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

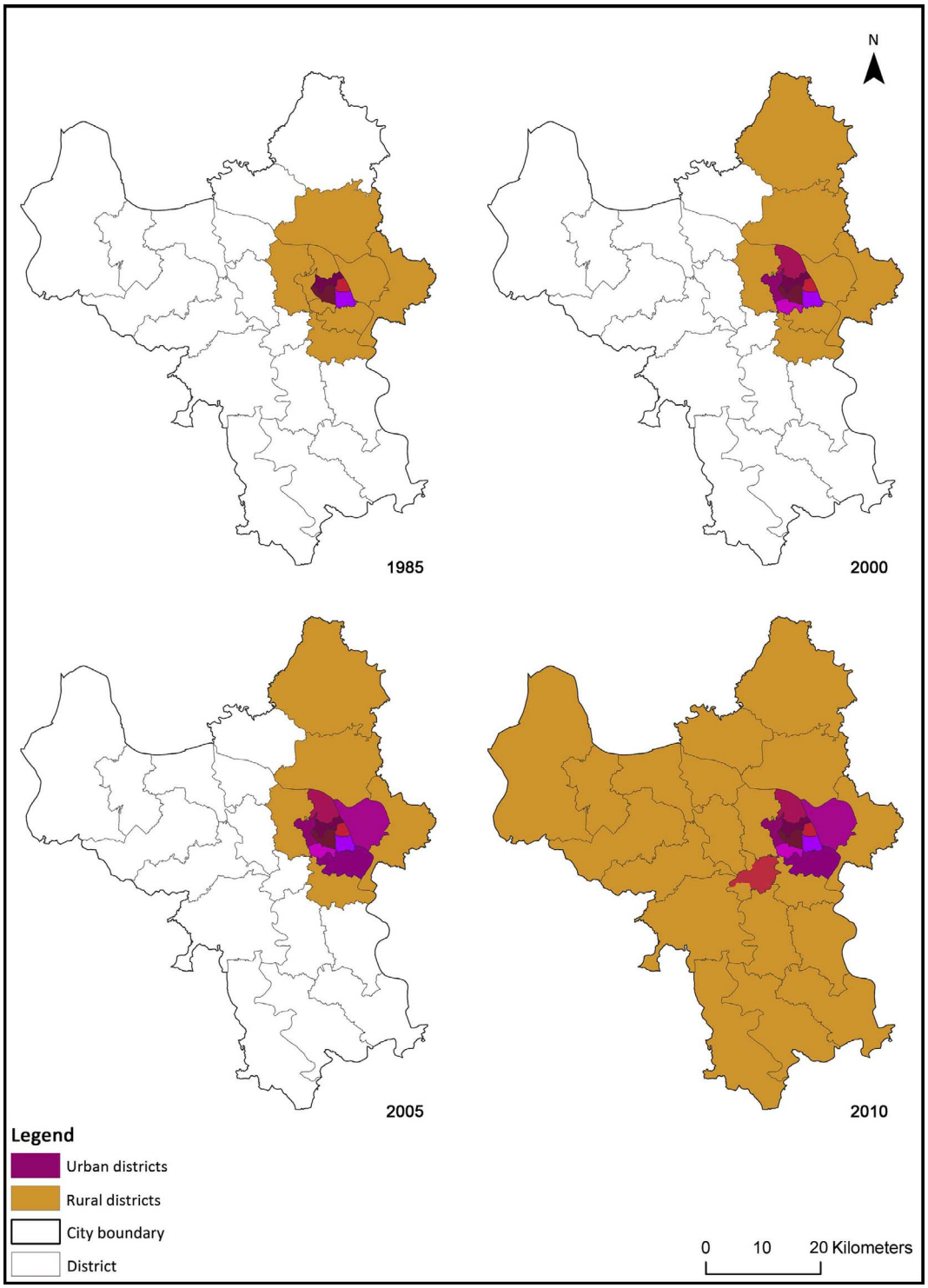

Fig. 2. Urban and rural districts of Hanoi 1985 till 2010.

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.