Master's thesis

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Moving Towards the Urban Ecological Restoration of The Bagmati River

How can different institutions collaborate, together with citizens, to help the restoration process

Master's thesis in Urban Ecological Planning
Supervisor: Prof. Dr.-Ing. Peter Gotsch & Assistant Prof. Mrudhula Koshy
June 2023

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Masteroppgave i Urban Ecological Planning
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Fakultet for arkitektur og design
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ABSTRACT

The Bagmati River found in the Kathmandu Valley in Nepal is considered holy for many worshippers who practice Hinduism and Buddhism, nevertheless today the river presents itself as a degraded, trash-filled, polluted stream that meanders its way through both Kathmandu and Lalitpur. Over the past few decades many issues concerning Bagmati have arisen such as the industry of sand mining, squatters settlements, religious activities, and sewage dumping have all contributed to the degradation of the river.

While there has been a growth in social awareness campaigns and environmental conservation programs through different government and non-government institutions over the past decade, none have really made a significant impact. This is due to a lack of resources available and the lack of ideal ecological solutions that could be implemented within the riverscape. Previously, the Bagmati was seen as the landmark of the Kathmandu Valley, where people enjoyed doing activities besides its banks and swimming in its clean waters, but as the cities have developed, its image has been reduced to a wasteland where many citizens just pass by its bridges not daring to go near its murky black waters.

For this reason, it is important to explore ways in which different institutions that have developed programs in the past could form partnerships and collaborate with citizens and communities to guide the ecological restoration of the Bagmati River. This is done by presenting a restoration plan where the different ecological solutions researched are outlined and an analysis is made of the possible areas they could be implemented within the Bagmati River. Hence, the goal is to provide stakeholders with knowledge of which ecological solutions can be implemented within the Bagmati in order for them to work simultaneously with each other to accelerate the restoration process of the river. Ultimately forming a case study that could be further implemented in other highly polluted rivers found across the globe.

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13th June 2023

Trondheim, Norway

Alberto Vertiz

STATEMENT OF ORIGINALITY

Here, I certify that this is my own work and that the materials have not been published before, or presented at any other module, or program. The contents presented in this thesis are my own study and work, not a “duplicate” from others. Where the knowledge, ideas, and words of others have been drawn upon, whether published or unpublished, due acknowledgments have been given.

June 2023

Trondheim, Norway

Luis Alberto Vertiz Jaime

PREFACE

Having lived in different parts of the world like Singapore, China, and Mexico, and visited many countries in Asia like Vietnam, Malaysia, and Myanmar, I have experienced different lifestyles and I've broadened my conceptual understanding of how cities could function and develop in order to be efficient but at the same time ecological and sustainable. Today, cities are not just world-renowned for their multi-storied architectural marvels but also for their consistent efforts to create garden cities, where ecology is a key factor where people can coexist with nature to live a better life. In my travels in Asia, I have witnessed how communities use the rivers as a way of life in order to transport themselves, conduct activities, or even live on them as water is a precious resource for us humans since the beginning of civilizations. As an architect-planner, I strongly admire this philosophy, and I am determined to build a career where I can shape built environments where humans can live harmoniously with each other but also co-exist with flora and fauna.

My design explorations throughout my academic experience have been strongly rooted in the concept of ecology and the creation of garden cities. For instance, during my Bachelor's in Architecture, I developed a project in river rehabilitation for a river situated in the south of Mexico City. Here, along with my teammates, we were able to distinguish the different problems the river faced, and why the neighborhoods around it were not using it. We quickly found out that it wasn't perceived as an attractive place, it was polluted, and it was considered unsafe to walk at night. Therefore, we proposed to implement different activities on the river shoreline, as well as cleaning practices where the community would be involved, and provide secure places, especially for women and children at night.

With projects like these, the factor of maintenance is key so that it doesn't deteriorate again, so it's always important to strive for easy, passive urban ecological solutions of community involvement in order to keep the area well-maintained so that future generations are able to use it.

For this master's thesis, I felt motivated to address the case study of the Bagmati River in the Kathmandu Valley, Nepal. This is because I soon found out about the many challenges the river poses due to factors such as sand mining, religious activities, and squatter settlements being in the area. Therefore, I was looking forward to implementing my methodology to uncover answers to how ecologically restore this heavily polluted urban river

Furthermore, I was excited to explore a new country and engage with the lives of the local communities, their traditions, and culture. I believe that this fieldwork gave me important insights into how citizen engagement can address issues and impact the development of ecological solutions to restore an urban river. Ultimately, changing the ecosystem within a green-blue infrastructure and creating a better livable urbanscape for communities.

Rivers are what started civilizations in the past and the reason why we have survived throughout the decades as these provided initially water to live. Therefore, it is important to conserve and maintain their ecosystems and environment so that we humans can co-exist with the flora and fauna found in these blue-green infrastructures but also give us a green urbanscape of open spaces for us to conduct various activities. I am aware that this investigation did not cover many aspects due to the topic of the restoration of urban rivers being a never-ending process in urban ecological planning. Nevertheless, hopefully, with this thesis, I was able to contribute a small part to the investigation on ecologically restoring urban rivers using citizen engagement and ideas for the further development of the topic.

TABLE OF CONTENTS

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

BAP - Bagmati Action Plan

BASP - Bagmati Area Sewerage Construction/Rehabilitation Project

BRBIP - Bagmati River Basin Improvement Project

BRF - Bagmati River Festival

CIUD - Center of Integrated Urban Development

COVID-19 - Corona Virus Disease of 2019

DO - Diffused Oxygen

ECCA - Environmental Caps for Conservation Awareness

HPCIDBC - High-Powered Committee for Integrated Development of Bagmati Civilization

IOE - Institute Of Engineering

KMC - Kathmandu Metropolitan City

LMC - Lalitpur Metropolitan City

MLD - Million Liters Daily

NIURS - Nepal Institute for Urban and Regional Studies

NGO - Non-Governmental Organization

NRCT - The Nepal River Conservation Trust

NTNC - National Trust for Nature Conservation

NTNU - Norwegian University of Science and Technology

SDGs - Sustainable Development Goals

SWOT - Strengths, Weaknesses, Opportunities, Threats

PID - Project Implementation Directorate

PCPA - People Centric Planning Approach

UEP - Urban Ecological Planning

UN - United Nations

UNESCO - United Nations Educational, Scientific and Cultural Organization

1. INTRODUCTION

Since the first civilizations started appearing, human beings have always preferred settling alongside sources of water, as water is the vital liquid that gives us life. This is because it is a source of food production in terms of crops, drinking water, and transportation through the use of boats. For this reason, rivers, lakes, and estuaries have become vital for the rise of towns, as human populations were freed from direct dependence on food getting (Dury, 2022). Humans could now establish themselves in one place and further develop their civilizations, to what they have become today.

According to National Geographic, a river is "a ribbon-like body of water that flows downhill from the force of gravity. A river can be wide and deep, or shallow enough for a person to wade across" (National Geographic Society, 2022. paragraph 1). The water in rivers is fresh, meaning that it contains less than one percent salt. However, rivers still carry and distribute important salts and nutrients to support plant and animal life (National Geographic Society, 2022). For this reason, humans have always been searching for rivers to build their civilizations. Rivers often originate high up in the mountains due to rainfall or the melting of ice and snow accumulated in the mountain peaks. Rivers then meander through the geographical sites of nature until they reach the sea where they merge with the salty sea water. Humans started intercepting these rivers at various points throughout history in order to build their civilizations and now, many important rivers around the world pass through several cities that have been urbanized with tens of thousands of people living along its banks.

Urban Rivers

Today, rivers that flow through major cities have been denominated as urban rivers. One definition states that urban rivers include rivers, or river segments, which originate or flow in urban regions, as well as canals or channels, which are man-made but have, over time, achieved characteristics of natural rivers (Yue, 2012). This is because urban patterns have changed the morphology of how they flow through cities by limiting their natural space by making them wider or shorter, as well as building walls parallel to them. The result of this has made these rivers feel they have been trapped in the urban density within cities. Furthermore, industrial development has caused water pollution, erosion, sedimentation, and downstream flooding. Human activities have decreased the naturalness, diversity, feasibility, and beauty of urban river landscapes (Yue, 2012).

Before the turn of the 21st century, the topic of *urban rivers* started to gain popularity as people started discussing how these urbanized rivers could be brought back to their original environmental state in an ecological way. This is important as river corridors play important ecological roles such as providing habitats, acting as filters and barriers, and being water sources (Kondolf and Pinto, 2017). Additionally, these rivers form part of the green infrastructure of urban spaces of cities, where people can walk, interact, and do various activities along its banks. This is due to the de-industrialization of towns in the 20th century but also to the era of consciousness where global warming and climate change factors came to be known better.

Many governmental and non-profit organization initiatives in many cities around the world have started urban development plans and programs in order to rescue the vitality and bring back the scenery that these rivers once had before the industrial revolution and where global city populations were much less than what they are now. While many programs have been successful in the global north[1], plenty have failed in the global south[2] (Breuste *et al*, 2013). This is attributed to unorganized planning programs set up by the government and institutional bodies that lack available resources, existing capacities, insufficient planning systems, etc. Therefore, the inhabitants that live near these rivers have opposed the decisions, as these will have a negative impact on their economy and social lives. Furthermore, other initiatives that have been a success have been a burden to marginalized communities and governments have kept these neighborhoods out of the sight of tourists and other communities within their own country or city (Everard *et al*, 2012).

This thesis will focus on the urban river of Bagmati, which is located in the Kathmandu Valley in Nepal. This topic will be addressed as the Bagmati River has been subjected to weak planning mechanisms, degraded environmental quality, and a lack of environmental programs. Therefore the river has degraded over time to the point where no life exists underwater, and the citizens of Kathmandu are no longer able to enjoy it.

1 States that are generally seen as part of the Global North tend to be wealthier, less unequal and considered more democratic and to be developed countries who export technologically advanced manufactured products; the North—with one quarter of the world population—controls four-fifths of the income earned anywhere in the world. 90% of the manufacturing industries are owned by and located in the North (Li, 2022).

2 The phrase "Global South" refers "broadly to the regions of Latin America, Asia, Africa, and Oceania. It is one of a family of terms, including "Third World" and "Periphery," that denote regions outside Europe, North America and Australia, mostly (though not all) low-income and often politically or culturally marginalized. The use of the phrase Global South marks a shift from a central focus on development or cultural difference toward an emphasis on geopolitical relations of power" (Dados and Connell, 2012. p.12).

Urbanization of the Kathmandu Valley

The urban valley of Kathmandu in Nepal with an urban population of 2.9 million people, comprises the cities of Kathmandu, Lalitpur, and Bhaktapur as seen in Figure 1 Kathmandu Metropolitan City (KMC) is the largest of the three, with a total population of nearly one million people according to the last census made in 2011 (Karki, 2019). The city is spread over 49 square kilometers and consists of 32 wards and is the capital city of Nepal. Here is where all the governing institutions lie as well as the tall commercial buildings. The KMC is a very dense city, with a total density of 19,900 people per square kilometer.

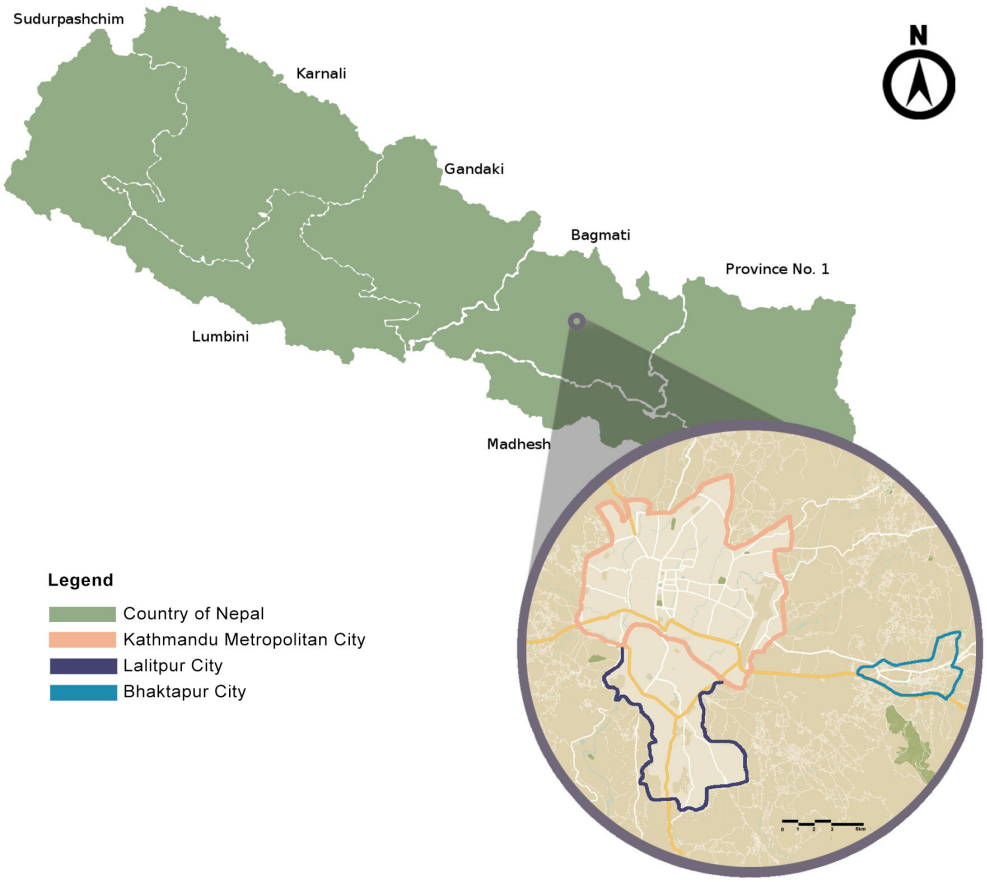


Fig 1. Map of the Kathmandu Valley subdivided into cities, within the greater map of Nepal. (Source: Author, adapted from Google map, 2023)

To the south of the Kathmandu Metropolitan City lies Lalitpur, the second largest entity as seen in Figure 1 The city of Lalitpur is defined by the Bagmati River as once you cross the river from the north of Kathmandu, you find yourself in Lalitpur. Several gates and pillars can be seen across the different bridges that cross the Bagmati River, welcoming citizens into the city as seen in Figure 2. According to the 2011 Census conducted by the Central Bureau of Statistics (CBS), Lalitpur has a total population of 284,922 people (Karki, 2019). It has narrow streets

and five-story buildings which consist mostly of shop houses. Finally, to the east of KMC, the small but dense city of Bhaktapur is found. It has an area of only 7 square Kilometres with a density of 11,000 people per square kilometer. Bhaktapur once served as the capital city of Nepal back in the 12th century and it is one of the major Newar settlements of the country (Bhaktapur, 2023). Here is where the Nyatopala temple lies, which is the tallest temple in the whole of Nepal (Bhaktapur, 2023).

Fig 2. Gates that welcome people into the city. (Source: Author, 2023)

Here, the river Bagmati meanders its way from the northeast, separating the cities of Lalitpur and Kathmandu, and at various points, the Manohara and Bishnumati rivers join until it exits the valley via Chobar in the South-West (Subedi and Sehgal, 2022) as seen in Figure 3 smaller streams also join the river while it passes through the city. The Bagmati's river headwater is located at the tributaries of Mahabharat and Chure Ranges which are 2690 meters high and found in the Shivapuri-Nagarjuna hills. This river runs through the city and then descends down passing several villages until its mouth joins the Kamla River found in India as shown below in Figure 4. This region is known as the Indian Gangetic Plain, which also includes part of Bangladesh and where all rivers end at the Meghna Estuary in the Bay of Bengal (National Trust for Nature Conservation, 2022).

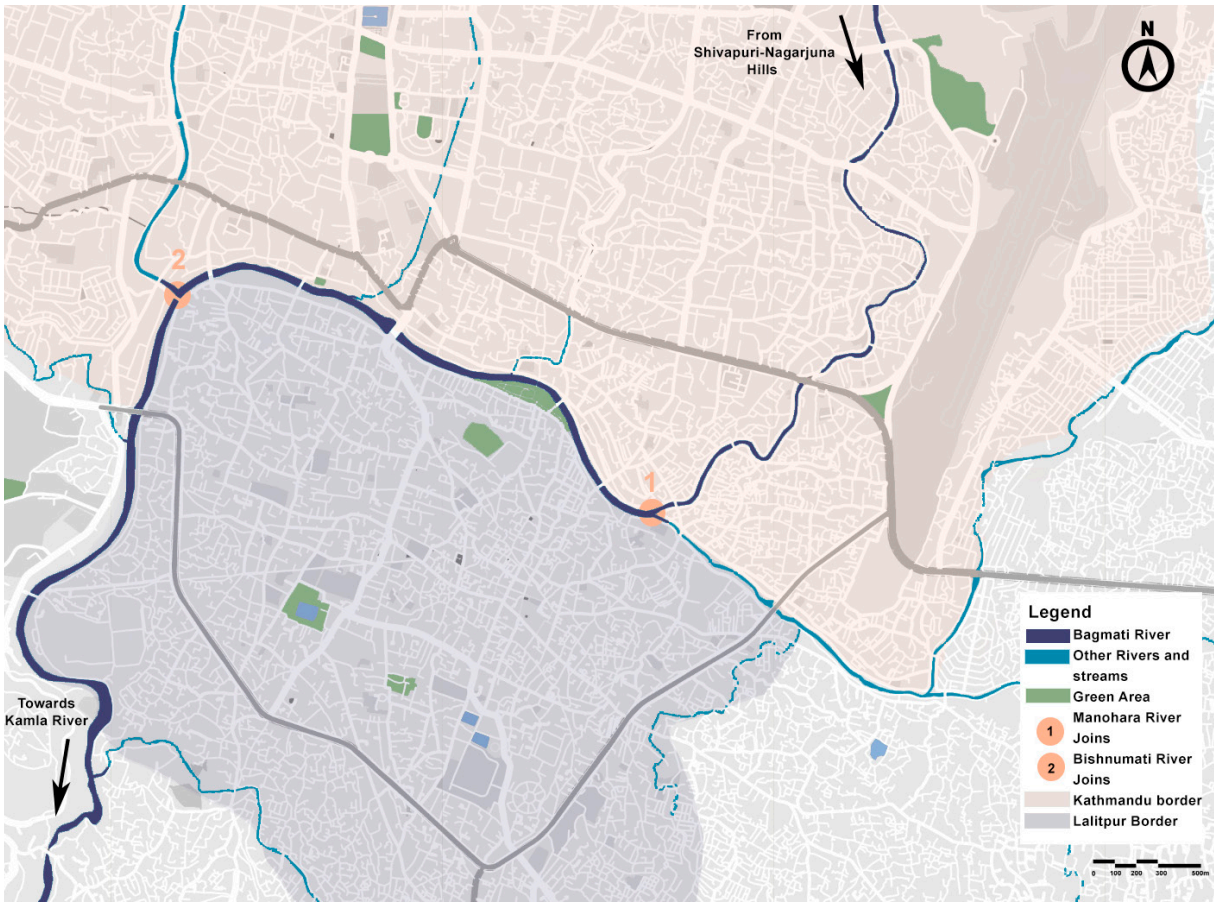


Fig 3. Map representing the separation of KMC and LMC due to the Bagmati River. (Source, Author, adapted from google maps, 2023)

The UNESCO World Heritage Site of Pashupatinath is the most significant temple dedicated to the god Shiva and it is believed that those who die in that temple will be reincarnated as a human in their next life (Evason, 2017). This plays a major part in the history of the Bagmati River as for both Hindus and Buddhists the river is considered holy, especially in the Hindu culture. With 93% of the Nepali population being religious, a census in 2011 showed that 81.3% are believed to be Hindu, 9% Buddhist, and 4.4% Muslim (Evason, 2017). This is because rivers represent the goddess “Ganga” and it is believed that the river can purify people’s souls especially after one has passed away. For these reasons alongside the river banks of Kathmandu, many religious temples as well as cremation sites have been built to perform several rituals.

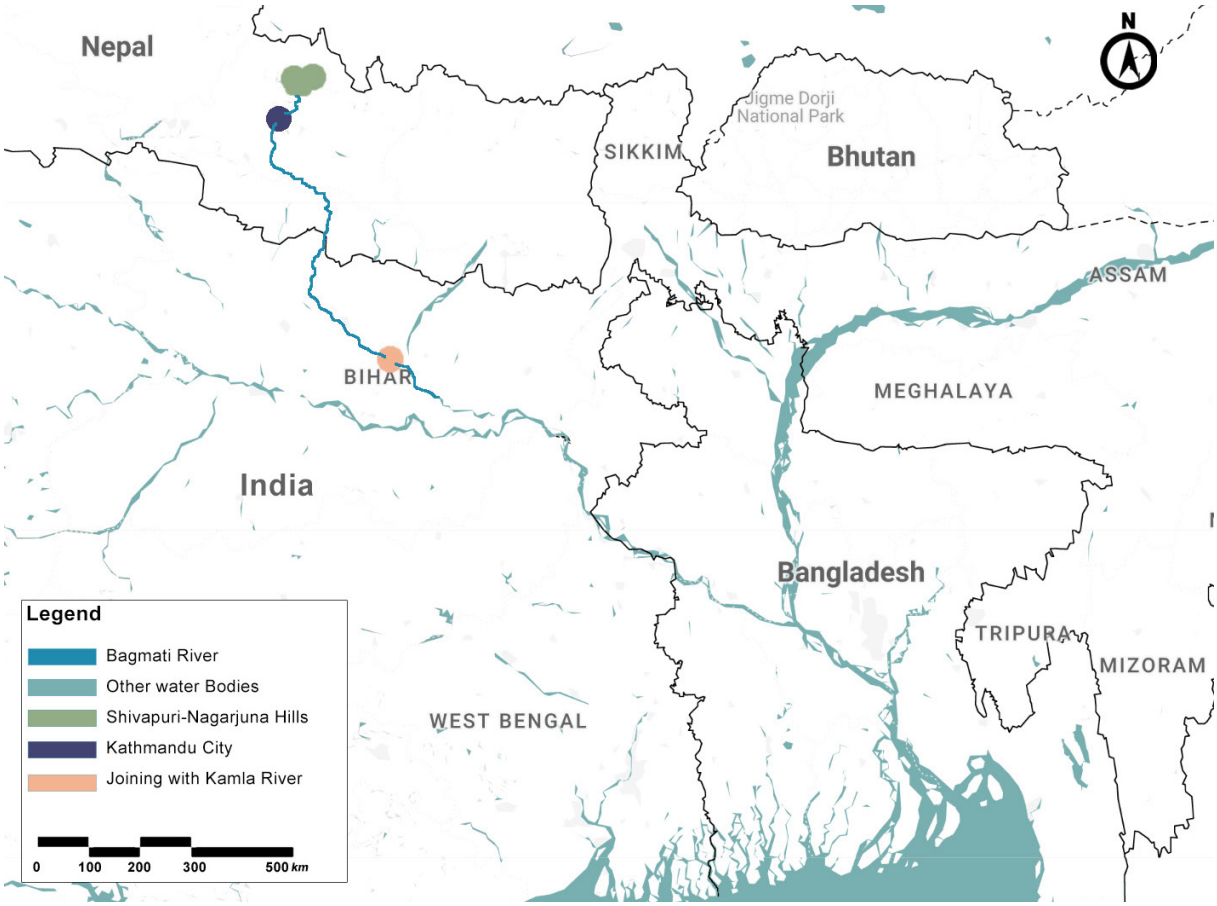


Fig 4. Map showing how the Bagmati River makes its way to the Bay of Bengal. (Source: Author, adapted from google maps, 2023)

Moreover, this is why many elderly people who follow Hinduism make the journey to Kathmandu in order to live the last few months or weeks of their life in the temple to eventually die. Rituals are then performed such as dipping the feet of the dead body in the river three times to end their reincarnation cycle before the body is cremated (Subedi and Sehgal, 2022). Their remains are put into the sacred Bagmati River, which eventually meets the holy river Ganges, further down the stream in India.

Despite the river being the image of the goddess "*Ganga*", unfortunately, the river has suffered from degradation and pollution in the Kathmandu Valley as the decades have passed. The water is no longer clear as its headwater when it leaves the valley. The color of the river is muddy brown and there is solid waste that can be seen floating, furthermore, it has the smell of sewage infused into it. These impure characteristics are mostly due to sewage water and industrial materials being dumped into the river at various points. Additionally, the widespread dumping of garbage, sand mining in riverbeds, human encroachment on the banks, floodplains, and exposed channelization have contributed to the degradation process (Alley, 2012).

With a fast-urbanizing city, Kathmandu's urban areas face environmental degradation, congestion, lack of water supply, mismanagement of waste disposal, unemployment, and poverty (Shrestha, 2021). These factors have therefore impacted the people that live in the Kathmandu Valley as they no longer conduct activities alongside the river banks, due to not feeling part of the river anymore.

Defining the Overarching Objective and Research Questions

After giving a brief scope of what is meant by urban rivers and also presenting a small overview of the Bagmati River and its characteristics, the next section will outline the overarching objective of the thesis as well as the complimentary research questions.

Having explicated the scope of the situation regarding the pollution and the degradation process of the Bagmati River as well as presenting insights from an urban ecologically planning perspective, the overarching objective to be explored is:

> ***The potential ways in which different institutions could collaborate, together with citizens, to guide the ecological restoration process of the Bagmati River.***

To investigate the overarching objective, three research questions are drawn up in order to analyze during the fieldwork phase:

- **RQ1 - What urban ecological solutions have institutions implemented in the past and what are the opportunities and challenges when involving citizens in the restoration process?**
- **RQ2 - What ecological restoration solutions could engage citizens to interact and feel part of the Bagmati River shoreline?**
- **RQ3 - How can urban ecological solutions guide the restoration process of the Bagmati River?**

Relevance of Study

It is important to analyze the overarching objective as a way to draw attention to how citizens perceive urban rivers. This is important because these rivers are not a landmark for cities anymore, and they do not provide citizens with their initial purpose which was a source of clean drinking water, as well as water to irrigate crops and provide transport and activity opportunities for the people that settled around them.

In this specific case study of the Bagmati River, it is vital to explore how the citizens of Kathmandu and Lalitpur feel about the actual state of the river, and if it influences their everyday life in some way or another. This is relevant as the Bagmati River forms part of the urban public space of the city, and where various activities take place such as cultural and religious practices. Furthermore, it is fundamental to address how citizens can be engaged and share their opinions and insights on how the river can be restored in order for them as well as future generations to keep using this green urban space that once characterized the city.

It is essential to research the topics of ecology and restoration when it comes to urban rivers. This is because they form the basis for the process of restoration of urban rivers to form a riverscape that not only is attractive for people visiting the city but actually can be used by people living there for their daily urban activities. Not to mention, the restoration of the Bagmati River forms part of the urban ecological planning of a densely packed valley which is that of Kathmandu. Here is where citizen engagement is significant for developing methods and planning techniques for how the Bagmati River can be restored ecologically. Essentially giving the opportunity to citizens to feel part of the river once again and to acknowledge that the Bagmati River is the heart of the Kathmandu Valley.

Outline of Thesis

This thesis is divided into eight different chapters. The first chapter gives an introduction to the topic of urban rivers, as well as the case study the thesis will be based on, which is the Bagmati River found in Kathmandu, Nepal. Here the overarching objective and research questions are defined. The Theory chapter takes a dive into explaining the different agendas found in Urban Planning, Brown, Green, and Blue. Furthermore, it defines the concepts of Ecology, Urban Ecology, and Ecological Restoration. All of this is to associate the research questions and explore the different concepts and their potential applications within the case study. This chapter is followed by the Methodology, where qualitative research methods are used for the collection of primary and secondary data. Here the limitations and challenges are also presented to the methods employed such as qualitative mapping, semi-structured interviews, and transect walks.

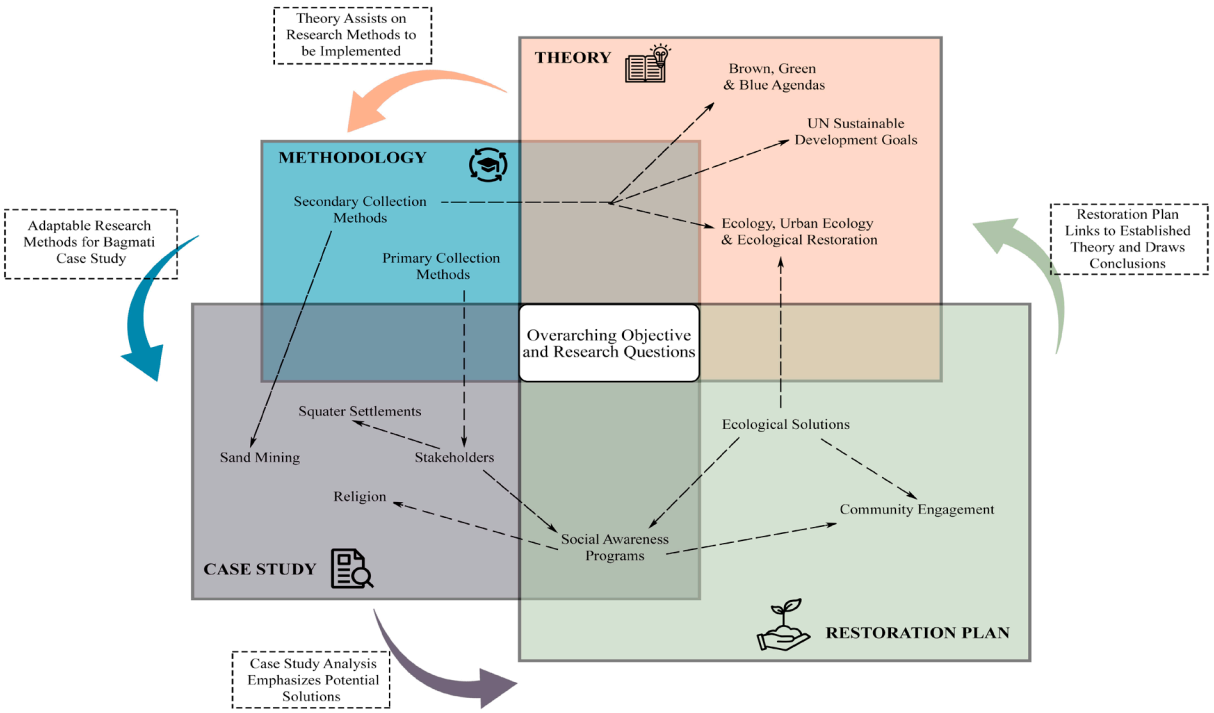


Fig 5. Research Design (Source: Self-made by author, 2023)

Chapter four outlines the study area within the Bagmati River and the different issues found along the river border. Next, the results and findings are presented based on the qualitative methods used. The different stakeholders are analyzed based on previous programs implemented and their challenges and opportunities are evaluated. Towards the end, chapter 6 discusses the potential restoration plan and possible ecological solutions that could be implemented with citizen engagement.

Finally, the Discussion and Recommendations chapter ties down the findings and the potential ecological solutions found within the case study of the Bagmati River, and the Conclusion and Implications address the research questions and overarching objective. In order to better understand why it is essential to include citizen engagement in the restoration of the Bagmati for citizens to feel part of the ecological urban river that passes through the Kathmandu Valley.

2. THEORY

This section develops a theoretical base for the topics that are outlined below. First, the existing knowledge of the Green, Brown, and Blue Agendas, highlights the differences in priorities between the three agendas and the challenges faced in reconciling the agendas in terms of urban development. The second section will present the topics of Ecology, Urban Ecology, and Ecological Restoration. These interlinked concepts combine the perspectives of social scientists, biologists, human ecologists, urban geographers, and planners to understand the evolution of these concepts together. It also takes into account the important roles of ecology within citizens, urban policy-making, and management decisions in informing and guiding policy for the social, economic, and environmental aspects of cities.

Finally, the United Nations Sustainable development goals will close the theoretical framework where a focus on some of these will be emphasized, to tie how the different agendas as well as ecological restoration fall under some goals. Moreover, these goals with the guidance of the other theories would ultimately aid in answering the research questions and the overarching objective.

Brown and Green Agendas

Within urban planning theory, there exists many agendas when it comes to the improvement of the urban environment of cities. Firstly, the brown agenda deals with sanitary and environmental health issues, such as unsanitary living conditions, hazardous pollutants in the urban air and waterways, and the accumulation of solid waste (Satterthwaite and McGranahan, 2000). These problems can be found normally in low-income societies as well as marginalized communities that inhabit the global south.

On the other hand, lies the green agenda. This agenda has a vision for long-term ecological sustainability as it focuses on the contribution to urban base production, consumption and waste regeneration, resource depletion, and global climate change (Satterthwaite and McGranahan, 2000). These perspectives are taken into action by high-income nations where they have a better abundance of resources and where there is not such a major gap between income groups.

Furthermore, Allen and You (2002) mention that “typically proponents of the green agenda have been seen as environmentalists, whereas those of the brown agenda are seen as urbanists and development workers” (Allen and You, 2002. p.36). The green agenda is presented by the protection of the ecosystem and the immediate and deferred effects of human activity at the

regional and global scale. On the other hand, the Brown agenda focuses on the well-being of humans as well as social justice as it looks into the immediate problems found at a local level, especially those suffered by low-income groups.

Satterthwaite and McGranahan (2000) in their paper named "*Environmental health or ecological sustainability? Reconciling the brown and green agendas in urban development*", make reference to Haughton's equity principles. Here Haughton (1999) has identified five interconnected equity principles that can be applied to environmental problems in urban areas in order to facilitate the different perspectives that both agendas address, namely: Intragenerational equity, Procedural Equity, Intergenerational Equity, transfrontier Equity, and Interspecies Equity.

Within the proponents of the brown agenda, Haughton (1999) states that intragenerational equity justifies the need for healthy and safe living and working environments for urban dwellers. Additionally, procedural equity is important to ensure that all people are treated fairly and can engage in democratic decision-making processes in the management of the urban areas where they inhabit (Haughton, 1999). This could be seen through participatory processes of the communities in deciding what to implement or remove in the area they inhabit to create a better environment for themselves.

The priorities for the green agenda acknowledge the concern that urban development does not draw on finite resource bases and degrade ecological systems in ways that compromise future generations. Furthermore, Haughton (1999) states that the need to prevent urban consumers or producers from transferring their environmental costs to other people or ecosystems such as waste is important to keep the environment healthy and clean. This complements the last idea as there should be interspecies equity, with the rights of other species needing to be recognized (Haughton 1999). The protection of nature plays a vital role as, without flora and fauna, ecosystems degenerate leaving unhealthy environments that can cause other urban problems such as acid precipitation, and loss of nutrients in agricultural land.

Allen and You (2002) give an example addressing how green agenda supporters rightly point out the serious consequences of not planning for urban waste collection and disposal. The emphasis on expanding collection coverage and keeping its price affordable has resulted in cities overexploiting landfills and often transposing the problem to nearby areas. Consequently, this leaves landfills to become uncontrollable stockpiles, contaminating nearby water sources and encroaching into nearby agricultural land, which ultimately affects human health. (Allen and You, 2002).

	The 'Brown' Environmental Health Agenda	*The 'Green' Sustainability Agenda*
Characteristic features of problems high on the agenda:		
Key impact	Human health	Ecosystem health
Timing	Immediate	Delayed
Scale	Local	Regional and global
Worst affected	Lower income groups	Future generations
Characteristic attitude to:		
Nature	Manipulate to serve human needs	Protect and work with
People	Work with	Educate
Environmental services	Provide more	Use less
Aspects emphasized in relation to:		
Water	Inadequate access and poor quality	Overuse; need to protect water sources
Air	High human exposure to hazardous pollutants	Acid precipitation and greenhouse gas emissions
Solid waste	Inadequate provision for collection and removal	Excessive generation
Land	Inadequate access for low income groups to housing	Loss of natural habitats and agricultural land to urban development
Human wastes	Inadequate provision for safely removing faecal material (and waste water) from living environment	Loss of nutrients in sewage and damage to water bodies from the release of sewage into waterways
Typical proponent	Urbanist	Environmentalist

Note: The entries in this table are only indicative. In practice, neither the agendas nor the issues they address are so clearly delimited. For example, while the table refers to lower income groups as the worst affected by 'brown' environmental problems, in most urban centres there is considerable variation even within lower income groups in the extent and nature of environmental health risks in the shelters and neighbourhoods in which they live. Each person or household makes their own trade-off between, for instance, cost, locations with good access to employment or income-earning possibilities, space, tenure (including the possibility of home ownership) and the factors that influence environmental health (eg, quality and size of the accommodation, and the extent of the basic infrastructure and services).

Fig 6. Table Stereotyping the Brown and Green Agendas for Urban Environmental Improvement. (Source: Satterthwaite and McGranahan, 2000)

“Brown agenda supporters often share this green agenda concern for unrealistically low collection charges. They point out how the discrepancy between collection costs and revenues often inhabits expansion to low-income areas and helps ensure that high proportions of the population in many cities remain uncovered by collection services” (Allen and You, 2022. p.38).

While both agendas are represented as a contrast of priorities that need to be addressed, governments and citizens debate on focusing on one or another for the future urban development of cities. This is because one agenda focuses on the immediate needs of the people while the other has a more sustainable approach for future generations and the long-term impacts on the city as a whole, these can be seen in Figure 6.

Environmental and ecological development have become concepts of discussion more and more between communities and citizens. This is with the aim towards the context of global climate change and urban development within cities, but often measures of green ecological agendas lead to trade-offs with brown social development agendas. Non-profit organizations (NGOs) have more influence on developing plans and investment priorities with the assistance of participatory methods of the community to increase the synergies between green and brown agendas. “Most of the innovations also take place after decentralization and democratic reforms and they need to be understood in the context of these broader, national level reforms” (Velazques, 1998. p.55) as described by Velazques, (1998) in the case study of Manizales in Colombia.

Moreover, Satterthwaite and McGranahan (2000) state that a well-informed public debate about environmental priorities backed up with good documentation of local and regional ecology, provides the best defense against the misuse of brown and green agenda arguments by powerful commercial, industrial, and real-estate concerns. With the green agenda having a vision for long-term ecological sustainability in urban areas, the next section will discuss the blue agenda which encompasses the freshwater and marine settings that are found around urban areas.

Blue Agenda

The brown and green agenda has been well-established in literature and theory by Satterthwaite and McGranahan (2000) at the turn of the 21st century. Even though the green agenda talks about the environmental aspect of water bodies, the “health-promoting potential of water bodies or blue spaces have received less attention in comparison, despite a small but growing body of evidence suggesting that access and exposure to blue space can provide a variety of health and well-being benefits” (Gascon *et al*, 2017. p.1207).

Foley and Kistemann (2015) express that blue space is generally understood to encompass both freshwater and marine settings. However, with the exception of large or saline lakes and estuaries where freshwater and marine settings merge, these two environments substantially differ in their physical and hydrological properties and the ecosystem services and amenity values they provide. Furthermore, experiences in freshwater blue space are likely to consist of different scenery, smells, sounds, and opportunities for recreation than experiences in coastal environments (McDougall *et al*, 2020). It is often considered a subset of the broader green agenda and seeks to address issues such as water pollution, over-extraction, habitat destruction, and the impacts of climate change on freshwater systems.

Blue spaces seek to address the unique challenges faced by cities and urban areas in managing their water resources, including issues such as aging infrastructure, increased demand for water due to population growth, and the impacts of climate change. This can include measures such as improving the efficiency of water distribution systems, reducing water waste and leakages, promoting the use of rainwater harvesting and greywater reuse, and investing in green infrastructure to manage stormwater runoff (Marsalek *et al*, 2001). In addition to protecting and improving water resources, it is also recognized for its potential to support economic development, enhance public health, and improve the quality of life in communities (McDougall *et al*, 2020).

"While the term 'blue space' is generally well understood in current nature-health literature, the treatment of coastal and freshwater environments in studies concerned with access and exposure to blue space and health varies widely" (McDougall *et al*, 2020. p.3). Especially in an urban context as exposure to freshwater can reduce human stress and also provide cognitive restoration to aquatic environments which are highly restorative. Types of freshwater also vary in their ability to facilitate certain opportunities for physical activity and social interaction, but often some interactions with water are prohibited in urban waterways and canals due to health risks associated with immersion in these bodies of water (McDougall *et al*. 2020).

Finally, the blue river agenda prioritizes the protection and restoration of river ecosystems, with an emphasis on preserving biodiversity, improving water quality, and supporting sustainable water use. This can include measures such as reducing point-source pollution from industry and agriculture, promoting conservation and restoration of riparian and wetlands habitats, and managing water resources for multiple uses, including human consumption, agriculture, and energy production (Foley and Kistemann, 2015). For this reason, it is also important to explore the topics of ecology, urban ecology, and ecological restoration. This is with the aim to understand more about how rivers are ecological ecosystems within an urban context.

Ecology, Urban Ecology, and Ecological Restoration

When talking about ecology, terms such as ecological systems, urban ecology, and ecological restoration are emphasized as these contribute to how biological cycles work but also how we as humans plan cities. According to the United States Environmental Protection Agency, an "ecological system" (ecosystem) is a biological community consisting of all the living organisms (including humans) in a particular area and the non-living components, such as air, water, and mineral soil, with which the organisms interact" (US Environmental Protection Agency, 2022. paragraph 2). This is why the topics of ecology, urban ecology, and ecological restoration are important in the discussion of the Bagmati River found in Nepal. Here, relevant theories will be presented about the topics and how they relate to one another.

Ecology

The word ecology has a recent origin, it was first proposed and introduced into science by the German biologist Ernst Haeckel in 1866 in his book Generelle Morphologie Der Organismen (Stauffer, 1957). Haeckel defined ecology as «the study of the natural environments including the relations of organisms to one another and to their surroundings» (Haeckel, 1866. p.333). This concept started being discussed in the 1960s, as environmental issues started gaining public attention regarding the flora, fauna, and the environment that surrounds us. Additionally, after the first photographs were taken of the Earth from outer space in the late 1960s during the space race, during the 1970s, almost everyone became concerned about pollution, natural areas, population growth, food and energy consumption, and biotic diversity, as indicated by the wide coverage of environmental concerns in the popular press (Odum, and Barrett, 1971). In the decade of the 1970s, many environmentalists refer to it as the "decade of the environment,» as this was initiated by the first «Earth Day» on 22 April 1970. "Then, in the 1980s and 1990s, environmental issues were pushed into the political background by concerns for human relations problems such as crime, the cold war, government budgets, and welfare. As we enter the early stages of the twenty-first century, environmental concerns are again coming to the forefront because human abuse of Earth continues to escalate" (Odum and Barrett, 1971. p.4).

Today, ecology is a highly interdisciplinary field that encompasses a wide range of topics, from the study of individual species and their interactions to the functioning of entire ecosystems and the biosphere. The insights and discoveries of ecologists have important implications for our understanding of the natural world and for addressing pressing environmental challenges such as climate change, habitat destruction, and species extinction. Additionally, many universities today now offer a wide variety of courses and have separate departments, careers, institutes, and schools of ecology. "While the scope of ecology is expanding, the study of how individual

organisms and species interface and use resources intensifies. The multilevel approach, brings together «evolutionary» and «systems» thinking, two approaches that have tended to divide the field in recent years" (Odum and Barrett, 1971. p.4). Additionally, this thesis aims to understand ecology more through an urban planning framework, as to how ecology is viewed when it comes to urban rivers and how these contribute to the cityscape. Furthermore, the ecology around the context of the Bagmati River in terms of flora, fauna, and the environment that surrounds it.

Urban Ecology

One such approach within ecology is Urban Ecology. This term was first talked about in the Chicago School of Sociology in the 1920s (Gaston, 2010). Alberti (2008) defines urban ecology as "the study of the ways that human and ecological systems evolve together in urbanizing regions" (Alberti, 2008. p.xiv), suggesting that it is the interaction between many disciplines such as social scientists, biologists, human ecologists, and urban geographers.

Gaston, (2010) expresses in his book Urban Ecology that the concept can be divided into two approaches: 1) the ecology 'in' and 'of' cities and 2) the ecology of urbanization gradients. The majority of urban ecology research falls into the category of ecology 'in' cities, with only a few examples of ecology 'of' cities that have been researched. Alberti (2008) argues that if the discipline of urban ecology is to advance and enhance our understanding of urban ecosystems, it will require the active development of more inter- and transdisciplinary ecology 'of' cities studies. This is because this approach treats cities as distinctive ecological systems and studies their patterns, processes, functions, and dynamics. "The discipline of urban ecology is at the forefront of creating the knowledge base, conceptual frameworks, and tools that are crucial for building and maintaining sustainable and resilient cities and towns in the future" (McDonnell, 2011. p.13). The goal of urban ecology is to understand how urban ecosystems function, and how they can be managed and conserved in a sustainable way. This knowledge is crucial for addressing the challenges of urbanization, such as the loss of green spaces, the degradation of urban ecosystems, and the impacts of urbanization on regional and global ecosystems.

The urban ecology research community has recognized social behaviors of citizens, urban policy-making, and management decisions as important roles within urban ecology. This is because these roles can be used to inform and guide policy when talking about the social, economic, and environmental aspects of a city (Bai. and Schandl, 2010). This can be seen in Figure 7 by Bai and Schandl (2010) where urban system structures and functions are based on performance indicators in order to create outputs. These indicators, therefore, impact the ecological restoration of a natural area or a water system which is the case of the Bagmati River.

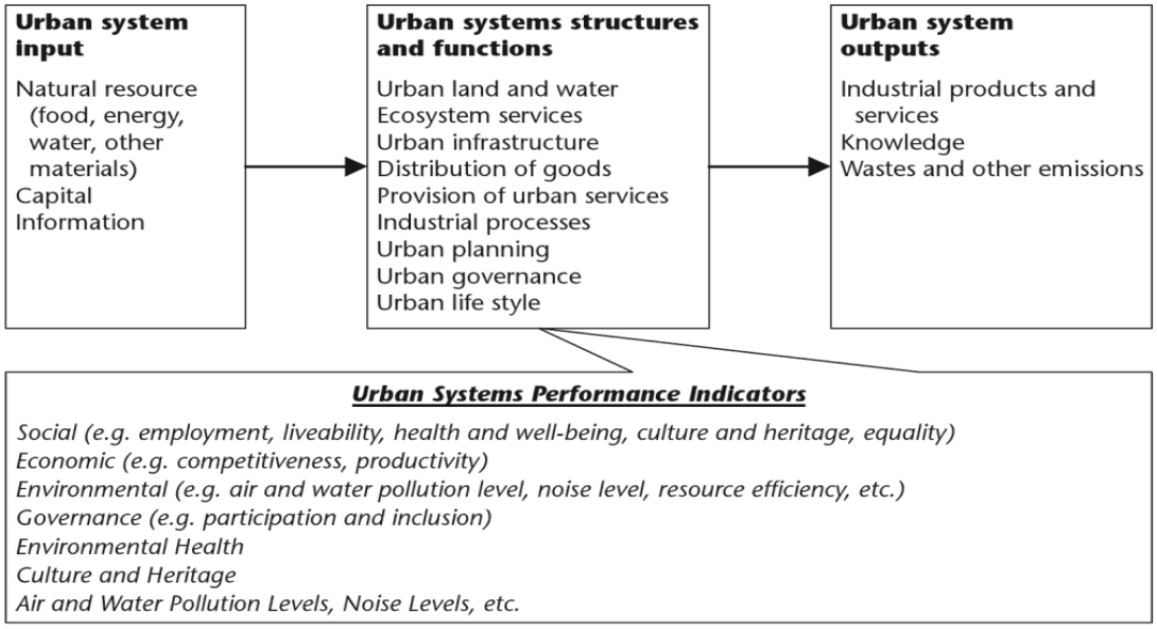


Fig 7. Integrated Urban metabolism and urban system performance indicators. (Source: Bai. and Schandl, 2010)

Ecological Restoration

The National Research Council in 1992 defined ecological restoration as the return of an ecosystem to a close approximation of its condition prior to disturbance. Additionally, it is a "process of repairing damage caused by humans to the diversity and dynamics of indigenous ecosystems" (Jackson *et al*, 1995. p.71). The early pioneers of ecological restoration were influenced by the emerging field of ecology and the recognition of the interconnections between ecological processes and the health and functioning of ecosystems. They recognized the need for a more holistic approach to restoring degraded ecosystems, one that considered not only the physical and biological aspects of restoration but also the social and cultural context in which restoration takes place. Jackson et al, (1995) list four social and biological conditions for the success of ecological restoration, this is as follows: "how nature is valued by society, the extent of social commitment to ecological restoration, the ecological circumstances under which restoration is attempted, and the quality of restorationist's judgments about how to accomplish restoration" (Jackson *et al*, 1995. p.72). These are important as the aim is to "halt degradation and to redirect a disturbed ecosystem in a trajectory resembling that presumed to have prevailed before the onset of disturbance" (Aronson *et al*, 1993. p.9).

Van Diggelen *et al*, (2001) in their paper "*Ecological Restoration: State of the Art or State of the Science?*" suggest researchers and investigators be aware that the restoration process of a site needs to be broken up into three different levels. This is important as the levels are steps that serve as a guide for understanding what a restoration process is. The three levels are as follows:

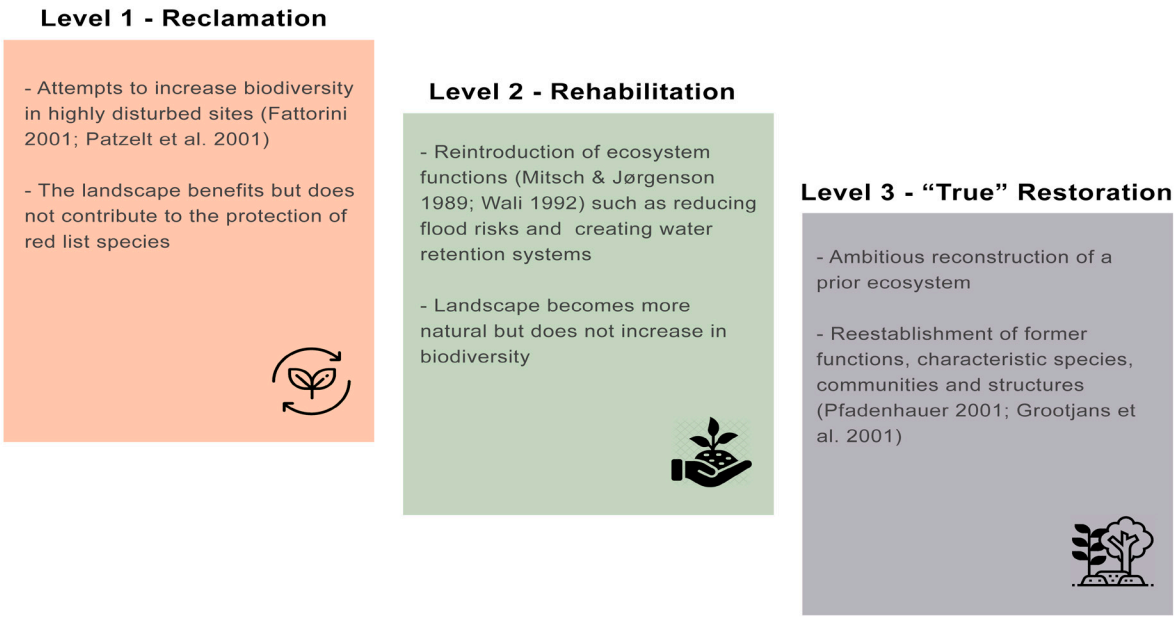


Fig 8. The three levels of restoration (Source: Author, adapted using information from Van Diggelen *et al*, 2001, 2023)

These restoration processes of course vary depending on the scale of the area to be investigated and the activities that take place alongside. Higgs (1997) argues that good restoration requires a view expanded beyond the technical to include historical, cultural, political, aesthetic, and moral aspects. This is why the support from communities is important for any restoration project, as these provide information about the context to researchers as they are the ones that are living near the investigation area.

Within the theory of ecological restoration, various conceptual frameworks have been developed by researchers to express the quantitative criteria for restoration success. Hobbs and Norton in 1996 listed six ecosystem attributes to be restored when analyzing ecology these are: "(I) composition and relative abundance of species; (II) vertical arrangement of vegetation and soil components; (III) horizontal arrangement of ecosystem components; (IV) heterogeneity of components; (V) ecosystem functions, such as energy transfer and matter cycling; and (VI) succession dynamics and resilience" (Hobbs and Norton, 1996. p.97).

Additionally, Ewel (1987) listed five criteria: (I) self-sustainability; (II) resistance to invasions of 'undesirable' species; (III) original productivity; (IV) nutrient retention; and (V) integrated biotic interaction for judging the success of ecosystem reconstruction. These criteria for restoration success provide a framework for evaluating the outcomes of restoration efforts and for guiding the development of restoration goals and objectives. They also highlight the importance of considering the full suite of ecosystem attributes, including both the biotic and abiotic components, when planning and implementing restoration projects.

Both Hobbs & Norton's (1996) and Ewel's (1987) criteria provide valuable insights into the outcomes and goals of ecological restoration and have been widely adopted and applied in restoration practice. However, the choice of criteria and the specific goals and objectives for a particular restoration project will depend on a variety of factors, including the ecosystem type, the extent and severity of degradation, and the specific challenges and opportunities presented by the site. Monitoring and maintenance are the most important aspects when it comes to ecological restoration, as the goal might be reached, but the ever-changing environment will eventually change its conditions.

The criteria listed by Hobbs & Norton (1996) emphasize the importance of restoring the composition and relative abundance of species, the structure and arrangement of vegetation and soil components, and the ecosystem functions that support the health and resilience of the system. By restoring these attributes, the goal is to create ecosystems that are able to maintain their integrity and function in the long term, even in the face of environmental stressors and other challenges. This is why the topic of ecological restoration plays an important role when it comes to discussing the United Nations Sustainable Development Goals as many goals are linked to the restoration of green and blue spaces to create awareness about sustainable cities and communities for the benefit of future generations.

United Nations Sustainable Development Goals in Ecological Restoration

In 1992, the United Nations established the Commission on Sustainable Development (CSD) where they would work towards a core set of indicators that equally emphasize the "economic, social, environmental and institutional aspects of sustainable development" (Robinson, 2019). The following year, the CSD published a testbed selection of 130 indicators, with the aim of having a "good set of indicators" by the year 2000. These indicators would be reconfigured several times until 2015 at the United Nations General Assembly, 17 interlinked sustainable development goals and 169 targets were designed to be achieved by 2030 as seen in Figure 9 (United Nations, 2022).

Fig 9. United Nations Sustainable Development Goals Concept. (Source: United Nations, 2022)

Even though not named ecological goals, this concept of sustainable development is now commissioned to the Division of Sustainable development goals (DSDG) which plays a key role in the evaluation of UN system-wide implementation of the 2030 Agenda and on advocacy and outreach activities relating to the SDGs. In order to make the 2030 Agenda a reality, broad ownership of the SDGs must translate into a strong commitment by all stakeholders to implement the global goals. DSDG aims to help facilitate this engagement (United Nations, 2022). Within the goals, traces of the brown, green, and blue agendas as well as Urban Ecology and Ecological Restoration can be identified. Such goals include 'SDG 6 – Clean water and sanitation', 'SDG 11 – Sustainable Cities and Communities, SDG 14 – Life below water' and 'SDG 15 – Life on land'. This is important as these agendas alongside the concept of ecology helped answer the overarching objective. Furthermore, the topic at hand is a reference to how a restoration project of an urban river contributes to the SDG goals established for the 2030 global agenda of the United Nations. This is because moving towards the restoration of the Bagmati represents how a sustainable city with the help of its communities, could achieve the regeneration of life below water, and the ecology of life on land with the help of partnerships and it's collaboration together to achieve common goals.

Connecting the Theoretical Frameworks

The theoretical frameworks explained above helped to uncover answers for the overarching objective as well as the research questions of this thesis. Within the theory presented, key concepts overlap and are linked between them when understanding restoration processes and citizen engagement when talking about urban development. It was essential to understand the perspectives within the brown, green, and blue agendas as they addressed different aspects of environmental sustainability and resource management. These agendas were linked to ecology, urban ecology, and ecological restoration as well as the UN sustainability goals established.

The Brown Agenda focuses on addressing environmental issues related to pollution, waste management, and remediation of contaminated sites. In the context of ecology, the brown agenda is concerned with understanding and mitigating the environmental impacts of pollution and contamination within ecosystems. This involves studying the effects of pollutants on biodiversity and the overall health of ecosystems. Urban ecology is linked to the brown agenda as it emphasizes the need for sustainable waste management practices and the restoration of polluted urban environments. Ultimately, following the concepts of ecological restoration as its aim is to restore degraded ecosystems and improve their ecological health.

On the other hand, the Green Agenda discusses ecological practices, the conservation of natural resources, and the protection of biodiversity. Ecologically, the green agenda seeks to understand and conserve natural ecosystems, study biodiversity patterns, and investigate the ecological processes that support ecosystem resilience. In urban ecology, the green agenda promotes the incorporation of green spaces, such as parks and urban forests, into cities to enhance biodiversity, provide ecosystem services, and improve the overall well-being of urban residents. This is relevant as the green agendas further explore the ecological restoration and enhancement of natural habitats and ecosystems, which contribute to biodiversity conservation and the overall sustainability of landscapes.

Furthermore, as discussed, the Blue Agenda links both theories but with an emphasis on the sustainable management and conservation of water resources, such as rivers, lakes, wetlands, and coastal areas. From an ecological perspective, the blue agenda involves studying the ecological dynamics of aquatic ecosystems, including the interactions between biotic and abiotic components, as well as the impacts of human activities on water quality and aquatic biodiversity. This is by addressing the sustainable management of urban water bodies and the integration of water-sensitive design principles in urban planning to improve water quality and provide habitat for aquatic species within urban ecology. Not to mention, ecological restoration plays a role in the engagement of citizens in activities such as wetland restoration,

river rehabilitation, and coastal ecosystem conservation, which aim to enhance the ecological integrity and functionality of aquatic ecosystems.

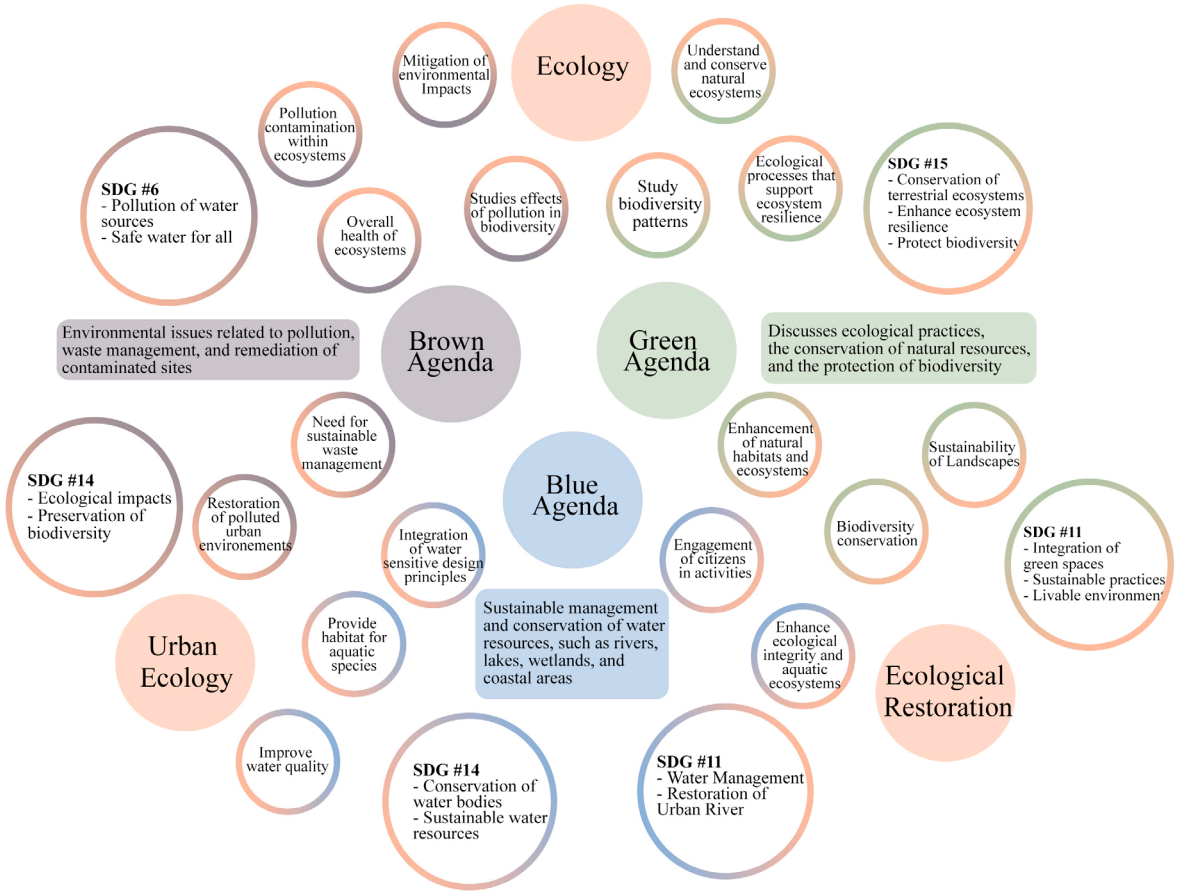


Fig 10. Theoretical Framework Diagram (Source: Self-made by author, 2023)

Finally, the link between the brown, green, and blue agendas within ecology, urban ecology, and ecological restoration make emphasis on the UN Sustainable Development Goals (SDGs) as they establish key insights in the aim to reach the 2030 sustainability agenda. These theories make emphasis on SDGs #6 Clean Water and Sanitation, SDG #11 Sustainable Cities and Communities, SDG #14 Life Below Water, and SDG #15 Life on Land.

The Brown Agenda aligns with SDG #6 by addressing pollution and contamination of water sources, aiming to ensure access to clean and safe water for all. Moreover, it mitigates the ecological impacts of pollution, as it contributes to the preservation of marine ecosystems and biodiversity promoting SDG #14. Here, the Green Agenda supports SDG #15 by promoting the conservation and sustainable use of terrestrial ecosystems, including efforts to protect biodiversity and enhance ecosystem resilience. This is linked to Urban Ecology as it contributes to advocating the integration of green spaces and sustainable practices in urban areas, leading

to more livable and environmentally friendly cities, emphasizing SDG #11 which establishes Sustainable Cities and Communities. Besides linking the above SDGs, SDG #14 Life Below Water, plays an important role in this thesis as the blue agenda focuses on the sustainable management and conservation of water bodies, contributing to the protection and restoration of marine and coastal ecosystems. This is supported by promoting sustainable water resource management and ensuring access to clean water for all. A combination of these theoretical frameworks and their interlinks has contributed to understanding approaches to ecologically restore the urban river of Bagmati.

By addressing these agendas within the context of ecology, urban ecology, and ecological restoration, various SDGs are directly or indirectly supported. These links demonstrate how these agendas and fields of study contribute to the broader global efforts outlined by the UN SDGs, promoting ecological restoration and citizen engagement within sustainable developments, environmental protection, and the well-being of both ecosystems and communities. These linkages will help as guidance when answering the overarching objective based on the case study of the Bagmati River.

3. METHODOLOGY

The next stage in the process to answer the overarching objective is to present the methodological framework of this study. This section discusses the methodology employed, as well as the main data collection methods. This research takes the form of a qualitative method approach to gather relevant data for answering the research questions that are at hand. Additionally, a mix of primary and secondary data collection methods are emphasized which include literature reviews, exploratory fieldwork, observation, transect walks, semi-structured interviews, and qualitative mapping. These methods collectively helped analyze the fieldwork conducted within the Bagmati River. At the end of the chapter, various limitations and challenges that were encountered during the fieldwork will be presented.

Qualitative Research Methods

The study is mainly based on qualitative research methodology as this approach is relevant in bringing forward complex realities based on the context of the research (Américo *et al,* 2022), especially when analyzing a specific context such as the Bagmati River. Qualitative research allows the researcher to gain a comprehensive knowledge base on a particular subject, while inductively developing more themes around it (Schuemann, 2014). This creates a more flexible and adaptable approach to the research process. The researcher can adjust their research design and methods based on the emerging themes and findings. This approach enables the researcher to be open to unexpected and diverse perspectives from participants and to identify new research questions to explore. In addition, qualitative research often uses a small sample size, which allows for more in-depth and detailed data collection and analysis where organizations, citizens, and personnel can be evaluated. “Qualitative methods are often used in evaluations because they tell the program’s story by capturing and communicating the participants’ stories” (Patton, 2002. p.173).

In the case study of the Bagmati River, qualitative research allowed me to explore the perspectives and experiences of the people living in the river basin. It provided an opportunity to investigate the social, cultural, and economic factors that contributed to the river’s degradation. This was done through secondary and primary data collection methods as seen in Figure 11. By conducting literature reviews both academic and grey, I was able to have a first glance at the context and the research that had been done around the Bagmati River. Additionally, by doing exploratory fieldwork, transect walks, photograph and visual representations, qualitative mapping, and semi-structured interviews with local stakeholders, and experts, I was able to gain a deeper understanding of issues related to the river’s pollution, challenges institutions face, and

the potential opportunities that could be implemented. “This identification of the unit allows us to not only demarcate the boundaries of our case but also determine and commit to the context” (Flyvbjerg, 2011 cited in Shrestha, A. 2021. p.47).

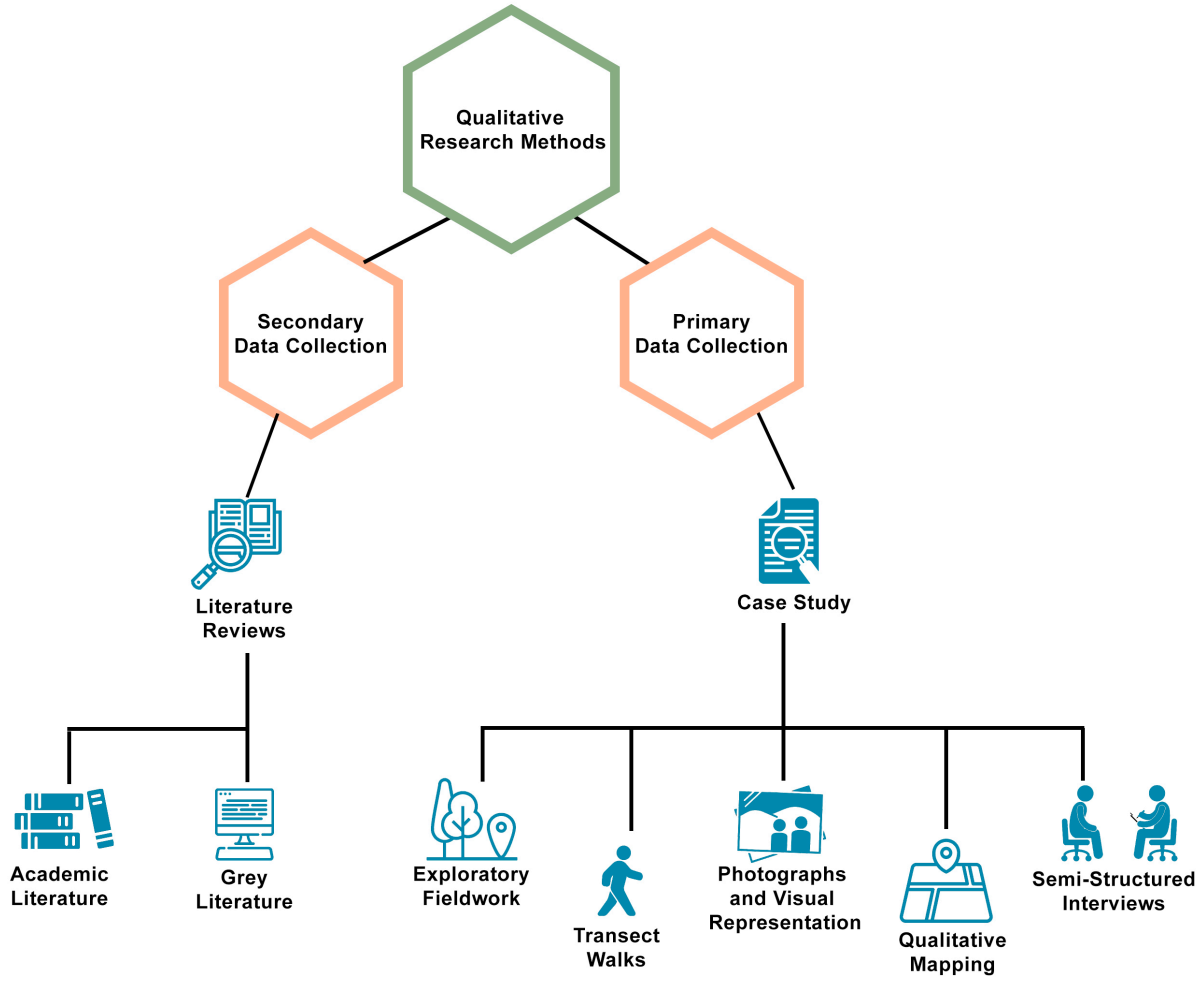


Fig 11. Types of Methods Implemented for Thesis (Source: Self-made by author, 2023)

Overall, qualitative research is a valuable methodology for exploring complex social and environmental issues such as the degradation of the Bagmati River. It allowed me to gain a comprehensive understanding of the context and the experiences of those affected by the issue (Njie and Asimiran, 2014), in this case widening the conceptualization of existing theory based on fieldwork observations. Hence, exploring how government and non-government engagement has impacted the river itself throughout the years, and at the same time acquiring knowledge of the feelings, experiences, and perspectives of citizens towards the Bagmati River and its actual state. Below a methodology interrelation diagram is presented outlining how the research methodologies are related to one another and their implementation within the fieldwork months.

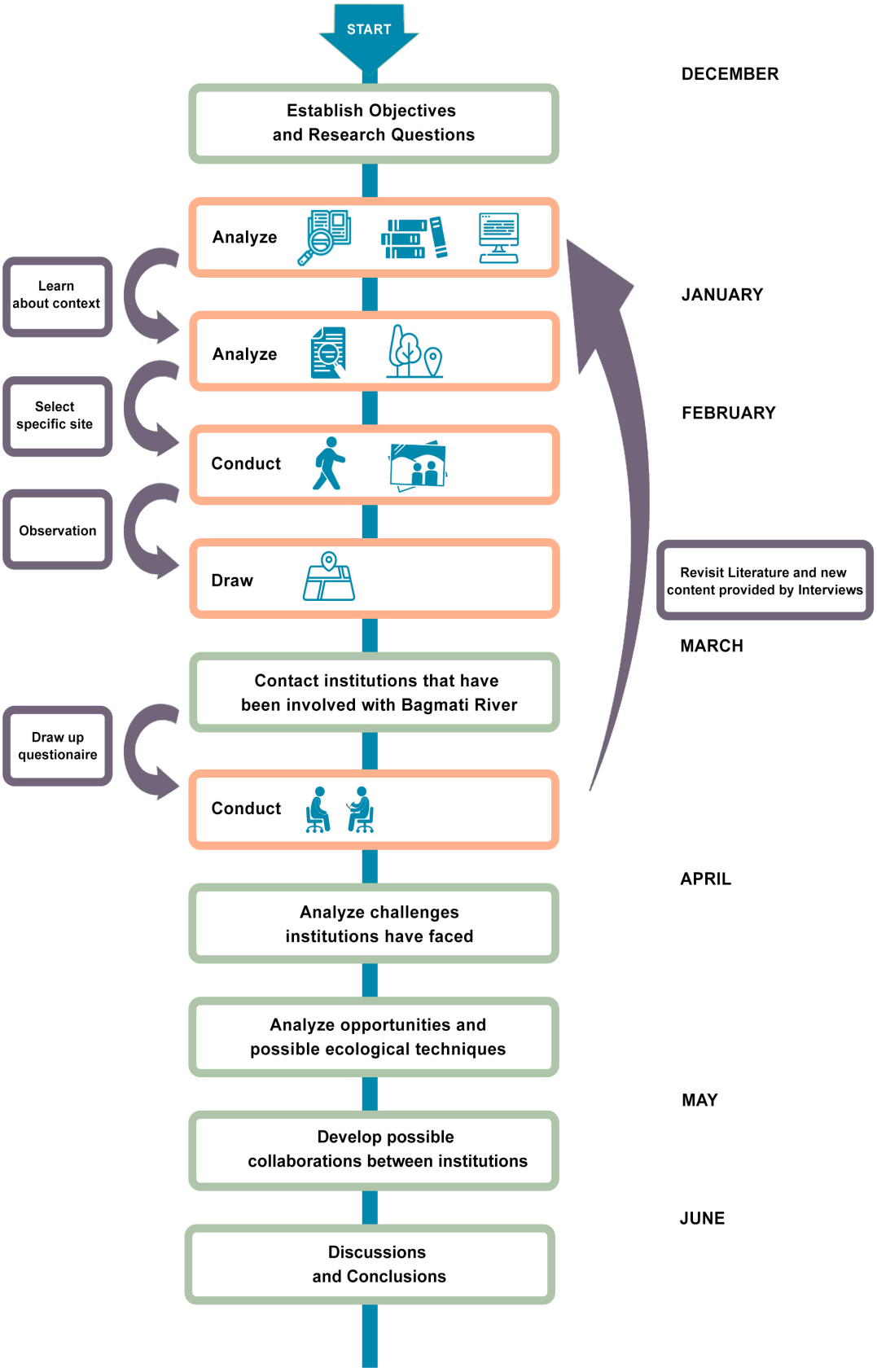


Fig 12. Methodology interrelation timeline (Source: Self-made by author, 2023)

Secondary Data Collection Methods

This part outlines the secondary data collection methods that were used for the investigation. These include literature reviews which encompass academic literature such as thesis and academic papers related to social, cultural, and economic factors, and grey literature such as reports, working documents, policy papers, etc, about issues around the Bagmati River. These methods allow one to have a broad overview of the past research that has been done on the different topics concerning the Bagmati River and how this case study can be linked to previous cases of other restoration projects of different rivers. This was to design a restoration process further and draw out conclusions for the thesis.

Literature Reviews

According to the University of Edinburgh, a literature review is a piece of academic writing demonstrating knowledge and understanding of the academic literature on a specific topic placed in context (Literature Review, 2022). The method creates a foundation for the researcher of the case study area. Furthermore, this allows the researcher to fill in the research gaps that have not been identified as the literature review also includes a critical evaluation of the material. This is important as it would, "determine whether an effect is constant across studies and discover what future studies are required to be conducted to demonstrate the effect. Techniques can also be used to discover which study-level or sample characteristics have an effect on the phenomenon being studied" (Snyder, 2019. p.335) for example if studies are only focused on a certain cultural context.

On the other hand, grey literature is used to "extend the scope of findings in the reviews by incorporating relevant contemporary material in dynamic and applied topic areas where scholarship lags" (Adams, 2017. p.433). This can be particularly important in areas of emerging or rapidly changing fields as grey literature can also provide insights into policy and best practices, as well as areas for improvement of the case study being researched.

In the context of the study of the Bagmati River, literature reviews were used to explore the concepts of Green, Brown, and Green Agendas. Here papers such as Satterthwaite and McGranahan (2000) and McDougall et al (2020) provided the necessary theory of the agendas within an urban planning context. Furthermore, academic papers on Ecology (Odum and Barrett, 1971), Urban Ecology (Alberti, 2008), and Ecological Restoration (Van Diggelen et al, 2001) helped me understand these concepts and why they are an important factor when discussing urban rivers. Moreover, grey literature was used to immerse me in the context of the

Bagmati River and understand its current state and the challenges it faces. Here, government and non-government institutional reports, national and international articles published on academic websites or journals, information extracted from institutional websites, as well as master's theses based on the context provide information on policies and programs that have been implemented to address environmental degradation and pollution in the river.

Overall, the knowledge acquired from the literature reviews was able to give an overview of the context and identify key issues that contribute to the degradation of the river itself. Additionally, giving me the scope to implement my primary data collection methods, and ultimately answer the research questions and overarching objective established.

Primary Data Collection Methods

This section highlights the main qualitative primary data collection methods that were implemented during fieldwork on the Bagmati River. Methods such as a case study approach, exploratory fieldwork, transect walks, photographs, visual representations, qualitative mapping, and semi-structured interviews allowed the collection of relevant on-site information that was later used to design and draw out conclusions for the thesis.

Case Study Approach

The case study is a method that "aims to produce an invaluable and deep understanding - that is, an insightful appreciation of the "case" - hopefully resulting in a new learning about real-world behavior and its meaning" (Yin, 2011. p.XIX). This approach lets the researcher get a wide overview of topics of a specific site or country in order to understand the broader picture of the problems around their specific topic of research. A case study is typically selected when contemporary events within a certain period of time and space need to be analyzed. This is because the focus is given to a specific community, event, campaign, or phenomenon that is happening frequently within a specific site (Yin, 2009). This of course needs to be aided by several research methods in order to understand and process relevant data for the researcher to acquire relevant knowledge of their topic. The most common methodological evidence that can be used is observation and interviews (Yin, 2009) as these provide the researcher to get a first glance at the area being researched and also talk with local people that live and have experienced certain problems being investigated firsthand.

The opportunity to research the case study of the Bagmati River that flows through Kathmandu, Nepal was the starting point to uncover a wide range of topics that are associated with it.

This is because there are many issues and variables that play into how the Bagmati River has degraded over a specific period of time. Context issues such as sand mining, religion, squatter settlements, pollution, and the lack of citizen awareness offered insights on how the case study research could possibly touch other broader challenges that the Nepali government and non-governmental institutions have been trying to tackle over the past several decades.

This case study of the Bagmati River is relevant to Urban Ecological Planning as it is a large-scale urban opportunity to broaden the conceptual knowledge and enhance citizen awareness about the different issues and insights that surround the river itself. Furthermore, it is an opportunity to use different methods of research such as exploratory fieldwork, transect walks, photographs, visualizations, qualitative mapping, and semi-structured interviews to gain a deeper understanding of the case study at hand. These are analyzed further next.

Exploratory fieldwork

As stated above, the thesis was fieldwork-based as I had the opportunity to live in Kathmandu, Nepal for three months. Between the 16th of January and the 12th of April, I was able to get a first-hand investigation of the Bagmati River. The intention of the fieldwork was to collect relevant data through observing and photographing key challenges and opportunities that I witnessed while doing transect walks along the riverside. The photographs taken are used throughout various chapters of the thesis to help analyze the context as well as to showcase the actual state of the Bagmati River at various points in the study area. Different notes, shapes, and arrows were overlaid to identify key points. This is with the aim to evaluate what sort of urban ecological planning solutions could be implemented in different areas and in which ways can one engage citizens to participate in the restoration process.

Moreover, several transect walks between the Tinkune Bagmati Bridge next to Subidhanagar District all the way down to Kupondole Kuleshwor Bridge where the Teku District is found were made. This was done during the first two months of the fieldwork. During the transect walks, mappings were made to identify relevant context areas as well as possible objects that were hazardous to the contamination and pollution of the river. These maps with their relevant data were divided into three sections to study them further, as seen in the section on Qualitative Mapping Analysis of the thesis.

Semi-structured interviews were conducted with non-government organizations as well as activists to get to know what programs they had been running when addressing the restoration of the Bagmati River. These interviews were conducted with key informants of the organizations

and were based on a small questionnaire that was drawn up previously. Nevertheless, as it was an informal conversation, other questions were asked depending on the interviewed responses and the impacts of the programs they had been involved in. Upon my arrival to Nepal, I only had the contact of two key informants but as they started sharing contacts with me of other organizations who might be interested in my thesis, a total of 14 people were interviewed during my three-month stay.

Transect Walks

The World Bank defines a transect walk as a method for describing and showing the location and distribution of resources, features, landscapes, and main land uses along a given transect (World Bank, 2022). This means that it helps researchers have a first-hand scope of the area they will be investigating as it gives them the ability to identify relationships among topography, soils, natural vegetation, cultivation, other production activities, and human settlement patterns (World Bank, 2022). Furthermore, water bodies such as rivers, lakes, and oceans also need to be considered as these form the urban and natural environments the site researchers are investigating.

"Two to three hours should be allowed to do a transect walk" states the World Bank in order to focus and collect relevant data. It was intended to do multiple transect walks during the on-site investigation to see how the local communities use the riverside of the Bagmati. Furthermore, it was intended to sit down at specific locations at different times of the day and observe what activities or interactions the citizens had with the river itself depending on the day of the week and hour. This was to capture and record on maps relevant data of what I spotted during the different days to determine if it was an often occurring activity or it was spontaneous.

As stated above, the site was chosen on the identification of major problems and challenges that I was able to observe with the potential of opportunities that could be implemented with the help of communities that inhabited or used the area. In the end this was done only during the first month in order to get a firsthand glimpse of the river itself and the amount of pollution that the river had. The transect walks were normally conducted during the morning and afternoon as these were the best times of day to walk along the riverside. This is because it is when the weather was the best and it was not recommended to walk during the night due to poor lighting infrastructure and security reasons. The transect walks were made between the Tinkune Bagmati Bridge and the Kupondole Kuleshwor Bridge as this site was chosen to be investigated as it was the center of Kathmandu and the most diverse in terms of activities. The walks were made on both sides of the river and sometimes possessed challenges as fences, buildings, and roads made it hard to see the river and document relevant data. Various activities were witnessed such as religious offerings, citizens washing clothes, and animals roaming around.

Photographs and visual representation

Sociologists, and anthropologists have primarily used photographs to document social realities, showcasing the way of life of local communities and capturing its context (Singhal and Devi, 2003). For this reason, photographs of the surrounding area of the Bagmati River as well as of people doing various activities were taken in order to represent the daily life that people undertake on the Bagmati riverside. This is important as Lykes (1997) states that "the process of taking a photograph provides an opportunity to develop a story that was previously rejected, silenced or overlooked. Further, the photograph's narrative becomes a participatory site for wider storytelling, spurring community members to further reflect, discuss and analyze the issues that confront them" (Lykes, 1997. p.741). The photographs did not intend to disrespect the local communities or showcase them in a disrespectful manner, and all religious as well as life activities are shown with the utmost respect. Additionally, the pictures were taken in a manner to avoid showing the faces of citizens and if there were to be, these were further blurred to hide any identity.

Photographs and visual representations are key concepts that always need to be emphasized when engaging communities and citizens in order to participate in a project. These aspects are important as "visual events of visual anthropologists, and the teaching and learning of visual anthropology" (Pink, 2011. p.438) are what is shaping the world today. Since the turn of the 21st century, visual media has acquired a lot of attention as diagrams, photos, and interactive schemes have given people a chance to not only express themselves in a more open way but also relate even more to one another. This is considered vital in a case study research thesis like this as community engagement would be the driving factor to coming up with ecological solution ideas to restore the Bagmati riverscape.

Qualitative Mapping

As stated above, qualitative mapping was a method implemented in the early stages of the fieldwork as this allowed me to get a glimpse of the context that surrounded the Bagmati River. In the first few weeks, while doing my transect walks I started recording various objects and key components I witnessed within the Tinkune Bagmati Bridge next to Subidhanagar District all the way to Kupondole Kuleshwor Bridge. Key components such as bridges, temples, sewage pipes, livestock, religious steps, farms, and sand accumulation spots were recorded on a physical map that I printed of the area as seen in Appendix 1. This was with the aim of further dividing the map into three sections and quantifying how many of each element I saw in order to analyze the challenges and opportunities each area possessed.

This method of data collection proved to be challenging at some points, as some areas of the riverside could not be easily accessed. This was due to objects such as fences, piles of sand, buildings, roads, and vegetation obstructing the line of sight of the river.Moreover, some parts of the riverside were steep, full of wild vegetation, and without an actual pavement so I had to wander around the roadside to do the recordings. Additionally, one area of the Bagmati River, as seen in section 2 of chapter Qualitative Mapping Analysis of the thesis, has been encroached by a community of squatters. Here, I was not able to walk alongside the riverside due to safety reasons. So recordings had to be done from the other side of the river, where the UN park sits.

These qualitative maps served to think about what kind of opportunities could be implemented for the Bagmati River and give me the overall context of how the river meanders through the cities of Kathmandu and Lalitpur. Analyzing how people make use of the different open spaces that have been developed around the riverside and if they interact with the river itself.

Semi-structured Interviews

While observation, photographing, and doing literature reviews form part of a strong path to data collection, it is also vital to approach different organizations as well as citizens that inhabit the area, as they are the real experts when it comes to describing the area and its challenges that the Bagmati has faced over the decades. Hence, citizens are able to express experiences with feelings and emotions about their culture, religion, and lives they have with the river.

Semi-structured interviews are a relevant method as it helps researchers target groups of people in order to obtain views and opinions about specific topics (McIntosh and Morse, 2015). Furthermore, these types of interviews create a more comfortable approach for the citizens being interviewed as they are able to express themselves more openly without restricting themselves to a yes and no answer (Fylan, 2005). This is because questions are deliberated as to how the conversation develops and informal notes can be generated (McIntosh and Morse, 2015). Therefore, more data can be collected and processed, but also this can cause challenges in analyzing the relevant data. This is because the answers expressed could be biased towards a specific topic, also the answers are not structured and they come with the perspective and ideas the person interviewed is answering. Furthermore, as the conversation is not being recorded, due to keeping the conversation more informal and comfortable for the person being interviewed, relevant information might be lost or not captured.

The idea for conducting semi-structured interviews was to first take a look at different literature reviews and record who were the relevant organizations that have appeared or been quoted on different topics surrounding the Bagmati River. These institutions may include government and non-governmental institutions, social activists, and researchers. Out of these institutions, I contacted the ones that seemed the most relevant for the topic of restoration of the Bagmati River. Once in contact with a few stakeholders, a table where details of the people with their organization, and email was established, to keep a record of the people interviewed, found in Appendix 2. Additionally, the aim of the first contacts was for institutions to channel me and open to more institutions or activists who are also interested in the thesis I was researching. This concept is often called snowballing in qualitative methodology as the researcher creates a network of contacts that can be approached for further investigation (Parker, 2019). All these people fell under the category of key informants as they were able to express how their institutions or actions have in some way helped the restoration and rejuvenation of the Bagmati River over the years. Furthermore, they have engaged citizens to help the process as well as to create awareness within their communities about the actual state of the Bagmati River.

A series of questions were established beforehand for the semi-structured interviews, in order to allow me to acquire relevant information about the institutions. Questions such as: Have you personally done any activities or had interactions with the river itself recently?; What project have you been involved in?; Have these benefited the restoration of the river in some way?; Have you heard of any other government or non-government programs being implemented in the past 10 years? These questions were the starting point of the conversation of what the institution was based on and what projects they have been a part of to help the restoration process along the years. After the interviewees provided me with key information, I formulated further questions on the spot to extend the conversation about a specific topic they shared. The starting questions of the semi-structured interviews can be found in Appendix 3.

Limitations and Challenges of Methods Employed

As with all investigations that require fieldwork, there are often issues and challenges that the researcher encounters when doing transect walks, mappings, and taking photographs. Here I discuss some of the limitations and challenges that I experienced during my three-month stay in the Kathmandu Valley.

Transect Walks - The transect walks on the border of the Bagmati River helped capture significant citizen activities and key issues that were found along different sections of the river. Although I was able to cover a large area of the Bagmati, there were some obstacles that hindered my access to the riverside. Firstly, in the Thapatali district, there is a big squatter settlement that sits on the river border and I was not able to access it, due to security reasons. Secondly, there were many wired fences that restricted access to the river border near the Koteshwor and Sankhamul districts. These fences limited my capacity to be near the river, and also its green areas, as I had to walk on the roadside with oncoming traffic to capture photographs and record relevant data.

Qualitative Mapping - As stated above, the limitations of reaching some parts of the Bagmati River made it hard to record data for the mappings I later developed. As I could not walk along the squatter settlement, recording data from the other side had to be done by looking down at the walls of the river to spot any sewage water pipes or other relevant issues. These were sometimes hard to spot as some parts had vegetation or obstacles that prevented a clear sight.

Photographs and Visualizations - Additionally, the taking of photographs of some areas of the river posed a challenge, especially due to the wired fences near the Koteshwor and Sankhamul districts. Here, I was not able to take good quality photographs as the line of sight was not clear and sometimes had to weave my camera through the fence and vegetation to get a good photograph.

Semi-structured Interviews - At the start of the thesis, the main aim was to reach out to institutions via email to ask to conduct semi-structured interviews in order to provide me with relevant data for the thesis. This posed to be a challenge at the start as I later learned that many people in Nepal did not check their email frequently or forget to respond. So through the very first interview, I managed to acquire, I was able to learn quickly that in Nepali society, everyone phone calls personal numbers in order to arrange meetings or relevant issues. Here is where the snowballing effect of contacts started developing as I was able to create a network of which people knew others from other institutions.

4. STUDY AREA - CONTEXT OF RESEARCH

The Bagmati River is a topic that has been researched extensively throughout its history with Deshar (2013), Khatiwada (2013), and Kiran (2010) talking about the squatter settlements along the river, while Shrestha (2021), Platman (2014) and Butcher (2021) write about how the river has changed over the years due to its management and the government. The Bagmati River's existence is not only the stepping stone for the foundation of the Kathmandu Valley but also as mentioned before, it represents the goddess '*Ganga*' in the Hindu religion. Additionally, many articles and reports have been written recently about the actual state of the river and programs have been developed on how to clean and deal with the everyday problems the river encounters. Some organizations that have led programs include the High Power Committee for Integrated Development of the Bagmati Civilization (HPCIDBC), the Center of Integrated Urban Development (CIUD), Integrated Development Society Nepal (IDS), and the Environmental Camps for Conservation Awareness (ECCA) just to name a few.

Therefore, this topic has presented many arguments, opinions, and ideas over the years regarding how the river is seen from different perspectives and by different groups of people living in Kathmandu and outside. A literature review was done for this thesis as part of a recompilation process to showcase the context of the Bagmati River is found in. Informing about the different problems, ideas, and projects that have been discovered and implemented as the decades have passed. Moreover, each document analysis has been written for a specific purpose and audience, and for this reason, it was important to understand each in a deeper meaning and how these were relevant to the thesis. These literature reviews were supported by the semi-structured interviews I had with key informants of institutions. Below I present the context of the Bagmati River in terms of religious activities, and the challenges it has faced due to sand mining, and squatters.

The Religious Importance of the Bagmati

As stated in the first chapters, 81.3% of the population in Nepal is believed to practice Hinduism and for this reason, many temples can be found in the Kathmandu Valley, especially along the Bagmati River as the river is considered holy. One major temple is the Pashupatinath which is a UNESCO World Heritage Site.

The Pashupatinath temple as photographed in Figure 13 is a very important site for all Hindu worshippers as this temple is dedicated to the deity of Shiva. In the Hindu scriptures, many stories are found on Shiva and Shivlinga. "The Shiva Purana which is dedicated to Shiva describes various forms of Shiva. Chapter 351 of Shiva Purana gives a description of Pashupatinath

Jyorthirling located in Nepal" (Patel and Thakur, 2020. p.31). The Shiva Purana text references the valley of Kathmandu as a holy place and where "Jyothirling of Pashupatinath takes the form of a natural element. As nature is complete in itself, no one has made it, Pashupatinath Jyotirlinga is the structure of nature among nature" (Patel and Thakur, 2020. p.32). This is why the temple of Pashupatinath was constructed in Kathmandu.

Fig 13. Pashupatinath Temple depicting Religious Rituals (Source: Author, 2023)

Therefore, many worshippers around Nepal and India make the journey to visit this sacred site to pay tribute to Shiva but also as their final resting place before they pass to a better life. Mr. Niroj Maharjan a heritage conservation volunteer in the Kathmandu Metropolitan City explains that when somebody dies, the body is taken from the hospital and wrapped from the neck to the ankles for the ceremony. When it arrives at the temple, first the body is put on a stone bed called '*Brahmanal'*. Here the feet of the body are dipped into the river, then in the old traditional ways, family members would feed the body its last water drops from the Bagmati river to signify that the person would directly transcend into heaven. Unfortunately, Mr. Maharjan states that this practice had to change because of the pollution that the river has endured over the years, as seen in Figure 13, therefore this practice has been substituted by family members bringing water in a plastic bottle which is then disposed of in the river itself, adding to the pollution already present. The presence of water is important for these rituals to take place; this is why the Pashupatinath temple as well as many other heritage temples are located next to the Bagmati shoreline.

Fig 14. Temple depicting Religious Activities on the riverbank of Bagmati River (Source: Author, 2023)

Pashupatinath being a holy site, many religious rituals such as cremations are done alongside the Bagmati river. The temple accounts with 10 cremation spots and up to 60 cremations a day are performed at the temple according to an interview I had with environmental activist Mr. Bikesh Shrestha. After the rituals are performed at the *Brahmanal*, the deceased body is taken to the cremation area and placed on a platform on top of the wood. Rituals are performed before the wood is set on fire and the body is left for some hours to be consumed. Later the ashes are gathered by family members and thrown into the Bagmati River, the wood is pushed off the platform into the river and transported downstream. In the past, the ritual consisted of the body and wood being burned fully, but today because of time constraints, the wood is burned until a certain point. The importance of this cremation ritual is that the body cremated is considered as "the worshipper to be freed from all the worldly pleasures, luxuries and all the earthly things which he compiles in his life. The venue of the cremation on the banks of the river Bagmati pledges itself to a vivacious and worldly bond-free farewell" (Patel and Thakur, 2020. p.33).

The religious descriptions of all of the above are important to the understanding of why the Bagmati River plays an important role in people's religious perspectives. Furthermore, it gives another perspective of the Bagmati River as religious activities along its banks also contribute

to the actual state it is found in. Religion plays a major part when it comes to Nepalese cultural heritage, and it is a very sensitive topic to write about especially being a foreigner who does not practice Hinduism. We could argue that yes, these cremation rituals and religious activities play a major role in the pollution that can be found in the Bagmati River, as human ashes and remains are being carried downstream. Furthermore, as worshippers perform activities on the Bagmati shorelines, debris such as food, flowers, plastic bottles, bags, clothing as well as the remains of the firewood of the cremations are left behind and eventually make their way into the water as seen in Figure 14. Polluting it in one way or another even if it is organic material.

Sand Mining

Since the fast urbanization of the Kathmandu Valley in the late 1970s, there has been a high demand for sand for building purposes. This led the sand mining industry to start acquiring its resources from large rivers across the valley, such as the Bagmati River. Therefore, sand mining has been one of the key factors in the degradation of the Bagmati River to this day. This is because, with the mining of sand, the Bagmati River has become shallower and narrower over the years as well as the natural filtration process of the river has been removed.

Due to the heavy sand mining during the 1980s, several incidents have happened such as in "1991 the Bagmati Bridge that links Kathmandu with Lalitpur collapsed due to haphazard exploitation" (Sayami and Tamrakar, 2007. p.90). This led the Government of Nepal to prohibit the mining of sand from riverbeds and start delivering licenses to mine sand from terrace deposits (Sayami and Tamrakar, 2007). Nevertheless, these prohibitions did not stop several small sand mining companies from excavating from the major rivers in the valley. "Commonly, miners used excavators to dig a channel in pre-monsoon season, so that sand could be collected in the ditches during monsoon (June–September)" (Sayami and Tamrakar, 2007. p.92). Furthermore "during post-monsoon, different sieves were used directly in the channel to separate gravel and sand" (Sayami and Tamrakar, 2007. p.92) with the aim to later on, sell it to construction companies for building purposes.

Fig 15. Narrowing the Bagmati by the Construction of Parks and Roads (Source: Author, 2023)

Mr. Maharjan, accounts that the river used to be much wider before with some temples being part of the river shoreline, as they had religious steps leading towards the river, but now a road as well as a park have been constructed between the temple and what is now the river, as seen on Figure 15. More evidence of how the river has become shallower over time is the foundation pillars of several bridges that can be seen above the actual water level of today as seen in Figure 16. Here we can witness that the river bed has decreased by approximately 4 meters. Of course, this evidence can be seen substantially more during the dry season when the water level of the river is low.

The removal of sand from the river bed of the Bagmati River has stopped the natural filtering of the water itself. This is especially important for the suitable flourishing of aquatic flora and fauna, but “this process does not take place, as a layer of organic and inorganic discharge has accumulated on the bed, sealing off access to the little sand that still exists” (Karki, 2019).

Fig 16. Effects of Sand Mining in Teku District (Source: Author, 2023)

Squatters

The Nepali term for squatters is "*Sukumbasi*" originally used in rural contexts to describe people without legal ownership of land and adapted to name the inhabitants as well of the urban informal settlement (Subedi and Sehgal, 2022). Since the 1950s, the Kathmandu Valley already shared its land with various squatter settlements but as the decades have passed and the cities of Kathmandu, Lalitpur, and Bhaktapur have developed, more and more people have settled in a land not formally entitled to inhabit. The "increasing trend in the number of the squatter settlements is one of the key issues related to uncontrolled urban growth in Kathmandu Valley. In 1985 it was estimated that there were only 17 squatter communities in Kathmandu, but now the number has grown to 40" (Deshar, 2013. p.128). Some of the most important settlements found alongside the Bagmati River are: "Shanti Nagar, Bijay Nagar, Jagrit Nagar, Gairigaun, Chandani Tole, Pragati Tole, Kalimati Dole, Kimal Phant, Bansighat, Kuriyagaun and Sankhamul" (Deshar, 2013. p.130).

Fig 17. Squatter settlement in Thapatali District (Source: Author, 2023)

Most of these settlements as seen in Figure 17 are located alongside the Bagmati River, and are therefore vulnerable to floods, especially during the monsoon season. "The squatter communities on the bank of Bagmati River are taken problematic rather than other settlements, it is because of the central location, heavy settlement area, and out of the sanitation and drinking water facilities" (Tanaka, 2009. p.145). Due to the lack of sanitation and trash collection infrastructure, these settlements contribute to the degradation of the river as pollution and waste of all kinds are heavily deposited into the Bagmati (Tanaka, 2009). Furthermore "Remnants of animals and Slaughterhouse wastes are another big problem. Construction debris thrown haphazardly along the corridor is also another source of pollution" (Deshar, 2013. p.138). The pollution caused by the squatter communities along the Bagmati River has far-reaching consequences. This is because, as stated before, the river is considered sacred by the Nepali people and is an important source of water for agriculture and drinking purposes. The heavy pollution caused by these settlements poses a serious threat to the health and well-being of the people living nearby and also affects the flora and fauna of the area.

Efforts have been made to address this issue, but until the mid-1990s, there was no clear government policy on this issue due to a lack of resources and political will. Therefore, few development agencies, either national or international, worked on shelter issues in urban Nepal (Tanaka, 2009). Keeping this in mind, The Government of Nepal destroyed squatter settlements

established on the bank of the Bagmati River in May 2012 to shift them to other locations but because of an organized protest against the government they resettled there after one month (Deshar, 2013). In 1993 the Lumanti organization was established and since then has worked as a driving force in putting urban poverty and shelter issues on the development agenda for these settlements.

The Lumanti organization has a wide range of activities in order to help these squatter settlements. These include: "shelter upgrades, micro-finance, education, and children's programs. Furthermore, the major initiatives of Lumanti are settlement enhancement and housing projects, saving and credit activities, water, health, hygiene, and sanitation interventions, education programs, documentation, advocacy, research, and surveys on squatter settlements and urban issues including community organization and mobilization activities" (Shrestha, 2009. p.10). Overall, the work of Lumanti is making a significant difference in the lives of squatter communities along the Bagmati River. By providing a range of support services, they are helping to improve living conditions, promote sustainable development, and empower these communities to build a better future (Shrestha, 2009).

Nevertheless, the pollution caused by squatter settlements along the Bagmati River is a complex problem that requires a multi-faceted approach. This is because even though institutions like Lumanti are helping the people living here, more and more squatter settlements appear each year alongside the Bagmati and therefore contribute to the degradation of the river. This is why, to truly address the problem of pollution in the Bagmati River, a concerted effort must be made involving key stakeholders, such as the government, local communities, and NGOs. This can be achieved through education, awareness campaigns, and the provision of incentives to encourage people to adopt ecological practices.

Qualitative Mapping Analysis

The Bagmati stretch between Tinkune Bagmati Bridge next to Subidhanagar District all the way down to Kupondole Kuleshwor Bridge where the Teku District is found has been selected as the area of study for the thesis. This is because this stretch of the river is found at the center of the Kathmandu Valley where the KMC and LMC are separated by the Bagmati River. As the river meanders its way through the cities, it collects a lot of pollution due to the vast urbanization of the valley. This can be seen through the forms of sewage pipes, trash accumulation, squatter settlements, and animals that are seen throughout the river shoreline. This section forms part of the qualitative methods that were implemented, focusing on transect walks, photographs and visualizations, and qualitative mapping. Here, detailed maps were generated in order to analyze the area selected.

A method for data collection for the thesis was transect walks alongside the river border to observe and distinguish different elements that would be important to analyze for the ecological restoration of the Bagmati River. The transect walks took place at the heart of Kathmandu and Lalitpur, where the river is the most contaminated as it meanders through the cities. The starting point was the Tinkune Bagmati Bridge next to Subidhanagar District all the way down to Kupondole Kuleshwor Bridge where the Teku District is found. For the analysis of this stretch of the Bagmati River, I divided the river into three portions so that a deeper analysis could be made by distinguishing different elements that I witnessed while walking along its border. The sections were divided as seen in Figure 18 by the different bridges found crossing the Bagmati and are as follows:

- Section 1 which is the area between Tinkune Bagmati Bridge to Shankhamul Bridge.
- Section 2 from Shankhamul Bridge to Thapathali Bagmati Bridge.
- Section 3 from Thapathali Bagmati Bridge to Kupondole Kuleshwor Bridge.

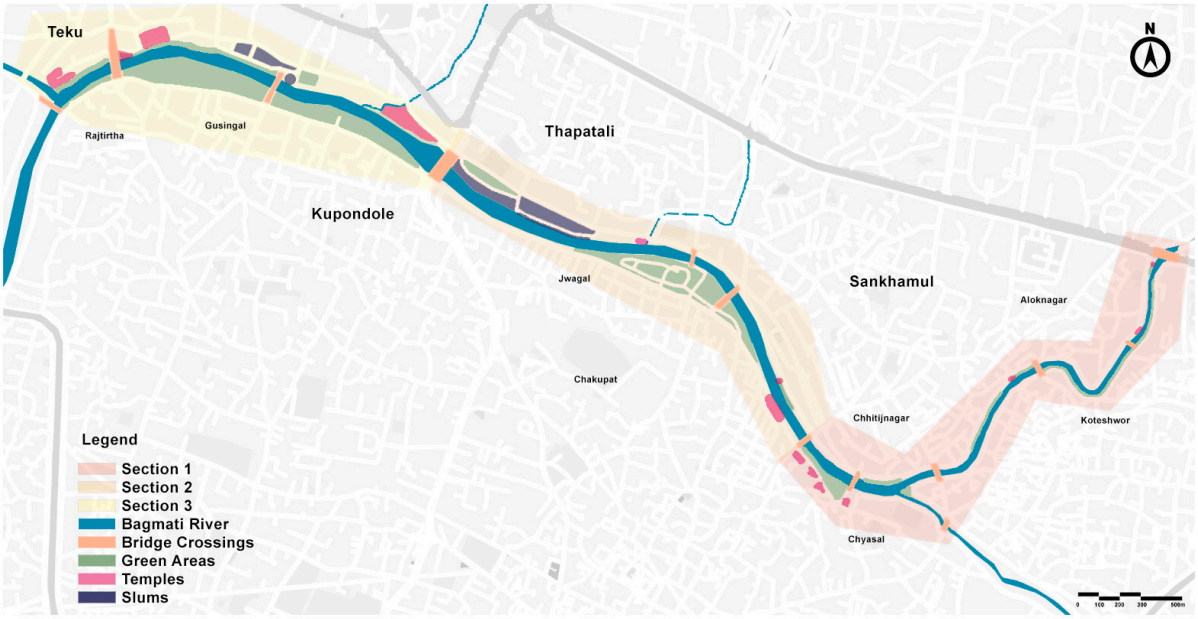


Fig 18. Map showing the division of the different sections of Bagmati River (Source: Author, adapted from google maps, 2023)

Section One

The first section of this map analysis consists of an area that starts from heavy traffic Tinkune Bridge until the Sankhamul Bagmati Bridge in the southwest. Here, four different districts surround the Bagmati River, consisting of Chhitijnagar, Aloknagar, Chyasal, and Koteshwor. This section of the Bagmati River consists of many narrow stretches and two-way roads run adjacent to it, leaving only a small space to develop different urban programs. Nevertheless, a few long green corridors and parks have been developed.

One such park is the Madan Bhandari Corridor as seen in Figure 19. This park stretches from the Mahadev Sthan Bridge all the way to Tinkune Bridge. Half of the park is still being constructed but during my transect walks, I saw many students and young people having a walk along the riverside. Within this bridge, a playground and a fitness area are located for people to use. In the southwest area of Figure 23, a big green area can be seen, Sankhamul Park is located here. This park as seen in Figure 20 has various sitting areas as well as a small amphitheater. Many people in the afternoon can be found here socializing and doing various activities. Furthermore, many citizens cross the park in order to access the different temples that can be found within the area. Another green area that seems like an observation deck is a park located at the acute angle where the Manohara River intersects the Bagmati River. From here you can get a good panorama view from the river and the cities of Kathmandu and Lalitpur. Finally, a big sports area can be seen south of Figure 23 which constitutes a big football stadium.

Fig 19 & 20. Madan Bhandari Corridor and Sankhamul Park (Source: Author, 2023)

Fig 21 & 22. Accumulated Sand & Restricted Viewing Path of Bagmati River (Source: Author, 2023)

As seen from Figure 23 there are many water drainage pipes that can be seen alongside the river border. I was able to count a total of 34 drainage pipes that discharge into the river. These pipes ranged from different diameters but mostly were made out of concrete. Additionally, some of these pipes were hard to record as they were hidden between the vegetation mesh that has developed over the years. In this section, only one recording of livestock was seen, and this was of two cows that were feeding on the vegetation found on one green corridor.

A total of 13 religious steps were seen during my transect walks, but these steps were steeper and seemed more like stairs that descended to the river. This is because, between the Bagmati Manohara Dobhan Bridge and the Tinkune Bridge, the parks and roads rested on high gabion walls that delimited the river wideness. Furthermore, many of these areas were hard to access as they were delimited by fences and an abundance of vegetation had grown over the years and had not been maintained as seen in Figure 22.

Finally, this section of the river seems that there are many ongoing construction processes to make it a better riverscape for its surrounding populations as many areas were under construction. Some of these are the extension of the Madan Bhandari Corridor but also the construction of a new car bridge next to Sankhamul Park.

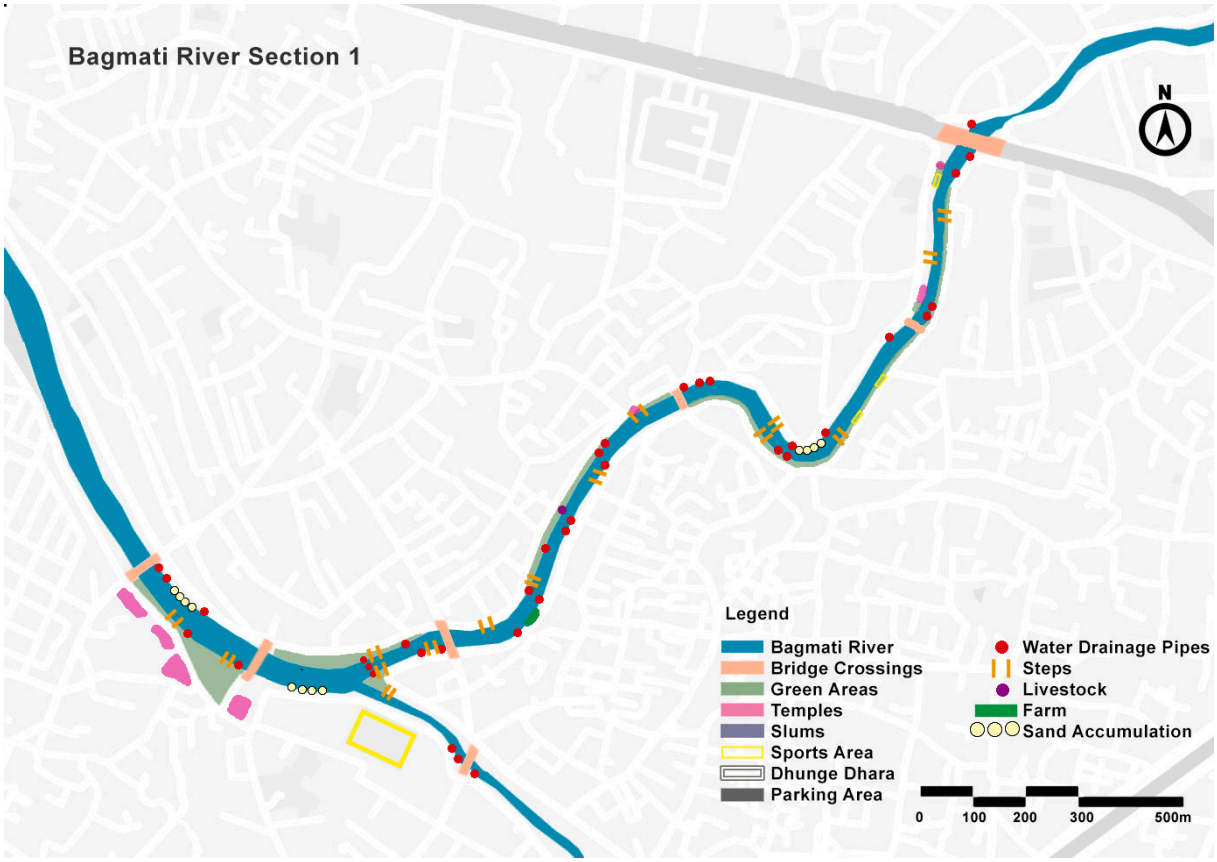


Fig 23. Qualitative Mapping Section 1 of Bagmati River (Source: Author, adapted from google maps, 2023)

Section Two

The next section can be found between the bridges of Sankhamul and Thapathali Bagmati Bridge. The districts found here are Thapatali, Sankhamul, Jwagal, and Chakupat. In this section of the river lies the UN park at its center as seen in Figure 24. This park offers citizens a large green space to do various activities such as play volleyball, cricket, sit and socialize on its grass areas and there is even a small informal food stall that I was able to witness in my transect walks. The park has an abundance of large trees that shade the area and are helpful during the hot summer months. Two bridges cross the UN park, one which is a big, heavy motorway and the other what seemed like a temporary pedestrian bridge. This is because its structure seemed that it was never fully finished and lacked accessibility to get on to. Another park that I encountered during my transect walks is the Sri Sathya Sai Kendra Sankhamul Park found on the South East of Figure 28. This park looked recently constructed as seen in Figure 25 and was very well maintained as the bushes were nicely cut, it had benches and even trash cans. The park included a structure that seemed like an obelisk and a small Hindu temple.

Fig 24 & 25. UN Park and Obelisk Park (Source: Author, 2023)

Fig 26 & 27. Sand Accumulation near Slums and Sewage water mixing with Bagmati River (Source: Author, 2023)

On the North West (see Figure 28) part of the map lies a big slum area. This slum area has slowly encroached the Bagmati River throughout the years according to accounts from my interviews. Furthermore, livestock such as chickens and goats can be seen roaming around its borders. Further livestock such as goats and two cows were seen near a temple site next to the Sankhamul bridge. On one part of the slum area, a large amount of sand could be seen accumulated (Figure 26). The sand continued under the Thapathali bridge and piled up even further with trash and vegetation that almost reached the bridge's bottom.

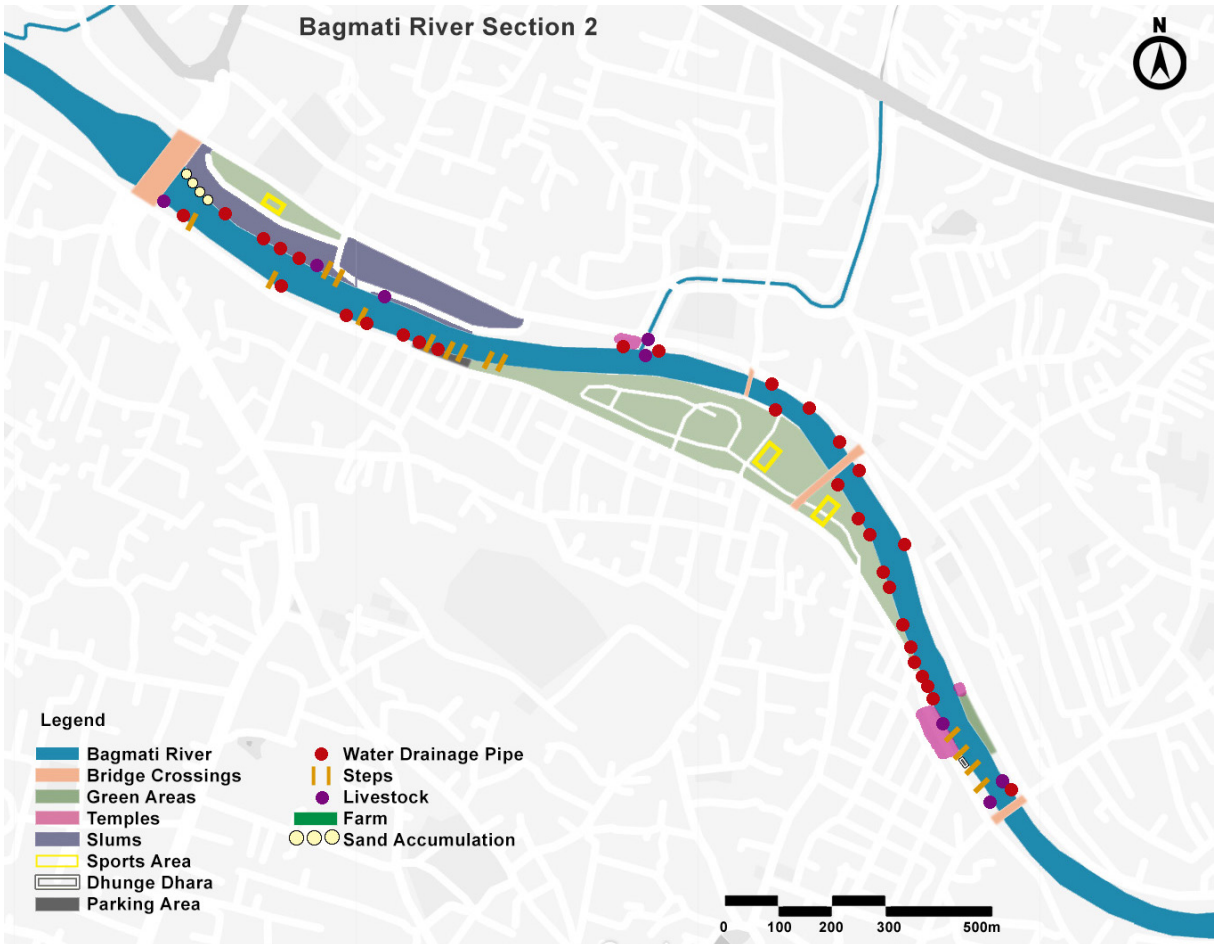


Fig 28. Qualitative Mapping Section 2 of Bagmati River (Source: Author, adapted from google maps, 2023)

As seen in Figure 28 in this portion of the river I was able to record a total of 31 water sewage pipes that open up to the Bagmati River. Most of them were made out of concrete and had large diameters, and even some were well constructed into the retaining walls of the UN park. At the south end of the map where a temple can be seen, a series of six drainage pipes were seen heavily discharging big amounts of liquid into the river. Here I was able to observe how the water from the Bagmati and from the sewage mixed as a line could be seen on the water like it was oil and water as seen in Figure 27, additionally, a dominant smell filled the air. Finally, several big step areas can be seen alongside the Lalitpur side of the Bagmati River. On the North West, these were part of a small promenade where a small number of people were seen

walking. Moreover, along the river border line of the Lalitpur side, all parks and areas had solar-powered lamp posts that would illuminate at night.

Section Three

Section three of the analysis comprises the districts of Teku, Rajtirtha, Gusingal, and Kupondole which are found between the Thapathali and Kupondole Kuleshwor Bridges. This stretch of the Bagmati River has many patches of green areas where two sports areas are found with one of them being a bicycle pump track where many children and teenagers can be seen. Many people can be seen walking around or doing activities in these green spaces such as playing cricket, football, as well as just sitting on the grass and having conversations as seen in Figure 29. As my research took place during the winter months of Nepal, people were also seen sitting or laying down taking in the sun's heat to warm up. Furthermore, in these green patches, two small farms can also be found where small vegetables are grown (Figure 30). On the northwest part of Figure 32 lies the district of Teku. This district has several heritage religious temples that citizens around the area visit on a regular basis. To the East the Mahadev temple can be located, but this is being renovated and reconstructed (Figure 31) after it was affected by the 2015 earthquake that shook the Kathmandu Valley.

Fig 29 & 30. Green Areas and Farm found in Gusingal District (Source: Author, 2023)

Fig 31 & 32. Mahadev Temple Reconstruction and Accumulated Sand in Gusingal District (Source: Author, 2023)

In the middle of Figure 33 a slum area can be identified, this slum area could be denominated as well established, as the houses were made out of bricks and even commercial shops are seen here. Near the temples and slums several livestock roamed around their premises such as goats and cows. Additionally, several monkeys were seen near the Mahadev temple.

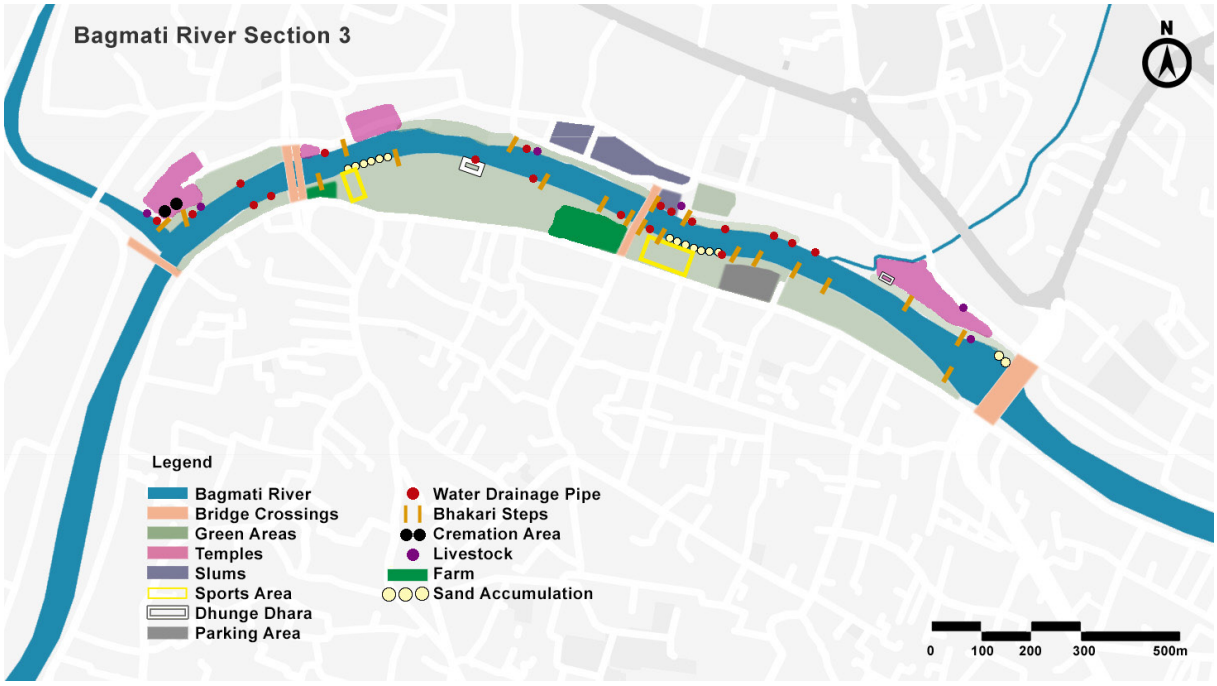


Fig 33. Qualitative Mapping section 3 of Bagmati River (Source: Author, adapted from google maps, 2023)

Along this section of the Bagmati River, I was also able to identify a total of 19 water drainage pipes that discharge sewage water into the river. These pipes ranged in diameter but were mostly made out of concrete. During my transect walks I witnessed many of them discharging sewage water with a potent smell. Moreover, two patches of sand accumulation could be identified, where sand mixed with trash and vegetation created small dunes that reached a height of 2 meters as seen in Figure 32. Finally, several step areas can be seen alongside the river shoreline, especially near the temple areas as these are important for religious purposes but also gives a chance for citizens to interact with the river. During my transect walks I did not witness anyone sitting down or being near them, apart from when several children had to run to get their cricket ball while playing.

5. RESULTS AND FINDINGS OF ATTEMPTS TO RESTORE THE ENVIRONMENT AND ENGAGE CITIZENS AROUND BAGMATI

The following chapter outlines the different institutions I was able to conduct semi-structured interviews with and how they have been involved in the restoration process of the Bagmati River through programs that have been implemented in recent years. These institutions have also contributed to citizen involvement in different activities to create awareness about pollution and recycling in order for citizens to have a better quality of life.

Stakeholders

Different types of stakeholders including non-profit organizations as well as government institutions have contributed to the restoration of the Bagmati River over the last few years. They have contributed by finding ways of restoring the river but also through trainings, campaigns, and programs involving citizens and communities in order to raise awareness about the state of the Bagmati River. From these institutions, I was able to conduct semi-structured interviews to get insights and knowledge of the programs they have conducted over the past years. From the data collected from the interviews, a stakeholder mapping was developed outlining the power and interest these institutions have towards the contribution of the restoration of the Bagmati River using citizen involvement.

As seen from Figure 34 the different organizations are placed in accordance to their power and interest they have, Within each bubble which determines if they are non-governmental or government institutions they outline the different programs they were able to share with me through the semi-structured interviews. The following institutions along with the programs they have implemented are analyzed next. An analysis is made through how they have contributed, and the challenges they faced. Additionally, their Strengths, Weaknesses, Opportunities, and Threats are synthesized using a SWOT analysis diagram for each, where I state my overall overview of the programs implemented and their results.

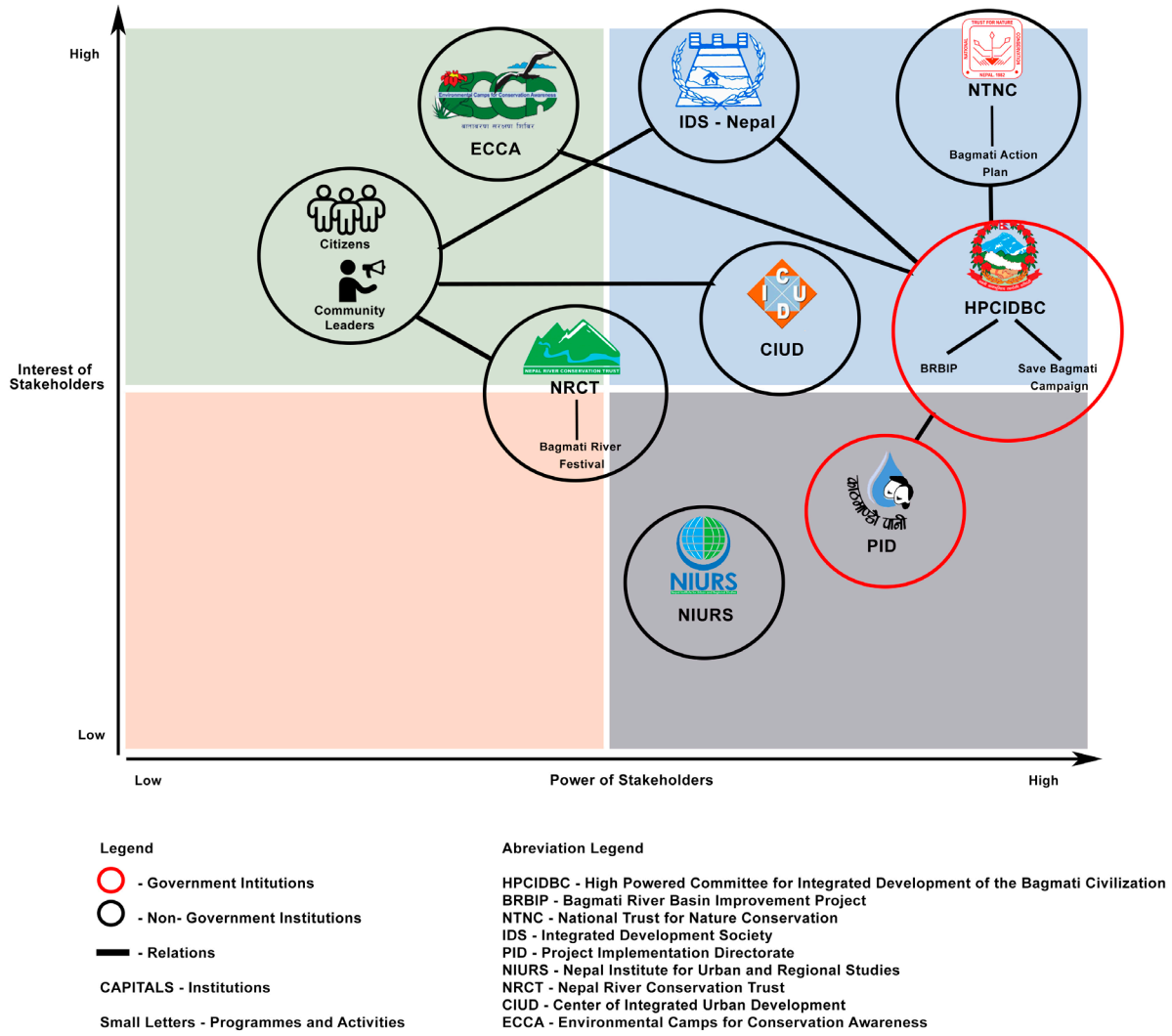


Fig 34. Power-Interest Stakeholder Mapping (Source: Self-made by author, 2023)

High Powered Committee for Integrated Development of the Bagmati Civilization (HPCIDBC)

The High Powered Committee for Integrated Development of the Bagmati Civilization (HPCIDBC) is a government office whose objective is to keep the Bagmati River and its tributaries clean by preventing the direct discharge of solid and liquid waste into the river and to conserve the river systems within Kathmandu. The HPCIDBC sets out to achieve this by constructing secondary sewage pipelines, water treatment plants, roads, and green belts along the banks of the river to create public awareness programs about the Bagmati's River state (HPCIDBC, 2023). Over the last decade, the HPCIDBC has been part of aiding the Save Bagmati River Campaign and has implemented the Bagmati River Basin Improvement Project (BRBIP). The following are discussed below.

Save Bagmati Campaign

Mr. Bikesh Shrestha is an environmental activist who in 2011 together with many friends started the "Save Bagmati Campaign". A campaign that is still active until this day. His goal was to establish a community in order to spread awareness and encourage other volunteers to join and clean up parts of the Bagmati River every Saturday. Mr.Shrestha outlines that at the start of the campaign, there was no official structure on how to proceed with the cleaning of the river, but as the weeks passed, volunteers started to take leadership roles and encouraging people how to proceed with the clean ups and which part of the Bagmati River should the campaign address next. His efforts since 2011 attracted voluntary participation of different organizations as the years have gone by, even the honorable Nepal Police and Nepal Armed Police Force (Shrestha, 2021). Furthermore, Mr. Strestha states that he personally visited the United Nations office in Kathmandu once to present the project to gather more volunteers from the UN. He was successful as they participated for several weeks and also funded equipment to help clean up heavy river material that they encountered.

At the start of the campaign, the debris that was found in the river was initially placed in an empty plot of land that Mr. Strestha owned near his house, and that was the accumulation point. He soon realized that as the project was being successful and more weeks passed that this was not a viable option, therefore, volunteers started contacting trucks that would help take the residue away. Now, all of the residue and debris that is found in the river is put into large trucks and sent to landfills which are located at the outskirts of the city.

During my fieldwork investigation, I was lucky to take part in the Save Bagmati Campaign for one week in March and I was able to witness how the group gathers in order to clean the riverside. Mr. Tost Raj Chhetri, an activist and former field coordinator of the Center of Integrated Urban Development (CIUD) guided me through the campaign. Every Saturday morning from 7:30 am to 9:30 am a group of around 150 people gathers in an area alongside the Bagmati River where they think it is most polluted and trash can be easily collected.

First, the group leaders give speeches and encourage the citizens attending the campaign through chants and the national anthem. Gloves, facemasks, and tools such as shovels, wrenches, and straw bins are provided to the people participating before making their way to the riverside. Here a small dump truck is placed near the clearing site and the people start working by collecting large pieces of trash that are found on the river banks as seen in Figure 35. Various objects are mostly cleared from the site, these include paper, cardboard, clothes, fabrics, and plastic items such as bottles, bags, and food wrappings are deposited in the straw bins. These bins are passed through a human chain and deposited on the dump truck where two people manage the waste by emptying the bins and throwing them back to the clearing site.

Fig 35. Save Bagmati Campaign clearing trash in Sinamangal District (Source: Author, 2023)

The session I was able to witness consisted of mostly women as seen in Figure 36. They normally form the chain but also help with the collection of trash. As the trash is being collected, some dried-up vegetation that is found alongside the river is collected and burned to ashes. Mr. Chhetri explained that these are burned in order to clear any obstruction towards the riverside. After a specific section is cleared, the group moves down the river, and the whole process is repeated. Depending on the section, volunteers also enter the Bagmati River to clear large floating objects.

When I visited the campaign, an environmental activist explained that the campaign has involved social workers, NGOs, schools, the police department, and the army over the years to help the cleaning campaign. Furthermore, he states that as many as 1,500 people have been seen helping with the clearance of debris alongside the Bagmati on a Saturday morning. Important government figures, actors, and famous Nepali people have made their presence in the cleaning campaign to promote awareness among communities and citizens of Nepal. Mr. Chhetri explained that the Save Bagmati Campaign is the main branch of the initiative of saving various rivers across Nepal. These campaigns have been organized through various Facebook and WhatsApp groups and all operate simultaneously on Saturday mornings across the nation.

Fig 36. Women in Bagmati Campaign clearing trash in Sinamangal District (Source: Author, 2023)

During my visit, the campaign cleared approximately 1.5 tonnes of trash according to Mr. Chhetri in a stretch of around 100 meters of the Bagmati River. Before, during, and after the campaign, words of encouragement and music were played through a speaker to encourage volunteers and also try and integrate citizens who are roaming around the area. I was able to talk to some volunteers during the campaign, and they explained that the main reason they get involved is because they want to help restore the Bagmati to how it used to be in the past. Additionally, helping gives them a sense of satisfaction and it helps the environment of the city, even if they live far from the Bagmati. Some also stated that they do it as a way to promote awareness and because the government does not do anything to clean the river.

At the end of the session, the participants clean themselves using water from a water truck and gather together to chant, dance and repeat their slogan which is "राष्ट्रको लागी हप्ताको २ घन्टा स्वयंसेवा, हाम्रो अभियान जारी छ ! जारी छ ! जारी छ ! " (Let us volunteer for the nation, two hours per week, Our campaign will continue, continue and continue). The dump truck with the trash collected is sent to the HPCIDBC office which according to Mr. Chhetri, is later deposited in the landfill site located in Banchare Danda.

Fig 37. Save Bagmati Campaign clearing trash in Sinamangal District (Source: Author, 2023)

Challenges and Opportunities

During my visit to the Save Bagmati Campaign I was able to witness some challenges and opportunities the campaign faced. These are shown in Figure 38 as a SWOT analysis. First of all, not all the trash from a specific place was collected within two hours, and this is because many items are very small and are mixed with vegetation and sand found on the shorelines. I would say only 65% of the trash is cleared. Therefore, a longer period of time would be needed to actually clean 100% of the area of all pollution. Furthermore, even though the campaign is organized through Facebook, it is not well organized on-site. As everyone is close together collecting trash instead of spreading out and covering both sides of the river as a result only a few hundred meters are cleared within one session.

Some opportunities that the citizens involved in the campaign could gain, is knowledge of how to implement different ecological solutions to stop trash from flowing down the river. These solutions could help trash get trapped in a specific area and would be easier for the campaign to collect the debris. Furthermore, the campaign could be expanded to several days with the help of school children contributing to the program and therefore creating citizen awareness of why it is important to keep the blue infrastructure of Kathmandu Valley clean.

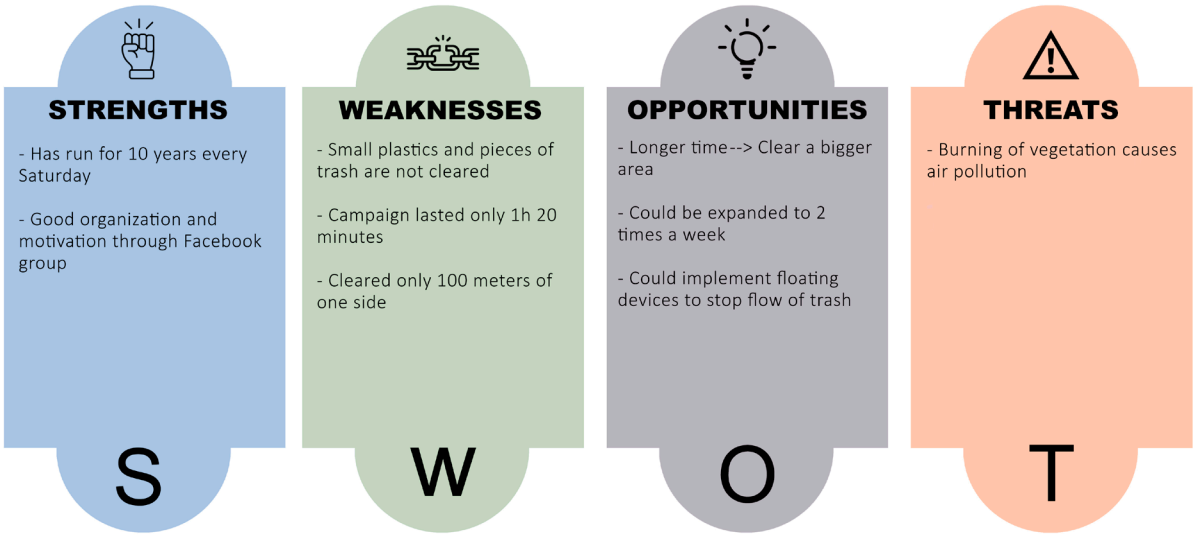


Fig 38. SWOT Analysis for Save Bagmati Campaign (Source: Self-made by author, 2023)

Bagmati River Basin Improvement Project (BRBIP)

In recent years, HPCIDBC developed the Bagmati River Basin Improvement Project (BRBIP) with the purpose to improve river health and flood management in order to impact and increase water security in the Bagmati River (Inception Report, 2019). Recently, since the earthquake that devastated the Kathmandu Valley in 2015, many plans within three packages have been in the works to make the riverside a more welcoming and greener place for citizens to interact with the Bagmati River. During one of my interviews, I was able to meet Ms. Nabina Mahar who is a civil engineer and resource management consultant working on the project of landscape reforming for the BRBIP. She was able to take me around the sites of the different projects that they have been part of since 2015.

The project site is found between the Thapathali Bridge and Teku Dobhan. This area's longitude extends approximately 2.5 kilometers on both sides of the river and crosses many bridges which form part of wards 1, 7, 10, 11, and 12 of the KMC and LMC (Inception Report, 2019). This area has been divided into three different packages for urban development, but all of them share the same common five outcomes (Inception Report, 2019):

1. Establish a system and develop capacities for integrated and participatory river basin management
2. Improve riverbank environment within urban areas
3. Increase water availability in the basin during the dry season through watershed conservation
4. Operation of flood forecasting and early warning system for the Bagmati River Basin
5. Efficient project management with effective stakeholder communication

Here, I will outline two packages that have been under development since 2015. The first package focuses on the development of the landscape adjacent to the river, while the other focuses on the restoration of monuments and heritage buildings.

Package - Landscaping

The landscaping package started in 2019 with the goal of creating an urban promenade for citizens to be closer to the Bagmati River as well as areas where people could do various activities. Ms. Mahar recalls that before the project started the site used to be a huge dumping site, where plastics, trash, and construction debris could be found. This of course was a huge problem for the Bagmati River as the trash would eventually fall into the river, polluting it every single day and causing clogging in various parts. Eventually, all the trash was cleared, and the soil was compacted in order for the design of the project.

The construction of the project faced some difficulties along the way such as the COVID-19 pandemic, which stopped the project for several months. Furthermore, she explains that many construction materials, such as fences, tiles, and pavement masonry over the years have been stolen as the project is an open area that has no fences to protect it, and it is difficult to store and protect the construction materials. During the monsoon season, the project has also faced flooding and this has caused trash as well as sand to be deposited on green spaces that have been developed. Ms. Mahar says it is a consequence due to the amount of deposited sand that is already found along the river border as seen in Figure 38. She states that the sand has been a problem for many years and the government plans to clear it, but there have been no further activities that show when they will do it. For this reason, the project is still ongoing as of now and is intended to be done by April 2023, with only basic finishing touches to be done.

Fig 38. Sand Accumulation in Bagmati River in Kupondole District (Source: Author, 2023)

As of now, the project has a promenade on both sides of the river that runs from the Thapathali Bridge to the Balkhu Ring road bridge. This promenade as seen in Figure 39 consists of a masonry pavement and opens up towards the river with Bhakari step sections that were built so that religious activities can be performed. Near the steps, some pump houses and ritual spaces have been constructed for worshippers. The promenade also features solar-powered lamp posts and many green grass areas for people to practice different sports and do various socializing activities. As of now, no trees have been planted as it's winter and they are hard to maintain, but Ms. Mahar assures that these will be planted in the summer months. Additionally, in some parts of the corridor, public toilets have been constructed as well as a parking lot for people who visit the area to park their motorcycles.

Fig 39. Landscape Package Promenade in Kupondole District (Source: Author, 2023)

Finally, during my interview with Ms. Mahar, she explains that as the years have gone by, the project has seen an increase in people using the various green areas to do various activities. People normally are seen here during the early morning or in the evening. Moreover, she identifies that there are some problems that affect the area that they cannot control such as cows grazing the public areas as well as many street dogs are seen roaming around and sleeping. Furthermore, as it is an open area, there are no fences or restrictions, so anyone can enter the corridor and people sometimes come to teach others how to ride a motorcycle.

As mentioned, the project is to be finished by April 2023, when the BRBIP will hand the project to the local government. The local ward government office will be responsible for maintaining the area in the future.

Package - Restoration of Historical Buildings/Monuments

On the 25th of April 2015, a 7.8 magnitude earthquake struck the capital city of Kathmandu, killing 8,964 people and leaving around 22,000 injured (April 2015 Nepal Earthquake, 2023). The magnitude of this earthquake made many buildings collapse as well as historical religious temples and monuments with several replicas following days after. This event led to many government and non-government institutions such as the BRBIP to help restore the historical temples and monuments.

During my interview with Ms. Mahar, I was able to visit two temples that are found inside the landscape package area that BRBIP is currently developing. Here I was able to meet architects Mr. Sumil Shakya, and Mr. Bishwas Paudel who explained what the Restoration of Historical Buildings/ Monuments package consisted of. This package is divided into three smaller packages where package one consists of restoring 11 monuments, package two of 13 monuments, and package three of 4 monuments (Inception Report, 2019). These temple sites collapsed or were heavily damaged during the 2015 earthquake due to the traditional and historical ways of construction, as heritage buildings were normally constructed without any plans only consisting of wood and brick.

Mr. Shakya explained that the restoration of the temples first started by demolishing the affected parts due to the earthquake, to be able to use better construction techniques in order to support the older structure. One new construction technique implemented was the interlocking of bricklayers together with lime mortar as seen in Figure 40 to create a stronger structure. The lime mortar is fixed inside the brick layers to leave the facade apparent only with brick. inside, different brick shapes are used together to create a stronger compaction. The structure is further compacted by wooden beams that are interlocked at different sections such as where windows, doors, and the distinction of floors as seen in Figure 41. This interlocking helps the building to have a stronger structure and that it can move all together if there were to be another earthquake. Even though this new construction technique of old Newari architecture is different, the facades still resemble the old style, as different elements such as the windows, doors, and wooden roofs are still being used as seen in Figure 42.

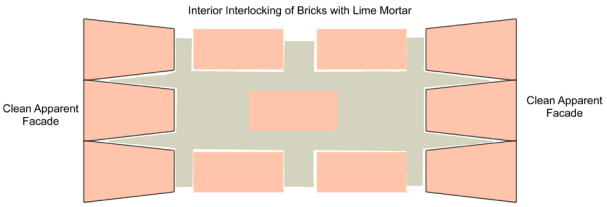


Fig 40. Interlocking of bricks of Newari Temple (Source: Self-made from informations gathered at interview, 2023)

Fig 41. Restoration of Mokshya Dhaam temple Tripureshwor District (Source: Author, 2023)

While talking to Mr. Paudel, he explained that there were some problems they faced when constructing the heritage temples. One problem is that within the monument site, there exist houses for religious devotees who live and house others when there are religious days. He explains that relocating these people was first a problem when the buildings suffered damage as they did not want to relocate far away from the temple site. For this reason, the group that consisted of 84 people (Inception Report, 2019) stayed just adjacent to the site and now a small squatter has been developed. Moreover, the different families were registered in the Inception Report of the BRBIP to acknowledge them, so they can be relocated when the reconstruction is completed but Mr. Paudel feels that now the number of people has grown and once the project is handed in May, these houses that normally are run by Babas will not be able to fit all the devotees and camps will be made outside.

Fig 42. Restoration of Mokshya Dhaam temple Tripureshwor District (Source: Author, 2023)

Finally, Ms. Mahar explains that this heritage package is linked to the landscape package as when the temples and monuments are opened, a lot of religious groups will be found doing activities within the promenade of the parks that have been designed. These activities will include the washing of themselves in the Dhunge Dharas, religious offerings will be placed inside the river and cremation spots may develop. Additionally, within the monument site, a museum is intended to be opened for foreigners to visit and see the religious activities. All these different programs will see a lot of citizens use the green areas provided by BRBIP.

Challenges and Opportunities

As stated above the different packages have presented different challenges over the past years, even though COVID-19 played a major part. This can be seen in the SWOT analysis in Figure 43. Here, The landscape package presented challenges of flooding due to the monsoon season, and also construction material was stolen which led to the project being delayed. The Restoration of Historical monuments also presented challenges such as the slow restoration process of the monuments due to the earthquake. Furthermore, relocating people and giving them aid possessed a challenge and the risk of pressuring the BRBIP to give them their houses back.

On the other hand, these packages present many opportunities that could be developed to create a place where citizens can feel part of the Bagmati River again. Opportunities such as the development of sports areas, a heritage museum, green shaded areas for the summer months and the implementation of urban furniture could all influence the feeling of being part of the Bagmati River. Furthermore, some possible ecological solutions could be implemented to engage citizen awareness and participation such as the planting of green vegetation, removal or landforming of the accumulation of sand in the river and the implementation of reed vegetation that could help the restoration of the Bagmati.

Fig 43. SWOT Analysis for Bagmati River Basin Improvement Project (Source: Self-made by author, 2023)

Integrated Development Society Nepal (IDS)

The integrated development society (IDS) is a non-profit organization that has been operating since the year 2000 with the aim to create social mobilization. This is to be able to involve citizens of Kathmandu to be part of educational participatory programs to help create awareness of environmental issues that are happening within the city. Their main priority is to minimize the flow of waste into the Bagmati River with the campaign slogan "Cleaning Bagmati from your kitchen" referring to the source of change; citizens' houses.

Ms. Prabha Pokhrel is the team leader of the organization and has been involved in various programs that have impacted, to some degree, the pollution around the Bagmati River. One such program was established between 2016-2020 which was the distribution of 4,000 composting bins. This program involved the different wards that are found alongside the Bagmati River as 30 to 40 volunteers would be trained in the topics of waste management and how to segregate trash using composting. These trainings would last three to four days and later the volunteers would act as facilitators and be assigned a ward where they would create groups within their communities and teach citizens why composting would help keep a cleaner and greener Kathmandu. IDS would provide the training as well as the composting bins to the communities.

The main goal of this campaign for IDS was to create a platform where the wards would take over and the program will self-sustain, as more people will get training and be involved and the network of composting would expand. Ms. Pokhrel states that within some wards, the program was very successful as four tonnes of waste was managed per day and some people started creating rooftop gardens with the waste. Furthermore, during COVID-19 many people started the trend of roof gardens to grow their own crops. This of course benefits citizens with health and more greenery around their homes.

Fig 44, 45 & 46. Recycled coaster, cushion, and plant pot (Source: Author, 2023)

Another campaign that IDS implemented recently was the design of different types of items using recycled products. The campaign consisted of a community focus orientation to teach citizens how to segregate waste in their houses and also waste that had been collected from the Bagmati River, and how it can be reutilized to create some useful everyday items. During my interview she showed me three products, one was a coaster, another one consisted of a small cushion for a chair and finally, a small pot used for decoration for plants, all of these were made out of plastic material as seen in Figures 44, 45, and 46. She explained that this campaign teaches people how to make products with recycled materials and why it is important to separate waste and not dump it into the rivers. Moreover, this program also collaborated with school children in grades 8 and 9 from schools that were located near the Bagmati River. This is with the purpose to teach young children how they could make an impact within their homes and everyday lives. Small clubs were created to teach children how to manage waste in their houses and see how this had impacted them within several months.

Challenges and Opportunities

Within all of these programs, Ms. Pokhrel expresses that many problems have arisen during the implementation. One problem that impacted all programs was COVID-19 as smaller groups had to be created and managed and sometimes training could not be given to these groups. Furthermore, the organic solid waste that is found within the Bagmati River has become a problem when cleaning as this has to be treated and managed differently when composting, and many people do not know how to manage it. She expresses that in order for composting to work, all waste has to be composted properly, if this is not the case, then the bins are of no use and the whole process falls apart, this is why the IDS training program is fundamental for the whole self-sufficient system to work. Additionally, an opportunity that could be implemented is to make citizens aware of the knowledge that composting can be a source of natural fuel if done correctly. This would decrease the money communities spend on buying fuel.

Moreover, only about 38% of waste is segregated within the Kathmandu Valley, and of this about 70% is collected by the private sector. This is because the trash collecting system has become a lucrative business where households have to pay approximately 400 rupees a month in order for trash to be collected. Ms. Pohkrel expressed that several times private companies have had conflicts with the government to allocate them land to use as landfills and therefore this affects the whole collecting system and it is why they dump the trash in other places or is piled up endlessly on the streets.

Despite the problems, some opportunities have arisen such as mobilizing community groups during festivals and religious events in temples and monuments to clean and create a different mindset towards worshippers that littering is not good for religious activities. This is with the aim to create awareness that trash should not be left behind during religious festivals and that sites should be kept clean for the well-being of all other worshippers who come. This is with the purpose of creating a better community in the Kathmandu Valley. This can be further done with the engagement of school children in order for them to also learn what to do during major festivals that take place.

Finally, IDS having large community engagement programs could find the opportunity to train people on how to implement possible ecological solutions as seen in Figure 47. Solutions such as the implementation and maintenance of restoration powders that eat the organic material or the plantation of different vegetation along the river that help capture CO2 and absorb chemicals from the river.

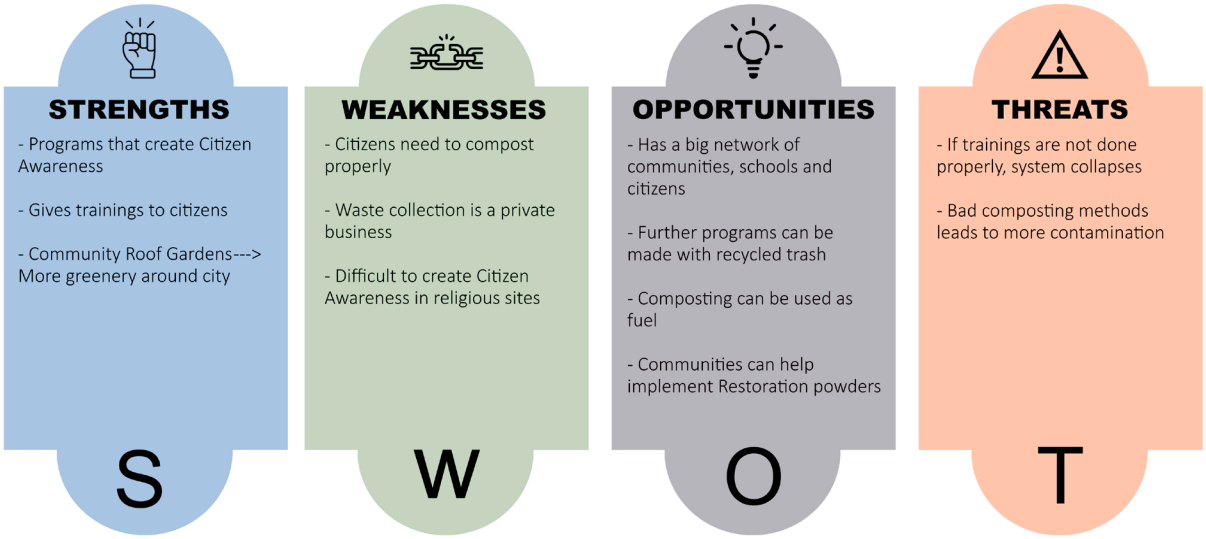


Fig 47. SWOT Analysis for Integrated Development Society Nepal (Source: Self-made by author, 2023)

Center of Integrated Urban Development (CIUD)

The Center of Integrated Urban Development is an institution that focuses on the urban development of communities by providing "basic infrastructures like water and sanitation, disaster management, information systems, and transportation planning" (CIUD, 2023). This is especially done with communities that lack resources and citizens who are more in need. Mr. Sudarshan Rajbhandari who is the Program Director of CIUD emphasized that water management, as well as water harvesting campaigns, have been done for citizens to learn about the importance of water and how rainwater can be a source.

While on my interview with Mr. Rajbhandari, I was able to learn of a project CIUD had implemented in 2017 together with UN-Habitat to construct a green park and develop public space management skills for citizens in order to create a better quality of life for the residents of Kirtipur. This was done using a participatory methodology called "People Centric Planning Approach (PCPA) for Green Public Space Management" (CIUD, 2017). It involved coordination, training, and campaigns in "leadership development, income generation and public open space management, solid waste management, open space management, gardening, and horticulture" (CIUD, 2017). This was done to create community awareness for the citizens of Kirtipur and to help design the park as well as manage it once it was operational.

One PCPA aspect which stood out was the design process of the park. This is because it was done through the computer game *Minecraft*. Young school children were given training and a plot of land through the game where they were free to design ideas that could be implemented. Furthermore, emphasis was made on inclusive public space as well as conserving and preserving the environment and ecology of the area. The most common ideas were gathered and mapped out to create a proposal. This idea of involving the youth to participate in the design process encourages children to become leaders as well as gain knowledge on how to develop ideas that would ultimately benefit their communities. Furthermore, CIUD expressed that "children are more occupied in modern computer games and indoor activities than playing outside" (CIUD, 2017). So it is an opportunity for them to design a space that will later encourage them to go out and enjoy it and play outside with friends.

Challenges and Opportunities

One challenge this program presented was the lack of a skilled workforce when constructing the park designed by students. This is because all of the labor was focused more on the reconstruction of buildings due to the earthquake that took place in 2015. Furthermore, after completion, there was no program related to the maintenance of the park, and therefore CIUD had to maintain it but did not have sufficient resources, this posed the threat of trash being left behind by students and heavy rainfall.

On the other hand, projects like these present various opportunities for further community awareness as youth are involved in the design process of an urban area, this could be expanded to further schools and projects across Nepal. Additionally, these programs can help come up with ecological solutions for the restoration of the Bagmati River in the long-term and these schools could help maintain their solutions. Finally, CIUD could help finance, manage, and implement the Aqualift ecological solution presented in the next chapter, to accelerate the restoration of the river.

Fig 48. SWOT Analysis for Center of Integrated Urban Development (Source: Self-made by author, 2023)

Nepal River Conservation Trust (NRCT) - *Bagmati River Festival*

The Bagmati river festival is an initiative started in 2001 by the Nepal River Conservation Trust (NRCT) and its aim is to provide a platform for all interested individuals and organizations to express their concerns and provide solutions to overcome the plight of this holy river (Dahal *et al*, 2011). Many government, non-government institutions, activists, businesses, and citizens have taken part in the festival that runs for two and a half months during the summer of each year. The festival "gives an equal opportunity to interplay science, sports, conservation education, recreation, music, religion, and social activities to produce synergy in conservation and gives a unique opportunity to interact among peoples of different areas and professions" (Dahal *et al*, 2011).

This sort of initiative gives a chance for people to get involved in participatory activities and programs in order to promote awareness about the Bagmati River and its degrading state. Some programs include clean-up campaigns, tree plantation, heritage walks, Bagmati eco challenges, training on waste management, kayak races along the river, and photography competitions. All of these programs and events aim for people to witness the state of the river today and create a sense of belonging towards it.

Since its establishment, every year the festival achieved various goals such as (Dahal et al, 2011):

- Established as a convenient and most effective platform to exercise different approaches to promote sustainability of Bagmati (a network of networks).
- A festival of all religions, age groups, professions, communities... (Image of a "common")
- A festival of all I/NGOs, I/GOs, CBOs, corporate', diplomats, clubs, initiatives etc. (working in Bagmati).
- Grew conservation awareness at all levels of a society. (An open school)
- An extensive media coverage (Radio, TV, Print & Electronic) (sensitization & Institutionalization of the agenda)
- A place where a wide range of issues can interplay

Unfortunately, during the COVID-19 pandemic, the festival had to be stopped for two years as massive crowd gatherings were prohibited. In 2022 the festival opened its doors again to the city but it mainly consisted of rafting programs throughout the river (Bagmati River Festival, 2023).

Challenges and Opportunities

The major challenge of the Bagmati River Festival would be to bring it back again to what it once was. This is because due to the COVID-19 pandemic, only the water rafting program has resumed. A lot of campaigns and citizen engagement would need to be done with the help of sponsorships to arrange and organize activities for the festival to resume again and this can be challenging. Even though this could be difficult, the Bagmati River and the citizens of Kathmandu would benefit greatly from this sort of festival. This is because a festival such as this brings with it a lot of opportunities as seen in Figure 49 to create awareness campaigns and engage citizen involvement to contribute towards ecological solutions for the Bagmati River. The festival used to run for two months, so it gives time to implement and experiment with a lot of ecological solutions, especially having a big workforce to help maintain it. This sort of engagement would ultimately help people feel part of the Bagmati and its surroundings once again like it used to be back in the 1990s.

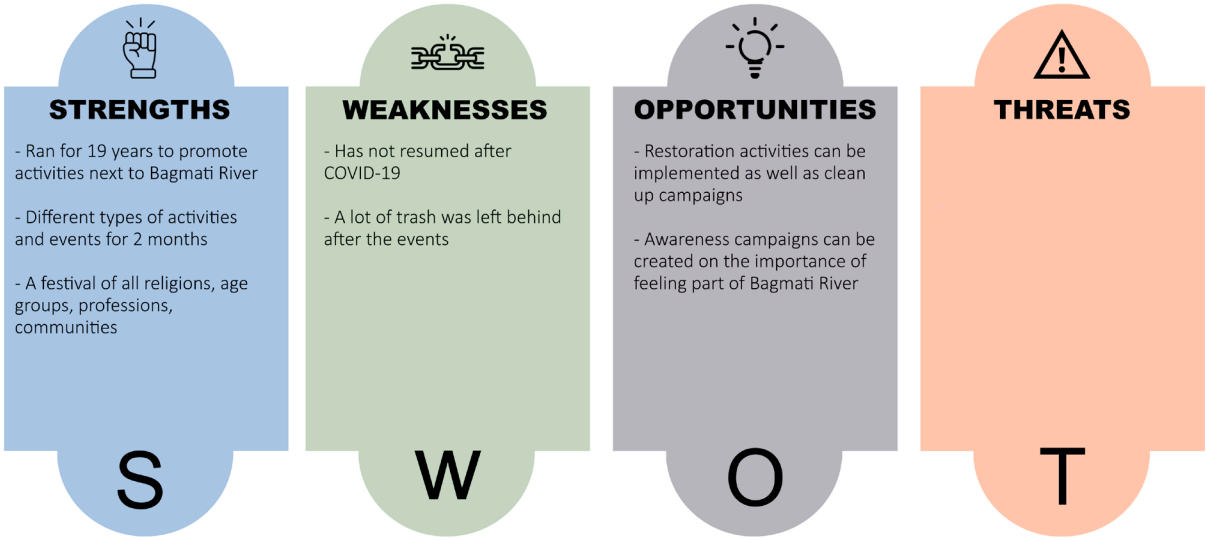


Fig 49. SWOT Analysis for Bagmati River Festival (Source: Self-made by author, 2023)

National Trust for Nature Conservation (NTNC) - *Bagmati Action Plan*

The Bagmati Action Plan was a report emitted by the High Powered Committee for Integrated Development of the Bagmati Civilization (HPCIDBC) and the National Trust for Nature Conservation (NTNC) in 2009 whose main vision was to "Clean, green and healthy river system that is full of life and valued by all" (Bagmati Action Plan (2009-2014), 2009). The Action plan was to be developed between 2009 and 2014 to restore and conserve the Bagmati River and its tributaries. First, the Bagmati River was divided into five different sections; Natural Conservation Core Zone, Rural Zone, Peri-Urban Zone, Urban Zone, and Downstream Zone (Bagmati Action Plan (2009-2014), 2009). This was with the objective to tackle each one individually and create the best possible solutions and outcomes. Different goals, objectives, and activities were made for each section to implement citizen engagement and improve the environment around them.

The strategy for the Action plan consisted in establishing HPCIDBC as the leading coordinator of the monitoring plan. "Regular monitoring is required from the concerned authorities and similar feedback to the implementers. Besides regular monitoring, a participatory or joint monitoring system is required where representatives from concerned stakeholders participate and monitor the program" (Bagmati Action Plan (2009-2014), 2009). These would give feedback to HPCIDBC on how the plan is going along and if more activities or actions needed to be performed in a specific section. Figure 50 shows the Pre-conditions and Priority Actions that were drawn up.

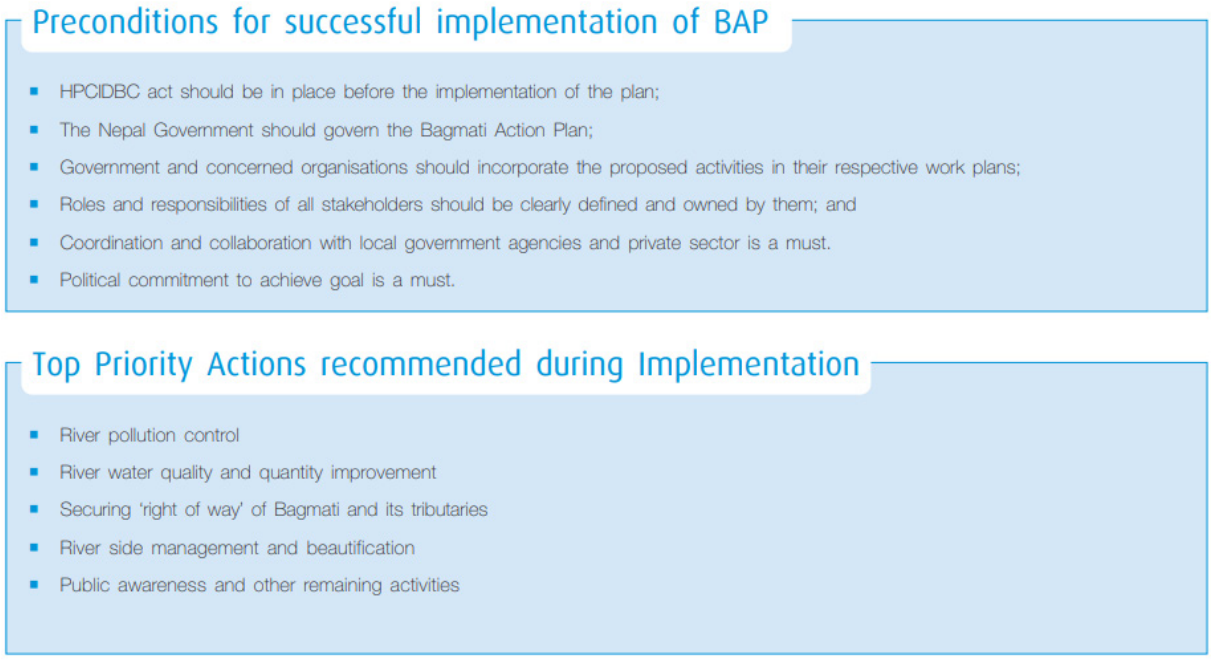


Fig 50. Preconditions and recommended actions of the Bagmati Action Plan (Source: Bagmati Action Plan (2009-2014), 2009)

As stated above, the Bagmati Action Plan also implemented different activities where relevant stakeholders and organizations would take part to help accomplish the vision of 'Clean, green and healthy river system that is full of life and valued by all'. Additionally, citizens would participate alongside these organizations in different activities during the five years and in the different five sections of the Bagmati and its tributaries. Some of the activities that the report outlined regarding HPCIDBC implementation and development of areas can be seen in Figure 51. The figure also shows how HPCIDBC would be monitoring and therefore verifying if the activities were accomplished.

Activities	Means of Verification
Promote rain water harvesting at household and community levels by constructing soak pits or through existing wells;	Number of households with rainwater harvesting
Promote onsite sanitation at household and community levels through measures such as septic tanks, fecals sludge management and other appropriate technologies;	Number of households with toilet increased
Construct community managed DEWATS at various locations such as Phutung, Sangla, Katunje and Satungal;	Number of households and area covered by DEWATS
Construct intercepting sewerage system along both the banks of the rivers; and construct septage treatment plants for faecal sludge management at locations such as Bhaktapur, Kirtipur, Harisiddhi and Bungamati	Itercepting sewerage system constructed along both the banks of the rivers; Septage treatment plants constructed in the specified areas
Prepare and implement landscape of riparian land to maintain green corridor	Land use plan of riparian land prepared and area landscaped by appropriate local agencies
Carry out bank protection works (80 km) using bioengineering technique; Construct access roads/foot trails along both the banks of the rivers; and establish a system for regular monitoring of river water quality at 12 locations	Locations along the river protected by appropriate local agencies. Access road/foot trails constructed along the banks of the river Water quality monitoring system established and operated by appropriate local agencies
Prepare restoration plans of important heritage sites and associated cultural activities; and conserve and restore deteriorated religious sites such as Mahalaxmi and Bishnudevi temples	Restoration plans of existing heritage sites and associated cultural activities prepared. Number of temples renovated and heritage sites conserved

Fig 51. Cross-cutting activities within Bagmati Action Plan (Source: Author, adapted from information gathered in Bagmati Action Plan (2009-2014), 2023)

Challenges and Opportunities

The Bagmati Action Plan did not accomplish what it was intended to do, as many activities within the plan were never implemented. Moreover, I believe the verification process of these activities presented in the Action Plan was weak, and many policies for their implementation were outdated. Secondly, the water treatment plants possess many challenges in their completion which has made their construction be behind schedule. This has increased the degradation of the Bagmati River over time as more and more untreated sewage water is being dumped every day.

On the other hand, the Bagmati Action Plan presented by NTNC was a very unique approach as it divided the Bagmati into different sections depending on its context. With this, many opportunities could be taken from it and could be further implemented in the future in the different sections NTNC established. Opportunities such as awareness programs and ecological solutions based on the different contexts of the river. Most importantly, I believe this action plan can be used as a teaching tool in high schools and universities to make students aware of how an action plan could be developed for a specific project, furthermore, how urban ecological planning could be developed within the Nepali context.

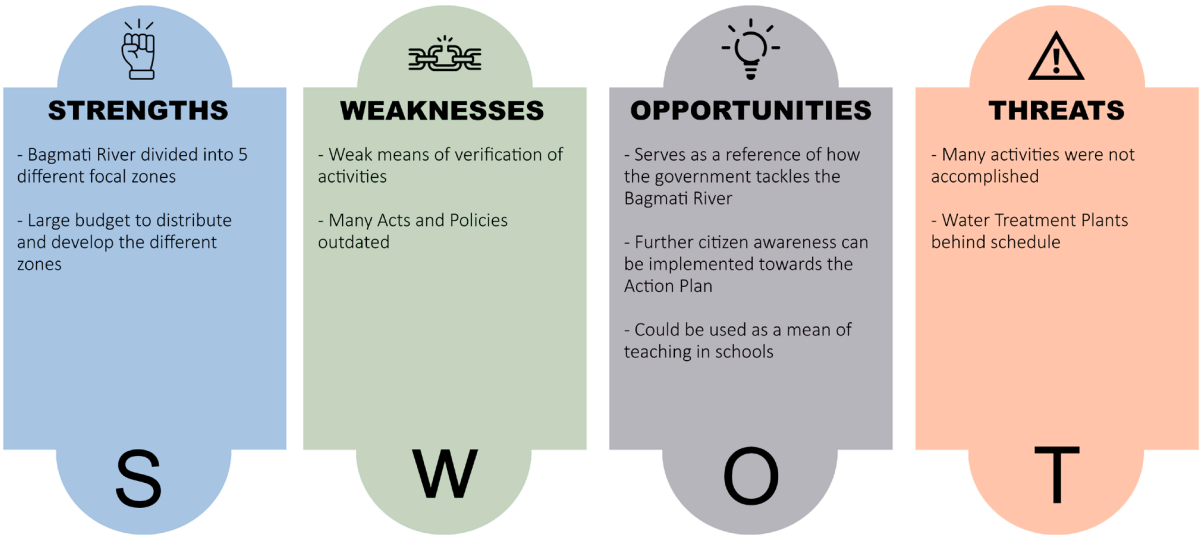


Fig 52. SWOT Analysis for Bagmati Action Plan (Source: Self-made by author, 2023)

Environmental Camps for Conservation Awareness (ECCA)

The Environmental Camps for Conservation Awareness is a non-governmental institution that seeks to implement awareness campaigns to acknowledge key problematic issues about the environment within Nepal. This institution creates awareness campaigns within schools and communities in order to promote the conservation of green areas within the Kathmandu Valley. Additionally, they provide counselor training campaigns for students and communities to participate in acquiring skills and the necessary knowledge to lead and monitor different campaigns within ECCA or environmental groups. Furthermore, ECCA's main focus group for its awareness campaigns are students within schools in order to create awareness knowledge on the topics of first aid, the importance of safe drinking water, drug abuse, sustainable construction, menstrual hygiene, heritage conservation, etc. This is for school children to share the knowledge provided but also implement other programs within their communities.

During my field research in Nepal, I was able to be part of an awareness campaign that provided students with insights into how to restore old heritage buildings. Here, the campaign leader with a group of students lead through the city center of Lalitpur in order to explain how heritage buildings could be restored using modern construction methods. Emphasis was made on how new buildings constructed within the area, could be made to resemble the old building styles. This was done using brick and wood facades in order for the city to keep a uniform cultural presence, especially to the Newari heritage. The interior of the buildings could be further developed into a modern space.

Apart from awareness campaigns for schools, ECCA has also collaborated with the National Planning Commission, Kathmandu and Lalitpur Metropolitan City institutions, and Adelphi Research institution based in Germany to investigate how environmental concerns have been managed within other urban rivers and how Nepal could learn from them in order to be implemented in rivers across the nation. These sorts of investigations and programs were published in a 2007 case study book titled "*Proceedings of International Symposium: Community-led Management of River Environment*". Here, investigations within the Singapore River, the Rhine River in Germany, and the Ganges in India were researched to see how they have managed pollution and degradation over the years in order to tackle the environmental and ecological aspects. Monitoring and management solutions such as the implementation of wastewater treatment plants, sustainable water management within citizens, the construction of wetlands and water catchment reservoirs all contributed to the potential sustainability and ecological renovation of the rivers mentioned within the case study book. Additionally, citizen engagement is a key factor in monitoring and managing the solutions presented as this establishes a sense of community importance and a feeling they belong in the projects implemented by the institutions.

Challenges and Opportunities

Among the awareness campaigns that ECCA has implemented in Nepal, many of these campaigns take part in rural or segregated communities that do not have many resources available to actually make an impact within their context. This is why ECCA in these types of situations implements more life awareness campaigns such as first aid, menstrual hygiene, or safe drinking water in order for communities to acquire valuable knowledge for their everyday life. Environmental or river conservation campaigns as well as trainings are more focused within urban areas. This sort of school campaign could further be expanded for the context of the Bagmati River by providing them with a chance to design or think of possible solutions for its restoration. Furthermore, they could aid in the implementation of ecological solutions in the future in order for them to get relevant skills that could later be used for other sorts of issues or problems within their communities.

On the other hand, as seen in the SWOT analysis, the research done on the learning outcomes of other rivers, some weaknesses, and threats were found with the institutions implementing such solutions within their context. Weaknesses such as not restricting industry to disposing of chemicals within the rivers, not having established regulations for monitoring and maintaining the degradation of rivers, and political continuity are not emphasized. These weaknesses should be re-established as the degradation of an urban river should call for national importance as these could cause threats to the population living in cities. Furthermore, one research article states that wastewater treatment plants should be given the same importance as those given to essential infrastructure such as roads and internet communications. This is because the implementation of such projects after urbanizing an area could be difficult to find the space and resources available.

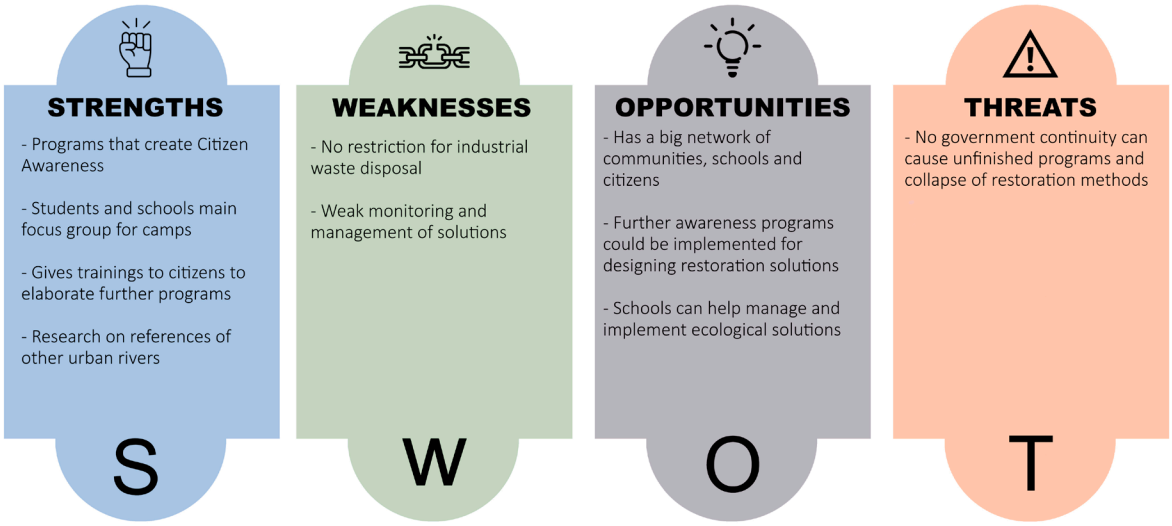


Fig 53. SWOT Analysis for Bagmati Action Plan (Source: Self-made by author, 2023)

Project Implementation Directorate (PID) - *Wastewater Treatment Plants*

The Project Implementation Directorate (PID) is an infrastructure directorate that forms part of the Nepali government. This Directorate is the main provider of safe and adequate water to the Kathmandu Valley, and since 2009 they have started developing wastewater treatment plants. This is with the purpose of creating a wastewater treatment system that can treat the sewage water of the KMC and LMC before it is discharged into the Bagmati River.

In an interview conducted with an enployee of PID, he explained that as of now, only one wastewater treatment plant is operating which is named Gueheshwari and is found near the Pashupatinath sacred temple. This treatment plant has a capacity of 32.4 million liters daily (MLD) but is being upgraded to 48.6 MLD by 2050. The problem lies that one treatment plant is not enough for the 2.9 million people that live in the Kathmandu Valley. Therefore, the project plan of PID is to construct eight wastewater treatment plants creating a grid that will work simultaneously to process approximately 499.6 million liters of sewage water daily as seen in Figure 54.

Plant Capacity in Million Liters Daily (MLD)					
Serial Number	Treatment Plants	Completed	Under Construction	Proposed Additional Capacity	Total Capacity (2050)
1	Gueheshwari	32.4	0	16.2	48.6
2	Gokarna		3	3	6
3	Sallaghari		14.2	0	14.2
4	Hanumanghat		1	0	1
5	Kodku		17.5	17.5	35
6	Dhobighat		74	286.6	360.6
7	Tukucha		17.2	0	17.2
8	Nakhu		0	17	17
	Total	32.4	126.9	340.3	499.6

Fig 54. Waste Water Treatment Plants Expected Capacity (Source: Author, adapted from information gathered in a semi-structured interview with PID, 2023)

Additionally, in the interview he acknowledges that the slow development process is due to the budget allocation for the different treatment plants, and for this reason, some are way ahead on construction phase than others. Furthermore, he assures that the construction of the plants will only help if the Bagmati River and its tributaries maintain a constant flow of water so that the treated water can be discharged easily. This is because during monsoon season, as of now, the current Gueheshwari plant has experienced an overflow of water as well as an influx of trash and pollution which has been seen clogging the pipes, but this has not stopped the treatment plant from operating.

Challenges and Opportunities

As stated, the main problem of PID lies in the budget allocation for the construction of the different wastewater treatment plants. Therefore, this has become a threat as the wastewater treatment plant's schedule of completion is pushed back, and in the meantime, the Bagmati is being polluted further.

Nevertheless, once they are completed, they will help reduce the amount of chemicals dumped into the river. This would give the opportunity for wildlife, both flora and fauna to establish once again and create a green landscape. PID being experienced with Reed Vegetation as it is used inside their water treatment plants could aid in advising for the construction of Reed Vegetation beds alongside the Bagmati River to further purify the water, especially those coming out of the sewage pipes found alongside the river shoreline. Another opportunity they could be involved in is with schools as they could bring students and show them the process of how a wastewater treatment plant works. This could give knowledge and create awareness for young teens on why it is important to treat wastewater correctly, before discharging it into the rivers and eventually the ocean.

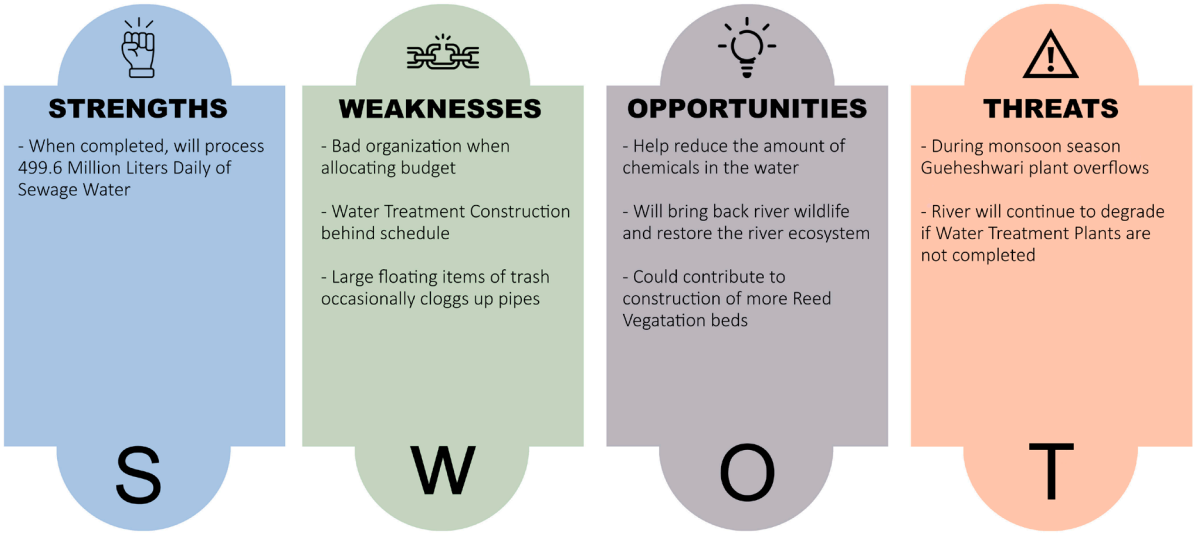


Fig 55. SWOT Analysis for Project Implementation Directorate (Source: Self-made by author, 2023)

Water State, Chemicals, and Bacteria

As mentioned, water pollution comes from different factors such as the rapid urban population growth, lack of citizen awareness, the discharge of industrial and domestic sewage, and the low capacity of treated wastewater in the water treatment plants. For these reasons, several hazardous chemicals such as Chloride, Nitrate, Phosphate, and Ammonia have infiltrated the Bagmati River. Today, the river has a grey-black color, it has a potent smell, and no life can be seen underneath its waters.

Various physicochemical analytical studies have been conducted on the Bagmati River such as Acharya and Pant (2021) and Rana (2020), to find out which elemental chemicals have resulted in the degradation of the river. First of all, it is important to acknowledge that the Bagmati River has a dry and wet season during the year, where "result showed that temperature was ranged between 30°C to 26.2°C and 14.32 °C to 12 °C in pre-monsoon and post-monsoon respectively" (Acharya and Pant 2021, p.99). This is important as higher temperatures enable the growth of microorganisms which leads to higher microbial activity.

Chemicals such as Chloride, Nitrate, Phosphate, and Ammonia were discovered to be infused into the water particles of the Bagmati. According to Acharya and Pant (2021), Chloride "might be due to untreated sewerage and the ash remains which are discharged in the river in between Tilganga and Aryaghat site" (Acharya and Pant 2021, p101). Furthermore, domestic sewage contains a high amount of nitrogenous compounds which are transformed into ammonia over time producing an unpleasant odor (APHA, 2012). This is why a high percentage of Nitrate can be found infused into the water as many domestic sewage pipes discharge water into the river as can be seen in the Qualitative Mapping Analysis Section of the thesis. With the high concentration of Nitrate, this chemical combined with others creates the compound of Ammonia, which is a highly hazardous chemical for humans as it causes irritations and burns when in contact. Furthermore, the infused Ammonia is the reason why the Bagmati River has a very distinct potent smell and long exposure to it at high levels can cause lung damage and blindness (The Facts About Ammonia 2011).

Apart from these chemicals, it is also important to analyze the amount of Diffused Oxygen that the Bagmati River has. "Water at lower temperatures will have higher levels of dissolved oxygen (DO) while warmer, polluted waters will have lower levels of DO. Healthy water should generally have dissolved oxygen concentrations above 6.5 - 8 mg/L" (Rana, 2020. p.25). According to Rana (2020), the Diffused Oxygen ranges from "4 - 9 mg/L during the monsoon and 1 - 16 mg/L post-monsoon" (Rana, 2020. p.25) while Acharya and Pant (2021) measured concentration in pre-monsoon at 9.7 mg/L at Sundarijal and 0 mg/L at Balkhu site. This shows

that it varies depending on the site and season in which the readings are taken, but one thing that concludes both studies is that the percentage of diffuse oxygen is very low in the Bagmati River and for this reason, life underwater cannot be maintained and has not been seen for many years.

Parameters	t-value	D f	P-value	Significance
Temperature (°C)	26.93	9	0.000	Significant difference
pH	5.578	9	0.000	Significant difference
Conductivity (μ S/cm)	5.265	9	0.001	Significant difference
Chloride (mg/L)	3.491	9	0.007	Significant difference
Dissolve oxygen (mg/L)	-.065	9	0.950	No significant difference
BOD_5 (mg/L)	3.424	9	0.008	Significant difference
Nitrate -N (mg/L)	3.154	9	0.012	Significant difference
Phosphate -P (mg/L)	1.053	9	0.320	No Significant difference
Ammonia (mg/L)	2.483	9	0.035	Significant difference

Fig 56. Table showing samples of Chemicals and their physiochemical parameters found in two seasons in the Bagmati River (Source: Acharya and Pant, 2021)

From the chemical analysis that has been done on the Bagmati River in recent years we can acknowledge the importance of PID and the Nepali government to develop and complete the wastewater treatment plants as soon as possible. This is because the treatment plants would eliminate these harmful chemicals before depositing the water into the Bagmati, ultimately relieving the river from bacteria and harmful chemicals that could kill potential wildlife trying to resettle within the urbanscape.

Nepal Institute for Urban and Regional Studies (NIURS)

The Nepal Institute for Urban and Regional Studies (NIURS) is an organization that advises the Nepali government on urban development policies and reforms in order to identify urban issues. NIURS does this by the study and research of city-level master plans, and trains mayors and community leaders on how to urban plan using policy guidelines and building laws to benefit their community.

The training programs are done through citizen forums where orientation and urban management ideologies are shared on how to manage neighborhoods in order to maintain infrastructure, create open spaces, and have better livable environments. This is important as 80% of the Kathmandu Valley is not planned, and therefore there is an organic shape to the city due to the urban sprawl. This is because there are many policy gaps within the government laws as stated by Mr. Kishore Thapa, Ex-Secretary of Urban Development Campaign and a member of NIURS that I interviewed.

He also explained that NIURS has conducted citizen activities within neighborhoods such as bicycle campaigns, group pedestrian routes, and has improved the pavement of areas around the city. All of this creates awareness as to why urban planning policies are important to the development of a better city.

Challenges and Opportunities

Nepal's urban and ecological policies for the construction and planning of different areas present a lot of gaps between the lines. This poses a challenge as community projects can sometimes take months to be approved. This became even more problematic after the 2015 earthquake as further measures were established for the approval of projects and different construction permits, to assure that no major damage was going to occur if another earthquake hit the nation. Furthermore, NIURS argues that the three cities in the Kathmandu Valley are not planned, and this creates infrastructure problems for the city especially when expanding roads or finding space to establish for example the wastewater treatment plants, as Kathmandu and Lalitpur are densely packed cities. The main challenge NIURS possesses is that it is a very small institution and therefore they do not have the resources to advise on policymaking to the vast number of wards and communities found in the Kathmandu Valley.

Nevertheless, this organization has great potential as it could promote policymaking for creating more green and blue infrastructure within Kathmandu. Furthermore, establishing policies where renewable energy sources must be used within projects in order to reduce carbon footprints and CO2 emissions. NIURS can also create community awareness campaigns on how to urban plan better neighborhoods, and why having green spaces are important in terms of health benefits. This is with the purpose of creating environmental policies where more green spaces can be created near the Bagmati River for recreational purposes. Aiming to increase the percentage of urban green spaces within Kathmandu Valley, which as of now sits very low.

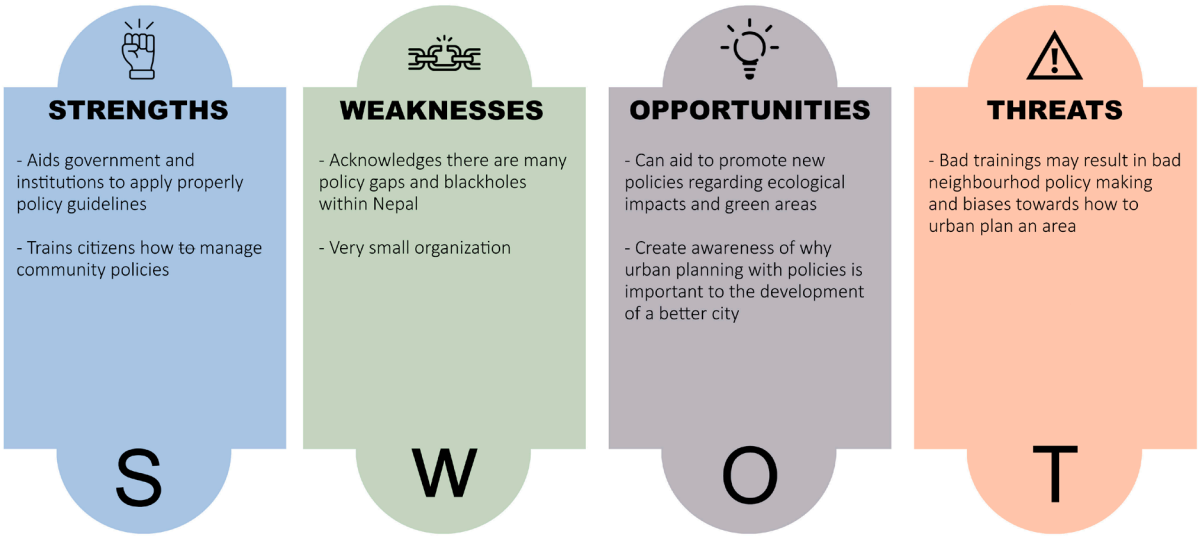


Fig 57. SWOT Analysis for Nepal Institute for Urban and Regional Studies (Source: Self-made by author, 2023)

Best Practices from Stakeholders

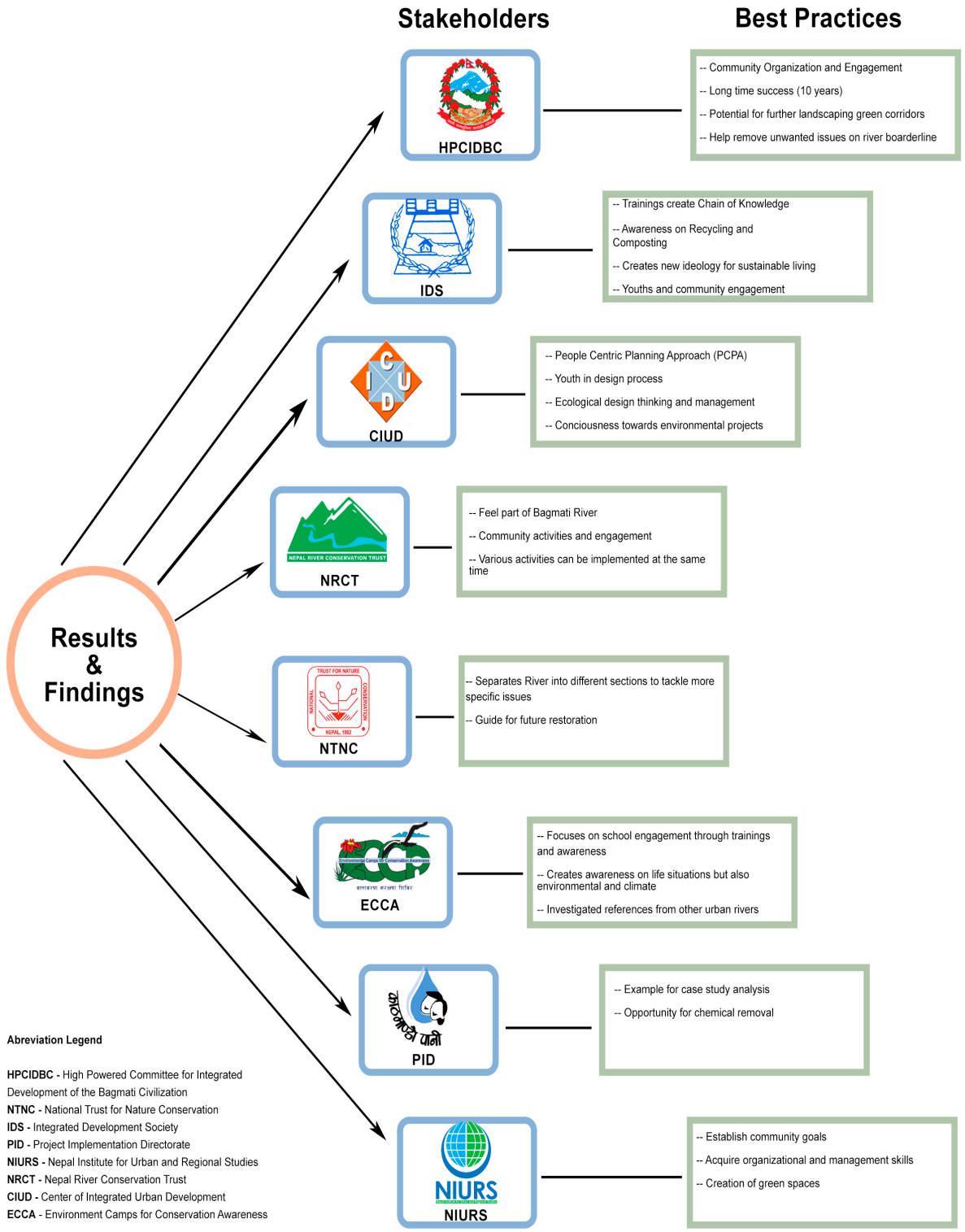


Fig 58. Learning Outcomes from Stakeholder Analysis (Source: Self-made by author, 2023)

Throughout my semi-structured interviews I was able to gather diverse qualitative data that I was able to analyze and see the challenges as well as opportunities these institutions face. As described above, there are organizations that tackle issues based on how to restore the Bagmati River, while others tackle issues of community engagement and citizen awareness of various topics around Kathmandu Valley. The programs and campaigns done by the stakeholders have contributed, to a certain extent as seen in Figure 58, for citizens to feel part of the Bagmati River again and even some of these programs are still practiced to this day.

The HPCIDBC Save Bagmati Campaign shows that community engagement is successful when cleaning the Bagmati River. Communities are able to organize and do a campaign that has lasted 10 years. Furthermore, the Landscaping Package proves that Bagmati's river border has a lot of urban ecological development potential as more green corridors and parks can be implemented in the future to help remove unwanted issues such as the landfill sites and help citizens be near Bagmati again.

IDS and ECCA community awareness programs and trainings give an example that young adults can learn certain skills and create a chain of knowledge to expand certain practices for the benefit of communities. Additionally, trainings and campaigns help the promotion of knowledge and give local groups life skills that can be further passed down within their social communities. ID program on recycling and composting is a way to teach students how to reduce waste within Kathmandu that eventually ends up in the Bagmati River, due to overflow and bad administration. Ultimately affecting the whole population and the water cycle for flora and fauna established. These sorts of awareness programs established by IDS and ECCA are an important factor as they can be implemented in schools and community centers in order to expand citizen awareness but most of all teach young children the ideology of why it is important to conserve the environment around us and teach how recycling and diminishing waste eventually does not pose a threat towards contaminating the green and blue infrastructure.

Continuing from the ideology from above, CIUD's People-Centric Planning Approach (PCPA) in engaging the youth in the design process of projects, is an important stepping stone in creating ecological awareness from a young age. This creates ecological design thinking and management which in the future allows children to be more conscious about the environment and its surroundings. NRCT's Bagmati River Festival poses a great opportunity for the further development of community awareness, not only in the conservation and restoration of the Bagmati River but also in why it is important to create campaigns and engage citizens to participate in various activities to help feel part of Bagmati. Moreover, this two-month festival gives the possibility to test and implement ecological solutions with citizen engagement. Unfortunately, like in all programs presented above, the main recent challenge was the COVID-19 pandemic, as this restricted many activities to resume and posed many problems to create an impact.

Lastly, NTNC Action Plan, PID Wastewater Treatment Plants, and NIURS Policy Making give past, present and future opportunities that could be implemented for the ecology of the Bagmati River. As said before, the Action Plan could be a learning opportunity implemented in school programs where the youth learn about the Bagmati and possible activities that can help restore it. NIURS policy-making campaigns help establish citizen goals within communities in order to create a more green and ecological Kathmandu Valley. This creates the opportunity for citizens to also learn how to manage and acquire organizational skills to accomplish common goals. Finally, when accomplished, the wastewater treatment plants will help aid the chemical removal and restoration of the Bagmati and this could be a future example case study for the proposal of further treatment plants in other rivers within Nepal.

Overall, different types of knowledge can be acquired from each institution to help the further urban ecological development of the Bagmati River. Additionally, these stakeholders could take command and aid the implementation of the Ecological Solutions presented in the next chapter.

6. ECOLOGICAL SOLUTIONS FOR THE SOCIAL ENGAGEMENT OF THE RESTORATION OF THE BAGMATI RIVER

The following are different ecological solutions that could potentially help the restoration of the Bagmati River. These solutions are presented in a way where social engagement could be done via different stakeholders. This is with the aim for citizens to learn how to implement but also how to maintain them in the long-term. These ecological solutions have been implemented in similar contexts and climates to the ones in Nepal, in areas such as Central America and South East Asia, where the climate is humid and hot but also can be dry during some months. Additionally, they have been shown to have contributed to the pollution removal and cleaning of blue infrastructure water sources via scientific and social experiments.

Restoration Plan

As seen from the chapter above, the Bagmati River has gone through a few restoration techniques in the past years in order to help restore sections of it. These different programs presented by the stakeholders have worked well within a small section of the Bagmati River. They have not lived up to their desired expectations due to weaknesses or challenges faced, but do possess large strengths and opportunities to expand their ideologies further. For this reason, I propose the idea to develop a restoration plan which would outline the establishment of ecological solutions. This is in order to accelerate the restoration process of the river, but also engage citizens to feel part of the Bagmati River again and do various activities within its borders.

The restoration plan proposed would consist of different ecological solutions which have been socially and scientifically tested in similar contexts to the one of the Bagmati River. The idea is for these ecological solutions to be implemented within the three different sections of the Bagmati that have been selected for this thesis. Moreover, these would have to be implemented almost simultaneously for them to accelerate the process of cleaning and restoring the heavily polluted water. Short-term impacts would likely be seen in some ecological solutions, but the long-term impact of annihilating harmful chemicals, bacterias and restoring the ecosystem would have to be maintained in order to see results. Furthermore, these ecological solutions are to be part of a social engagement of establishing groups of communities that stakeholders already have identified within their institutions in order to organize, implement and maintain the ecological solutions.

Finally, the restoration plan should aim to help accelerate the ecological restoration of the Bagmati River for the benefit of the environment that surrounds it, for wildlife to return and thrive within its waters, and for the citizens to feel part of the urban Kathmandutie identity Bagmati has given them throughout its history. The following section follows the research of the different ecological solutions to be implemented within the restoration plan.

Reed vegetation

Reed Vegetation is a common name for tall grass-like plants that are found all across the world typically in wetlands. Phragmites Australis also known as Common Reed is a variation that can grow up to 6 meters tall and has the ability to absorb high levels of methane and carbon dioxide as well as infused chemicals found in contaminated water sources. The plant is commonly used in "*phytodepuration"*, or natural water treatment systems since the root hairs are excellent at filtering out impurities in wastewater. Furthermore, "phragmites australis also shows excellent potential as a source of biomass" (Phragmites australis, 2023, paragraph 15).

Reed Drying Beds are used in order to evaporate water and absorb harmful chemicals and leave the sewage sludge dry in order to be burned or treated further. These reed drying beds are commonly composed of "plants such as phragmites australis or phragmites communis" (Wang *et al*, 2008, p.3241) which are planted in sand beds that are formed with any "convenient shape to accommodate the existing land conditions and space" (Wang *et al*, 2008, p.3241). This type of chemical removal idea of sewage water can be very effective and has minimal capital investment and low operational cost as the plants can be managed easily and grow very fast (Wang *et al*, 2008).

Reed beds are a common practice that has been used in many parts of the world to treat sewage and polluted water around local neighborhoods and also within wastewater treatment plants (Gholipour *et al*, 2022). Projects in Dubai (Wolfran, 2009), Indonesia (Kurniadie, 2011), the UK (ARM Limited, 2023), and China (Li *et al*, 1995) demonstrate the wide range of climates and contexts to which reed vegetation can be adapted in order for their use. In the context of Kathmandu, reed vegetation would not present any problem adapting as it has a high humidity percentage similar to the Common Reed that has been used in China and Indonesia. These have been used for both small scaled neighborhood projects but also can be found in extended areas within industrial areas of the countryside. The only challenge that scientists have discovered is that Reed vegetation can be very invasive in some natural environments, therefore they need to be controlled and maintained to not affect other wildlife around rivers and lakes. In the context of the Bagmati River, I believe that this would not possess a threat as the river as of now does not possess any water life or endangered species of plant, due to its high contamination.

Therefore implementing reed vegetation will definitely be more helpful than harmful to the environment of the Bagmati. Once other vegetation and water life find their way back to the river in the future, a further evaluation can be made to see if it affects wildlife.

BedNo.	Sludge loaded(m^3)	Sludge residue(m^3)	Reduction(%)
1	2313[a]	58	97.5
2	2132[a]	51	97.6
3	685[b]	71	89.6
4	2154[a]	56	97.4

N.B. [a] sludge DS approx. 0.4%
[b] sludge DS approx. 3.0%

Table 4. Sludge loading and reduction at Allerslev, Denmark[5]

Bed No.	Sludge loaded (m^3)	Sludge residue (m^3)	Reduction (%)
1	263[a]	18	93.2
2	253[a]	23	90.9

Fig 59. Table Showing the sludge reduction in different parts of Denmark (Source: Cooper *et al*, 2007)

A research investigation developed by Cooper *et al* in 2007 in different parts of Denmark, showed that reed vegetation can drastically reduce sludge volume by almost 95% in a one-year period as seen in Figure 59. This is because reed vegetation absorbs the water sludge contained and here lie infused chemicals such as Chloride, Nitrate, Phosphate, and Ammonia as seen in the Water State, Chemicals, and Bacteria chapter of the thesis. The reduction of the sludge depends on how concentrated the mass of sludge is, as there are two types of sludges: thin activated sludges and concentrated sludges. The sludges need to be inserted carefully into the reed vegetation in order not to damage them and so that the results are optimal (Cooper, 2007). This is an example of where Reed vegetation was used in a cold country, but a study presented by Kurniadie (2011) in Indonesia had similar results. Here Kurniadie (2011) was able to see that there was also a drastic decrease in chemicals such as Chloride, Nitrate, Phosphate, and Ammonia within a humid and hot country. These studies are important as reed vegetation therefore can survive and be implemented in different contexts and climates. Nepal has different rivers that run through different climates because of its location and high altitudes, therefore it can be considered that Reed Vegetation will thrive within Bagmati and its tributaries.

Below (Figure 60) an infographic depicts how this method of Reed bed vegetation could be implemented within different parts of the Bagmati River. The diagram depicts how with the sand accumulated already in the river, it can be used to create compacted sand barriers to isolate the sewage water being dumped into the river. Here, the reed vegetation acts upon it and gets filtrated to underground pipes which would deposit the clean water into the Bagmati.

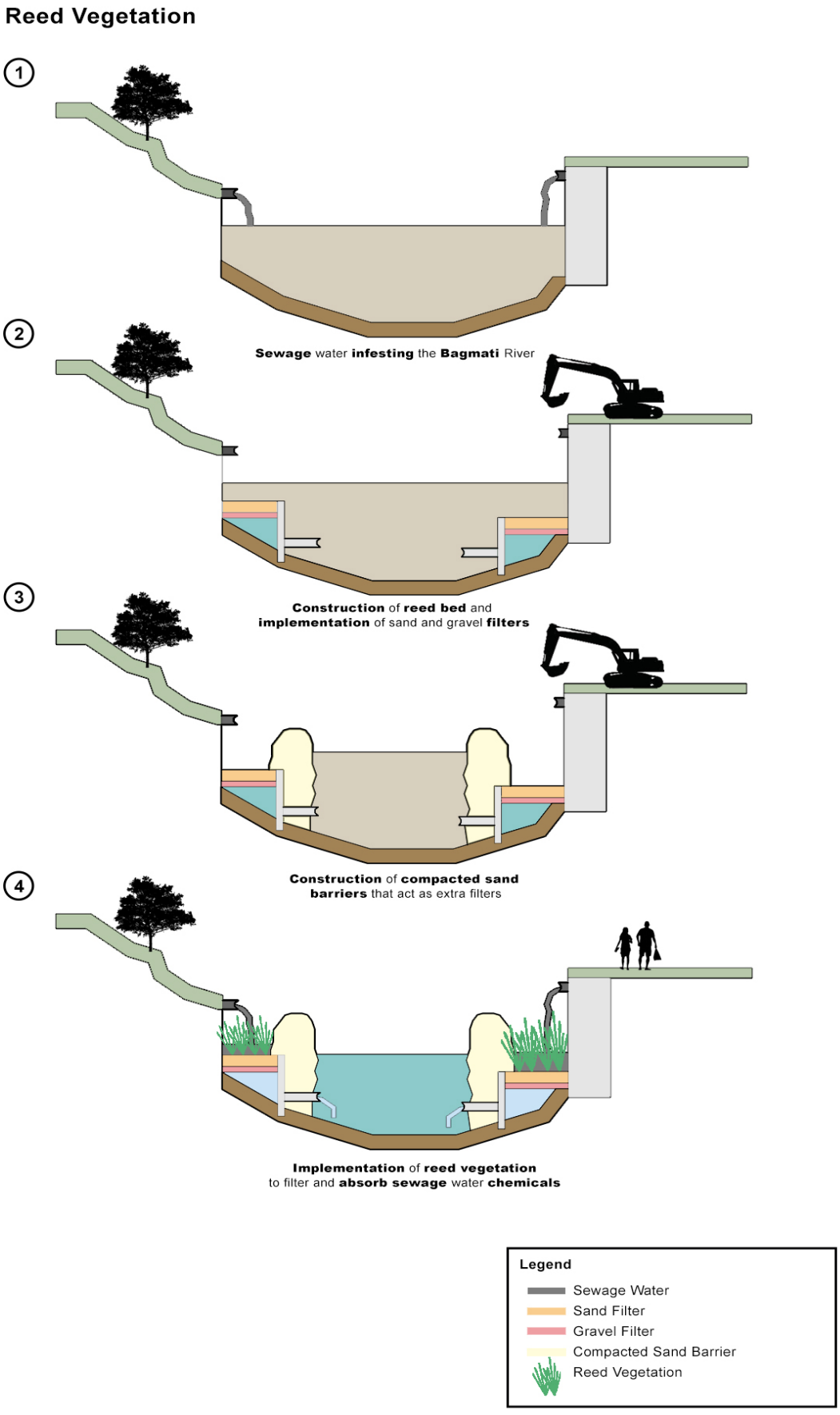


Fig 60. Ecological Solution of Reed Vegetation implementation (Source: Self-made by author, 2023)

Aqualift

In a study developed by the Center of Integrated Urban Development (CIUD) and presented to UN-Habitat, an experimental analysis was made of the implications of Aqualift in ponds and water bodies found around the Kathmandu Valley.

Aqualift are microbes that help augment the natural water cycle process within a natural water body. Various natural microbial organisms found in water bodies, usually break down harmful bacteria that could be a hazard to life under and above water, but once major pollution from human activity infiltrates these water systems, these natural microbial organisms can not keep up with the amount of pollution. Therefore, a solution to the faster regeneration of a water body is the implementation of additional microbes into the water to help augment the process (Center of Integrated Urban Development, 2017).

The purpose of the investigation conducted by CIUD was to study if the Aqualift microbes were a viable option to accelerate the microbial decomposition of sludge and organic material found in these polluted water bodies. Nine different ponds were the subjects to experiment with (Center of Integrated Urban Development 2018). Furthermore, this experiment was carried out to witness how these microbes, originally exported from Japan, would act in a context such as that of Nepal. If they would respond the same way or differently due to the climatological and environmental conditions of the Kathmandu Valley.

The experiment consisted of applying the Aqualift 900Ln series with a ratio of 100 grams per 1000 tons of water. The Aqualift formula includes aerobic, anaerobic, and facultative bacteria which are embedded into volcanic sand powder. The process is depicted in Figure 61. Here, “the bacteria breaks down the organic matter present in the water and feeds on it. Under the right conditions, a single bacterium will reproduce to yield several hundred million to several billion offspring in about 10 hours. The bacteria will increase and form a territory that avoids disease-causing bacteria from growing. The bacterium breaks down sludge, hydrogen sulfides, and other sulfides such KS, N2S to improve water quality and remove unpleasant odors and remove hazardous substances such as H2S will help improve air permeability, increase absorbability of nutrients and it will enable healthier growth of botanicals and agricultural products” (Center of Integrated Urban Development 2017. p.1).

These experiments were conducted for a period of seven months to see if the Aqualift bacteria would augment the process within a long period of time. The experiment presented by CIUD in 2018, concluded that in the water quality analysis of the ponds investigated, all the parameters measured had been reduced. These included: Biological Oxygen Demand (BOD), Chemical

Oxygen Demand (COD), Total Suspended Solid (TSS), Total Phosphate, Total Organic Matter, and Nitrate. CIUD stated that "This indicates that the bacteria is functioning and helping aquatic ecosystems remain healthy after the seven months of its application" (Center of Integrated Urban Development 2018. p20).

The use of the Aqualift bacteria proves in fact that it can be adapted to the context of Nepal, as it helped the acceleration and decomposition of organic matter and chemical components found in the nine ponds tested around the Kathmandu Valley (Center of Integrated Urban Development 2018).

The only challenge that would have to be investigated is if the Aqualift is able to be activated when there is a flow of water. If not, this method would have to be implemented during the dry season when the levels of flowing water are less and water stagnates in different zones.

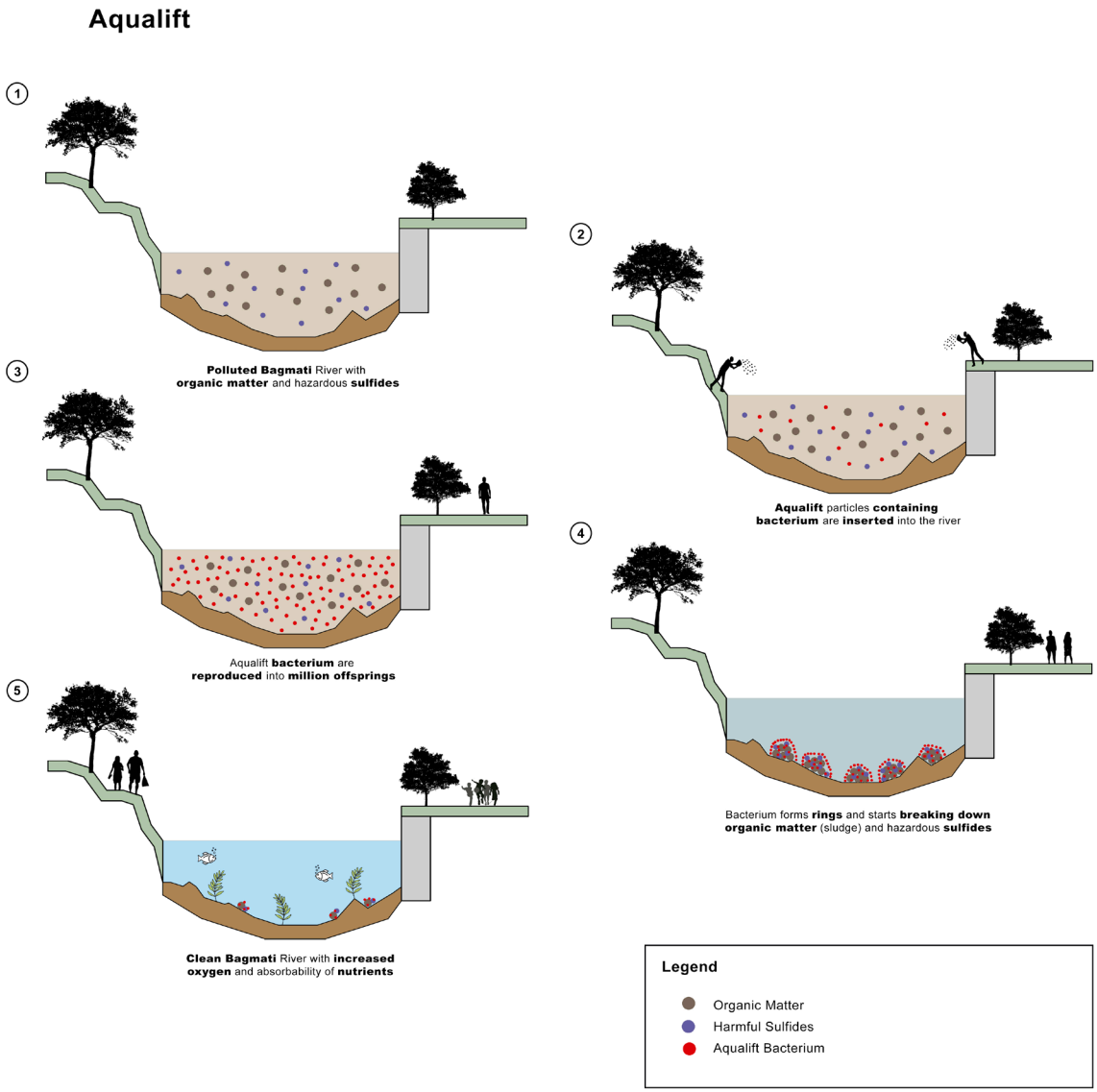


Fig 61. Ecological Solution of Aqualift Implementation (Source: Self-made by author, 2023)

P&G Purifier of Water

Similar to the Aqualift, Dr. Phillip Souter and his team in the late 1990s, invented the P&G Purifier of Water packets, which use the processes of coagulation and flocculation to separate contaminants and disinfect the water to make it clean and drinkable (P&G, 2022). Each packet contains 4 grams of soluble powder that can be used for 10 liters of water. These packets have been distributed by partnerships and foundations collaborating with P&G in order to help communities acquire clean drinking water for their daily needs. The P&G purifier of water has helped vulnerable communities found mostly in Central America, Africa, and Southeast Asia.

Within the soluble powder, two components are found: a coagulant (to cause particles to clump together and settle) and a form of chlorine that works slowly to inactivate remaining pathogens (P&G, 2022). The bacterial process of the package can be seen in Figure 62 and is as follows: "Particles that cause turbidity (such as silt or clay) are generally negatively charged, making it difficult for them to clump together because of electrostatic repulsion. However, coagulant particles are positively charged, and they are chemically attracted to the negative turbidity particles, neutralizing the latter's negative charge. With mixing, the neutralized particles then accumulate (flocculate) to form larger particles (flocs), which settle faster. The flocculants can then be settled out or removed by filtration.

Some bacteria and viruses can also attach themselves to the suspended particles in water that cause turbidity. Therefore, reducing turbidity levels through coagulation may also improve the microbiological quality of water. The flocculation process effectively removes larger organisms, such as parasites, and has been shown to be very effective even for smaller parasites, such as Cryptosporidium and Giardia. As well, when added to water, chlorine forms hypochlorous acid, which reacts through oxidization with microorganisms and kills them" (Centre for Affordable Water and Sanitation Technology (CAWST) 2018).

As of now, the powder is part of the Children's Safe Drinking Water Programme of P&G which has cleaned "19 billion liters of clean water to people in more than 90 countries" (P&G 2022), but the product can also be found in supermarkets and the e-commerce website *Amazon* across the world. Even though these packets have been used on a smaller scale for human drinking purposes, I believe that they could form a solution to restore the Bagmati River. The powder has the potential to clean larger water bodies due to its high effectiveness in removing hazardous viruses, bacteria, and parasites. This is because as stated, it has the same intention as Aqualift but, these sink to the bottom, therefore they will have to be removed every certain period of time from the river bed. Here is where community engagement could play a major role.

As with Aqualift one challenge that could pose a weakness would be to investigate if these particles act the same way when water is in motion. This is to research if the powder is able to coagulate and flocculate the parasites and hazardous particles as effectively.

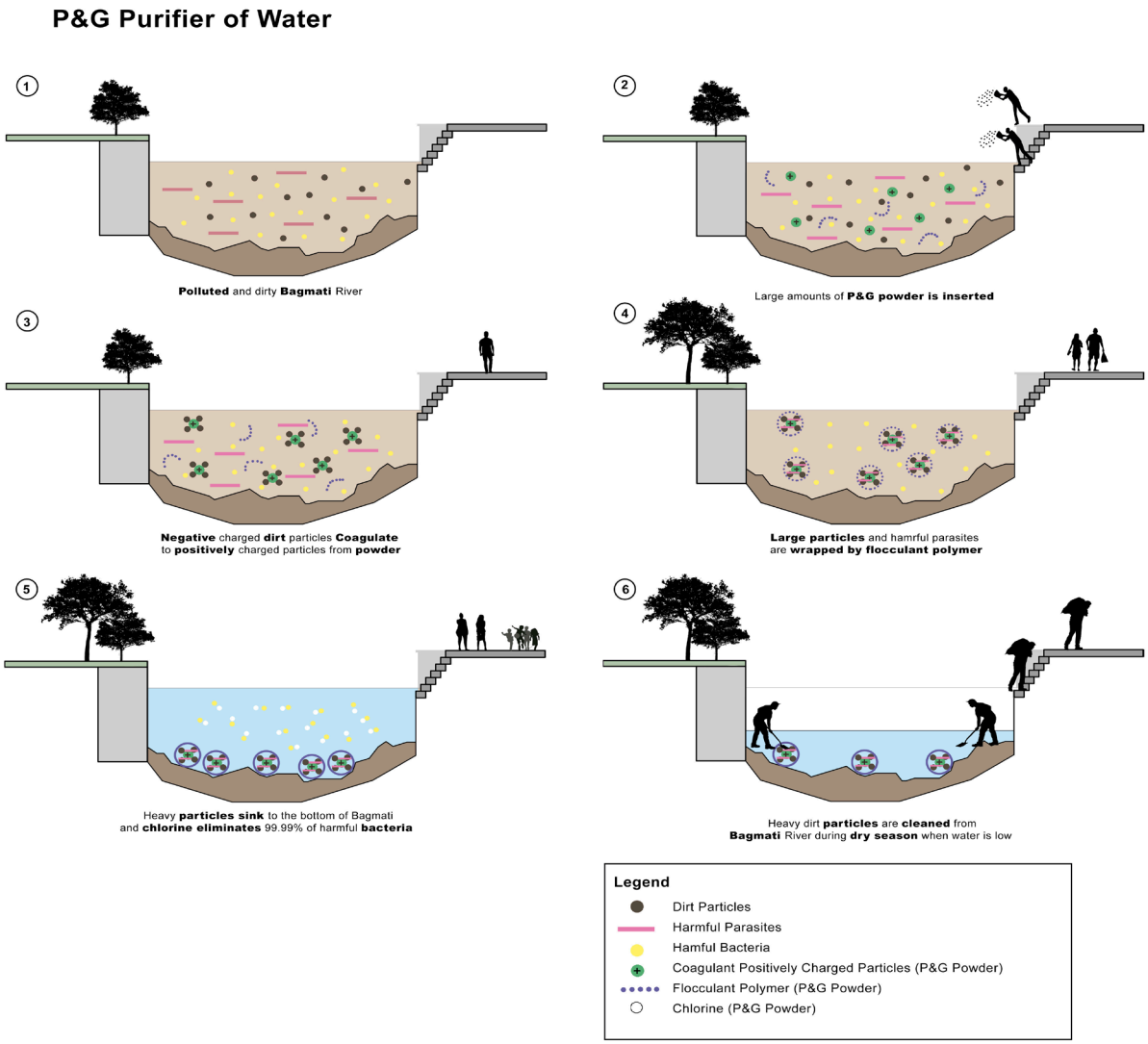


Fig 62. Ecological Solution of P&G Purifier of Water Implementation (Source: Self-made by author, 2023)

Barriers - The Ocean Cleanup

The Ocean Cleanup is a non-profit organization that was started in 2015 by Boyan Slat to develop and scale technologies to get rid of plastic pollution in the world's oceans. Their aim is to do this by intercepting floating plastic objects in rivers until they put themselves out of business once the oceans are clean (The Ocean Cleanup, 2023). The Ocean Cleanup throughout the years has established projects running in a wide range of different contexts and climates, in countries such as Indonesia, Malaysia, Vietnam, the Dominican Republic, Jamaica, Guatemala, and the United States. This is because major pollution happens in rivers that flow through big cities like Jakarta, Kuala Lumpur, and Santo Domingo and flow toward the ocean. This shows that they can be established anywhere in the world.

The Ocean Cleanup over the years has developed different methods to collect floating plastics that are usually found in rivers. These include (The Ocean Cleanup, 2023):

1. **Interceptor Original** (Figure 63) - This is a solar-powered boat that collects trash via a conveyor belt attached to a floating barrier which helps trash make its way toward the boat. The boat has 4 containers where trash is poured into and these can then be easily removed and taken to waste management facilities.

2. **Interceptor Barrier** (Figure 64) - Is a floating barrier that is usually placed at the mouth of small rivers that connect to bigger streams in order to deny trash from flowing into them. Trash is buffered here and then it can be easily collected.

3. **Interceptor Tender** (Figure 65) - This is a complementary small powered barge to the Interceptor Barrier which also has a conveyor belt to scoop up trash and offloaded it into a container onshore.

4. **Interceptor Trashfence** (Figure 66) - Is a pilot project which consists of an anchored chain-like fence structure that is placed in heavy-flowing rivers. This trash fence collects the most amount of trash possible and can withstand monsoon and hurricane floods.

Fig 63, 64, 65, and 66. Interceptor Original, Barrier, Tender, and Trashfence at Work (Source: The Ocean Cleanup, 2023)

Recently in 2021, the Ocean Cleanup gained a lot of media coverage via the YouTubers Mr.Beast and Mark Robber when they opened a fundraiser titled #TEAMSEAS to promote the clean up of oceans. Here, the Interceptor Original was showcased working in the context of the Dominican Republic. Since then, this campaign was able to raise 30 million pounds and has contributed to the removal of 33 million pounds of trash from the ocean (#TEAMSEAS, 2021).

The Ocean Cleanup non-profit organization can provide ideas on how to tackle the cleanup of the Bagmati River, especially in its wider areas and where other rivers such as the Manohara, Dhobi Kola, Iohu, and Bishumati intercept it. Furthermore, in the Chobar area where the river is wider and has more volume, a bigger mechanism can be placed as a last resort before following its way towards India.

During my transect walks, I was able to witness already two simpler ideas put into place along the Bagmati that were helping to stop trash from flowing further. As seen in Figures 67 and 68, these implementations resemble a smaller-scale idea of the Interceptor barrier and the Interceptor Trashfence.

Fig 67. Retaining fence found in Bagmati River near Pashupatinath Temple (Source: Author, 2023)

Fig 68. Wooden poles retaining floating trash in Aloknagar District (Source: Author, 2023)

To summarize, the different ecological solutions presented in this chapter aid in helping the removal of different chemicals, bacteria, and floating items found in highly polluted water. Therefore, these ecological solutions, as seen in Figure 69, if implemented and maintained at a larger scale could pose the probability of removing harmful particles found inside the river and could ultimately accelerate the restoration of the environment and ecosystems surrounding Bagmati. In the following chapter, these solutions will be discussed further on how they can be implemented with the collaboration of the different stakeholders analyzed and how citizen engagement could help develop and maintain further these ecological solutions in different stretches of the Bagmati.

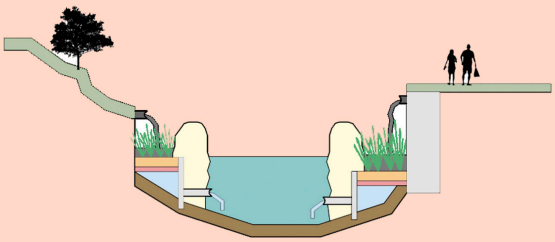
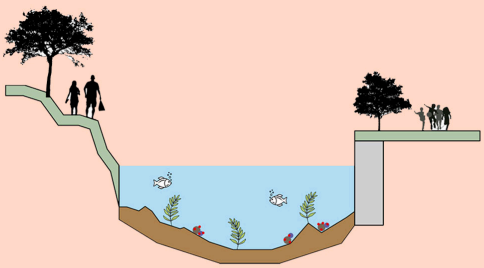
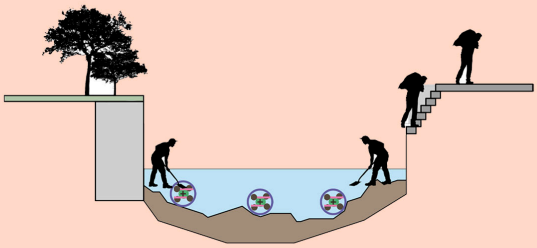
REED VEGETATION	Reed Vegetation beds that absorb and filter hazardous chemicals from sewage pipes.	
AQUALIFT	Bacterium which breaks down organic matter and harmful sulfides. Increases Oxygen and Nutrients for ecosystem to thrive.	
P&G WATER PURIFIER	Coagulant and flocculant polymers which clump and sinks dirt particles together with harmful bacteria. Creates sludge which needs to be removed.	
BARRIERS -THE OCEAN CLEAN UP	Trash accumulation barriers which stops floating items in a specific zone. Can be recollected manually or by robotic boat.	 

Fig 69. Summary of Ecological Solutions (Source: Self-made by author, 2023)

7. DISCUSSION AND RECOMMENDATIONS

The previous chapter identifies four possible ecological solutions that could be implemented in the Bagmati River in order to facilitate its ecological restoration for the coming years. As stated, I believe a comprehensive restoration plan is needed in order to involve different types of stakeholders as well as communities within the Kathmandu Valley. This is important as some stakeholders such as IDS, ECCA, and NRCT already possess large community groups doing various programs which impact the urban ecology and carbon footprint of the Kathmandu Valley. While other stakeholders such as CIUD, PID, and HPCIDBC have implemented ecological projects in the past which have, to some extent, helped beautify and restore the Bagmati River. As seen in stakeholder mapping (Figure 70) the stakeholders could be subdivided into their capacity to engage citizens' participation in various programs or their capacity on implementing restoration solutions to benefit the state of the Bagmati River. This is important as these stakeholders would need to collaborate, together with other communities and citizens, to implement and maintain the four ecological solutions that have been researched for this thesis.

In the following sections, a restoration plan would be developed in accordance with how these solutions could be implemented and which stakeholders I believe have the capacity to lead each restoration technique. Furthermore, a section on how each ecological solution relates to the established theory is presented, and additional recommendations which I believe need to be addressed by the government in order for the ecological solutions to be more effective.

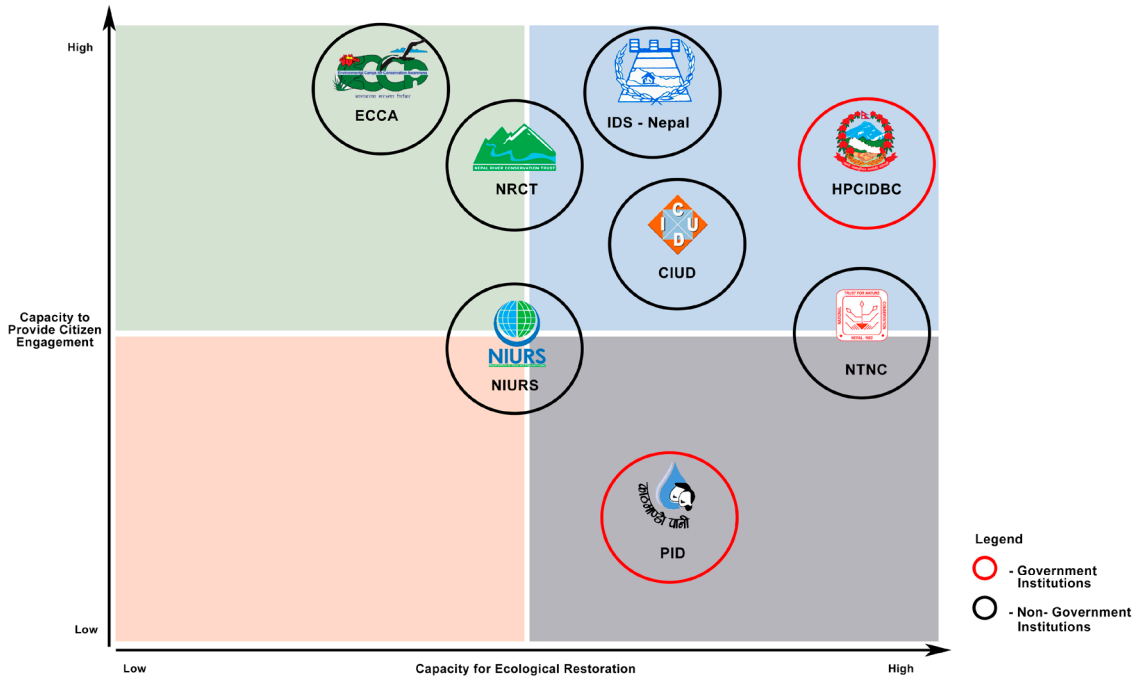


Fig 70. The Capacity of Citizen Engagement vs Ecological Restoration Stakeholder Mapping (Source: Self-made by author, 2023)

Restoration Plan

First of all, the implementation of reed vegetation beds alongside different parts of the Bagmati River would serve as a natural chemical filtration method. This is because it consists of sand, gravel, and reed plants which help absorb hazardous chemicals being dumped from the 84 open sewage pipes that I was able to record between the Tinkune Bagmati Bridge to the Kupondole Kuleshwor Bridge during my on-site transect walks.

Reed Vegetation beds are commonly used in wastewater treatment plants where hazardous chemicals are treated before being disposed of into the water cycle of rivers and oceans. For this reason, I propose that PID together with the HPCIDBC should take up the project in implementing this ecological solution. The PID having expertise in developing reed vegetation beds for their wastewater treatment plants should have the capacity to implement further beds alongside the HPCIDBC landscaping package which is soon to be accomplished. The accumulated sand which sits alongside some religious steps of sections two and three of my Qualitative Mapping Analysis, could be used to build up the walls and create filtration for the reed vegetation. This would not only filter the sewage water but also would create a barrier between the river's flow and the chemical-infused water. Furthermore, the reed vegetation needs to be implemented where the most amount of sewage is being discharged into the Bagmati. For this, the optimal locations would be where various sewage pipes are clustered together or that have been seen discharging large amounts of water. According to my mappings and transect walks I was able to identify 6 possible locations as seen in Figure 71 where this solution could be implemented. This is because as seen in Figures 71 and 73, I was able to witness these pipes discharging large amounts of sewage water every day.

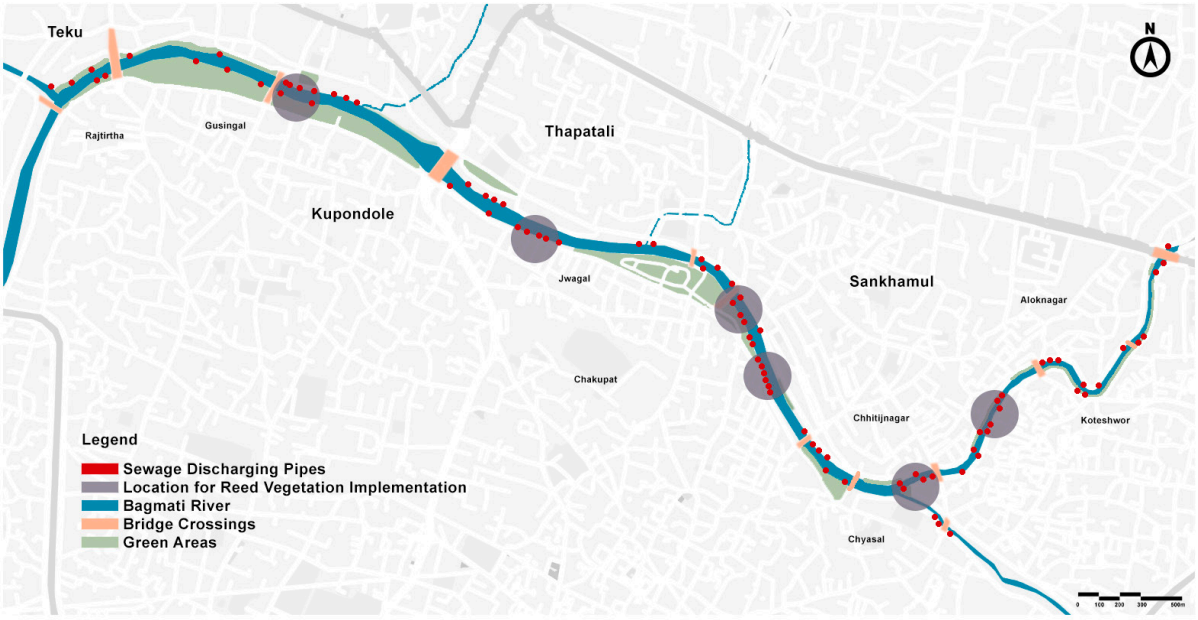


Fig 71. Optimal locations for implementation of Ecological Solution Reed Vegetation (Source: Self-made by author, 2023)

Fig 72 and 73. Sewage pipes constantly dump organic matter and chemicals into the Bagmati River (Source: Author, 2023)

If implemented correctly, reed vegetation could be very effective in cleaning and purifying all the sewage water discharging from the 84 pipes I was able to record during my transect walks. This is because the reed vegetation in the long-term could be expanded to a bigger surface area covering all the borderline of the river to form part of the riverscape and the permanent vegetation found within the Bagmati. For this of course, research would need to be done on how invasive reed vegetation can be once the fauna makes its way back to the river

NTNC having organized the Bagmati River Festival for several years, I propose for them to be involved in maintaining and further developing the project in the long-term. This is because NTNC has a large community outreach and its mission is to conserve the rivers around Nepal. Awareness campaigns could be implemented by NTNC to teach school children and other communities how this ecological solution works in removing harmful chemicals from sewage water. Furthermore, maintenance programs could be implemented in several months in the year to cut and treat the reed vegetation growing in the various areas of the Bagmati. This sort of practice emphasizes why ecology is important as it makes reference to Ernst Haeckel's (1866) definition of «the study of the natural environments including the relations of organisms to one another and to their surroundings» (Haeckel, 1866. p.333) presented in the Ecology section in Chapter 2 of the thesis.

Secondly, Aqualift is an ecological solution that has already been tested in the context of Nepal by the stakeholder CIUD in 2017. Here, CIUD was able to test this process in various lakes around the Kathmandu Valley region and according to the data collected, they proved to be very successful. Aqualift is a bacterium that helps augment the natural water cycle process within a natural water body. This helps break down organic matter and sulfides within a certain period of time and therefore reduces the number of harmful bacteria found in water. This gives water higher amounts of oxygen and generates nutrients for aquatic life and vegetation.

As CIUD has already experience in testing out this ecological solution before, I believe they should be the leading stakeholder in implementing it in different parts within Bagmati. The

implementation and monitoring of the Aqualift bacterium could be done by community groups that CIUD has worked with in the past such as when they developed a park in Kirtipur. Additionally, ECCA could help in creating community awareness programs and teachings could be provided to several citizens and also to teens in schools, on the positive outcomes and how Aqualift chemicals work. Furthermore, these groups could learn how to take various chemical readings throughout the year to collect data on how the organic material is being reduced. Additionally, this data would be useful to know if the Aqualift bacterium is efficient in a context where water is constantly flowing, or if it can only be implemented in still water. When deciding where to implement Aqualift, it could be implemented anywhere in the river as I believe that the river contains a lot of organic material from all the sewage pipes but also from the livestock roaming around the river.

In the case of Aqualift not making effect when water is flowing, the bacterium could also be implemented during the dry months of the river which range between December and April. Here water is seen stagnant in different parts of the river as seen in Figures 74 and 75. This water is green and has a potent smell, and therefore in these pockets, the ecological solution could be implemented. Furthermore, as Aqaulift is decomposing organic material, a focal point where it must be implemented is alongside the slum area found in the Thapatali District. I believe the implementation of an Aqualift solution is key here as the people who live in the slum areas are often seen using the river as a public toilet.

Fig 74 and 75. Green patches of chemically filled stagnant water next to steps of Bagmati (Source: Author, 2023)

As seen from CIUD implementation in 2017, the process takes up to 7-9 months to see actual results. Therefore, depending on the data collected during the first year of the implementation, I believe that this process should be implemented every year at different points of the Bagmati River. ECCA awareness campaign programs could aid in identifying potential spots where there are higher concentrations of organic material accumulated in the riverbed. In order to identify this, help from local universities could be acquired to share measuring equipment to help identify the organic material. Additionally, these university student groups could also help in monitoring the effect of Aqualift on the river.

Thirdly, P&G Purifier of Water packets are mostly used to obtain clean drinking water in Global South contexts as water is often scarce or difficult to obtain. These packets have been used in nations such as Panama, Nicaragua, Rwanda, Malawi, Pakistan, Indonesia, etc. The powder within these packets has the capacity to coagulate and flocculate dirt particles and harmful viruses but they have only been used on a smaller scale by purifying drinking glasses or big jug containers for vulnerable communities. Nevertheless, I believe that these packets have the potential, on a much bigger scale, to help the restoration of the Bagmati River. This is because it would help clear the water of all the dirt particles and further purify the water from harmful bacteria and viruses that could potentially harm citizens that might be in contact with the river.

For this ecological solution, I believe that the institution of IDS could lead the project in implementing, managing, and maintaining different parts of the river where these would be implemented. IDS counts with a large population of communities and social workforce that have been developing sustainable projects in the past few years. As I said, these packets would have to first be scaled up. For this, a partnership with P&G would probably be needed in order to obtain the powder recipe and rights. Additionally, some investigation would be needed beforehand to see how this ecological solution acts when water is flowing and the amount of time it takes for the particles to settle down on the river bed. Moreover, an investigation would have to be made regarding if the chemicals found in the packets affect the flora and founa within the context:

Once the powder is acquired and the investigations are done, hopefully, proven successful, IDS would have to create citizen awareness campaigns in order to teach a small group or community how to use the powder and see potential areas of implementation along the Bagmati. One possible suggestion would be in section 1 presented in my Qualitative Mapping Analysis. I believe this is a good location as the river here does not consist of a wide surface area, as seen in Figures 76 and 77, and therefore the P&G Solution could work more effectively and sludge could be removed more easily and faster. Depending on the investigations conducted before, a time would be decided for the powder to take effect on the river, afterward a team would be needed to remove and maintain the sludge accumulated on the river bed. I believe that the removal of the sludge could be done during the dry season, as here, there is not much water flow from Bagmati and the water tide diminishes significantly, where one is able to set foot on the Bagmati. As with the Aqualift, if the P&G powder is unable to be implemented when there is a heavy water flow, this can be implemented during the dry season of Bagmati. Finally, the sludge removed would have to be processed using composting methods in order to eliminate all organic material.

Fig 76 and 77. Bagmati River at Koteshwor District (Source: Author, 2023)

In order for this to help the restoration process of the Bagmati River, the P&G Purifier of Water packets would have to be implemented by IDS and other communities every certain amount of time in different parts of the river. Furthermore, maintenance would have to be emphasized for the removal of the sludge generated on the river bed. This can be done by creating community work removal campaigns where citizens can be engaged. If all the processes are to be done correctly, Bagmati River would have a much lower concentration of floating dirt particles and harmful viruses. In the long-term, the water would start becoming purified and clearer and the river bed once again would be visible.

On the other hand, as these packets would be implemented between the Tinkune Bridge and the Sankhamul Bagmati Bridge of section 1 of the Qualitative Mapping Analysis, this area as of now consists of some accessibility challenges. This is because there is an abundance of vegetation growing abruptly which makes it hard for citizens to be close to the river as there are no paths. This vegetation blocks the clear view of the river and also at some points makes its way into the river. Furthermore, some areas are fenced off by what looks like private property from nearby homes as chains and locks are seen placed on fence doors. Therefore, I propose that NIURS be involved in creating urban green policies which make the river shorelines public space for anyone to use. Furthermore, policies on the maintenance of these public spaces should be emphasized in order for people to have clear access towards the Bagmati River. Green public spaces such as parks or promenades could be developed in this area to promote more accessibility towards the river. This could be done by implementing universal design techniques that lead towards the river from the adjacent roads.

Lastly, the Ocean Cleanup has been operating in rivers that have similar contexts to the one of the Bagmati. These rivers found in Malaysia, Indonesia, Dominican Republic, and Vietnam have high polluting percentages as trash and heavy sediments are also being dumped into the rivers by communities but also industries. This NGO has four different solutions to tackling river pollution as seen in the Ecological Solutions chapter, in order to prevent pollution from reaching oceans and ultimately affecting a much wider ecosystem that has a wider diversity of flora and fauna. For this reason, the Ocean Cleanup is a good reference and ecological solution that could be implemented in the context of the Bagmati River as ultimately all of the pollution generated here, also meanders its way to India and eventually to the estuaries found in the Bay of Bengal.

As stated before, a partnership with the Ocean Cleanup campaign could be initiated in order to provide and implement some of their solutions within the Bagmati River. I believe that the HPCIDBC could act as the main stakeholder in taking up this project as they are a government institution that has the budget and power to create this kind of partnership and get funding to implement the ecological solutions. The Ocean Cleanup's Interceptor Original and Interceptor Barriers are the methods that I believe would be the most effective within the Bagmati River.

The Interceptor Barriers could be implemented at the intersections of smaller rivers that feed into the Bagmati. These rivers include the Manohara, Dhobi Kola, Ichu Nadi, and Bishnumati within my area of study as seen in Figure 78. Here the barriers will stop floating items such as plastics, vegetation, and other pollutants from reaching the mainstream of the Bagmati River. Here, the Save Bagmati Campaign could be involved together with other communities in clearing and cleaning the accumulated trash. This would create a much easier job for the Save Bagmati Campaign and therefore more sites could be tackled within one day, or as stated, the campaign could be expanded to several days a week in order to clear the trash. If so, schools from the surrounding area as well as communities could help clear the debris and trash every couple of days.

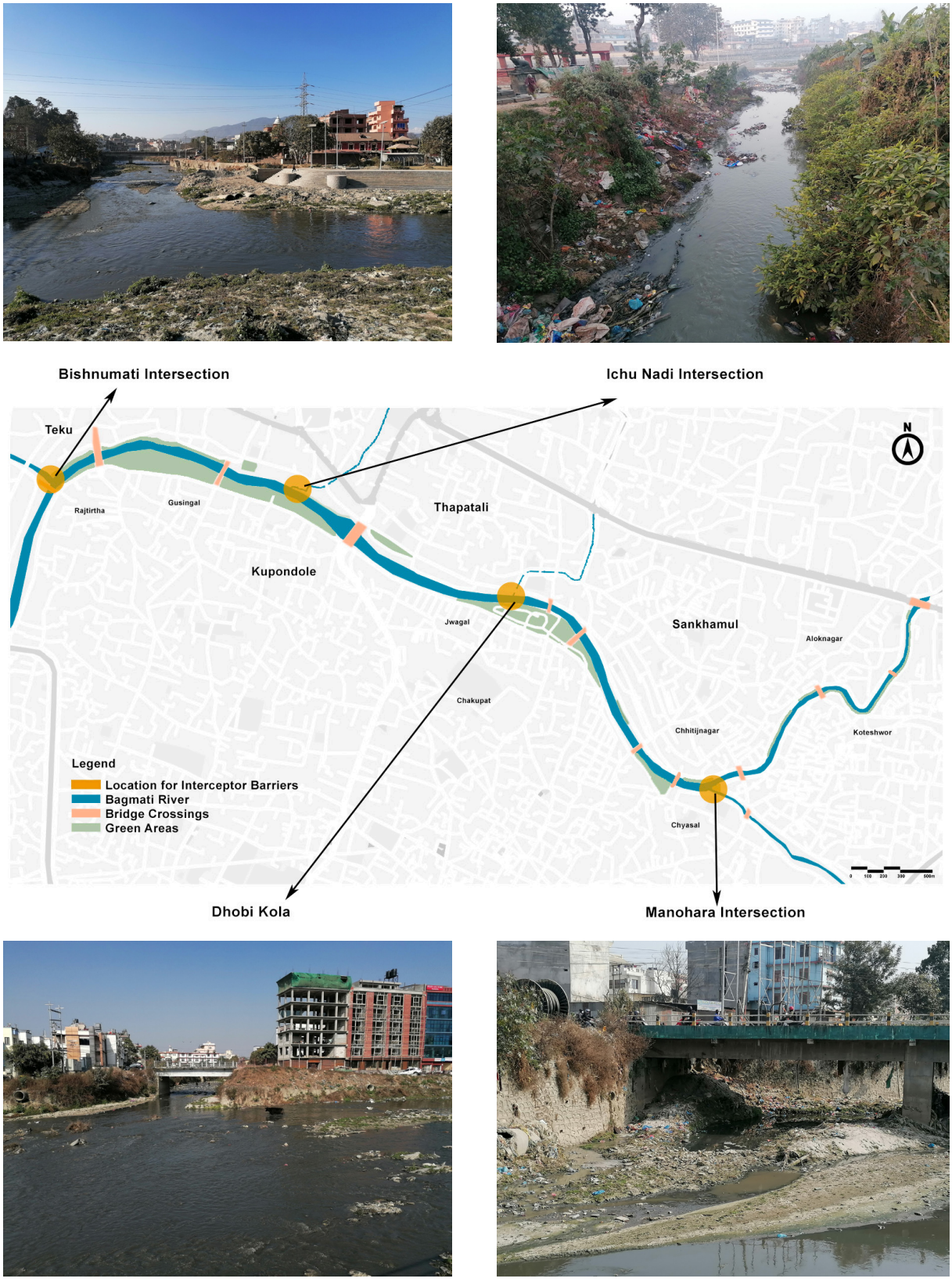


Fig 78. River intersections with Bagmati and possible implementation of Interceptor Barriers (Source: Self-made by author, 2023)

On the other hand, the Interceptor Original needs a much wider and deeper space in order to operate, which is why I propose that it be implemented in the Chobhar area of the Bagmati River. This is because it would serve as the last line of defense in clearing floating pollutants before the urban river exits the heavily urbanized area of the Kathmandu Valley. Furthermore, as seen in Figure 79, the Interceptor Original at Chobhar would have more space to operate, and together with the 360.6 MLD Dhobighat wastewater treatment plant which is set to be constructed here by PID would ultimately help the ecological restoration process of the Bagmati River follow its course downstream towards the natural plains of Nepal.

Fig 79. Chobhar District, the exit of Bagmati River from Kathmandu Valley (Source: Author, 2023)

Additionally to these methods by the Ocean Cleanup, as seen in Figures 67 and 68 in the chapter of Ecological Solutions for the Social Engagement of the Restoration of the Bagmati River, smaller scale references to these ecological solutions have already been implemented in some places. I believe these smaller scale solutions could further be developed by the Save Bagmati Campaign as they are low-cost and could easily be made and anchored within a Saturday morning of the campaign. These small-scale solutions would need to be implemented especially in more narrow stretches of the Bagmati River such as the ones found between

the Pashupatinath Temple to the Manohara Dobhan Bridge in the Chhitijnagar District. Here, trash and floating items would be accumulated much quicker and therefore the Save Bagmati Campaign would have to maintain these stretches more often. Social awareness campaigns by ECCA could be implemented to let citizens living in the area as well as local schools help maintain these stretches of the river by removing the floating items.

One of the challenges that I believe might arise with these low-cost ecological solutions would be during the monsoon season. This is because these sorts of ecological solutions might not resist the high flow of water, or might be sunk underneath the high-level rise of the river during monsoons. Therefore, potentially every year these solutions might have to be removed during monsoon season and implemented once again in order to continue accumulating plastic objects and for the process to be efficient.

The development of the four ecological solutions with their respective stakeholders fall under the restoration plan I propose should be made for the Bagmati River. As seen in Figure 80 an overview of these solutions states how each stakeholder should proceed in implementing and maintaining such solutions. Some stakeholders appear in more than one ecological solution as I believe they have the financial and social capacity to develop and help create awareness campaigns to teach communities about ecological solutions and their processes. Additionally, I would suggest for HPCIDBC take the overall reigns of the restoration process as it is a government institution, they possess the economic and social power to bring these other institutions to form partnerships between them in order to proceed with the possible restoration plan I have outlined for the Bagmati River. Moreover, HPCIDBC has different departments within its institution which could help organize the stakeholders and promote even further the four ecological solutions.

Additionally, to Figure 80, Figure 81 depicts a map outlining the possible areas where these ecological solutions could be developed in order for all of them to work simultaneously and ultimately help accelerate the restoration process of the Bagmati River. Also implementing them in different areas would engage different communities and social groups to participate in the development and maintenance of their long-term results. As seen they cover all three sections of the river analyzed for the thesis and pass through different districts found in both Kathmandu and Lalitpur.

RESTORATION PLAN		
Ecological Solution	**Stakeholders Involved**	**Implementation Plan**
Reed Vegetation	HPCIDBC, PID, NTNC	-- Develop in six analyzed clusters of discharging sewage pipes -- Use accumulated sand in river to create natural barriers -- Maintainance programs to cut and remove dead vegetation -- Awareness campaigns teaching schools and communities about the ecological solution
Aqualift	CIUD, ECCA	-- Investigate if it has the same effect when water is flowing -- Implement near squatter areas of Bagmati and stagnent areas -- Trainings on how to do chemical readings and monitor process -- Awareness campaigns to identify further implementation areas -- Every year implement the process
P&G Purifier of Water	IDS, NIURS	-- Research on large scale implementation and within a flowing environment -- Awareness campaigns for citizens to engage in implementing solution -- Implement in section 1 of analyzed area -- Trainings on sludge removal -- Trainings on sludge processing -- Implementation of policies to create an urban accesible area -- Implementation of policies to maintain degrading area
Barriers - Ocean Cleanup	HPCIDBC, ECCA	-- Creation of Partnership with The Ocean Cleanup -- Implementation of Interceptor Barrier in mouths of smaller rivers feeding to Bagmati -- Implementation of Interceptor Original in Chobhar District -- Clearing and cleaning of Interceptor Barriers -- Awareness and training campaigns on trash removal for schools and communities -- Implementation of low-cost barriers in analyzed sector 1 -- Maintainance of low-cost barriers

Fig 80. Restoration Plan Implementation Overview (Source: Self-made by author, 2023)

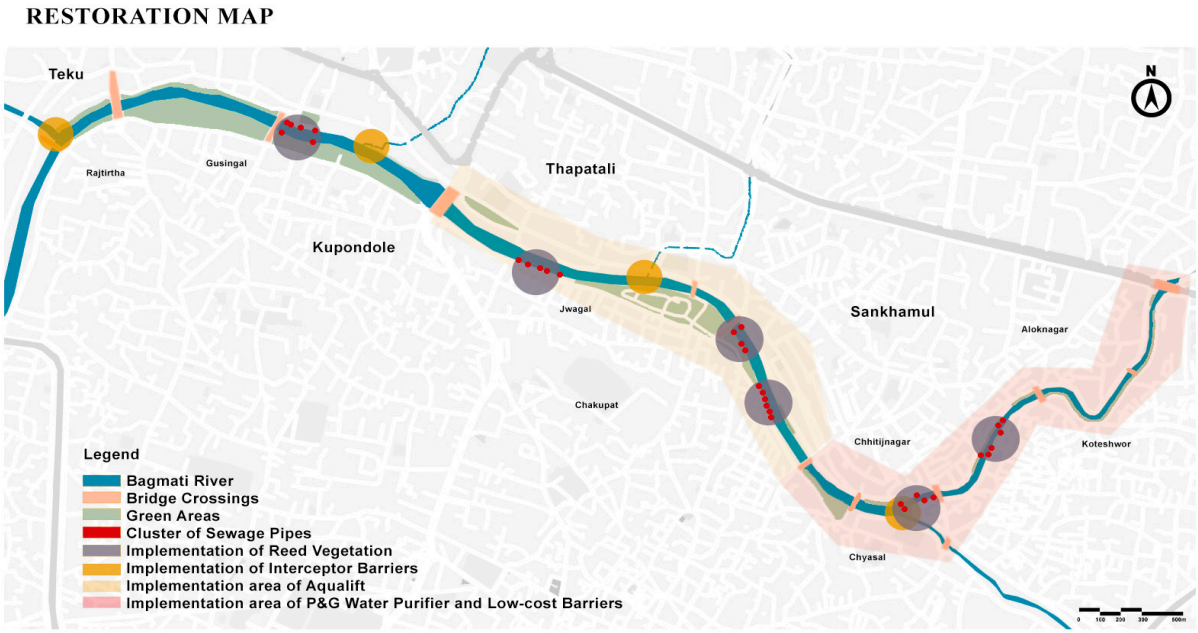


Fig 81. Restoration Plan Implementation Map (Source: Self-made by author, 2023)

Theory Revised

The ecological solutions presented showcase an understanding of how these make reference to the theory presented in this thesis. Firstly, these ecological solutions appeal to the brown and green agendas proposed by Sathherwaite and McGranahan (2000), as they deal with hazardous pollutants and environmental health issues. These have a particularly strong impact on low-income or marginalized communities for example, in this case, the context of Nepal. Furthermore, these ecological solutions help in regenerating the water cycle of a river and serve as a long-term ecological sustainability solution in bringing back a river to its natural state, therefore reducing the 'green' concerns for the river's health. On the contrary, brown concerns are found within Haughton's (1999) intragenerational equity as it justifies the need for healthy and safe living and working environments for urban dwellers irrespective of socio-economic status. As of now, these are not being met as the chemicals and waste being dumped inside the Bagmati River pose a hazard to human life if people were to be in contact with them.

One such chemical is Ammonia, which causes irritations and burns, and is strongly infused into the water. This when mixed with sulfides and nitrate causes a reaction that produces a strong odor that can be smelled when walking alongside the edge of the river and if exposed to it for long periods of time, it causes breathing and asthmatic problems for humans. This poses problems found at the local level within the different districts of the heavily urbanized Kathmandu Valley, therefore, social justice within the brown agenda needs to take effect. This could be done by engaging communities and citizens to be aware of the problems Bagmati has and how they can contribute to the restoration and cleaning of this holy river they perform rituals in. It is important to acknowledge this so that religious beliefs can further be transferred to future generations and why the green agenda prioritizes the concern that urban development does not draw on finite resource bases and degrade ecological systems (Haughton, 1999).

Here, the ecological solutions developed, implemented, and maintained by the collaboration between HPCIDBC, IDS, CIUD, NRCT, NTNC, ECCA, PID, NIURS, and engagement of citizens would tackle both agendas which normally are represented as a contrast of priorities that need to be addressed for the future urban development of cities. This is because the brown agenda focuses on the immediate needs of the people while the green agenda has a more sustainable approach for future generations and the long-term impacts on the city as a whole.

The Blue Agenda described by Foley and Kistemann (2015) and McDougall *et al*, (2020) plays a fundamental role when talking about the Bagmati River and its possible Ecological Solutions as it prioritizes the protection and restoration of river ecosystems, with an emphasis on preserving biodiversity, improving water quality, and promoting the conservation of ecological habitats.

This is because the ecological solutions presented aim to eliminate the organic material, harmful sulfides, bacteria, and viruses found in the murky water of Bagmati in order for aquatic life to prosper once again. Additionally, helping the development of experiences within a freshwater blue space consisting of scenery, smells, sounds, and opportunities for recreation within its environment (McDougall *et al*, 2020). This re-establishment of blue infrastructure within the urban context ultimately can reduce human stress, by giving them an area where different activities can be done and citizens can find a place of belonging next to the aquatic environments which are highly restorative. Just like the Bagmati River Festival's aim and purpose was, to bring citizens together and enjoy the green, blue infrastructure of the Bagmati.

Urban Ecology, "the study of the ways that human and ecological systems evolve together in urbanizing regions" (Alberti, 2008. p.xiv), plays an important role within the urban river of Bagmati as it shows how the river has evolved within the Kathmandu Valley. Some parts have been narrowed, excavated, and poisoned with harmful chemicals due to human activity. The goal of urban ecology is to understand how urban ecosystems function, and how they can be managed and conserved in a sustainable way. This is why the four ecological solutions proposed for this thesis have been researched and tested before in contexts similar to Nepal and their implementation would serve as knowledge in crucially addressing the challenges of urbanization and the opportunities these can impact in the regeneration of urban ecosystems.

Additionally, urban ecology plays important roles in decisions posed by community behaviors such as the ones IDS could implement, urban policy-making like NIURS is implementing and management decisions such as the HPCIDBC have developed with their packages. This is important as these roles can be used to inform and guide policy when talking about the social, economic, and environmental aspects of a city (Bai. and Schandl, 2010). The ecological solutions presented above further emphasize "the study of the natural environments including the relations of organisms to one another and to their surroundings" (Haeckel, 1866. p.333) presented by Hackel (1866) as these do not pose a threat to living organisms or other wildlife that might be living near the Bagmati. These might also include livestock and birds found in the area. This is important as it does not create habitat destruction or animal extinction as they are biological solutions, especially those of Aqualift and P&G Purifier Packets.

The "process of repairing damage caused by humans to the diversity and dynamics of indigenous ecosystems" (Jackson *et al*. 1995. p.71) is the main reason why these ecological solutions must be implemented within the Bagmati River. An ecological restoration holistic approach to restoring a degraded ecosystem, one that is considered not only the physical and biological aspects of restoration but also the social and cultural context in which restoration takes place (Jackson et al, 1995) must be implemented and therefore a restoration plan is required to potentially fulfill the three levels of restoration presented by Van Diggelen *et al*, (2001). I believe that the

choice of these ecological solutions for the social engagement of the restorations of the Bagmati River serves as an opportunity in emphasizing the importance of restoring the composition and relative abundance of species, the structure and arrangement of vegetation and soil components, and the ecosystem functions that support the health and resilience of the system. By restoring these attributes, the goal is to create an ecosystem that will be able to maintain its integrity and function in the long-term, even in the face of environmental stressors and other challenges (Hobbs & Norton, 1996).

Lastly, The UN Sustainable Goals of SDG #4 Quality Education, SDG #6 Clean Water and Sanitation, SDG #11 Sustainable Cities and Communities, SDG #14 Life below Water, SDG #15 Life on Land, and SDG #17 Partnerships for the Goals all play an important role in Moving Towards the Urban Ecological Restoration of the Bagmati River. This is because by creating partnerships between institutions and engaging citizens to participate, community awareness programs can be created to teach people how to implement ecological solutions to restore Bagmati. Furthermore, developing knowledge of the potential benefits the River Bagmati could bring if it is restored.

These ecological solutions are strongly linked to the UN Sustainable goals of SDG #6 Clean Water and Sanitation and SDG #14 Life below Water, as these agendas seek to provide citizens with clean and safe drinking water and for wildlife to prosper within the blue infrastructure. Even though the Bagmati River might not be 100% safe to drink its water after the restoration process, it gives a possibility for communities to enjoy activities alongside its banks and maybe in the future be able to swim in its waters again, like it used to be back in the 1990s. Furthermore, when considering the implications the ecological solutions have to eliminate organic waste, chemicals, and viruses being dumped from sewage pipes but also via public toilets that are found within the slum areas next to the Bagmati River, it provides the opportunity for fish found in the Shivapuri-Nagarjuna Hills to come back to the urban areas of Bagmati. Additionally, giving a chance for wildlife to reproduce and create a natural habitat once again, together with aquatic vegetation.

Recommendations

Along with the four ecological solutions discussed throughout the thesis here I would outline some recommendations that the Kathmandu and Lalitpur Metropolitan city offices could address in order for the solutions to work properly and also create a green urbanscape for citizens to enjoy.

First, I recommend that a vegetation maintenance program should be developed in order to cut and trim the vegetation growing abruptly next to some areas of the Bagmati. This is important as some vegetation branches grow towards the river and therefore trash can be seen being stuck and accumulated beneath this vegetation. If maintenance is done correctly, this would create a free flow of trash towards the low-cost barriers implemented by the Save Bagmati Campaign, and therefore trash would be collected easier. Additionally, trimming the bushes and long grass would create a more accessible space for citizens to enjoy being next to the river as activities could be developed in these spaces. This could be part of a proposed riparian zone management program by the ward offices:

Secondly, I would recommend that all the accumulated sand that would not be needed for the implementation of Reed Vegetation be sparse throughout the Bagmati. This is in order to create a filtration bed at the bottom of the river and also eliminate the sand dunes that are hindering the accessibility towards the river in some areas. Furthermore, during monsoon season this sand would be restricted to being deposited on the promenades and parks developed on the river shoreline if the Bagmati overflows.

Finally, I believe that a big awareness campaign with the implementation of public urban trash bins should be made in order to promote people to use them and not throw trash on the streets and public spaces. I strongly recommend this action as within my three-month stay in the Kathmandu Valley I was only able to witness a few trash bins throughout the cities and these were mostly placed in tourist areas. Furthermore, I was able to see people throwing away plastic objects as they passed by their motorcycles or walked along the street as there were no trash cans within sight across the cities. Moreover, as I learned from my interview with the stakeholder IDS, there is not a recycling culture yet established in Nepal and therefore low emphasis is made on how trash should be disposed of. This could be tackled by creating larger awareness and educational campaigns starting within kindergartens and schools but also including disciplinary measures for the population such as fines. Hopefully, these sorts of changes take effect in the future and I am able to witness them when I return one day to Nepal.

8. CONCLUSION AND IMPLICATIONS

The key objective of this thesis was to uncover answers regarding ***The potential ways in which different institutions could collaborate, together with citizens, to guide the ecological restoration process of the Bagmati River.*** After reviewing the theory based on Brown, Green, and Blue Agendas as well as Ecology, Urban Ecology, and Ecological Restoration in Chapter 2, a further outline of the methodology employed for the case study of Bagmati was discussed in Chapter 3. The fieldwork helped find key attempts in engaging citizens in restoration and as a conclusion ecological solutions were drawn up as potential ways in which the restoration process of Bagmati could be tackled. Ultimately all of the above was discussed as a potential restoration plan which helped answer the research questions proposed for this thesis.

RQ1 - What urban ecological solutions have institutions implemented in the past and what are the opportunities and challenges when involving citizens in the restoration process?

Interwoven in the stakeholder discussions presented in Chapter 5 on ***Results and Findings of Attempts to Restore the Environment and Engage Citizens around Bagmati*** are answers to how different institutions' programs have impacted the restoration of the Bagmati River. Programs such as the Save Bagmati Campaign, Landscaping Package by BRBIP, Cleaning Bagmati from your Kitchen, Bagmati River Festival, and the Bagmati Action Plan have had strong impacts in restoring slowly the Bagmati even though the COVID-19 pandemic created challenges in moving forward. Furthermore, within each stakeholder program, a SWOT analysis was made in order to outline challenges such as the stealing of materials, sand accumulation in order to remove trash, flooding due to monsoons, difficulties on creating awareness within religious communities, trash being left behind during festivals, budget allocation for wastewater treatment plants, no restrictions for industrial waste disposal and bad composting training.

On the other hand, these stakeholders possess a lot of opportunities as they have a wide range of communities and schools already working within their programs and have a lot of experience. Therefore, the creation of awareness campaigns and training for ecological solutions would help implement and develop them in the future in order to bring back the green and blue ecosystem. These opportunities were further strengthened by the positive learning outcomes I was able to analyze from the stakeholders interviewed, shining a light on the future of citizen engagement with ecological solutions that would ultimately restore the Bagmati.

RQ2 - What ecological restoration solutions could engage citizens to interact and feel part of the Bagmati River shoreline?

There is evidence presented within Chapter 6 on ***Ecological Solutions for the Social Engagement of the Restoration of the Bagmati River*** that suggests the need to develop a restoration plan in order to tackle the issues presented of the Bagmati River. Within this restoration plan, four solutions that compromise Reed Vegetation, Aqualift, P&G Purifier of Water, and Barriers of The Ocean Cleanup show their potential to be effective in restoring the Bagmati River. This is because these ecological solutions have been socially and scientifically tested in urban contexts similar to the Kathmandu Valley and have shown positive data and results in eliminating harmful bacteria, viruses, particles, and trash from different water sources.

Additionally, these ecological solutions in order to be developed and implemented in the three sections of the Bagmati River analyzed within this thesis, would make stakeholders collaborate together as some have the ecological restoration knowledge but do not have the community outreach other stakeholders possess. Moreover, for the ecological solutions being proposed to have an effective impact on the Bagmati River, these would have to be managed and maintained every certain time. For this reason, citizen engagement would play a vital role as awareness programs and training would have to be done by leading stakeholders, so communities can devote themselves to managing the ecological solutions.

RQ3 - How can urban ecological solutions guide the restoration process of the Bagmati River?

The interplay between the different ecological solutions presented in Chapter 7, ***Discussions and Recommendations*** gives a deep analysis of how and where these ecological solutions could potentially be implemented within the Tinkune Bagmati Bridge next to Subidhanagar District all the way down to Kupondole Kuleshwor Bridge where the Teku District is found. Here, leading stakeholders such as HPCIDBC, PID, CIUD, and IDS are outlined in potentially contributing to the implementation of the ecological solutions with the help of other stakeholders such as ECCA, NTNC, Save Bagmati Campaign, schools, and communities.

Furthermore, visual analysis through maps and personal photographs taken during the three-month fieldwork showcase the possible areas and critical spots where these ecological solutions could potentially be implemented to work best and have a positive impact in removing pollution, hazardous bacteria, and trash found infused into the Bagmati River. The idea is for all of the ecological solutions to be implemented simultaneously or during the monsoon or dry seasons the Bagmati River presents, in order to help accelerate the natural restoration process of the

river. This is why these solutions must be implemented within different parts of the Bagmati River with the aim to eradicate hazardous bacteria, viruses, and pollutants that would hinder the development of life below and above Bagmati. Furthermore, making citizens feel part of and do various activities closer to this blue urban infrastructure which meanders through the Kathmandu Valley.

Implications and Final Conclusion

This study helped uncover a range of ideas and concepts within urban ecological planning on how ecological solutions could help restore an urban river that has degraded over time due to the mismanagement and lack of consciousness people have toward green and blue infrastructure. The qualitative data collected from the semi-structured interviews helped me realize how some institutions try to push for citizens to engage in community activities and campaigns in order to generate an ecological impact on the overall state of the Valley. Furthermore, these citizens give themselves a sense of satisfaction towards contributing to the ecological restoration of the Bagmati River. This is important as during my three-month field research in Nepal, I was able to witness that there is not much culture when it comes to recycling or simply throwing trash away into trash bins. I was able to see a sad overview demonstrated of the amount of trash that was seen on the streets and the impactful scenes of mountains of trash and debris found inside the Bagmati River in some sections.

Additionally, I would just like to acknowledge that due to religious activities potentially contributing to the pollution of the Bagmati River, this topic I was not able to express any comments or opinions. This is because being a sensitive topic of discussion and myself not being a practitioner of Hinduism, I would suggest other investigators with the proper research knowledge to investigate how ecological solutions could be presented towards this topic.

Therefore, based on the research gathered on the various topics presented, I was able to come up with ecological solution references found in other urban rivers to tackle the precarious condition the Bagmati River founds itself today. Where mountains of sand are accumulated in its borders, livestock is seen in search of food, trash is seen floating downstream and thousands of black liters of sewage water are been discharged from pipes. This is why the development of a restoration plan ***in which different institutions could collaborate, together with citizens, to guide the ecological restoration process of the Bagmati River*** is crucial to eradicating all the issues the river presents today.

Moreover, further studies would be necessary to look into such as educational campaigns, financial strategies, and legal strategies of the co-production and participation process to further

bolster the success factors of the ecological solutions implemented. This in combination with other short-medium and long-term interventions within integrated strategies spanning different disciplines at different scales. All of this with the idea of one day potentially bringing back the Bagmati River to how many key informants remember it in their childhood, when they used to do various activities near its shores and even take a swim in its waters.

Finally, the thesis presents how ecological solutions implemented by stakeholders with the engagement of citizens and communities could potentially accelerate the ecological restoration of an urban river. In this case, the Bagmati River which is found in the Kathmandu Valley in Nepal. I believe this thesis could serve as an example of how different methods and ecological solutions could be used in conjunction to address the issue of pollution many urban rivers across the world have. As seen with the Ocean Cleanup, many rivers across the world face chemical pollution and trash accumulation due to the poor management we humans possess when disposing of residue generated by us. This is a problem as it makes its way toward oceans and ultimately disrupts or kills the environmental ecosystems of flora and fauna found within these blue infrastructures. It is important for these issues to be addressed as soon as possible in order to restore and create habitable and livable spaces for us humans and learn how to co-exist with flora and fauna without harming their ecosystems. This is why with this thesis I hope to put my small grain of sand to contribute to the wider perspective of urban ecological planning.

Figure 82. Bagmati River in Jwagal District (Source: Author, 2023)

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10. APPENDIX

APPENDIX 1: Qualitative Mapping made on site

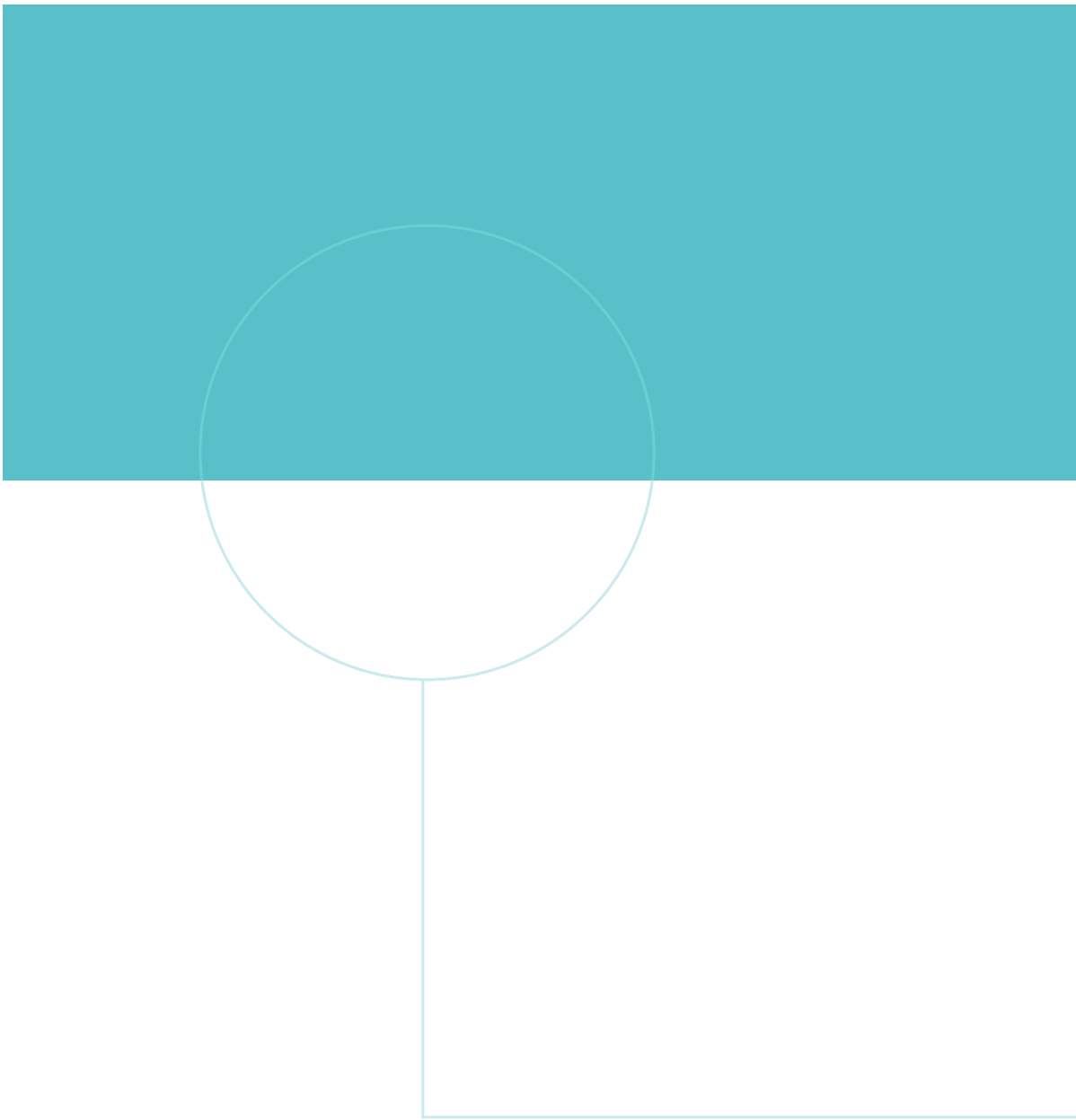
APPENDIX 2: List of key informants and interviewees

The following is a list of the key infomants I was able to conduct semi-structured interviws to uncover answers about their institutions and programs they have developed in the past. Furthermore, helping me paint a picture of how the Bagmati River used to look like in the 20th century.

KEY INFORMANTS		
NAME	ORGANIZATION	DATE OF INTERVIEW
Ms. Ramita Shrestha	Deputy Project Director of Bagmati River Basin Improvement Project (BRBIP), Ex-UEP Alumni	6 -Feb-2023 04-April-2023
Mr. Sudarshan Rajbhandari	Center of Integrated Urban Development (CIUD)	29-Jan-2023
Ms. Prabha Pokhrel	Team Lider of Integrated Development Society Nepal (IDSN)	15-Feb-2023
Ms. Nabina Mahar	Civil Engineer and Contractor of Environment and Resource Management Consultant	10-Feb-2023
Mr. Suril Shakya	Architect of Monument	10-Feb-2023
Mr. Bishwas Paudel	Civil Engineer in Earthquake Engineering of Monuments	10-Feb-2023
Mr. Kishore Thapa	Former Secretary of Urban Development Campaign	05- April-2023
Mr. Bikesh Strestha	Founder of Save Bagmati Campaign and environmental activist	26-Jan-2023
Mr. Tost Raj Chhetri	Volunteer and Coordinator of Save Bagmati River Campaign & Former Field Coordinator/Engineer at Centre for Integrated Urban Development (CIUD)	04-Mar-2023
Mr. Niroj Maharjan	Heritage Conservation Volunteer in Kathmandu Metropolitan City	20-Jan-2023

APPENDIX 3: Interview Guide for Informants

1. What is your name?
2. For which institution are you working? For how long have you been involved with this institution?
3. Describe how the Bagmati River used to look like before, in your childhood, did you do any activities on the river?
4. Describe what is your perception of the Bagmati now. How would you describe it?
5. Have you personally done any activities or had interactions with the river itself recently?
6. What does the Bagmati River represent for you?
7. What institutional programs have been done recently?
8. Have these benefited the restoration process of the river in some way? How?
9. Have these programs benefited the engagement of communities and citizens? Have they created citizen awareness towards Bagmati?
10. Are there any programs that the institution will implement in the future?
11. Do you have any suggestions for the improvement of the river? Ideas for people to interact more and be involved with the river itself?
12. Do you know of any ecological solutions that could be implemented for the restoration of the Bagmati River?



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