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CHALLENGING THE WATER REFORM NARRATIVE IN POST-CONFLICT LEBANON: THE CASE STUDY OF THE HYDRO-SOCIAL CYCLES ON JEANNE D'ARC STREET

by
RAYAN ABDALLA KAHALE

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Title: Challenging the Water Reform Narrative in Post-Conflict Lebanon: the Case Study of the Hydro-Social Cycles on Jeanne d'Arc Street

Responding to water-availability challenges, the Lebanese water sector has witnessed a wave of reforms, initiated in the year 2000, through the enactment of the law 221, and culminating in producing the National Water Sector Strategy (NWSS) in 2010. The reforms propose a bundle of structural adjustments and an array of large scale and costly, supply-sided, engineered projects, alongside network coverage augmentation, and upgrade of old distribution networks. Following the global trend of Integrated Water Resource Management (IWRM) paradigm and neo-liberalization principles, the reforms propose a shift from government-lead water sector provision to privatization, and public-private partnerships (PPP). The water reform narrative highlights a looming water crisis and documents current water shortages that must be addressed by increasing water supply, mainly through improved surface water management and storage.

Building on a single multiple-method case study design, this thesis looks at the hydro-social cycle on Jeanne d'Arc Street (Swyngedouw, 2004), through the lens of political ecology. Building on notions of coproduction (Ahlers *et al.*, 2014) that help transcend the formal/ informal binaries, the research documents the heterogeneity of the existing water network(s), and maps various water networks, users and stakeholders. It also traces circulating volumes of water, and monetary exchanges. The thesis also investigates the roots of the current conditions in the water sector and challenges the premises on which the reforms narrative is based. It presents (1) the impacts of wartime practices and post-conflict policies, and (2) water narrative and legal structures since Ottoman times up to present.

The research is concluded with four main findings: (1) water scarcity is a reflection of poor management practices and distorted social and power structures, (2) the existing water network exhibits a high degree of hybridity, (3) current conditions of water provision represent a coproduction between the formal and informal sector and the latter is an active partner in water provision (and must be perceived as such), (4) the informality that flourished during and after the civil war relieved the state of much of its duties and has now become somewhat of an obstacle to state-led reforms and developmentalist projects.

CONTENTS

Page

FIGURES

TABLES

ABBREVIATIONS

AUB	American University of Beirut
Bm^3	Billion Cubic Meters
BMLWE	Beirut and Mount Lebanon Water Establishment
BWE	Bekaa Water Establishment
CDR	Council for Development and Reconstruction
EU	European Union
GBA	Greater Beirut Area
HOA	Home Owner Association
IBT	Increasing Block Tariff
IWRM	Integrated Water Resources Management
L	Liters
m^2	Square Meters
m^3	Cubic Meters
Mm^3	Million Cubic Meters
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
NGO	Non-Governmental Organization
NLWE	North Lebanon Water Establishment
NWSS	National Water Sector Strategy
PPP	Public Private Partnership
PuP	Public Public Partnership
RO	Reverse Osmosis
UNDP	United Nations Development Program
WA	Water Authorities

CHAPTER 1

INTRODUCTION

In his introduction to the Guayaquil case study, Swyngedouw (2004) narrates the irony of seeing billions of liters of water circulating through the city streets, while half of city dwellers did not have access to sufficient potable water (Swyngedouw, 2004, p.2). The description bears a striking resemblance to what many residents of Beirut experience. Despite the wide potable water network coverage in Lebanon, estimated at 79%, and 85% in Beirut (NWSS, 2010, p.8), dwellers, however, often suffer from significant water shortages, in contrary to the continuous flows of water in the streets, be it in the form of rainwater streams in the winter, or the salient and often debilitating presence of large water tankers and bottled water trucks every day. Due to formal network shortages, dwellers are compelled to resort to a myriad of ways to secure access to their daily requirements of water, thus insinuating the existence of complex, and often unconventional networks of water supply.

Even though almost three decades passed since the end of the Lebanese civil war, infrastructure services still suffer from its effects. Wartime practices, including the use of infrastructure services as weapons between conflicting parties, non-payment, demand increase due to population displacement, fragmentation and minimal network repairs, among others, not only existed during the war, and in some cases persist until our present day, they also shaped post-war infrastructure reforms (Verdeil, 2017, pp.88-89).

The keen efforts to address the global water crisis since the late 1980's have resulted in a strong shift towards water management reform, and privatization. Lebanon has followed the international trend in 2010, by launching the National Water Sector Strategy (NWSS, 2010)[1]. From a technical perspective, water reforms and the NWSS were developed in line with previous national plans along global trends, focusing on increasing water supply through a network of large and costly dams and conveyors. From a management perspective, it introduced a shift from government-led water services provision to privatization which is facilitated by a series of structural adjustments and redistribution of roles between several government institutions.

Through a multiple-method case study design, this research explores how the existing, post-conflict, water provision conditions and practices in an upper middle-class neighborhood in Beirut challenge the plausibility of neoliberal water reform proposed in the National Water Sector Strategy (NWSS). Using a formal middle-class, mixed-use, urban neighborhood in Beirut, I demonstrate and document the multiplicity of water supply networks, actors and practices, as well as their entanglement, fragmentation and hybridity, in ways that pose significant limitations to the implementation of neo-liberalization schemes proposed in recent water reform and NWSS.

The chosen study area is Jeanne d'Arc Street, a street centrally located in Ras Beirut neighborhood. The street is on a junction with the American University of

[1] The NWSS was prepared in 2010 and passed under resolution number 2, dated 09-03-2012.

[2] Despite the fact that the Dublin principles (1992) stated that water is a finite economic good, however,

Beirut's campus, making the street highly desirable for real-estate investment, but also bringing in AUB as a stakeholder to engage in policy recommendations. Furthermore, the street harbors an array of businesses, including shops, hotels, and furnished apartments, thus presenting a wide array of users and uses.

Anchored in a hydro-social network approach, this research investigates two fundamental premises of recent water reforms and the NWSS:

(1) the issue of water scarcity, and

(2) the plausibility of neo-liberalization of water service provision.

Working on the street of Jeanne d'Arc in Ras Beirut, I produced micro-scale water circulation maps, indicating monetary and water volumes exchanged in the neighborhood. The maps serve two main purposes:

(1) to show the total consumption volumes of water and the high reliance on cistern water for utility use, and

(2) to redefine stakeholders on the scale of a neighborhood, illustrating the significant presence of hybridity in the water provision network(s) and highlighting the role of the informal sector.

In addition, I provided macro-scale maps showing mobility and the geographical linkages, the informal water network creates between source and user.

By adopting a qualitative methodology and in-depth interviews with key informants in the Street, and mapping exercises, I explore and document the various

practices and sub-networks of water provision, including the various types of water subscriptions, cistern water cycles, water well cycles, as well as the different types of water storage within buildings.

My research contributes to the literature on water management by providing an empirical investigation of water provision conditions, consumption and practices in a formal urban neighborhood, which is seldom studied. It provides a more critical understanding of water reform as it unpacks the relation between the political realm and the realities of the water network in post-conflict contexts and redefines influential stakeholders accordingly. Moreover, the empirical study underscores the prevalence of co-production, hybridity and heterogeneity of the water network(s). Finally, the thesis seeks to enrich water management discussions by highlighting the vital role of water-conscious urban planning and management and linking urban water management to urban planning and policy.

After this introduction, Chapter 2 of the thesis is dedicated to the literature review which summarizes three main strands of related literature covering (1) water management paradigms, especially in light of rapid urbanization, (2) the literature on informality, especially in the Global South, and (3) the literature on political ecology and the hydro-social cycle. The chapter is concluded with four relevant case studies, from the Global South. The case studies identify potential partners and policy improvements to ameliorate water provision conditions.

Chapter 3 in the thesis provides an overview of water provision conditions in Lebanon giving background information on the water sector, its recent challenges, and water reform strategies. Included in the chapter are two pilot studies, the first is

quantitative and the second qualitative. The former uses a stated preference approach to elicit user preferences in the choice of water management schemes in Ras Beirut neighborhood. The latter explores and highlights the main networks entailed in water supply provision in Sidani Street, Ras Beirut.

Chapter 4 presents the findings. The chapter is set out by creating building typologies (residential and commercial), and categories (new, medium and old). The water provision conditions, practices, volumes, and actors involved are illustrated using the identified typologies and categories.

Chapters 5 and 6 present the analysis of the findings. Chapter 5 unpacks the documented phenomenon of network hybridity looking at its elements and cost, highlighting the importance of recognizing shadow partners in the hybrid network, namely the water cisterns. Chapter 5 explores the network of cisterns, as well as their impact on consumption patterns. Chapter 6 explores the policy aspects causing, prolonging, and exacerbating hybridity.

Finally, Chapter 7 provides a summary of findings and analysis. It concludes with proposed policy recommendations and potential improvements, as well as further research suggestions.

CHAPTER 2

ON WATER MANAGEMENT AND POLITICAL ECOLOGY

My research explores four main strands of literature: the first provides a general overview of water management paradigms, and their evolution, highlighting the most recent trends. Secondly, I explore urbanization and water services, focusing on the debate of formal and informal water service delivery, which studies alternative types of organizations and frameworks, especially in the context of the Global South, where the formal sector faces several challenges and deficiencies. In the third strand, I examine political ecology, and the socio-hydro cycle, which investigates the social relations that both reflect and formulate the flows of water resources in the urban environment. And lastly, I examine several relevant case studies from the Global South.

2.1 Water Management

Water management paradigms encompass a complex web of interrelated, and often-contesting economic, environmental, technical, social, institutional and political components. During the past decades, significant shifts in water management paradigms have taken place, due to the ongoing negotiation between the different disciplines, and the importance accorded to each one of them. Questions related to the significance of water resources, the method of their distribution, and the nature of the institutions that is best equipped to govern the process are materialized in the various forms of water management paradigms.

The value attributed to water resources, a subject of debate in several UN conferences, and the definition of water as a right versus water as a commodity[2] sets the premise upon which management approaches are constructed. A power struggle ensues, between democratic governance and technological or economic efficiency, often sacrificing the former in favor of the latter (Swyngedouw, 2009, p.59). The struggle is also manifested in the changing types of ownership and institutional organization of the water sector. Water management has evolved from a primarily state-led sector that suffered from significant failures and deficiencies, especially in the Global South, to privatization and public private partnerships (PPP) to mitigate the shortcoming of the public sector. However, privatization failed in spreading network coverage, and living up to its propagated role in providing efficient service and healthy competition that serves the interest of users, chiefly due to the natural monopoly of water, and the significant buried costs entailed in water networks. Thus, the private sector is declining in many cities, and a subsequent return to public sector engagement, through public public partnerships (PuP), and re-municipalization (Jaglin and Zérah, 2010, p.7).

Furthermore, different management principles are materialized in varying technical approaches to water projects. Supply-oriented management push towards large-scale and costly projects to maximize water delivery, whereas demand-oriented

[2] Despite the fact that the Dublin principles (1992) stated that water is a finite economic good, however, UN committee on Economic, Social and Cultural Rights (2002) recognized water as a public good and a human right, and the 15th session of the Human Rights Council passed a resolution affirming safe and clean water as a human right (A/HRC/15/L.14).

approaches emphasize efficient allocation of water, and recent years witnessed a shift from the former to the latter approach (Gleick, 2000).

The evolution of water management since the turn of the 20th century can be divided into five main paradigms (Allan, 2000, pp.325-326): (1) pre-modern, (2) industrial modernity, (3) ecological, (4) economic, and (5) political-institutional. The evolution of water management paradigms was initially similar in the North and South, yet a divergence occurred, chiefly due to the principles of industrial and reflexive modernity and their effect on the Northern political economies (Allan, 2000, p.325), which did not occur in the same manner in the context of the South. Thus, the diverging evolution in water management paradigms echoed social dynamics, intellectual principles and political debates, and the different types and forms of modernity that took place in the two different contexts, asserting the geographic inequality of modernity, that is in turn translated into new waterscapes (Swyngedouw, 1999, p.461), Swyngedouw explains that "modernity is deeply, and inevitably a geographical project, in which the intertwined transformations are both medium and expression of shifting power positions that become materialized in the production of new water flows and the construction of new waterscapes."

2.1.1 Contemporary Water Management

In recent years, the Integrated Water Resources Management (IWRM) approach was considered, by many, as the holy grail of water management (Biswas, 2008, p.15). IWRM became popular in the 1990s, however, the concept was only rediscovered as it has been around for over 60 years, with unconvincing result records

(Biswas, 2008, p.7). The most quoted definition of IWRM is the one articulated by the Global Water Partnership (GWP, 2000):

> *"A process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without comprising the sustainability of vital ecosystems."*

The IWRM paradigm, according to Biswas, emerged in response to the realization that water issues are becoming more complex and multi-disciplinary, and cannot be addressed from a single angle, as it relates to most human activities. However, there was no effective consensus on what either one of the terms used in its definition means. The vagueness of the adopted definition allowed, if not encouraged, according to Biswas, people and institutions to carry on old water management practices under the new, but ambiguously defined paradigm name (Biswas, 2008, p.8), in order to attract more funding, or to gain more recognition and visibility (Biswas, 2008, p.14). Nonetheless, since its reemergence in the 1990s, IWRM gained a nearly universal sweeping popularity, which Biswas explains as mainly due to two main factors (Biswas, 2008, p.15): the first is the reductionism of the term, and the second is the amount of funds that have been poured to promote its application. However, Biswas argues that during two generations, IWRM proponents failed to effectively implement it, and hence IWRM's contribution to improving water management has been marginal. Furthermore, IWRM's reductionist approach that over simplifies the complex process of water management, fails in capturing the different political structures, social organizations, economic frameworks, and environmental conditions that vastly vary from one context to the other, as well as the technical and institutional implausibility of integrating

resources management. Consequently, Biswas argues, IWRM can only be applied in some instances, on a micro scale intervention, but is not implementable on meso or macro levels (Biswas, 2008, p.21), and is therefore doomed to decline (Biswas, 2008, p.22).

2.1.2 Water Management and Urbanization

The challenges facing water management and provision are numerous, including population growth, rapid and highly dense urbanization, technological development, agriculture and food security issues, industrialization and economic growth, as well as global climate changes (Biswas *et al.*, 2009). However, it is important to note that these challenges are more prominent and acute in the developing countries. While both developed and developing[3] countries face similar global challenges of water scarcity, water provision conditions in the developed countries are significantly more favorable than those in developing countries. Steady economic growth enabled investment in water and sanitation infrastructure projects in response to the needs of the growing urban population, in addition to a solid policy ground that provided a favorable environment to achieve water provision projects (Biswas *et al.*, 2009, p.12). Furthermore, developing cities are plagued with high urbanization rates, densification and rapid population growth. The needs of the ever-increasing surge of population in these cities exceed the managerial and fiscal abilities of the governing

[3] The authors highlight the different water conditions and challenges between developed and developing countries, however, in this study I refer instead to countries of the Global South, as it builds on geographic distinction which breaks linear assumptions of development.

authorities, that often fail to deliver equitable and sustainable services, which in turn has significant impacts of the health and quality of life of urban dwellers of these cities (Biswas *et al.*, 2009, p.13).

2.2 Informality in the Water Service Sector

One of the main byproducts of this rapid urbanization in the Global South is the rise of informality in the water sector. Since its first utilization in 1973 to describe the income opportunities in Ghana (Ahlers *et al.*, 2014, p.2), the term informality has been revisited, and redefined several times in scholarly work. However, it is important to understand Its recent use, especially in relation to the water sector, was mainly ignited by three factors, according to Ahlers *et al.*, the first being the shift that emerged from the 1970's onwards towards neo-liberalization, a paradigm characterized by a shift in the state-society relationship. This shift minimized the role of the state from the prime provider of water services to the role of monitor and enabler. The shift was further cemented through the commercialization of water, thus opening a large niche for private providers to deliver water services to urban dwellers according to new provision schemes and arrangements. The second factor, according to Ahlers *et al.*, is the widespread wave of rapid urbanization, which further expanded hybrid and informal economies that pervaded various sectors of the society in the Global South. Subsequently, informality became *"an organizing logic, a system of norms that governs the process of urban change itself"* (Roy, 2005, as cited in Ahlers *et al.*, 2014, p.3). The emerging logic of informality was visible in poor slums, and wealthy neighborhoods alike (Ahlers *et al.*, 2014). Lastly, donor communities attempting to achieve one of the

Millennium Development Goals (MDGs) to halve the number of people without access to potable water, placed an emphasis on alternative and informal water provision schemes, and small scale private providers, after the failure of the formal network, whether operated by public or private actors, in achieving actual improvements in expanding the reach of the network, and improving delivery conditions.

The literature addressing informality in the water sector can be divided into two main strands (Ahlers *et al.*, 2014, pp.4-5); the policy-oriented literature, and the critical literature anchored in the social sciences. Policy oriented literature builds its loosely identified description of informality in relation to the state, condemning all activities outside the regulatory framework of the state as informal. Thus, informality in this strand of literature implies inferior attributes, and is often regarded as backward given that it develops outside state power (Dovey and King, 2011, as cited in Ahlers e*t al.*, 2014, p.4), thus concluding that it must either be regulated by the state or eliminated. By doing so, policy-oriented literature cements the dichotomous binary of formal versus informal categories of water delivery services. Paradoxically, the literature often shifts its position in other instances, and considers the informal sector as an entrepreneurial endeavor (Eales, 2008; Solo, 2003; Conan, 2003, as cited in Ahlers *et al.*, 2014, p.4), however, that perception stems from values attributed to the private sector and its dominating market mechanism and principles of flexibility, competition, innovation and willingness to invest, and the ability to recover costs without relying on state subsidies (Plummer, 2002, Nijru 2004, Kjellen and McGranahan, 2006, as cited in Ahlers *et al.*, 2014, p.4). Despite the existing contradictory perception of the informal sector, Ahlers *et al.* conclude that the recommendations found in the policy-oriented

literature mostly indicates the need to formalize and regulate the informal sector, and integrate it within state power.

On the other hand, critical social science literature provides a more complex and nuanced reading of informality, emphasizing the social and political nature of practices and processes of urban informality (Ahlers *et al.*, 2014, p.4). A clearer definition of informality is posited *"Transactions are informal when they do not rely on standardized bureaucratic rules and procedures for their execution or enforcement and are not legally recognized by the state"* (Assaad, 1996, as cited in Ahlers *et al.*, 2014, p.4). Furthermore, critical scholars reject the utilization of the dichotomous binary of formal versus informal, adopted by the first strand of literature, and consider informality as an integral part of territorial practices of state power (Roy, 2009, as cited in Ahlers *et al.* 2014, p.4). The argument proposed by scholars is that through the creation of opaque and malleable modalities of governance, the state can be selective in legitimizing and normalizing some providers and services, while dispelling others, without any significant legal repercussions. However, the degree to which the state contributes in the creation of informality is a controversial issue among scholars. Nonetheless, building on the above-mentioned argument, informality can be defined as a specific form of urbanization (Roy 2005, as cited in Ahlers *et al.*, 2014, p.5).

What both strands of literature do have in common is that informality is always defined in relation to the state, however, the second strand of literature postulates that adopting a binary notion of formality and informality is not only unhelpful, it is in fact incorrect. Notions of hybridity and co-production (Ahlers *et al.*, 2014) are more helpful in highlighting the conditions and fragmented social practices of water provision,

especially because formal service provision encompass informal components, on the other hand, conditions for informality are often created by structures of formal governance, therefore, the boundaries between formal and informal are blurred, and highly contested and negotiated (Roy, 2009, as cited in Ahlers *et al.*, 2014, p.5).

2.3 The Archipelagos of Water Service Provision

One particularly useful model to help understand water supply provision in the Global South is its description as an archipelago of water provision (Bakker, 2003). Bakker uses the metaphor of the archipelago in contrast to the homogeneous network, typically found in the Global North, in order to underpin the fragmented, segmented and intertwined nature of water supply provisions she identified in the South (Bakker, 2003, p.339). More importantly, Bakker aims to challenge the foundation upon which lay most of the reform approaches, including privatization. Bakker reveals the underlying Northern bias imbedded in the proposed solutions, which are only applicable to homogeneous networks. Furthermore, Jaglin and Zérah (2010), much in line with Bakker, demonstrate the multiple modes of water supply provisions in the South, showing the blurred boundaries between public and private provisions. The authors stipulate the importance of looking at the existing modes of water production and supply as an existing reality, beyond attributing them to failures of management schemes of public and/or private actors. The existing diversified water provision modes in the South are thus an urban phenomenon that must incur new sets of questions, regarding their integration and regulation, for whom and by whom (Jaglin and Zérah, 2010, p.14).

2.4 Political Ecology: An Urban Hydro-Social Cycle Framework

A significant number of contesting paradigms exist in the literature about water management; however, my thesis will be rooted in the field of political ecology. The concept of political ecology has initially emerged in the 1970s and came as an alternative to apolitical ecology (Robbins, 2012, p.20). Apolitical ecology approaches and narratives regarding the environment, according to Robbins, encompasses two main trends; eco scarcity and modernization (Robbins, 2012, p.14), however, both trends fail to capture the most fundamental challenges in contemporary ecology by overlooking the substantial influence of political economic forces. Conversely, political ecology is not to be considered more political than apolitical ecology, it simply is more explicit about the assumptions and normative upon which the research is based (Robbins, 2012, p.20).

Numerous definitions were coined for political ecology throughout the field's evolution since its emergence in the 1970s, however, for this research, I will adopt Watts's definition of political ecology "to understand the complex relations between nature and society through a careful analysis of what one might call the forms of access and control over resources and their implications for environmental health and sustainable livelihoods" (Watts, 2000, p.257, as cited in Robbins, 2012, p.16). The latter definition is especially helpful to understand the relation between the natural and built environment and the process of urbanization. In that sense, political ecology addresses the decision making process within the built environment (Kaika, 2014); for once we

acknowledge that there is no urban outside the natural[4], we can then understand that every decision related to the natural environment and its various resources lies very much within the political realm, and that a separation between the natural and the built environment is not only unrealistic, but it is also limiting to the development and sustainability of both.

The hydro-social research emerges from the perspective of political ecology, transcending binaries of nature versus society, and stipulating that the flow and circulation of water is "…a *combined physical and social process, as a hybridized socio-natural flow that fuses together nature and society in inseparable manners"* (Swyngedouw, 2009, p.56). Scholars of the field shed light on several issues, challenges, and conflicts that the hydro-social research can tease out and reveal, including the hegemonic role of neoliberal structures, that deepens inequalities, by applying principles of commodification and privatization, placing much of the hydro-social cycle in the financial nexus, and altering water right prerogatives, granting access to water to some, while excluding others through market mechanisms, thus prioritizing exclusive property right, irrespective of social or environmental needs (Swyngedouw, 2009, p.58). Scholars agree that the neoliberal approach not only failed to improve water provision condition, it exacerbated inequalities between the rich and the poor, causing the poorer segments of society to pay a higher price in both monetary and

[4] Building on the brief summary given by Prof. Maria Kaika, 2014, in an interview explaining political ecology, published in 2014, by Entitle, the European Network for Political Ecology https://www.youtube.com/watch?v=Z5PRfxNUBao

health and sanitation terms, than richer communities (Gleick, 2004, as cited in Swyngeduouw, 2009, and Kacker and Joshi, 2012).

Power geometries and social actors determine entry to the water cycle; inclusion and exclusion are results of social processes. Drafting strategies and policies, water projects designation, water routes, and water distribution and evacuation, are all products of the interplay of social, power, and economic determinants, manifested in the physical flows of water (Swyngedouw, 2009, p.58). The Hydro-social cycle approach attempt to unpack the process through which social relations manifest, produce and alter hydro-flows and vice versa, positing that *"Hydraulic environments are socio-physical constructions that are actively and historically produced both in terms of social content and physical environmental qualities."* (Swyngedouw, 2009, p.56).

Imagining a different social organization is a pre-requisite to creating more equitable, inclusive and democratic water management schemes. The new imaginary of a social order must build on a thorough understanding of the intricate relation between the socio-technical organization and the hydro-cycle in a given community (Swyngedouw, 2009, p.59).

2.5 Conceptual Framing and Problem Definition

Building on the explored strands of literature summarized above, I privilege two main conceptual frameworks. First, I build on the concept of hydro-metabolic power networks developed by Swyngedouw (2004), which unpacks the enmeshed relations between physical and social networks. Through my case study I seek to demonstrate their inseparability, vitality and significance. Mapping the political power

dynamics in Lebanon during and after the war years will highlight how the power asymmetries, and chaotic governance during the civil war, created the conditions for an informal economy of infrastructure services. Post-conflict political practices, including laissez-faire regimes, fragmentation, sectarianism and clientelism resulted in additional weakening of the formal sector, while the informal service sector flourished even further. The socio-hydro metabolism concept brings to the forefront the effects of post-conflict political practices and supply sided vision and policies of the water service sector and its main stakeholders, leading to the current precarious water provision conditions in Lebanon. Two, I use the framework of co-production of water provision (Ahlers *et al.*, 2014). The concept helps transcend binaries, and normative categorization imbedded in the formal/ informal divide, offering a more accurate depiction of how water provision works. The concept does not annul either one of the terms (formal and informal) and does not allude to collaboration between the two. Co-production captures power asymmetries, and contesting political aspirations articulated in new practices of hybrid service arrangements that are in fact a result of the interaction of socio-political, economic, biophysical and infrastructure drivers (Ahlers *et al.*, 2014, p.2).

Within the frameworks elaborated above, the thesis addresses the following question: How does a hydro-social networks approach to the analysis of water provision in urban middle-class neighborhoods inform water reform policy in post-conflict Lebanon?

In order to address the question, The research is designed to collect information on existing practices through the case study of Jeanne d'Arc Street, exploring and

documenting the daily reality and practices of various water networks, operators, and users, and juxtaposing the existing practices and conditions with the assumptions and premises delineated in recent policy reforms and NWSS, thus aiming to shed light on blind spots that can only be captured on a macro-scale, however, taking into account the multiplicity and complexity of reform policies, the thesis cannot be considered as a review or critique of current policies.

2.6 Case Studies

The case studies I examined offer insights of the main challenges facing urban water management reform in the Global South, including the disconnection between urban planning and water planning management (Toteng, 2002), the disillusionment of the often-propagated informal water sector, revealing its monopolies and bottlenecks (Kacker and Joshi, 2012). The case studies also offer solutions, and new conceptual frameworks to better address the growing challenges in the water sector. Solutions include involving the private sector in addressing water challenges, through a stakeholder theory-driven perspective (Toteng, 2004), the formalization of alternative water providers, and the activation of neighborhood committees (Matsinhe *et al.*, 2008), and leveraging the existence of multiple providers to the best interest of users, through increasing user-awareness and political competition (Kacker and Joshi, 2012).

2.6.1 Filling the Gap Between Urban Planning and Water Planning

The case study in Gaborone, Botswana (Toteng, 2002) highlights the gaps in the legal and policy frameworks pertaining to water management. Toteng explores the

disjunction between urban planning and water planning, she stipulates that the rapid urbanization of Gaborone, coupled with elitist, comprehensive spatial planning, chiefly concerned with land use-planning, such as land subdivision, zoning and development control, leaves little room for other issues like urban water planning and development. Thus, this deepens the dichotomy between urban planning policies, and urban water management, and further entrenches technocratic and engineering approaches to water management, that overlook the political ecology and political economy dimensions of urban planning and urban water planning. Toteng concludes by highlighting the importance of integrating incremental planning that introduces marginal changes in existing policies, as well as the involvement of non-state actors, including non-governmental, and community organizations, and have them actively participate in the water planning process, policy and decision making.

2.6.2 Involving Private Actors in Urban Water Conservation

Also set in Gaborone, Botswana, E.N. Toteng's more recent work (Toteng, 2004), proposes valuable propositions for improving water services, by including private actors in water conservation projects, according to stakeholder theory, in which Totneg identifies private actors as dormant stakeholders, who can in fact have influence over state actors. Toteng relies on qualitative research to identify the extent of involvement of several private actors in water management. The research included manufacturing industries (breweries, and soap industries), leisure, hotel and catering industries, quarrying and construction industries. Most private actors under study, did not have any involvement in urban water planning, and had a lack of clear water

conservation or recycle policies. However, most participants relied significantly on water for their activities, in both quantity and quality, in varying degrees.

Toteng findings highlight several points, including, (1) the lack of public policy guidance, suggesting the need for a clear policy requirement from the state to incorporate water conservation policies, (2) the lack of private sector participation in water planning. Due to the power differential between state and private actors, private actors are not invited, or engaged in the process water management, and therefore, do not have the power to influence decision making and policy in the water management system in Gaborone. Toteng concludes that active engagement of the private sector can have positive impacts of water management, especially water conservation and recycling, building on existing positive initiatives that were documented in Gaborone. However, these initiatives will remain fragmented and insignificant, unless they were set within larger frameworks, and organizational layouts.

2.6.3 Transforming the Vicious Cycle of Informal Water Provision into a Virtuous Cycle

Another relevant case study is Sangam Vihar, an informal settlement in New Delhi (Kacker and Joshi, 2012). The case study documents the poor water provision conditions that dwellers suffer from, depending almost entirely on water tankers and independent private providers, yet having little or no control over the price or quality of the water they buy, since these independent providers try to achieve high returns on their risky investment. Thus, the community is trapped in a vicious cycle of relationships between residents, independent providers and politicians, leading to

irregular access, and poor quality of service (Kacker and Joshi, 2012, p.28). However, the authors conclude that the very existence of that network can be an opportunity to improve water provision conditions, especially due to the existence of a piped network, thus, transforming the vicious cycle into a virtuous cycle, with increased accountability and reliability, through a set of proposed guidelines (Kacker and Joshi, 2012, pp.33-34), including:

> *"(a) heightening resident's stakes in a formal system, by virtue of the investment required by the household; (b) generating demand for accountability through levy of user charges; (c) the formation of geographically well- defined groups of households with a shared sense of dissatisfaction and purpose; (d) rising resident awareness of rights, and expectations of service delivery through public utilities; and (e) political competition leading to a break with past patronage relationships."*

2.6.4 Neighborhood-based Management Model

The case study closely investigates water supply mechanisms in the peri-urban areas of greater Maputo, Mozambique, including household water resale activities of alternative service providers and small-scale independent providers (Matsinhe *et al.*, 2008). The study was commissioned to help build a strategy to improve water supply condition of the urban poor, focusing on selected areas of peri-urban Maputo, representative of most of peri-urban areas. The study develops useful tools to investigate the following aspects of service delivery, (1) quality of service, (2) legal status of the different independent providers, and (3) the organization of water supply provision on a neighborhood level. Matsinhe *et al.* conclude that alternative water supply will continue to play a dominant role in water service provision, therefore, the study proposes a neighborhood-based management model, in parallel with the

legalization of independent providers, and decentralization of certain regulatory functions of water service, as well as activating the role of the municipality.

2.6.5 Synthesis

The urban water landscape is constantly reproduced as a result of various social and political transactions that are manifested in the urban sphere. The literature on political ecology incorporates an understanding of the effects of global capital flows on urban infrastructure, while the literature on informality sheds a light on the role of state actors in producing informal urban conditions. However, it is crucial not to undermine the agency of users, manifested through their daily practices to secure their access to adequate amounts of portable water, Ahlers *et al.* (2014) highlight the importance of studying how these daily practices produce the "lived" water landscape (Lefebvre, 1991, as cited in Ahlers *et al.*, 2014, p.6). My research aims to fill that gap in the literature, through the documentation of micro daily practices of users, as well as micro governance structures.

Furthermore, the literature implies favorable water provision conditions in upper income neighborhoods, home to the political and business elite. However, governance failures in the Global South identified by Bakker (2003), highlights the importance of the political component in water provision, as it indicates a strong relation between uneven access to water services and inequitable urban governance (Jaglin and Zérah, 2010, p.7). A question that must be raised, which was not adequately addressed in the literature, is related to the existence of inequalities, and heterogeneity of water provision and/or the archipelagoes of water supply within the privileged

neighborhoods. The case studies, set in informal contexts, offer a rich toolbox for investigation, that I utilize to gauge the diversity and hybridity of water provision in formal settings.

CHAPTER 3

CASE STUDY PROFILE: WATER SERVICE PROVISION IN JEANNE D'ARC STREET

Building on the highlighted gaps identified in the literature, my research aims to analyze, unpack and map the water provision networks, on the micro-scale of a neighborhood, revealing the types, forms and relations between the different networks, in order to answer the following question, how do urban dwellers secure access to adequate water. In what follows I present the related study profile, including a general overview of water in Lebanon, and in Beirut.

3.1 Water Sector Conditions in Lebanon

Lebanon is relatively one the most water endowed countries in the region, due to the fact that water originates from within its territory, as a result of Lebanon's mountainous landscape, and the Karst geological formation occupying almost two thirds of its terrain, which endows the country with 250 perennial springs and 17 rivers, and 15 major aquifers (Riachi, 2016, p.5). However, the brisk change in climate over the past decade had a significant impact on the water table in Lebanon, and under continued conditions of climate change, almost two thirds of the Lebanese territory are expected to suffer from severe desertification by the year 2025 (MoA 2003, as cited in Riachi 2016, p.5). Furthermore, the aggravating climate conditions, and the significant decrease in recent years of annual precipitation and snow cover, coupled with uncontrolled water pumping of aquifers have had a significant impact on spring flows and aquifer levels.

Moreover, the impacts of climate change and its effects on the decrease of annual rainfall figures should reasonably imply that there will be a decreasing amount of surface water, and surface water runoff. However, the latter fact seems to be missing from all the national reports and water tables available. Although several sources expect that the country will suffer from negative water balance in the near future (Comair, 2007; El Fadel *et al.,* 2001; Makdissi, 2007; El Jurdi, 2001; NWSS, 2010), yet the policies and water reforms addressing the issue still depend in much of its planning on surface water storage and does not sufficiently address ground water. Furthermore, several additional factors are aggravating water stress, including the increasing demand of the finite source of water, ever-increasing urbanization, old irrigation schemes in rural areas, leakage in the water supply networks, and unmonitored over exploitation of ground water threatening future availability of water, coupled with ongoing laisser-faire policies, and legal pluralism especially relating to ground water exploitation.

Water resources in Lebanon are broadly divided between surface and ground water. The surface water flows are estimated at an annual average of 3400 Mm^3 (MoEW, 2010), including flows of both national and Trans-boundary Rivers. Ground water, on the other hand, is harder to accurately estimate, due to the limited number of comprehensive studies undertaken on a national scale. In fact, aside from the point 4 mission by the American reclamation Bureau[5], the only two comprehensive studies for

[5] Although the authors of the assessment of ground water resource in Lebanon do not clarify what is meant by point 4, but the term is usually used in referenced to Harry Truman's Inauguration speech of four points, in which he states: "we must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas"

groundwater resources were completed in the 1970s and the most recent was finalized in 2014 (MoEW and UNDP, 2014, p.8).

Water consumption is divided between three sectors; (1) agriculture[6] (irrigation): 61%, domestic use: 30%, and industrial use: 9%. Potable water network coverage in Lebanon is approximately 79%, exceeding the average coverage in the MENA region estimated at 75% (NWSS, 2010, p.8). However, more than one-third of the water network is older than 30 years, and is worn-out, and often leaking. As for the wastewater network conditions, despite its relatively large coverage, estimated at 60%, the amount of treated water does not exceed 8% of total consumption (NWSS, 2010, p.11), falling below the average in the MENA region, estimated at 32%.

Furthermore, the water sector in Lebanon faces several challenges and problems. The problems include dysfunctional institutions of water management and failures in administration, accounting and financing (Ghitotti and Riachi, 2013, p.146), water pollution, with figures indicating that approximately 80% of municipal water is polluted despite chlorination and water treatment (Makdissi, 2007, p.379). Moreover, significant inequalities in water distribution and pricing exists, where marginalized areas suffer ten times more from discontinuous access to water supply than the affluent dwellers (Makdissi, 2007, p.378). The latter problems are exacerbated by the lack of reliable data on water, since much of water supply figures build on surveys carried out

[6] According to the 2012 World Bank estimates, agriculture accounted for an estimated 7% (or US$ 3 billion) of the annual GDP, a very small figure when compared to the consumption of 61% of the nation's water resources.

during the 1950s and 1960s (Makdissi, 2007, p.373), in addition to the absence of a clear political agenda to exert water as a human right in the current reform trend, which addresses the water crisis as primarily a series of technical and managerial failures. Overlooking the effective implementation of water as a human right creates a gap between the political discourse that adopts water as a human right in Lebanon, and the reform strategy that follows neoliberal trends of water as a commodity (Makdissi, 2007, p.286).

3.2 The Issue of Water Balance

Water balance is defined, in the Oxford Dictionary of Geography, as "The balance at any location between the input (precipitation, P), and the outputs: evapotranspiration (E) and run-off (R):P=E+R." (Oxford Dictionary of Geography, 2009). Concepts such as water balance, and ground water balance or water budget, serve as indicator of the amount water discharge versus recharge in a given area, and helps predict and indicate water deficits. Having accurate accounts of water balance, and water recharge rates are paramount in informing and drawing governing directives of policy. In this section, I shed light on the contrasting data on water balance in existing reports and water tables, as well as the possible indications and implications of this contradictory data.

In the "Water Sector in Lebanon: An Operational Framework for Undertaking Legislative and Institutional Reform" report prepared by the General Director of Hydraulic and Electric Resources, Dr. Fadi Comair, predicts pessimistic water balance figures (Comair, 2007, p.16). Comair's study simulates water balances based on

estimated demands[7], forecasting significant deficits in the water balance in Lebanon, reaching approximately 700 Mm^3, and projected to increase to 1660 Mm^3 in 2030. Comair confirms the vital importance of launching several projects of water storage dams and applying IWRM as key elements in addressing the anticipated water balance deficits (Comair, 2007, p.20). The NWSS also confirms the pessimistic negative water balance, calculating ground water recharge deficit at 200 Mm^3 [8].

In contrast, the 2014 UNDP report "Assessment of Ground Water Resources in Lebanon" exhibits more promising accounts. The estimated water balance in Lebanon falls between 2,140 Mm^3 for the dry year (2010-2011) and 4,675 Mm^3[9] for the wet year (2011-2012), (MoEW and UNDP, 2014, p.71). Nonetheless, the report highlights the alarming drop in ground water aquifers slightly exceeding 150Mm^3 in certain basins, especially along the coastal ground water basin, primarily due to heavy urbanization. However, the figures vary across the territory.

A significant disparity exists between the UNDP reports, and all other recent reports, including the NWSS. Contradictory estimates of water balance deficits, coupled with a minimization of ground water recharge that are shown in most reports, according to Riachi (Riachi, 2016, p.8), are an essential part of supply-sided policies, that over

[7] Comair's report (2007) affirms the inevitability of negative water balance values in Lebanon; however, the lack of data in Lebanon allows room to question the solidity of the report's conclusion. In fact, Bakkar (2010) suggests that there is often a worldwide exaggeration of the upcoming water crisis in order to push towards privatization schemes. That being said, the absence of an efficient water management and equitable distribution of good quality water are undeniable (Makdissi, 2007).

[8] The report estimates annual consumption at 1.5 Bm^3, half of which are extracted from ground water, while estimating the ground water recharge at 0.5 Bm^3

[9] These figures do not account for runoff to the sea or deep percolation

estimates surface water, and under-calculates ground water recharge, thus leading to policy rhetoric that encourages large surface water storage projects, and minimizes, if not overlooks the role of ground water, yet what is clearly missing in these water table reports, according to Riachi, is the evident decrease in annual precipitation rates, due to climate change, the drop in rainfall rates is expected to increase in the coming years. The implication of climate change on annual precipitation, and therefore on surface water runoffs are largely missing from policies advocating for dams. Having accurate accounts of water flow levels, depletion and recharge rates are essential for developing effective policy directives.

3.3 Water Reforms and the National Water Sector Strategy

The National Water Sector Strategy (NWSS) continues the long-standing legacy of supply-sided policies and engineered hydraulic missions envisioned since the French Mandate, according to Riachi (Riachi, 2016, p.29). The Ministry of Energy and Water (MoEW) proposed the NWSS in 2010, which was passed by the Lebanese Government under the Resolution number 2, March 9th, 2012. The NWSS complements the reform wave initiated in the year 2000, through the enactment of Law 221. The proposed reforms are anchored in the paradigm of hydraulic mission, aimed to increase water supply, and introduce improvements to the water network. Technically, the latter is achieved by proposing a large and costly network of dams and surface water storage projects, in addition to water conveyors and water pumping stations along the Lebanese territory, financed through loans from international donors and development banks, while tendering and bidding for these projects is performed by the Council for

Development and Reconstruction (CDR), thus assigning the key role of channeling funding to CDR[10]. On the institutional level, NWSS stipulates that MoEW must primarily play the role of policy-maker and monitor for the four initiated water establishments, namely, Beirut and Mount Lebanon Water Establishment (BMLWE), North Lebanon Water Establishment (NLWE), South Lebanon Water Establishment (SLWE), and the Bekaa Water Establishment (BWE). The establishments are planned to have a high level of financial, managerial and technical autonomy. The newly proposed institutional and organizational setting is vital, according to the NWSS; to pave the road for private sector involvement, in the form of privatization, or public private partnerships (PPP), that are expected to play a key role in improving water service coverage and quality.

3.4 Water Service Provision in Beirut[11]

The primary source for potable water in Beirut is in Jeita and Kashkoush springs. An additional source is the Antelias spring in the north of metropolitan Beirut. Secondary resources, especially in the arid summer seasons are Damour and Naameh in the south[12]. Water is transported from the spring location, and stored in several storage

[10] Loans and funding conditions must also be read in conjunction with recent recommendation of the CEDRE conference, held in Rome, on the 15th of March 2018. The conference stipulated the need for serious action by the Lebanese government to reform institutions and limit corruption.

[11] The bulk of information in this section builds on an interview with Mr. Georges Kadi, head of the technical department at the Beirut and Mount Lebanon Water Establishment (BMLWE) conducted in May 2014, in addition to the feasibility study report of the "Rehabilitation of Transmission Channel of the Jeita Spring Intake-Dbayeh WTP" project, 2011.

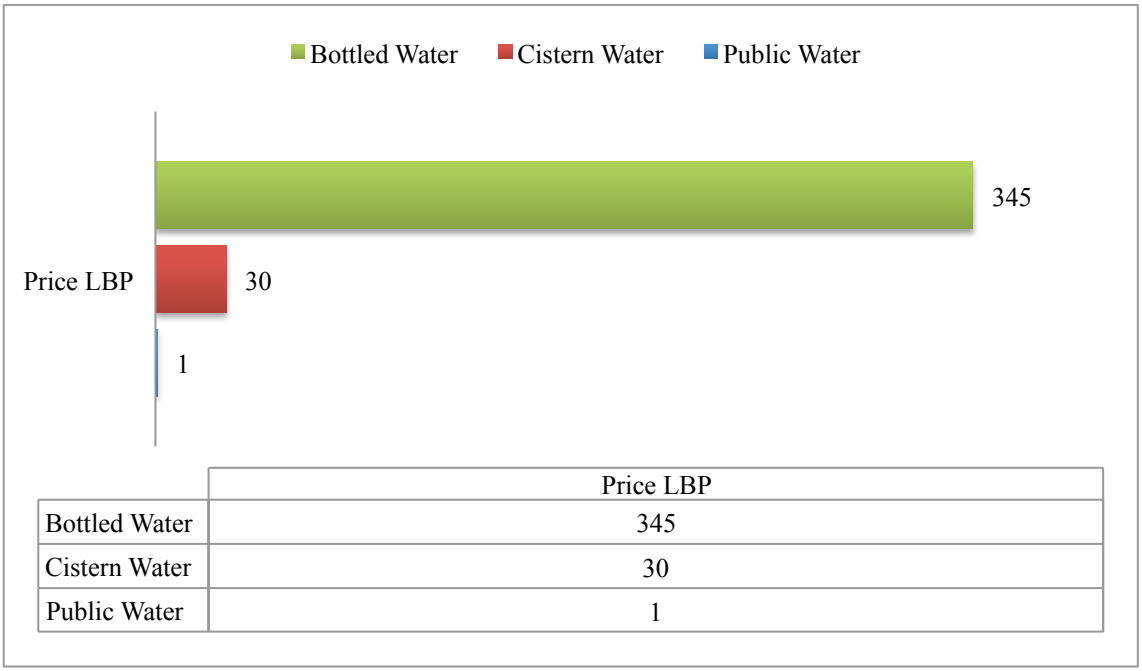
tanks throughout Beirut: in Achrafieh, Tallet el Khayyat, Burj-Abi-Haidar and Naameh. The water is subsequently pumped into primary, secondary and tertiary networks across the city.

According to the BMLWE, water distribution throughout municipal Beirut is consistent. However, the drought of recent years has dropped the water production figures of Jeita spring as low as 50,000 m^3/day, hence falling far below the water requirements of municipal Beirut, estimated at 350,000 m^3/day, thus decreasing the hours of public water supply to reach its lowest records of 1-2 hours per week[13].

Moreover, even during years when there is no draught, the highly intermittent and unreliable supply, poor water quality, and the lack of trust by urban dwellers to drink publicly supplied potable water, has led to the reliance on a myriad of artisanal and industrial alternatives, including private water tankers (vendors) and bottled water. The cost of the latter alternatives (per Liter of water) exceeds the cost of the publicly supplied water. The chart below builds on data I have collected during the draught months of September and October 2014 in various areas in Beirut, including, Hamra, Mar Elias, Clemenceau and Achrafieh, the average price of cistern water was calculated at the average rate of US$ 21/barrel[14].

[13] I recorded this figure in Hamra, in Sadat Street, for a duration of 3-4 weeks during the month of September 2014.

[14] Data collected through short inquiry survey in 2014, in order to understand the gravity of price variation between different sources.



	Price LBP
Bottled Water	345
Cistern Water	30
Public Water	1

Figure 1. Different Prices for One Liter of Water in Beirut, 2019

(1 LBP = 0.000664 USD)

The above chart (Figure 1) is indicative, showing the magnitude of price disproportions. However, the difficulty to estimate cost of publicly supplied water must be noted, since the annual subscription tariff is a flat rate of roughly US$ 200/apartment[15] irrelevant of effective hours and total volume of water supply. Therefore, an accurate measurement of the actual quantities of water received by households is hard to attain.

3.5 Pilot Studies

In order to understand the mechanisms and networks through which residents secure their access to adequate potable water, I conducted two pilot studies aiming to

[15] Apartment area equal or inferior to 200 m^2

identify main networks and actors of different water provision schemes, both private and public, exploring complexities and potential entanglements of the different supply schemes. The pilot studies were undertaken during the years 2014 and 2015 in the neighborhood of Ras Beirut[16]. The pilot studies utilized different research methods, and scales. The choice of the neighborhood of Ras Beirut was based upon my preliminary observation regarding the neighborhood, including, (1) the fast erection of new buildings throughout Hamra, resulting in a dense, rapidly urbanized neighborhood (2) the mixity of its urban fabric of old and new buildings, offering a diversity of tenure patterns and water supply conditions, (3) the mixed-use of the neighborhood, as residential area, a commercial hub, as well as being the home of several educational institutions, which incorporates a variety of social networks and arrangements, and (4) its character as an upper-middle class neighborhood, which usually demonstrate favorable water supply conditions, thus making irregularities, and degrees of informality more visible.

3.5.1 Pilot Study (A), User Preferences on Water Management Schemes, A Choice Modeling Survey in Hamra

Pilot Study (A), used a quantitative method, using a choice modeling/ stated preference technique. The survey included two sections questionnaire; the first addressed socio-economic and tenure factors, as well as participant's assessment of the

[16] The two pilot studies were undertaken as term papers for the following courses at the American University of Beirut: Political Ecology of Water (Instructor: Dr. Roland Riachi), and Environmental Economics (Instructor: Dr. Ali Chalak).

current water provision conditions, while the second part was the choice modeling cards. The study area encompassed Hamra and Ras Beirut. The pilot relied on random sampling, the unit of analysis was the household, and the sample size was 50 households. The survey was carried out during the month of May 2015. The goal of pilot (A) was to gauge user preferences of the different supply schemes and institutional arrangements that were mapped in the first pilot study, exploring water challenges from the viewpoint of the users.

Gauging user preference between different institutional organizations, formal and informal, was a challenge, since both terms seemed rather abstract to participants. Therefore, the pilot devised a proxy of "secure access to water" where formal services were considered as ones with secure access, while informal services were presented as insecure access. Operationalizing notions of informality through measures of secure access to water allowed a more nuanced reading of existing vulnerabilities of urban dwellers, and avoided binaries (legal/ illegal, public/ private).

The survey findings revealed an overwhelming preference for a centrally led provision scheme (akin to a public actor), despite the negative assessment of government performance in current water service provision.

3.5.2 Pilot Study (B), Water Services on Sidani Street

The pilot study builds on a qualitative method, which investigated one section of Sidani Street, having the building as the unit of analysis, and a sample size of 17 buildings. Mapping and fieldwork were carried out during the months of November and December 2014. The study explored the following aspects: (1) building description,

including the condition and age of the building, number of apartments and dwellers, (2) water supply methods, encompassing public supply, private water wells, private vendors and bottled water, and (3) the building's infrastructure, which includes the existing water network of the building, water storage capacity and distribution, type of connection to public water supply, water treatment plants, and the presence of both service and potable water networks. Through the pilot study, I created several maps, illustrating water conditions in the study area. Findings included the following:

(1) The water supply provision is highly fragmented and hybridized, and a single uniform network does not really exist. In fact, water provision schemes and networks were highly diverse (including different combinations of public and private, formal and informal).

(2) A significant number of alternative and informal arrangements secure sufficient access to water despite Ras Beirut being a regulated neighborhood.

(3) There is a significant relation between the age of building, and the number of networks of water supply relied on. Residents of older buildings resort to a larger number of water suppliers/ networks to secure sufficient water.

In summary, both pilot studies revealed three key findings: (1) the highly blurred and intertwined networks[17] of formal/informal water service provision in Beirut, (2) the paramount presence of informality of provision, within formal urban settings,

[17] By using the term networks here, I am referring to a myriad of social, class, economic and physical networks.

and (3) the significant, and nearly dominant, inclination of survey participants to formalize water service provision through a centralized institution.

Figure 2. Study Area Map

(Kahale, 2019)

Figure 3. Building Age Map

(Kahale, 2019)

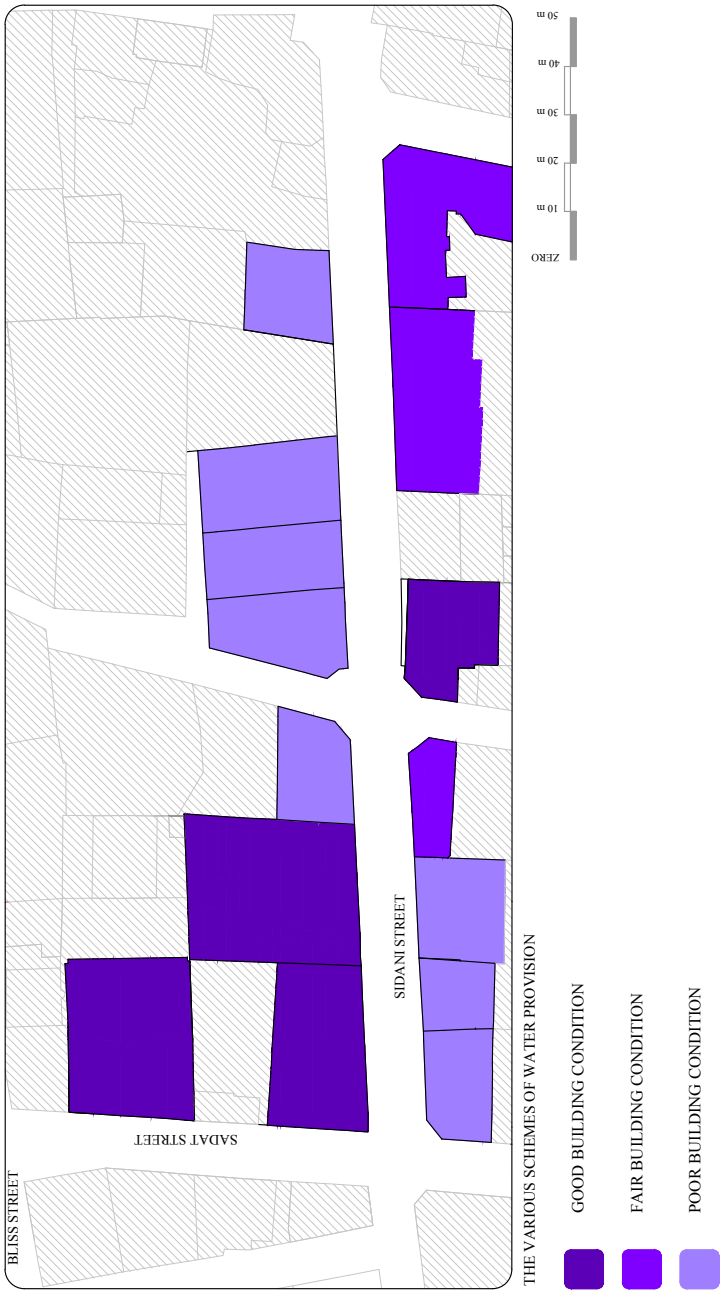


Figure 4. Building Conditions Map

(Kahale, 2019)

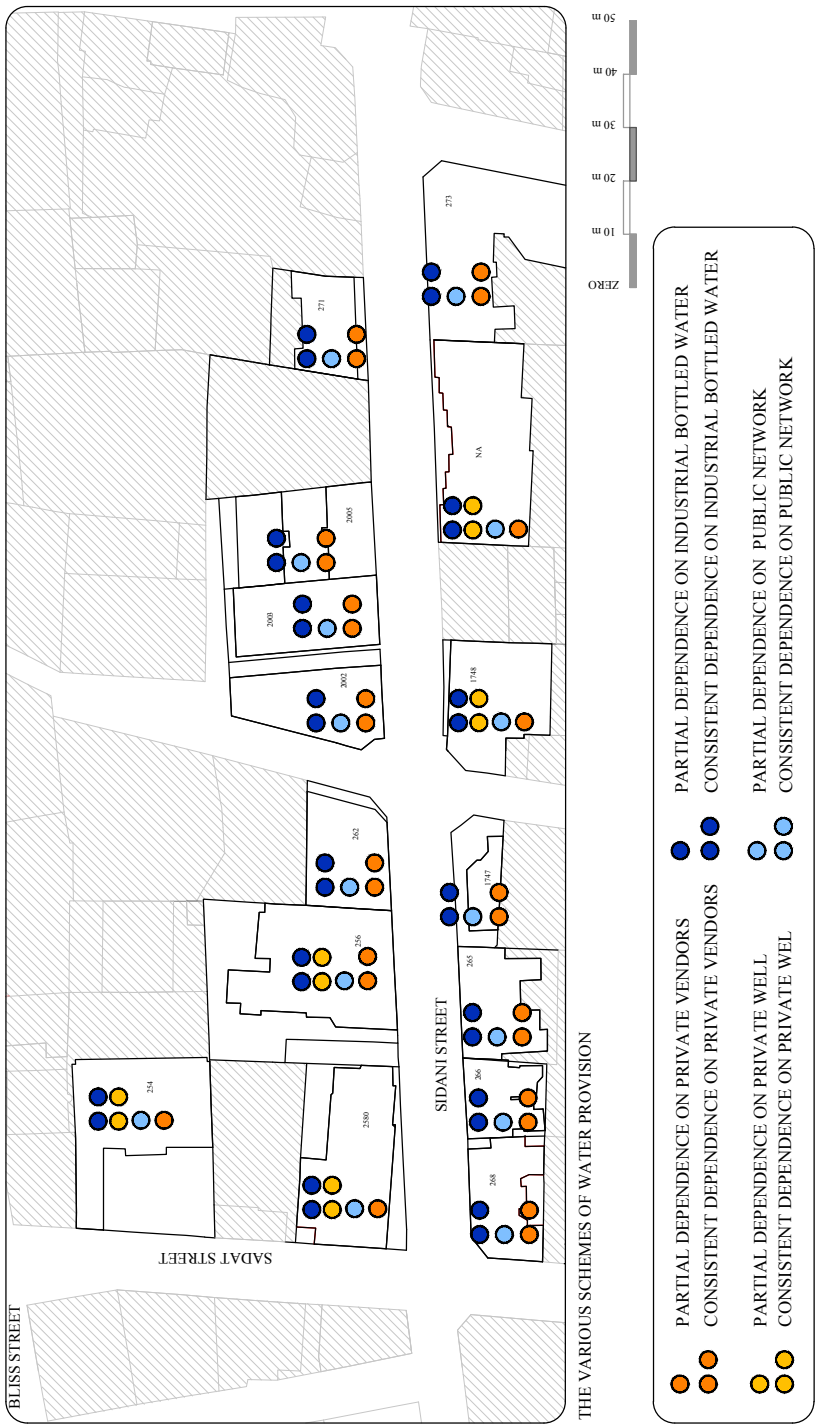


Figure 5. Water Provision Types Map

(Kahale, 2019)

CHAPTER 4

JEANNE D'ARC STREET: WHO GETS WHAT WATER, WHEN, WHY AND HOW

4.1 Buildings, Conditions, and Typologies

The Street of Jeanne d'Arc is centrally located in the neighborhood of Hamra, and Ras Beirut, and is one the main circulation veins connecting the famous Bliss street, home to the American University of Beirut (AUB), to the vibrant and commercial street of Hamra. Jeanne d'Arc Street has been the target of several recent studies, and projects instigated by the Neighborhood initiative at AUB, one of them in collaboration with Beirut Municipality. The project resulted in upgrading the street's infrastructure, asphalt road was paved, sidewalks were widened and improved for walkability, lighting and seating for users along the street were provided, as well as designated offloading parking spots for commercial trucks to improve circulation and decrease traffic. The rehabilitation of infrastructure was primarily focused on waste water upgrade; all waste water pipes were replaced, and storm water network was separated from sewage water, according to the current director of The Neighborhood initiative project, Mona Hallak. Water supply network on the other hand was not upgraded, only broken or damaged pipes were replaced. However, what is noteworthy in this experience, in relation to my research, is the very little data available on infrastructure. According to Hallak, this was a big challenge for the contractor, as there were no maps or documents indicating location and routes of the different service networks. Another challenge Hallak pointed

out, that they faced during execution, is the varied, undocumented levels of building entrances along the street. Given the sloped nature of Jeanne d'Arc Street, all building entrances should have followed the Street's slope. However, the varying levels of buildings that did not follow the Street's slope made linking waste water junctions to main sewer pipe very challenging. The conditions described by Hallak, are unlikely in such a high-end and regulated neighborhood[18].

Due to its central and axial location with AUB, the street is highly desirable for real estate investments, in the form of the many high-rise buildings being constructed along the street, and commercial activities, including shops, printing stores, bars, fast food restaurants, hairdressers, mobile shops, hotels and furnished apartments. The first section of the street, branching from Bliss Street, is where most of the older buildings are located, whereas, newer construction is seen further along the street. The diversity depicted above indicates the highly mixed used and heterogeneous crowd of residents. Old tenants in old run-down houses co-exist with new owners of luxury apartments, transient tenants in hotels and furnished apartments, with significantly varying lifestyles, budgets and utility needs. This provides a fertile ground to compare and measure disparities.

The fieldwork was carried out during the months of August, and September 2017, with subsequent visits to verify and cross check data during the months of October and November 2018. The fieldwork aimed to cover the buildings located on

[18] The Contractor informally reported the infrastructure conditions as being worse than the southern suburb, an area of the city known for its decrepit infrastructure.

Jeanne d'Arc Street, between the intersection on Makhoul Street and up to the intersection on Baalbeck Street.

The study was divided into four main stages:

(1) Initial street survey and mapping, of land use, and building typology;

(2) Semi structured interviews with janitors, leading to the definition of building categories;

(3) Structured in depth interviews with selected janitors, representing the three building categories;

(4) Verification of water network maps with the janitors, as well as cross-referencing with building management. The fourth stage was performed after the initial data analysis and synthesis.

The initial survey covered land use. The street's buildings can be divided into two main types, residential and commercial (hotels, and furnished apartments). Many residential buildings along the street have several shops on their ground floor, especially older buildings; however, the buildings with the shops will still be considered as residential buildings, since the predominant nature of function is residential. Each of the two categories will be examined separately, due to the different tenure and water consumption pattern of each.

Figure 6. Land use Map, Jeanne d'Arc Street, 2019
(Data Collected September 2017)

Within the highlighted study area, 20 buildings were randomly selected for another round of interviews and questionnaires. The sample included three vacant buildings, as well as ten residential and seven commercial buildings. The questionnaires included questions about general building conditions, such as building age, number of apartments and floors, presence of public water subscription, presence of janitor, as well as water resources that reach the building, including all subscribed networks (public water, water cisterns, water well, bottled water), in addition to subscription cost, and general consumption rates. Water infrastructure within each building was initially investigated to explore the varying types and capacities of existing storage capacities, and lastly building tenure and occupancy rates were explored.

Building on the second round of questionnaires, I decided that the two main types of buildings, residential and commercial will each be studied separately, due to highly differential pattern of tenure and consumption, as well as the high variability of building conditions within the commercial type, since they are mostly old buildings but have undergone recent renovation. Three categories of residential buildings were identified, according to their age. The age of building generally indicates two main things: the period in which the building was constructed, and the governing norms and conditions during that time, in addition to the general maintenance and upkeep of the building. Therefore, the three identified sub-categories are, (1) new buildings (0-15 years), (2) medium-aged buildings (15-40 years), (3) old buildings (40 years+). The criterion of age was selected, as it was the most indicative of the general water supply, and water storage conditions within the buildings. One building from each category was selected for an in-depth study, and documentation of practices. Buildings belonging to

category 1 have the most elaborate water storage schemes and capacity, large underground storage tanks are present, the underground water tanks, typically built in concrete, have an automatic pumping system that pushes water to individual storage tanks placed on the roof floor. Whereas buildings belonging to category 2, do not typically have such large storage capacity, yet the residents still have access to significant volumes of water through their individual storage tanks, provided through the close monitoring of shared storage tanks, and an increased likelihood of the building having a well, due to looser regulation related to digging wells during the period of construction of the corresponding building. Management of water supply in building categories 1, and 2 are typically centralized, through the Home Owner Association (HOA), and implemented by the hired janitor. Buildings belonging to category three, however, operate in a different manner, the total storage capacity is usually inferior than that found in categories 1 and 2, water storage system is typically shared, in some cases, in very old, and rundown buildings, the purchase and storage for both public water, and cistern water is performed individually, by the home owner/ tenants themselves, which is reflected in a higher price per cubic meter of water.

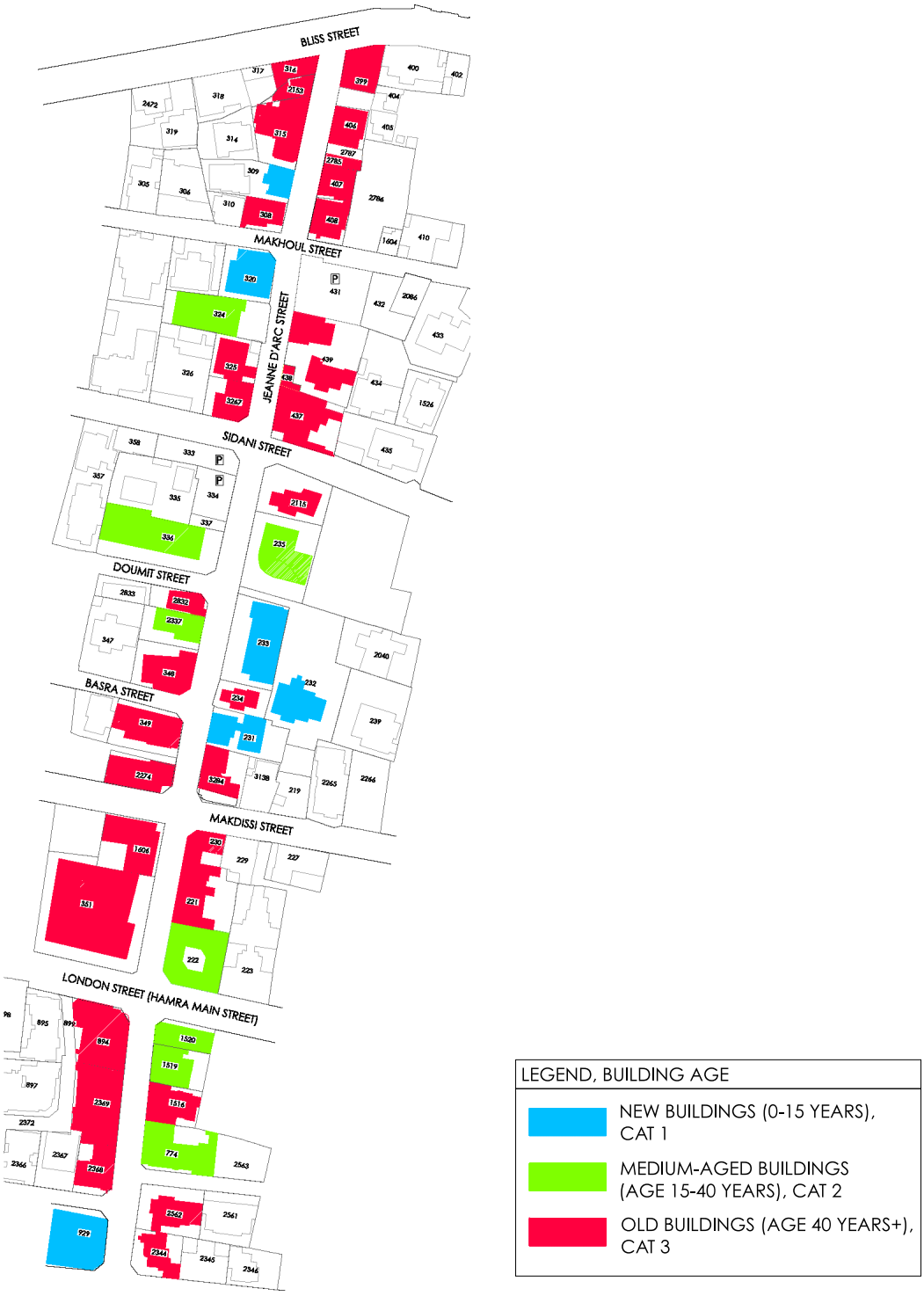


Figure 7. Building Age Map, Jeanne d'Arc Street, 2019
(Data Collected September 2017)

A building from each age category was selected for an in-depth study and documentation of practices, namely, JD 233 (Category 1), Ghandour Building (Category 2), and Makdissi Building (Category 3). Additionally, one commercial building was also studied in depth, the Relax furnished apartments.

The main challenge in the study was to generate figures related to water consumption, and pricing, in each of the contributing networks. The figures generated below cannot be regarded as absolutely accurate, as they were extrapolated through a series of calculations. The starting point was September 2017, since the main public water valve of all of Jeanne d'Arc Street was cut off during the infrastructure works that took place during the summer and autumn of 2017. Utility water was exclusively provided by water cisterns, by calculating the total volume of water consumed by each building, in relation to occupancy rate, approximate consumption figures per apartment were generated. During later visits, in October 2018, and by obtaining cistern numbers purchased throughout the year, as well as annual public subscription, and monthly costs of cistern water, I was able to generate volumes, prices and percentages of consumption of the two main water resources; public and cistern water.

4.2 Securing Water on Jeanne d'Arc Street, Daily Practices and Negotiations

In what follows I explore in depth the water provision conditions of the three highlighted building categories.

4.2.1 New Buildings, A State of Abundance

Case Study 1, Building Category 1, JD 233

The building is probably one of the newest buildings in the Street; it was inhabited in the summer of 2017. The building is composed of two blocks, A and B, and a total of 28 apartments, having an approximate area of 250 m^2, and 150 m^2 respectively. The building was visited twice, the purpose of the second visit was to confirm the figures of the first round of data collection, as well as monitor consumption patterns in relation to increased occupancy. The first round of data collection took place during August and September 2017, with an occupancy rate of approximately 18%, while the second round of data collection took place during October 2018, with the occupancy rate increasing to 75%.

Water pumped by BMLWE enters the building at street level, through a metered water gauge. The main feeding pipe guides the water to the 5^{th} basement underground, to a valve that diverts water into two separate routes, drinking and utility. Drinking water valve is then connected to four polyurethane water tanks, each having the capacity of 1,000 L. Then the water is pumped automatically to two tanks of a capacity of 2,000 L located on the roof, and is then distributed to all 28 apartments, through a special drinking tap, located in the kitchens. Utility water, on the other hand, is stored in a larger concrete tank, capacity 250,000 L, the water is stored in the 5^{th} basement in two tanks, each with a capacity of 2,000 L. An automatic pump propels the water to the roof tanks, reaching 28 tanks (one tank of 2,000 L per apartment). Whenever the water level drops, water from the underground storage tank is automatically pumped to the deficient tank. A total storage capacity of 318,000 L is

available, considering all storage tanks underground and on the roof, making the total accessible water for each of the 28 apartments 11,357 L/day, calculated at full occupancy. The janitor, (A.) monitors water levels. He performs daily inspections of the concrete common storage tank on the 5th basement, to ensure no runoffs, or flooding. Moreover, since the janitor's room services (water supply) are directly linked to the main tanks on the 5th basement, he is the first to note water running low.

The building has two other networks that circulate water, but does not consume it. The first being the mechanical heating network of apartments, composed of individual small tanks present on the roof of the building; the small tanks are filled directly from the common utility tank on the 5th basement floor. Each apartment has a small tank of 200 L. However, this system barely consumes any water, as it recirculates the water within a closed cycle. The last network is the rainwater and irrigation drainage network. Rainwater drains, and irrigation drains from planter boxes are all collected and connected to a manhole on the 5th basement floor. The manhole has an automatic pump that pumps up collected water to a manhole on the ground floor. The latter is connected directly to the main public line under the street. No provision for rainwater collection exists in the building.

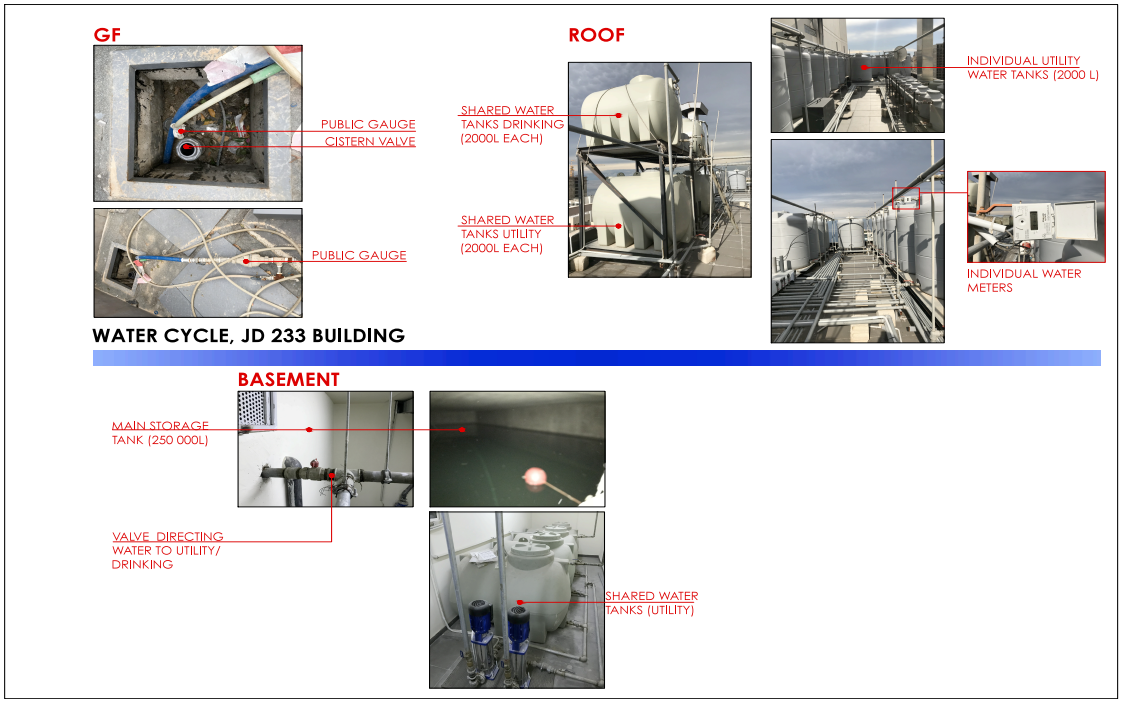


Figure 8. Water Network Infrastructure, JD 233 Building, September 2017

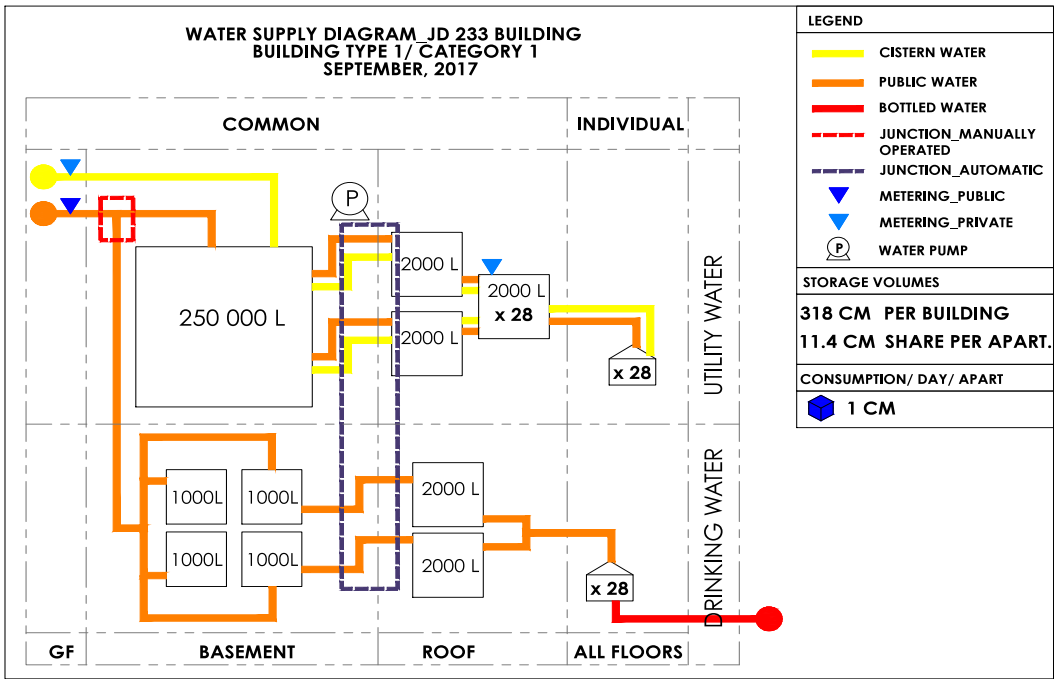


Figure 9. Water Cycle Diagram, JD 233, September 2017

During the first field inspection, the building's water gauge was still that of the construction site, which means water supply was low. Despite the occupancy rate was as low as 18% and only six out of 28 apartments were occupied, three to four water cistern tanks were purchased every twelve to fourteen days. Approximately the building consumed two cisterns a week, each having the capacity of 24,000 L, at an average price of US$ 70. The water cistern hose is in the same water supply manhole that houses the public gauge. However, the cistern has a separate inlet that is directly connected to the common storage tank. The janitor contacts the same water supplier once the storage tank is half empty. The supplier, Ziad Rashkidi, has a fleet of approximately seven tanks[19], with varying storage capacity between 24,000-32,000 L. The tanks fill their water mainly from two or three different wells in Roueisat and Jdaideh. The janitor performs procurement and monitoring of tank filling. Payments, on the other hand, are handled by the developer that constructed the building, on monthly basis, since there is no HOA yet. Residents pay in advance maintenance fees to the developer as an annual lump sum. The total annual fee of services includes several items, including the maintenance and running costs of elevators, generators, cleaning, janitors, cistern water, etc. Exact figures were not provided, however, the total budget collected for the year 2017-2018 was US$ 216,500, which amounts to approximately US$ 650/apartment/month.

[19] Data was obtained from one the tank drivers, who requested to remain anonymous, and requested to not contact the owner.

The diagram shown in Figure 10 illustrates the management scheme of water tanks.

The municipality cut off public water in the entire street was cut off, during August and September 2017. Primary reliance was on the water cisterns. Thus, approximate daily consumption rates per apartment were calculated at 1 m^3, based on the total number of water cisterns procured per week.

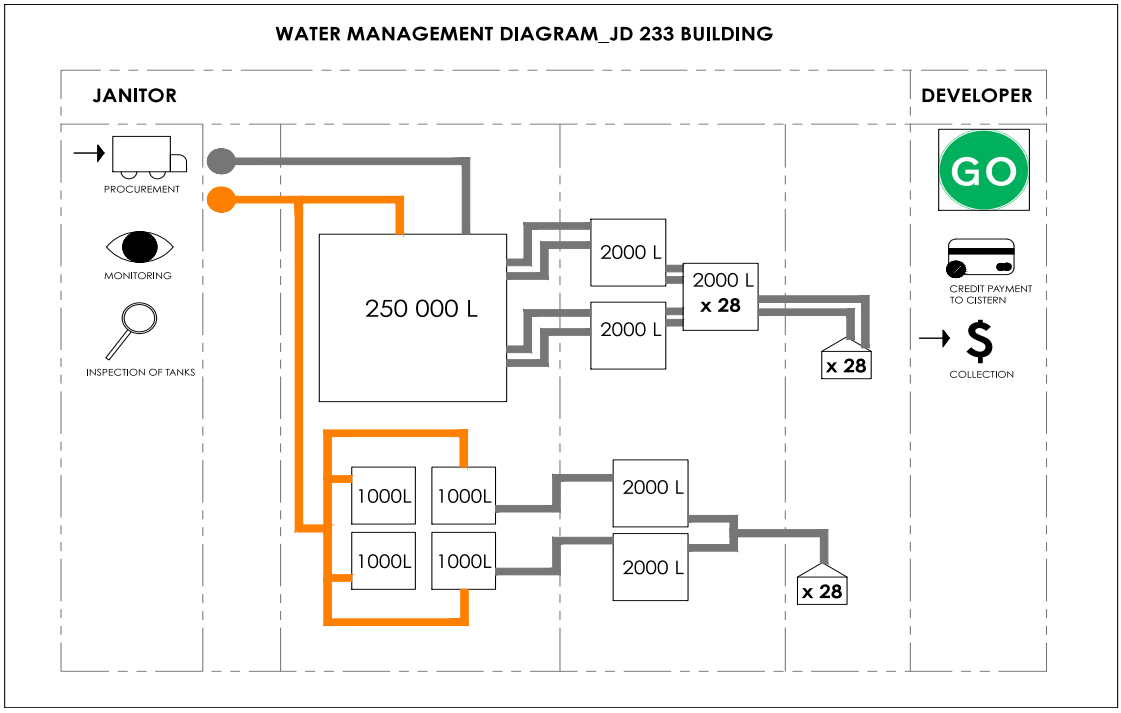


Figure 10. Water Management Diagram, JD 233, 2017

In addition to public water, and cistern water, the building's residents also rely on an external network to obtain drinking water. Private water bottle companies have individual arrangements with apartments: water is delivered on weekly basis to subscribed users. During the initial inspection three company trucks visited the building to deliver water on a weekly basis, which means approximately four tanks circulated on

Jeanne d'Arc Street in order to deliver extra water to the building, as shown in Figure 11. Water cisterns respond within one or two hours: they arrive at night, starting 8pm onwards, the cistern is parked on the street pavement, and causes minor constriction for traffic. Drinking water trucks, on the other hand deliver water in the morning between 8 and 12 am, at peak traffic hours, often causing more traffic congestion.

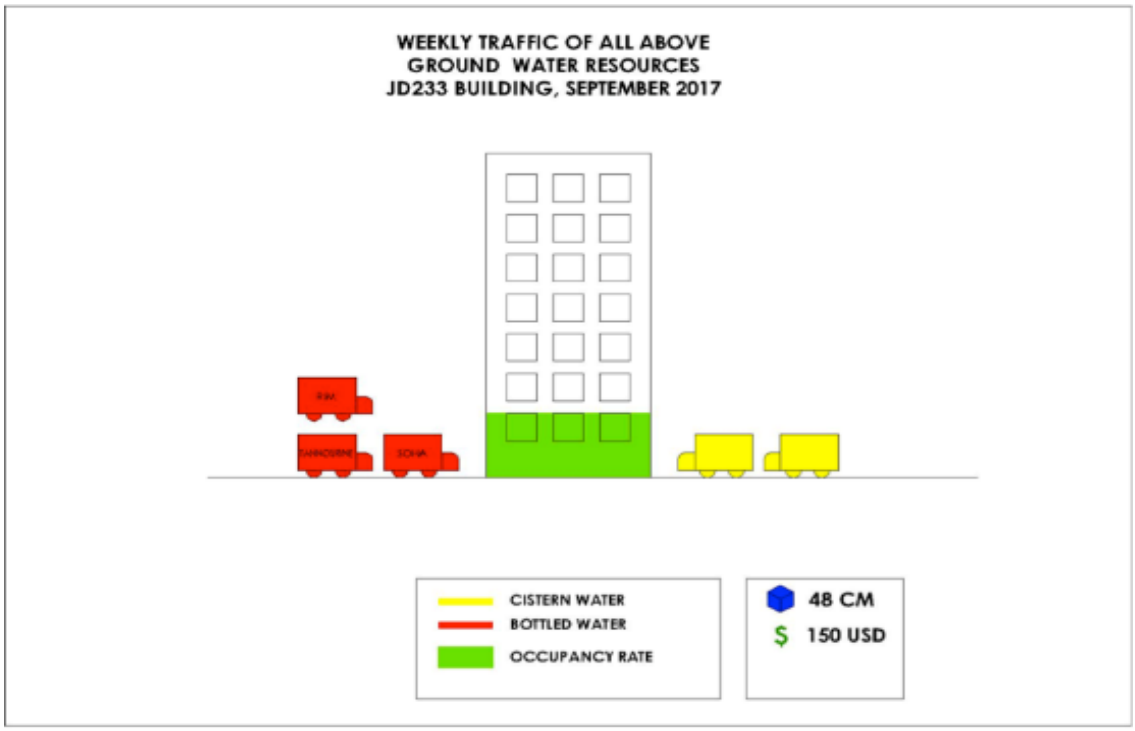


Figure 11. Illustration showing Occupancy vs. Traffic Impact, JD 233 Building, September 2017

The building was inspected again during the month of October 2018, at which point the occupancy rate had increased to approximately 75%. Twenty-one apartments were inhabited; thirteen out of the twenty-one inhabited apartments were rented out.

One significant difference between the two visits is the formalization of the water gauge done in February 2018. The process of formalizing the gauge is essentially

increasing the width of the main branch that supplies the building with water. During the construction phase, the hose had a diameter ¼", whereas with the new hose connection, the diameter is now 1" (see Figure 12), which according to the building's janitor has made a significant impact on water availability.

Old Water Gauge Connection
JD 233, September 2017

New Water Gauge Connection
JD 233, October 2018

Figure 12. Water Gauge Connection

Public water is supplied every other day, following a rotation, therefore, if a supply rotation is missed, the next supply would be in four days. During each rotation, water is supplied between four to seven hours, typically during nighttime, and early hours of the morning. Due to the very large water storage capacity, the janitor reported that during the months of February, March, April, May, August and September no water cisterns were purchased, and the public water was sufficient on its own for utility. Water cisterns were purchased during the months of June and July. In June 48,000 L were purchased (two tanks), and 72,000 L in July (three tanks).

I have also noticed that consumption rates have dropped since my first visit in September 2017, where the average daily per apartment was estimated at 1 m^3. In October 2018, however, that figure dropped to 0.7 m^3. One possible explanation is that during October 2017, many apartments were moving in or were cleaning their

apartments to put them out for rent or sale, therefore excessive amounts of water was consumed.

Furthermore, traffic related to water bottle companies increased with the increase of residents, water bottle trucks deliver water to the building on all days of the week except Mondays.

4.2.2 Medium-Aged Buildings, Water Stress

Case Study 2: Building Type 1, Category 2, Ghandour Building

Ghandour building is located on Plot# 235, and was completed in the year 2000, the building has 10 floors, and 20 apartments, all apartments have an area of 220 m^2. On the ground floor there are eight shops, two of which are rented out, and two shops are operated by their owners, while the remaining four were vacant. The building has a salty well, that is used for general cleaning purposes. The building has an HOA, and a paid accountant. The building's janitor (K.) has worked in the building for 15 years, and lives on the ground floor with his family. Building service fees are paid by owners to the HOA, and collected by the janitor, each apartment pays US$ 200/month, while each shop pays US$ 135. The fees cover all services (janitor, cleaning, water, generators, etc.). The occupancy rate of the building is 85%, only three apartments out of 20 are empty. The majority of residents are homeowners. The building relies on four water resources, namely, public water, cistern water, bottled water, and local water well. The public water supply, according to the janitor, is highly variable between summer and winter. During the summer, public water supply, which is approximately two to three hours, every other day, is halved during the months of the summer. The public

subscription fees are paid for the entire building and are approximately US$ 6,220 annually. The public subscription water enters the building at ground level, and is directed to the underground basement, where the water meter gauge is located, there are 12 shared tanks, each with the capacity of 2,000 L, the water is then pumped to the roof floor, where there is a total of nine storage tanks, six of them are shared by the twenty apartments, while the remaining three are for the shops located on the ground floor. The building has its own water well, but the water is very saline, and is therefore only used for cleaning purposes. Additionally, the building heavily relies on water cisterns, water cisterns are procured almost on daily basis during the winter, and up to twice daily during the summer.

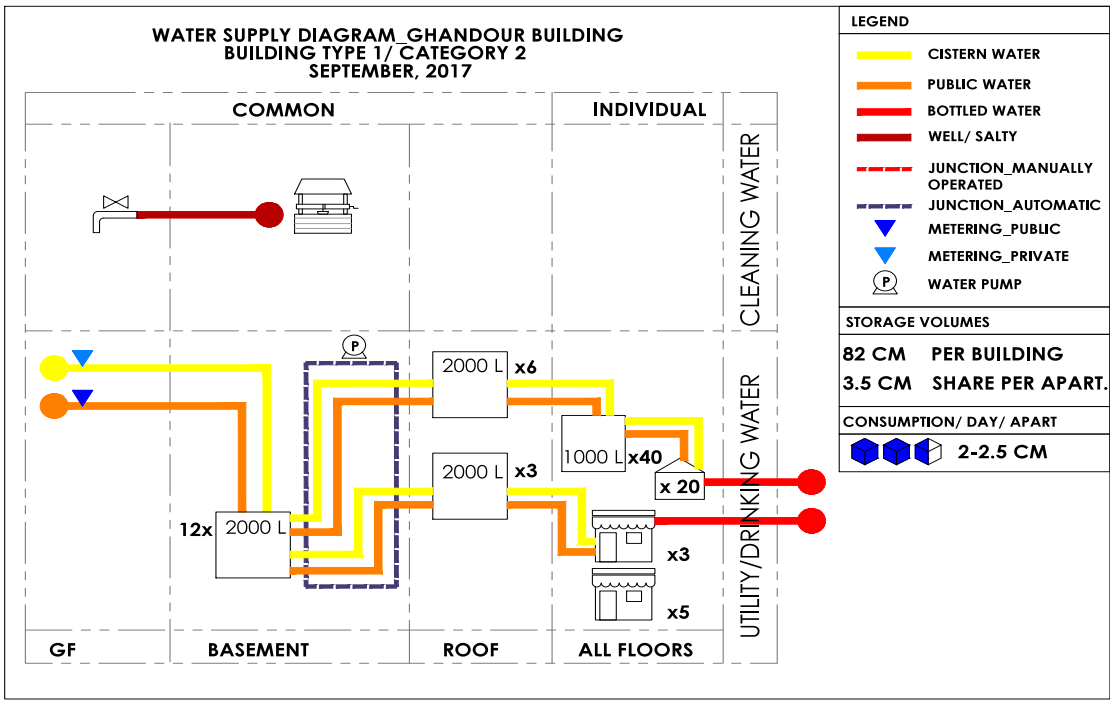


Figure 13. Water Cycle Diagram, Ghandour Building, September 2017

The total water storage capacity in the building is a network of 61 tanks with a total a capacity of 82,000 L, broken down into 24,000 L shared tanks, and 18,000 L distributional tanks, and 40,000 L individual tanks. Calculating the share of each apartment and each shop is tricky, since shops and apartments share the same common tank underground, and water share is directly proportional to consumption, which means, the more an apartment or shop consumes, the faster the tank will get refilled from the shared tanks. To simplify, I will assume that both apartments and offices have equal shares from the total storage capacity, making each share approximately 3,500 L. However, it is to be noted that only three of the eight existing shops are currently connected to the building's water network, meaning each shop has a 2,000 L water tank. All calculations of water shares are made based on an assumption of full occupancy. Moreover, shops are charged according to the metered reading on their storage tanks, according to the manager at "Mr. Brown Diner", located on the corner of the building. To further illustrate the complexities within the network, one of the shop spaces, functioning as a diner, installed a reverse osmosis filtration (RO) unit, thus creating a tertiary network within the building, as well as augmenting total consumption. The manager states that their daily consumption of water is roughly estimated at 2,000 L, however, due to the presence of the RO filter, the water volume that enters the filtration unit is in fact double the consumption, making their effective daily use of water 4,000 L.

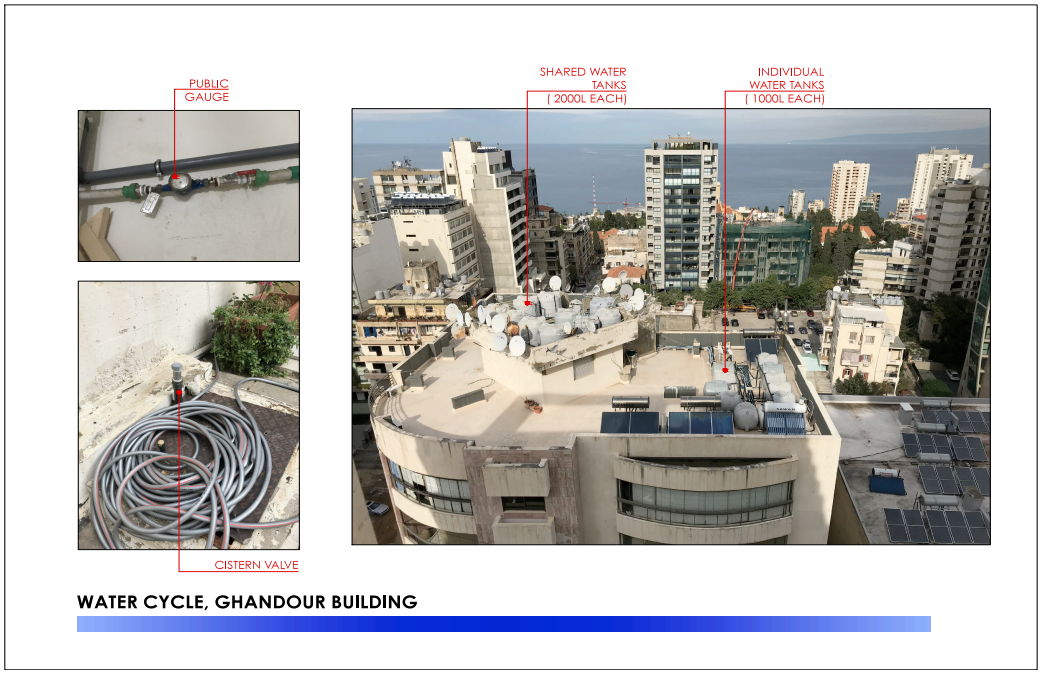


Figure 14. Water Network Infrastructure, Ghandour Building, September 2017

The Janitor oversees monitoring and procuring water. The building has a regular supplier, Shamoun, who delivers water within one to two hours upon request. The payment is done on a monthly/ bi-monthly basis and carried out by the janitor using the money collected as building maintenance fees. The Janitor monitors the underground tanks and calls the water cistern company once the water level in the underground tanks reaches a quarter of its capacity, an electronic indicator is installed at the janitor's room (see Figure 15). On average, the building purchase 230 m^3 of water per week, at a rate of US$ 2.1 per cubic meter, making the weekly cost of cistern water US$ 490, that number almost doubles during the month of summer.

Figure 15. Water Level Indicator, Ghandour Building, October 2017

The building's residents also rely on bottled water for their drinking supply, according to the janitor; four water companies make weekly deliveries to the building.

As for the traffic impact, 11 to 12 tanks circulate the street of Jeanne d'Arc in order to provide water for Ghandour building. Bottled water delivery trucks are usually smaller and cause less traffic impacts. On the other hand, large water tanker, often cause a traffic block in order to reach the building, due to the length of the tanker, and the small radius of maneuvering in the narrow streets.

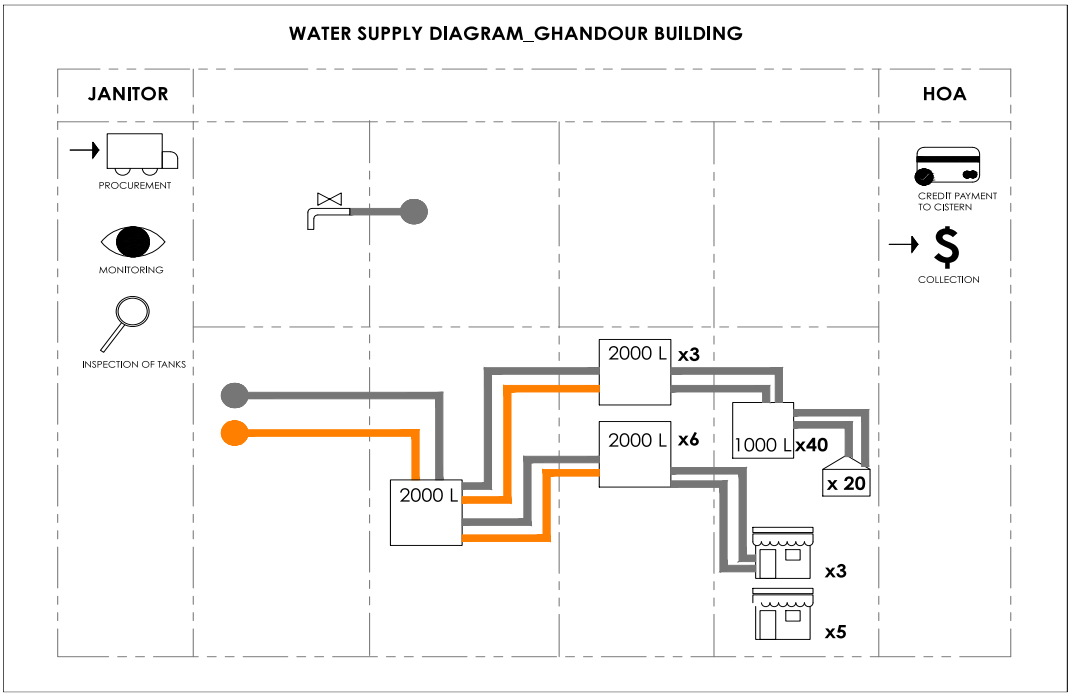


Figure 16. Water Management Diagram, Ghandour Building, September 2017

Figure 17. Illustration showing Occupancy vs. Traffic Impact, JD 233 Building, September 2017

4.2.3 Old Buildings, A Daily Negotiation

Case Study 3: Building Type 1, Category 3, Makdissi Building

The building is located on plot number 349, and belongs to the third category, built in 1958. The building has eight floors, and a total of 16 apartments. There are several sizes of apartments, varying between one to two-bedroom apartments. Five apartments are inhabited, and three apartments are rented out as offices, making the occupancy rate approximately 50%. The building has a hired building manager that is in charge of accounting and general management and maintenance of the building. The annual charge includes all services, except cistern water. The annual charge varies between years. Some of the building's expenses are fixed, such as lift maintenance, generator maintenance, electricity for common areas, janitor, etc. However, the building's maintenance cost varies due to the building's old age, and the different issues that arise every year. For the year 2017, the total annual expenses were US$ 41,000. The total amount is divided among residents according to each owner's share from the total built up area. On average, apartments pay between US$ 1,500-2,000 annually, depending on the apartment size. The annual public water subscription fees amount to approximately US$ 4,660, and are included in the annual building expense.

The building has four shops and a pub/ restaurant on the ground floor. The shops are all connected to the building's water network, except for the pub, which has its own separate water storage tanks[20]. Shop owners also pay a percent of the annual

[20] The issue of water supply at the pub opens a controversy. The pub manager stated that they have no public subscription, and relies exclusively on water cisterns filling their private water tank. However, an

expenses, according to their shares. The additional sums related to water cisterns is divided among resident owners and shops only, with shops paying roughly one third of the amount paid by apartments.

Water supply is highly variable, as discussed in earlier sections. However, this issue is particularly visible in Makdissi building due to the small common tank. The janitor (H.) reported turning off the public gauge, to prevent water flooding from the building's small-shared tank (1,000 L), especially during months of winter 2017.

The building has a 22 m^3 public gauge subscription that reaches the ground floor level and fills a small tank of a 1,000 L capacity. Consequently, water is pumped to the roof floor, filling a large shared tank with a 24,000 L capacity, the large tank fills a total of 12 tanks, six tanks with a capacity of 2,000 L, and six tanks with a capacity of 1,000 L, making the total water storage capacity, assuming all tanks are full, 43,000 L. Thus, the share of accessible water per apartment/ shop, at full occupancy rate, is 2,150 L.

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informant in Makdissi buildings, claims that the pub has a public gauge subscription, with an outlet preceding the outlet of the building, thus the informant claims that the pub has tampered the gauge, and is taking the water share of the building, while paying a much inferior amount to that paid by the building.

Figure 18. Water Network Infrastructure, Ghandour Building, September 2017

Cistern water circulates within the same network as public water. However, the entry point is the large common tank on the roof. The janitor procures water cisterns from the same supplier of JD 233, Ziad Rashkidi, but the price of the tank is higher since water needs to be pumped to the large shared tank on the roof floor. A cistern of 30,000 L is purchased every 7-10 days, with an average price of US$ 110. The janitor is responsible for observing shared tanks to monitor water shortage. The janitor is also responsible for the cistern water procurement and overseeing the water filling process. In addition, the janitor is responsible for cash payments to the cisterns, supplied by HOA; however, the janitor needs the go ahead from HOA management before proceeding with ordering the cistern.

Finally, the building has a water well, but the water is salty, and the water well is not used.

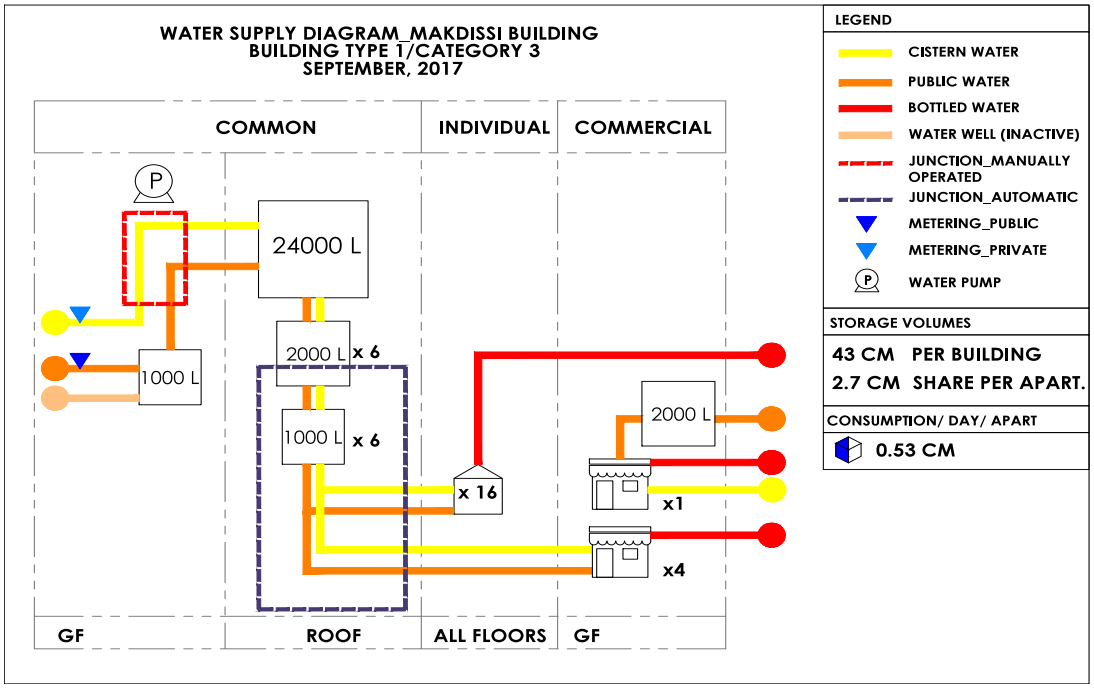


Figure 19. Water Cycle Diagram, Makdissi Building, September 2017

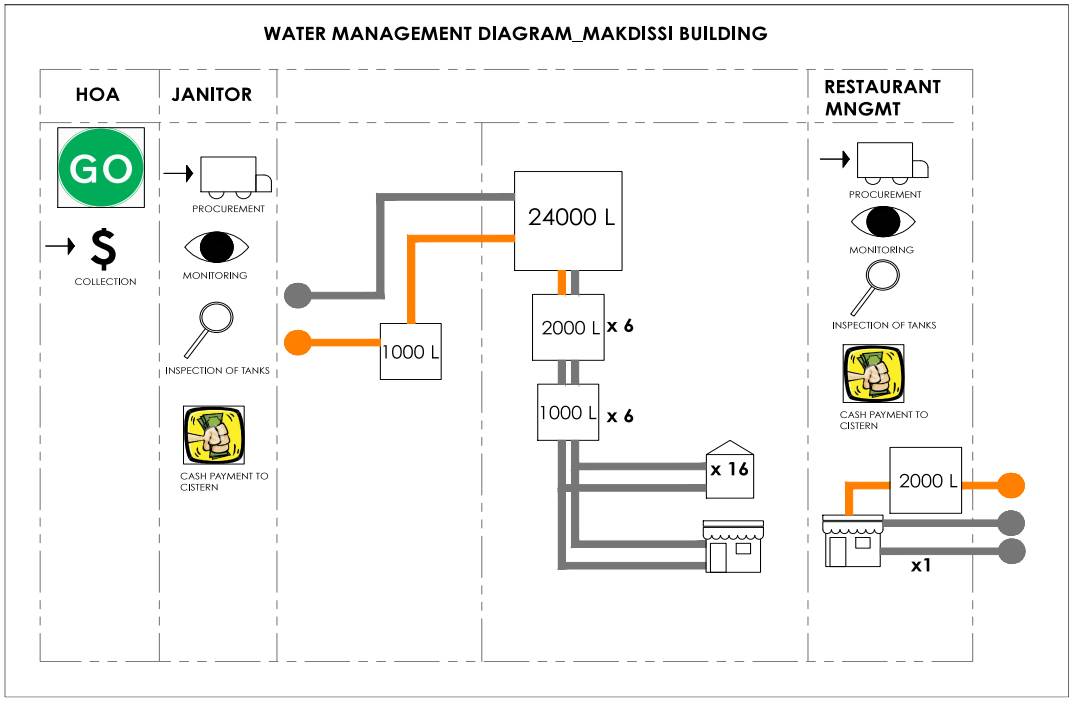


Figure 20. Water Management Diagram, Makdissi Building, September 2017

During my verification visit in October 2018, I was informed that in order to mitigate the issue of public water loss, and improve water storage capacity, the building management cleared out the infrastructure of heating system, that is no longer functional, located in the basement, and created a 10,000 L common tank, connected to the newly installed 2,000 L tank at the public gauge point, making the total water volume available 54,000 L, and the share of each apartment and shop 2,700 L.

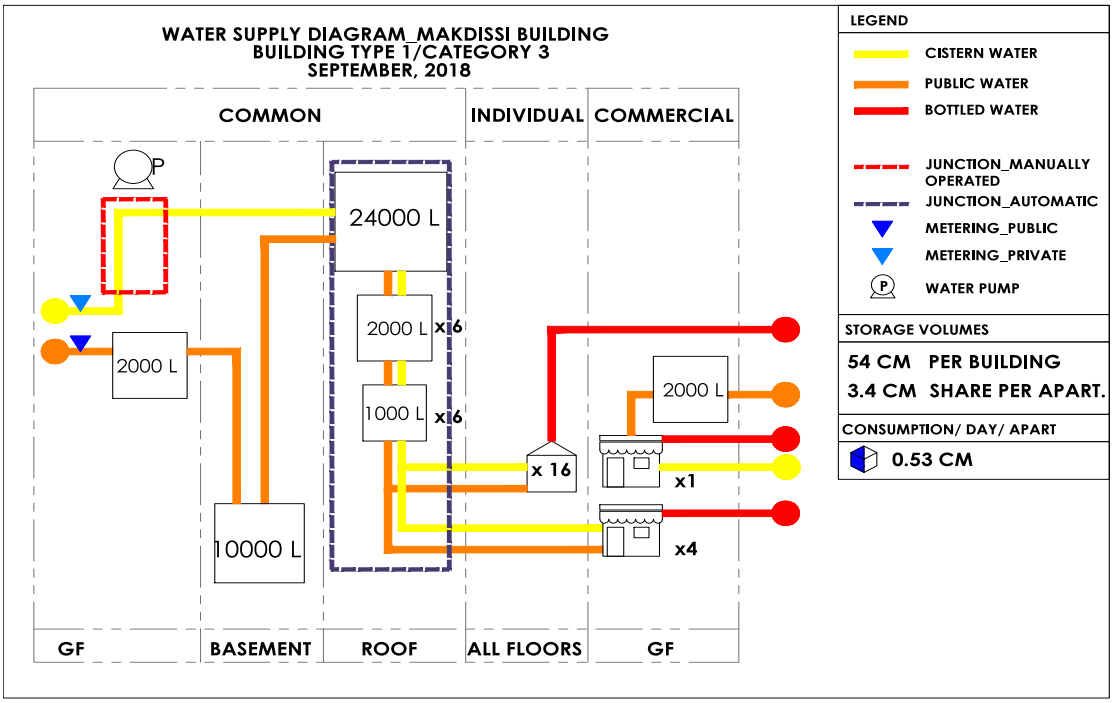


Figure 21. Water Cycle Diagram, Makdissi Building, September 2018

Residents of the building purchase bottled water. Approximately four delivery trucks circulate weekly for bottled water supply, in addition to two water cisterns, delivering utility water to the building and to Bedivere, making the total weekly circulation approximately six trucks. The traffic impact of cisterns is significant, and

often causes congestion in Jeanne d'Arc, as the truck attempts to turn from Jeanne d'Arc towards Basra Street, to park along the pavement.

Figure 22. Illustration showing Occupancy vs. Traffic Impact, Makdissi Building, September 2017

4.2.4 Buildings Type 2, Commercial Buildings

Commercial buildings on Jeanne d'Arc Street are either hotels and furnished apartment buildings, or office buildings. Within the study area, there are only two office buildings (Plot numbers, 351 and 929) and are mostly vacant; therefore, in my study I will focus on hotels and furnished apartments. I choose to study them as a different typology due to two main reasons: the first relating to the function of the building, which affects water consumption, and the second relates to the storage capacity, which is reflected on the pattern of water cistern outsourcing.

The study area has four hotels (Casa d'Or, J Hotel, Berkley Hotel, 309 Hotel) and five furnished apartment buildings (West House, Divan, Relax, M Suites, Sunrise), occupying approximately 24% of the 38 plots under study.

4.2.5 Furnished Apartments, High Consumers

Case Study 4: Building Type 2, Relax Furnished apartments

The building is located on plot number 229, the property used to be an old residential building that was renovated in the years 2005-2006, and turned into a commercial building of furnished apartments. The building has a resident janitor, in addition to front desk employees, and management. The building has seven floors, each floor has six apartments, adding up to a total of 42 furnished apartments. Average occupancy rate is 30-40%, with a rise in occupancy during the summer, up to 70%. The building has two shops on the ground floor. Only of the two shops utilize water from the building's public water subscription.

The building relies on three main water networks: public water, cisterns and bottled water, in addition to the inactive network of the water well. The well was probably dug during the building's renovation. The well was functional during the first few years of operation when the water was still sweet, but since the year 2009, the water became more and more saline, and a water treatment unit was installed on the roof. However, due to the high running costs of the treatment unit, costing approximately US$ 600 per month, the water well was discontinued. Therefore, the water well network, with its two tanks of 1,000 L is inactive, except for some occasional use for cleaning.

The building relies mostly on public and cistern water. The main utility network is composed of a shared storage tank located on the ground floor level, with the capacity of 2,000 L, the water in the shared tanks is pumped to the roof to four shared distributional tanks, each with the capacity of 2,000 L, the water in the shared tanks is connected to the different apartments. The annual public subscription costs US$ 3,130. Due to intermittent public supply, the building also heavily relies on cistern water, purchasing approximately eleven tanks every month, at an average cost of US$ 100 per tank, amounting to approximately to US$ 1,100. However, the latter figures drop considerably during the months of winter. Cistern water circulates within the same network as public water, and it has two filling points. Water is either filled at ground floor, in the case the cistern had no water pump, or water from cistern is pumped directly to the roof to fill the four distributional tanks. The same tank driver is contacted always; he fills the water from a well in Antelias. Payments for cisterns are typically made per cistern. Monitoring of tanks, procurement of cistern, supervision during filling, and payment are all done by the building's janitor, while general accounts and budget are kept with front desk staff.

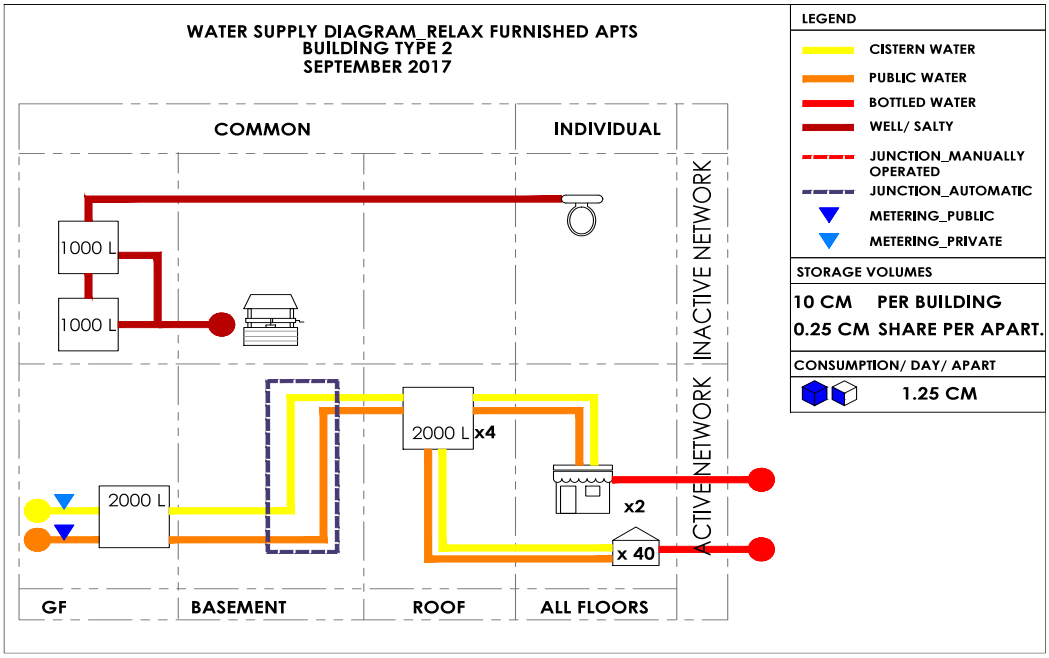


Figure 23. Water Cycle Diagram, Relax Furnished Apartments, September 2017

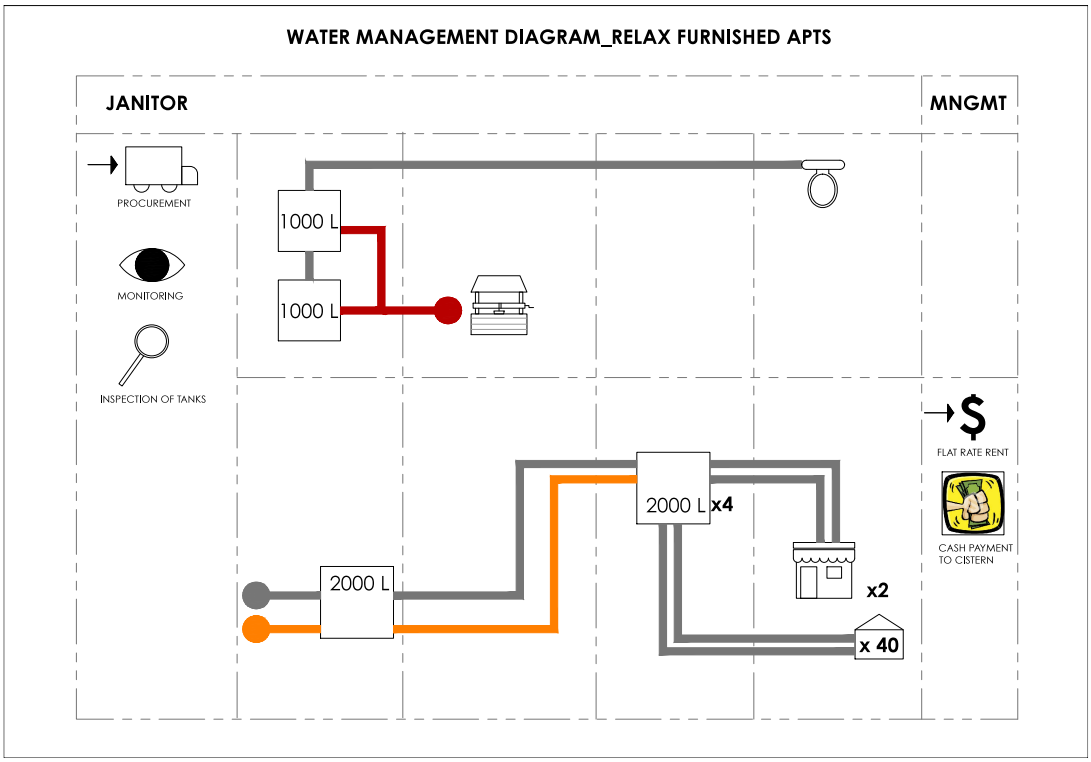


Figure 24. Water Management Diagram, Relax Furnished Apartments, September 2017

The number of purchased cisterns varies significantly between winter and summer. During the summer, up to eleven or twelve cisterns are procured monthly, each cistern having the capacity of 30,000 L, reaching up to 360,000 L of water, and a total cost of US$ 1,000-1,200 per month. During the winter, the figure drops considerably to as little as four to five cisterns per month, with a total quantity of 150,000 L of water, and an approximate cost of US$ 500. The weekly number of delivery tanks is not too high, with approximately two to three trucks circulating weekly, depending on the season. However, the traffic impact is more visible on Makdissi Street, where the hotel entrance is located, especially that the pavement on Makdissi Street is narrower than

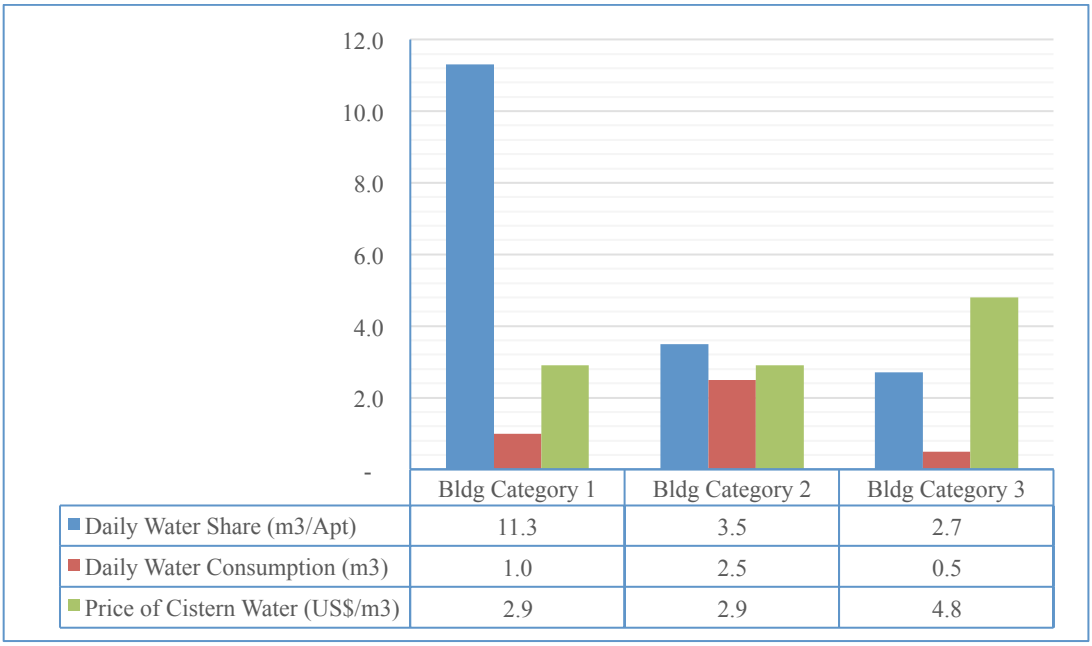
that in Jeanne d'Arc, and there are no designated offloading spots, therefore, the parked cistern causes restricted traffic.

The high reliance on cistern water can be explained by comparing the consumption figures to water share per apartment (water share/ apartment at full occupancy is approximately 240 L, while consumption reaches up to 1,250 L[21]). This is a result of the relatively small total storage capacity (compared to residential buildings), and the excessive consumption rates, especially taking into account that the furnished apartments do not have any appliances that consume large amounts of water.

4.2.6 Synthesis of Case Studies

When comparing the findings of the selected case studies, several issues arise. The first being the disparity between the different water infrastructure schemes in the three building categories resulting in unequal water shares per household. Newer buildings tend to have more collective storage tanks, as well as individual storage tanks for each apartment, which are not present in older buildings, as well as lower prices of cistern water per cubic meter, mainly due to underground storage that does not need pumping. The latter inequality is also manifested in consumption patterns: increased water availability, as seen in the findings, is often reflected in augmented consumption.

[21] According to the data collected through interview with front desk manager.



	Bldg Category 1	Bldg Category 2	Bldg Category 3
Daily Water Share (m3/Apt)	11.3	3.5	2.7
Daily Water Consumption (m3)	1.0	2.5	0.5
Price of Cistern Water (US$/m3)	2.9	2.9	4.8

Figure 25. Comparative Chart of the Three Building Categories, 2017

Another factor that must be taken into consideration with regards to consumption patterns is the different socio-economic background of the residents of the three categories of buildings. This can be detected by looking at the building's annual maintenance fees, which reflects the resident's living standards in relation to water consumption. The graph (Figure 26) shows how consumption rates increase proportionally with the increase in annual maintenance fee.

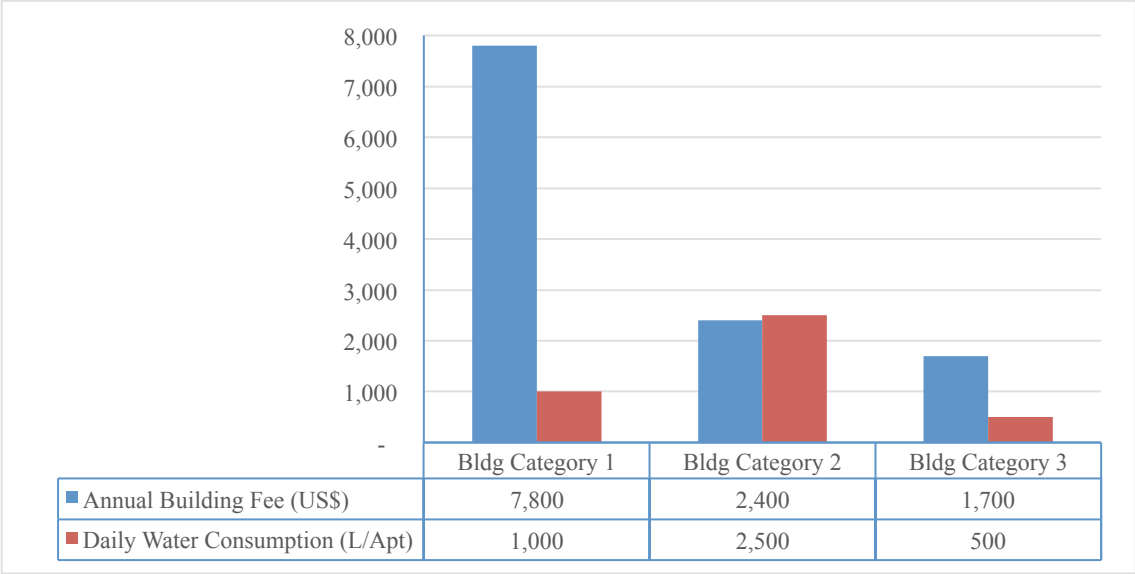


Figure 26. Socio-Economic Status and Water Consumption Rates, 2019

The second finding is the high degree of hybridity in the network, and the significant presence of shadow partners in the water provision process. Based on the total consumption rates of the three categories of buildings and building on water cistern consumption figures of summer of 2018, I was able to roughly estimate the percentages of water source contribution to the total water consumption, as shown in Figure 27.

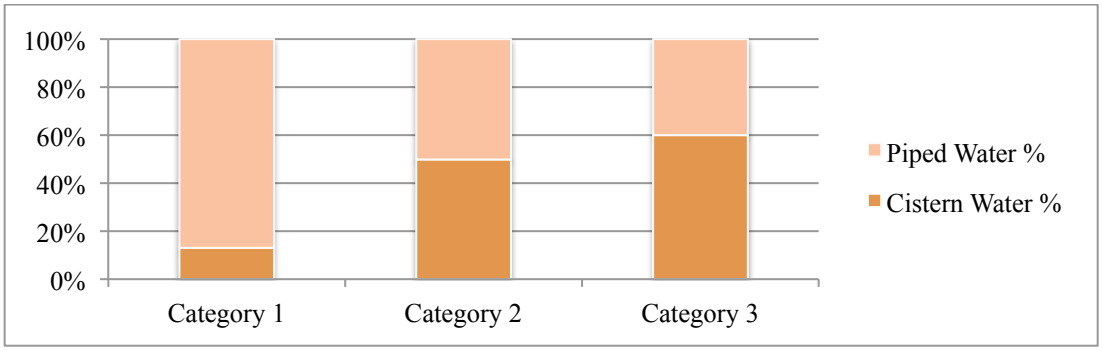


Figure 27. Percentage of Water Source Contribution to Consumption in Summer 2018

Another way to show the extent of this shadow partnership between water cisterns and public water, is to estimate the annual cost of the cistern network, in comparison to the annual fees of public subscription. The below chart (Figure 28) demonstrates the cistern network's share from the market, in the three building categories under study.

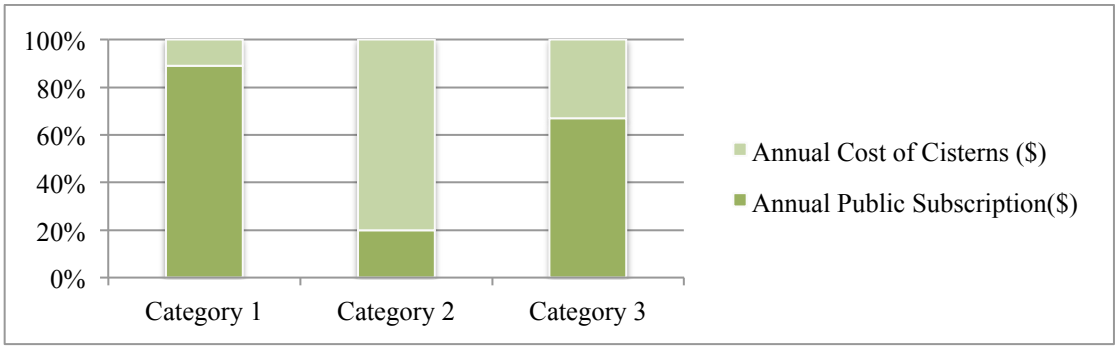


Figure 28. Distribution of Annual Monetary share between Public and Cistern Water

And lastly, if we are to compile the data above about water circulation and water consumption volumes, we find that it exceeds, the daily needs recognized by the BMLWE, estimated at 1 m^3/household[22]/day, to double or more, reaching in some instances 2.5 m^3. One can conclude that water is in fact available, at least in the study area, although it is indeed insufficient in other neighborhoods; which leads us to an important understanding relating to water scarcity; *" the scarcity of water is not a single process caused by the shortage of resources but the outcome of present and past decisions and interventions that produced perverse consequences that affect some groups and locations more than other*" (Ioris, 2016, p.128). Understanding the issue of

[22] This applies to households with an area equivalent of inferior to 200 m^2.

scarcity as a byproduct of political and conflicting interests, decisions and processes can shift the dominant paradigm from a crisis response, that *"neglect the social construction of water scarcity by limiting the analysis to the (largely utilitarian) balance between supply and demand*" (Ioris, 2016, p.126; Ioris, 2001), to one that is actively engaged in social justice and equity, raising questions related to water management, especially ground water management, which is currently filling the gap in water supply, through water wells and water cisterns, but under poor, and often non-exiting regulations, as seen in documented practices above, and will be further elaborated in following sections. Additionally, the extra volumes of water are translated into extra traffic, and circulation bottlenecks, especially for the large trucks circulating in narrow streets, with heavy traffic.

CHAPTER 5

HYBRIDITY, COPRODUCTION AND THE INFORMAL SECTOR

5.1 Hybrid Networks

5.1.1 Unpacking Hybridity

As we have seen in chapter four, residential and commercial buildings in Jeanne d'Arc Street, are dependent on a myriad of water resources and suppliers to secure their daily needs of water. Users are subscribed to a number of networks, varying between three to four networks. All surveyed inhabited buildings have a public subscription, except for vacant ones, in addition to purchasing water cisterns for utility use, and bottled water for drinking, while only some of the buildings have an active well. All three staple resources require transportation and delivery network from resource to user that stretches across a vast territory, significantly larger than the service area. The physical network of public water in Beirut, for example, comprises the pipelines that transport water from Jeita to a number of designated public storage reservoirs, which ultimately feeds buildings along the piped network reaching all subscribed buildings. The cistern water on the other hand, connects a different axis, where most private wells feeding the water are either in Choueifat area, or Jdaideh area, and they transport water to different neighborhoods in Beirut, including Hamra, Talet el Khayat, Cornish el Mazraa, Verdun, etc.

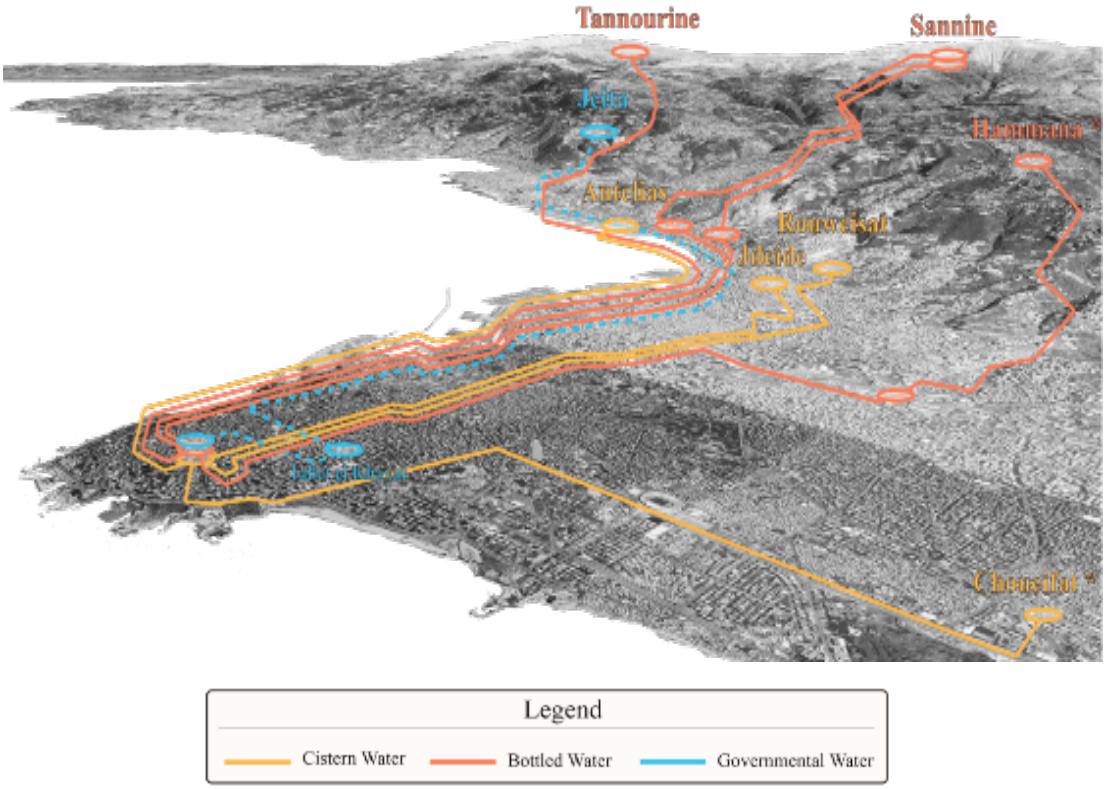


Figure 29. Map showing the Hybrid Web of the Three Main Water Resources Supplying the Study Area

Fieldwork findings indicate a high degree of hybridity in the water network(s). The term hybrid is used in the sense that different sources and networks are intertwined in order to secure the requirements of water for livelihood, and neither one of these networks can achieve that on its own. The hybridity, as seen in the research, has two main elements (1) physical hybridity, and (2) institutional hybridity.

A single homogeneous water supply network is typically composed of three main items: water resource, water storage reservoirs, and a buried piped network that transports water from source to end users, in addition to pumping and treatment stations, depending on the resource. Whereas the physical element of hybridity in the study area

is manifested in the multiple physical components, including the private factories that produce the bottled water, the fleets of trucks that transport both bottled water, and cistern water, the pumping motors of the cistern trucks, the road networks utilized by these trucks to deliver water, the network of private wells that feed the trucks, the private desalination units that exists in some buildings.

On an institutional level, a uniform network is composed of the main water authority/institution that builds, extracts, manages, delivers, monitors and charges for the water provision process. In some cases the latter duties are divided among a number of institutions, but are typically governed by a single monitoring body that oversees that each of the institutions is carrying out their respective duties. In the study area, the institutional hybridity is expressed in two ways: the first being the wide array of actors and entities involved in the water provision process, and the interdependence of the different institutions on each other to achieve water provision. The actors in the study area include the BMLWE with all its various components, the numerous water cistern companies, and bottled water companies, in addition to companies that maintain desalination units for wells. Janitors and HOA also play a significant role in identifying water shortages and procurement of water. Interestingly, fieldwork indicates a high degree of interdependence between the differently functioning networks. In my research, the use of the terms formal and informal water provision mechanisms follows the principles highlighted in the literature review, in relation to the formal governing institutions. Therefore, suppliers/ resources that are managed by entities having an authorization/ permit from the Lebanese state, will qualify as formal, while suppliers/ resources operating without permits/ authorization from the state will be considered as

informal. Thus, if we are to look at the resource itself, one can outline four main types, (1) metered public water, considered as a formal resource governed by BMLWE, (2) water cisterns, considered as informal, since tanks are filled from unpermitted wells, as we will see in subsequent sections, (3) private wells that exist in buildings will be considered informal, since they do not follow state regulation of pumping and depth, and lastly, (4) private bottled water companies, considered as formal, since they are under national licensing. Nevertheless, the boundaries and distinctions between these resources and their corresponding category (formal vs. informal) become highly blurred when they are examined through a network lens that incorporates the provision process, and daily practices of users and operators.

Upon examining the route for each of the above-outlined resources, from resource to user, fieldwork findings show that almost none of the networks can be classified as purely formal or purely informal. The concept of co-production becomes especially helpful in this case: each building relies on the enmeshed formal and informal network in order to obtain its daily needs of water. For example, water cisterns are to a degree formal, in terms of having a company name and registration in the Ministry of Finance[23], yet the wells where water is pumped out are rarely authorized, as we will see in later sections of the study. The majority of users perceive water cisterns as the most reliable source or water. However, the tankers owe much of their reliability to their high mobility, which relies entirely on the formal road network. Similarly, despite the cistern

[23] This is true for some of the water cistern companies. However, field informants confirmed that some of the water cistern companies do not have permits. Further investigation is needed to explore the issue of permits, but is outside the scope of this study.

being an informal arrangement, all buildings, especially new ones have a separate valve, embedded and routed within the building's infra-structure, which provides a direct link of tank water from edge of building to underground storage tanks, as discussed in the findings section.

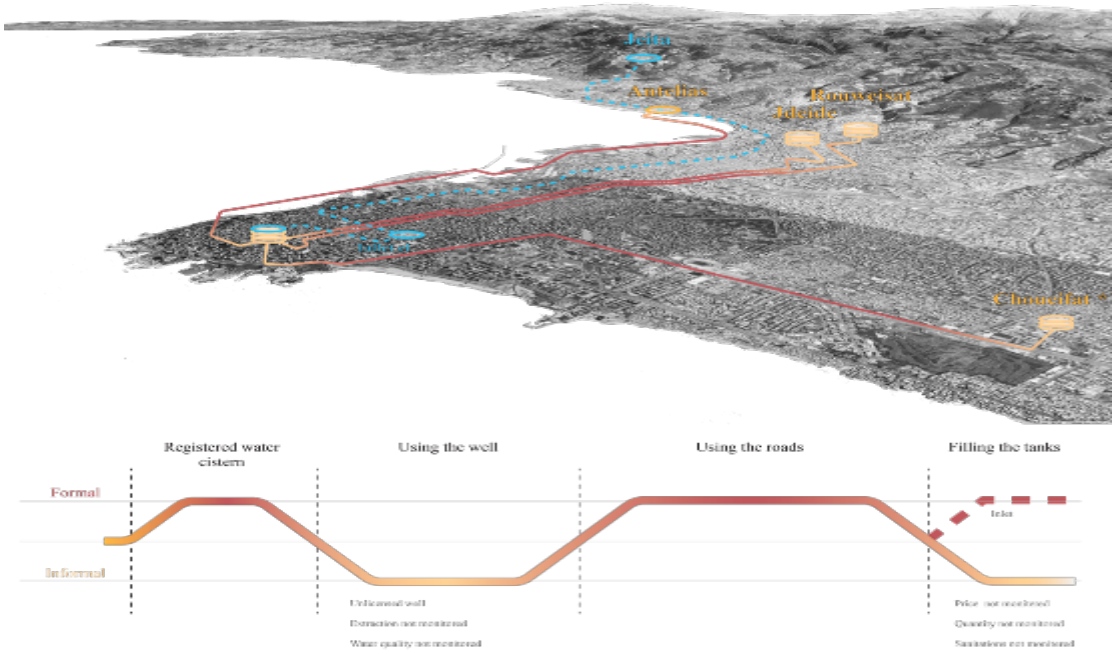


Figure 30. Map showing the Different Formal and Informal Segments of Water Cisterns Route

Public subscriptions on the other hand have intermittent, and often unpredictable water supply, especially varying between winter and summer. It also varies annually, between years with heavy rainfall, and drought years. For example, in Makdissi building, during the winter of 2016-2017, the janitor reported closing off the public subscription valve, due to overflow of water that flooded the existing storage tank. Whereas, during the summer of the same year, the building had to purchase five trucks during the month of summer to meet their daily needs. The latter incident led the

management to install a 10,000 L water storage tank in the basement and re-route the gauge connection. Furthermore, through the interviews with janitors and building management, they described several informal practices that exist in the street and are performed by some buildings in order to obtain more public water. The first is installing a small water suction/ extraction pump to the water gauge valve, in order to take a bigger share of water, which reduces the amount of water reaching the following subscriber. Another practice is to increase the opening within the water gauge itself, the practice is referred to as "*tarmaseh*". According to the interviewees, such practices are covered through informal arrangements with government employees, allowing their oversight during inspection. The persistence of such practices demonstrates a degree of informality within the formal structure, generating disparities of supply of the public piped network.

In conclusion, both main water networks, piped and cistern water seem to navigate through formal and informal segments, either in operation, i.e. institutional hybridity, or en route, i.e. physical hybridity.

5.1.2 The Cost of Hybridity

Building on fieldwork findings, I will highlight the three main costs of network hybridity, from the smaller to the larger spheres of influence, including (1) users, (2) traffic impacts, and (3) overconsumption of water, and especially ground water, excluding the externalities related to health and sanitation, associated with poor water quality. The first sphere includes the users, who are paying large and often unequal sums of money in order to obtain their daily needs of water: the pricing of water cistern

is exorbitant in comparison to public water, it is also unregulated, and varies according to all sorts of factors, including neighborhood, volume of water purchased, and the location of storage tanks, resulting in a variety of prices per cubic meter of water, even within the same street.

Table 1. Disparity of Cistern Quantity& Price, September 2017

Name of Building	Lot #	Age Category	Cisterns/ week	Price/m^3 (US$)
Khoury	325	3	3	1.33
Garden Tower	232	2	7	2.33
JD 233	233	1	2	3.00
Ghandour	235	2	7	2.33
Takkoush	348	3	1	11.80
Makdissi	349	3	1	3.67
Soudairi	1516	3	2	2
Relax	229	3	1	3.33
Sunrise	2562	3	2	4.00
Casa D'or Hotel	221	3	7	5.00
Berkley Hotel	774	3	3	3.33

The large number of cistern tanks, and bottled water trucks circulating the narrow streets of Hamra have a significant traffic impact, both in terms of the influx of vehicles, and size of vehicles, that cause traffic congestion, and bottlenecks, especially when the long trucks attempt to enter a narrow alley to reach a building, as is the case for both Ghandour and Makdissi buildings. The numerous maneuvers the truck need to do, in order to reach its parking spot can take up to several minutes, resulting in congestion at Sidani/ Jeanne d'Arc , and Bliss/ Jeanne d'Arc crossings.

And lastly, the main source compensating shortages in the water supply is ground water, through wells on the outskirts of the city. The wells offer a reliable short-term solution for water shortage. However, the poor monitoring of water quality and

excessive extraction practices presents health hazards, and long-term threat for future water availability.

5.1.3 The Importance of Recognizing Hybridity and Informal Shadow Partners

While the existence of the informal water sector is highly visible in the form of water tankers heavily circulating the streets of the capital Beirut, the operators of the informal cistern network are seldom considered as important stakeholders in water reform plans and policies. The oversight of the informal network operators might be attributed to a conception correlating informal practices to informal settlements. However, as this thesis has demonstrated informal practices exist and flourish within formal settings. The empirical data demonstrates that informal water provision not only exists in a formal neighborhood, it is an integral part of its water supply network, essential to households in order to secure their daily needs of water. Therefore, the water tankers, and their network of operators, cannot be viewed as an isolated and temporary arrangement in response to seasonal water shortages, but as a shadow partner in the water provision scheme in Jeanne d'Arc Street.

The importance of recognizing the informal sector as a shadow partner of the water provision process sheds an important light on key stakeholders in the utility water sector and highlights their significant market share. The existence of a strong and highly lucrative informal sector of water provision renders most technical solutions that address network rehabilitation and augmenting supply insufficient if not coupled with a vision to either formalize, reformulate, or integrate the informal sector and its key

players. Fieldwork findings[24] indicate that the market share of cistern in the study area is approximately at 38% of the total utility water market, excluding drinking bottled water. Rough figures were calculated for approximately 18 buildings, where the approximate annual cost for cisterns is estimated at US$ 120,000, and Annual public subscription estimated at US$ 195,000. However, it is important to note that the return on investment is much higher for the informal operators, due to the disparity of network costs. The expenses of the informal operators are limited to the fleet of cistern tanks and their maintenance, cost of filling cistern at source[25], and transportation expenses (driver's salary, fuel…etc.). Whereas the formal piped network is very costly to install, maintain and operate.

5.2 The Informal Network of Cisterns

The network of cisterns feeds on a number of privately owned wells, mostly located at the outskirts of the city, as per the survey[26] carried out by Constantine *et al.* (2016). Some supply points may have up to three wells per point. None of the surveyed wells were authorized for use as domestic water supply. Most of them had agriculture licenses, and the remaining wells either had an industrial/ car wash license, or no license at all (Constantine *et al.*, 2016, pp.87-88). Pumping rates and water quality monitoring

[24] The figures are calculated as average figures, building on annual subscription fees, and average cost of cistern water, calculated at half the consumption of summer, building on feedback from janitors interviewed.

[25] Cost of filling water tankers is approximately US$ 7-10 in the study area.

[26] The study surveyed 33 privately owned wells, distributed in 24 filling points, with varying number of wells in each point, and supplying 34 cistern operators.

had no provisions in either one of the wells. Pumping was as per demand, varying between as much as 2000 m^3/day/well in the summer season, and as little as 80 m^3/day/well during the winter. Tankers on the other hand, which were also surveyed in the study, varied in capacity between 1.2 and 30 m^3. Only half the tankers performed regular chemical and water cleaning of the tanks, while some tanks were reportedly never cleaned. The diagrams below (Figure 31, Figure 32, Figure 33) provide a general overview of cistern material, cleaning, and capacity. However, what is particularly significant in this study is the number of trips and volume of water circulated in the 34 surveyed tanks. During the summer season, more than 395 trips were documented, and a total volume of 32,600 m^3/day.

Furthermore, the study documents the economic burdens of the use of cistern water (Constantine *et al.*, 2016, p.91). Prices of pumping water varied according to well and tank size, while cistern price varied depending on the distance of the filling point, and on the location of the storage tank, where pumping water to roof tanks costs more per cubic meter of water. The study concluded that the cisterns profit of water delivery varied between 16-414%, for ground floor storage tanks, and 61-729% for storage tanks located on roofs. According to the authors, the cost of water cisterns, paid by consumers ranges between 3.5-11 US$/$m^3$ which is almost 8-24 times more costly compared to municipal water at 0.42 US$/$m^3$ (Constantine *et al.*, 2016, p.93), implying a markup of 760-2410% from municipal water, excluding all related environmental and health externalities, of which are the health impacts of poor water quality, high salinity that can affect house hold appliances, and the increase of sea water intrusion due to excessive pumping of water.

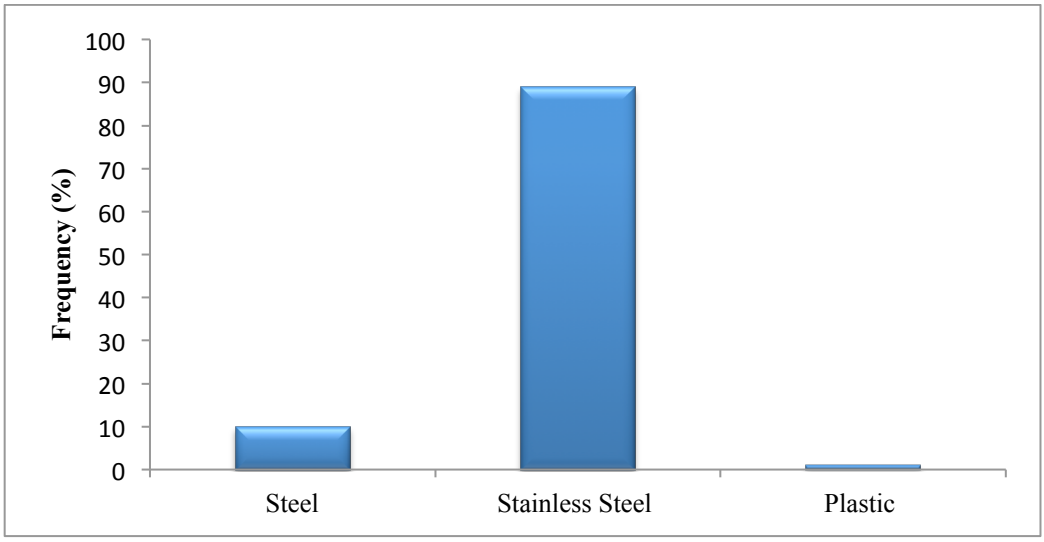


Figure 31. Tank Specification of Cisterns

(Constantine *et al.*, 2016)

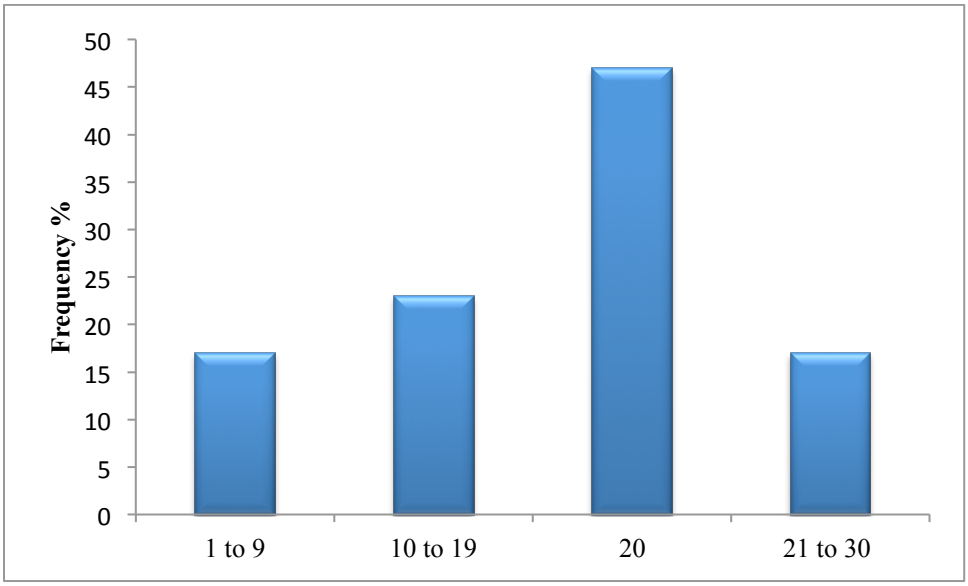


Figure 32. Tank Capacity of Cisterns in Cubic Meters

(Constantine *et al.*, 2016)

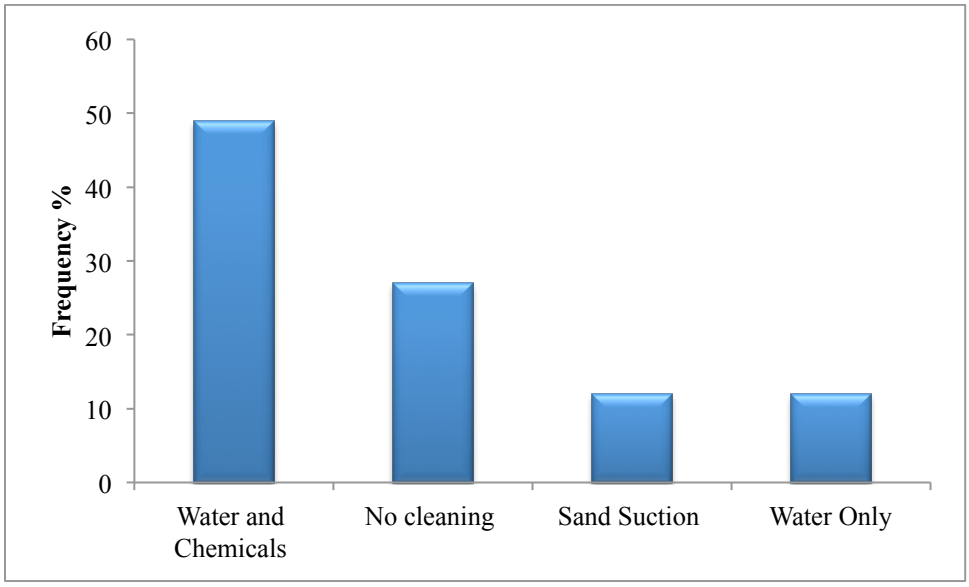


Figure 33. Cleaning Methods of Cistern Tanks

(Constantine *et al.*, 2016)

5.2.1 Understanding the Prevalence of Informal Water Services

The sections above describe the informal cistern network in Beirut and document their significant role in the water provision cycle, however, it is important to look at the reasons why the end users actually resort to using the informal services. Sima and Elimelech observe three general characteristics of the informal water sector: (1) adaptability, (2) responsiveness to consumer's needs, and (3) financial viability and efficiency (Selendy, 2011, pp.235-236).

The authors highlight the ability of private vendors of water to quickly adapt to the changing needs and conditions of consumers when compared to piped networks, especially in contexts where municipal infrastructure projects take an extensive time, and by the time they are fully implemented, they often fail to respond to the needs of an ever-growing population. This adaptability is mostly due to the high mobility these

vendors have, and the lack of permanent and buried infrastructure, in addition to the small scale, and entrepreneurial approach to service delivery. Furthermore, the authors stipulate that the above is particularly true in post conflict contexts. The unregulated small-scale vendors take advantage of asymmetrical regulations and can quickly mobilize their resources to meet the increasing urban and suburban demand for water.

Another important feature of informal water vendors is their high responsiveness to consumer's needs, when compared to municipal and public water services. Client loyalty resulting from high responsiveness to client's needs is paramount in the dynamics of the informal sector, due to the direct nature of the contract between consumer and vendor, and the competition amongst the many vendors that operate within a single neighborhood. The vendors develop their network in certain neighborhoods in the city, therefore, there is a high context specificity in the manner the vendors develop their business, which can explain why the residents would opt for contracting with the private vendors, despite the higher cost, when compared to public water services.

And lastly, the informal vendors function in a highly efficient manner, with virtually no unaccounted-for water loss, and 100% collection rate.

In my fieldwork, I found that the above outlined features are often brought up with interviews with janitors; where they described the water cisterns as the most reliable source of supply, available within a few hours, especially in buildings where the consumption is high, and janitors regularly monitor and inspect shared storage tanks (building types 1and 2). Whereas older, smaller buildings, such as Takkoush building (building type 3), with no HOA/ janitor, did not report cisterns as the most reliable

source, and still perceived it as secondary to the public network. Nonetheless, the high mobility, responsiveness and efficiency of the informal network can explain users inclination to it. Especially in comparison to the public network, that has intermittent and irregular supply hours, unlike electricity, where power cuts happen at certain times, in rotation, making the prediction of received water difficult.

5.2.2 Consumption Patterns and Informal Providers

Furthermore, empirical data implies, that the existence of the informal partner and its high responsiveness to consumer's needs has had its effects on consumption practices. Especially due to the direct nature of transaction in the informal water network; the water is pumped out of private wells, stored in cistern tanks, transported directly to users. Moreover, excessive consumption is still priced at the basic rate of cistern water (US$ 3-4 on average per cubic meter of water). In fact, buildings with shared tanks, and high consumption of water, such as Ghandour building, pay an average of US$ 2.33 per cubic meter of cistern water, whereas, smaller, and older building with individual tanks, such as Takoush building, pay as much as US$ 11.82. As a result, higher water consumption rates are not priced at higher, or incremental blocks, to the contrary higher consumption rates lead to lower pricing per cubic meter. Another example is Ghandour building's high- consumption rates, reaching up to 3 m^3/apartment/day, during summer of 2017. This consumption is triple the designated water supply per apartment, by the public operator. This is made possible by the highly responsive informal supplier, that charges all additional consumption at an equal or

slightly inferior rate, as demonstrated in the previous section. This finding provides insight to the mutual benefits of both user and informal provider.

CHAPTER 6

THE CHICKEN AND THE EGG: THE PARADOX OF POLICY AND PRACTICES

6.1 Policies

6.1.1 Historical Context

Fieldwork findings indicate a significant reliance on ground water, through a network of unregulated wells, and a fleet of trucks transporting the water from source to user. However, when this reality is contrasted with post-war policy addressing water usage, not much weight is granted to groundwater. In fact, the bulk of policy reforms are built around engineered solutions of surface water storage, in the form of 20 dams on Lebanon's 17 rivers (Riachi, 2016, p.4). The argument supporting the construction of dams stems from the assumption that the only way to relieve the pressure on ground water is by increasing surface water storage, while aquifers must be maintained as strategic reservoirs, resulting in a supply sided vision for water policies that overlooks the formulation of a clearly delineated water policy with regards to the conservation and utilization of ground water. Failing to recognize that the impacts of climate change and its effects on the decrease of annual rainfall figures should reasonably imply that there would be a decreasing amount of surface water, and surface water runoff, a fact that seem to be missing from all the national reports and water tables available, according to Riachi. The latter supply sided policy also fails to address the urgent challenges of

private property laws and legal pluralism entailed in the issue of ground water exploitation, thus leading to the depletion of groundwater, especially under the current political and legal structure in Lebanon, dominated by laissez-faire regimes, and prioritization of private property laws.

In order to better situate the discussion about water policies within the historical context of the country, I will closely examine the historical roots of private property regulations, and laws governing ground water, from Ottoman times, until recent policy reforms. Additionally, I will explore the effect of wartime practices, and post-war policies on entrenching fragmentation and hybridity in the water network.

6.1.2 Laws Governing Water

Current conditions of uncontrolled ground water consumption and pumping, are better understood when they are examined from a historical perspective, shedding light on the origins and evolution of legal structures, and common practices paving the way to the sporadic exploitation of ground resources.

Riachi provides a rich overview of the legal evolution of the water right, from Ottoman to Modern times (Riachi, 2016).

First of all it is crucial to understand the entangled relation between land property and water rights, given the tremendous impact the former has had over the latter. According to the Sunni Hanafi doctrine that ruled the Ottoman courts, there are two types of water right (Riachi, 2016, p.16) the *mubah*, and the *mulk*. While the first referred to the public domain, comprised of seas lakes and rivers, with free access to all, the latter referred to the private ownership of canals and wells, as well as *haq el intifaa*,

which referred to the different types of easements of water resources, noting that the easements were transferable through inheritance and land sale. During that era, the bulk of lands, especially the agricultural lands in the Bekaa, the South, and the Akkar Valley in the North was *mushaa* land, organized under the *timar* system, a land tenure system based on land concessions in return of a collected tax given to local leaders and the higher-ranking military. On the other hand, the Mount Lebanon region, was home to the early development of private land property, due to its political structures of settlements around notable Emirs and monasteries, as well as the type of terraced agriculture, feeding on Karst springs that took place in the region. The birth of the *Daftar Khan*, and the *Medjella*, in 1858 and 1877 respectively, as legal frameworks for all sectors, which were part of the modernization process undertaken by the Ottoman administration, under European pressure, building much of their legal structures on the French Napoleonic cadaster system, paved the way to increased value of land and its resources, especially water, while enabling private property rights. Although the *Medjellah* stated that ground water ownership is forbidden, while allowing the use of public water for irrigation and drinking, known as *haqq el shifa* and *haqq el shereb*, under the condition of not exhausting the water resource, however, it gave property rights of wells and rivers to land owners, and allowed digging wells, as well as restricting access to private wells, legitimizing acquired water rights. Thus, the *Medjellah*, initiated the first privatization trend of *mushaa* land (Riachi, 2016, p.17).

The era of the French Mandate that followed the Ottoman rule cemented private property rights of water, and radically altered water management through the enforcement of three regulations *"1) land registration and the privatization of the*

collective land under mushaa, 2) the establishment of water laws, and in parallel; 3) the introduction of a hydraulic engineering paradigm" (Riachi, 2016, p.17). The water code enacted by the French Mandate recognized, through the Decrees 339, 1920 and 1930, (Riachi, 2016, p.17) the right of individuals on water, with a clear mention of the rights of digging pre-authorized wells on private property, stipulating that land ownership included both what is on the surface of the land and what is beneath it. Furthermore, the Decree 320/1926 allowed digging wells without permits if the depth does not exceed 150 meters, and if the well flow is below 100 m^3/day. The latter regulation continued through the irrigation boom in the 1960s and 1970s through the Decree 14438/1970, maintaining the right of digging wells without permits (under 150 m of depth, and below 100 m^3 of flow/day) disregarding the vast geological diversity across the Lebanese territory.

In recent years, the Decree 14438 has undergone changes in the licensing process of digging a well, under the order 118/2010. The latter order accords the technical inspection, reporting and processing of requests for digging wells, previously performed by the Ministry to three private companies, selected by the ministry of water and energy, on renewable yearly contract. According to Riachi, the latter changes were devised mainly due to shortage in geologist, hydro-geologist, and technical expertise in the Ministry, as a result of not hiring new staff, mainly due to political decisions (Riachi, 2016, pp.19-20). However, the general constraints regarding permits of wells have not changed, where permits are applicable for all wells over 150m in depth, and a yield exceeding 100 m^3/day. And despite the fact that reporting any nearby public water

springs or catchments are mandatory in the application process, often mistakes are found in the reports presented to the Ministry by the three private companies.

It is noteworthy that, since the enactment of the 118 order, the number of license requests has dropped from as much as 2,000 to 500, essentially due to the high costs of the process paid to the private company (between US$ 800-1, 000). Therefore, the digging of wells continues, and thus, the system in place, according to Riachi (Riachi, 2016, p.21) is contributing to the increase of unlicensed wells. The latter condition is exacerbated by the scattered responsibilities of monitoring, reporting and implementation of penalties on unlicensed wells, among several institutions, including the Ministry of Energy and Water as well as Ministry of Interior, with its various legal bodies of enforcement.

In 2000, a wave of reform in the water sector was initiated, through Law 221, which merged the former 22 local water offices into four regional water authorities. However, the institutional fragmentation still persists. The Council for Development and Reconstruction (CDR) is the chief governing body for large-scale investment projects, responsible for the allocation and channeling of funds, as well as tendering and management. However, the dispersion of duties and responsibilities continues between several institutions including the Ministry of Energy and Water (MoEW) with its two main directorates: (1) General Directorate of Hydraulic and Electric Resources (GDHER), and General Directorate of Exploitation (GDE); the Ministry of Interior and Municipalities (MoIM), the Ministry of Public Health (MoPH), Ministry of Environment (MoE), Ministry of Public Works and Transportation (MoPWT), the Ministry of Agriculture (MoA), in addition to the General Directorate of Urban

Planning, Municipalities and local authorities, who can, and have played an instrumental role in water management in some instances, yet, they remain systematically impoverished, as a way to keep the centrality of power among elect parliamentarians (Riachi, 2016, p.25).

The consecutive reforms (Law 221/2000, and NWSS, 2010) primarily focused on a shift to privatization and PPP, and their related structural adjustment. Both reforms elaborated on technical, fiscal and administrative issues related to water management, however, both schemes seem to have missed out on clarifying and coherently distributing responsibilities amongst the different actors, and overlooking ground water, while a vision that conserves and manages aquifers is still missing (Riachi, pp.27-28).

Another legacy governing the water management paradigm predates recent developments in the sector (Riachi, 2016, p.29). The supply sided vision that was prominent in the NWSS, involving massive investments in large scale water storage dams, and inter-basin transfers, was a continuation of a vision initiated during French Mandate era (1920-1943). This supply sided directive has continued since, and was only temporarily interrupted during years of unrest. However, Riachi points out that a shift of narrative occurred throughout these years, from a rhetoric of modernization of an under-developed country, with unfulfilled hydraulic potential, and led by colonial visionaries, to a rhetoric of an urgent response to a looming water crisis, resulting from climate change and population increase.

6.1.3 The Social Effects of Policy

In this section, I will examine the socio-economic effects of the reform measures that were performed in Lebanese water, and electricity sectors, as explored by Eric Verdeil. What is particularly relevant in Verdeil's findings is that they highlight policy tools and their complex social effects, beyond the mainstream readings of the sectarian and confessional system that has governed the country since the end of the civil war, and left undeniable traces. Verdeil explored reform policies in the main infrastructure sectors: electricity, waste and water, tracing the differing approaches the state have taken towards the latter sectors, making three crucial conclusions relating to the different dimensions of policymaking (Verdeil, 2017, pp.105-108). The first conclusion relates to the definition of service districts: in the water sector, the state has resorted to redefining boundaries along metropolitan lines, following principles of economies of scale, in order to incur greater revenue for operators. Secondly, there is a difficulty in tracing a fully-fledged liberalization trend in the services sector in Lebanon, despite the numerous ventures and exorbitant gains of the private sector in some domains. However, the failure of public-private partnerships, such as the water management contract in Tripoli, with Ondeo-Suez, have put on hold further attempts at privatization schemes, despite the political lobbying for privatization of services. The last strand of policy relates to funding. In the water sector, the operation cost and maintenance of drinking water is covered by lump-sum payments made by users. The lump-sum tariffs have significant social and environmental impacts, because they provide no incentive at all for water rationing, and the low consuming households indirectly subsidize the high consuming households. Verdeil concludes that the socio-

economic effects of policy tools, are still evident even if the institutions that made them are dysfunctional (Verdeil, 2017, p.107).

6.2 Practices

6.2.1 Civil War Practices and Legacies

In order to understand the phenomenon of hybridity as a response by the informal sector to the unmet needs of inhabitants by the formal sector, one must trace back its origins, during the period of the civil war and the post-war reconstruction in Lebanon. That period has led to the systematic weakening of the formal sector and the rise of the informal sector, leading to a general failure of the state, through its formal institutions. That failure can be explained along four main axes (Verdeil, 2017, pp.88-89). The first being the practices that were carried out by militias using infrastructure such as water and electricity as means of territorial domination, or reestablishing power balance by using infrastructure as tools to pressure their opponents. Thus, armed militias replaced the state, which in turn diminished its role of management and regulation of these resources. According to Verdeil:

> *" ...These practices shaped reconstruction plans. In these plans, the factors governing the development of power stations and water sources were not purely technical or financial. The plans also took into consideration how warring groups might control these resources if hostilities were renewed."*

Secondly, infrastructure networks suffered greatly from neglect, by both the state and the militias. Maintenance and investment in the infrastructure sector receded, despite the significant population increase of fifty percent during the war years, and the

substantial displacement of residents across the country, which redistributed the needs and pressure on infrastructure networks. The networks failed to meet the need of the country's residents, which explains the extensive rationing policies in the aftermath of the war. The third legacy that the war has created is the prevalent practice of illegal branching to public networks, or "theft" (Verdeil, 2017, p.89). The phenomenon was a result of the withdrawal of public actors, and their replacement by militias, the phenomenon also existed in informal settlements, where legal access to services was impossible. The fourth and last consequence of the war, according to Verdeil, is the emergence of the informal sector of service provision, for water and electricity. During the first half of the war, these informal services were owned and operated by individuals, and resident collectives. In the second half of the war, commercial enterprises for the informal services often supervised by militias and charging exorbitant prices, multiplied.

Rationing of services, and intermittent supply has continued persistently until the current day. Reliance on the informal network became a standard practice of residents for the reasons explored in previous sections. Several reform attempts by the national government have taken place in recent years, as explored earlier.

6.2.2 Water Reform, a Stalemate Situation

As such, the strengthening and flourishing of the informal water sector took place and reflected in the consolidation of a heterogeneous hybrid network of water supply. This hybridity has alleviated the formal institutions from a significant part of their duties for a number of decades, and filled the gaps of supply, much in line with

Roy's propositions (Roy, 2009, as cited in Ahlers *et al.*, 2014, p.5) that *" conditions for informality are often created by structures of formal governance, therefore, the boundaries between formal and informal are blurred, and highly contested and negotiated"*. However, the entrenched hybridity today is, in many ways, putting a hold on the implementation of the proposed reform. In fact, if we juxtapose on the one hand Verdeil's conclusion, that no clear traces of liberalization trends can be seen in the water management sector, with the predominantly neoliberal rhetoric in the NWSS, on the other hand, we can see the dichotomy between policy and implementation. Despite the dominant political interests and desire to neo-liberalize the water sector, through a series of structural adjustments, all assuming that the state is the pivotal actor in the water provision process, fieldwork findings indicate a high degree of hybridity and fragmentation within the network, and highlights multiple actors involved in the water provision reality that cannot be neglected. This paradox, among other conflicts of interests, and failures of the state, are leading to a status quo in further implementation of the NWSS. Thus, the very conditions of informality created by structures of governance have become an impediment to the implementation of the newly established water sector strategies, building on Roy's argument (Roy, 2009, p.81), that *"the states developmentalism has been held hostage by the very informality that facilitates Its transactions, so insurgence has been trapped by the very informality that gave it a place in the city."*

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary and Analysis of Findings

The question that drove this thesis was; is there water in Beirut, and if so, where is it? Fieldwork findings demonstrate the presence of water, yet they reveal the fragmentation and hybridity of water delivery, between various resources, surface and ground water, various networks, buried and mobile, and various institutions, formal and informal. Water does exist, and is consumed at relatively high rates, threatening future availability, especially in the light of continuing climate change, reflected in droughts, and diminishing annual precipitation rates. However, water volumes, prices, and quality vary widely between users, even within the same street. The real question should be: how can the water cycle be improved in order to establish efficiency and equity in distribution and consumption.

Water shortages, are especially visible in the public water service delivery, as seen in Jeanne d'Arc Street, where it falls short of fulfilling the needs of its residents on daily basis, especially during the summer season. The shortage in the water network pushes residents to resort to other networks and practices to meet their daily needs of water. Furthermore, the continued water shortage since the civil war was reflected in various practices by developers and contractors, as well as users, to increase access to water, including resorting to water cisterns, tampering public gauge meters, digging wells, and creating more elaborate water storage schemes, and water access points for

the informal water network. Many of these practices have become an inherent part of a building's infrastructure, resulting in disparity of daily access to water between buildings, especially between older and newer buildings.

The thesis reveals the high degree of reliance on cistern water for utility use, through the mobile network of trucks, although percentages of reliance on cisterns vary between buildings, and across different seasons. However, four facts related to water cisterns make addressing the issue on a national scale a vital matter: (1) cistern water is unregulated ground water; therefore, despite the dominant rhetoric of surface water supply augmentation, the reality on the ground is that the significant shortage of water is compensated by unmonitored extracted volumes of groundwater, that are supplied through informal networks, threatening the future availability of water if left to the existing chaotic extraction practices, (2) cistern water quality has very little to no monitoring, due to the high degree of informality in its network, therefore, in addition to its relatively high price per square meter, it bears a lot of externalities, especially related to water pollution and health, (3) the high degree of responsiveness, and reliability of the cistern's network is resulting in an increase in available volumes of water, thus altering and augmenting consumption patterns, in a manner that threatens the long term availability of water, and lastly (4) the traffic impacts of the water cisterns are especially visible on streets like Jeanne d'Arc, where density is high, and alleys are narrow to maneuver with such large trucks.

The thesis also demonstrates the high degree of hybridity of the water supply network(s), physical and institutional, existing within each network, as seen in the practices of residents to obtain more volumes of public water, and in the routes each of

the networks uses. The latter findings is crucial to acknowledge in future national strategies and policies related to water, as it sets a new premise for stakeholders, shadow partners and key actors in the water supply network. The documented hybridity in the study area is best described, as coproduction where neither network is sufficient on its own to meet the daily requirements of users and residents.

The thesis also highlights an important shift from a rhetoric focused on water crisis and scarcity to one concerned with social justice. The fieldwork demonstrates that injustice exists even within the same street, neighbors on Jeanne d'Arc Street pay different sums of money for the same amounts of water, as well as consume different volumes of water. The latter is a result of varying social practices across varying social spheres, and must be addressed as such, much in line with Jamie Linton's statement (Linton, 2014, p.114) that *"water is not the problem per se; rather all water problems are fundamentally social problems, and need to be addressed as such"*.

Water supply on Jeanne d'Arc Street also exhibits a high degree of informality, despite the formal setting of the street. This finding can lead policy along two axes; the first is opening new prospects of policy tools since it means that tools used in informal settlements can be applicable in formal settings. And secondly, it means that the role of the informal actors is more significant than just temporary and transitory. The current role of informal actors cannot be neglected, and despite its many negative consequences, the informal providers have established efficient networks, and have insights into consumption patterns due to the direct nature of interaction between supplier and user.

7.2 Concluding Remarks

Increasing public water supply, as proposed in recent water reform policies and NWSS, will help alleviate challenges related to water shortage that people are suffering from. However, increasing water volumes supplied to users on its own will not resolve issues of water distribution injustice, that are a result of ongoing practices by users and operators, and are overlooked by public institutions.

The assumption that increased water supply volumes will automatically delete other methods of water supply is also inaccurate, as seen in the research, since the supplementary networks, of water cistern, run a very lucrative sector, covering approximately 38% of the water market share. Shadow partners of water supply have flourished mainly as a response to a need, as discussed earlier. However, they have also thrived within a political atmosphere, and laisser-faire practices by public actors and institutions that implicitly allowed, if not encouraged, their existence. Therefore, water supply solutions that would not include them, at least as a transitional partner, are very likely to face challenges once applied on the ground. Any solution related to controlling and monitoring the water cistern network must be coupled with a new vision and legal framework related to private land property laws, especially relating to exploitation of groundwater.

Proposed solutions of water supply augmentation through a network of dams across the country, as elaborated in recent water reforms, seem to overlook some essential facts: (1) the karst geographic formation of most of the Lebanese territory, making dams a sub-optimal solution for water collection, (2) climate change, and the significant decrease in annual precipitation, (3) surface water collection, and how it can

be optimized instead of costly and environmentally taxing dams, by designing rain water collection pits, that can be used for irrigation (which represents a significant water expenditure in Lebanon).

It is important to look at the supply-sided directive in the Lebanese water reform, and more specifically the proposed series of dams proposed in the NWSS, within the larger circuit of capital it represents. As explained by Patrick McCully, large dams require massive funding, typically provided by international development banks, such as the World Bank, one of the key actors, that is keen to approve loans for large dams (McCully, 2001, p.258), because it means that large amounts of money will be circulating within the dam industry's iron triangle, composed of pork barrel politicians[27], engineering companies and consulting agencies and bureaucracies. Especially since large dams building has almost stopped in northern countries, aid agencies played a vital role, by extending access of engineering and construction companies of the north, to the "under-developed" south (McCully, 2001, p.255), and thus the statement (Fearnside, as sited in McCully, 2001, p.243):

> *"like the pyramids of ancient Egypt, these massive public works demand the effort of an entire society to complete but bring virtually no economic returns. Even if the structures are simply built and abandoned, they serve the short-term interests of all concerned- from firms that receive construction contracts to politicians wanting employment and commerce the projects provide to their districts during the construction phase"*

[27] The phrase "pork barrel" comes from the practice of Southern plantation slave owners; as they marked special occasions to their slaves by rolling a barrel of salted pork.

7.3 Recommendations for Planners

The fieldwork findings demonstrate the heterogeneity, complexity and hybridity of the water supply network on Jeanne d'Arc Street. Although the findings cannot be considered as representative of all of Beirut, or Lebanon, they do shed light on important issues and actors that must be considered for efficient policy and planning.

Proposing viable solutions for an issue that is so entangled and complex is not an easy task. However, I've aspired throughout this research to unveil as many of the different layers of the issue as possible.

Planners can play a key-role in creating a new imaginary for a more equitable and sustainable narrative of water reforms. Engaging in a debate about private property laws, for instance, that aims to acknowledge and preserve public rights within private property, in relation to ground water, might set new frameworks for ground water exploitation. Planners must also address the issue of shadow partners, creating schemes where they can be integrated within existing water provision, might alleviate over-consumption of ground water, and over-charging of users, through limiting informality. Planners can also play a pivotal role in the agriculture sector. Engaging with specialists to limit incidences of over irrigation, and resorting to land-use planning tools to designate rainwater collection pits, can contribute in resolving over-expenditure in the current water irrigation schemes. And lastly, planners are the best equipped to shift the social narrative to a more equitable one, allowing sustainable practices to replace old, short-termed ones.

In the following paragraphs, I will draw two scenarios: an ideal imaginary for water supply provision, and a proposed framework for action, under the current water supply conditions.

Building on the notion of water as a right, and not a commodity, potentially the best actor to play that role, in an ideal setting of a functioning state, is the public actor that would provide uniform water supply, and uniform pricing. Vision for water is developed on a national scale, in order to divide fairly between the different consuming sectors, and users. All water meters are inspected for any malpractices, ensuring that each gauge caters fairly to its subscribed users. If public institutions can perform efficient collection, and monitoring of free riders of the water network, high consumers of water may be charged at higher rates, to cross subsidize low water consumers. Much in line with water pricing in Iran (Biswas *et.al.*, 2001, p.110) where up to five cubic meter of monthly water consumption is exempt from any charge, water consumption of up to 25 m^3 is charged at the regular rate, water consumption between 25-45 m^3/month is increased by 25 percent, while water consumption above 46 m^3/month is charged with a 30 percent increase.

Involving private partners in the regulation of informal providers might contribute to better value for price, as well as limit externalities. Learning from the case study of Gaborone, Botswana (ref. section 2.6.2), and the case study of Sangam Vihar informal settlement in New Delhi (ref. section 2.6.3), as well as the case study of Maputo, Mozambique (ref. section 2.6.4). Although there are no industries or large businesses on Jeanne d'Arc Street, there is, however, a large number of hotels and furnished apartments, that rely on the Street's central location, therefore they can be

included as one of the two main groups having high stakes (alongside residents). While both groups seeks good quality water, for a lower price, the residents place more importance on water quality, while the hotels give more weight to better prices. Given that the role of cisterns cannot be discarded quickly, a neighborhood/ street -scale association composed of representatives from both home owners/ tenants of residential buildings and hotels can play a role in improving service and controlling water quality and price, building on some of the tools and frameworks outlined in the case of Sangam Vahar, and Maputo. The role of such an association is aimed to address three main challenges documented through the field work: (1) The disparity of price per cubic meter; this is especially the case for smaller and older buildings, where residents need smaller quantities of water, and typically pay much higher prices; the association will help group these buildings, in a way that one large truck can fill up for several buildings at once, which will also have positive impacts on traffic. (2) Since no testing is performed on cistern's water, the association can provide regular water testing, in order to identify suppliers providing the best quality. (3) Traffic, the large number of trucks circulating the street at most hours of the day is one the challenges identified; once all required trips of water cisterns are scheduled with the neighborhood association, cistern trips can be organized at late hours of the night, or early hours of the morning, to minimize their impact on traffic.

Contractors and developers can be perceived as part of the solution in addressing water challenges. Although they are profit-seeking and have contributed to the problem in many ways, however, they are also the most receptive to market needs, and the most adaptive, as they need to ensure their buildings lures investors, and buyers.

As seen in the fieldwork, all medium and new buildings (basically buildings constructed during or after the war) accommodate for a designated cistern gauge, and storage capacity is also significantly increased throughout the years. Additionally, new buildings also developed new routes for water within the building, as seen in JD 233, separating drinking and utility water thus isolating cistern water in a separate network, and leaving the drinking water clean. The examples indicate the sector's high adaptability to user needs. By shifting the narrative to a more demand-conscious one, several improvements can be made to the internal network of water. For example, prolonging the life cycle of water within the building, through the reuse of grey water within the building, either for general cleaning or irrigation. Another possible improvement is separating utility and drinking water networks within the building, in which case residents can rely on public water for their drinking and cooking needs, since the public water quality is acceptable, with potentially the need to add a simple filter to the kitchen sink, which can significantly minimize the consumption of bottled water. This shift in conception of the building's infrastructure can be nudged through means of policy related to building regulations and permits procedures, through certain exemptions for buildings that do incorporate grey water reuse within buildings, and that create separate dinking/ utility water networks. This would mend the gap between urban planning and water planning, identified in the case study of Gaborone (ref. section 2.6.1) through simple measures. On the other hand, the Neighborhood Initiative at AUB can play an active role of educating and informing the residents of the many benefits of grey-water reuse and minimizing water consumption.

7.4 Suggestions for Further Research

Lastly throughout my investigation on how the residents of Jeanne d'Arc Street secure their daily water, several other issues surfaced throughout the research, I will be listing below a number of issues that need further investigation and research.

- Water charges and feasibility studies regarding IBT. While the literature data is contradictory on the usefulness of IBT, a context specific feasibility study can shed light on the effectiveness of such measures.
- Regulatory frameworks: The feasibility of a neighborhood association to regulate cistern water price, circulation and quality needs a survey that can be designed in a way to investigate user's willingness to pay for the association fees, in return of improved quality of water, and decreased price.
- Water quality: Surveys of wells along Jeanne d'Arc Street, as well as water quality surveys of the public network at different points along the street can be conducted, especially that most residents report salinity of water, and it is worth investigating the source of the water salinity.
- Water Storage: A cost benefit analysis of the varying water storage schemes can be done, in order to determine the ideal balance between water supply hours, and storage schemes within the building.
- Grey-water reuse: operationalizing the concept of grey water reuse within building, especially in the case of existing buildings, and creating cost-efficient solutions to integrate additional water cycle within the building is also worthy of further study.

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