AMERICAN UNIVERSITY OF BEIRUT

RECLAIMING RIPARIAN LANDSCAPES: THE CASE OF AL-GHADIR RIVER IN SOUTHERN BEIRUT

by
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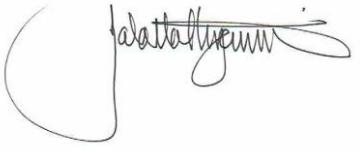

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AN ABSTRACT OF THE THESIS OF

Mariam Kassem Bazzi for Master of Urban Design
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Title: Reclaiming Riparian Landscapes: The Case of Al-Ghadir River In Southern Beirut

Al-Ghadir River is one of the smallest rivers in Lebanon. It extends from its headwaters in the mountains of Aley to the Mediterranean Sea. In the 1950s, the landscape was predominantly agricultural, the river a destination for local promenading. However, the rapid urbanization, which took place in Beirut's southern periphery, has caused radical transformations to the watershed. Anthropogenic influences have modified the natural riparian environment resulting in a degraded landscape of unregulated village expansion, industries, and informal settlements. Chaotic urban expansion and industrial waste discharge into the river have alarming repercussions on people and the environment. With these changes to the watershed, Al-Ghadir no longer supports agriculture, nor does it serve as an amenity destination. Today, Al-Ghadir river is a degraded landscape and environmental health hazard to the inhabitants of the settlements.

This thesis investigates these issues from a multidisciplinary lens taking into account that the river is a complex integrated system the embraces hydrology, ecology, and culture. The aim is to reclaim Al-Ghadir river and restore its value as a healthy environment and amenity landscape. An ecological landscape methodology was applied at three different scales: the watershed scale, the river-corridor level; and the settlement level. The outcome is a vision for a sustainable watershed, ecological landscape planning strategy for the river corridor, and an urban landscape design intervention at the settlement level. The design intervention strives to transform Al-Ghadir's degraded canal into a public space that caters to the people of the settlement and restores the ecological value of the river.

This thesis addressed a very timely environmental issue that is threatening the quality of living in the proximity of coastal rivers in Lebanon. By providing environmentally sustainable and socially responsive strategies, this research could then act as a prototype for rehabilitating abused riparian landscapes.

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INTRODUCTION

1.1. Overview

1.1.1. Historical Evolution of Al-Ghadir River Landscape

Al-Ghadir River is one of the smallest rivers in Lebanon, located in the southern Beirut area. The proximity of the river to the capital city played a crucial role in shaping its landscape throughout history. Before the 1950s, the landscape of the river basin was predominantly agricultural. Olive groves dominated the coastal area, the Sahraa Al- Choeuifat, while fruit orchards and vineyards were present in the mountains upstream. Sahraa Al- Choeuifat was known for its high-quality olive oil, which is very much alive in the collective memory (Bou Akar, 2012).

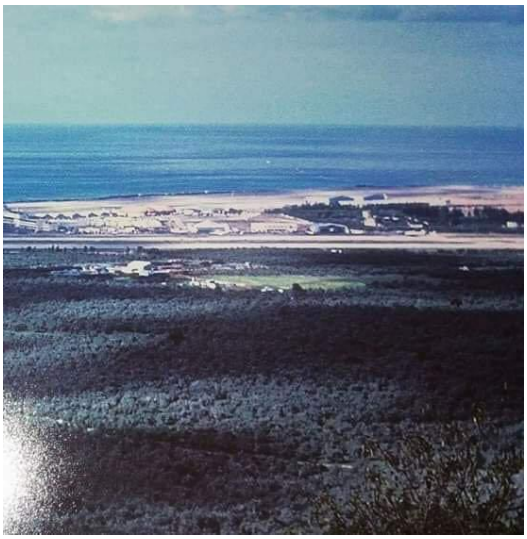


Figure 1. Olive Orchards in Choeuifat (1960s)
Source: A resident in Al-Ghadir settlement

The elderly of Kfarshima recall Beiruti families gathering at the edges of the river on the weekends. At that time, the village was known for its agro-industrial activities. Watermills for wheat and olive pressers dotted the riverbanks.

The major shift started taking place at the coastal area as a result of two fundamental changes: (1) urban-rural migrations of families from the Beqaa who settled in Sharaa Al- Choeuifat starting the 1950s (Fawaz & Peillen, 2002) and (2) the classification of Choeuifat and Kfarshima as industrial zones in the Ecochard's plan of Beirut Greater Area (Institut français d'urbanisme, 1963). As a result, large factories were established along the river. Since then, industrial activities have intensified, slowly transforming the river landscape.

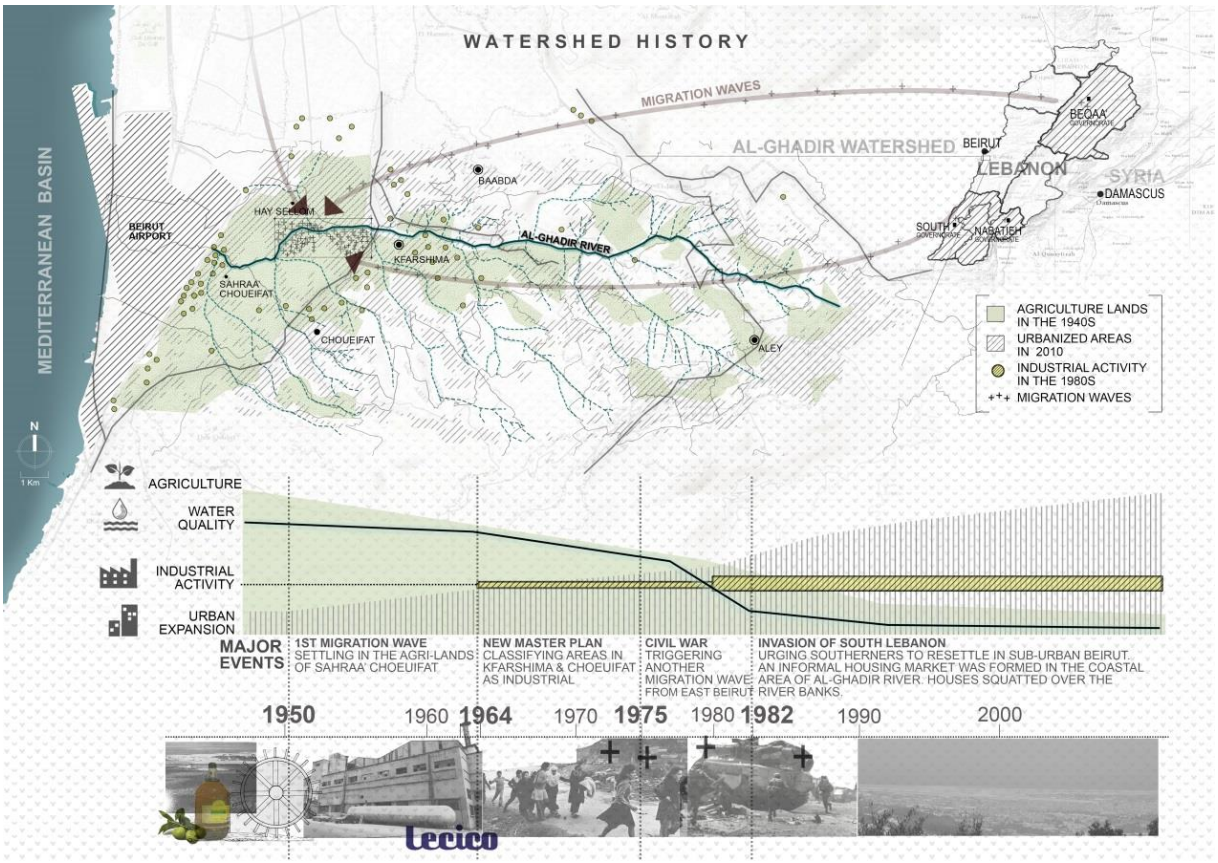


Figure 2 The History of Al-Ghadir Watershed
Source: By author

During the Lebanese Civil War (1975-1990), families fled the Beqaa to the peripheries of Beirut in successive waves seeking employment opportunities (Fawaz & Peillen, 2002). Rural migrants occupied the area in the vicinity of Beirut's airport through

an informal mode of urbanization (Fawaz & Peillen, 2002). Soon, this area started to attract low-income families seeking access to housing. Due to many different occasions of warfare in 1976, 1978, 1982, several flocks of war-displaced people followed (Fawaz,2000). These factors contributed to the establishment of a housing market in Al-Ghadir settlement.

Unregulated urban expansion caused houses to encroach over the river corridor, transforming the landscape into a chaotic informal urban setting. Similarly, the industrial zones expanded to reach the river edge imposing severe environmental threats on the river and its surroundings. In addition to this, a strip of garages occupied the riverbanks near the industrial zones. They also contributed to the pollution of the river.

Figure 3 River Channel in AL-Ghadir Settlement Source: By author

Figure 4 River Channel in Kfarshima Industrial Zone Source: By author

1.1.2. Contemporary challenges and approaches to riparian landscapes

Al-Ghadir River is one of the many cases in the world where riparian landscapes are facing dire situations due to challenges of human activity and climate change. In this discourse, many have supported a holistic perspective of riparian rehabilitation that addresses ecological health issues, hydrology, and open space collectively, as an integrated system. Connectivity is a key concept that integrates the

layers and stitches elements of the riparian system. In parallel, interdisciplinary approaches are highly advocated as the complexity of riverine systems requires contributions from design, engineering, planning and policy, ecology, and hydrology.

1.2. Thesis Position

1.2.1. Research Problem

Al-Ghadir River suffers from the natural and anthropogenic disturbances which have occurred over the last 50 years. The impact on the riparian system and the surrounding environment has led to the current situation where the river is subject to pollution, abuse, and neglect. This research defines three main issues that anchor the problem of Al-Ghadir River.

A. <u>The morphological modification of the river channel and riparian zone leading to a deterioration of the river ecology</u>

The alteration in the physical character of the river is the main factor in the hydrological dynamic. This factor includes blockage of tributaries, shrinking the active floodplain in size, and decreased streamflow. The radical land-use changes, mainly the reduced vegetative cover and the dense urbanization, led to a significant alteration in the runoff quantity, velocity, and patterns. Consequently, this has caused an escalation of flooding every winter. Another hydrological aspect is the deterioration in water quality caused by industrial waste discharge and the informal dumping of solid waste into the river. The industrial compounds along the river lack sustainable waste treatment systems. Despite the mitigating procedures followed by some of these factories, most of them are insufficient. Organic, physical, and chemical

pollutants are discharged by underground pipes directly into the river damaging the riparian ecology. This damage is evident in the deterioration of flora and fauna quality and diversity and the physical character of the river. The river now harms urban health and compromises the wellbeing of riparian species.

B. The altered role of the river from a natural landscape to a neglected waste dumping site, thus entirely losing its cultural value.

As a result of land-use changes which took place and the deteriorated environmental conditions aforementioned, Al-Ghadir River lost its significant role as a landscape amenity and a communal open space. Not only does it no longer serve as a destination for recreation, but also it does not benefit agriculture as its water is no longer safe for irrigation. Moreover, the recurrent flooding is imposing an enormous threat to the houses along the river. Damages to these houses and infrastructure were recorded during the latest flood events. In addition to that, the leaking of polluted water to the houses and the exposure to the dumped waste is causing a serious health threat to the dwellers.

C. The disorganized institutional set-up through which the river system is managed, leading to temporary problem-solving rather than a comprehensive approach to the river problem.

The river system is currently managed through multiple municipalities, each in charge of a segment of the overall watershed. Therefore, each one of these

localities deals with the river in its local dimension rather than as an integrated, connected system. This compartmentalized approach is exacerbated by political tensions between different municipalities. Failing to realize the need for an integrative approach to managing river systems, impedes efforts to overcome the current problems of Al-Ghadir.

1.2.2. Research Questions

This thesis investigates the case of Al-Ghadir River through an ecological approach. This approach constitutes the ecological integrity of the river, design, and planning of the system, and the institutional scheme governing this system. The thesis aims to explore the ecological landscape methodologies in planning and design and come up with strategies that are environmentally sustainable and socially responsive. As it responds to the research problem, the thesis raises the following primary question and three minor questions:

How can the application of the ecological landscape approach help in reclaiming AL-Ghadir River as an ecological corridor and active public space?

1. How can the ecological landscape planning of the river ensure the integrity of the fragmented riparian landscape ecologically, environmentally, spatially, socially, and economically?

2. How can a landscape design improve environmental health and transform the degraded river segment in Al-Ghadir Settlement into a multi-functional public space?

3. What is the institutional framework that could be adopted to facilitate the governance and maintenance of Al-Ghadir River?

The hypothesis was that a holistic ecological landscape approach could provide a strategy that would bring back the vital role that a river can play, given its high ecological and cultural value. Adopting this approach to the context of Al-Ghadir can help in providing planning and design recommendations that would abolish the hurdles standing against the environmental sustainability of the site.

1.2.3. Research Significance

This thesis investigated a very timely issue of environmental deterioration that is affecting the quality of living in Al-Ghadir area and many other cases around the world. As our globe is suffering from the drawbacks of climate change, it is expected that such cases will become more pervasive. This project would then present itself as a model for dealing with deteriorated watercourses through a comprehensive approach. This model is distinguished by its interdisciplinary framework that deals with the complex riparian ecosystem from a hydrological, ecological, and cultural perspective. Moreover, this thesis takes the challenge of bringing in open spaces to a less privileged community by reclaiming the overlooked and neglected spaces around the edges of the river. Consequently, the thesis would be advocating for the notion of green justice and the "right to the landscape" to everyone.

1.3. Thesis Methodology

The research methodology applied the principles of the Ecological Landscape Planning and Design over the case study of Al-Ghadir River. This methodology incorporated strategies and guidelines applied over 3 scales: The watershed scale, the corridor-level scale, and the urban design scale at the level of the settlement. At the level of the watershed, the adopted methodology used the concept of Ecological Landscape Associations (ELAs). This concept has helped in constructing a holistic understanding of the landscape and informed the research about the essential entities that form the landscape mosaic.

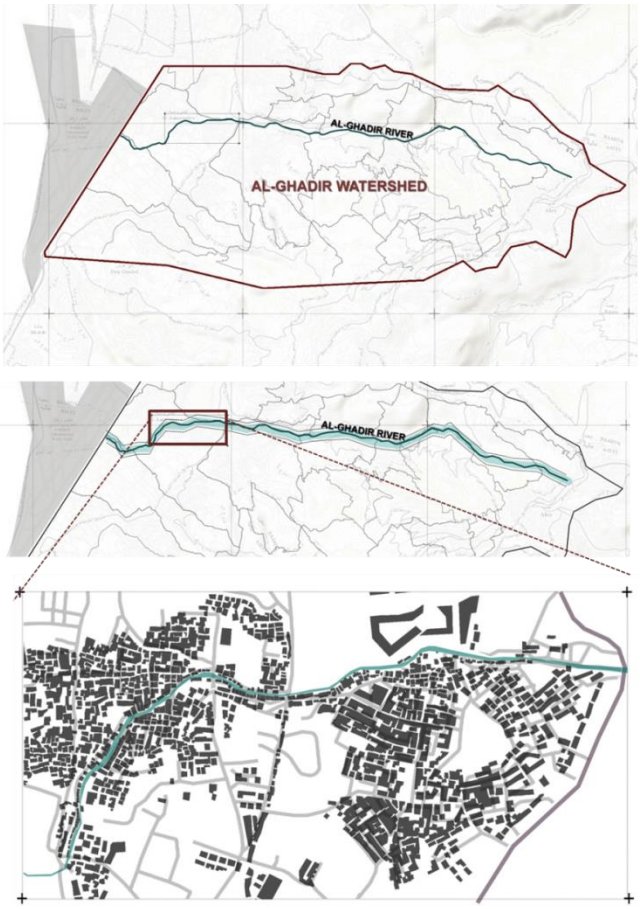


Figure 5 The scales of Intervention
Source: By author

Moreover, urban and landscape planning analysis was conducted to identify the abiotic, biotic, and cultural components of the landscape. At the corridor- level, the methodology applied guidelines in urban planning and ecological design. The aim was to create a continuous green corridor that stitches the urban, ecological, and hydrological features of the river. Finally, at the level of the informal settlement, the methodology applied the principles of urban landscape design. The aim was to come up with an engaging riverfront that celebrates the cultural and ecological value of the river.

The research went through a data collection phase in order to apply the methodology, starting with archival research. The research reviewed historical material of AL-Ghadir River from the early 1900s until recent years. They include topographic army maps, remote-sensing images, land use maps, and forest coverage maps. Those maps were used to document the changes that happened to the landscape, channel pattern, and infrastructure. It further helped in assigning the different ecological landscape associations (ELAs) present in Al-Ghadir River, which later helped in the watershed strategy. The hydrological analysis also required looking back on precipitation records and climatic documentation.

The second research method is the field survey across two areas: Al-Ghadir watershed, and Al-Ghadir Settlement. The first field survey aimed to have a broad view of the landscape typologies present in the watershed. The survey consisted of mapping the biotic features of the landscape (fauna and flora species, patches, and corridors) and taking photographs. The second field survey, however, was more thorough as it carried a detailed mapping of the settlement. This survey included the built environment and the infrastructure (buildings typologies, streets, and sewage networks), the socio-economic practices, and land use. This field survey also included interviews with the slum dwellers. The purpose of these face-to-face interviews was to understand the current situation of the river from the resident's perspective and note the people's perception of Al-Ghadir's value and their expectations from any rehabilitation project that could take place.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

Rivers are essential elements of the urban system as they provide the necessary vital resources and services crucial for human existence, including food, water, and transportation links (Francis, 2012). Therefore, they hold a significant ecological and societal role within the larger urban systems (Francis, 2012). In a broader landscape, streams and river systems perform as corridors of unique significance (Forman et al., 1996). They are considered among the most remarkable environments due to their rich ecology, diversity, and aesthetically pleasing sceneries (Marsh, 2010). In many semi-arid regions, more than half of the population lives within a one km buffer from the river, which becomes an asset in their daily life (Naiman et al., 1993). Researchers have developed a great interest in rivers as ecological networks that possess social and environmental benefits (Dempsey et al., 2018). In addition to their recreational benefits, they regulate water flow, improve climatic conditions, and help in carbon sequestration (Dempsey et al., 2018).

Unfortunately, riparian landscapes are the most degraded and misused (Marsh, 2010). In addition to natural disturbances, anthropogenic disturbances have affected riparian systems tremendously (Naiman et al., 2005). Human activities have a significant role in the transformations taking place at the aquatic and terrestrial levels (ibid). The fragmentation and loss of habitat are the main consequences of land-use change resulting

from these actions (ibid). Therefore, understanding riparian systems from a human's perspective is essential to develop a sustainable model of riparian systems balancing between nature and culture (ibid).

In the twentieth century, approaches to river reclamation focused on one aspect of the problem, mainly in the structural part of the river, with less interest in ecology and recreation (Downs and Gregory, 2014). However, in recent literature, many have supported a landscape perspective of riparian system reclamation, which takes into account the relationship between living beings and their environment, including man and nature (Naiman et al., 2005). Many disciplines have participated in establishing a radical shift in the methods of river basin analysis and management (Downs and Gregory, 2014). This section aims to provide a profound analysis of riparian systems and their influences on their hydrological, ecological, and cultural contexts. It will investigate the contemporary approaches to river reclamation and management influencing design, engineering, planning, and governance.

2.2. The Hydrological Dimension in Riparian Landscapes

Riparian systems are dynamic and transitional zones constituting heterogeneous habitats, robust energy systems, and diverse ecological dimensions (Naiman et al., 2005). They are semi-terrestrial zones shaped by freshwater. A riparian system extends over the surface area between the edges of the water body to the communities upstream, and it is usually defined through its hydrological, ecological, and cultural context (ibid).

From a hydrological perspective, size, geomorphology, biotic arrangement, and climate distinguish different draining catchments (ibid). Catchments are also referred to as watersheds or drainage basins. The following section explores the components of a drainage basin, approaches to river channel classification, river channel hazards and stress, and the river continuum concept.

2.2.1. Drainage Basin Components

2.2.2.1. River channel

A river channel is a linear feature along the valley floor, where water flows in a natural manner (Downs and Gregory, 2014). Two essential elements of a river channel are "channel equilibrium" and "stream-flow" (Otto et al.,2004). They are both interdependent, in the sense that if one variable changes, the other will adjust itself to reach equilibrium (Otto et al.,2004). In the case of a storm-water surge, the increase in stream-flow will cause an increase in sediment load in order for the channel to maintain equilibrium. The erosion caused by a channel seeking equilibrium justifies the need for free space around the river for a channel to adjust freely (Otto et al.,2004).

2.2.2.2. Floodplain

A floodplain is the valley floor in which the river channel rests. It is essential to distinguish between the genetic floodplain and the hydraulic floodplain. The former being the landform near the channel made up of alluvial deposits, while the latter being the area flooded at least one time during a return period (Downs and Gregory, 2014).

A floodplain plays a significant role in storing flooded water, enhancing the quality of water, sustaining river wildlife, and providing recreational space (Otto et al.,2004).

2.2.2.3. River corridor

The river corridor includes the linear landscape elements adjacent to the river channel. The width of the corridor may vary. It can include the whole floodplain if not restricted by human activities (Downs and Gregory, 2014).

2.2.2.4. Drainage network

The drainage network encompasses the system of a stream and river channels in a particular basin (Downs & Gregory, 2014).

2.2.2.5. Drainage basin or catchment

The drainage basin or catchment is the area of land which accumulates all the surface runoff through the drainage network (ibid). Topographic ridges, called channel divides or watersheds, frame each catchment (Naiman et al., 2005). All runoff water drains into the same point in the river channel (ibid). In the USA, river basins are used for large areas, while the term watershed is used for small-scale basins.

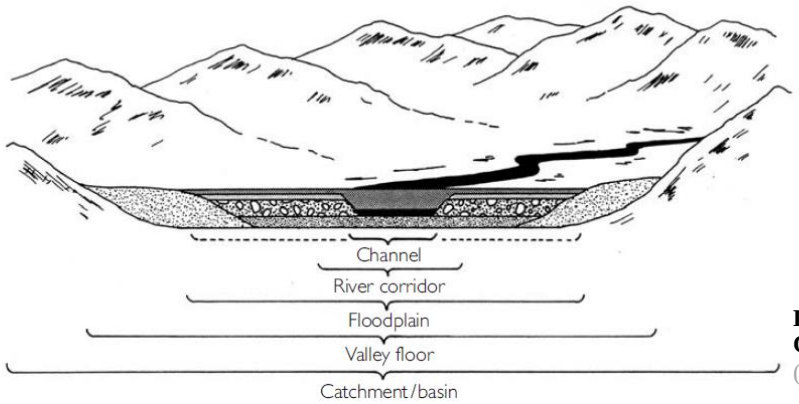


Figure 6 Drainage Basin Components Source: (Downs & Gregory, 2014)

2.2.2. River Channel Classifications

Understanding the different typologies of river channels and their arrangement in the basin is basic to understanding the functionality of the river (Downs and Gregory, 2014). Its categorization is essential in river channel management because each typology of channels has its potentials and reclamation rate (Downs and Gregory, 2014). According to Downs and Gregory (2014), a river channel classification should adopt a holistic approach that encompasses all characteristics of the river channel (channel pattern, river ecology, and morphology), and at a catchment scale. It should also acknowledge river channel processes taking seasonality and the short-term channel dynamics into consideration (Downs and Gregory, 2014).

2.2.3. River Hazards and Stress

Ideally, in native riparian systems, the natural distress that occurs causes temporary changes to the system (Naiman et al., 2005). Rarely does it create permanent damage, and the system acclimatizes to the new conditions through an instant recovery phase (Naiman et al., 2005). However, stress caused by anthropogenic disturbances may have devastating repercussions on the system, which may not heal completely (Naiman et al., 2005). In response to these hazards, which pose possible threats to human wellbeing, emphasis on river channel management was made (Downs and Gregory, 2014).

River channel management depends on a river hazard assessment. For this assessment to take place, channel adjustments are thoroughly studied (Downs and Gregory, 2014). There exist three types of river hazards, according to Downs and Gregory (2014):

- The disastrous event, occurring suddenly, caused by an excessive channel widening following a storm-water surge
- The gradual alteration of the channel leading to an abrupt change
- The gradual alteration of the channel which has relatively slow consequences

Urbanization, a major anthropogenic disturbance agent, has a significant effect on stream hydrology (Otto et al.,2004). First, it amplifies the peak flow in contrast to predevelopment conditions (ibid). Second, urbanization amplifies the volume of urban runoff during a storm event, and it shortens the duration needed to join the stream (ibid). Third, it causes recurrent flooding, and it intensifies its harshness (ibid). Forth, as it decreases the level of water infiltration in the catchment, it causes a decrease in stream-flow during dry weather conditions (ibid). Finally, those effects collectively cause a surge in the runoff velocity during storm events (ibid).

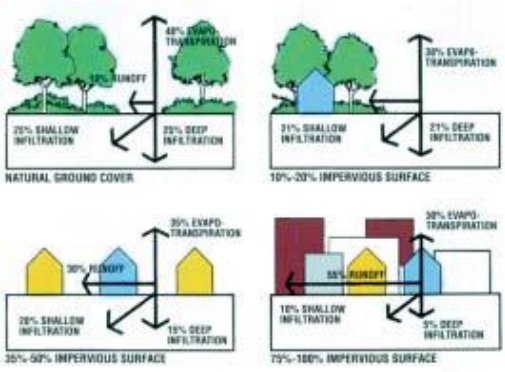


Figure 7 Effect of Urbanization on Stream Hydrology Source: (Otto et al.,2004)

Forman (2014) identified the main conditions and central features that affect urban streams. It is ideally influenced by three major conditions: water quality, water quantity, and channel habitat conditions, which may be affected by local or watershed conditions (Forman, 2014). Therefore, the quality of water on a certain site along the stream may be affected by a sewage pipe directed to the site.

2.2.4. The River Continuum Concept

The implicit notion that a river channel is a steady, single-thread channel from headwaters to the sea may undermine the interaction of fluvial components in lotic ecosystems and dismiss the lateral or transverse aspect of riparian systems (Downs and Gregory, 2014). In contrast, the river continuum concept embraces the connectivity of river systems and the holistic view in which they are studied (ibid). This concept views rivers from a four-dimensional perspective, including:

- The longitudinal continuity of the river from the headwaters to the sea (ibid)
- The lateral continuity from the aquatic to the terrestrial stressing on the connection between the system components (ibid)
- The movement in the stream-flow incorporating the water flux and sediments (ibid)
- Time highlighting the gaps that can occur during channel processes (ibid)

2.3. The Ecology of Riparian Landscapes

Vigorous rivers, along with the riparian zones linked to them, are "complex interconnected corridors" that facilitate the distribution of biota and making them better suited to the environment (Naiman et al., 2005). They are ideal places for "dispersal," which is a biological phenomenon of faunal and floral populations finding the suitable place where their necessary resources are present (Naiman et al., 2005). Migrating birds, for example, found in riparian zones a navigational tool, a place for a stopover, and a habitat for nurturing their broods (Naiman et al., 2005). Additionally, river banks are

ideal environments for plants that are adapted to flooding (Naiman et al., 2005). They form intricate vegetative patterns varying according to soil and hydrology (Naiman et al., 2005). The following section highlights the notion of rivers as ecological corridors and the contemporary concept of infrastructural landscapes.

2.3.1. Rivers as Ecological Corridors

The concept of ecological networks and greenways are two key concepts introduced by Ecology based on research in conservation biology and landscape ecology (Makhzoumi and Pungetti, 1999). These concepts focus on the importance of connecting fragments of protected landscapes to build a system (Makhzoumi and Pungetti, 1999). Therefore, they represent a shift from traditional conservation techniques that were focused on conserving isolated sites and species (Makhzoumi and Pungetti, 1999). Green corridors stand out as they cut through urban areas (Forman, 2014), and have a significant appealing effect on urban and rural settings (Makhzoumi and Pungetti, 1999).

2.3.2. Rivers as Infrastructural Landscapes Embracing Ecology

In urban contexts, it is crucial to understand the river ecology as part of an interconnected system that formed along with infrastructural systems. Before modern ecology, urban streams were nothing but a part of a storm-water drainage system. Their water transported all kinds of wastes, effluents, and human wastewater from commercial areas, industrial zones, and urban settings (Forman, 2014). With the advent of landscape urbanism, the intertwining between infrastructure and the natural system became highly encouraged. This notion was brought together through the definition of landscape infrastructure. According to Crezniak (2013), landscape infrastructure aims to bring in line both the ecological and social dimensions into a technical and logistical scheme that

mimics nature. For infrastructure to become landscape, it has to be a stimulator of new forms of interaction; it should reduce marginalization and segregation, and effectively integrate territories (Hung, 2012). This process could only be achieved through merging architecture, mobility, and landscape. Therefore, it leads to the formation of new infrastructural systems, which should be redefined through a set of new standards that bring in "natural systems of ecology" (Hung, 2012). Similarly, Richard Weller describes the landscape as a space where "ecological transactions" take place (Czerniak, 2013). Moreover, landscape infrastructure embraces the notion of multifunctionality, where infrastructure can provide pedestrian movement, water management, and ecological services (Hung, 2012). The aim is to provide useable landscapes with new functions while taking into consideration their local context (Hauck and Kleinekort, 2011).

2.4. The Cultural Significance of Riparian Landscapes

Riparian systems, being landscapes, hold both natural and cultural meanings. People perceive them differently according to the social groups they belong to (Naiman et al., 2005). This conception explains the evolving perception of these landscapes with time (Naiman et al., 2005). Rivers are a combination of landscapes that we know, make, feel, and believe (Naiman et al., 2005). This section highlights the importance of the social and cultural connectivity of rivers.

2.4.1. The River Culture

In recent literature, a "river culture" represents the notion where the hydrological, biological, and cultural uses of the river meet to ensure the ecological and cultural diversity of rivers (Kondolf and Pinto, 2016). Connectivity is the critical term now used at many different layers. Besides the hydrological and ecological integrity of a

river, urban designers and politicians used it to ensure the accessibility of riverfronts to people (May, 2006).

Traditionally, at regional scales and across continents, the longitudinal connectivity of rivers was essential for transportation, navigation, and land exploration (Kondolf and Pinto, 2016). Later, it became an asset for commerce as the sizes of canoes developed to become diesel-powered ships (Kondolf and Pinto, 2016). On a local scale, in addition to the longitudinal connectivity, there has been lateral and vertical connectivity manifested in the development of the riverbanks for public use (Kondolf and Pinto, 2016). More frequently, in the Global South, these riverbanks were used for multiple purposes from fishing, washing clothes, recreation, and swimming (Kondolf and Pinto, 2016). These crucial interactions between humans and water rendered the health and wellbeing of riparian residents contingent on the health of the river (Kondolf and Pinto, 2016). Their aesthetic value, as well, depended on the water quality. Many rivers, especially in the Global South, are suffering from many difficulties regarding sanitation and the unequal access to streams (Kondolf and Pinto, 2016). With time, the social role of rivers changed as they responded to myriad influences from political decisions, economic trends, and social practices.

2.4.2. Rivers as Public Destinations

In urban contexts, the main issues which planners are concerned with are making the rivers accessible to people, especially in the densest urban areas, and linking them to the city, whether visually or conceptually (May, 2006). For this, they create bridges, pedestrian pathways, greenways, and riverfront destinations (May, 2006). They aim by this to develop social and cultural destinations for city dwellers (May, 2006).

However, the physical scale of the river, as compared to the city, affects the functionality of the river. Bridging over a small creek is relatively less challenging than that on a larger river, which may impose engineering challenges. Narrow streams may still allow communication of people from opposite sides across the river (Kondolf and Pinto, 2016). Those rivers, most often, have been brutally encroached over or channeled to become small canals between buildings. Sometimes this makes it impossible to intervene in the riverbanks or to establish a continuous walkway. Restoration of riparian systems in these cases becomes limited as the range for flood management resolutions becomes reduced (Kondolf and Pinto, 2016).

Enhancing the social and cultural connectivity in contemporary design approaches to riverbanks sometimes is contradicting with the hydrological and ecological connectivity of riparian systems (May, 2006). These approaches focus on human interaction with water, which necessitates bridging over the river, crossing over the banks, embankment of the river, and landscaping for the aesthetics regardless of the wildlife (May, 2006). Although sometimes these approaches represent a thriving social and culture model, from an ecological perspective, they remain poor (May, 2006).

2.5. Reclaiming Riparian Landscapes

In light of the myriad contemporary issues challenging riparian landscapes, many disciplines have been studying methods and approaches to river reclamation. These approaches influenced science, engineering, planning, and design, and advocated for an interdisciplinary contribution to the reclamation of riparian systems. The following section explores the landscape perspective of the riparian system, the integrated

watershed management approach, the principles of urban riverfront design, and the governance of river basins.

2.5.1. Planning for a sustainable Ecological system

Naiman et al. (2005) advocate for the landscape perspective of the riparian system; it is an approach that constitutes two notions. The first is that the spatial arrangement of species affects their relationships with their environment, thus demanding a clear understanding of the processes that determine the dynamics of populations, communities, and ecosystems (Naiman et al., 2005). The second is that social dynamics cannot be dissociated from nature. Therefore, an interdisciplinary approach (including geography, history, anthropology, economy, and sociology) is necessary to assess the spatial organizations and humans (Naiman et al., 2005).

Naiman et al. (1993) also state that the significance of riparian corridors should influence science and policy. Maintaining the ecological connectivity of riverine systems from the headwaters to the sea is the broad-scale strategy that should be adopted by planners (Naiman et al., 1993). Issues related to species biodiversity, sustainability, and water quality should be the main concerns for decision-makers (Naiman et al., 1993). To do so, they should take several considerations into account. First, they should acknowledge the fact that the environment is an effective user of water; therefore, disturbances on the hydrologic systems should be controlled. Second, an alteration in the water flow can damage the ecological system. Finally, it is crucial to balance between the short-term human water needs and the long-term water needs vital for humans and riparian corridors (Naiman et al., 1993).

2.5.2. Integrated Watershed Management

River channel management, which started first in the nineteenth century, was focused solely on river training (Downs and Gregory, 2014). It was followed by river discharge regulation in the twentieth century, which was attained through the construction of dams, weirs, and channelization schemes (Downs and Gregory, 2014). Therefore, the typical aim of river channel management was regarded from the lens of flood protection and water supply. It was focused mainly on the problem-solving of one particular issue, regardless of the whole context (Downs and Gregory, 2014).

Several scholars described the need for an alternative approach that is holistic -incorporating the whole river basin. Downs and Gregory (2014) explain the reasons behind this. First, focusing on one problem, usually over one section of the channel, leaves behind several impacts on other parts of the river, such as pollution or flooding. Second, dealing with river issues separately causes a lack of coordination between the legislative bodies. Third, the inefficiency which came as a result of targeting problems such as flooding, erosion, navigation independently, and the pressure exerted by the anthropogenic influences in floods, increased water demand, regulation of flow necessitated a new integrative approach. Similarly, Naiman et al. (2005) stated that maintaining riparian landscapes is a sophisticated approach that necessitates the integrity of the system across many levels. Riparian zones need to be addressed as systems where conservation and development are incorporated together (Naiman et al., 2005).

The notion of integrated river basin management has been reflected through different terminology depending on the disciplines involved, the nature of the approach, and the institutional framework adopted (Downs and Gregory, 2014). Through the

analysis of different frameworks of river basin management adopted across 20 years, the term integration was used to reflect the unification of different objects in the river basin "in the sense of complete by the addition of parts" (Downs and Gregory, 2014). An integrated river basin management requires considering the basin as an ecosystem. A successful management scheme adopts the following recommendations at a basin-scale:

- Conserving or enhancing the role of the river before the disturbance or degradation, its natural value
- Preservation of the basin's wide-ranging functions
- Enhancement of the basin's environmental health
- Setting regional planning guidelines

2.5.3. Urban Riverfront Reclamation

In contemporary landscape architecture, scholars have studied how design can influence the recovery process of landscapes and ecologies. Landscape architects have been concerned in examining the specificity of a site taking advantage of the edges and barriers which architects and planners abandoned and ignored (Marot, 1999). Doing so, they sought the opportunity of reclaiming damaged areas and bringing back the sense of place that was lost (Marot, 1999). The significance of this phenomenon does not exclusively include the recovery of time and place, but it also extends towards the restoring of vanished ecologies (Corner, 1999). Corner (1999) measures "the reclaiming of sites" through a threefold approach that incorporates the recovery of cultural, social, and ecological forms and programs. According to him, it should first enrich the cultural assets of the site and ensure the restoration of the memory of time and place (Corner, 1999). Second, it should develop new social programs and activities (Corner, 1999). As it

does so, it has to explore innovative ways of bringing in new tools for public recreation. Similarly, Otto et al., 2004 state in the five planning principles for urban riverfront reclamation the need to strengthen the river's environmental and cultural history through an engaging riverfront. Finally, the reclamation of sites should diversify ecological processes (Corner, 1999). This strategy was intensely facilitated recently by developing satellite imaging and increasing the media interest in natural disasters. Hence, environmental issues such as waste, pollution, and deforestation could be directly identified and studied (Corner, 1999).

Otto et al. (2004) define eight design principles of urban riverfront reclamation:

1. Preserve existing natural features of the river by excluding engineering solutions that harmful for the river ecosystem, such as dams.
2. Use buffers to protect natural areas around the river such as wetlands
3. Bring back riparian wildlife
4. Manage water resources through a non-engineering approach
5. Minimize the use of hardscape to decrease imperviousness. This approach may include strategies to remove existing buildings and paving.
6. Control storm-water through natural processes
7. Create a balance between ecological protection and public access
8. Celebrate the river's cultural and environmental history

2.5.4. Governance of River Basins

To take advantage of the opportunities given by water and to minimize threats imposed at human settlements at proximity to water bodies necessitate the establishment of social organizations and systems of governance (Huitema and Meijerink, 2017). Similarly, Naiman et al. (2005) believe that there is a lack of institutional frameworks that address the management of such ecosystems cohesively and which devaluate the complexity of the riparian systems. Therefore, in order to implement the watershed management approach successfully, new institutions should be formed (Naiman et al., 2005). Those institutions should be adaptive to the changes in riparian systems and focus on the management of conservation and development (Naiman et al., 2005).

In line with this, governance scholars and practitioners have advocated for the notion of River Basin Organizations. A design of RBO should take into considerations the following five rules, (Huitema and Meijerink, 2017):

- Authority rules. They designate the positions held in the organization and what actions can be made. As an example, a specific position can deal with water quality only.

- Aggregation rules. They indicate methods to decide on individual and collective choices. An example of this could be a rule which states that the right choice is the one which benefits the most considerable number of people.

- Boundary rules. They indicate the geographical context in which this organization may exert authority.

- Information rules. They indicate the source of scientific knowledge needed.

- Pay-off rules. They have to do with the costs and benefits given to participants.

2.6. Conclusion

From what has preceded three notions should be acknowledged in reclaiming riparian landscapes. First, a river is a system of interconnected components, features, and processes. Reclamation approaches should take into consideration that a river is not just a linear thread of running water from headwaters to the sea. They should thoroughly study fluvial processes over extended time-scales, the changes in biota and wildlife habitat, and the interconnection between aquatic and terrestrial components of the Riparia. Moreover, it is essential to highlight the fact that human and anthropogenic factors play significant roles in this system. Reclamation approaches should amplify the cultural contributions to the river system and control the hazards and stresses exerted by anthropogenic disturbances on the system. Second, any approach to river management should encompass the basin or watershed area. The need to address several challenges affecting river channels simultaneously requires the adoption of a holistic basin-scale approach. Third, the complexity of riparian systems requires a cross-disciplinary approach that puts together the contributions of science, engineering, planning and policy, and design.

CHAPTER 3

THE ECOLOGICAL LANDSCAPE APPROACH AND ITS APPLICATION ON AL-GHADIR LANDSCAPE

3.1. Ecological Landscape Design Paradigm

Makhzoumi and Pungetti (1999) have advocated for a paradigm shift in design where new methodologies embracing ecology and culture are explored. The ecological landscape design paradigm was hence explored which supported a holistic understanding of the complex layers of the landscape which came as a product of the natural and cultural evolutionary processes (Makhzoumi and Pungetti, 1999). To investigate these complex layers, the Ecological Landscape Association (ELA) tool was developed, that is a versatile landscape planning and design tool in two ways (ibid): First, it is a conceptual and practical tool to provide in-depth understanding of patterns and processes interacting in a specific landscape; and second, ELA distinguished, concrete blocks, can guide designers in developing matrices and solve problems and inspire ecologically and culturally responsive design strategies.

The methodology Makhzoumi and Pungetti propose contributes to the formation of ecological landscape design in four ways: First, it allows for structuring of the landscape within a framework which helps the designer in synthesizing an ecological understanding into a design process dynamically and interactively; Second, its flexibility allows for its applicability at various scales; Third, extended time in the methodology

allows for a dynamic and interactive framework; Finally, this concept is linked to problem-solving tools.

3.2. Reading Al-Ghadir Watershed Landscape

AL-Ghadir watershed is a typical Mediterranean landscape distinguished by its heterogeneity. The diversity of the Mediterranean Landscape is derived from the change of topography, the variation of local climates, and the changing degree of human intervention. Climate and anthropic influences are two main factors that influence this heterogeneity and are essential in the understanding of the evolution of these Mediterranean landscapes (Makhzoumi and Pungetti, 1999).

3.2.1. Abiotic Components of Al-Ghadir Watershed

3.2.1.1. Climate and Rain Fall

Lebanon belongs to the Mediterranean region characterized by a typical Mediterranean climate with four seasons (Haddad et al., 2014). The rainy period lasts between November and March, followed by a dry season where very minimal precipitation occurs (ibid.). The annual precipitation in the coastal

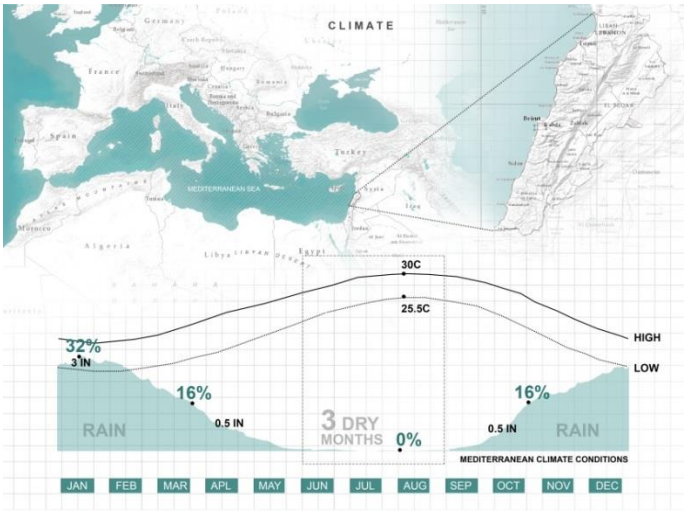


Figure 8 Mediterranean Climate
Source: By author

plain ranges between 600mm and 800mm, while the mountain areas receive around 1000mm to 1400mm (Haddad et al., 2014). Therefore, the average rainfall of the watershed varies between 700 and 1300 mm/year.

3.2.1.2.Topography

The watershed area varies in altitude from coastal sea level to 1000m above sea level, which shaped the landscape from an alluvial plain to a mountain system. Topography influenced the vegetative cover over the watershed where agricultural lands dominated in the coastal plain, and forests occupied the hills and slopes.

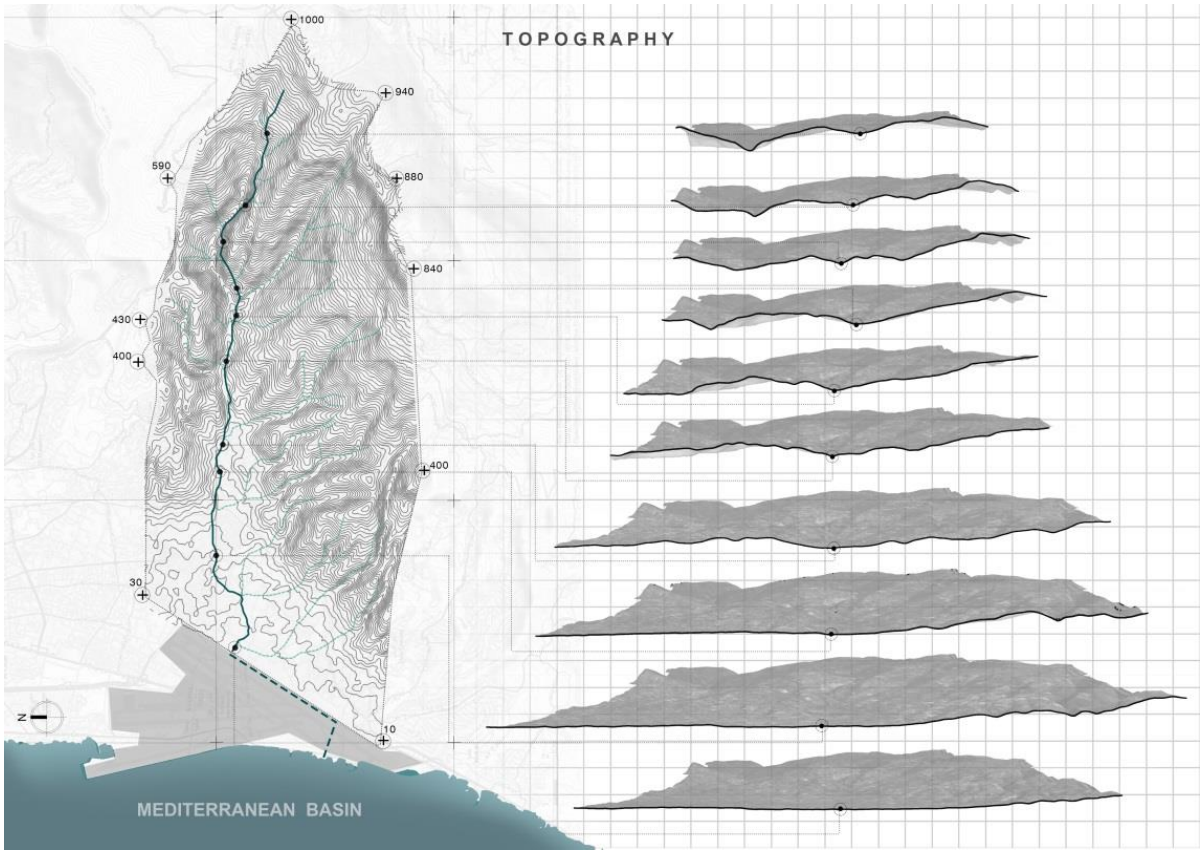


Figure 9 Topography
Source: By author

3.2.1.3.Hydrology

i. A Degraded Watershed

Al-Ghadir watershed area is estimated to be around 40 km2 covering areas in Baabda and Aley. 52% of the land-cover is impervious surfaces (buildings, streets), while 33% is natural areas, and 15% is agricultural. According to Brabec et al. (2002), a catchment in which imperviousness exceeds 30% is considered to be "degraded."

Figure 10. A view of the coastal area from Bsous. Source: By author.

ii. Drainage Analysis:

The peak flow in the 40km2 catchment area is around 406.5 m3/s, in a 100-year storm, as estimated by a study conducted by Dar Al-Handasah.

Topography subdivides Al-Ghadir catchment into nine sub-catchments. The flow variables (runoff quantity, velocity, and peak flow) in these sub-catchments vary as a function of area and land-use. The runoff volume varies between 65 m3 to 170 m3 between S1 and S8; however, it sharply increases to

exceed 2000m3 in S9 (Dar Al-Handasah, 2014). Similarly, the peak flow and velocity are in a proportional relationship. The peak flow in S9 increases distinctly to become around 338.5 m3/s in a 100-year storm (Dar Al-Handasah, 2014). This quantity is equivalent to 82% of the total discharge in the catchment. These alarming results of the drainage analysis suggest that S9, the sub-catchment that includes Al-Ghadir settlement, is at high risk of flooding in case of a storm-water surge.

iii. The River Channel And Floodplain:

Al-Ghadir River is a single-thread straight channel that extends over 14 km from its headwater near Aley to the sea in the vicinity of Beirut Airport. Anthropogenic disturbances and land-use changes led to many river channel modifications, shrinkage in the floodplain, and loss of tributaries. In the natural areas upstream, the floodplain remains intact, covered with riparian vegetation with a width of the river channel around 20 m. As the context varies from foothills to coastal urban areas, the floodplain and river channel width shrink in size. In Kfarshima and Hay sellom, houses and hangers squatted over the active river channel, and the floodplain completely vanishes. In the informal settlement, the width of

Figure 11. The two typologies of floodplain.
Source: By author

the river diminishes to reach 4 m in some areas—furthermore, the runways of Beirut's airport cover around 2 km of the river channel.

iv. Water Quality:

Human activity has a massive impact on the riparian water quality. In Al-Ghadir catchment, there are three contributors to water pollution.

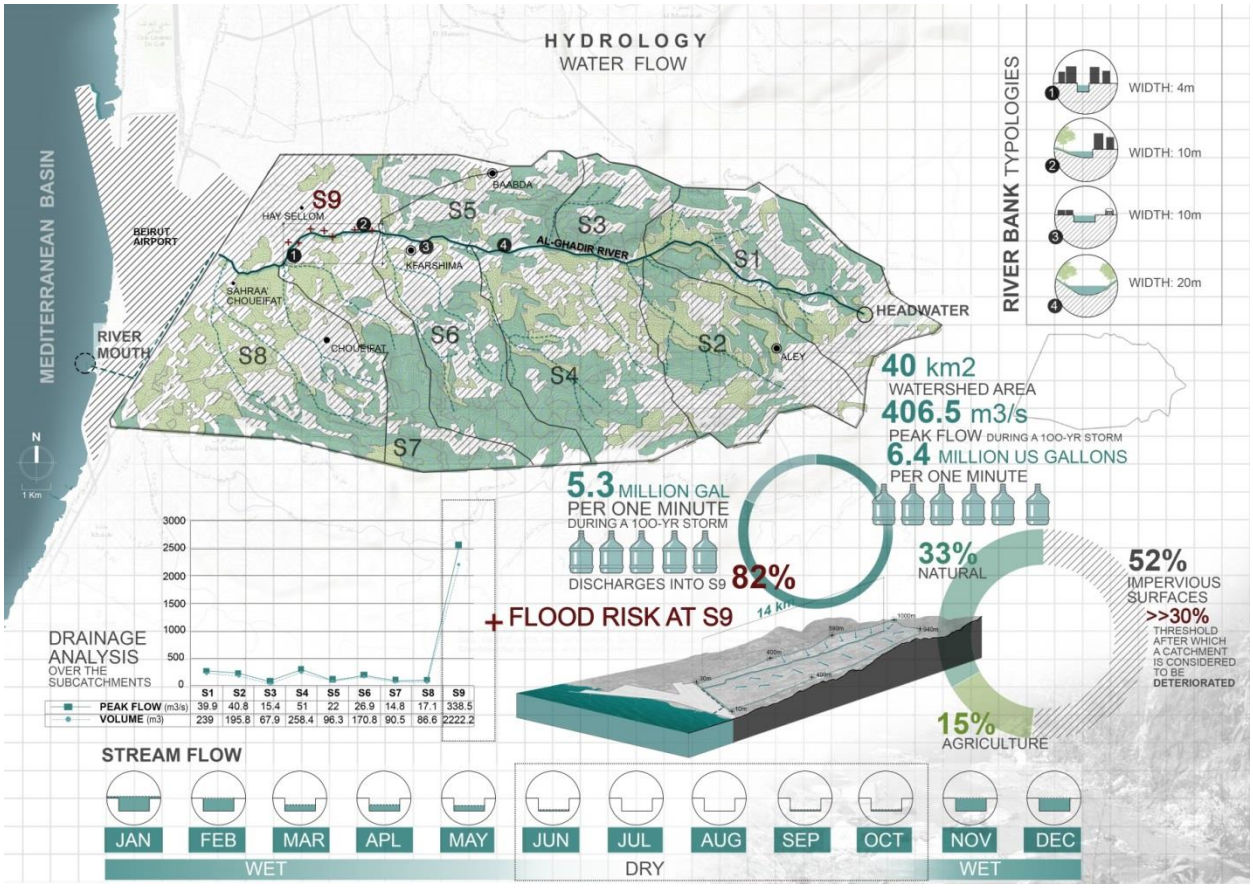


Figure 12. Hydrological Analysis of the Watershed. Source: Info by Dar (2014)- Infographic designed by author

First, Al- Ghadir river channel carries all the sewage water from the villages upstream. Sewage networks, when they exist, overlap with the runoff water due to the absence of storm-water networks.

Second, many industries present in Wadi Cahhrour, Kfarshima, and Choeuifat discharge their waste into the river channel. In Kfarshima, most of these industries are stone processing plants, concrete mixers, tiles and paint industry, and sand washers (Abi Shdid et al., 2017). Their pollutants are mostly physical and chemical, namely mud with other chemical materials (ibid.) The ministry of environment recommends mitigating procedures such as ponds for polluted water sedimentation. However, the ponds are often non-sufficient, and the excess of polluted water discharges into the riverbed (Abi Shdid et al., 2017). Moreover, garages for car repair take over the riverbed discharging oil and grease substances into the stream.

Figure 13. underground channel discharing Lececo's industrial wastes to the river. Source: By author

In contrast, the industries in Wadi Chahrour and Choeuifat are animal slaughterhouses and leather production industries. They produce organic and chemical wastes discharged directly into the waterways with no mitigating procedures. Also, farms are present in Choeuifat, which releases organic wastes produced by the livestock and cleaning process. These pollutants collectively change the color of the river from time to time.

Figure 14. Three changing color of the river in Kfarshima and Aamrousiye. Source: by author

The third contributor to the river water pollution is the solid waste dumping into the river in AL-Ghadir settlement. The lack of proper garbage collection plan by the municipality urges the dwellers to use the channel as a dumping site, especially when the river is dry. These solid wastes block the water canals and cause flooding of the contaminated water in the first storm event of each winter, leading to an environmental emergency.

Figure 15. Solid wastes dumped into the river channel in Hay Sellom. Source: by author

It is also worth mentioning that a treatment facility is present near the sea. Sewage water is supposed to be treated before being discharged into the sea; however, this facility is currently incapacitated, with the result that sewage water, along with the polluted water river, is discharged untreated to the sea.

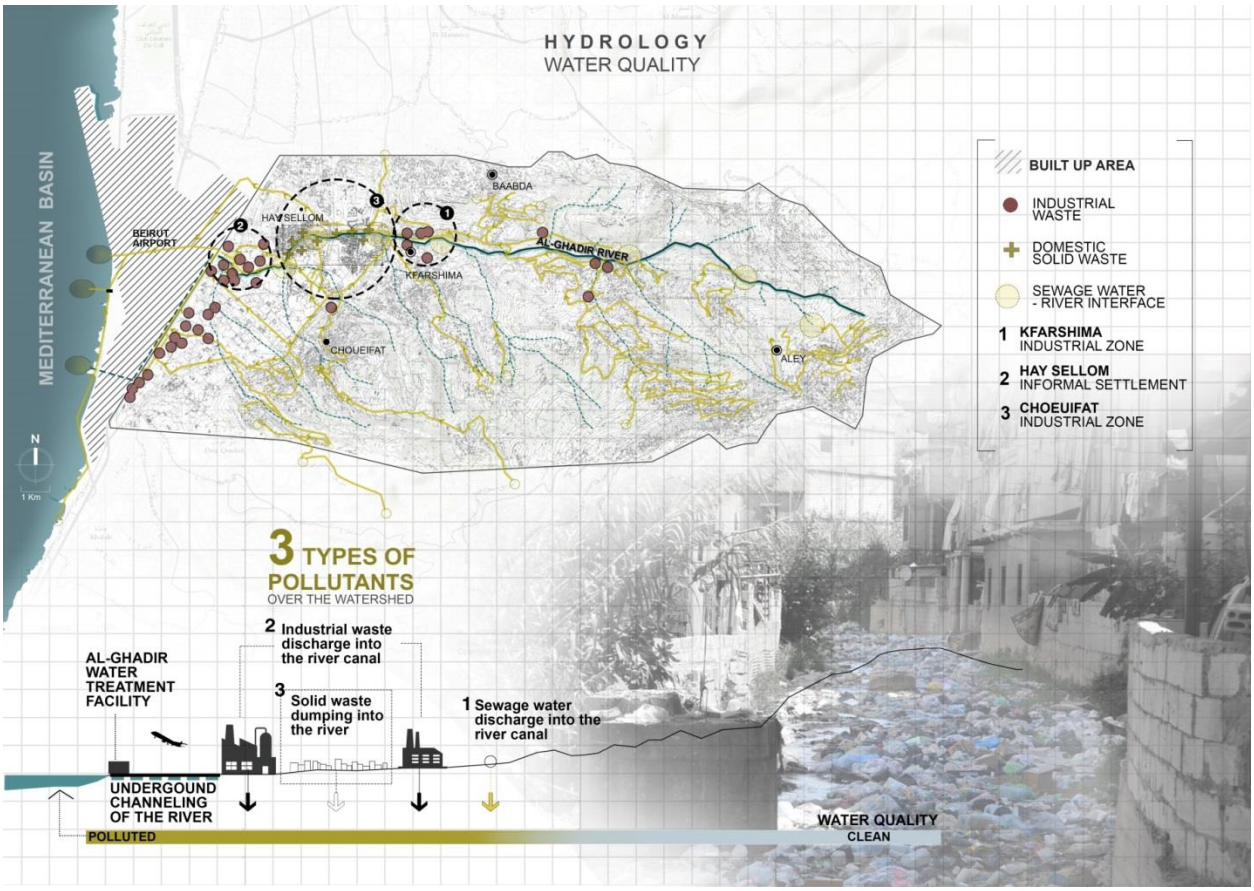


Figure 16. Water quality in the watershed. Source: by author.

3.2.2. Biotic Components of Al-Ghadir Watershed

The biotic components of the watershed includes woodlands and maquis scrublands. Found prevalently in the higher altitudes of the watershed, they cover up to 33% of the total watershed area.

3.2.2.1. Woodlands

There are five types of woodlands: the open and dense mixed woodlands (including *Pinus brutia, Quercus calliprinos*), the broadleaved woodlands, the open and mixed coniferous woodlands (including *Pinus pinea*). These woodlands are native to the Mediterranean region. They are home to many wildlife species, namely migrant birds (*Lanius nubicus, Parus major, Sylvia curruca, Serinus syriacus, Turdus merula, Hippolais pallida),* insects, and mammals *(Sciurus anomalus, Meles meles canescens, Sus scrofa lybicus)* (Wild Lebanon, n.d.). Forests play an essential role in the hydrologic system as they mitigate the effect of other land-use on the riparian ecosystem (Brabec et al., 2002). They also influence water quality variables at a catchment scale (Brabec et al., 2002). According to Brabec et al. (2002), 15% of the forest landcover should be preserved to mitigate the effects of water-level variations.

3.2.2.2.The maquis:

The maquis habitats are native, mature Mediterranean scrublands. They include a selection of wildflowers and shrubs such as *Michauxia campanuloides, Iris palaestina, Anacamptis pyramidalis, Asphodelus microcarpus, Anenome coronaria* (Wild Lebanon, n.d.) The abundance of these flora makes them habitats for a wide range of

reptile fauna (*Chamaeleo chamaeleon, Testudo graeca*), insects (the mantids) and grazing animals (ibid). They also attract a varied group of birds such as *Carduelis chloris, Turdus merula, Merops apiaster,* and *Lanius nubicus* (ibid).

Figure 17. the biotic components and the wildlife in the watershed. Source: Army maps redrawn by author

3.2.3. Cultural Components of Al-Ghadir Watershed

3.2.3.1. Agricultural Landscapes

Agriculture is one of the most important cultural practices of this region. Historical maps of the watershed show a dominance of olive orchards, fruit trees, and vineyards. Some villages depended on agriculture and agro-industry to flourish their economies. An example of this is Choeuifat and Kfarshima, where the production of olive oil was one of the primary triggers of their economy. Urbanization and the shift in economies from agriculture to the industrial sector, however, caused shrinkage in the agricultural lands.

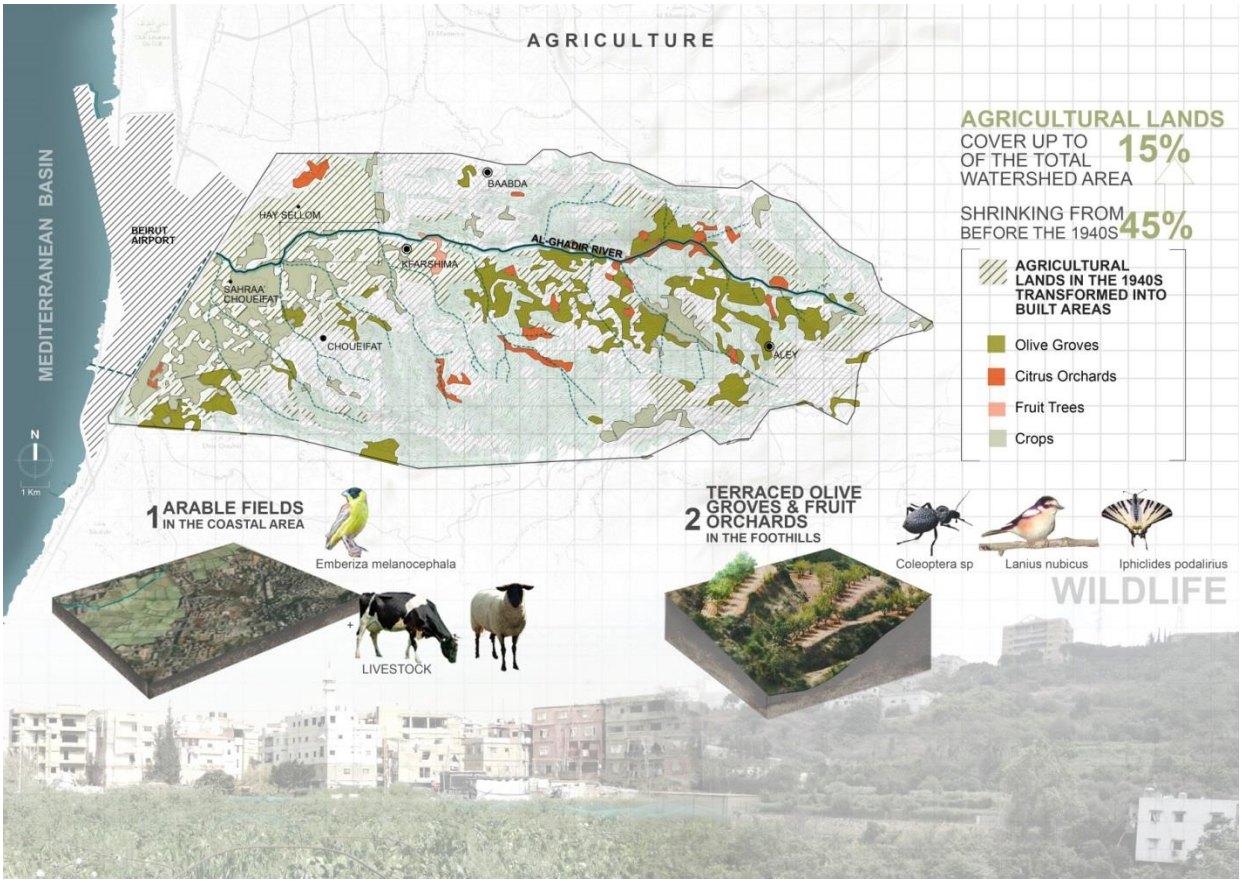


Figure 18. The agricultural cover in the watershed. Source: Army maps redrawn by author

Now two typologies of agriculture exist in the watershed: Arable fields in the coastal area; and terraced olive and fruit orchards in the foothills. These landscapes attract a few migrating birds such as *Emberiza melanocephala* (Wild Lebanon, n.d.).

3.2.3.2. Built-up Landscape

Topography and the proximity to the capital city played a significant role in the distribution and density of built-up areas across the watershed. The coastal area contains the highest density of built-up areas compared to the foothills. Two main urban landmarks are present there: Beirut Airport and the Lebanese University campus in Hadath. The areas at the foothills are mainly rural landscapes, and the buildings are mostly of the Lebanese vernacular architecture typology.

3.2.4. Ecological Landscape Associations of Al-Ghadir Watershed

After the extensive reading of the landscape layers in AL-Ghadir watershed, the following Ecological Landscape Associations were identified:

ELA 1: Built-Coastal

constitutes 30% of the watershed area. It exerts a severe threat to the riparian system and the environment.

Figure 19. ELA 1 diagram. Source: by author

ELA 2: Built – Foothills

constitutes around 22 % of the watershed area, and it preserves a cultural significance due to the presence of Lebanese vernacular architecture.

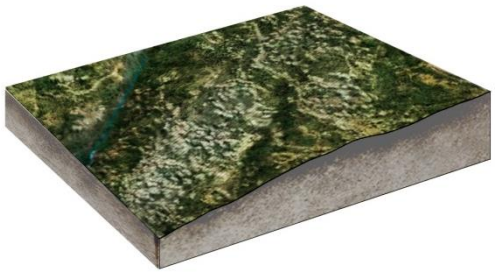


Figure 20. ELA 2 diagram. Source: by author

ELA 3: Agriculture- Coastal

constitutes the least percentage of the watershed. It holds hydrological, ecological, and cultural significance.

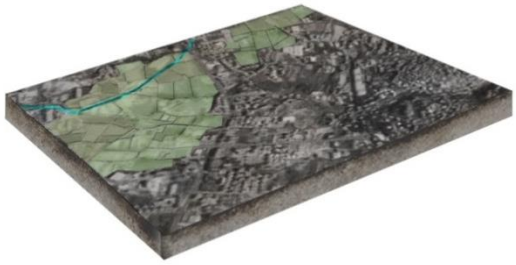


Figure 21. ELA 3 diagram. Source: by author

ELA 4: Agriculture -Foothills

constitutes around 8% of the watershed area. It maintains ecological importance as it provides habitat for wildlife species and a cultural significance as olive orchards are part of the Mediterranean culture.

Figure 22. ELA 4 diagram. Source: by author

ELA 5: Woodlands-Foothills

covers 23% of the watershed. It

Figure 23. ELA 5 diagram. Source: by author

provides ecological and hydrological benefits and presents a significant asset to the watershed.

ELA 6: Scrublands- Foothills

covers 10% of the watershed and preserves ecological and hydrological significance.

Figure 24. ELA 6 diagram. Source: by author

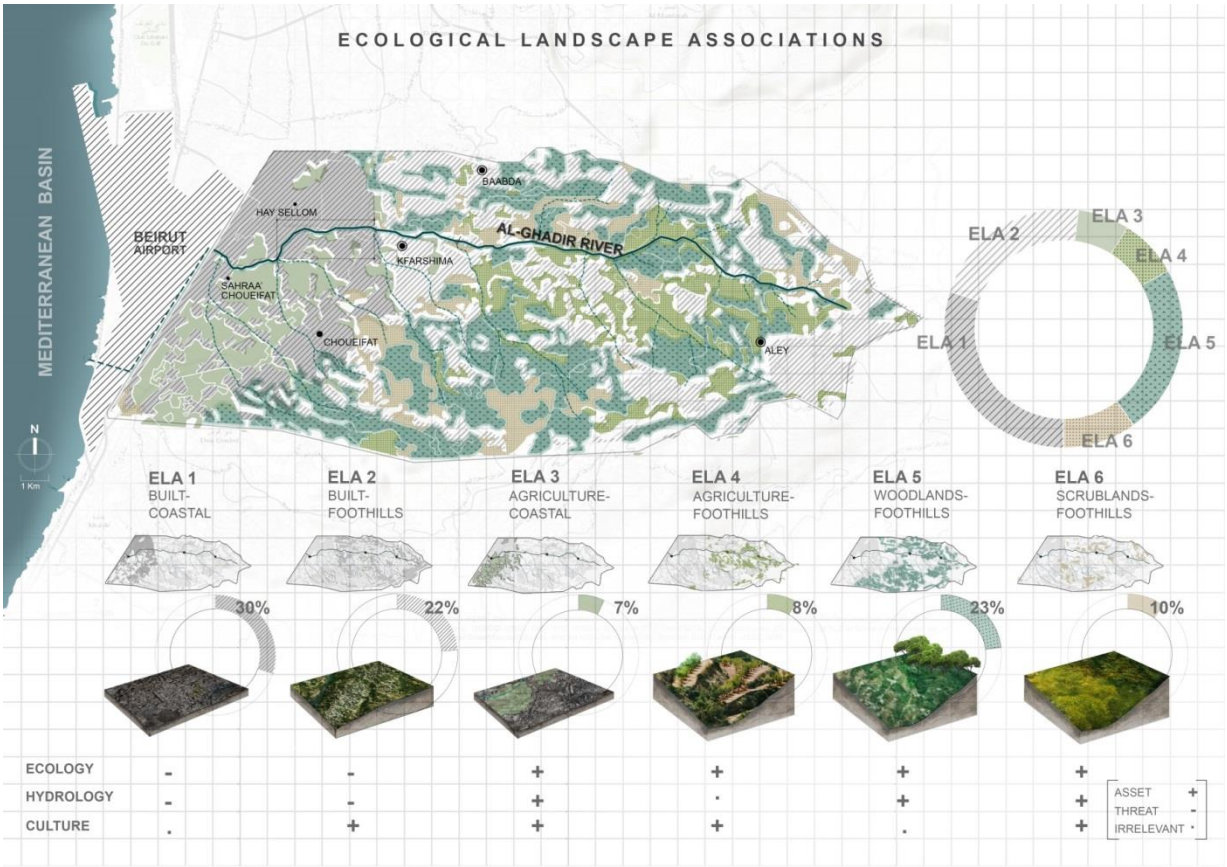


Figure 25. ELAs of the watershed. Source: by author

3.3. The Existing Water Governance Framework

Water in Lebanon, encompassing the terrestrial and the underground, is a national asset that is deemed to be a public good according to the Water Resources Law. The regulatory laws in Lebanon progressed since the irrigation laws of the Ottomans and the modified laws during the French mandate (El Hajj et al., 2015). The latest was a new water law issued in the year 2000 (Law 221/2000), which now regulates the water sector (El Hajj et al., 2015). Law 221/2000 allocates the roles of each institution concerned with the management, governance, and conservation of water resources. The following is a discussion of the primary and secondary actors involved in water governance in Lebanon as expected by the law.

3.3.1. Major Actors

Ministry of Energy and Water (MoEW) ***وزارة الطاقة والمياه***

The role of this ministry falls under the scope of policy-making, planning and implementation, conservation and resource management, in addition to regulation and enforcement (El Hajj et al., 2015). According to El Hajj et al., (2015), MoEW is expected by law to:

1. produce research-based and nationwide studies linked to large-scale projects in the hydraulic and electric sector
2. Develop and monitor the implementation of large-scale water infrastructures such as dams and treatment facilities
3. supervising other public institutions working on the water sector, and providing recommendations in water-related issues

4. Control groundwater extractions and issuing permits for wells

5. Quantify and manage the nation's water resources

6. Control the quality of terrestrial and underground water resources, and protect them from pollution

Water Establishments مصلحة مياه بيروت وجبل لبنان ولبنان الشمالي ولبنان الجنوبي

There are four regional water establishments in Lebanon, created in the year 2000, distributed over four regions: North Lebanon, South Lebanon, Beqaa Valley, Beirut and Mount Lebanon (USAID, 2010). They are responsible for the studying and distribution of domestic water and wastewater services (El Hajj et al., 2015).

The Litani River Authority (LRA) المصلحة الوطنية لنهر الليطاني

LRA is a public institution that is responsible for the monitoring of the Litani River Basin. Its responsibilities include establishing and monitoring hydro electrical power plants and irrigation systems in the river basin (El Hajj et al., 2015). This institution has proven to be quite a successful model of river basin authorities in Lebanon. The history, methodology, and planning framework of this authority will follow in Chapter 5.

3.3.2. Secondary Actors in River Basin Management

Ministry of Environment (MoE) وزارة البيئة

MoE is concerned with the health of the environment. Little does it have control over water resources (USAID, 2010); however, it is responsible for controlling pollution and in evaluating Environmental Impact Assessments (El Hajj et al., 2015).

Ministry of Public Health (MoPH) وزارة الصحة العامة

MoPH is only concerned with the quality of drinking water and the waterborne diseases (El Hajj et al., 2015).

Ministry of Finance (MoF) وزارة الإقتصاد

MoF‘s responsibilities are limited to budgeting implementation projects (El Hajj et al., 2015).

Ministry of Agriculture (MoA) وزارة الزراعة

The role of MoA falls under the scope of planning, governing, and monitoring of public irrigation projects (El Hajj et al., 2015).

Council for Development and Reconstruction (CDR) مجلس الإنماء والإعمار

CDR’s role by law is to activate funds and support MoEW and the WEs (El Hajj et al., 2015).

Central Fund for the Displaced الصندوق المركزي للمهجرين

This authority is only concerned with the restoration and reconstruction of water supply systems in Chouf, Baabda, and Aley (El Hajj et al., 2015).

Council for the South مجلس الجنوب

This institution is responsible for constructing water supply systems in the south and west Beqaa (El Hajj et al., 2015).

3.3.3. Challenges to the Water Sector in Lebanon

Although laws governing water resources have undergone several reforms, they still fail in achieving sustainable water management. El Hajj et al. (2015) identified the following challenges to the water sector in Lebanon:

(1) The lack of operational decrees, delays in the confirmation of laws by the cabinet, political stalemate, and lack of proper coordination between involved entities renders the laws in the water sector weakly enforced

(2) The interlocking of duties expected by institutions in the water sector as a result of vague and indefinite laws

(3) The establishment of illegal water networks amid the government's inaction

(4) The shortage of data at a national scale

(5) Other issues related to administrative and financial problems

CHAPTER 4

AL-GHADIR SETTLEMENT CASE STUDY

4.1. Historical Evolution of the Settlement

The 1950s: Formation of the settlement

Al-Ghadir settlement is the urban extension of Hay el Sellom informal settlement, which emerged in the mid-1950s, and transformed the area from agricultural lands into a high-density residential area (Fawaz, 2000). Formerly, the area was dominated by mulberry trees, which were the source for the silkworm industries mainly managed by the Druze and Christian Maronite families of the region (Fawaz, 2000). Upon the recession of the silk trade economy, olives and orange orchards took over the place (Fawaz, 2000). Starting the 1950s, successive migrant waves coming from the Beqaa took over the orchards. Therefore, Hay el Sellom belongs to the typology of slums formed due to urban-rural migrations (Fawaz & Peillen, 2002).

1975-1990: Successive wars causing additional waves of migration

The war condition increased the chances of squatting property over the riverbed and two Waqf lands nearby (Fawaz, 2000). The religious segregation back then, made Hay el Sellom the only refuge for lower-income Muslim (mainly Shiite) migrants who wish to stay close to the capital city (Fawaz, 2000). Later in the 1980s, houses started squatting on the riverbeds and formed an illegal settlement over the river. People came to the area to work in agriculture lands around the river (CDR, 2005). After the Israeli invasion of south Lebanon in 1982, another wave of war-displaced migrants

settled in Al-Ghadir area, mainly seeking employment in the industries of Choeuifat (CDR, 2005).

1990-Now: The settlement as a large housing market

The saturation of the land in the 1980s stimulated vertical densification of the neighborhoods; thus, Hay el Sellom became a massive housing market (Fawaz & Peillen, 2002). Now, these neighborhoods are attractive to foreign workers renting rooms (Fawaz & Peillen, 2002). Amid this chaotic expansion, houses encroached more on the river and public lands, imposing threats to the river and the environment.

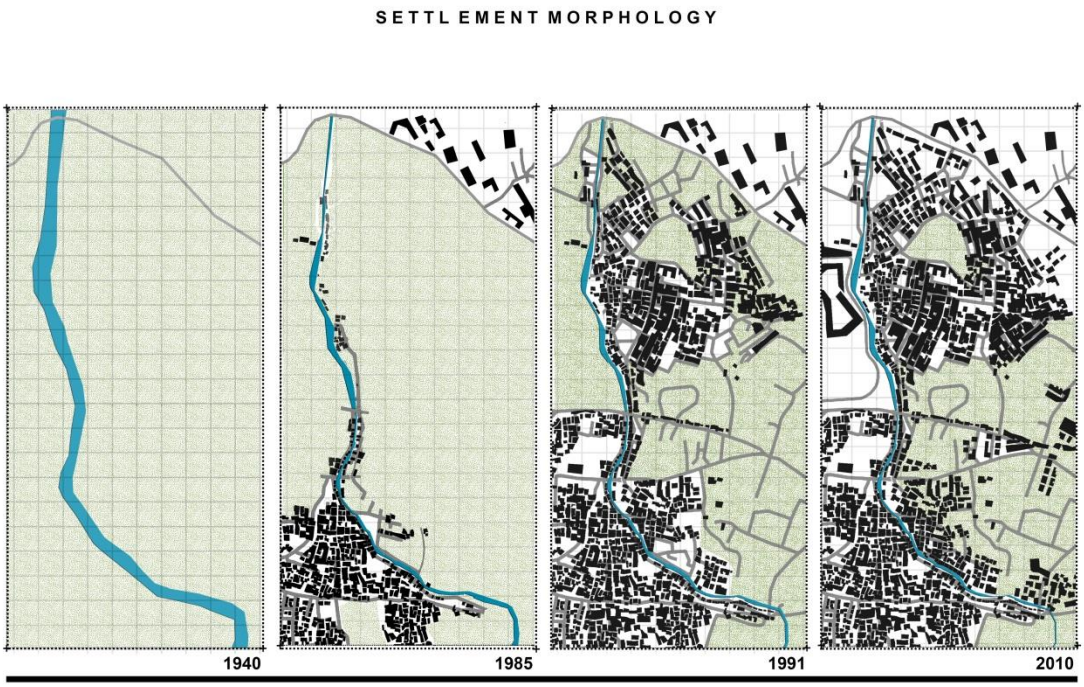


Figure 26. Historical Evolution of the settlement. Source: Historical images from AUB archives - redrawn by author

4.2. The Urban Physical Conditions

4.2.1. Figure- Ground

The figure-ground map shows a disproportionate distribution of the solid and voids pattern along the opposite sides of the river. The southern edge shows a continuous

houses stretch, while the northern edge disrupts in the middle of the settlement. Similarly, there are patches of void scattered randomly. The logic behind this is that the ownership of land was a significant agent in the settlement morphology. As the settlement grew with the advent of migrants from the Beqaa, landowners engaged in the housing market. This process contributed to the formation of the slum the way it is. Additionally, the land to the northern east of the river belongs to the Lebanese University. This explains the presence of the open space and the two relatively large buildings.

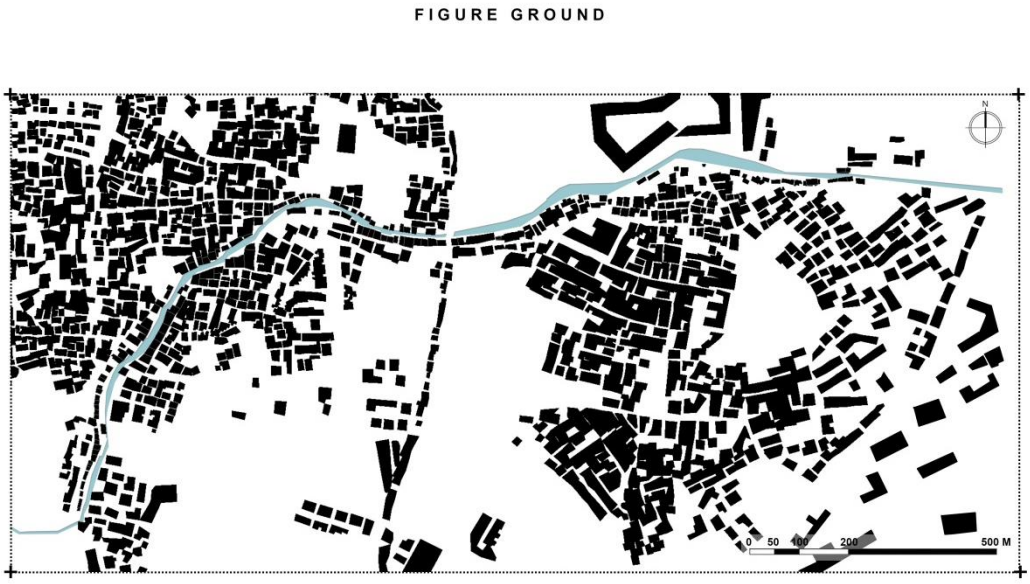


Figure 27. Figure ground map of the settlement. Source: by author

4.2.2. Land-Use and Vacant Spaces

In terms of land-use, the study area is mostly residential. More than 90% of the buildings are residential (CDR, 2005). However, agricultural lands are present abundantly towards the southern area of the settlement. These lands are mostly abandoned. Additionally, three commercial strips exist. Two of them are inside the settlement, while the third one is on the western edge on old Saida road. The far eastern strip connects to Hay El-Sellom souk, which is a famous commercial strip for lower-income communities.

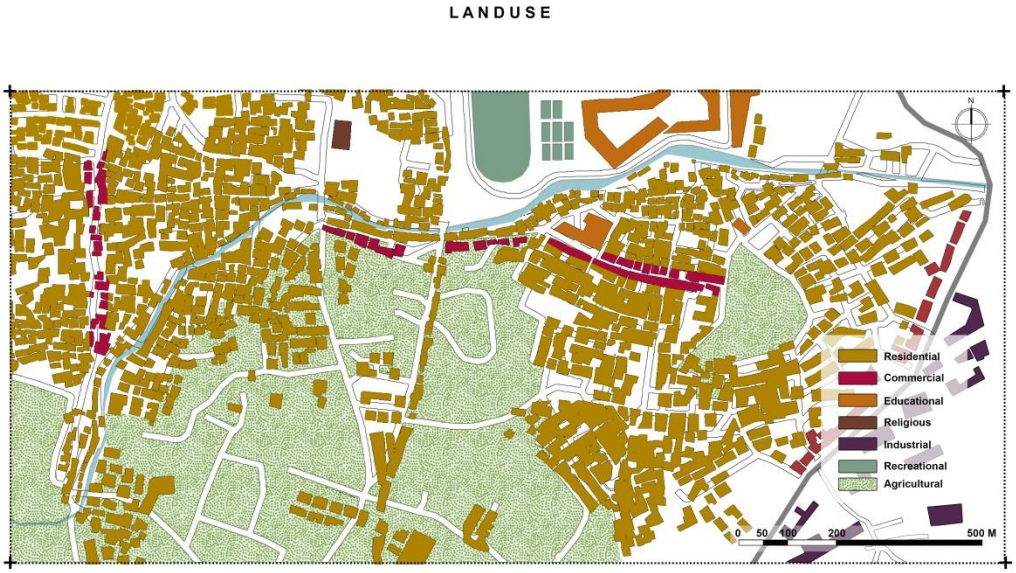


Figure 28. Land use map. Source: by author

Moreover, the land on the northern edge of the river is occupied by the Lebanese University campus. The buildings at a proximity to the riverbank are the student dorms. Recreational areas with Football and tennis fields are also present.

Although the settlement is very dense and buildings encroach over the riverbanks, vacant spaces still exist along the edges of the channel. Dwellers use these spaces as parking lots.

Figure 29. Vacant space near river. Source: by author

VACANCY

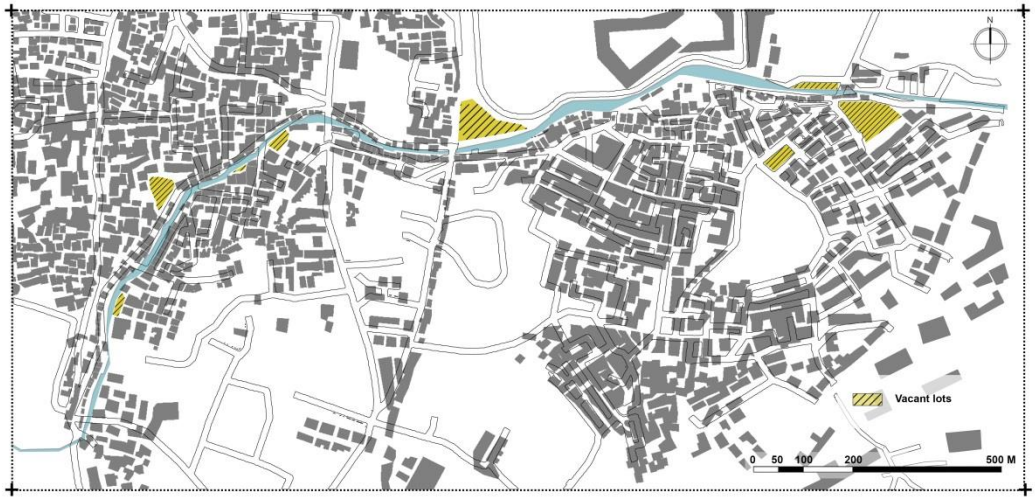


Figure 30. Vacant lots map. Source: by author

4.2.3. The Road Network

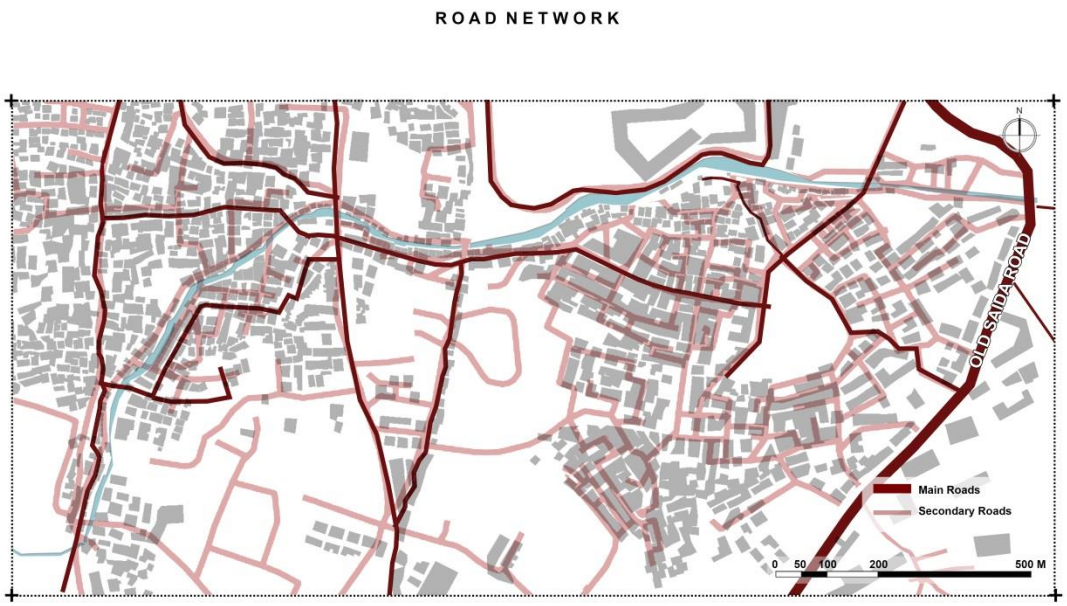


Figure 32. Road network map. Source: by author

The road network inside the settlement is not aligned with the river corridor. However, three major roads bridge over the river channel connecting both sides of the river. As for the buildings in dense areas, they are connected through a network of small

Figure 31. Proposed road network plan. Source: Choeifat master plan from DGU -redrawn by author

alleys. Cars can hardly pass inside them. The settlement borders with old Saida road which connects southern Beirut area to the south.

The master plan of Choueifat shows a significant number of proposed roads to be implemented. The planned roads bridge over the river in five different places, and it takes over an abundant number of buildings. This network plan is not yet implemented due to the lack of funding.

4.2.4. Encroaching Buildings

According to the law of water, riverbanks are public domain. Their governance is devoted to the Ministry of Energy and Water, and its privatization is prohibited. This law considers the entire river channel and an offset - defined according to a decree specific to each water body.

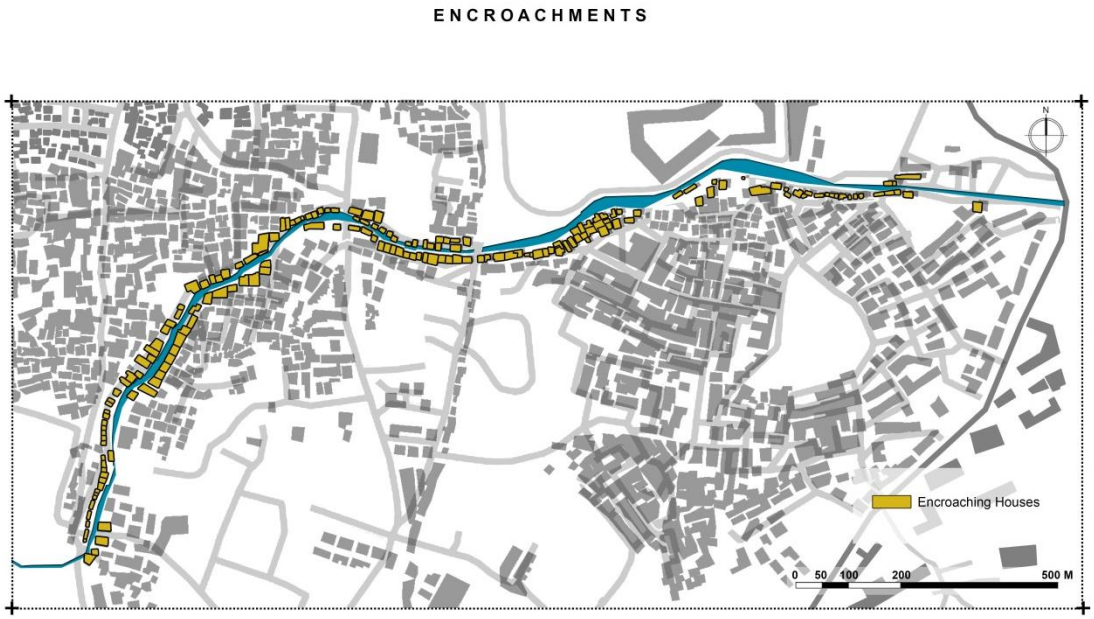


Figure 33. Encroachments over the river. Source: by author

According to Decree 14312 issued in 1970, specific to AL-Ghadir River, a 10-meter offset is required to both sides of the River. Based on this decree, more than 200 buildings are currently encroaching on the public domain.

Due to the illegal and chaotic mechanism in which the settlement grew, most of the buildings were built without the supervision of specialists (CDR, 2005). This rendered the buildings in a terrible condition (CDR, 2005). Rarely do sun rays infiltrate to the houses (Fawaz, 2000). Building typologies evolved with time. In the 1980s, houses were made of temporary structures like wood and steel. With time, they changed steel into permanent concrete houses (CDR, 2005). The settlement contains around 250-300 houses where almost 90% of it is residential (CDR, 2005). From these buildings, two typologies of housing units can be distinguished: (CDR, 2005)

1. Single houses each containing a single housing unit. They mimic the rural housing typologies where a small green space is present in front of each house. These units contain two to three rooms, and they mainly dominate along the riverbed.

2. Buildings which contain a group of housing units. This typology resembles the modern urban fabric and it is mostly present around the river. They are typically

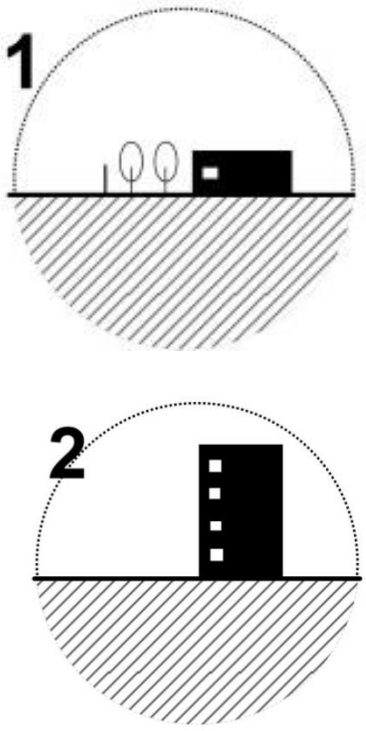


Figure 34. Two houses typologies. Source: by author

three to four storey buildings with an average of 8 apartments per building where each apartment does not contain more than 2 rooms.

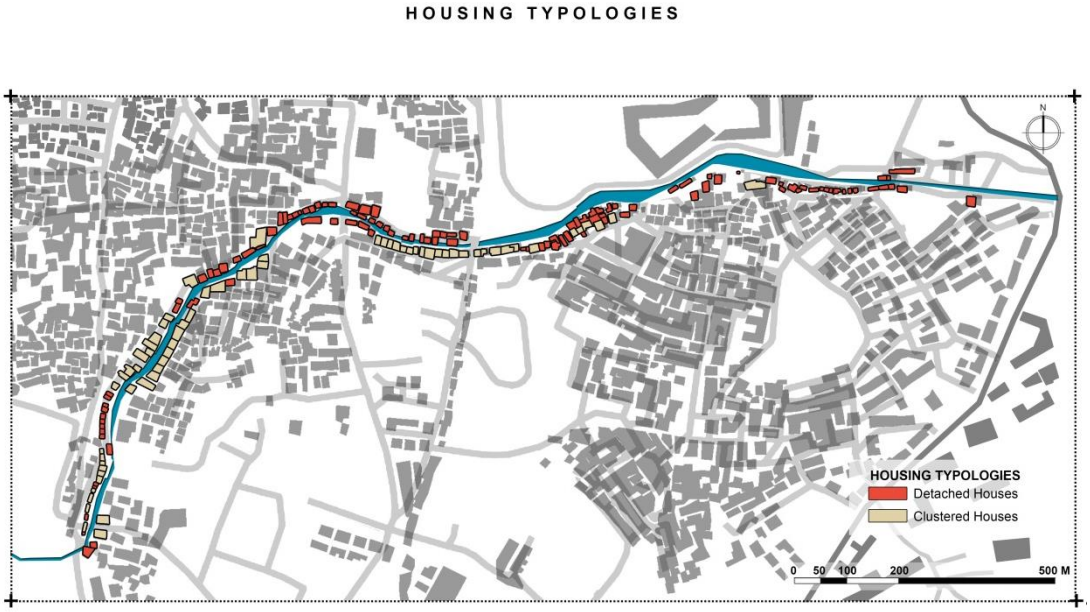


Figure 35. Housing typologies. Source: by author

4.3.The River Channel

4.3.1. Hydrology

4.3.1.1. Physical Alteration of the River

As the settlement grew and houses encroached over the river, its width has been altered. The width of the river channel varies between 4m and 10 m (Dar, 2014). The flow rate of the river at the

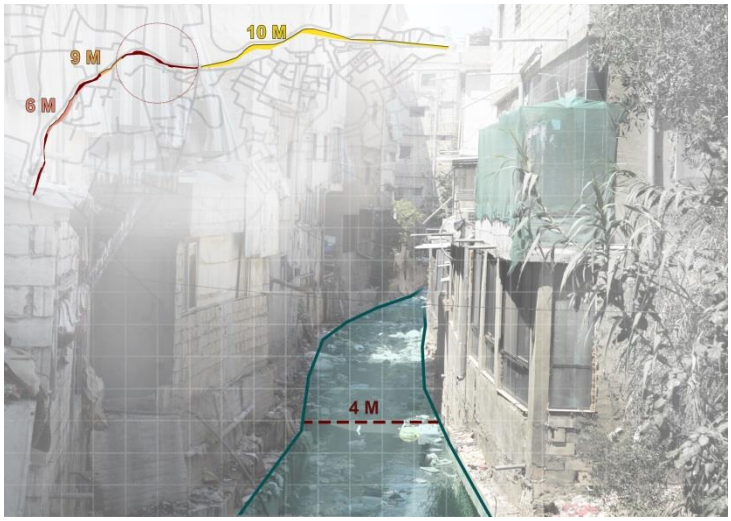


Figure 36. River channel width. Source: by author

sub-catchment encompassing the settlement is 160m3/sec which is considered critical and alarming (Dar, 2014). More than 90% of the river channel's velocity exceeds 7.5m/s which can impose critical threats to the channel's structure (Dar, 2014).

4.3.1.2. Sewage Infrastructure

The existing sewage network is old and does not accommodate the growth of the settlement (CDR, 2005). Some of these were constructed informally by the residents themselves, which explains its lack of efficiency. Many houses built on the river discharge their sewage directly into the river (CDR, 2005).

Figure 37. Wastewater discharge into the river. Source: by author

4.3.1.3. Solid Waste Dumping

A hazardous threat imposed on the residents is the solid wastes that are being dumped directly into the river corridor. Those wastes vary in their physical constituents, from small plastics bottles to large solid elements such as unneeded furniture. These wastes are

Figure 38. Solid waste dumped into the river. Source: by author

the major causes of flooding as they hinder the streamflow, especially under bridges. In addition to the health and environmental hazards, this has a disturbing visual effect for the dwellers and passersby.

Figure 39. Dredging of the channel to clear up sediments and waste. Source: Union of southern suburbs Facebook page

Before each winter season, Dahye municipalities, in collaboration with the ministry of public works, launch an operational maintenance campaign to clear the channel from wastes and sediments.

4.3.2. River Ecology

Riparian vegetation is almost extinct along the riverbanks inside the settlement. However, a few Ecucalyptus species and Arundo donax are still present at the edge of the Lebanese university campus.

Figure 40. Riparian vegetation present in the settlement. Source: by author

4.3.3. The River Culture

Testimonies taken from the site demonstrate the intimate connection people had had with the river before it became a degraded canal. They recall scenes of people crossing the river by ladders they introduced and occupying the edges of the riverbed. According to people there, Al-Ghadir River was a destination for recreation during weekends and vacations. “About thirty five years ago, under each olive tree you would see a family having a picnic”, said an old man in his 60s. “We used to drink from the river back then”, said a woman who claimed she had been living in the area for more than twenty five years.

In response to my question of “how would you like to see the river if any project would be implemented now”, one dweller living nearby the river suggested completely covering of the river, while the other suggested adding huge walls to prevent people from throwing garbage into it. Unfortunately, the cultural value of the river is now completely lost.

CHAPTER 5

RECLAIMING AL-GHADIR RIVER A SUSTAINABLE CATCHMENT AND AN ECOLOGICAL CORRIDOR

5.1. Al-Ghadir Integrated Watershed Management Strategy

As the main objective, this thesis aims to reclaim Al-Ghadir riparian landscape. To do so, it adopted a vision that strives for a sustainable watershed and an integrative green corridor. This vision builds on minimizing the drawbacks of the hydrological and environmental degradation and capitalizing on the ecological and cultural assets of the watershed. The fundamentals of this vision are eight catchment-based management guidelines targeting urban, natural, and agricultural land use. They are focused on land use and urban planning guidelines as well as water and resource management.

A. Reducing accelerated urban runoff and sediment delivery to the river channel using non-structural alternatives for storm-water control.

This could be done through establishing best practices land management policies. This mainly targets ELA 1 where urban density is relatively high. The selected best practices policies include the following:

1. Encourage roof planting to reduce storm-water runoff through a municipal bottom-up approach and giving incentives to urban dwellers. Low-income communities can implement roof planting using low cost and recyclable material.

2. Impose storm-water harvesting in dense neighborhoods via traditional rainwater harvesting systems. This process requires a delivery system and storage reservoirs, which could be acquired through minimal costs. Besides, this technique will allow for later use of water storage, offsetting the demand for water in the dry season, especially in agriculture. The Lebanese law does mention this concept in Property Law 3339/1930 and the law of water; however, they are only concerned with the ownership of these waters. Nonetheless, they do not recommend or urge reducing storm-water runoff by landowners or mention the need to harvest this water.

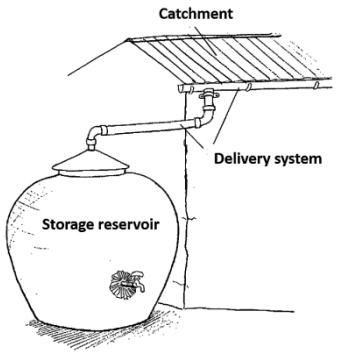


Figure 41. Rain water harvesting system. Source: HATUM & WORM (2006)

3. Incorporate the use of pervious pavement, bio-retention techniques, and urban greening to the environmental laws to minimize imperviousness in urban settings.

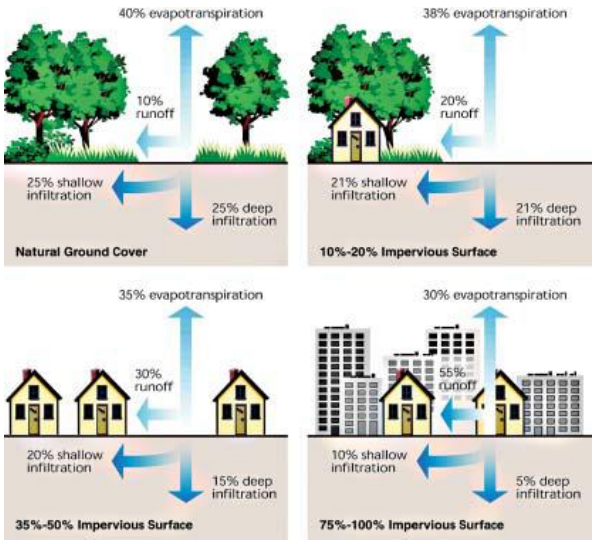


Figure 42. Impact of impervious surfaces. Source: Otto et al. (2004)

B. Protecting the river

stream and its tributaries from urban expansion through land-use control.

This guideline targets ELAs 1 and 2. Municipal master plans should enforce the setbacks on waterways and ensure its implementation.

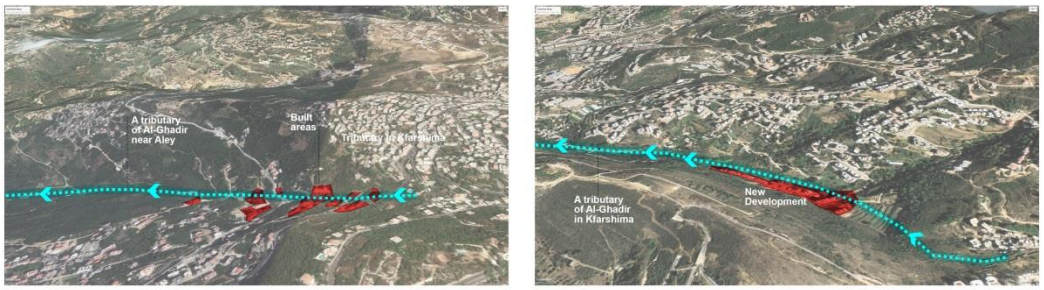


Figure 43. urban expansion over tributaries. Source: by author

C. Rejuvenating the existing arable lands and rethinking their role as socio-economic assets.

This thesis proposes a new urban agriculture model where public authorities, landowners, communities, and NGOs participate in building a more sustainable future for lower-income communities. This scheme involves local authorities giving incentives to landowners to activate their abandoned lands and transform them into community gardens. This step will create employment opportunities in

Figure 44. Women empowerment in lower-income communities. Source: by author

agriculture for the local community, especially for women. This model will also invite local NGOs such as UNDP, Greenpeace, and Jihad Al-Binaa to conduct workshops and training sessions for locals who wish to enhance their knowledge of agricultural practices.

D. Acknowledging the cultural significance of olive groves in ELA 4.

This approach requires local municipalities to launch olive picking festivals at the beginning of the wet season as a way to celebrate the cultural importance of olive groves in the Mediterranean culture.

E. Protecting the existing woodlands (ELA 5) to minimize the impact of other land use.

The thesis recommends the reinforcement of environmental laws that protect woodlands from urban expansion or wood-cutting. This recommendation draws from the hydrological importance of these woodlands in infiltrating storm-water and reducing the impact of imperviousness in watersheds. In addition to that, the thesis proposes integrating hiking trails that will establish a connection between people and these landscapes.

F. Rethinking the role of scrublands (EL6) as the elements in the riparian network.

G. Establishing the river channel as a multifunctional ecological corridor through a corridor-level strategy.

Section 5.2. will present this strategy.

H. Provide an institutional framework through which the watershed will be governed.

Section 5.3. will explain this framework in details.

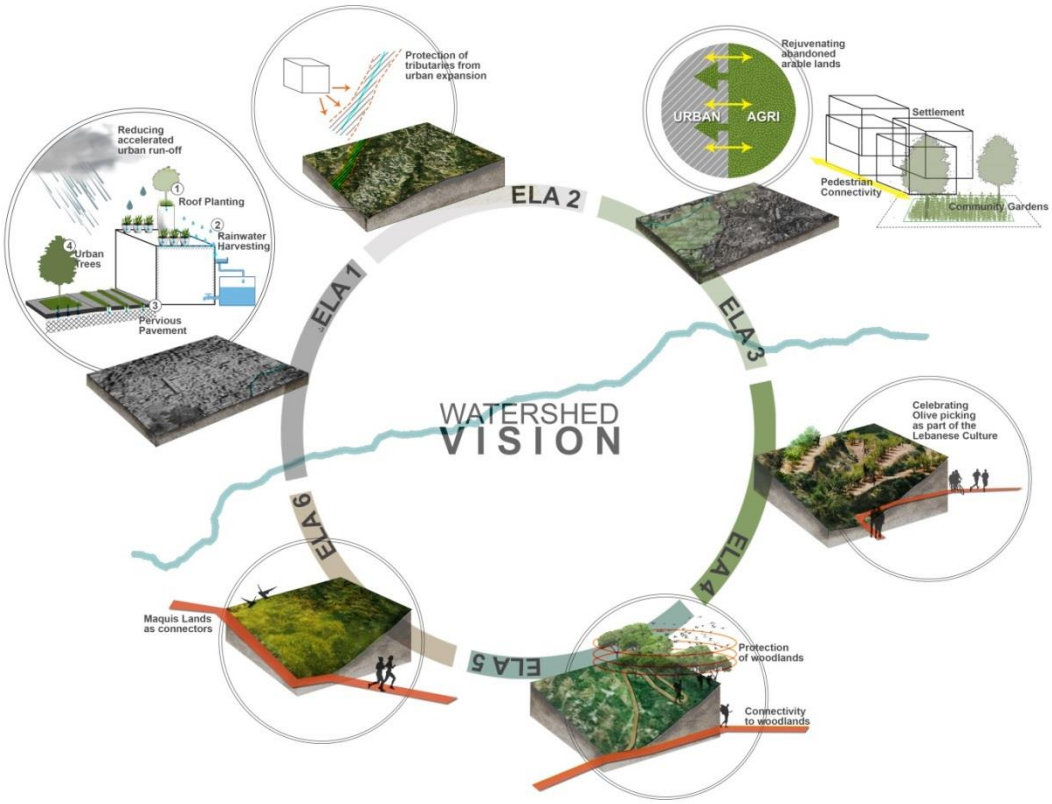


Figure 45. Watershed Vision. Source: by author

5.2. Corridor -Level Strategy

Building from the watershed vision, the thesis developed corridor-based strategies to ensure the reclamation of the riparian landscape. These strategies are three-folded targeting the integrity of the hydro-system, the ecological continuity of the river, and the exploitation of this

I. Hydrological Integrity: Ensuring the longitudinal river continuum from headwaters to the sea and minimizing stress on the river channel

A. Reducing River channel hazards and minimize stress through the removal of encroachments on the riverbanks, as necessary.

The strategy aims to acquire a minimum of 16 m channel width and an expanded floodplain. This strategy will guarantee a lower runoff velocity, and decreased risk of flooding in cases of storm-water surge. The relocation of the vulnerable buildings will take place in two particular spots, as follows:

a. The relocation of 25 clusters of garages in Kfarshima. These clusters can be gathered to form a car services center on a separate lot inside the industrial zone and close to a major road.

b. The relocation of around 115 houses encompassing 364 housing units. This step will free up to 12,000 m2 on the riverbanks and will allow the widening of the channel to at least 16m. The thesis recommends that the relocation process be studied through an inclusive and participatory approach. The resettlement strategy should consider a fair mechanism that

would take into consideration the people's right to housing. The plan should be preceded with detailed analysis and interviews with neighborhood dwellers. However, this extensive research is beyond the scope of this thesis.

B. Enhancing and expanding the river corridor spatially through reactivating vacant lands which occupy strategic locations along the river corridor.

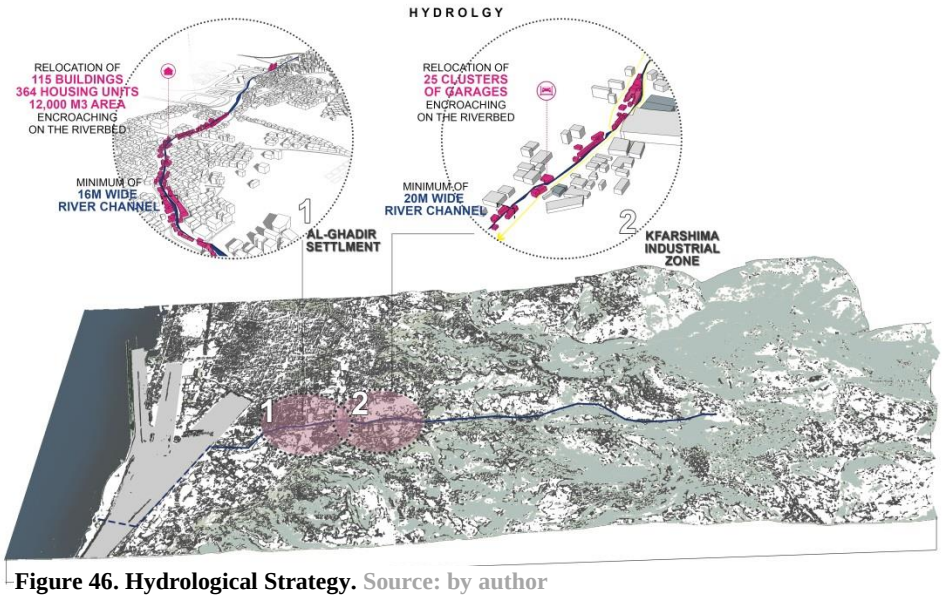


Figure 46. Hydrological Strategy. Source: by author

II. Ecological Integrity: Restoring the ecological integrity and environmental health of the river

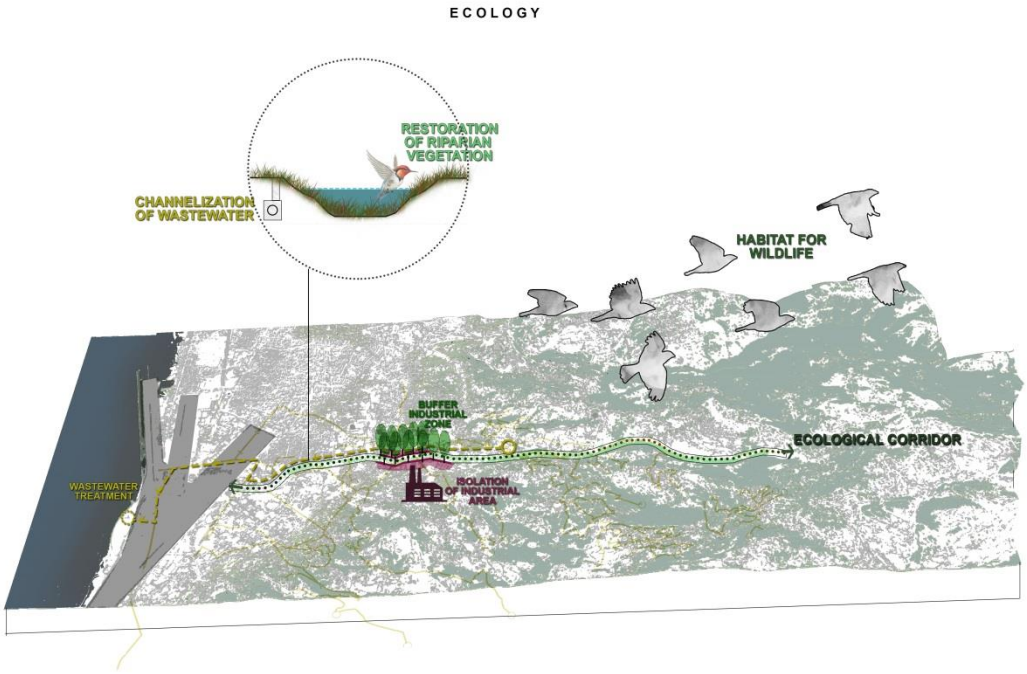


Figure 47. Ecological Strategy. Source: by author

A. Redirecting the discharge of sewage water into an underground culvert that it connected to Al-Ghadir treatment plant to mitigate pollution from wastewater.

B. Reinforcing the environmental protection law 444/2002 which protects rivers from industrial pollutants by requiring all industries to treat their industrial waste in-situ, and states the legal actions against violating institutions.

The research also proposes launching monitoring campaigns that ensure the enforcement of these laws and initiate the legal actions against violating institutions.

C. Restoring the natural and ecological functions of the rivers by reincorporating riparian vegetation and enhancing the floodplain with a more natural edge.

D. Incorporating green buffers to protect the corridor from disturbances such as industries

III. Cultural Network: Regenerating the river corridor as a public realm that will reestablish the intimate connection between people and the river landscape

A. Establishing the river corridor as a linear walkable and recreational space by redesigning the corridor and a network of open spaces at three strategic points:

- Zone 1 Al-Ghadir upstream

- Zone 2- The Industrial Zone

- Zone 3- Al-Ghadir Settlement

A continuous public space can help people overcome the socio-political barriers strengthen the social ties between them.

B. Reconfiguring the road network inside the industrial zone in order to shift the industrial traffic circulation away from the river banks to the peripheries. This will ensure the isolation of the industrial zone and avoid the pollution and disturbance of industrial traffic for the green corridor users.

C. Connecting the villages upstream to the main river corridor through tributary trails.

D. Incorporating the Lebanese University campus into the river corridor by creating a permeable edge between the recreational zone inside the campus and the river

E. Reestablishing the connection between agricultural landscapes and the river through social and cultural activities

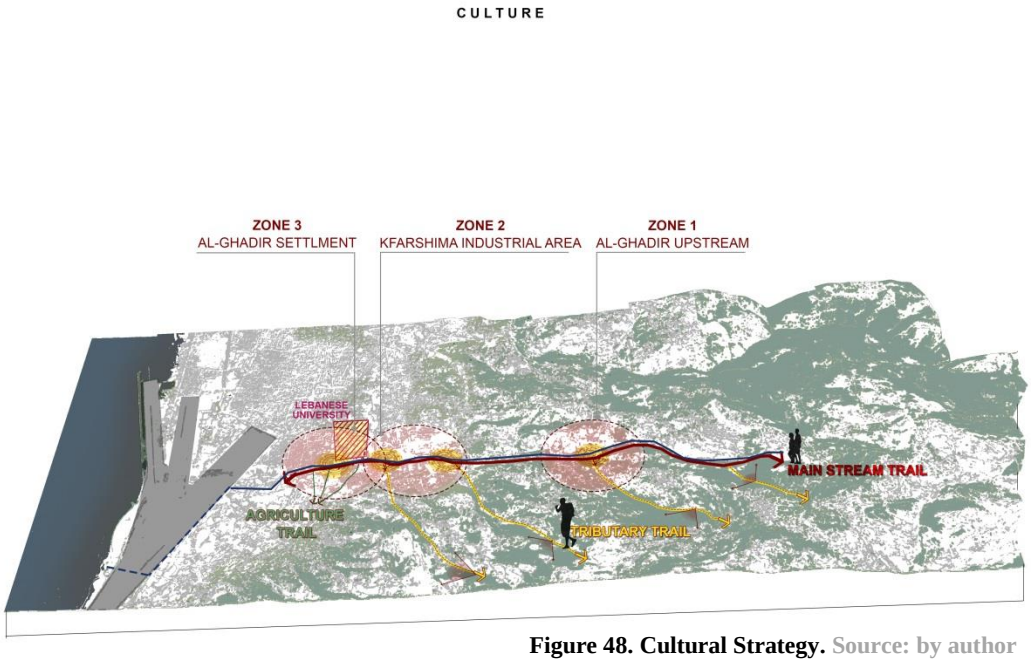


Figure 48. Cultural Strategy. Source: by author

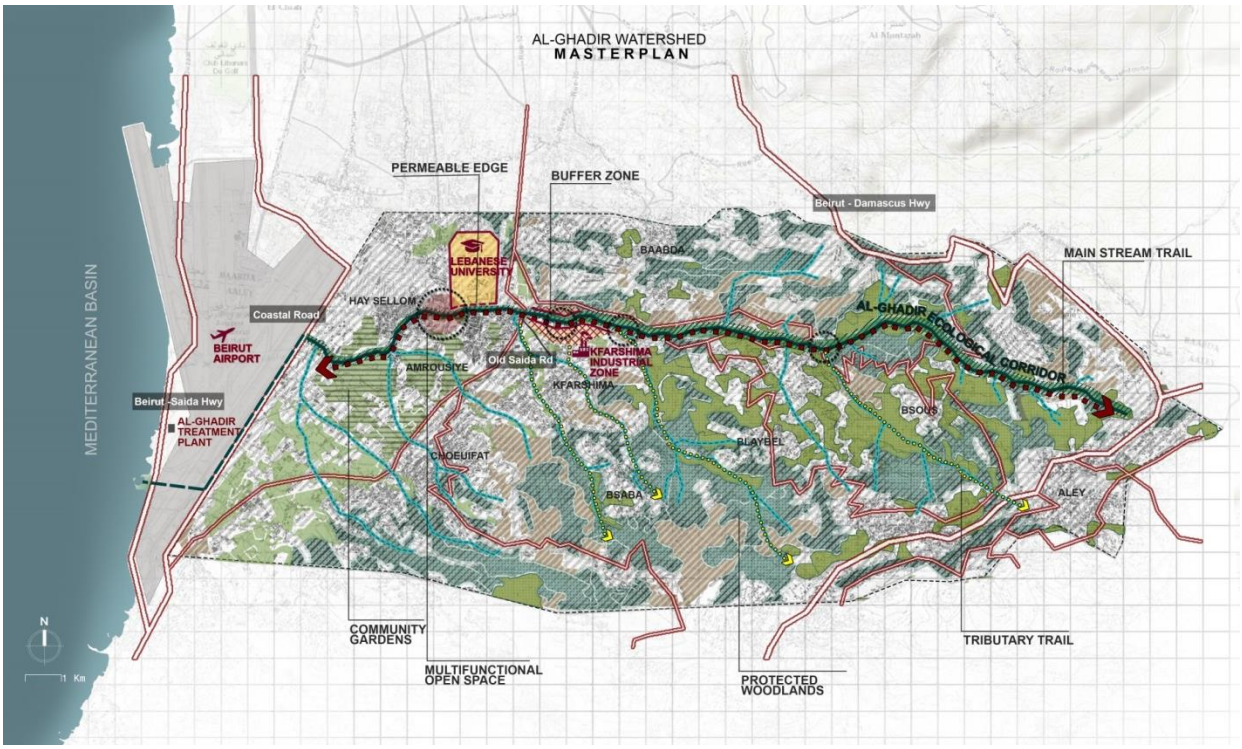


Figure 49. Watershed Master Plan. Source: by author

Figure 51. Zone 1 vision. Source: by author

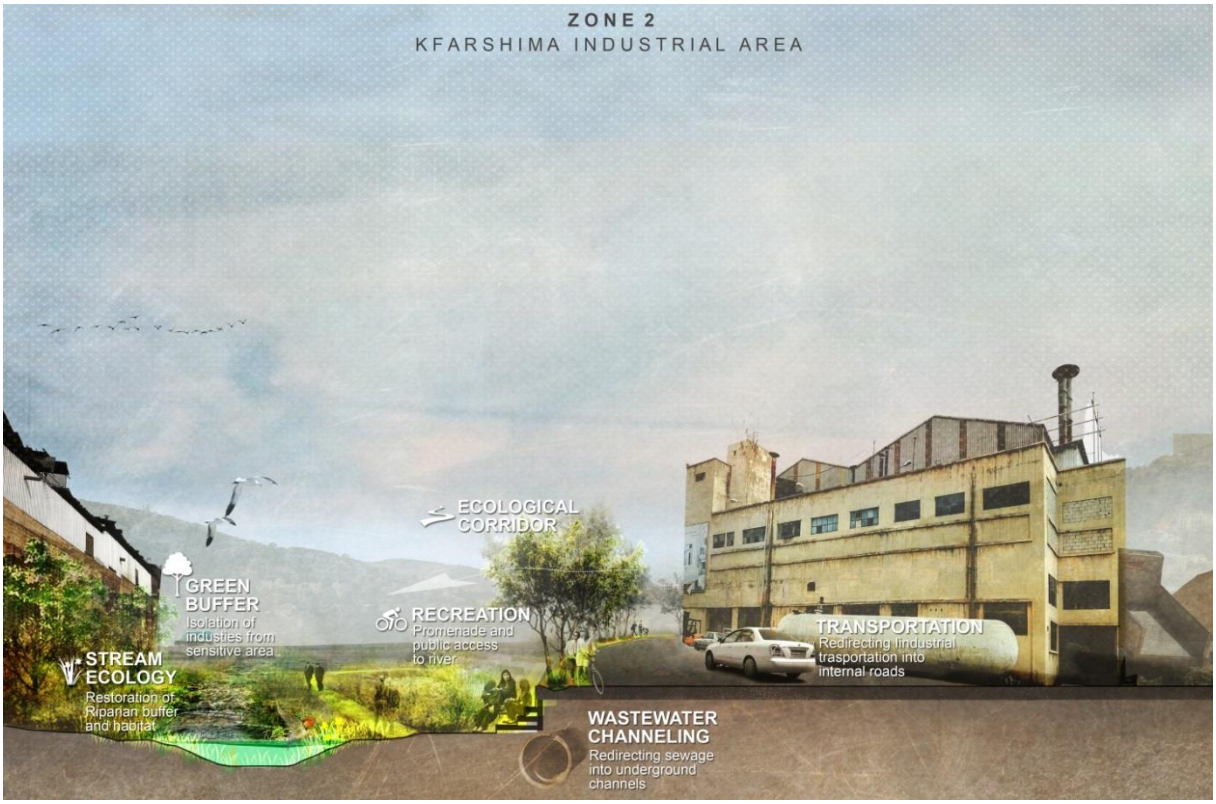


Figure 50. Zone 2 vision. Source: by author

Figure 52. Zone 3 vision. Source: by author

5.3. Institutional Framework

5.3.1. Issues in the Existing Governance Scheme

Added to the challenges faced by the water sector in Lebanon discussed earlier is the lack of coordination between entities on the local administrative level. Al-Ghadir River extends over ten municipalities from its headwaters to the sea, while the whole watershed includes an additional 14 municipalities. Exacerbated by political tensions in some cases, each municipality operates over its own dissected territory of the catchment with little cohesion between entities. Therefore, many issues remain unsolved, given the overlapping of the responsibilities and the lack of dialogue between different

stakeholders. These circumstances lead to the conclusion that Al-Ghadir River lacks a governing institution that deals with the issues arising cohesively.

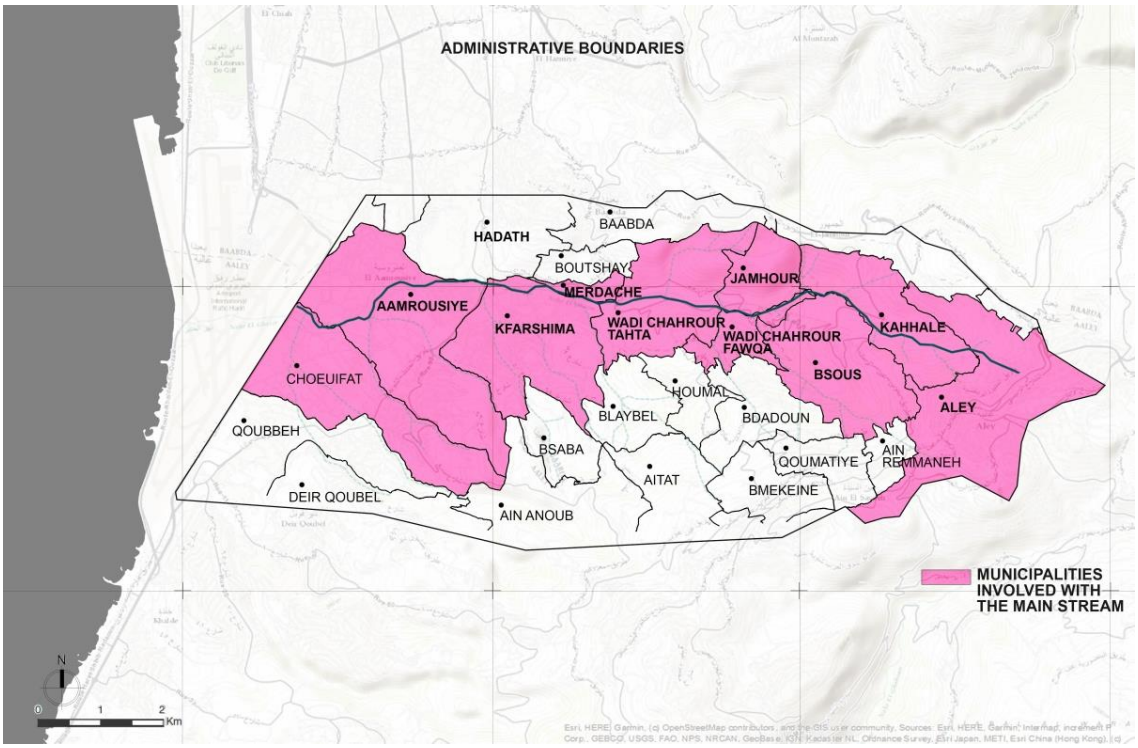


Figure 53. Administrative boundaries in the watershed. Source: by author

5.3.2. The Proposed Institutional Framework

This research proposes a new governance scheme that builds on the successful example of Litani River Authority in Lebanon. The Litani River Authority is a public institution launched in 1954 with a sole mission to implement the Basin Development Plan for Litani River (UNDP, 2010). This plan was concerned with large scale projects related water storage and hyro-power (UNDP, 2010). LRA's scope of work expanded progressively to include the implementation of irrigation schemes in the south (UNDP, 2010). Currently, MoEW delegates two tasks for the authority: to conduct hydrological analysis to all Lebanese rivers and govern Litani Basin (UNDP, 2010).

This research suggests incorporating adjustments to LRA's mission and scope of work to integrate the governing of all rivers in Lebanon. Hence, LRA becomes a public institution with the following mission statement:

> *Lebanese Rivers Authority (LRA) strives to protect, reclaim, and build sustainable catchments to all Lebanese rivers and enhance their corridors from their headwaters to the sea.*

The new institution will comply with the following rules:

1. Boundary: MoWE will delegate LRA to have a mandate over an assigned river for a specified period. During this period, LRA exerts authority over the whole watershed of the given river.

   Expected scenario: According to a decree (XXX/2020), MoWE grants LRA full authority over AL-Ghadir watershed from 2020-2025

2. Information: LRA should employ a multidisciplinary team consisting of hydrologists, engineers, ecologists, urban planners, and designers to assist in data collection, analysis, and planning strategies.
3. Responsibilities: LRA responsibilities fall under two categories:
   1. Establishing sustainable watershed strategies *(this applies to one or two rivers assigned to LRA)*
   2. Monitoring river basins *(this applies to all Lebanese rivers)*

A Proposed scenario of LRA operating over Al-Ghadir Watershed

A. Propose a watershed strategy for Al-Ghadir watershed

B. Monitor the implementation of resettlement strategies and the restoration projects

C. Propose new policies as necessary or suggest policy reforms related to riparian systems or water management, and communicate them with ministries in charge

D. Facilitate synergies between ministries and all concerned stakeholders (industries, municipalities, local communities)

E. Assign a monitoring committee to ensure the enforcement of environmental protection laws and take necessary legal actions in case of violations

CHAPTER 6

THE ECOLOGICAL LANDSCAPE DESIGN INTERVENTION AT AL-GHADIR SETTLEMENT

6.1. Urban Design Strategy

In this section, the thesis defines the urban design strategy adopted in Al-Ghadir settlement. This strategy revolves around the main pillars of the lower-corridor strategy discussed earlier. The goal is to redesign the river system as public amenity that will renew its ecological and socio-cultural benefits. This strategy will create a robust, welcoming, and interactive riverfront that will become a public destination for the people of Al-Ghadir. By this, the river will become an active agent in revitalizing the settlement. The main guidelines of this strategy are:

A. Spatial Connectivity: Providing a pedestrian network will connect the river to the two main souk arteries of the settlement, to the community gardens, the sports area in the university campus, and the adjacent mosque. The purpose is to re-knit the urban fabric of the settlement, and directs its dwellers to the central public destination.

B. Networked Spaces: Providing a continuous promenade along the river channel that connects to the main stream corridor all the way upstream and to the main landmarks in the settlement. The main activities will be centered in the middle of the channel where in a multifunctional open space. This area will host a market, social events, and seating areas. In order to accommodate for this, the thesis will provide design solutions will amplify the capacity of this area to host people.

C. Green corridor: Providing a linear strip of trees that are important for the ecological corridor. These trees will be assigned in a planting strategy, and they will take part in providing shading for the seating areas.

Figure 54. Urban Design Strategy. Source: by author

6.2. Landscape Urban Design Intervention In The Focus Area

6.2.1. Concept Diagram

As previously mentioned, the thesis will provide a landscape urban design intervention in the focus area assigned above. The purpose of this intervention is to create the following:

A. A vibrant central hub in the area that hosts several open spaces, an open market, and an amphitheater connecting the sports area to the site with a connecting plaza at the center

B. A pedestrian friendly open space that engages the whole neighborhood and connects the souk strips, community gardens, and educational institutions to the site

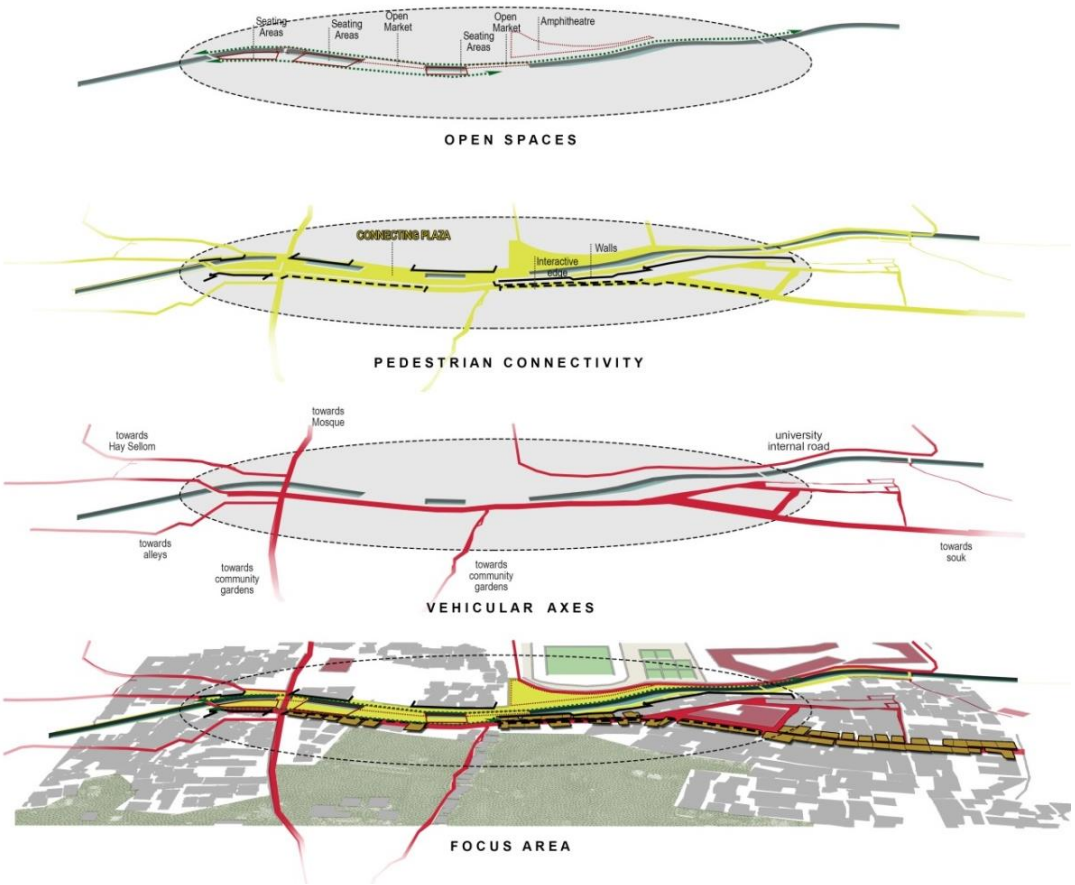
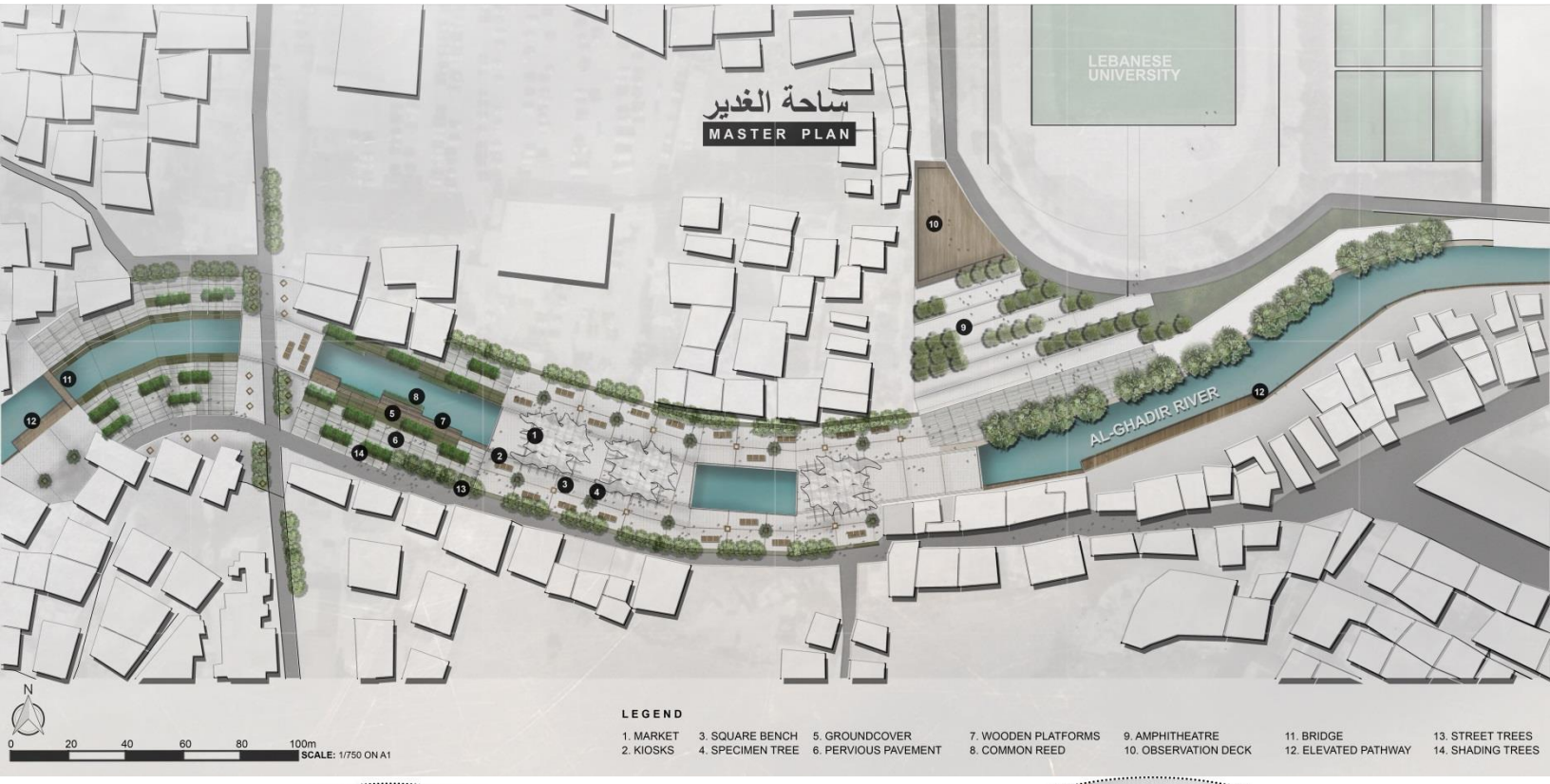
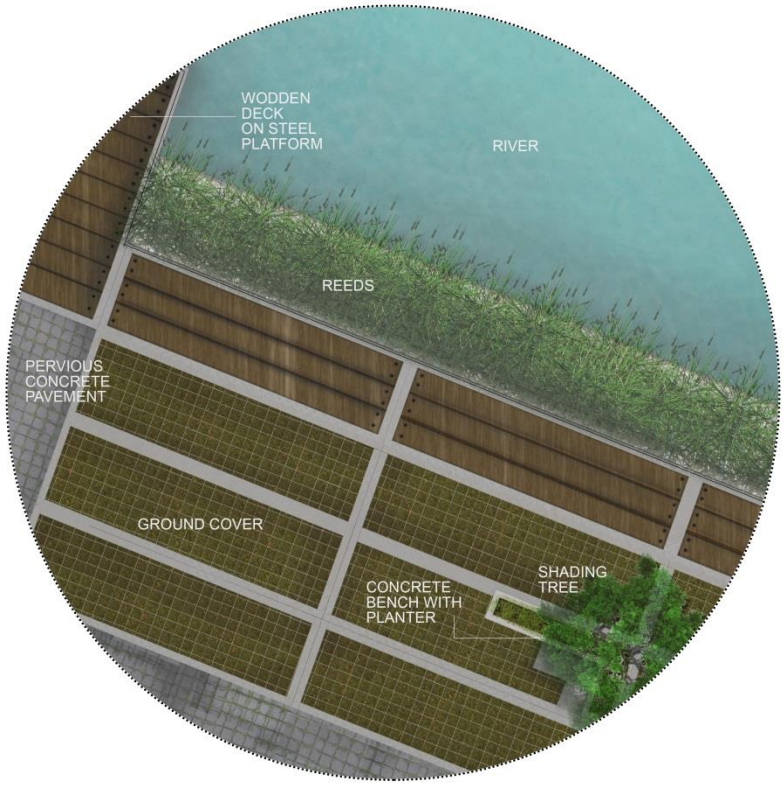


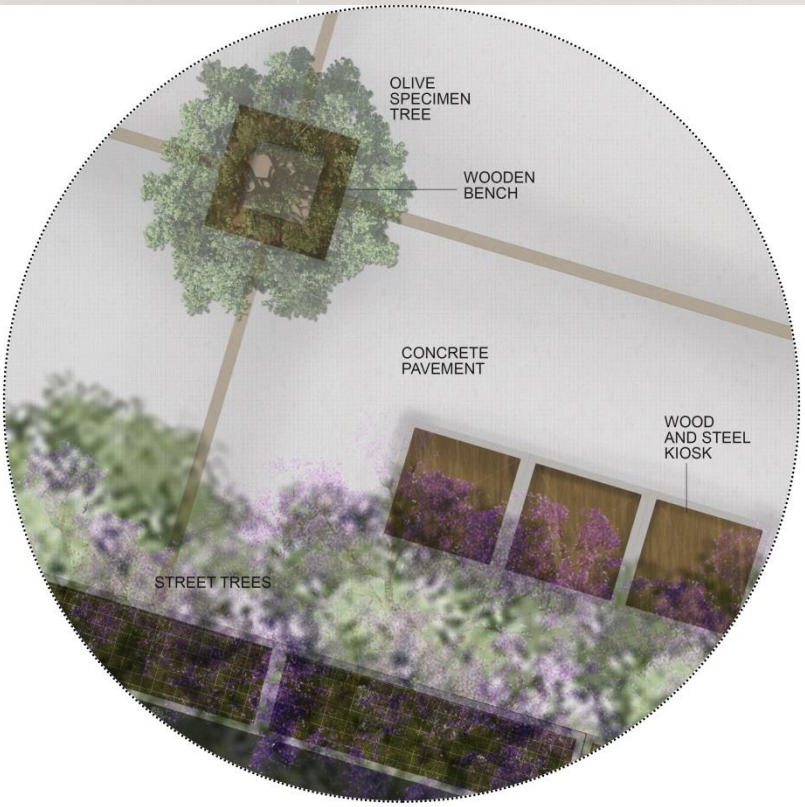
Figure 55. Concept diagram for focus area. Source: by author

6.2.2. Master Plan





DETAILED PLAN 1
RIVERSIDE AREA



DETAILED PLAN 2
STREET SIDE AREA

Figure 56. Design Master Plan. Source: by author

6.2.3. Typologies of River Edge

The design offers different typologies of public access to the river. The aim is to create a more engaging space for users, and accommodate for a more number of people. The four typologies are: elevated walkways, covered channel, lower balconies, and elevated platforms.

A. Elevated Walkway

In order to overcome the necessary wall barrier, the design created a level of floodable walkways. They are small corridors used for connectivity in narrow spots.

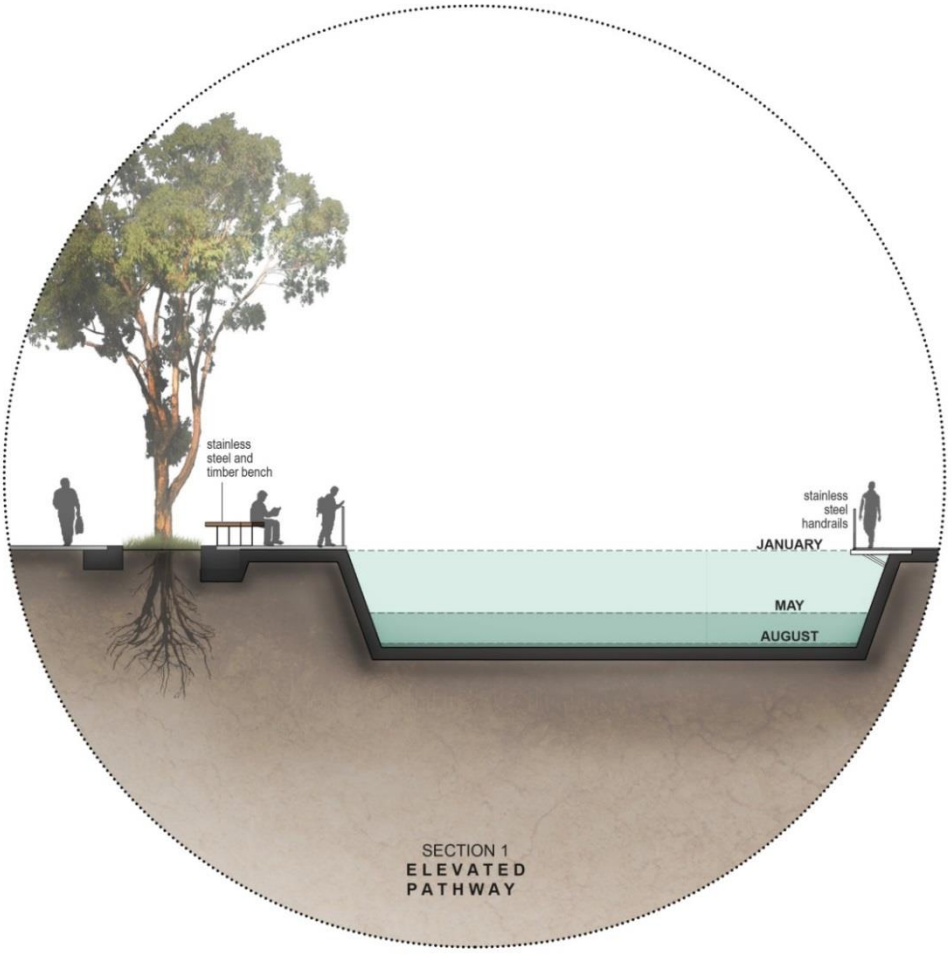


Figure 57. Section 1. Source: by author

B. Covered Channel

In order to provide more space that would cater for an open market, the river channel is covered with reinforced concrete supported by structural steel beams.

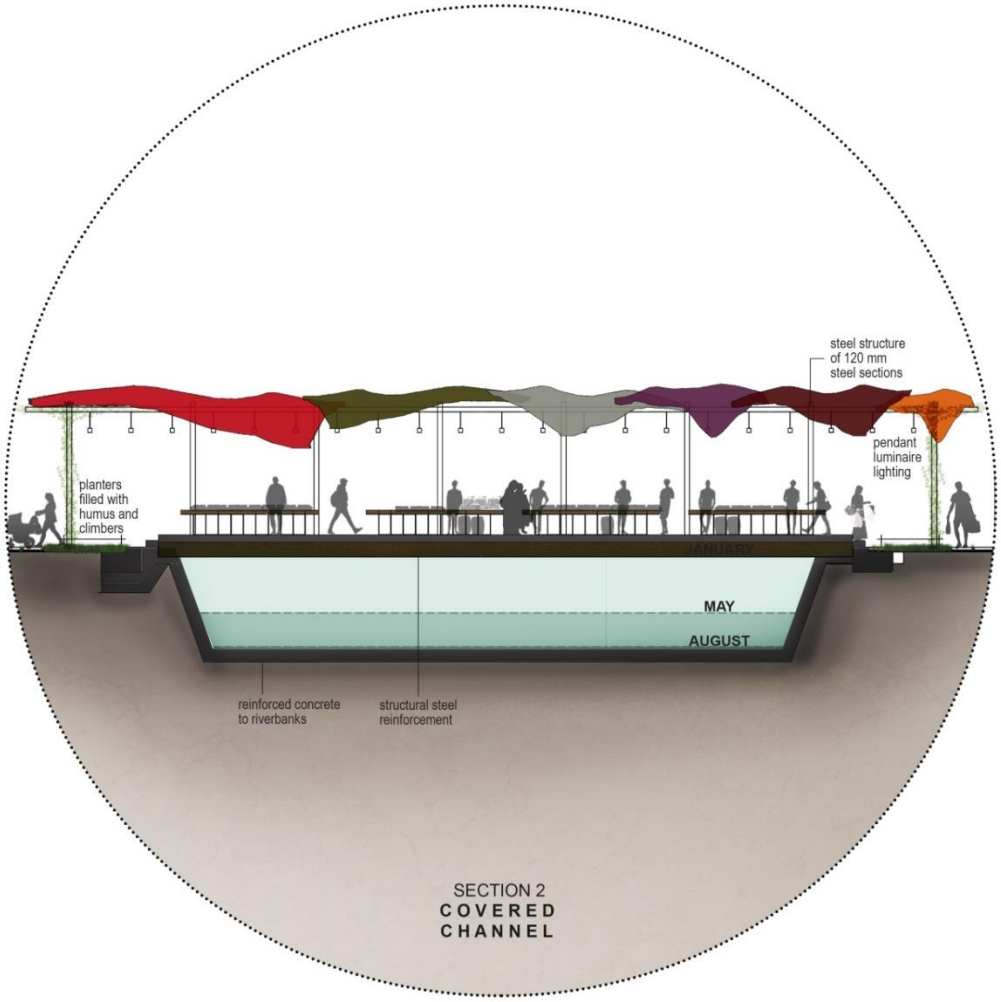


Figure 58. Section 2. Source: by author

C. Lower Balcony

Another typology of the river edge is the lower balcony. A platform connects to the riverbank to create a unique experience at a close proximity to water.

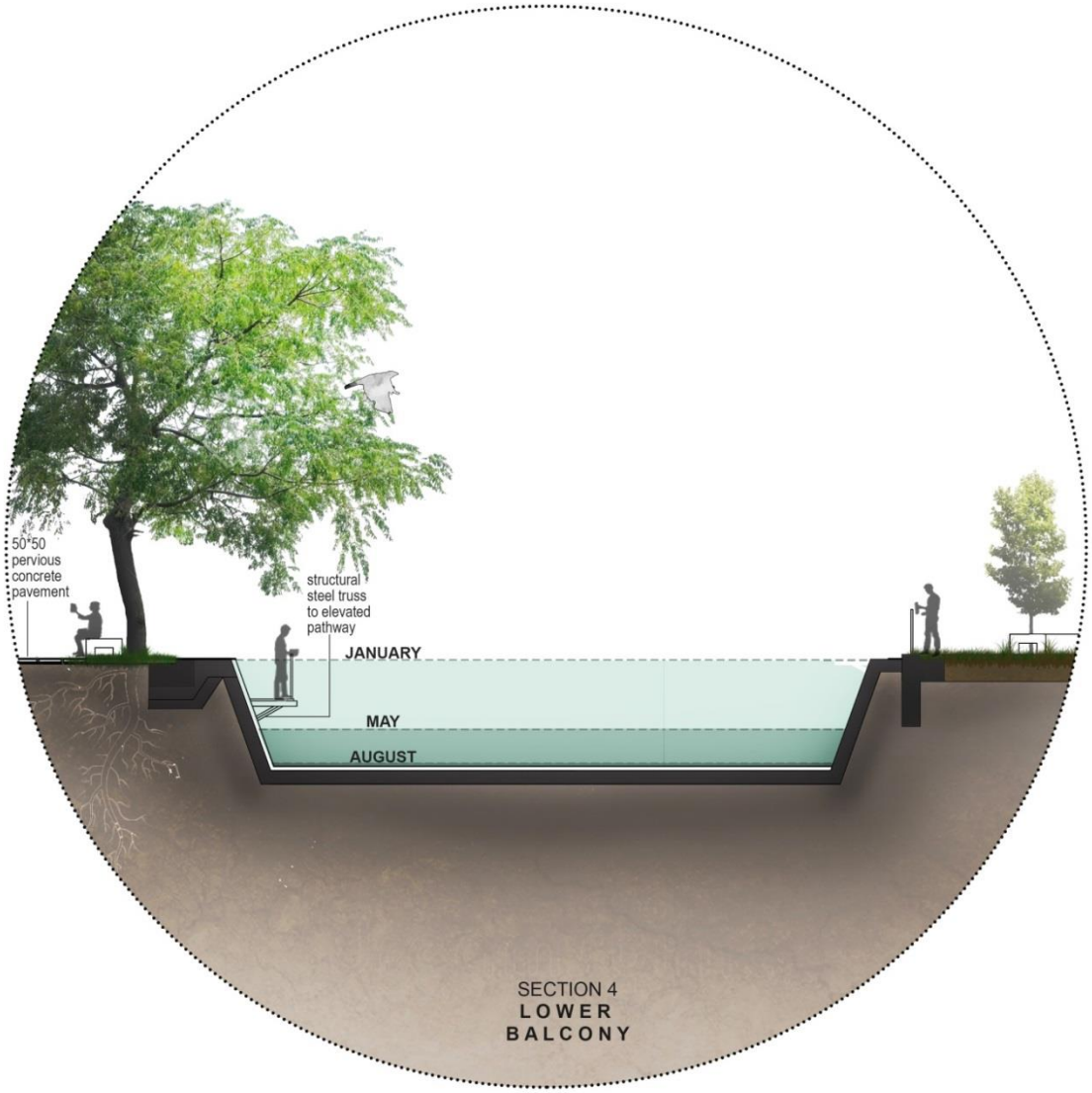


Figure 59. Section 3. Source: by author

D. Elevated Platforms

The design extends over the river channel through stepped platforms. The platforms are steel structure covered with timber wood finishing. They are floodable during the wet season, while they become accessible after May.

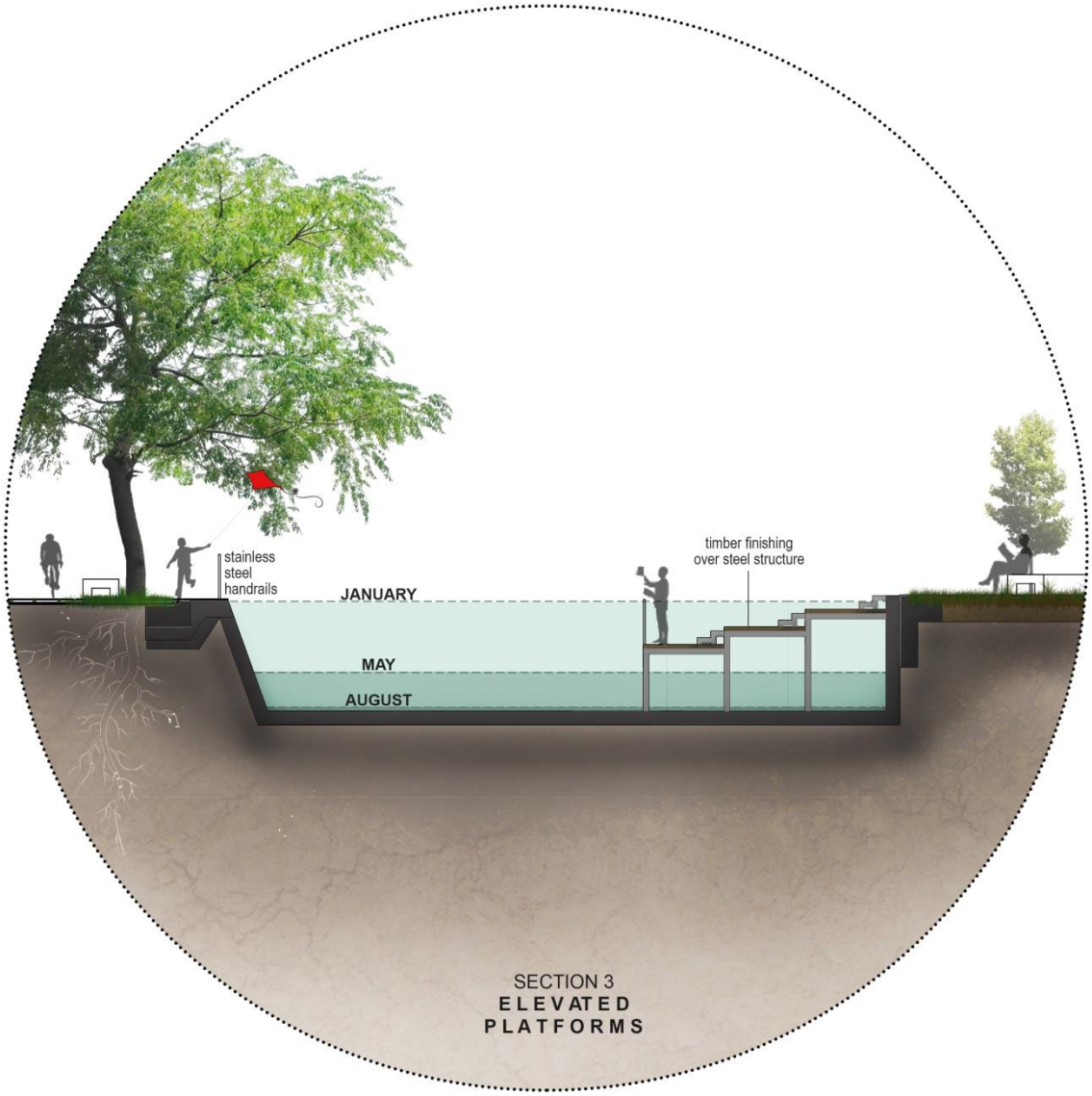


Figure 60. Section 4. Source: by author

6.2.4. Soft-scape Strategy

The design provides a plating strategy that takes into account two notions:

1. The ecological corridor that necessitates native species which can contribute to the ecology and wildlife.

2. The socio-economic circumstances in which this design is expected to be built. Therefore, species which require low cost and low maintenance where chosen.

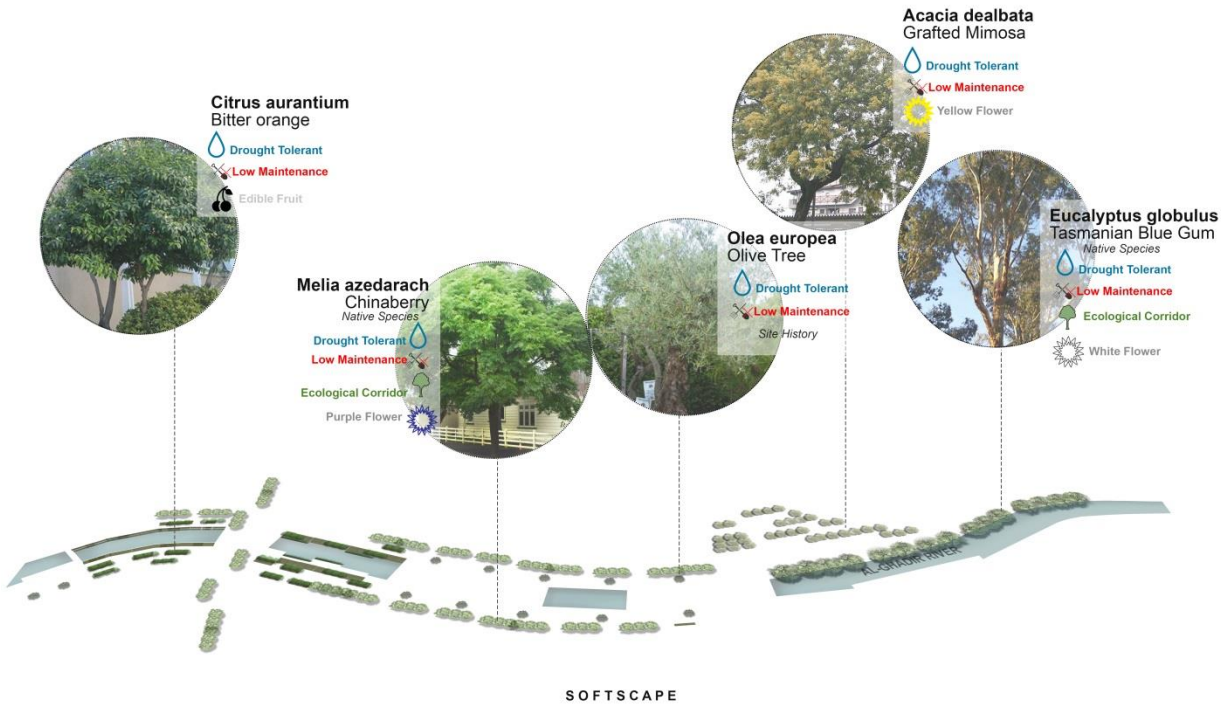


Figure 61. Planting Strategy. Source: by author

6.2.5. Hardscape Strategy

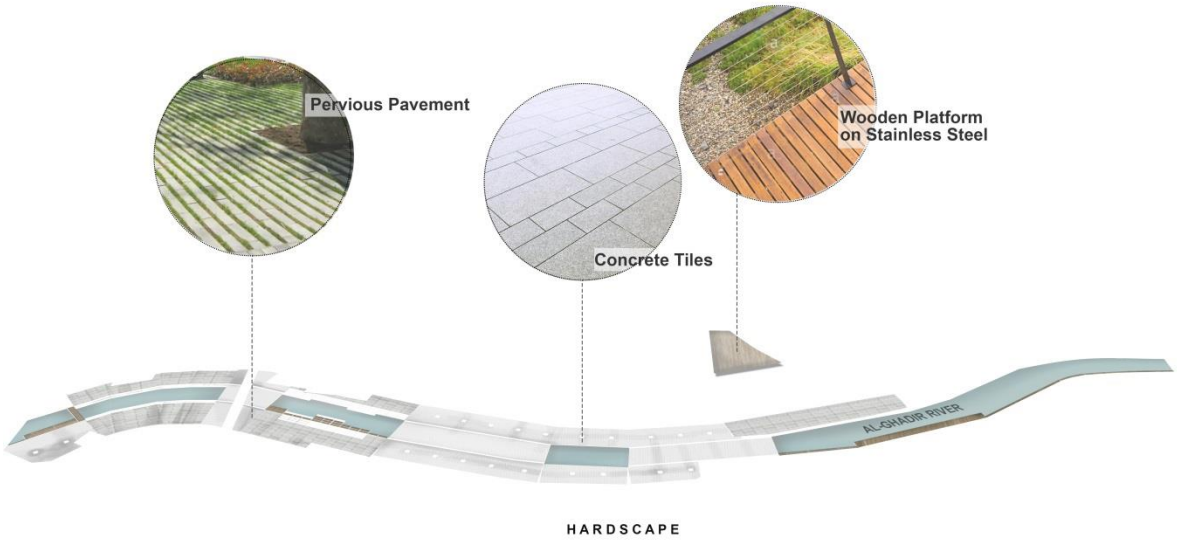


Figure 62. Hardscape strategy. Source: by author

6.2.6. Mood Images

Figure 63. Mood Image showing central plaza. By author

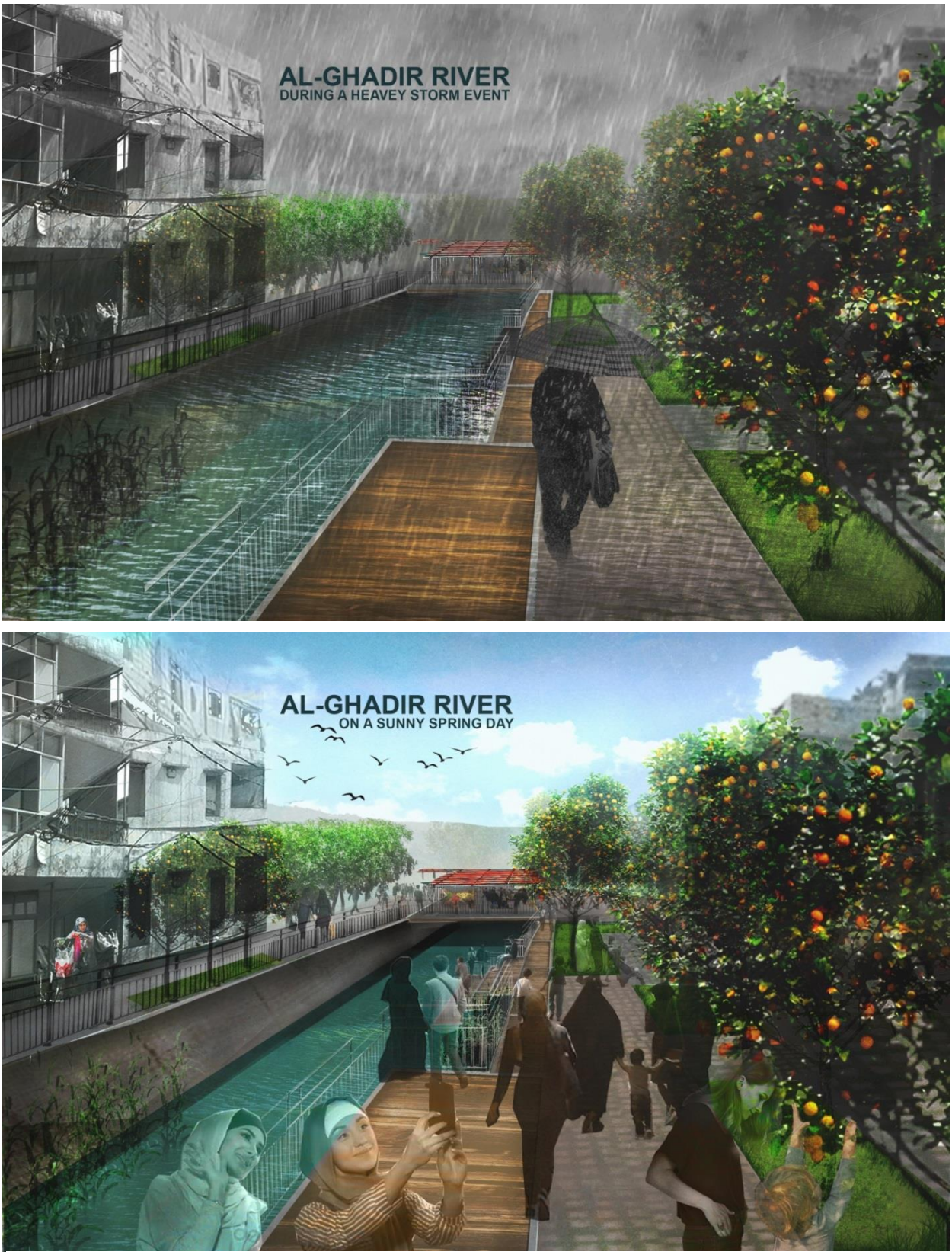


Figure 64. Mood Images showing the river in winter and spring. By author

CHAPTER 7

CONCLUSION

7.1. A Model for Reclaiming Riparian Landscapes

A river is not just water flowing in nature. Rivers are complex systems that encompass intricate ecologies and complex processes that embrace ongoing changes to the riparian geomorphology and hydrology, to social practices and cultural perceptions of the river and shifting political paradigms. The case study of Al-Ghadir captures the direct impact of coastal urbanization, predominantly unregulated, in degrading coastal rivers and streams in Lebanon, ecologically, environmentally, and spatially. This thesis presented a model for reclaiming the riparian landscapes through an ecological approach. This model helps overcome the fragmented approach to the use and management of river landscapes. The three main pillars of this model are:

First, the ecological landscape approach is multi-scalar targeting three levels of intervention:

A) The catchment-based analysis which studies the biotic, abiotic, and cultural components of the watershed landscape

B) The river corridor scale strategies which targets the hydrological and ecological integrity of the river channel and its utilization as a linear cultural corridor

C) The urban-scale which investigates the urban layers of a defined area to reactivate the riverbanks as a landscape amenity for the human realm.

Second, an ecological approach to river reclamation should be multidisciplinary as it should involve research from various domains such as landscape ecology, engineering, and urban planning.

Third, an ecological approach helps understand the mosaic of ecosystems as natural and semi-natural wildlife habitats. Reclaiming riverine landscapes should consider habitat restoration as an integral part of the reconstructed landscape.

7.2. Al-Ghadir: A Degraded Watershed

The case study analysis at the watershed scale demonstrated that Al-Ghadir is a degraded catchment with a high percentage of imperviousness and an alarming river pollution level. Industrial wastes, sewage discharge, and solid waste all contribute to the deterioration of the river. As a result, the river itself has lost its cultural and ecological value and is currently an environmental hazard. Moreover, the research identified the most vulnerable area over the watershed, Al-Ghadir settlement. On the other hand, the study uncovered the main assets of the basin that could be built on. These assets include a considerate percentage of forest cover, scrublands, and a large patch of arable lands in the vicinity of the settlement.

7.3. Reclaiming Al-Ghadir River

In an attempt to reclaim Al-Ghadir riparian landscape, the thesis recommended strategies and guidelines across three different scales (watershed scale, corridor-level, and settlement-level), addressing the problem from four dimensions:

7.3.1. The Ecological Dimension:

From an ecological dimension, the thesis proposed measurements towards natural resources conservation, namely the Pine and Oak woodlands present in the upstream level of the watershed. The thesis stressed the importance of these landscapes in mitigating the effects of high-density urban areas on the hydraulic system, preserving biodiversity, and providing a human realm suitable for recreation. As for the river channel, the thesis reimagined Al-Ghadir River as an ecological corridor by restoring its ecological functions (restoration of riparian vegetation and green buffers).

7.3.2. The Environmental Dimension:

The thesis also addressed the environmental degradation of the river system due to alarming levels of pollution. In this domain, the thesis resorted to legislative measures and structural engineering processes. In the legislation part, the thesis proposed the reinforcement of environmental protection law 444/2002, which forces industries to treat their wastewater and take action against violations. As for the river channel engineering measurement, the thesis proposed an independent wastewater channel to avoid direct discharge of sewage into the river.

7.3.3. The Spatial Dimension:

The thesis addressed the spatial dimension from a hydrological perspective. As the drainage analysis confirmed that the coastal sub-catchment (S9), which holds the settlement endures alarming peak flow and velocity intensities, the thesis proposed a twofold strategy to address spatial encroachment onto the river domain: first, increasing the size of the river channel to accommodate the increased flow; second, relocation of 115 houses and 25 informal garages encroaching on the river domain.

7.3.4. The Planning Dimension:

From a planning dimension, the thesis stressed the importance of integrated watershed management, that addresses river reclamation from a holistic perspective. This approach necessitates incorporating the river basin in the planning framework. However, given the complexity of this approach, the thesis proposes an institutional framework that can address Al-Ghadir watershed holistically. This governance scheme suggests incorporating adjustments to the currently available river basin authority LRA to encompass all Lebanese rivers. By this, LRA will be responsible for protecting, reclaiming, and governing Al-Ghadir River.

7.4. Research Limitations

Although this research-based its methodology on extensive analysis done on the settlement level and several site visits that required interaction with people, the integration of people's thoughts was limited to their perception of the river and their knowledge about the existing situation. This research prioritized a multi-scalar

comprehensive approach over a bottom-up approach in design. Therefore, it lacked a participatory approach in the planning and design thinking that could have had a considerable impact on the design outcome. However, this approach requires meetings and workshops with the local community, and due to time constraints, it was unfeasible.

Moreover, the research presented vision and strategies which were bound to a particular time after implementation. Rivers, however, are dynamic systems, and time is a significant factor in shaping and transforming these systems. Natural ecosystems respond to natural processes such as ecological succession, which has an impressive impact on riparian systems in particular. Therefore, this research lacked this specific concept. From another perspective, the implementation of such visionary projects necessitates phasing. The study could have presented a proposal for the implementation plan that could happen over the years.

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