation networks?

Example extracted from the WOP case study: COPASA MG and EMSAPUNO S.A.

Water utilities in Peru are known as EPS (Empresas Prestadoras de Servicios). The Empresa Municipal de Saneamiento Básico de Puno – EMSAPUNO S.A. operates as a municipal utility within the framework of the National Legislation of Peru for the provision of urban water and sanitation services. It is a publically-owned company limited by shares, with the municipalities of Puno as the majority shareholder, and Desaguadero as the minority shareholder. For about 31 years, EMSAPUNO used to provide urban water and sewerage services to 4 municipalities in the region of Puno, i.e. Puno, Llave, Juli y Desaguadero, but, due to political decisions in the recent years, it now provides water services to the cities of Puno and Desaguadero exclusively.

In the national context, EMSAPUNO depends most directly on the federal Ministry of Housing, Construction and Sanitation (Vivienda), whose water and sanitation branch emits policies for the water utilities. EMSAPUNO also has a direct relationship with the National Superintendence of Water and Sanitation Services (SUNASS), which regulates the performance, development, and auditing of the utilities, regulates and approves the tariff structures, and defines improvement programs for the utilities. The Ministry of Health (MINSA) oversees drinking water quality aspects, and the National Water Authority (ANA), which is associated with the Ministry of Agriculture (MINAG), regulates and controls water permits. The Ministry of Environment (MINAM) controls water intakes, treatment and distribution and the protection of water resources from contamination.

II. Partnership creation

Having described the context in which the partnership operates in the previous chapter, the next block highlights the development towards a partnership and the resulting design of the envisaged partnership. Two strongly related components are differentiated in the formation and design of the partnership block. The first concerns the history of collaboration and essentially concerns how and under what conditions the partners first started working towards a partnership. The second component concerns partnership formation and describes how the partners engaged in the

partnership. This dimension not only looks at the partnership itself, but also at the specific interests and motivations of the partnering utilities and other organizations involved in forming the partnership. It also describes the financing of the WOP, the diagnosis of needs and the agreement characteristics.

History of Collaboration

The history of collaboration focuses on the origins of the creation of the partnership. Every single water partnership is unique, depending on the external context, the diverse background conditions of implementation and the specific characteristics of the partners stemming from different surrounding environment. This uniqueness is brought to the partnership by the different partners and greatly influences the functioning of the partnership,[26] In this block important questions focus on first contact of the partners, enabling factors which support initial collaboration and other significant pre-formation features.

First contact

19. What was the reason for the first meeting(s) of the partners? Were all partners willing to enter the partnership?
20. What was the nature of this initial contact (type of contact, level at which contact took place, frequency, etc.)?
21. What was the timing since the first idea till the final formalization? Is it possible to develop a time-line of different steps in the initial creation of the partnership?

Enabling factors

22. Were any facilitating third parties involved in enabling collaboration between the partners (donors, network organizations, etc.)? What was the nature of the role played by these organizations?
23. How important was this introduction phase in setting the foundations for building confidence and trust between partners? How is the initial 'culture' of cooperation and what was the initial level of trust among partners?

---

[26] Brinkerhoff (2002: 220) argues that the pre-history of collaboration can be considered "as a 'facilitative factor' of the partnership formation processes." See: Brinkerhoff, J.M. (2002) Assessing and improving partnership relationships and outcomes: a proposed framework. Evaluation and Program Planning 25, 215–231. https://doi.org/10.1016/S0149-7189(02)00017-4.

24. What is the role of pre-formation features such as willingness to adapt and share knowledge, receptivity to new solutions, flexibility in taking corrective action, responsiveness to unexpected situation or existence of champions? What were the most important factors in making the partnership successful?

Example extracted from the WOP case study: SIAAP and ONEE

The genesis of the WOP goes back to the 1990s when a Director of the Moroccan utility, who was then employed in France as a Senior Engineer, first met with SIAAP's General Manager. He later joined ONEE and when the Moroccan utility took on sanitation service provision in 2001, he sought collaboration with his previous professional contacts in France to assist his utility in this transition.

The WOP developed in two distinct phases with joint financing from the partners. Contrary to many other WOPs, no external funding was necessary. From 2002 to 2008, the WOP had broad objectives and consisted for the most part of 15-day visits by Moroccan delegations to the Paris facilities of SIAAP, four or five times a year. In this first phase, SIAAP covered the expenses of visiting professionals from ONEE. In 2009, a second agreement to achieve more concrete results based on ONEE's expressed needs incorporated seven thematic "improvement tracks" developed via peer-to-peer exchanges, beginning with water quality. In this current phase, expenses are more equally shared and experts from SIAAP have spent more time in Morocco, which has improved knowledge sharing.

III. Partnership formalization

The formalization process concerns the actors and partnering mechanisms that emerged through the collaboration between partners. This step describes the efforts of partners in designing an effective partner relationship. In looking at partnership formation, this framework examines the parties involved and their motivations to engage, the partnership characteristics and the different steps at the start of the WOP (financing, diagnosis of needs, agreement).

The parties: mentor, mentee, facilitator(s)

Water partnerships draw together mentor and mentee parties. Both partners can be a single organization or a group/consortium of organizations. In addition, third parties often play a facilitating role by either providing (financial) resources or expertise, which facilitate the formation of the partnership. This section analyzes the parties involved in the partnership. In addition, special attention is given to the interests and motivations that partners and facilitators have to be involved in when facilitating such partnerships.

Mentor's characteristics

25. Where does the utility come from, what are the core activities of the utility and what are its main size and service characteristics? Please fill in the following table:

Size and Service Indicators	*Year X*	*Year X+1*	*Year X+2*
Population served (in thousands):			
Water supply			
Sanitation			
Water supply connections (in thousands)			
Kiosks/standpipes			
No of Employees			
Length of network (in kilometers):			
Primary			
Secondary			
Tertiary			
Unaccounted for water (percent of total)			
Working Ratio			
Staff per 1000 connections (water supply)			
Staff per 1000 population served (water supply)			
Service coverage - water supply			
Service coverage - sanitation			
Billing/collection ratio			
Annual turnover of the utility (in thousands US$)			
Average monthly customer bill water and wastewater (in US$)			

26. What is the legal status of the utility and who owns the utility or its shares (in case of a shareholding company)?
27. What is the general governance structure of the utility?
28. How do financiers and donors perceive the mentor utility (according to mentor and donors)?
29. Has the utility been involved in other WOPs? If other WOPs exist please list the nature of the WOP (objectives, budget, duration, motivations, etc.)? (How) have experiences and lessons learnt in these other WOPs been brought into this partnership?

Mentors' motivations, interests, opportunity[27]

30. Why has the mentor utility engaged in this partnership? What are its motivations and interests in developing such partnership(s)? Please consider the following possible interests/motives:
    - Corporate Social Responsibility (CSR): What is the CSR approach in the water utility and how did this partnership fit into this approach?
    - Instrumental Motives: These are motives which are to (eventually) support or strengthen performance of the mentoring utility (learning new processes and technology, etc.). The partnership may be a way of developing human resources (reward for good employees, attracting young staff), or reducing costs, etc.?
    - Networking motives: The partnership may provide the utility a way to enter into certain networks which provide benefits for the organization.
    - Relational Motives: These motives concern the portrayal of the utility in a broader context. These motives are linked to CSR and the instrumental motives, but revolve around how the utility is viewed by the public, shareholders and other (important) actors a reason to engage in the WOP. Does the partnership provide a degree of legitimacy or enhance the corporate image of the utility?
    - Commercial motives: The WOP may also be a way of exploring new business opportunities in preparation of commercial activities. The WOP then acts as a preparation for such commercial activities.

Mentee's characteristics

31. Has the utility been involved in other WOPs? What were their experiences with other WOPs?
32. What are general size and service characteristics of the utility? Please fill in the following table:

Size and Service Indicators	*Year X*	*Year X+1*	*Year X+2*
Population served (in thousands):			
- Water supply			
- Sanitation			
Water supply connections (in thousands)			
Kiosks/standpipes			

[27] Warning: the researcher should be aware that the mentor may commonly answer CSR as their main motive but maybe not so easily instrumental or commercial motives. The researcher should try to triangulate this data and adapt rationally the questions to the interviewee.

No of Employees
Length of network (in kilometers):
- Primary
- Secondary
- Tertiary
Unaccounted for water (percent of total)
Working Ratio
Staff per 1000 connections (water supply)
Staff per 1000 population served (water supply)
Service coverage - water supply
Service coverage - sanitation
Billing/collection ratio
Annual turnover of the utility (in thousands US$)
Average monthly customer bill water and wastewater (in US$)

33. What is the legal status of the utility and who owns the utility or its shares (in case of a shareholding company)?
34. What is the general governance structure of the utility as specified by laws and utility statutes?

Financing (related to the mentee utility)

35. What have been the financial investments in water infrastructure of the utility over the past decade? And in the near future? What types of funds were provided (debt, equity, grant...; specify the amounts with each type of funding)? To what extent are they related to the WOP activities?
36. Who provided the funds and what were the conditions for the disbursement of funds?
37. How do financiers and donors perceive the recipient utility (according to mentee and donors)?

Mentee's motivations, interests, opportunity

38. Why did the mentee utility engage in this partnership WOPs? What are its motivations and interests in pursuing this partnership? Please consider the following possible interests/motives:
    - Financial motives: The partnership may be a way for the utility to access investment funding linked to the partnership.
    - Instrumental motives: The partnership may allow for capacity development of the mentee utility. Allowing the utility to develop capacity for certain tasks and activities that fall within this partnership, performance of the utility may be enhanced.

- Networking motives: The partnership may provide the utility a way to enter into certain networks which provide benefits for the organization. Does capacity building drive the mentee to engage?
- Relational motives: These motives concern the portrayal of the utility in a broader context. Partnering with a well-known mentor utility may benefit the corporate image of the mentoring utility.

Facilitator(s)' characteristics and nature of facilitation

39. What type of organization(s) facilitated the partnership (multilateral, bilateral or private donor; civil organization: NGO, CBO, RBO, foundation, local authorities, etc.)? Is the facilitator a global, regional, national or local actor?
40. How have they facilitated the process?
41. Would have the partnership been possible without their intervention (e.g. financial support, matchmaking, formalization, etc.)?

Facilitators' interests, motivations, opportunity

42. What are the interests and motivations of the facilitating organizations in forming this partnership? What benefit does this partnership provide for the facilitating organization(s)?
43. What are their pre-requirements and conditions for facilitating this partnership? In other words, is facilitation of the partnership dependent on specific conditions/features? What is the mandate of the financier? Does it limit the partnership to specific improvements?
44. How do the facilitating organizations view Water Operator Partnerships? What is their perception of such partnerships and on what do they argue this perception?

Financing (of the WOP)

45. What are the available funds for the partnership? What are the sources of these funds? Which kind of expenses were the funds expected to cover? On what basis were funds to WOPs determined? What were the conditions linked to each of the funding sources?
46. What are the resources that each partner brings to the partnership and are they specified in the agreement?
47. To what extent is the partnership not-for-profit but also not-for-loss (e.g. payment for staff time)? How the partners could assess the cost-effectiveness of the WOP (optimize use of available resources)?

In the following sections the framework examines the actual setup of the partnership and how this is formalized through agreements or contracts. What these sections highlight are the more formal

arrangements underlying the WOP. As such, the section describes formalized agreements rather than the actual practice (which is the topic of the next section on partnership implementation).

Diagnosis of needs

48. Who did conduct the diagnosis of needs (mentor, mentee, both partners, external consultant...)? How (leading party, sequencing)? Who decided the focus of work? How was this decision made and approved? Was the diagnosis of needs the basis for decision-making and agreement formulation? Was there any type of participatory consultation process?
49. According to the mentee, how was the choice of experts made on the mentor side? Was the match a good one in terms of expertise needed and provided?

Agreement characteristics

50. What type of agreement was established between the parties (Memorandum of Understanding, convention, contract, etc.)?
51. What is the duration and expected planning of the partnership?
52. What are the expected objectives, targets, activities, expected deliverables, outputs and outcomes from the project stipulated in the agreement? Is there any time schedule mentioned in the agreement? How is the monitoring, evaluation and reporting implemented in the project?
53. How is the remuneration scheme to the partners designed? When is it paid and under which conditions? Are there monetary penalties/incentives, etc...?
54. Does the contract specifically define the roles and responsibilities of each partner within the partnership (decision maker, leader, coach, conflict resolution role, others)?
55. To what extent is there any degree of flexibility to change targets, financial arrangements, deadline, etc. explicitly indicated in the agreement?
56. Does the contract/written agreement specifically incorporate other stakeholders with a say in the partnership (local authorities, donors, civil society, regulator, external auditor, consultancy or engineering firm, others)?
57. Are there partnership governance mechanisms specified in the agreement for:
    - Communication and interaction
    - Work planning and budgeting
    - Accountability and reporting
    - Financial flows
    - Decision making processes
    - Roles to take by each partner
    - Conflict resolution process

Example extracted from the WOP case study: WAF and HWA

The WAF, HWA, and the Asian Development Bank signed a Memorandum of Understanding on March 21, 2013. It presents succinctly each partner and joint implementation actions; it does not address questions linked to the general administration of the WOP (objectives, governance structure, etc.). The 12-month work plan details the planned activities (mostly remote consultation, study visits and on-the-job training) and designated experts for each improvement track, but overall the agreement leaves room for adaptation.

IV. Project Implementation

The core of the Water Operator Partnership is formed by the implementation of the partnership. In this framework, two dimensions have been distinguished in the implementation phase. The first dimension relates to partnership management. Partnership management concerns the inter-organizational dynamics which steer and support the development and implementation of the Water Operator Partnership activities. Under this partnership management, the framework identifies improvement tracks which form the backbone of the water operator partnership. The improvement tracks concern objectives, inputs, activities/processes which lead to desired outputs and outcomes. These outputs and outcomes represent the capacity development and performance improvements towards which Water Operator Partnerships are geared. Depending on the scope, the number of improvement tracks may vary. A broad Water Operator Partnership may incorporate a large number of improvement tracks. A short and narrower partnership may only revolve around one or two tracks.

Management of the partnership and Inter-organizational dynamics

58. Is there a specific person (unit) in charge of management of the partnership project in each of the partners?
59. Did the partners share an approach to the Water Operator Partnership in terms of the roles to be played, the way of communicating, or decision-making?
60. How and to what extent do the partners share information about the partnership? Do the partners share information on a regular and comprehensive basis?
61. Have there been conflicts/misunderstandings between partners during the project? What type of conflicts and how have they been addressed? Has the relationship between partners changed after the conflict? Would have been possible to foresee those conflicts?
62. How is the interaction between partners at management level and operational level? Formal (planned) or informal (unplanned)? Frequency of each type of interaction? Collect

examples at both levels. (e.g. daily contact working together in same task, planned periodic meetings, sporadic meetings, occasional informal encounters, sharing coffee, others) and at which levels in the organization (board, management, technical positions, etc.)

63. How has the level of interaction both at management and operational level changed throughout the project? Would you say that partners are working as a team or in an isolated way?
64. What were the perception and role in the partnership (both at management and operational levels) of each partner at the beginning of the project? Has that changed over time?
65. Which were the dominant governing mechanism(s) for decision making at the beginning and has it changed over time[28]:
    - the contract (obligations and responsibilities as stipulated in the underlying agreement of partnership)?
    - decisions at high level on one of the partners (i.e. CEO, managers; even if they were not aligned with the contract specifics)?
    - shared understanding on what were the priorities (even if they were not aligned with the contract specifics)?
    - trust and mutual understanding?
66. Has the level of trust between partners changed along the partnership time? How? Which have been the most influencing factors contributing to the evolution of trust (milestones of activities, changes)?

Improvement tracks

67. What are the *improvement tracks*, *areas of improvement* and *activities* implemented within each area of improvement in the project so far, both at operational and at management/policy level?
68. Are these improvement tracks different than the initially specified tracks? What possible changes have been made?

For each improvement track, please specify:

---

[28] Governing mechanisms: *market-oriented* (contract), *bureaucratic-oriented* (SOPs, lines of accountability, subordination, etc.) or *culture-oriented* (trust, shared norms of behavior and reciprocity, a sense of belonging that drives enforcement and compliance).

69. What are the main objectives of the improvement track?
70. What inputs are used to achieve the objectives?
    - *Material:* funds, products, logistics, facilities, commitment
    - Can you quantify the total material inputs from the mentees, mentors and facilitators?
    - What financial resources are provided by the mentees, mentors and facilitators?
    - *Non-material:* knowledge, know-how, staff time, network
    - Can you quantify the total non-material inputs from the mentees, mentors and facilitators?
    - What resources are provided by the mentees, mentors and facilitators?
71. What activities are undertaken as part of the improvement track?
72. Briefly describe the process through which the improvement track is implemented.
73. What are the outputs achieved in the improvement track?
    - *Tangible*: service performance
    - What are the tangible outputs achieved by the project?
    - What activities can be associated to these outputs?
    - *Intangible*: improved organizational and human resources capacity
    - What are the intangible outputs achieved by the project?
    - What activities can be associated to these outputs?

Example extracted from the WOP case study: WAF and HWA

Energy efficiency

Interest in addressing energy efficiency became a clear priority during the analysis of needs. Half of WAF's operating budget is spent on energy bills for a total about FJ$25 million dollars (US$12 million). The partners agreed on one main objective for this improvement track: provide training opportunities to WAF staff so they would learn to conduct energy efficiency audits. WOP funds were allocated to bring a HWA energy efficiency audit expert to Suva. A reciprocal visit by a senior WAF manager to Newcastle, Australia, was also planned but has not taken place due to time constraints.

During the last week of November 2013, the HWA energy efficiency audit expert travelled to Nadi and Suva to undertake onsite training for four WAF personnel from the Energy Unit created in 2012 (a senior manager, graduate electrical and mechanical engineers). The topics addressed during this course included:

- *Preparing and conducting energy audits*
- *Drafting energy plans and an energy policy*
- *Data collection methods*

• *Creating an energy baseline* *The training sessions by HWA helped WAF staff to implement energy saving measures. Based on this capacity-building activity and others (e.g. in India), the Energy Unit started to renegotiate energy supply contracts and to lower energy consumption, starting with four pilot sites. The WAF had achieved a reduction in electricity usage of more than FJ$2.7 million (approximately US$1.3) from such initiatives by the end of 2014. Further, management has simulated "competition" between all operational sites in order to create incentives to reduce energy bills.9 Overall, the audit training by HWA has been helpful to WAF in identifying current energy use in its plants and in using this information to prioritize energy saving projects and identify maintenance, safety and control issues.*

V. Evidence of progress towards impact and effectiveness of the project

Although the analysis of performance-based outputs is not sufficient to comprehend the functioning and performance of a partnership, it remains an essential indicator for most stakeholders, as well as partner utilities, to assess the effectiveness of a partnership. Particularly for WOPs, which have a strong emphasis on strengthening the capacity of the mentee utility, performance-based outputs may not provide a full picture of the overall impact of the partnership. In this sense, this framework also employs alternative assessment methods to evaluate the effectiveness of the partnership. This assessment method, which is defined as the partnership narrative in this section, hinges more on experiences and qualitative assessments of key informants rather than on the achievement of (quantifiable) targets.

Changes in performance of the mentee (KPIs)

74. To what extent have the objectives of the partnership been achieved?
75. How have the key performance indicators of the water operator (related to the improvement tracks) changed during the years of the partnership. How has the partnership contributed to these changes?
76. How has the partnership influenced size and service indicators?

Size and Service Indicators	*Year Y+t*
Population served (in thousands)	
- Water supply	
- Sanitation	

Water supply connections (in thousands)
Kiosks/standpipes
No of Employees
Length of network (in kilometers):
- Primary
- Secondary
- Tertiary
Unaccounted for water (percent of total)
Working Ratio
Staff per 1000 connections (water supply)
Staff per 1000 population served (water supply)
Service coverage - water supply
Service coverage - sanitation
Billing/collection ratio
Annual turnover of the utility (in thousands US$)
Average monthly customer bill water and wastewater (in US$)

Changes in capacity of the mentee

Organization capacity change in general at the three levels

77. Were individual, organizational and institutional capacities assessed at the start, during and after the partnership project? How?
78. How was performance deficiency linked to capacity gaps?
79. Which are the most significant changes in your individual capacity as a result of the partnership project (if any)?
80. Which are the most significant changes on organizational capacity as a result of the partnership project (if any)?
81. Which are the most significant changes on capacity at sector level as a result of the partnership project (if any)?
82. To what extent the knowledge acquired through the partnership is being used and has been turned into new working routines?
83. To what extent can the change trends obtained through the partnership be maintained beyond the partnership project duration?

Results derived from the project targeted improvement tracks

Tangible outputs from each improvement track

84. Identify of all the tangible outputs from each improvement track at management and operational level, expected and unexpected (including documents, methods and procedures, equipment, infrastructure, information systems, resource mobilized, etc.)

Relational capital of partners

85. How would you describe the quality of the relationship between partners, both at management and operational level?
86. What is the evolution that it has followed since the beginning of the project, both at management and operational level? Can you explain why did it follow such evolution?

Satisfaction of partners and stakeholders

87. Is the staff involved satisfied with the working processes of the external partner? Explain why.
88. Is the staff involved satisfied with the results obtained so far?
89. Which are the most valuable activities? Why?
90. Which are the least valuable activities? Why?

Example extracted from the WOP case study: WAF and HWA

Stronger capacity

This WOP aimed primarily at strengthening the capacity of WAF. The knowledge and working methods acquired through WOPs have contributed to positive changes in mentee performance. As explained previously, attribution of performance improvements to the WOP is not straightforward; nonetheless, processes of individual, organizational and institutional capacity-building do drive these positive changes. The mentee implements new technical and managerial knowledge, know-how and working methods gained through the partnership to improve the quality of service delivery. But this case study shows that changes in capacity are less likely to be measured. At the beginning of this WOP, staff capacities were not formally identified and it is hard to precisely evaluate the progress made thanks to this partnership, as both partners recognize.

Increased Access

The partnership has contributed to improved services. According to the partners' conservative estimates based on WAF's intermittent supply list, the quality of drinking water services improved for 12,732

people who moved from receiving intermittent supply to 24/7 water delivery. Furthermore, 400 people who were previously not connected to the WAF network but located in close proximity to pipes receiving intermittent supply, gained access to drinking water services. According to the HWA modeling expert, these intermittent supply pipes were effectively inactive (i.e. no water supply), however once the intermittent supply issue was rectified and supply was restored, the adjacent customers were then able to connect.

V. Project evaluation

Impact in terms of sector targets

91. Did the partnership contribute to the overall development objectives of the water operator and sector targets?
92. Did the partnership trigger unplanned activities/any change that proved relevant for the development of the sector?

Effectiveness

93. To what extent have the targeted objectives been achieved so far? Explain.

Efficiency

94. Do you think the partnership work was executed efficiently? What could have been done differently to increase efficiency?
95. What are the strengths and weakness of this partnership?
96. To what extent is current performance attributable to the partnership according to key informants?
97. How do internal and external characteristics and ongoing events have influenced the progress and results achieved through the partnership (size, finance and budget, sector developments, donor facilitation, government interference, etc.)?
98. To what extent have the partners' behaviors influenced the partnership (commitment, learning intent and support to knowledge transfer and organizational change, capacity to train the local staff, etc.)? Explain.
99. Can you think of other factors that have positively or negatively affected the project?

Success factors and challenges

100. Which would you consider the best practices in the partnership?
101. Which would you consider critical success factors in the partnership?
102. Which would you say are the main lessons learned from the partnership?
103. Which would you say are the main challenges learned from the partnership?

Replicability

104. To what extent do you think this partnership project can be replicated elsewhere?
105. What would be the conditions under which this partnership project would be replicable?

Appendix 3. A review of the current status of small-scale seawater reverse osmosis desalination

Publication No.	**P-VIII**
Type	Journal article
Journal	*Water International*
SJR Score	0.797
Status	Published
Reference	Song, J., Li, T., **Wright-Contreras, L.**, & Law, A. W.-K. (2017). A review of the current status of small-scale seawater reverse osmosis desalination. *Water International*, *42*(5), 618–631. https://doi.org/10.1080/02508060.2017.1330841
Abstract	The current status of small-scale desalination (produced water capacity 100 m3/day or less) is reviewed to provide an overview of the market segment. The use of energy-recovery devices in this market segment is also reviewed. We find that the Middle East accounts for the largest market share worldwide at present, and reverse osmosis is overwhelmingly dominant among the desalination technologies adopted. Implementation of energy-recovery devices at small scale is rare, which leads to relatively high energy consumption for small-scale seawater reverse osmosis desalination systems.

WATER INTERNATIONAL, 2017
https://doi.org/10.1080/02508060.2017.1330841

Routledge
Taylor & Francis Group

TECHNICAL NOTE

A review of the current status of small-scale seawater reverse osmosis desalination

Jie Song [a,b], Tian Li [b], Lucía Wright-Contreras [c] and Adrian Wing-Keung Law [b,d]

[a]NTU-Hyundai Urban System Centre, Hyundai Engineering & Construction Co. Ltd, Singapore; [b]Environmental Process Modelling Centre, Nanyang Environment and Water Research Institute, Nanyang Technological University, Singapore; [c]URBANgrad, Technical University of Darmstadt, Darmstadt, Germany; [d]School of Civil and Environmental Engineering, Nanyang Technological University, Singapore

ABSTRACT
The current status of small-scale desalination (produced water capacity 100 m^3/day or less) is reviewed to provide an overview of the market segment. The use of energy-recovery devices in this market segment is also reviewed. We find that the Middle East accounts for the largest market share worldwide at present, and reverse osmosis is overwhelmingly dominant among the desalination technologies adopted. Implementation of energy-recovery devices at small scale is rare, which leads to relatively high energy consumption for small-scale seawater reverse osmosis desalination systems.

ARTICLE HISTORY
Received 27 October 2016
Accepted 12 May 2017

KEYWORDS
Small-scale desalination; reverse osmosis; energy-recovery device; statistics

Introduction

With increasing populations, rising demands in agricultural and industrial sectors, and effects of climate change, the need of freshwater for consumptive and non-consumptive uses poses a significant challenge to sustain human activities now and going forward (Delgado & Moreno, 2008). Currently, about 1.2 billion people lack access to safe drinking water, and water stress is projected to rise more than 60% by 2025, affecting up to 90 countries across the globe (Elimelech & Phillip, 2011; Service, 2006). Even though water covers over 70% of the earth, 97.5% of the available water is salty (Delgado & Moreno, 2008; Service, 2006). With water scarcity taken as 0.5 m^3/day per capita or below, strikingly, more than 50% of the 70 cities with over one million inhabitants suffering from water scarcity are coastal (Delgado & Moreno, 2008). Currently, the total global contracted capacity of desalinated water production has reached 92 million m^3/day (Virgili, Pankratz, & Gasson, 2016). This is more than four times the desalinated water production in the year 2000 (Delgado & Moreno, 2008).

In this study, a comprehensive overview of the current status of small-scale desalination facilities (produced water capacity of 100 m^3/day or less) is performed to gain a deeper understanding of this important market segment. The Statistics section presents the results of a survey to summarize the state-of-the-art of small-scale desalination projects around the world. The key information was gathered from the DesalData database (Desaldata, 2016), which contained a total of 302 projects contracted from

CONTACT Adrian Wing-Keung Law cwklaw@ntu.edu.sg

2010 to 2015 with a produced water capacity of 100 m^3/day or less. The section on Energy-Recovery Devices for Small-Scale SWRO reviews related studies found in open literature, and summarizes the state-of-the-art technologies and applications of ERDs for small-scale seawater reverse osmosis (SWRO), from commercial products to laboratory attempts. To the best of our knowledge, the small-scale desalination market has not previously been isolated for analysis in the literature.

Small-scale desalination

The desalination industry has the potential of 19% annual growth, with a market worth more than US$ 30 billion (March, 2015). Within this market, the Middle East accounts for around half of the world's desalination capacity at the moment (Urbonienė, 2010), or 60% according to WHO (2008). Spending to improve desalination technology during the past half-century exceeded US$ 1 billion (Zander et al., 2008), and efficiency has increased around 4% annually (Dawson & Brennan, 2012). Because of the significant investment, reported desalination costs have been brought down to US$ 0.60–0.89/m^3 (Urbonienė, 2010; Zander et al., 2008). Among the desalination technologies, reverse osmosis and multi-stage flash (MSF) thermal desalination technologies produce the highest volume of water, with contributions of 65% and 21%, respectively. However, reverse osmosis is rapidly increasing its market share since it is more effective than thermal desalination, with lower energy requirements, lower operating temperatures, and lower water production costs.

Large-scale reverse osmosis systems are widely accepted as an economically viable approach for alternative water supply in many major coastal cities (Greenlee, Lawler, Freeman, Marrot, & Moulin, 2009). For example, Singapore has constructed two major SWRO facilities, with the third and fourth expected to be completed by 2017 and 2019, respectively (Straits Times, 2016). With SWRO, reverse osmosis membranes need to be operated at high pressures (50–70 bar) to compensate for the high osmotic pressure (Greenlee et al., 2009). Thus, high energy consumption and potential environmental impacts are the main challenges.

Earlier reverse osmosis desalination processes consisted of a high-pressure pump and a membrane filtration unit. Pre-treated feedwater was pressurized through the high-pressure pump, and permeate and brine were released at atmospheric pressure. The direct discharge of the high-pressure brine wasted a large amount of energy in the brine stream, and caused high energy consumption of ~10 kWh/m^3, until just a few decades ago (Gude, 2011). Since then, the introduction of ERDs has made SWRO technology more affordable by significantly reducing energy consumption (Silbernagel, Kuepper, & Oklejas, 1992). Using ERDs, the residual energy of brine is recovered to pressurize the seawater feed, enabling the SWRO process to function with energy consumption as low as 3 kWh/m^3 (Farooque, Jamaluddin, & Al-Reweli, 2004; Gude, 2011; Stover, 2007).

Compared to the rapid development of large-scale desalination, attention to the market segment of small-scale desalination (produced water capacity of 100 m^3/day or less) is rare. But small-scale desalination is also in great demand to provide fresh water for social infrastructure, industrial facilities, recreational areas, inland and coastal development projects, and marine vessels, to name a few (Pankratz, 2012, 2013, 2014; Virgili et al., 2016), and could also serve isolated communities in arid and semi-arid regions, requiring small capital cost, and small capacities and flow rates that fit a small number of membrane modules.

According to the International Desalination Association, containerized desalination systems are growing at 15% annually (KSB, 2013).

Compared to large-scale desalination, the advantages of small-scale desalination are: (1) capital construction costs are lower; (2) small-scale systems can be operated *in situ*, and thus they can substantially reduce energy costs by keeping the distance and elevation to the raw water sources to a minimum; and (3) decentralization of water supply provides flexibility in the range of available solutions that can be suited to the different needs of each sector. At the same time, it should be noted that small-scale SWRO systems typically have a life expectancy of only 10 years, compared to the 30 years which large-scale systems can offer at the moment; and labour costs required for small-scale systems may amount to only 20% (Delgado & Moreno, 2008).

On a global scale, the International Desalination Association's latest desalination yearbook (Virgili et al., 2016) categorized the total installed capacity for desalination from 2006 to 2015 into general/other (41%), power (18%), refining and oil/gas (each to 14%), and mining and electronics (each 5%). Earlier reports of the cumulative installed capacity from 1980 to 2012 by Pankratz (2012) showed a clearer separation between municipal and industrial-related plants, with 62% and 26% of the worldwide installed capacity, respectively, and with the remaining 12% distributed across other uses, including power stations, irrigation, tourism, military, and demonstration purposes. These statistics also showed that the applications of small-scale desalination are diverse, including offshore oilfield services, oil rigs, resort islands, ports, passenger ships, military projects, police stations, schools, universities, hospitals and hotels. Thus, the small-scale systems not only serve important industrial and private developments, but also provide critical water supply to small communities living in coastal areas, and emergency supplies for locations affected by natural disasters and conflict zones (Delgado & Moreno, 2008; Wood, 2007).

Statistics

Figure 1 shows the number of contracted projects in different years, with a peak observed in 2012. The detailed output capacity of small-scale desalination systems is shown in Figure 2. Their capacity was close to 100 m^3/day, in which the largest percentage was 41.4% delivering 80–100 m^3/day. Following that, 9.3% was in the range of 60–79 m^3/day, 15.9% in the range of 40–59 m^3/day, 13.2% in the range of 20–39 m^3/day, and the remaining 20.2% in the range of 0–19 m^3/day. The full range suggests small but finite demand for super-small-scale desalination.

Figures 3 and 4 illustrate the worldwide distribution of small-scale desalination projects from 2010 to 2015, and the 10 countries which host the largest number of small-scale desalination projects and the highest capacity of desalinated water production. Of the 302 projects analyzed, Saudi Arabia held first place with 16.2% of the total; United Arab Emirates was second, with 9.9%, followed by Qatar with 8.6%, Chile with 7.9%, the US with 7%, Ecuador with 5.6%, and the UK with 5.3%; further down were Greece with 3.3%, China with 3% and Italy with 2.3%. This distribution is in fact similar to large-scale desalination, in which the Middle East also accounted for the largest market share in this six-year period.

Regarding the technologies applied to small-scale desalination, Figure 5 shows that 95% of projects used reverse osmosis, and 2.6% with 'other' processes. Membrane distillation and

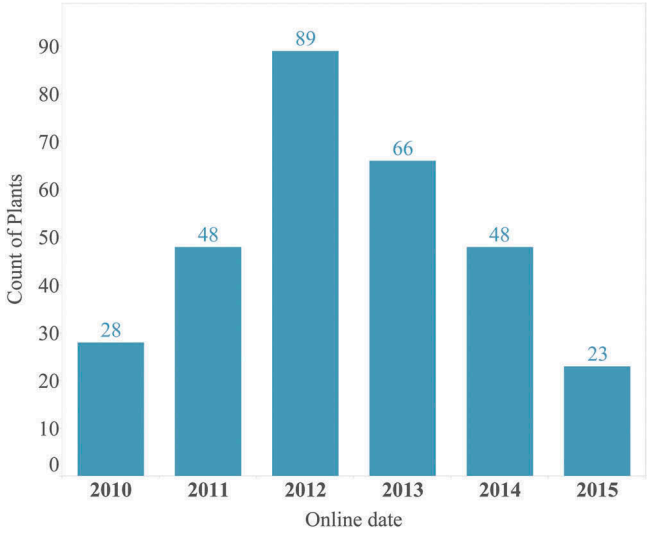


Figure 1. Number of small-scale desalination projects contracted from 2010 to 2015. (Authors' analysis, based on data from Desaldata, 2016.)

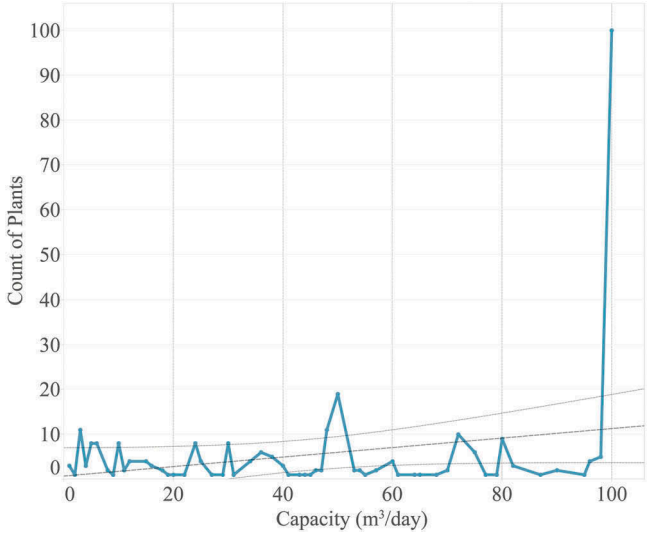


Figure 2. Capacity of small-scale desalination projects from 2010 to 2015. (Authors' analysis, based on data from Desaldata, 2016.)

nanofiltration accounted for 0.7% each, and electrodialysis, MSF and vapour compression were very low, at 0.3% each. As discussed before, reverse osmosis technology is considered increasingly 'more reliable and cost competitive' (Delgado & Moreno, 2008), and it is clearly dominant in the small-scale desalination market.

From 1990 to 2011, the contracted projects for the overall desalination market catered primarily to seawater. The capacity for seawater was 2.4 million m^3/day in 2011, and for brackish water only 1.3 million m^3/day (Pankratz, 2013). However, attributed to the 'global

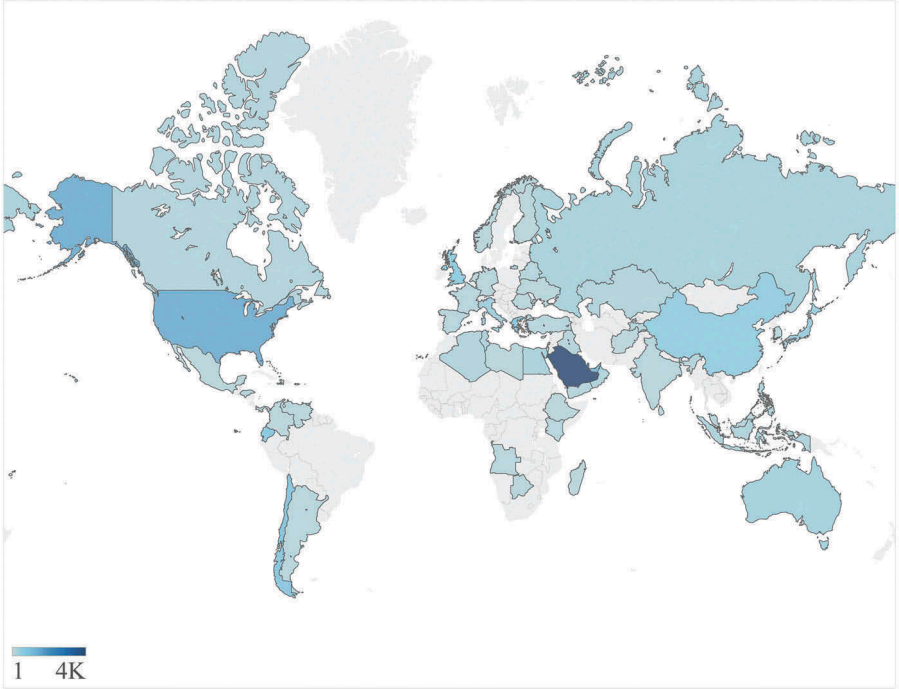


Figure 3. Countries with largest capacity of small-scale desalination projects from 2010 to 2015 (unit: m^3/day). (Authors' analysis, based on data from Desaldata, 2016.)

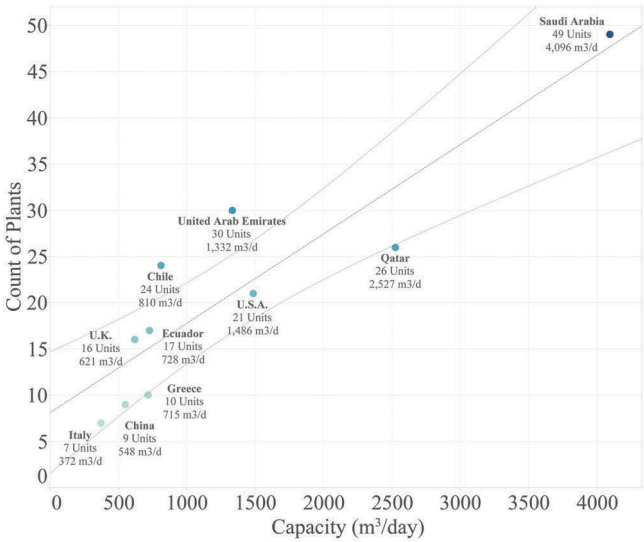


Figure 4. Top 10 countries for number and capacity of small-scale desalination projects from 2010 to 2015. (Authors' analysis, based on data from Desaldata, 2016.)

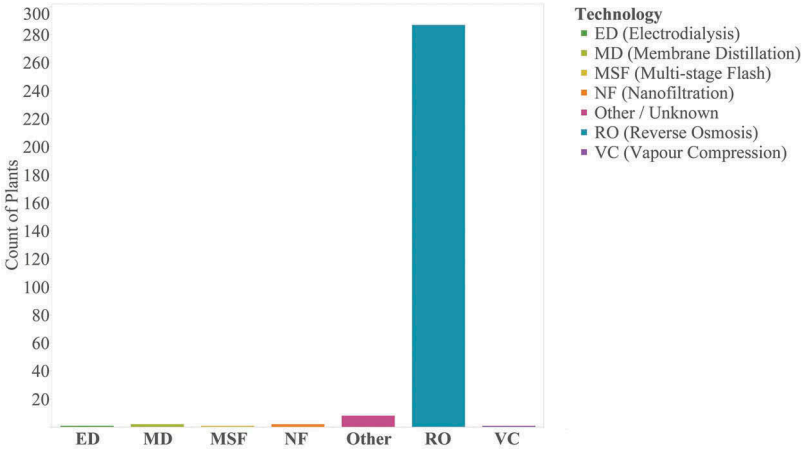


Figure 5. Technologies for small-scale desalination projects from 2010 to 2015. (Authors' analysis based on data from Desaldata, 2016.)

economic slowdown', the contracted capacity of seawater fell to 0.63 million m^3/day, and brackish water to 0.28 million m^3/day (Virgili et al., 2016). Figure 6 shows that, in contrast to large-scale desalination, the leading feedwater stock was instead brackish water, representing 44.7% of the total feed for small-scale desalination projects, followed by seawater (SW) with 30.8%, pure/tap water with 12.9%, river or low-concentration saltwater (RW/LCSW) with 6%, wastewater (WW) with 3.6%, and brine with 1.7%. This shows that small-scale desalination is more adaptive to the availability of feedwater sources.

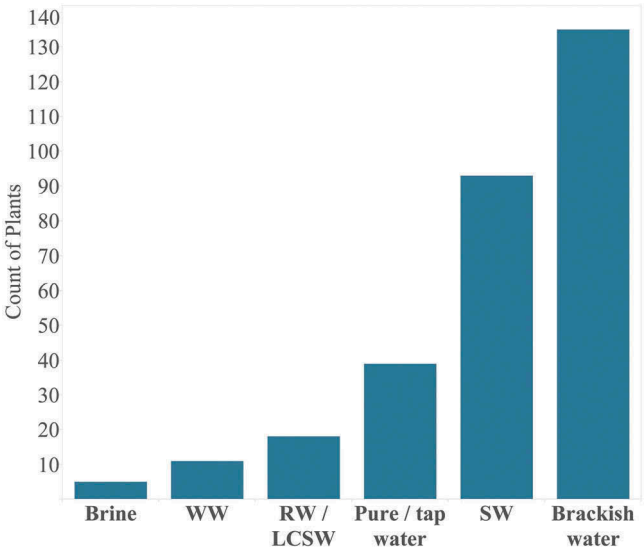


Figure 6. Feedwater quality in small-scale desalination projects from 2010 to 2015 (WW, RW, LCSW and SW represent wastewater, river water, low-concentration salt water and seawater, respectively). (Authors' analysis, based on data from Desaldata, 2016.)

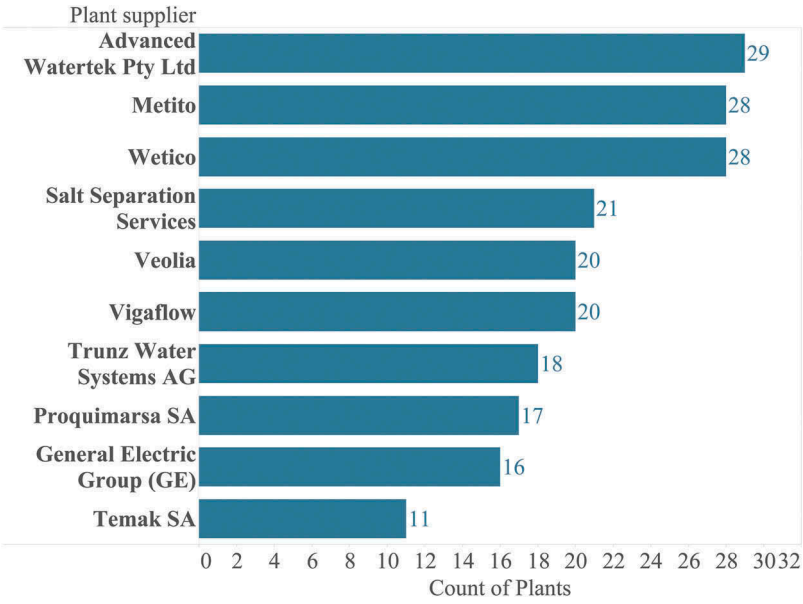


Figure 7. Top 10 small-scale project suppliers from 2010 to 2015. (Authors' analysis, based on data from Desaldata, 2016.)

Finally, the major suppliers in the small-scale desalination market were considered. The top 10 suppliers during 2010 to 2015 were Advanced Watertek Pty Ltd, Metito Group, Wetico, Salt Separation Services Ltd, Veolia, Vigaflow, Trunz Water Systems AG, Proquimarsa, General Electric Group and Temak SA (see Figure 7). The location of these suppliers is shown in Figure 8, with the size of the dot indicating relative capacity.

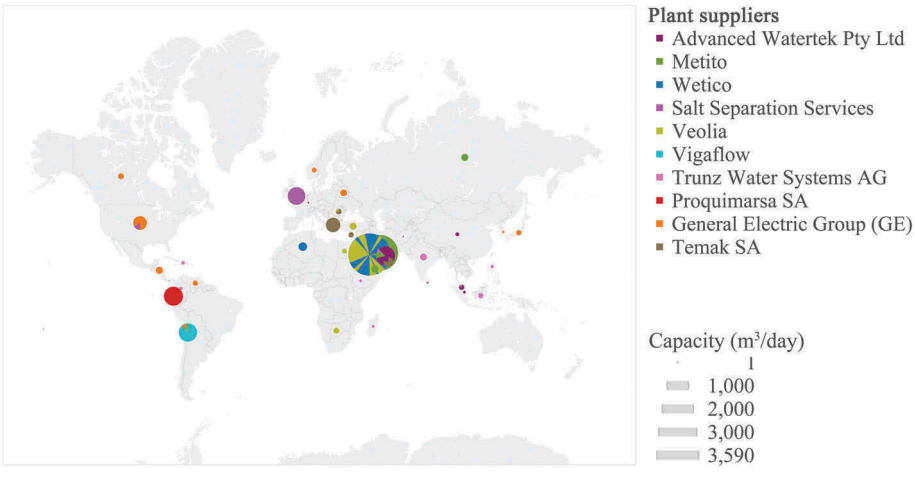


Figure 8. Location of top 10 suppliers in small-scale desalination, indicating capacity, from 2010 to 2015. (Authors' analysis, based on data from Desaldata, 2016.)

Energy-recovery devices for small-scale SWRO

Introduction of energy-recovery devices

As mentioned earlier, energy-recovery devices (ERDs) are now widely adopted in large-scale SWRO plants, as they recover pressure energy and therefore lower operating energy costs significantly. With the implementation of ERDs, the energy consumption of SWRO can be reduced to 2–3 kWh/m^3 (Peñate, de la Fuente, & Barreto, 2010; Stover, 2007). ERDs for large-scale SWRO can be broadly classified into two types: turbine (centrifugal) and positive displacement (Gude, 2011; Peñate et al., 2010). In the former, the pressure energy in the brine is converted to mechanical energy, and then back to pressure energy to the feed, through a shaft. This type of device has relatively low costs, but also low energy-recovery efficiency due to the energy transformation process. The latter is the latest technology, in which the pressure energy of the brine is transferred to pressurize seawater directly based on the positive displacement principle. Normally, energy transfer occurs in two static chambers alternately, with the reciprocal movement of the pistons inside (Gude, 2011; Went, Kroemke, Schmoch, & Vetter, 2010). In general, positive displacement has a higher energy-recovery efficiency (i.e. up to 98%) and is now preferred in most of the recently built large-scale SWRO plants (MacHarg, 2001). Popular commercial positive displacement ERDs for large-scale SWRO include DWEER, SalTec, and the PX isobaric pressure exchanger.

ERDs for small-scale SWRO

Despite the popularity of ERDs in large-scale SWRO plants, the use of ERDs in small-scale decentralized SWRO applications, which rely on isolated reverse osmosis modules rather than reverse osmosis module trains, is still rare in the available information. According to Desaldata (2016), only 3 of the 302 small-scale projects between 2010 and 2015 used ERDs. This might be attributed to the high capital cost and the requirement of skilled personnel for installation, and also partially to the lower pressure energy for brackish water compared to seawater. In this section, a few examples of ERDs that have been applied to small-scale SWRO systems as reported in the literature are discussed and compared comprehensively. Table 1 summarizes the features of the different ERD technologies described in the examples.

Isobaric pressure exchanger

The isobaric pressure exchanger is a type of rotary ERD based on the positive displacement principle in which the pressure energy in brine is used to pressurize seawater directly (MacHarg, 2003). Currently, the popular products include the PX pressure exchanger, developed by ERI, and the XPR, developed by Isobaric Strategies. An isobaric pressure exchanger can be used in both large- and small-scale SWRO applications by adjusting the number of units. The energy transfer in the isobaric pressure exchanger occurs in a cylindrical rotor, which normally spins at 1500 RPM (Kim, Kang, Lee, Jeon, & Choi, 2013). A part of the fluid works as a buffer to reduce direct crossflow of seawater or brine, as there is no physical barrier, such as a piston, in the duct. However, the absence of a physical barrier allows high longitudinal mixing (6–7%) of brine and seawater (Stover, 2004) which might be attributed to turbulence inside the

Table 1. Comparison of energy-recovery devices in small-scale seawater reverse osmosis.

ERD type	Commercial product	Working mechanism	Energy-recovery efficiency (%)	Applicable scale	Advantages	Disadvantages
Isobaric pressure exchanger (Fritzmann et al., 2007; Kim et al., 2013; MacHarg, 2003; Stover, 2004; Stover, 2010)	PX pressure exchanger, XPR, etc.	Positive displacement principle / Pressure-pressure	96–98	Large and small	High and stable efficiency; no electrical component	Noisy; mixing and leakage; requires additional booster pump
Pressure amplifier (Mohamed et al., 2005; Spectra Watermakers, 2016; Thomson, Miranda, & Infield, 2003)	Clark pump, ENERCO pressure intensifier, etc.	Positive displacement principle / Pressure-pressure	93–97	Small, up to 10 m^3/day	High efficiency; no need of booster pump	Fixed membrane recovery rate
Water hydraulic pump-motor (Kim et al., 2010; KSB, 2016; Lu et al., 2011)	SALINO, Danfoss pump, etc.	Positive displacement principle / Pressure–mechanical energy–pressure	24–47	Small to medium, up to 1000 m^3/day	Compact in space; no need of booster pump; no mixing	Low efficiency; corrosion problems

duct flows (Song & Law, 2015). The longitudinal mixing leads to more energy demand for the subsequent SWRO processes.

Due to the elimination of the piston inside the duct, isobaric pressure exchangers have a high energy-recovery efficiency of 96–98% (Stover, 2007, 2010). Also, the rotation of the rotor is driven by the flow itself, which replaces the valve system of normal positive displacement ERDs (Kim et al., 2013). This should reduce the frequency of mechanical malfunctions. However, a booster pump is required for the high-pressure seawater outflow to compensate for the longitudinal mixing as well as for the energy loss in the SWRO process (Gude, 2011; Stover, 2007). One example of the application of an isobaric pressure exchanger in small-scale SWRO is the Resort Island project in Fiji supplied by Ace Water Treatment. It has provided drinking water, using an isobaric pressure exchanger for energy recovery, with a capacity of 100 m^3/day since 2012 (Desaldata, 2016).

Pressure amplifier

The Clark pump is an energy-recovery and pressure-amplification device, specially developed by Spectra Watermakers for small-scale SWRO (Spectra Watermakers, 2016; Thomson, Miranda, & Infield, 2003). Technologies based on a similar mechanism include the hydraulic energy recovery device (Sun, Wang, Xu, Wang, & Wang, 2009), the ENERCON pressure intensifier (Paulsen & Hensel, 2005), and the pressure exchanger-intensifier (Folley, Suarez, & Whittaker, 2008). Basically, the device consists of a cylinder which is divided into two separate compartments, two pistons (one in each compartment), and a rod which solidly connects the two pistons. The piston assembly (pistons plus rod) can move back and forth inside the cylinder.

The Clark pump is based on the positive displacement principle, but applied somewhat differently from the conventional ones. As the piston assembly moves from left to right, the seawater in the right compartment is pushed out of the cylinder by both the low-pressure seawater from the left inlet and the high-pressure brine from the top inlet. In other words, the two streams work together to pressurize the seawater. At the same time, the depressurized brine in the left compartment leaves the cylinder. From the working principle, it is obvious that the pressure and flowrate satisfy the following equations under an ideal situation (Thomson et al., 2003):

$$PH = PL + PB(1 - R) \tag{1}$$

$$QH = Q_L = Q_B/(1 - R) \tag{2}$$

where P is the pressure, Q the flowrate, and R the ratio of the cross-sectional area of the rod to that of the piston, and subscripts H, L and B represent high-pressure seawater, low-pressure seawater and high-pressure brine, respectively. The above equations also suggest that due to mass conservation, the recovery rate of SWRO equals R, which is typically 10% in a standard model (Thomson et al., 2003).

Since the Clark pump is designed for small-scale SWRO, it is normally used with a single 2.5 × 40 inch reverse osmosis membrane element (Spectra Watermakers, 2016). A reversing valve system is used to control the inflow and outflow. A low-pressure feed pump is required to pressurize the seawater to about 5 bar, but there is no need for a booster pump to further pressurize the high-pressure seawater (Bermudez-Contreras & Thomson, 2010). In a laboratory test conducted at Loughborough University, the

energy-recovery efficiency of the Clark pump ranged from 90% to 97% under various operating conditions (Thomson et al., 2003). Another test conducted at the Agricultural University of Athens showed a small-scale SWRO system with a Clark Pump using two reverse osmosis membranes connected in series and a specific energy consumption of about 3.7 kWh/m^3 with a fresh water production of 2.6 m^3/day (Mohamed et al., 2005).

Water hydraulic pump-motor

The water hydraulic pump-motor is another type of technology which can be applied to recover energy in small-scale SWRO (Kim et al., 2010; Lu et al., 2011). Instead of transferring the pressurized brine directly to seawater, as in the previous two technologies, the water hydraulic pump-motor converts the pressure to mechanical energy and then back to pressure (Kim et al., 2010). The system normally consists of an axial piston pump and an axial piston motor, and the latter works as an ERD as well (Kim et al., 2010; Lu et al., 2011). Currently, there are mainly two products in the market, the Danfoss pump (Valbjørn, 2009) and the SALINO (KSB, 2013). In the following section, the SALINO is introduced in detail, as it was specially developed for energy recovery in small-to-medium-scale SWRO.

The SALINO Pressure Center is a product of KSB, which aims to provide integrated solutions for small- and medium-sized reverse osmosis plants, with produced water capacity of less than 1000 m^3/day (KSB, 2016). The seawater enters the system at a low pressure. It is raised to a high pressure by the axial piston pump and then directed through the reverse osmosis membrane. The resulting high-pressure brine is returned to the system, where its hydraulic energy (pressure) is converted into mechanical energy (torque) by the axial piston motor. The torque is transferred by a shaft to the axial piston pump to pressurize the newly incoming seawater. As the motor is partially driven by the energy from the high-pressure brine, the electrical energy demand for the motor is reduced (KSB, 2016). Hence, the SALINO system possesses a great advantage of up to 75% energy savings compared with systems without ERDs (KSB, 2016). Also, in this system, brine and seawater do not mix, as the two streams are not in contact. SALINO is a containerized system: only one motor is required, all components are integrated without any pipe connections, and the size is compact (0.75 m^2) (KSB, 2016).

Only a few studies have evaluated the performance of Danfoss pumps (Dimitriou, Mohamed, Karavas, & Papadakis, 2015; Drabløs, 2005; Kim et al., 2010). According to the experimental results of Dimitriou et al. (2015), a minimum specific energy consumption of 4 kWh/m^3 was obtained in a small-scale SWRO unit equipped with Danfoss pumps at a pressure of 59 bar. Regarding SALINO, it was reported that the first unit was operated close to the Red Sea (KSB, 2013), but no practical operating information could be found in the literature.

In summary, the isobaric pressure exchanger is the most widely applied for energy recovery, due to its high energy-recovery efficiency of 96–98% (Fritzmann, Löwenberg, Wintgens, & Melin, 2007; Gude, 2011). However, its development is constrained by high capital and maintenance costs (Fritzmann et al., 2007). For the Clark pump and the water hydraulic pump-motor (Danfoss pumps and SALINO), most of the applications are still at lab scale (Kim et al., 2010; Lu et al., 2011; Mohamed et al., 2005; Thomson et al., 2003). The primary reason might be the relatively low energy-recovery efficiency. One example of using the Clark pump for energy recovery is Solar Cube, a system developed by Spectra Watermakers for emergency use and disaster relief (Wood, 2007).

Conclusions

This study reviewed the current status of small-scale desalination (produced water capacity of 100 m^3/day or less) for the recent six-year period of 2010–2015, based on the DesalData database. Dozens of small-scale desalination projects were newly contracted every year in this period. Among them, Saudi Arabia and United Arab Emirates accounted for the largest market share (more than 25%). Reverse osmosis was the most common technology applied in this market segment. Compared to large-scale desalination, where seawater is the dominant feedstock, small-scale desalination is more adaptive to diverse sources, including both brackish water and seawater. In view of its wide usability and high adaptability, the application of small-scale SWRO is far from fully developed at the moment. The main reason is presently attributed to its relatively high cost. According to the survey, the use of ERDs remains rare in small-scale SWRO. Since SWRO without ERDs has high energy consumption, the implementation of ERDs should be a high priority for the development of cost-effective small-scale SWRO in the future. Although some commercial products have been developed specially for small-scale SWRO, they are rarely used. The primary reasons can be attributed to the perceived complexities of installation, the lower pressure energy required for brackish water, and the cost involved, which may not justify the capital investment for a separate ERD. In summary, improvements in small-scale SWRO in terms of lowering the energy cost are still imperative going forward.

Acknowledgements

The authors would like to acknowledge the primary funding support from the Singapore National Research Foundation. We would also like to acknowledge the funding support from the German Federal Ministry of Education and Research (BMBF), which made the partnership between the Technical University of Darmstadt and Nanyang Technological University possible, in the frame of the Thematic Network 'Clean Water China and Southeast Asia', DAAD Programme Strategic Partnerships and Thematic Networks 2012, Programme Line B, Project No. DAAD: 56268477.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported primarily by the National Research Foundation Singapore [NRF2015NRF-POC001-007] and by the German Federal Ministry of Education and Research [DAAD: 56268477].

ORCID

Jie Song http://orcid.org/0000-0001-9538-1798
Tian Li http://orcid.org/0000-0001-5117-7883
Lucía Wright-Contreras http://orcid.org/0000-0003-3879-1744
Adrian Wing-Keung Law http://orcid.org/0000-0002-2593-6361

References

Bermudez-Contreras, A., & Thomson, M. (2010). Modified operation of a small scale energy recovery device for seawater reverse osmosis. *Desalination and Water Treatment*, *13*, 195–202. doi:10.5004/dwt.2010.990

Dawson, J. S., & Brennan, J. (2012). *Desalination: Solutions and roadmap for an improved water supply*. New York, NY: Nova Science Publishers.

Delgado, D. J., & Moreno, P. (2008). *Desalination research progress*. New York, NY: Nova Science Publishers.

Desaldata. (2016). GWI Desaldata database. Retrieved from https://www.desaldata.com/

Dimitriou, E., Mohamed, E. S., Karavas, C., & Papadakis, G. (2015). Experimental comparison of the performance of two reverse osmosis desalination units equipped with different energy recovery devices. *Desalination and Water Treatment*, *55*, 3019–3026.

Drabløs, L. S. (2005). Testing of Danfoss APP1.0-2.2 with APP pumps as water hydraulic motors for energy recovery. *Desalination*, *183*, 41–54. doi:10.1016/j.desal.2005.04.022

Elimelech, M., & Phillip, W. A. (2011). The future of seawater desalination: Energy, technology, and the environment. *Science*, *333*, 712–717. doi:10.1126/science.1200488

Farooque, A. M., Jamaluddin, A. T. M., & Al-Reweli, A. R. (2004). *Comparative study of various energy recovery devices used in SWRO process* (Technical Report No. TR.3807/EVP 02005). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.501.5964&rep=rep1&type=pdf

Folley, M., Suarez, B. P., & Whittaker, T. (2008). An autonomous wave-powered desalination system. *Desalination*, *220*, 412–421. doi:10.1016/j.desal.2007.01.044

Fritzmann, C., Löwenberg, J., Wintgens, T., & Melin, T. (2007). State-of-the-art of reverse osmosis desalination. *Desalination*, *216*, 1–76. doi:10.1016/j.desal.2006.12.009

Greenlee, L. F., Lawler, D. F., Freeman, B. D., Marrot, B., & Moulin, P. (2009). Reverse osmosis desalination: Water sources, technology, and today's challenges. *Water Research*, *43*, 2317–2348. doi:10.1016/j.watres.2009.03.010

Gude, V. G. (2011). Energy consumption and recovery in reverse osmosis. *Desalination and Water Treatment*, *36*, 239–260. doi:10.5004/dwt.2011.2534

Kim, Y., Kang, M. G., Lee, S., Jeon, S. G., & Choi, J.-S. (2013). Reduction of energy consumption in seawater reverse osmosis desalination pilot plant by using energy recovery devices. *Desalination and Water Treatment*, *51*, 766–771. doi:10.1080/19443994.2012.705549

Kim, Y. C., Ham, Y.-B., & Park, S.-J. (2010). Energy recovery through a water-hydraulic motor in a small scale RO desalination system. *Desalination and Water Treatment*, *15*, 172–177. doi:10.5004/dwt.2010.1682

KSB. (2013). Compact high energy system for RO plant. *World Pumps*, *2013*, 27–28.

KSB. (2016). SALINO® pressure centre by KSB. Retrieved from https://www.ksb.com/salino-en

Lu, Y., Zhao, Y., Bu, G., & Shu, P. (2011). The integration of water vane pump and hydraulic vane motor for a small desalination system. *Desalination*, *276*, 60–65. doi:10.1016/j.desal.2011.03.023

MacHarg, J. P. (2001). The evolution of SWRO energy-recovery systems. *Desalination and Water Reuse*, *11*, 49–53.

MacHarg, J. P. (2003). Retro-fitting existing SWRO systems with a new energy recovery device. *Desalination*, *153*, 253–264. doi:10.1016/S0011-9164(02)01144-X

March, H. (2015). The politics, geography, and economics of desalination: A critical review. *Wiley Interdisciplinary Reviews: Water*, *2*, 231–243. doi:10.1002/wat2.1073

Mohamed, E. S., Papadakis, G., Mathioulakis, E., & Belessiotis, V. (2005). The effect of hydraulic energy recovery in a small sea water reverse osmosis desalination system; experimental and economical evaluation. *Desalination*, *184*, 241–246. doi:10.1016/j.desal.2005.02.066

Pankratz, T. (2012). *International Desalination Association (IDA) desalination yearbook 2011-2012, Water Desalination Report*. Oxford: Media Analytics.

Pankratz, T. (2013). *International Desalination Association (IDA) desalination yearbook 2012-2013, Water Desalination Report*. Oxford: Media Analytics.

Pankratz, T. (2014). *International Desalination Association (IDA) desalination yearbook 2013-2014, Water Desalination Report*. Oxford: Media Analytics.

Paulsen, K., & Hensel, F. (2005). Introduction of a new energy recovery system - optimized for the combination with renewable energy. *Desalination*, *184*, 211–215. doi:10.1016/j.desal.2005.03.060

Peñate, B., de la Fuente, J. A., & Barreto, M. (2010). Operation of the RO Kinetic® energy recovery system: Description and real experiences. *Desalination*, *252*, 179–185. doi:10.1016/j.desal.2009.06.078

Service, R. F. (2006). Desalination freshens up. *Science*, *313*, 1088–1090. doi:10.1126/science.313.5790.1088

Silbernagel, M., Kuepper, T., & Oklejas, E. (1992). Evaluation of a pressure boosting pump/turbine device for reverse osmosis energy recovery: Extended testing on a seawater desalination system. *Desalination*, *88*, 311–319. doi:10.1016/0011-9164(92)80123-Q

Song, J., & Law, A. W. K. (2015). Longitudinal dispersion of turbulent oscillatory pipe flows. *Environmental Fluid Mechanics*, *15*, 563–593. doi:10.1007/s10652-014-9374-z

Spectra Watermakers. (2016). The spectra clark pump. Retrieved from https://www.spectrawatermakers.com/us/us/explore/our-technology

Stover, R. L. (2004). Development of a fourth generation energy recovery device. A 'CTO's notebook. *Desalination*, *165*, 313–321. doi:10.1016/S0011-9164(04)00240-1

Stover, R. L. (2007). Seawater reverse osmosis with isobaric energy recovery devices. *Desalination*, *203*, 168–175. doi:10.1016/j.desal.2006.03.528

Stover, R. L. (2010). Retrofits to improve desalination plants. *Desalination and Water Treatment*, *13*, 33–41. doi:10.5004/dwt.2010.1064

Straits Times. (2016). PUB calls tender for 4th desalination plant, to be built in Marina East by 2019. Retrieved from http://www.straitstimes.com/singapore/environment/

Sun, J., Wang, Y., Xu, S., Wang, S., & Wang, Y. (2009). Performance prediction of hydraulic energy recovery (HER) device with novel mechanics for small-scale SWRO desalination system. *Desalination*, *249*, 667–671. doi:10.1016/j.desal.2009.03.009

Thomson, M., Miranda, M. S., & Infield, D. (2003). A small-scale seawater reverse-osmosis system with excellent energy efficiency over a wide operating range. *Desalination*, *153*, 229–236. doi:10.1016/S0011-9164(02)01141-4

Urbonienė, I. A. (2010). *Desalination: Methods, costs and technology*. New York, NY: Nova Science Publishers.

Valbjørn, A. (2009). ERD for small SWRO plants. *Desalination*, *248*, 636–641. doi:10.1016/j.desal.2008.05.113

Virgili, F., Pankratz, T., & Gasson, J. (2016). *International desalination association (IDA) desalination yearbook 2015–2016, Water Desalination Report*. Oxford: Media Analytics.

Went, J., Kroemke, F., Schmoch, H., & Vetter, M. (2010). The energy demand for desalination with solar powered reverse osmosis units. *Desalination and Water Treatment*, *21*, 138–147. doi:10.5004/dwt.2010.1302

Wood, R. (2007). Sun- and wind-powered, solar cube is a self-contained water purification system. *Journal American Water Works Association*, *99*, 38–41.

World Health Organization (WHO). (2008). Guidelines for drinking-water quality. Retrieved from http://www.who.int/water_sanitation_health/dwq/gdwq0506.pdf

Zander, A. K., Elimelech, M., Furukawa, D. H., Gleick, P., Herd, K. R., Jones, K. L., … Wood, W. W. (2008). *Desalination: A national perspective, National Research Council*. Chicago, IL: The National Academies.

Appendix 4. Authors' contribution statements

Prüfungskommission
Technische Universität Darmstadt
FB 15 Architektur
El-Lissitzky-Str. 1
D-64287 Darmstadt

Cumulative dissertation
Author's contribution according to §9 (5) of the 8th Amendment to the Doctoral Regulations dated 08/02/2018

Lucía Wright Contreras
PhD Student

URBANgrad
Fachbereich Architektur
Technische Universität Darmstadt

March 25, 2019

Dear PhD Committee,

Relevant to the requirements to receive the title of Doctor of Engineering (Dr.-Ing.), I hereby state that my role in the following article concerned:

- data collection relevant to the global analysis of small-scale desalination plants (DesalData, 2016);
- mapping and elaboration of Figures 1, 2, 3, 4, 5, 6, 7 and 8;
- initial writing of sections: Introduction, Small-scale desalination, Statistics, and contribution to Conclusions.

Song, J., Li, T., **Wright-Contreras, L.,** & Law, A. W. K. (2017). A review of the current status of small-scale seawater reverse osmosis desalination. *Water International*, 1-14. DOI: 10.1080/02508060.2017.1330841

We hereby declare that the above information is true and correct:

Jie Song Co-author	Tian Li Co-author	Lucía Wright-Contreras Co-author

Adrian Law Wing-Keung
Co-author

In Agreement with academic supervisors:

Prof. Dr.-Ing. Annette Rudolph-Cleff Technische Universität Darmstadt	Prof. Dr. Miranda Schreurs Technische Universität München

Prüfungskommission
Technische Universität Darmstadt
FB 15 Architektur
El-Lissitzky-Str. 1
D-64287 Darmstadt

Cumulative dissertation
Author's contribution according to §9 (5) of the 8th Amendment to the Doctoral Regulations dated 08/02/2018

Lucía Wright Contreras
PhD Student

URBANgrad
Fachbereich Architektur
Technische Universität Darmstadt

March 25, 2019

Dear PhD Committee,

Relevant to the requirements to receive the title of Doctor of Engineering (Dr.-Ing.), I hereby state that my role in the following article concerned:

- data collection,
- writing of all sections,
- correcting and corresponding through the peer-review process.

The co-authors had the role of:

- supporting with their expertise,
- providing feedback after each peer review.

Wright-Contreras, L., March, H., & Schramm, S. (2017). Fragmented landscapes of water supply in suburban Hanoi. *Habitat International*, 61, 64-74. DOI: 10.1016/j.habitatint.2017.02.002

We hereby declare that the above information is true and correct:

Sophie Schramm
Digitally signed by Sophie Schramm
DN: cn=Sophie Schramm, o, ou, email=s.schramm@uu.nl, c=NL
Date: 2019.03.27 11:32:17 +01'00'

Lucía Wright-Contreras Co-author	Hug March Co-author	Sophie Schramm Co-author

In Agreement with academic supervisors:

Prof. Dr.-Ing. Annette Rudolph-Cleff Technische Universität Darmstadt	Prof. Dr. Miranda Schreurs Technische Universität München

Prüfungskommission
Technische Universität Darmstadt
FB 15 Architektur
El-Lissitzky-Str. 1
D-64287 Darmstadt

Cumulative dissertation
Author's contribution according to §9 (5) of the 8th Amendment to the Doctoral Regulations dated 08/02/2018

Lucía Wright Contreras
PhD Student

URBANgrad
Fachbereich Architektur
Technische Universität Darmstadt

March 25, 2019

Dear PhD Committee,

Relevant to the requirements to receive the title of Doctor of Engineering (Dr.-Ing.), I hereby state that my role in the following article concerned:

- writing and contribution for the information relevant to water supply,
- input with quotes from interviews elaborated in Hanoi,
- co-elaboration of maps of Hanoi's urban areas (Figures 1 and 2).

Schramm, S., & **Wright-Contreras, L.** (2017). Beyond passive consumption: Dis/ordering water supply and sanitation at Hanoi's urban edge. *Geoforum*, 85, 299-310. DOI: 10.1016/j.geoforum.2017.06.016

We hereby declare that the above information is true and correct:

Sophie Schramm
Digitally signed by Sophie Schramm
DN: cn=Sophie Schramm, o, ou, email=s.schramm@uu.nl, c=NL
Date: 2019.03.27 11:31:21 +01'00'

Sophie Schramm
Co-author

Lucía Wright-Contreras
Co-author

In Agreement with academic supervisors:

Prof. Dr.-Ing. Annette Rudolph-Cleff
Technische Universität Darmstadt

Prof. Dr. Miranda Schreurs
Technische Universität München

Prüfungskommission
Technische Universität Darmstadt
FB 15 Architektur
El-Lissitzky-Str. 1
D-64287 Darmstadt

Cumulative dissertation
Author's contribution according to §9 (5) of the 8th Amendment to the Doctoral Regulations dated 08/02/2018

Lucía Wright Contreras
PhD Student

URBANgrad
Fachbereich Architektur
Technische Universität Darmstadt

March 25, 2019

Dear PhD Committee,

Relevant to the requirements to receive the title of Doctor of Engineering (Dr.-Ing.), I hereby state that my role in the following article concerned:

- writing and contribution for the information relevant to water supply,
- input with quotes from interviews elaborated in Hanoi.

Schramm, S., & **Wright-Contreras, L.** (forthcoming). Suburban constellations of water supply and sanitation in Hanoi. In P. Filion & N. Pulver (Eds.), Critical Perspectives on Suburban Infrastructures: Contemporary International Cases. Toronto: University of Toronto Press.

We hereby declare that the above information is true and correct:

Sophie Schramm
Digitally signed by Sophie Schramm
DN: cn=Sophie Schramm, o, ou, email=s.schramm@uu.nl, c=NL
Date: 2019.03.27 11:29:49 +01'00'

Sophie Schramm
Co-author

Lucía Wright-Contreras
Co-author

In Agreement with academic supervisors:

Prof. Dr.-Ing. Annette Rudolph-Cleff
Technische Universität Darmstadt

Prof. Dr. Miranda Schreurs
Technische Universität München

Prüfungskommission
Technische Universität Darmstadt
FB 15 Architektur
El-Lissitzky-Str. 1
D-64287 Darmstadt

Cumulative dissertation
Author's contribution according to §9 (5) of the 8th Amendment to the Doctoral Regulations dated 08/02/2018

Lucía Wright Contreras
PhD Student

URBANgrad
Fachbereich Architektur
Technische Universität Darmstadt

April 1, 2019

Dear PhD Committee,

Relevant to the requirements to receive the title of Doctor of Engineering (Dr.-Ing.), I hereby state that my role in the following book chapter concerned:

- building a database of 483 water operator profiles and 204 water operators' partnerships (WOPs) profiles as basis for the analysis.

Pascual-Sanz, M., Perkins, J., Kiyenje, J., & **Wright-Contreras, L.** (2018). Water operators' partnerships for universal and sustainable access to water services. In A. M. Badia Martí & L. Huichi Sancho (Eds.), Agua, recurso natural limitado: entre el desarrollo sostenible y la seguridad internacional (pp. 79–91). Madrid, Spain: Marcial Pons.

We hereby declare that the above information is true and correct:

Maria Pascual-Sanz
Co-author

Julie Perkins
Co-author

Julissa Kiyenje
Co-author

Lucía Wright-Contreras
Co-author

In Agreement with academic supervisors:

Prof. Dr.-Ing. Annette Rudolph-Cleff
Technische Universität Darmstadt

Prof. Dr. Miranda Schreurs
Technische Universität München

Prüfungskommission
Technische Universität Darmstadt
FB 15 Architektur
El-Lissitzky-Str. 1
D-64287 Darmstadt

Cumulative dissertation
Author's contribution according to §9 (5) of the 8th Amendment to the Doctoral Regulations dated 08/02/2018

Lucía Wright Contreras
PhD Student

URBANgrad
Fachbereich Architektur
Technische Universität Darmstadt

April 1, 2019

Dear PhD Committee,

Relevant to the requirements to receive the title of Doctor of Engineering (Dr.-Ing.), I hereby state that my role in the following article concerned:

- data collection,
- writing of all sections,
- correcting and corresponding through the peer-review process.

The co-authors had the role of:

- supporting with their expertise,
- providing feedback after each peer review.

Wright-Contreras, L., M., Perkins, Pascual-Sanz, J. & Soppe, G. (under revision). WOPs and their supporting role in the improvement of urban water supply in Da Nang. *International Journal of Water Resource Development.*

We hereby declare that the above information is true and correct:

Lucía Wright-Contreras
Co-author

Julie Perkins
Co-author

Maria Pascual-Sanz
Co-author

Gerard Soppe
Co-author

In Agreement with academic supervisors:

Prof. Dr.-Ing. Annette Rudolph-Cleff
Technische Universität Darmstadt

Prof. Dr. Miranda Schreurs
Technische Universität München

Appendix 5. Agreement of Cooperation (AoC) between UN-Habitat and TU Darmstadt

UN-HABITAT
FOR A BETTER URBAN FUTURE

SMALL-SCALE AGREEMENT OF COOPERATION

1. This Small-Scale Agreement of Cooperation (hereinafter referred to as the "Agreement") is entered into between the United Nations Humans Settlement Programme ("**UN-Habitat**") and **the Technische Universität Darmstadt ("TU Darmstadt")** (hereinafter collectively referred to as the "**Parties**" and individually as the "**Party**") and consists of this document, including Annex A ("General Terms and Conditions"), Annex B ("Project Document and Implementation Schedule") and Annex C ("Project Budget and Payment Schedule").

2. Subject to their respective regulations, rules, policies, practice, procedures and availability of funds, the Parties shall collaborate in implementing the ***WOPs Documentation and Analysis project*** (hereinafter referred to as the "Project").

3. The Parties shall keep each other informed of all relevant activities hereto related.

4. As set forth in detail in Annex B, the Parties shall be responsible for:

UN-Habitat's responsibilities	***TU Darmstadt Responsibilities***
Under this Agreement, UN-Habitat, through its Global Water Operators' Partnership Alliance (GWOPA) under the Urban Basic Services Branch ("UBSB"), shall be responsible for the overall supervision and backstopping of the Project execution, including: (a) Providing funds to TU Darmstadt up to a maximum amount of **US$25,000 (United States Dollars Twenty-Five Thousand)** in accordance with the procedure set forth under paragraph (5) herein below and in Annex C (the "*Payment Schedule*") attached hereto; (b) Providing technical assistance and guidance to TU Darmstadt for the implementation of the Project; (c) Supervising on the timely implementation of the Project in accordance with the time-line set out in this Agreement; and (d) Reviewing and approving the final drafts of reports prepared by TU Darmstadt (if the case may be); etc. The additional responsibilities can be obtained from the Project document.	Under this Agreement, TU Darmstadt shall be responsible for the implementation of the Project as described in Annex B, including: (a) *WOP Case Study in Vietnam –* Conduct a full Case study on a WOP following the BEWOP Analytical Framework and work with the respective water utilities and with GWOPA to prepare the case study in GWOPA's narrative case and factsheet formats for editing, designing and publishing by the GWOPA Team; (b) *Diagnostic Tool Survey and Analysis* Working in collaboration with UNESCO-IHE, the partner will gather and analyze a wide set of diagnostic tools for utilities. The resulting report will describe and compare the tools to facilitate access to them by users, and to identify trends and potential gaps in the available set of diagnostics; (c) *Cleaning, Analyzing and Improving WOP Database* Retrieve WOP and Operator profile data tables from the previous website and clean and reorder them for better access in the new site and analyze the existing data for key trends and produce a number of related charts using Tableau. In addition produce a short report with recommendations for the GWOPA secretariat to improve the quality, ease and sustainability of future data collection data by the Secretariat. The report should advise on: graphic displays of trends, comparative analysis of data by region, time period or other variables, etc.

5. UN-Habitat shall provide TU Darmstadt with funds up to a maximum amount of **US$25,000 (United States Dollars Twenty Five Thousand),** to be made available in ***[three]*** installment(s) as indicated in Annex C (the "*Payment Schedule*").

6. The payment shall be deposited to the following Bank account and in the manner provided in Annex C (the "*Payment Schedule*") in USD:

Bank Name and Address Stadt-und Kreissparkasse Darmstadt Rheinstraße 10-12, 64283 Darmstadt	**Wire Instructions** IBAN: DE36 5085 0150 0000 7043 00 BIC / SWIFT-Code: HELADEF1DAS Indicate: "Kostenstelle 150007"
Account Title and Number Technischen Universität Darmstadt Account Nr. 704 300 (BLZ 508 501 50)	**Signatories (2)** Dr. Manfred Efinger Prof. Dr.-Ing. Annette Rudolph-Cleff

7. Upon UN-Habitat's written request, TU Darmstadt shall refund any funds provided in excess of the maximum amount set out above, as well as any non-duly authorized disbursements.

8. TU Darmstadt shall submit to UN-Habitat, substantive progress reports and a final report, as required in Annex B. TU Darmstadt shall also submit a financial report, itemized as per Annex C, on the use of funds provided to be certified by TU Darmstadt's competent financial officer, together with support documentation for expenses incurred. UN-Habitat has the right, at its own expense, to have the records of TU Darmstadt related to this cooperation reviewed and audited.

9. TU Darmstadt shall adhere to the all the reporting requirements as set forth under **clause 8** herein above, and with the understanding that UN-Habitat shall not release any installment payments under this Agreement:

(a) Prior to the satisfactory review by UN-Habitat of the financial and implementation progress reports submitted by TU Darmstadt;

(b) If TU Darmstadt substantially deviates from the agreed plans and budgets as set forth in Annexes B and C respectively; and

(c) If UN-Habitat finds any evidence of financial mismanagement of the Project funds occasioned by TU Darmstadt in implementing the Project.

10. UN-Habitat shall claim repayment in full or in part any funds provided for the Project from TU Darmstadt if the funds are found to be misused or not satisfactorily accounted for. Such repayment shall be in accordance with the United Nations Financial Regulations and Rules. Before withholding disbursement or reclaiming UN-Habitat and TU Darmstadt shall consult with a view to resolving promptly the matter.

11. TU Darmstadt declares and guarantees that no offer, gift payment, consideration or benefit of any kind which constitutes illegal or corrupt practice, has been or will be made to anyone by TU Darmstadt, either directly or indirectly to any UN-Habitat official or agent, as an inducement or reward for the award or execution of this Agreement. Any such practice is grounds for terminating this Agreement or the taking of any other corrective action as required.

12. TU Darmstadt shall inform UN-Habitat of any illegal or corrupt practice or any other misuse of funds in any activity financed under this Agreement that TU Darmstadt is aware of, or that has been

brought to its attention, whether or not under TU Darmstadt's responsibility. TU Darmstadt shall provide UN-Habitat with information on the findings and any actions or measures taken by it. Upon receipt of such notification, the Parties shall promptly consult with each other to determine further actions to be taken. TU Darmstadt shall keep UN-Habitat informed of the progress of any formal investigation concerning the matter and provide UN-Habitat with a final report on the finding of such investigation upon its conclusion.

13. This Agreement may be terminated by either Party giving the other party a written notice of thirty (30) days prior to its intention to terminate in accordance with the procedures set for the in section 13.0 of Annex A, General Terms and Conditions.

14. This Agreement may be modified by written agreement between the Parties hereto in accordance with the procedure set forth in section 26.0 of Annex A, General Terms and Conditions.

15. Should it become evident to either Party during the implementation of the Project that an extension beyond the expiration duration set out in paragraph (20), below, will be necessary to achieve the Objectives of the Project that Party shall, without delay, inform the other Party, with a view to entering into consultations to agree on a new completion date. Upon agreement on the completion date, the Parties shall conclude an amendment to this effect, in accordance with paragraph (16) above.

16. Any notice required to be given by either Party under this Agreement shall be given in writing and shall be deemed given when actually received by the other Party, to the following addresses:

To UN-Habitat	**To TU Darmstadt**
For Operational Matters: Names: Faraj El-Awar Title: Head, GWOPA/ UN-Habitat Address: Nostra Senyora de la Merce Pavillion, Sant Pau Art Nouveau Site Sant Antoni Maria Claret, 167, 08025 Barcelona, Spain Telephone Number: 0034693108101 Email Address: faraj.el-awar@unhabitat.org	**For Operational Matters:** Names: Annette Rudolph-Cleff Title: Prof. Dr. Address: El-Lissitzky-Straße 1 64287 Darmstadt Telephone Number: +49 (0)6151 16-22161 Email Address: rudolph@stadt.tu-darmstadt.de
For Financial and Policy Matters: Names: Andrew Cox Title: Director, Operations and Management Address: UN-Habitat, P.O. Box 30030 Nairobi 00100, Kenya Telephone Number: +254-20-7623218 Email Address: andrew.cox@unhabitat.org	**For Financial and Policy Matters:** Names: Verena Jörg Title: Ass. iur. Address: Schleiermacherstr. 10/12 64283 Darmstadt Telephone Number: +49 (0)6151 16-57223 Email Address: joerg.ve@pvw.tu-darmstadt.de

17. Title to any equipment and supplies that may be furnished by UN-Habitat or procured through UN-Habitat funds shall rest with UN-Habitat until such time as ownership thereof is transferred. Except for equipment whose title has been transferred, all other equipment shall be returned to UN-Habitat at the conclusion of the project. Such equipment, when returned to UN-Habitat, shall be in the same condition as when delivered to TU Darmstadt, subject to normal wear and tear. TU Darmstadt shall be liable to compensate UN-Habitat for equipment determined to be damaged or degraded beyond normal wear and tear.

UN-HABITAT
FOR A BETTER URBAN FUTURE

18. This Agreement shall enter into force upon signature by the Parties being effective from the date of the latest signature, and shall remain valid for a period of *18* **months,** or unless earlier terminated by either Party in accordance with clause (13) above.

IN WITNESS WHEREOF the undersigned duly authorized representatives of UN-Habitat and TU Darmstadt, have signed this Agreement in two (2) originals at the place(s) and on the date(s) below written.

For UN-Habitat	For TU Darmstadt
Andre Dzikus **Coordinator** **Urban Basic Services Branch**	Stefan Weisenseel, Vertreter des Kanzlers **Dr. Manfred Eflinger** **Chancellor**
Place: Nairobi, Kenya **Date:** 15/5/17	**Place: Darmstadt, Germany** **Date:** 28/06/2017

UN HABITAT
FOR A BETTER URBAN FUTURE

ANNEX A

General Terms and Conditions

1.0 LEGAL STATUS: The Cooperating Entity/Contractor shall be considered as having the legal status of an independent Cooperating Entity/Contractor *vis-à-vis* UN-Habitat. The Cooperating Entity's/Contractor's personnel and sub-contractors shall not be considered in any respect as being the employees or agents of UN-Habitat.

2.0 SOURCE OF INSTRUCTIONS: The Cooperating Entity/Contractor shall neither seek nor accept instructions from any authority external to UN-Habitat in connection with the performance of its services under this Agreement/Contract. The Cooperating Entity/Contractor shall refrain from any action that may adversely affect the United Nations or UN-Habitat and shall fulfill its commitments with the fullest regard to the interests of UN-Habitat.

3.0 COOPERATING ENTITY/CONTRACTOR'S RESPONSIBILITY FOR EMPLOYEES: The Cooperating Entity/Contractor shall be responsible for the professional and technical competence of its employees and will select, for work under this Agreement/Contract, reliable individuals who will perform effectively in the implementation of this Agreement/Contract, respect the local customs, and conform to a high standard of moral and ethical conduct.

4.0 ASSIGNMENT: The Cooperating Entity/Contractor shall not assign, transfer, pledge or make other disposition of this Agreement/Contract or any part thereof, or any of The Cooperating Entity's/Contractor's rights, claims or obligations under this Agreement/Contract except with the prior written consent of UN-Habitat.

5.0 SUB-CONTRACTING: In the event the Cooperating Entity/Contractor requires the services of sub-contractors, the Cooperating Entity/Contractor shall obtain the prior written approval and clearance of UN-Habitat for all sub-contractors. The approval of UN-Habitat of a sub-contractor shall not relieve The Cooperating Entity/Contractor of any of its obligations under this Agreement/Contract. The terms of any sub-contract shall be subject to and conform to the provisions of this Agreement/Contract.

6.0 OFFICIALS NOT TO BENEFIT: the Cooperating Entity/Contractor warrants that no official of the United Nations and UN-Habitat has received or will be offered by the Cooperating Entity/Contractor any direct or indirect benefit arising from this Agreement/Contract or the award thereof. The Cooperating Entity/Contractor agrees that breach of this provision is a breach of an essential term of this Agreement/Contract.

7.0 INDEMNIFICATION: The Cooperating Entity/Contractor shall indemnify, hold and save harmless, and defend, at its own expense, UN-Habitat, its officials, agents, servants and employees from and against all suits, claims, demands, and liability of any nature or kind, including their costs and expenses, arising out of acts or omissions of the Cooperating Entity/Contractor, or the Cooperating Entity/Contractor 's employees, officers, agents or sub-contractors, in the performance of this Agreement/Contract. This provision shall extend, *inter alia*, to claims and liability in the nature of workmen's compensation, products liability and liability arising out of the use of patented inventions or devices, copyrighted material or other intellectual property by the Cooperating Entity/Contractor, its employees, officers, agents, servants or sub-contractors. The obligations under this Article do not lapse upon termination of this Agreement/Contract.

8.0 INSURANCE AND LIABILITIES TO THIRD PARTIES

8.1 The Cooperating Entity/Contractor shall provide and thereafter maintain insurance against all risks in respect of its property and any equipment used for the execution of this Agreement/Contract.

8.2 The Cooperating Entity/Contractor shall provide and thereafter maintain all appropriate workmen's compensation insurance, or the equivalent, with respect to its employees to cover claims for personal injury or death in connection with this Agreement/Contract.

8.3 The Cooperating Entity/Contractor shall also provide and thereafter maintain liability insurance in an adequate amount to cover third party claims for death or bodily injury, or loss of or damage to property, arising from or in connection with the provision of services under this Agreement/Contract or the operation of any vehicles, boats, airplanes or other equipment owned or leased by the Cooperating Entity/Contractor or its agents, servants, employees or sub-contractors performing work or services in connection with this Agreement/Contract.

8.4 Except for the workmen's compensation insurance, the insurance policies under this Article shall:

8.4.1 Name UN-Habitat as additional insured;

8.4.2 Include a waiver of subrogation of the Cooperating Entity/Contractor's rights to the insurance carrier against UN-Habitat; and

8.4.3 Provide that UN-Habitat shall receive thirty (30) days written notice from the insurers prior to any cancellation or change of coverage.

8.5 The Cooperating Entity/Contractor shall, upon request, provide UN-Habitat with satisfactory evidence of the insurance required under this Article.

9.0 ENCUMBRANCES/LIENS: The Cooperating Entity/Contractor shall not cause or permit any lien, attachment or other encumbrance by any person to be placed on file or to remain on file in any public office or on file with UN-Habitat against any monies due or to become due for any work done or materials furnished under this Agreement/Contract, or by reason of any other claim or demand against the Cooperating Entity/Contractor.

10.0 TITLE TO EQUIPMENT: Title to any equipment and supplies that may be furnished by UN-Habitat shall rest with UN-Habitat and any such equipment shall be returned to UN-Habitat at the conclusion of this Agreement/Contract or when no longer needed by the Cooperating Entity/Contractor. Such equipment, when returned to UN-Habitat, shall be in the same condition as when delivered to the Cooperating Entity/Contractor, subject to normal wear and tear. The Cooperating Entity/Contractor shall be liable to compensate UN-Habitat for equipment determined to be damaged or degraded beyond normal wear and tear.

11.0 COPYRIGHT, PATENTS AND OTHER PROPRIETARY RIGHTS

11.1 Except as is otherwise expressly provided in writing in the Agreement/Contract,] UN-Habitat shall be entitled to all intellectual property and other proprietary rights including, but not limited to, patents, copyrights, and trademarks, with regard to products, processes, inventions, ideas, know-how, or documents and other materials which the Cooperating Entity/Contractor has developed for UN-Habitat under the Agreement/Contract and which bear a direct relation to or are produced or prepared or collected in consequence of, or during the course of, the performance of the Agreement/Contract, and the Cooperating Entity/Contractor acknowledges and agrees that such products, documents and other materials constitute works made for hire for UN-Habitat.

11.2 At the request of UN-Habitat, the Cooperating Entity/Contractor shall take all necessary steps, execute all necessary documents and generally assist in securing such proprietary rights and transferring or licensing them to UN-Habitat in compliance with the requirements of the applicable law and of this Agreement/Contract.

11.3 Subject to the foregoing provisions, all maps, drawings, photographs, mosaics, plans, reports, estimates, recommendations, documents, and all other data compiled by or received by the Cooperating Entity/Contractor under the Agreement/Contract shall be the property of UN-Habitat, shall be made available for use or inspection by UN-Habitat at reasonable times and in reasonable places, shall be treated as confidential, and shall be delivered only to UN-Habitat authorized officials on completion of work under the Agreement/Contract.

12.0 USE OF NAME, EMBLEM OR OFFICIAL SEAL OF THE UNITED NATIONS AND UN-Habitat: The Cooperating Entity/Contractor shall not advertise or otherwise make public the fact that it is a Cooperating Entity/Contractor with UN-Habitat, nor shall the Cooperating Entity/Contractor, in any manner whatsoever use the name, emblem or official seal of UN-Habitat or the United Nations, or any abbreviation of the name of UN-Habitat in connection with its business or otherwise.

13.0 CONFIDENTIAL NATURE OF DOCUMENTS AND INFORMATION: Information and data that is considered proprietary by either Party and that is delivered or disclosed by one Party ("Discloser") to the other Party ("Recipient") during the course of performance of the Agreement/Contract, and that is designated as confidential ("Information"), shall be held in confidence by that Party and shall be handled as follows:

13.1 The recipient ("Recipient") of such information shall:

13.1.1 Use the same care and discretion to avoid disclosure, publication or dissemination of the Discloser's Information as it uses with its own similar information that it does not wish to disclose, publish or disseminate; and

13.1.2 Use the Discloser's Information solely for the purpose for which it was disclosed.

13.2 Provided that the Recipient has a written Agreement/Contract with the following persons or entities requiring them to treat the Information confidential in accordance with this Agreement/Contract and this Article 13, the Recipient may disclose Information to:

13.2.1 Any other party with the Discloser's prior written consent; and

13.2.2 The Recipient's employees, officials, representatives and agents who have a need to know such Information for purposes of performing obligations under the Agreement/Contract, and employees officials, representatives and agents of any legal entity that it controls, controls it, or with which it is under common control, who have a need to know such Information for purposes of performing obligations under this Agreement/Contract, provided that, for these purposes a controlled legal entity means:

13.2.2.1 A corporate entity in which the Party owns or otherwise controls, whether directly or indirectly, over fifty percent (50%) of voting shares thereof; or

13.2.2.2 Any entity over which the Party exercises effective managerial control; or

13.2.2.3 For UN-Habitat, a governing organ or subsidiary organ of UN-Habitat established in accordance with the Charter of UN-Habitat.

13.3 The Cooperating Entity/Contractor may disclose Information to the extent required by law, provided that, subject to and without any waiver of the privileges and immunities of UN and UN-Habitat, the Cooperating Entity/Contractor will give UN-Habitat sufficient prior notice of a request for the disclosure of Information in order to allow UN-Habitat to have a reasonable opportunity to take protective measures or such other action as may be appropriate before any such disclosure is made.

13.4 UN-Habitat may disclose Information to the extent as required pursuant to the Charter of United Nations, resolutions or regulations of the General Assembly, or rules promulgated by the Secretary-General.

13.5 The Recipient shall not be precluded from disclosing Information that is obtained by the Recipient from a third party without restriction, is disclosed by the Discloser to a third party without any obligation of confidentiality, is previously known by the Recipient, or at any time is developed by the Recipient completely independently of any disclosures hereunder.

13.6 These obligations and restrictions of confidentiality shall be effective during the term of the Agreement/Contract, including any extension thereof, and, unless otherwise provided in the Agreement/Contract, shall remain effective following any termination of the Agreement/Contract.

14.0 FORCE MAJEURE; OTHER CHANGES IN CONDITIONS

14.1 In the event of and as soon as possible after the occurrence of any cause constituting force majeure, The Cooperating Entity/Contractor shall give notice and full particulars in writing to UN-Habitat, of such occurrence or change if the Cooperating Entity/Contractor is thereby rendered unable, wholly or in part, to perform its obligations and meet its responsibilities under this Agreement/Contract. The Cooperating Entity/Contractor shall also notify UN-Habitat of any other changes in conditions or the occurrence of any event that interferes or threatens to interfere with its performance of this Agreement/Contract. On receipt of the notice required under this Article, UN-Habitat shall take such action as, in its sole discretion; it considers to be appropriate or necessary in the circumstances, including the granting to the Cooperating Entity/Contractor of a reasonable extension of time in which to perform its obligations under this Agreement/Contract.

14.2 If the Cooperating Entity/Contractor is rendered permanently unable, wholly, or in part, by reason of force majeure to perform its obligations and meet its responsibilities under this Agreement/Contract, UN-Habitat shall have the right to suspend or terminate this Agreement/Contract on the same terms and conditions as are provided for in Article 15, "Termination", except that the period of notice shall be seven (7) days instead of thirty (30) days.

14.3 Force majeure as used in this Article means acts of God, war (whether declared or not), invasion, revolution, insurrection, or other acts of a similar nature or force.

14.4 The Cooperating Entity/Contractor acknowledges and agrees that, with respect to any obligations under this Agreement/Contract that the Cooperating Entity/Contractor must perform in or for any areas in which UN-Habitat is engaged in, preparing to engage in, or disengaging from any peacekeeping, humanitarian or similar operations, any delays or failure to perform such obligations arising from or relating to harsh conditions within such areas or to any incidents of civil unrest occurring in such areas shall not, in and of itself, constitute *force majeure* under the Agreement/Contract.

15.0 TERMINATION

15.1 Either party may terminate this Agreement/Contract for cause, in whole or in part, upon thirty (30) days notice, in writing, to the other party. The initiation of arbitral proceedings in accordance with Article 16.2 ("Arbitration"), below, shall not be deemed a termination of this Agreement/Contract.

15.2 UN-Habitat may terminate forthwith this Agreement/Contract at any time should the mandate or the funding of the Project be curtailed or terminated, in which case the Cooperating Entity/Contractor shall be reimbursed by UN-Habitat for all reasonable costs incurred by the Cooperating Entity/Contractor prior to receipt of the notice of termination.

15.3 In the event of any termination by UN-Habitat under this Article, no payment shall be due from UN-Habitat to the Cooperating Entity/Contractor except for work and services satisfactorily performed in conformity with the express terms of this Agreement/Contract.

15.4 Should the Cooperating Entity/Contractor be adjudged bankrupt, or be liquidated or become insolvent, or should the Cooperating Entity/Contractor make an assignment for the benefit of its creditors, or should a Receiver be appointed on account of the insolvency of the Cooperating Entity/Contractor, UN-Habitat may, without prejudice to any other right or remedy it may have under the terms of these conditions, terminate this Agreement/Contract forthwith. The Cooperating Entity/Contractor shall immediately inform UN-HABITAT of the occurrence of any of the above events.

16.0 SETTLEMENT OF DISPUTES

16.1 Amicable Settlement The Parties shall use their best efforts to settle amicably any dispute, controversy or claim arising out of this Agreement/Contract or the breach, termination or invalidity thereof. Where the parties wish to seek such an amicable settlement through conciliation, the conciliation shall take place in accordance with the UNCITRAL Conciliation Rules then obtaining, or according to such other procedure as may be agreed between the parties.

16.2 Arbitration: Any dispute, controversy, or claim between the Parties arising out of the Agreement/Contract or the breach, termination, or invalidity thereof, unless settled amicably under Article 16.1, above, within sixty (60) days after receipt by one Party of the other Party's written request for such amicable settlement, shall be referred by either Party to arbitration in accordance with the UNCITRAL Arbitration Rules then obtaining. The decisions of the arbitral tribunal shall be based on general principles of international commercial law. For all evidentiary questions, the arbitral tribunal shall be guided by the Supplementary Rules Governing the Presentation and Reception of Evidence in International Commercial Arbitration of the International Bar Association, 28 May 1983 edition. The arbitral tribunal shall be empowered to order the return or destruction of goods or any property, whether tangible or intangible, or of any confidential information provided under the Agreement/Contract, order the termination of the Agreement/Contract, or order that any other protective measures be taken with respect to the goods, services or any other property, whether tangible or intangible, or of any confidential information provided under the Agreement/Contract, as appropriate, all in accordance with the authority of the arbitral tribunal pursuant to Article 26 ("Interim Measures of Protection") and Article 32 ("Form and Effect of the Award") of the UNCITRAL Arbitration Rules. The arbitral tribunal shall

have no authority to award punitive damages. In addition, unless otherwise expressly provided in this Agreement/Contract, the arbitral tribunal shall have no authority to award interest in excess of the London Inter-Bank Offered Rate ("LIBOR") then prevailing, and any such interest shall be simple interest only. The Parties shall be bound by any arbitration award rendered as a result of such arbitration as the final adjudication of any such dispute, controversy, or claim.

17.0 PRIVILEGES AND IMMUNITIES: Nothing in or relating to this Agreement/Contract shall be deemed a waiver, express or implied, of any of the privileges and immunities of the United Nations, including UN-Habitat.

18.0 TAX EXEMPTION

18.1 Section 7 of the Convention on the Privileges and Immunities of the United Nations provides, *inter-alia*, that United Nations, including UN-Habitat, is exempt from all direct taxes, except charges for public utility services, and is exempt from customs duties and charges of a similar nature in respect of articles imported or exported for its official use. In the event any governmental authority refuses to recognize UN-Habitat exemption from such taxes, duties or charges, the Cooperating Entity/Contractor shall immediately consult with UN-Habitat to determine a mutually acceptable procedure.

18.2 Accordingly, the Cooperating Entity/Contractor authorizes UN-Habitat to deduct from the Cooperating Entity/Contractor's invoice any amount representing such taxes, duties or charges, unless the Cooperating Entity/Contractor has consulted with UN-Habitat before the payment thereof and UN-Habitat has, in each instance, specifically authorized the Cooperating Entity/Contractor to pay such taxes, duties or charges under protest. In that event, the Cooperating Entity/Contractor shall provide UN-Habitat with written evidence that payment of such taxes, duties or charges has been made and appropriately authorized.

19.0 OBSERVANCE OF THE LAW: The Cooperating Entity/Contractor shall comply with all laws, ordinances, rules, and regulations bearing upon the performance of its obligations under the terms of this Agreement/Contract.

20.0 SEXUAL EXPLOITATION

20.1 The Cooperating Entity/Contractor shall take all appropriate measures to prevent sexual exploitation or abuse of anyone by it or by any of its employees or any other persons who may be engaged by the Cooperating Entity/Contractor to perform any services under this Agreement/Contract. For these purposes, sexual activity with any person less than eighteen years of age, regardless of any laws relating to consent, shall constitute the sexual exploitation and abuse of such person. In addition, the Cooperating Entity/Contractor shall refrain from, and shall take all appropriate measures to prohibit its employees or other persons engaged by it from, exchanging any money, goods, services, offers of employment or other things of value, for sexual favors or activities, or from engaging in any sexual activities that are exploitive or degrading to any person. The Cooperating Entity/Contractor acknowledges and agrees that the provisions hereof constitute an essential term of the Agreement/Contract and that any breach of these provisions shall entitle UN-Habitat to terminate this Agreement/Contract immediately upon notice to the Cooperating Entity/Contractor, without any liability for termination charges or any other liability of any kind.

20.2 UN-Habitat shall not apply the foregoing standard relating to age in any case in which the Cooperating Entity/Contractor's personnel or any other person who may be engaged by the Cooperating Entity/Contractor to perform any services under the Agreement/Contract is married to the person less than the age of eighteen years with whom sexual activity has occurred and in which such marriage is recognized as valid under the laws of the country of citizenship of such Cooperating Entity/Contractor's personnel or such other person who may be engaged by the Cooperating Entity/Contractor to perform any services under this Agreement/Contract.

21.0 AUTHORITY TO MODIFY: No modification or change in this Agreement/Contract shall be valid and enforceable against UN-Habitat unless provided by an amendment to this Agreement/Contract signed by the Cooperating Entity/Contractor and a duly authorized official of UN-Habitat.

Annex B. Project Document and Implementation Schedule

WOPs Documentation and Analysis

BACKGROUND

UN-Habitat is the United Nations programme working towards a better urban future. UN-Habitat's mission is to promote socially and environmentally sustainable human settlements development. Mandated by the UN General Assembly in 1978 to address the issues of urban growth, it is a knowledgeable institution on urban development processes, and understands the aspirations of cities and their residents. Since this time, UN-Habitat has been working in human settlements throughout the world, focusing on building a brighter future for villages, towns, and cities of all sizes.

Access to basic services such as water and sanitation *in urban areas is a specific thematic* focus of UN-Habitat. *UN-Habitat leads the Global Water Operators' Partnership Alliance (GWOPA), which aims to drive a growth in Water Operators' Partnerships (WOPs) and increase impacts.* Water Operators' Partnerships (WOPs) are peer-support arrangements between two or more water or sanitation operators, carried out on a not-for-profit basis in the objective of strengthening their capacity. GWOPA is promoting WOPs as a means of bolstering the ability of public water and sanitation service providers to play their full role in delivering quality basic services to all. Since its foundation in 2007, the Alliance has been advocating for and enabling effective water operators' partnerships (WOPs) between water and sanitation operators around the world.

One of GWOPA's activity areas is to track, document and analyse the WOPs practice globally. GWOPA gathers macro data on WOPs with the support of an online WOP profile database in which it aims to briefly describe all known WOPs being practiced around the world. Detailed Case Studies are then conducted on a much smaller subset of these WOPs in order to drill into the details of WOPs practice. On the basis of global trends and lessons from comparative analysis of the WOP cases, GWOPA, as part of the BEWOP project, is now focusing on the development of specific tools to assist water operators in implementing effective WOPs.

Technische Universität Darmstadt (TUDA) is a leading university of technology founded in 1877 based in Darmstadt, Germany. TUDA has played its part in addressing the urgent issues of the future with pioneering achievements and outstanding research and teaching. TUDA focusses on selected, highly relevant problem areas. Technology is at the heart of all the disciplines at TUDA.
In order to expand its expertise strategically, TUDA maintains a variety of partnerships with companies and research institutions. It is a vital driving force in the economic and technological development of the Frankfurt-Rhein-Neckar metropolitan area. TUDA's excellent research has been recognised by multiple grants within the Excellence Initiative. Its graduates enjoy an excellent reputation in the business world. The outstanding performance of TUDA makes it one of the leading universities of technology in Germany and has earned us international visibility and renown.

The Department of Design and Urban Development of TUDA (*Fachgebiet Entwerfen und Stadtentwicklung, EST*) is at the intersection of urban development and architecture. Urban realities are the result of different negotiation and development processes, within which the built city is only one of many parameters. In this respect, the topic of urban development is not only explored in terms of planning, but also dealt with in an interdisciplinary discourse, including its historical, social, economic and ecological aspects. Practice has shown that successful planning links different subjects and scales of study.

Under EST's latest urban planning projects is reSOURCE WATER. In the BMBF project Semicentral, EST took a systemic approach to resource and recovery center and residential area in Qingdao, China. Amongst its research groups, EST manages "Urban Health Games" which was established at the department in 2012, along with the HBS post-graduate program "Urban Infrastructures in Transition: The Case of African Cities" in 2014, and the DFG postgraduate program 2222 "Critical Infrastructures" in 2016. Prof. Dr. A. Rudolph-Cleff directs the MA program "International Cooperation in Urban Development," which is funded by the Erasmus Mundus European cluster of excellence. She has received various awards as an architect/city planner: *Beispielhaftes Bauen* from the Chamber of Architects of Baden-Württemberg, Haus. *Häuser Quartiere 2013* from the ministries of Baden-Württemberg, and recognition with her students in the international competition "Designing Resilience in Asian Cities" at the National University of Singapore.

OBJECTIVES

The objective of this collaboration is to support GWOPA in its WOP documentation and analysis activities. This work will increase GWOPA's ability to monitor and draw lessons from WOPs practice and provide relevant guidance to WOP implementers.

TUDA will support GWOPA in the analysis of a WOP Case Study in Vietnam, as well as the improvement, expansion and analysis of GWOPA's online data and water utility diagnosis tools. Data includes Operator and Supporting Organization Profiles, Benchmarking data, and WOP Profiles.

ACTIVITIES

The Partner will collaborate with the GWOPA Team in three related activities:

1. **WOP Case Study in Vietnam**

The partner will conduct a full Case study on a WOP following the BEWOP Analytical Framework. To conduct the case study, the partner will need to travel. The partner will work with the respective water utilities and with GWOPA to prepare the case study in GWOPA's narrative case and factsheet formats for editing, designing and publishing by the GWOPA Team.

2. **Diagnostic Tool Survey and Analysis**

Working in collaboration with UNESCO-IHE, the partner will gather and analyze a wide set of diagnostic tools for utilities. The resulting report will describe and compare the tools to facilitate access to them by users, and to identify trends and potential gaps in the available set of diagnostics.

3. **Cleaning, Analyzing and Improving WOP Database**

The partner will retrieve WOP and Operator profile data tables from the previous website and clean and reorder them for better access in the new site. The partner will analyze the existing data for key trends and produce a number of related charts using Tableau. In addition, the partner will produce a short report with recommendations for the secretariat to improve the quality, ease and sustainability of future data collection data by the Secretariat. The report should advise on: graphic displays of trends, comparative analysis of data by region, time period or other variables, etc.

OUTPUTS

1. A Narrative Case Study and Fact Sheet on the Da Nang – VEI case.
2. Completed table with descriptive and comparative analysis of (minimum 30) diagnostic tools for water and sanitation operators.
3. Cleaned and organized WOP and Operator profile tables with a written and graphic analysis of key trends and a set of recommendations for future data collection methodologies and display.

Payment requests are to be accompanied by narrative reports and key resources used in providing support during the previous period.

IMPLEMENTATION SCHEDULE

The small-scale Cooperation Agreement between UN-Habitat, through its Global Water Operators' Partnership Alliance (GWOPA), and the Technische Universität Darmstadt (TUDA), will be divided into three Work Packages (WP). Concerning the 1st work package **(WP1: WOP Case Study Vietnam)**, an in-depth analysis including narrative and factsheet of the Da Nang – VEI WOP will be carried out. This will require travelling to visit the respective water utilities during the established time frame. The 2nd work package **(WP2: Diagnostic Tool Survey and Analysis)** concerns the descriptive and comparative analysis of collected diagnostic tools for utilities and will conclude with a completed table with descriptive and comparative analysis of diagnostic tools for water and sanitation operators. During the 3rd package **(WP3: Cleaning, Analyzing and Improving WOP Database)**, the main objective will be to deliver a cleaned and organized database with WOP and Operator Profile tables, accompanied by a written and graphic analysis of key trends and a list of recommendations for future data collection methodologies and display. The expected duration may overlap between activities.

Involved cooperation partners: GWOPA, TUDA

WP 1: WOP Case Study in Vietnam **April 2017 – July 2017**

Duration: 4 months

The partner will conduct a full Case study on a WOP following the BEWOP Analytical Framework. To conduct the case study, the partner will need to travel. The partner will work with the respective water utilities and with GWOPA to prepare the case study in GWOPA's narrative case and factsheet formats for editing, designing and publishing by the GWOPA Team.

UN-Habitat / GWOPA's responsibilities		**TUDA's responsibilities**
1. Provide information on Da Nang – VEI case		1. Prepare questionnaires for field research
2. Provide contacts for both water utilities		2. Travel to water utility in Vietnam
3. Share BEWOP Analytical Framework		3. Write narrative of case study
4. Provide fact sheets of similar case studies		4. Produce fact sheet on Case study
5. Schedule meetings with TUDA in Barcelona		5. Travel to GWOPA Secretariat
UN-Habitat / GWOPA's contribution		**TUDA's in-kind contribution**
Travel and stay in Asia	4,250.00 USD	TUDA (scientific supervision): 1,120.00 USD
Travel and stay in within EU	2,500.00 USD	
Personnel	2,460.00 USD	
Hardware	4,600.00 USD	
Software (update)	300.00 USD	

Milestone WP1: A Narrative Case Study and Fact Sheet on the Da Nang – VEI case.

WP2: Diagnostic Tool Survey and Analysis **Aug. 2017 – Nov. 2018**

Duration: 4 months

Working in collaboration with UNESCO-IHE, the partner will gather and analyze a wide set of diagnostic tools for utilities. The resulting report will describe and compare the tools to facilitate access to them by users, and to identify trends and potential gaps in the available set of diagnostics.

UN-Habitat / GWOPA's responsibilities	TUDA's responsibilities
1. Provide existing diagnostic tools for utilities 2. Share diagnostic tool analysis framework 3. Schedule meetings with TUDA in Barcelona	1. Analyze diagnostic tools for utilities 2. Produce descriptive/comparative analysis 3. Travel to GWOPA Secretariat
UN-Habitat / GWOPA's contribution	**TUDA's in-kind contribution**
Travel and stay in within EU 1,000.00 USD Personnel 2,460.00 USD	TUDA (scientific supervision): 1,120.00 USD

Milestone WP2: Completed table with descriptive and comparative analysis of (minimum 30) diagnostic tools for water and sanitation operators.

WP3: Cleaning, Analyzing and Improving WOP Database **Dec 2017 – June 2018**

Duration: 8 months

The partner will retrieve WOP and Operator profile data tables from the previous website and clean and reorder them for better access in the new site. The partner will analyze the existing data for key trends and produce related charts using Tableau. In addition, the partner will produce a short report with recommendations for the secretariat to improve the quality, ease and sustainability of future data collection data by the Secretariat. The report should advise on: graphic displays of trends, comparative analysis of data by region, time period or other variables, etc.

UN-Habitat / GWOPA's responsibilities	TUDA's responsibilities
1. Provide existing standpoint of WOP database 2. Share access to data on Operator Profiles 3. Advise on parameters for data collection 4. Advise on needed output regarding tables, charts and graphics 5. Schedule meetings with TUDA in Barcelona	1. Clean and organize WOP database 2. Organize WOP data and identify gaps 3. Analyze and map WOP database (sugg. Tableau: tables, charts, graphics) 4. Create dashboards for on-going analysis 5. Travel to GWOPA Secretariat
UN-Habitat / GWOPA's contribution	**TUDA's in-kind contribution**
Travel and stay in within EU 2,000.00 USD Personnel 4,920.00 USD Software (update) 510.00 USD	TUDA (scientific supervision): 2,240.00 USD

Milestone WP3: Cleaned and organized WOP and Operator profile tables with a written and graphic analysis of key trends and a set of recommendations for future data collection methodologies and display.

In regards to intellectual property created during the time-frame of WP1, WP2, and WP3, the contract of this small-scale Cooperation Agreement between UN-Habitat / GWOPA and TUDA, both parties are committed to informing one another on the usage given to this material. With prior notice, the material may be used for private publications, joint publications, and academic purposes. As indicated in Annex A ("General Terms and Conditions"), in point 11.1, "except as is otherwise expressly provided in writing in the Agreement/Contract, UN-Habitat shall be entitled to all intellectual property and other proprietary rights including, but not limited to, patents, copyrights, and trademarks, with regard to products, processes, inventions, ideas, know-how, or documents and other materials which the Cooperating Entity/Contractor has developed for UN-Habitat under the Agreement/Contract and which bear a direct relation to or are produced or prepared or collected in consequence of, or during the course of, the performance of the Agreement/Contract, and the Cooperating Entity/Contractor acknowledges and agrees that such products, documents and other materials constitute works made for hire for UN-Habitat." Thus, this Agreement/Contract gives equal rights over the intellectual property to both parties.

Annex C: Project Budget and Payment Schedule

BUDGET

Activity	Element	Requested CA costing and breakdown (with cost sharing)	
		UN-Habitat	TUDA in-kind contribution
1	Travel and stay in Asia Travel and stay in within EU Personnel Hardware Software (update)	4,250.00 2,500.00 2,460.00 4,600.00 300.00	- - 1.120 00 - -
2	Travel and stay in within EU Personnel	1,000.00 2.460.00	1.120.00 -
3	Travel and stay in within EU Personnel Software (update)	2.000.00 4,920.00 510.00	- 2.240.00 -
	Total (USD)	**25,000.00**	**4,480.00**
	Percentage (%)	**85%**	**15%**

PAYMENT SCHEDULE

Instalment	Upon	Anticipated Date	Percentage	Amount (USD)
1	Upon signing this agreement and the issuance of a payment request	15.04.2017	30%	7,500.00
2	Upon completion of Activities1 and 2 and submission of an interim expenditure report and a payment request.	25.11.2017	40%	10,000.00
3	Upon completion of activities 3 and submission of a final expenditure report and payment request.	28.07.2018	30%	7,500.00
			100%	**25,000.00**

WOPs Documentation and Analysis GWOPA - TUD ssCA Updated: 22.03.17

Implementation Schedule

April 2017 - July 2018

No.	Activity	01 APR	02 MAY	03 JUN	04 JUL	05 AUG	06 SEP	07 OCT	08 NOV	09 DEC	10 JAN	11 FEB	12 MAR	13 APR	14 MAY	15 JUN	16 JUL
WP1	**WOP Case Study In Vietnam**																
1	Preliminary background: Da Nang – VEI case																
2	Prepare questionnaires for field research																
3	Travel to water utility in Vietnam																
4	Write narrative of Case Study																
5	Produce fact sheet on Case Study																
6	Travel to GWOPA Secretariat																
	Milestone: Case Study narrative & fact sheet																
WP2	**Diagnostic Tool Survey and Analysis**																
7	Collect existing diagnostic tools for utilities																
8	Analyze diagnostic tools for utilities																
9	Produce table with descriptive and analysis																
10	Travel to GWOPA Secretariat																
	Milestone: Analysis of WOPs diagnostic tools																
WP3	**Cleaning, Analyzing & Improving Database**																
11	Clean and organize WOP database																
12	Retrieve data from WOP profiles																
13	Organize WOP data and identify gaps																
14	Analyze of WOP database																
15	Map WOP data (tables, charts, graphics)																
16	Create dashboards for on-going analysis																
17	Travel to GWOPA Secretariat																
	Milestone: Clean WOP database and analysis																

REQUEST FOR AMENDMENT OF AGREEMENT OF COOPERATION

Agreement No: GC/17/026

RECEIVED

A/ Organization Details

Name: TU DARMSTADT

Third Party ID:

Mandate: TUD is a leading university of in Darmstadt, Germany. TUD has played its part in addressing the urgent issues of the future with pioneering achievements and outstanding research and teaching in various technical disciplines. TUD's excellent research has been recognised by multiple grants within the Excellence Initiative. The outstanding performance of TUD makes it one of the leading universities of technology in Germany and has earned us international visibility and renown.

Note: If Third Party ID is not available, 'Third Party Addition' request form MUST be attached

B/ Agreement Details

Purpose Summary: **(Purpose of Amendment)**

The proposed amendments will address the partners concerns with clauses in the UN-Habitat AoC through the acceptance of a 'side letter' clarifying the points of concern.

Work Months: (Aggregate period- Original + Extension)

Starting: Ending:

C/ Attachments

Agreement (Amendment-1)	Yes	X	No
Project Document	Yes	N/A	No
Budget	Yes	N/A	No
Audited Account Statement	Yes	N/A	No
Proof of Non Profit	Yes	N/A	No
Other (Specify):			

D/ Budget Clearance

FC(If Amendment involves additional funds)	Amount in USD
WBSE: SB-000637-12 (BEWOP).	
Total:	-

E/ Grant Amount Breakdown

Personnel	9,840.00	Travel Subtotal:	
Travel	9,750.00	Travel Cost:	3,600.00
Activities		DSA	6,150.00
Misc. & AOS	5,410.00	Other:	
Total:	25,000.00	Sub-total:	9,750.00

F/ Payment Details (Show payment details as per the amendment & Include amounts already disbursed)

Phase / Output	Amount in USD
Upon signing of the contract and first payment request, 30% of the total amount	7,500.00
Upon completion of Activities1 and 2 and submission of an interim expenditure report and a payment request, 40% of the amount	10,000.00
Upon completion of activities 3 and submission of a final expenditure report and payment request, 30% of the amount	7,500.00
Total:	25,000.00

G/ Agreement Requirements

Organization shall submit progress reports every	4	months
Organization shall submit final reports within	2	month(s) of completion of assignment
Organization is authorized variations of	10%	percent on each line item of the budget
Organization shall return unused supplies/funds within	1	month(s) of completion of assignment
Organization is authorized overhead of	0%	percent of total budget

H/ Approvals:

	Name	Signature	Date
Requesting Office	Faraj El Awar		28/06/2017
Certifying Officer	Rosemary Kiragu		20/7/2017
Head Substantive Office	Andre Dzikus		20/7/17.
Designated Signatory	Andre Dzikus		25/7/17

I/Legal Review and Clearance

Legal Officer	Saidou N'Dow		24/07/2017

REVIEWED AND CLEARED BY LEGAL OFFICE

Signed: Date:

TECHNISCHE UNIVERSITÄT DARMSTADT

Technische Universität Darmstadt | Karolinenplatz 5 | 64289 Darmstadt

Amendment to the Agreement of Cooperation between Technische Universität Darmstadt (TU Damstadt) and the United Nations Human Settlements Programme (UN-Habitat)

Regarding the WOPs Documentation and Analysis project between GWOPA (UN-Habitat) and TU Darmstadt, for the Department of Design and Urban Development (Fachgebiet Entwerfen und Stadtentwicklung,

The Parties concluded a Small-Scale Agreement of Cooperation, dated [28/06/2017] with a completion date of [27/11/2018] with UN-Habitat providing funds to TU Darmstadt up to a maximum amount of 25,000.00 United States Dollars for the implementation of the aforementioned Project,

As TU Darmstadt is a Public University, the parties mutually agree to amend the following provisions with regard to sec 21.0 of Annex A:

Das Präsidium
Der Kanzler

Bearbeiterin:
Ass. iur. Verena Jörg
Dezernat VI
Vertragsangelegenheiten

Karolinenplatz 5
64289 Darmstadt

Tel. +49 6151 16 - 57223
Fax +49 6151 16 - 57204
joerg.ve@pvw.tu-darmstadt.de

31. January 2017

Agreement

Sec 1. In Connection with Annex A ("General Terms and Conditions"):

The parties agree that this side letter amends the respective provision in the Agreement and Annex A.

Sec. 7

The parties agree, that the language of sec 7 within the agreement is changed as follows:
TU Darmstadt shall submit to UN-Habitat, substantive progress reports and a final report, as required in Annex B. TU Darmstadt shall also submit a financial report, itemized as per Annex C, if the use of funds provided to be certified by the TU Darmstadt's competent DEPARTMENT, together with the support documentation for expenses incurred.....

Annex A

Sec 7 Indemnification is amended as follows:

The Cooperating Entity/Contractor shall indemnify, hold and save harmless, and defend, at its own expense, UN-Habitat, its officials, agents, servants and employees from and against all suits, claims, demands, and liability of any nature or kind, including their costs and expenses, arising out of grossly negligent or intentional acts or omissions of the Cooperating Entity/Contractor, or the Cooperating Entity/Contractor's employees, officers, agents or sub-contractors, in the performance of this Agreement/Contract. This provision shall extend, inter alia, to claims and liability in the nature of workmen's compensation, products liability and liability arising out of the use of patented inventions or devices, copyrighted material or other intellectual property by the Cooperating Entity/Contractor, its employees,

officers, agents, servants or sub-contractors. The obligations under this Article do not lapse upon termination of this Agreement/Contract.

8.0 INSURANCE AND LIABILITIES TO THIRD PARTIES – is amended as follows:

8.1 The Cooperating Entity/Contractor is selfinsured in accordance with VV to § 34 LHO ("Grundsatz der Selbstversicherung").

8.2 The Cooperating Entity/Contractor shall provide and thereafter maintain all appropriate workmen's compensation insurance, or the equivalent, with respect to its employees to cover claims for personal injury or death in connection with this Agreement/Contract.

8.3 - 8.5 deleted because of new 8.1

11.0 COPYRIGHT, PATENTS AND OTHER PROPRIETARY RIGHTS is amended as follows:

Entity/Contractor retains ownership to all intellectual property and other proprietary rights, including but not limited to, patents, copyrights and trademarks, with regards to products, processes, inventions, ideas, know-how, or documents and other materials which the Entity /Contractor has developed within the scope of the Agreement but UN- Habitat shall be entitled to an option to gain a license regarding this rights.

11.1 - 11.3 deleted

13.6 CONFIDENTIAL NATURE OF DOCUMENTS AND INFORMATION is amended as follows :

13.6 These obligations and restrictions of confidentiality shall be effective during the term of the Agreement/Contract, including any extension thereof, and, unless otherwise provided in the Agreement/Contract, shall remain effective following any termination of the Agreement/Contract for a period of 5 years.

TECHNISCHE UNIVERSITÄT DARMSTADT

13.7 addition:

Scientific Publication: Both Parties agree on informing the other party promptly about intended publications within 30 days before the submission or publication date. Publications of the parties have to respect the Guidelines for Good Scientific practice. Any information owned by either the Entity/Contractor or UN-Habitat that has been marked as confidential or that has not been made available before in the context of the Cooperation and that is either a Result or not, requires prior written permission by the owner. If any Parties regards any of the information that is to be published as patentable matter for which protection is to be sought, the publication shall be withheld for the required time period to file a patent application but no longer than 6 months.

This Amendment shall become effective as of the date of countersignature. All other terms and conditions of the Agreement remain valid and enforceable.

The undersigned duly authorized representatives of TU Darmstadt and UN-Habitat have signed this Amendment in two (2) originals on the date(s) and at the place(s) below written.

For TU Darmstadt	For UN-Habitat
Stefan Werseus - in Vertreter des Kanzlers Dr. Manfred Efinger Kanzler Place: Darmstadt Date: 28/06/2017	Andre Dzikus Coordinator, Urban Basic Services Branch Place: Nairobi, Kenya Date: 25/7/17

TU Darmstadt FB 15 Architektur
FG Entwerfen + Stadtentwicklung
Prof. Dr. Annette Rudolph-Cleff
Karolinenplatz 5 Darmstadt
Telefon 06151-1622161 Fax 06151-1622163

Prof. Dr. Annette Rudolph-Cleff