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INSTITUTE OF ENGINEERING  
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**EVALUATING RIVER SETBACK IN KATHMANDU VALLEY:  
INTEGRATING SOCIO-ECONOMIC FACTORS INTO POLICY  
DEVELOPMENT**

BY

**BINISHA SHAHI**

A THESIS

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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis report titled "Evaluating River Setback in Kathmandu Valley: Integrating Socio-Economic Factors into Policy Development" submitted by Ms. Binisha Shahi (079-MSUrP-003) in the partial fulfillment of the requirements for the degree of Masters of Science in Urban Planning.



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## DECLARATION

I hereby declare that the thesis entitled "Evaluating River Setback in Kathmandu Valley: Integrating Socio-Economic Factors into Policy Development", submitted to the Department of Architecture in partial fulfillment of the requirement for the degree of Master of Science in Urban Planning, is a record of an original work done under the guidance of Dr. Ajay Chandra Lal, Institute of Engineering, Pulchowk Campus. Except for the material consulted, which has been properly referenced and acknowledged, all of the work in this thesis was done by me.



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## ABSTRACT

Evaluation of river setback policies in Kathmandu Valley reveals significant challenges due to rapid urbanization and encroachments on riverbanks, particularly along the Bagmati and Dhobikhola rivers. Existing setbacks, ranging from 4 to 20 meters, are inconsistent and poorly enforced, exacerbating flood risks and environmental degradation. High land values and rental rates in riverfront areas complicate enforcement, with some areas showing significant urbanization and infrastructure development. A flexible, hydrology based approach to setback regulations is necessary, integrating flood risk assessments, green infrastructure, and socio-economic factors. Strengthened coordination among agencies and revised legal frameworks are crucial for effective implementation and balancing urban development with environmental conservation.

Keywords River Setback, River Buffer, Socio-economic factors, River Regulation, Legal framework

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## ACRONYMS

HPCIDBC : High Powered Committee for Integrated Development of Bagmati Civilization

KVDA: Kathmandu Valley Development Authority

KII: Key Informant Interview

KMC: Kathmandu Metropolitan City

LMC: Lalitpur Metropolitan City

BAP: Bagmati Action Plan

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## 1. Introduction

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Rivers have historically been central to human settlements, providing essential resources like water, navigation routes, and livelihoods. Ancient cities such as those along the Nile, Ganga, and Huang-Ho, and modern cities like London, Paris, and Delhi, have thrived due to their proximity to rivers. This symbiotic relationship offers tangible and intangible benefits, including water supply, biodiversity, recreation, and religious significance. However, cities have often failed to protect rivers, leading to pollution, biodiversity loss, floodplain encroachment, and overexploitation. Urban development, prioritizing economic growth, has frequently harmed the very rivers that sustain them.

Nepal is abundant in water resources, with over 6,000 rivers and rivulets spread across various river basins. (Giri, K.C., & Khadka, 2022) The Bagmati River is one of the largest rivers in the Kathmandu Valley, the capital region, and has 57 rivers and rivulets as its tributaries.(Baidya & Budhathoki, 2023)

The Bagmati River, considered sacred by Hindus and a vital water source for the Kathmandu Valley, has suffered significant pollution due to human activities. These include settlements along its banks, unplanned urban development within the river basin, and the direct dumping of untreated sewage and solid waste into the river. Furthermore, sand extraction from the riverbed, construction of public infrastructure within the river corridor, and illegal squatter settlements along the banks have further degraded the river environment and compromised water security for the local population. (Baidya & Budhathoki, 2023)

A river buffer or setback refers to a designated zone along a watercourse that is safeguarded from development in order to maintain its natural functions and minimize hazard risks. These areas are often managed similarly to, and alongside, buffers for wetlands and other environmentally sensitive zones such as tundra, steep slopes, and wildlife habitats. The primary goal is to protect the various functions riparian zones offer—such as hydrological, ecological, biological, aesthetic, recreational, and educational benefits. Buffers also aid in preserving stream banks and native vegetation. Local ordinances and regulations typically enforce these buffers and setbacks, restricting or completely prohibiting certain types of development within their boundaries. Overall, they serve to reduce or prevent the negative impacts of land development on watercourses while delivering a range of additional advantages. (Hazards, 2017)

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The Kathmandu Valley, home to an expanding urban population, is increasingly vulnerable to environmental hazards like flooding, land erosion, and habitat loss, especially along its rivers. The development of appropriate river setback policies is critical to mitigate these risks and protect both the environment and the socio-economic well-being of its residents. This study aims to evaluate the current river setback policies in the Kathmandu Valley, assess their effectiveness, and propose guidelines that integrate socio-economic factors.

## **1.1 Background**

The Kathmandu Valley, a region of immense cultural, historical, and environmental significance, faces mounting challenges in balancing urbanization with ecological sustainability. River setbacks have emerged as a critical focus area to address issues such as flooding, pollution, and habitat degradation. Over the years, several policies, plans, and strategies have been formulated to guide development and ensure the conservation of river systems and their surrounding areas.

The Kathmandu Valley Physical Development Plan - 2028 (1972) recognized the importance of aligning development with the valley's geographical features. It recommended settling the plain lands (tar) while maintaining greenery in wetland areas (dol). Later, the Urban Development and Conservation Scheme 2045 BS (1988) prioritized conservation efforts, including the protection of riverbanks and wetlands, under the Ministry of Housing and Physical Planning.

Further advancing this agenda, the Kathmandu Valley Urban Development Plan and Program 2048 BS (1991) highlighted the need to restrict development near rivers and wetlands and emphasized conserving critical watersheds like Phulchoki and Chandagiri. In 1994, the Bagmati Basin Water Management Strategy and Investment Program proposed strategic actions for the protection and development of the Bagmati watershed, although its implementation was constrained.

Environmental sustainability took center stage in the Environmental Plan and Management of Kathmandu Valley (1999), which underscored the importance of restricting development in high-risk and environmentally sensitive areas, including riverbanks. The National Land Use Policy 2069 (2012) expanded this vision to a national scale, advocating for land classification,

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identification of safe zones, and mitigation of adverse impacts in flood-prone and environmentally fragile areas.

The Long Term Development Concept Plan of Kathmandu Valley (2000) aimed to address past shortcomings and provided comprehensive strategies for efficient land use, agricultural conservation, and sustainable urban expansion. In line with these objectives, specific measures were recommended for river conservation, including delineating rights-of-way based on 100-year return flows, prohibiting harmful activities such as sand extraction, and protecting rivers from pollution and encroachment.

The establishment of the High Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC) marked a significant step in river system conservation. Its Bagmati Action Plan (2009–2014) envisioned a clean, green, and life-supporting river system, categorizing the river basin into zones with tailored conservation goals and activities.

Despite these efforts, challenges persist in implementing these strategies due to rapid urbanization, competing land demands, and inadequate enforcement. This study evaluates the effectiveness of river setbacks within the Kathmandu Valley by integrating socio-economic considerations, aiming to inform and refine policy development for sustainable land use and river conservation.

## **1.2 Need**

Nepal has more than 6,000 rivers and rivulets flowing through a tectonically unstable geology. Seventy-five to eighty percent of the annual rainfall occurs during the four months of monsoon (June-September) greatly increasing the flow in these rivers. Poor geological formation in one hand and increased flow on the other hand has made the situation even more vulnerable for the people living nearby these rivers. Every year, during the monsoon season, most of the rivers pose great threat to such people and sometimes cause widespread damage to the life and property. (Flood Control and Management Manual , 2019)

Urban vulnerability is largely a consequence of improper urban management, inadequate land use planning, ill-regulated population density, poor construction practices, ecological imbalance, infrastructure dependency, and inadequate provision for open spaces. The accumulation of risks because of all of the pervasive situation and inappropriate decisions made in the past aggravate the vulnerability. The worsening vulnerability of urban areas is one of the

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primary reasons for increase in disaster losses. The concept of vulnerability recognizes that a natural hazard alone by itself does not cause a disaster, but a disaster happens as an outcome of the interaction of biophysical condition or the presence of a natural hazard, and vulnerable conditions of people exposed to such hazards. (Joshi, Basnet, Duwal, & Dawadi, 2013)

There is a pressing need to evaluate and refine river setback policies to ensure the long-term resilience of both the natural environment and the communities that live near rivers. As urban development intensifies, inadequate river setbacks contribute to increased vulnerability to flooding and environmental degradation, while also jeopardizing local livelihoods.

Furthermore, there is a lack of comprehensive research that links river setback policies to the socio-economic context of local communities. It is crucial to balance flood risk mitigation and conservation with the needs of the people living along riverbanks, many of whom may face displacement or loss of livelihoods if policies are enforced without proper consideration.

### **1.3 Importance**

This research will be vital for Local Communities to protect their livelihoods and ensure equitable access to resources while preserving their relationship with rivers. This will be important for the Government Bodies which require evidence-based policy recommendations to balance urban development with environmental sustainability and flood risk management.

### **1.4 Problem Statement**

Rapid urbanization and the increasing demand for land in the Kathmandu Valley have led to significant encroachments on riverbanks, exacerbating environmental degradation, increasing flood risks, and undermining the ecological balance of the region. To address these issues, various legal and policy frameworks have been introduced over time to establish and enforce river setbacks. However, inconsistencies in implementation, overlapping jurisdictions, and varying setback requirements have limited their effectiveness.

According to the काठमाडौं र ललितपुर नगर पालिका क्षेत्र तथा काठमाडौं उपत्यकाको शहर विस्तार क्षेत्र भित्र गरिने निर्माण सम्बन्धि मापदण्ड, २०५०, Construction is prohibited within 20 meters on either side of rivers like Bagmati, Bishnumati, and Dhobikhola. Similarly, the काठमाडौं उपत्यका भित्रका नगरपालिका र नगरोन्मुख गा. वि. स. हरूमा गरिने निर्माण सम्बन्धि मापदण्ड, २०६४ reaffirmed this 20-meter

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setback for major rivers but allowed variations for others, such as 9 meters for Dhobikhola (based on project-specific planning).

A subsequent amendment to the 2064 guidelines (काठमाडौँ उपत्यका भित्रका नगरपालिका र नगरोन्मुख गा.वि.स.हरूमा गरिने निर्माण सम्बन्धी मापदण्ड, २०६४ (संसोधन) standardized these setback distances for specific rivers, but the approach introduced further variations, such as:

- Bagmati, Bishnumati, Manohara, and Hanumante Rivers: 20 meters
- Dhobikhola: In the area of Dhobikhola Project Planning, according to Dhobikhola Project Planning and other area 9 m
- Nakhhu River: 12 meters
- Balkhu, Karmanasha, Kodku, Sangle, and Mahadev Rivers: 10 meters
- Karkhushi River: 6 meters
- Tukucha, Samakhushi, and others: 4 meters

Moreover, the Supreme Court issued a landmark ruling requiring an additional 20-meter open space along riverbanks to strengthen conservation efforts on Shrawan 11, 2081. However, this decision was challenged by the government on decision made on Bhadra 30,2081, citing procedural irregularities and potential conflicts with existing laws. The review petition raised concerns about the practicality of implementing such broad measures and their alignment with ground realities, especially in densely urbanized zones.

Despite the establishment of various legal and policy frameworks to regulate river setbacks in the Kathmandu Valley, inconsistencies in implementation, overlapping jurisdictions, and varying setback requirements have led to ineffective enforcement, resulting in continued riverbank encroachment, environmental degradation, and increased flood risks

## **1.5 Research Objective**

The primary objective of this study is to evaluate the existing river setback policies in Kathmandu Valley by considering socio-economic factors. Specifically, the research aims to:

- Assess the effectiveness of current river setback policies by determining the economic value of riverfront area.
- Propose an effective system for river setback regulation

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## **1.6 Topic Validity**

The topic is highly relevant given the increased risks of flooding, erosion, and environmental degradation in the Kathmandu Valley. With urban development expanding rapidly, revising river setback policies is an urgent issue that requires immediate attention. Additionally, the integration of socio-economic factors into policies is an evolving area of study in urban planning and environmental management. This research will contribute significantly to both fields by providing an evidence-based approach to river setback policy development.

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## **2. Conceptual Framework and Methodology**

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### **2.1 Conceptual Framework**

This research develops a framework to evaluate river setback policies in Kathmandu Valley, integrating socio-economic factors to inform evidence-based guidelines. The conceptual framework operates within a pragmatic paradigm, acknowledging both scientific data and local socio-economic realities by integrating multiple analytical approaches. It focuses on utilizing grid-based land cover mapping, questionnaire surveys, Key Informant Interviews (KIIs), and land value and rent analysis to create evidence-based, context-sensitive river setback guidelines. The study is grounded in a pragmatic paradigm that combines quantitative and qualitative methods, allowing for both scientifically robust data and in-depth community insights to inform policy development.

### **2.2 Ontology**

The framework acknowledges the dynamic relationship between river systems and human settlements, recognizing that environmental processes (such as flooding and land degradation) and socio-economic realities (such as land use, livelihoods, and property values) are interconnected. It is based on the understanding that both objective scientific data and subjective human experiences shape the impact of river setback policies.

### **2.3 Epistemology**

A constructivist approach is adopted, emphasizing that knowledge is constructed by integrating both quantitative data (e.g., land cover maps, land values) and qualitative insights (e.g., community perceptions of rivers). This approach fosters co-creation of knowledge, involving local communities, policymakers, and experts, ensuring the framework reflects diverse viewpoints and experiences.

### **2.4 Methodological Paradigm**

The research follows a pragmatic paradigm, emphasizing actionable solutions that balance environmental sustainability with socio-economic equity. The use of mixed methods, including grid-based land cover mapping, questionnaire surveys, KIIs, and land value analysis, enables

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the development of policies that are scientifically grounded while considering the socio-economic context of Kathmandu Valley.

#### Core Dimensions of Analysis- Socio-Economic Factors

- **Land Use and Zoning:** Grid-based land cover mapping will assess the spatial distribution of land uses around rivers, such as residential, agricultural, and commercial areas, to understand how setback policies may impact different sectors.
- **Perception of Risks and Benefits:** Questionnaire surveys will gather data on community perceptions of flood risks, safety, and the benefits or challenges posed by river setbacks.
- **Land Value and Rent Analysis:** Assessing changes in land values and rental prices in proximity to riverbanks to understand the economic impact of setback policies on property markets.

## **2.5 Framework Design- a Mixed-Method approach**

#### Quantitative Analysis:

- **Grid-Based Land Cover Mapping:** GIS tools will be used to map land cover and land use along river corridors in Kathmandu Valley, identifying areas that are vulnerable to flooding and encroachment. This will help assess the environmental and socio-economic impact of proposed river setback policies.
- **Land Value and Rent Analysis:** Using property value data, changes in land prices and rents will be analyzed to understand the economic impact of river setback policies. This will allow for an evaluation of how setback regulations may affect local real estate markets and livelihoods.
- **Questionnaire Survey:** A structured survey will be conducted among residents and business owners along riverbanks to assess perceptions of flood risks, river benefits, and the impact of setback policies on their livelihoods.

#### Qualitative Analysis:

- **Key Informant Interviews (KIIs):** Semi-structured interviews with experts, policymakers, and river management authorities will provide insights into regulatory challenges, policy effectiveness, and the implementation of river setback policies.

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- Community Consultations: Focus group discussions and community consultations will allow local residents to voice their concerns, perceptions, and experiences regarding river setbacks and their socio-economic impacts.

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### **3. Literature Review**

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#### **3.1 River and Cities**

The world's Great Rivers have enabled the growth of cities. From Cairo on The Nile, Vienna on the Danube, and Ho Chi Min City on the Mekong, to Shanghai and the Yangtze, New Orleans and the Mississippi, and Manaus on the Amazon, great rivers have connected human settlements to water, food, trade, culture, capital, and innovation. In ancient times, rivers provided the best locations for humans to settle and served as the initial means of connectivity and livability, enabling the establishment of towns, settlements, and cities. Nowadays, rivers are the life force that can make our cities sustainable. However, rapid urbanization along riversides, if not managed sustainably, can threaten ecosystems, biodiversity, and overall environmental health. Also, due to their intrinsic ties with nature, human settlements on rivers are particularly vulnerable to climate change, facing strong environmental and socioeconomic consequences of natural disasters, floods, wildfires, and droughts, which exacerbate issues such as food and water security, as well as air quality. (Forum, 2024)

Cities often owe their existence to rivers; however, when cities begin to develop, the river turns into a barrier whose crossing becomes one of the more important engineering issues in municipal infrastructure. As a part of nature, a river significantly influences the form of a city. Its development can, in turn, also impact the shape of the river. It becomes an element of urban composition. This mutual dependency is a key problem in spatial planning. Finding the right balance between the natural character of the river, and the introduction of city structures into its course, leads to the creation of a balanced space, naturally utilized by city dwellers. (Rybka & Rafał , 2018)

#### **3.2 River Setback**

River setback is a tool for standardised development within the river zone. A river buffer or setback refers to a designated zone along a watercourse that is safeguarded from development in order to maintain its natural functions and minimize hazard risks. These areas are often managed similarly to, and alongside, buffers for wetlands and other environmentally sensitive zones such as tundra, steep slopes, and wildlife habitats. The primary goal is to protect the various functions riparian zones offer—such as hydrological, ecological, biological, aesthetic, recreational, and educational benefits. Buffers also aid in preserving stream banks and native

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vegetation. Local ordinances and regulations typically enforce these buffers and setbacks, restricting or completely prohibiting certain types of development within their boundaries. Overall, they serve to reduce or prevent the negative impacts of land development on watercourses while delivering a range of additional advantages.(Hazards, 2017)

The international approaches used to determine required buffer zone widths varied considerably from simple one-size fits all approaches to others that rely on extensive site-specific information to inform buffer width requirements. Three generic approaches were identified which are briefly outlined below:

- **Fixed-width:** The fixed width approach typically applies a standard buffer width to a particular water resource type. In some instances, a generic width is applied regardless of any characteristic of the water resource. However, this approach is more typically applied to a class of wetland or river type or a specific land use type / activity.
- **Modified fixed-width:** In this approach, a matrix of factors is typically used to categorize wetlands and / land uses with category specific standard buffer widths being applied to the resource. These widths may however be modified based on relevant on-site factors where more detailed information is available.
- **Variable width:** This approach usually requires the development of a detailed formula and methodology for considering site-specific factors such as wetland type, adjacent land use, vegetation, soils, wildlife habitats, slope, desired function and other special site-specific characteristics to calculate buffer widths. (Macfarlane, et al., 2014)

### **3.3 Principles in River Setback**

Different river setback regulations highlight a nuanced and multifaceted approach, balancing ecological preservation, flood risk mitigation, and socio-economic development. These frameworks emphasize the importance of dynamic zonation, activity classification, flood mitigation, and public use and conservation.

#### **3.3.1 Dynamic Zonation: Flexibility in River Setbacks**

One of the key principles in river setback regulations is dynamic zonation, where setbacks are adjusted based on the type of river, flood risks, and the surrounding topography. Rather than using a one-size-fits-all approach, setbacks vary based on local geographic and hydrological

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conditions. For instance, floodplain rivers, which are more prone to flooding, often require larger setbacks than mountain rivers with steeper gradients, where the flood risk is lower.

#### River Regulation Zone (RRZ) of India, 2016

In the RRZ framework, rivers are categorized based on their type and flood risk. For floodplain rivers, setbacks extend up to 500 meters from the High Flood Line (HFL) in unembanked areas, but only 100 meters in embanked areas. For mountain rivers, setbacks range from 5 meters to 50 meters, depending on the river's slope. This zoning strategy allows for site-specific considerations, such as the potential for erosion, flooding, or biodiversity preservation. (Mission, 2021)

### **3.3.2 Activity Classification: Tiered Regulation for Sustainable Development**

Activity classification involves regulating the types of activities permitted in different setback zones. A tiered approach allows for low-impact activities (such as recreation, eco-tourism, or conservation efforts) in sensitive areas, while more restrictive measures are placed on high-impact developments, such as heavy construction or industrialization. This ensures that urban development can proceed without compromising ecological health.

#### Draft River Conservation Zone Rules of India, 2012

In these rules, riverfronts are divided into several zones, including the No Development Zone (NDZ), which prohibits any construction or human intervention in ecologically sensitive floodplain areas. Additionally, the rules establish High Impact Zones (HIZ) and Medium Impact Zones (MIZ), where development is allowed but regulated to minimize harm to the environment. In these zones, activities such as eco-tourism or community parks are encouraged, while larger infrastructure projects are discouraged. (Mission, 2021)

### **3.3.3 Flood Mitigation: Using Flood Recurrence Data for Setback Determination**

Integrating flood recurrence data into setback regulations is crucial for reducing the risk of flood damage and protecting riverfront developments. By analyzing past flood patterns and using predictive modeling, urban planners can determine appropriate setback distances to mitigate flood risk and ensure long-term resilience. This approach not only helps in disaster prevention but also contributes to sustainable urban development.

Pune and Nashik use flood recurrence data to establish Blue Flood Lines (for a 1-in-25-year flood event) and Red Flood Lines (for a 1-in-100-year event). Construction is prohibited within the Blue Flood Line, while development is allowed in areas between the Blue and Red Flood Lines, provided that the development is elevated above the flood level. This helps protect the infrastructure while ensuring that public spaces, such as gardens or parks, are not at risk of flooding.

### **3.3.4 Public Use and Conservation: Enhancing Socio-Economic Value**

Promoting public use of riverfront areas, while maintaining ecological integrity, can significantly enhance the socio-economic value of these spaces. Riverfront developments should integrate green spaces, recreational areas, and public amenities to foster community engagement, tourism, and environmental stewardship. These spaces can also serve as climate buffers, reducing the urban heat island effect and improving the overall quality of life for local communities.

### Bihar Building Bye-Laws, 2013

In Bihar, setbacks from the Ganges River are defined as 200 meters, with development limited to government-led conservation efforts, such as parks and beautification projects. These projects include recreational amenities, such as walking paths and gardens, which attract both locals and tourists. Such spaces not only improve the aesthetic value of the riverfront but also contribute to the mental and physical health of the community. (Mission, 2021)

## **3.4 Evaluation of Buffer Zone in Haraz River, Iran**

Afshar and Hosainy (2013) conducted a detailed study on the buffer zones along the Haraz River in Iran, focusing on determining the most appropriate width for river buffer zones based on a variety of environmental, socio-economic, and technical factors. The primary aim of this study was to develop a systematic approach for assessing the optimal buffer width, which balances ecological preservation and socio-economic needs. (Afshar & Hosainy, 2013)

In this study, the researchers identified key environmental and socio-economic parameters that influence the size of the river buffer zone. These factors include:

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- Topography: The natural landscape and terrain of the river basin.
  - Climate: Weather patterns that affect water flow and erosion.
  - Hydrology and Morphology: Water flow characteristics and the shape of the riverbed, which directly impact erosion rates and water quality.
  - Human-Induced Factors: Land use changes, urbanization, and other anthropogenic activities that can exacerbate erosion, pollution, and habitat loss.

The methodology used in the study involved several steps to determine the optimal buffer zone:

- Parameter Identification: Nine critical parameters were selected for analysis, each of which was found to significantly impact the width of the buffer zone. These included both physical factors like soil erosion and hydraulic conditions, as well as socio-economic influences such as human activities near the riverbank.
- Weightage Assignment: Each parameter was assigned a weight, with values ranging from zero (indicating no impact) to one (indicating maximum negative impact). This weightage allowed for the relative importance of each factor to be quantified and incorporated into the calculation of the buffer width.
- Buffer Width Calculation: The total buffer width was calculated as the product of the sum of weighted parameters. By normalizing the weightage values, the researchers were able to determine a standardized buffer zone width that reflected the combined impact of environmental and human factors.
- Comparison with Existing Buffer Zones: The final step in the methodology involved comparing the calculated buffer widths with the existing buffer zones in the study area to assess whether they were sufficient for meeting the environmental goals of bank stabilization and water quality protection.

This study provides a comprehensive methodology for determining river buffer zones, with an emphasis on integrating environmental and socio-economic factors. The combination of technical factors, such as hydrology and morphology, with human-induced parameters, like land use and socio-economic activities, creates a balanced approach for river management.

### **3.5 Plan and Policy in Nepal**

The Kathmandu Valley, a region of immense cultural, historical, and environmental significance, faces mounting challenges in balancing urbanization with ecological

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sustainability. River setbacks have emerged as a critical focus area to address issues such as flooding, pollution, and habitat degradation. Over the years, several policies, plans, and strategies have been formulated to guide development and ensure the conservation of river systems and their surrounding areas.

#### Physical Development Plan of Kathmandu Valley (1969)

This plan highlighted the need for balanced urban development and identified uncontrolled urban expansion, loss of agricultural land, and ecological degradation as critical challenges. However, the plan did not provide explicit guidelines on river setbacks but emphasized the importance of regulating urban sprawl near water bodies.

#### Kathmandu Valley Physical Development Plan (1972)

This plan introduced the concept of land-use zoning, recognizing the importance of maintaining greenery in wetland areas. It acknowledged the risks associated with urban expansion into flood-prone zones but lacked specific setback regulations.

#### Land Use Plan of Kathmandu Valley (1976)

The first major effort to categorize land use, this plan included zoning regulations and proposed the protection of wetland areas. The Kathmandu Valley Town Development Committee was established to enforce zoning rules, but rapid urbanization led to the diminishing effectiveness of this plan.

#### Kathmandu Valley Urban Land Policy Study (1986)

With technical assistance from USAID, this study provided detailed data on land use, ownership, and topography, highlighting the necessity for river setbacks. However, the policy remained largely unimplemented due to institutional and enforcement limitations.

#### Kathmandu Development Authority Act (1988)

This Act established the Kathmandu Valley Development Authority (KVDA), granting it powers to regulate land use, halt unauthorized construction, and enforce urban development plans. However, river setback regulations were not explicitly mentioned.

#### Urban Development and Conservation Scheme (1988)

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This initiative aimed at conserving wetlands and riverbanks, indirectly contributing to river setback regulations. Land pooling and guided land development programs were introduced to control urban expansion in environmentally sensitive areas.

#### Local Self Governance Act (1999)

The Act empowered local governments to implement land use planning and approve development projects. It mandated municipalities to define land-use zones, including conservation areas near rivers, but enforcement remained weak due to resource constraints and lack of coordination.

#### Long Term Development Concept Plan of Kathmandu Valley 2002 (2059 BS)

The Long Term Development Concept Plan of Kathmandu Valley was prepared by the Kathmandu Valley Town Development Committee in July 2000 and approved by the Government of Nepal (GoN) in 2002. It provided strategies for managing urban growth, decentralizing economic activities, and conserving natural resources.

Key strategies included Conservation of river corridors by delineating a right-of-way based on 100-year return flow analysis and prohibiting activities such as sand extraction, waste dumping, and squatter settlements. Despite these provisions, implementation challenges due to the lack of an operational framework have limited its effectiveness.

#### National Urban Policy 2007 (2064 BS)

The National Urban Policy promotes sustainable urban management and balanced urban growth. It emphasizes disaster risk reduction and local-level mitigation planning. Key provisions include:

- The responsibility of local bodies to prepare disaster management plans addressing river flooding, landslides, and other hazards.
- Prohibition of development in environmentally sensitive areas, including riverbanks.
- Strengthening building codes and ensuring safe construction practices in flood-prone areas.

#### National Land Use Policy 2012 (2069 BS)

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The National Land Use Policy aims for optimal land utilization while conserving environmental resources. Key provisions related to river setbacks include:

- Classification of land for residential, agricultural, industrial, and conservation purposes.
- Protection of water recharge zones, forests, and water sources.
- Identification and conservation of flood-prone areas, with strict development controls in these regions.
- Implementation of land pooling and green space conservation to balance urban growth and environmental sustainability.

#### Bagmati Action Plan (2009-2014)

The Bagmati Action Plan (2009-2014) was formulated to address the environmental degradation and urban encroachment of the Bagmati River and its tributaries in Kathmandu Valley. Developed with support from the United Nations Environment Programme (UNEP) and UN-Habitat, the plan aimed to restore the river ecosystem through integrated conservation and management strategies. (GoN/NTNC, 2009)

#### Objectives and Strategies

- The primary objectives of the Bagmati Action Plan included:
- **Pollution Control:** Implementing waste management solutions to prevent direct disposal of sewage and industrial effluents into the river.
- **Riverbank Protection:** Enforcing regulations to prevent further encroachment and rehabilitate degraded areas.
- **Biodiversity Conservation:** Restoring riparian vegetation and aquatic ecosystems to enhance biodiversity.
- **Public Awareness and Community Participation:** Encouraging local engagement through education, advocacy, and community-based initiatives.

#### Zonation Approach

To ensure targeted interventions, the Bagmati Action Plan divided the river system into five zones:

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- Natural Conservation Core Zone: Encompassing the upstream regions with minimal human interference to maintain water quality and ecological balance.
  - Rural Zone: Managing agricultural practices and preventing waste disposal in tributaries.
  - Peri-Urban Zone: Addressing emerging urbanization challenges and improving sanitation infrastructure.
  - Urban Zone: The most critical area, focusing on wastewater treatment, solid waste management, and green infrastructure development.
  - Downstream Zone: Managing sedimentation, water flow regulation, and agricultural water use.

### Implementation and Challenges

The implementation of the Bagmati Action Plan faced several challenges, including weak institutional coordination, lack of enforcement mechanisms, and financial constraints. Despite these issues, the plan laid the groundwork for long-term river conservation efforts, influencing subsequent urban planning and environmental policies in Kathmandu Valley.

The Bagmati Action Plan remains a significant milestone in Nepal's efforts to integrate sustainable urban development with environmental conservation, highlighting the need for continued commitment from government agencies, non-governmental organizations, and local communities.

### Bagmati Action Plan II

The Final Report - Planning Report for the Preparation of the Bagmati Action Plan (BAP), completed in June 2022, serves as a strategic blueprint for the restoration and conservation of the Bagmati River System in Kathmandu Valley. The report was commissioned by the High-Powered Committee for Integrated Development of the Bagmati Civilization (HPCIDBC) and prepared in collaboration with various consulting agencies. The Bagmati River, which holds significant cultural, religious, and environmental value, has been under severe threat due to rapid urbanization, pollution, and encroachment. While the Bagmati Action Plan (2009-2014) attempted to address some of these concerns, urban expansion and socio-environmental changes necessitated the development of a new long-term action plan with a 20-year vision. (HPCIDBC, 2022)

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- **Key Environmental and Socio-Economic Issues**

One of the most pressing concerns identified in the report is the severe environmental degradation of the river. The unchecked discharge of untreated sewage, industrial effluents, and solid waste has significantly reduced water quality. The extraction of sand from riverbeds, coupled with the construction of unregulated infrastructure, has further disrupted the natural flow of the river. Land use changes, particularly the expansion of informal settlements and squatter communities along the riverbanks, have exacerbated these problems. Furthermore, the deterioration of religious and historical sites along the river has raised cultural and heritage conservation concerns. The decreasing water discharge, coupled with increasing flood risks, underscores the need for urgent intervention through sustainable urban planning and river management strategies.

- **Hydrological and Environmental Analysis**

To support informed decision-making, the report includes hydrological modeling and GIS-based studies to analyze flood risks, pollution sources, and land-use changes. The study identifies certain areas—Gokarneshwar, Guheshwori, the Manohara-Bagmati confluence, and the Bishnumati confluence—as high-risk flood zones. Furthermore, an assessment of existing infrastructure, including roads, sewer networks, and wastewater treatment plants, was conducted to evaluate their efficiency. Despite previous interventions, water pollution remains critical, particularly in Dhobi Khola, Mahadev Khola, and Bishnumati River, where sewage discharge density is highest.

- **Zoning Approach for River Conservation**

The report introduces a zoning strategy that divides Kathmandu Valley into three major zones: Conservation Zone, Peri-Urban Zone, and Urban Zone. The Conservation Zone, which includes forested areas such as Shivapuri, Nagarjun, and Phulchowki, serves as a critical water source. Conservation efforts in this zone focus on reforestation, groundwater recharge, and ecotourism promotion. The Peri-Urban Zone, a transition area between urban and rural regions, requires a balanced approach to development and conservation to minimize environmental impacts while supporting urban expansion. The Urban Zone, which comprises the densely populated city center, presents the most significant challenges due to high population density and rapid construction. This zone requires strict pollution control measures, improved wastewater management, and preservation of cultural heritage sites.

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- **Action Plan and Investment Requirements**

The Bagmati Action Plan is structured for implementation over a 20-year period, divided into four phases: short-term (0-5 years), first mid-term (6-10 years), second mid-term (11-15 years), and long-term (16-20 years). The total estimated budget required is NPR 279.6 billion, with NPR 147.6 billion allocated for the short-term phase. The key initiatives include the development of wastewater treatment plants, riverbank protection using bioengineering methods, greenbelt expansion, and the enforcement of strict regulations to prevent further encroachment. Additionally, special attention is given to revitalizing religious and cultural sites along the river, ensuring that the historical and spiritual essence of the Bagmati Civilization is preserved.

- **Implementation and Monitoring Strategies**

For the successful execution of the plan, a strong institutional framework is emphasized. The strengthening of HPCIDBC is crucial, along with improved coordination among governmental agencies, municipalities, and private sector stakeholders. A comprehensive monitoring and evaluation system is also proposed to track progress, address implementation challenges, and ensure adaptive management strategies. The report highlights the importance of public engagement, awareness campaigns, and incentives for sustainable practices to encourage community participation in river conservation efforts.

The Bagmati Action Plan (2022) provides a well-structured and scientifically backed roadmap for restoring and sustaining the Bagmati River System. By addressing environmental, socio-economic, and infrastructural challenges through a phased approach, the plan aims to improve water quality, restore the river ecosystem, and safeguard cultural heritage. However, the success of this ambitious initiative depends on strong governance, public support, and sustained financial commitment from both governmental and non-governmental sectors. If implemented effectively, this plan can transform the Bagmati River into a clean, sustainable, and culturally vibrant waterway, benefiting both present and future generations

### **3.6 Legal Framework in Nepal**

River setback regulations in Kathmandu Valley have evolved over time through various legal provisions and amendments. These regulations primarily aim to control construction near riverbanks, prevent encroachment, and ensure sustainable urban development.

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## Initial Regulations

काठमाडौं र ललितपुर नगर पालिका क्षेत्र तथा काठमाडौं उपत्यकाको शहर विस्तार क्षेत्र भित्र गरिने निर्माण सम्बन्धि मापदण्ड, २०५० regulation, formulated under काठमाडौं उपत्यका नगर विकास समिति, prohibited construction within 20 meters on either side of major rivers such as:

- Bagmati River
- Bishnumati River
- Dhobikhola River

This regulation established a foundational legal framework to regulate development along riverbanks, addressing concerns related to flooding, environmental degradation, and haphazard urban expansion.

## Revised Regulations

A subsequent revision, काठमाडौं उपत्यका भित्रका नगरपालिका र नगरोन्मुख गा. वि. स. हरूमा गरिने निर्माण सम्बन्धि मापदण्ड, २०६४, reaffirmed the 20-meter setback for major rivers but introduced variations for other rivers based on project-specific planning and environmental considerations. For instance, the setback for Dhobikhola was reduced to 9 meters in certain areas where project-specific planning had been implemented.

## Standardization of Setback Distances

Further amendments under काठमाडौं उपत्यका भित्रका नगरपालिका र नगरोन्मुख गा.वि.स.हरूमा गरिने निर्माण सम्बन्धी मापदण्ड, २०६४ (संसोधन) revised standardized the setback distances for different rivers across Kathmandu Valley. This regulation categorized rivers based on their size and ecological significance, applying the following setback rules:

Major Rivers (20-meter setback):

- Bagmati River
- Bishnumati River
- Manohara River
- Hanumante River

Dhobikhola River:

- 
- 9 meters in general areas
  - Setback determined by Dhobikhola Project Planning in designated project zones

Medium-Sized Rivers (12-meter setback):

- Nakhhu River

Small to Medium Rivers (10-meter setback):

- Balkhu River
- Karmanasha River
- Kodku River
- Sangle River
- Mahadev River

Minor Rivers (6-meter setback):

- Karkhushi River

Small Streams and Tributaries (4-meter setback):

- Tukucha River
- Samakhushi River
- Other minor rivers and streams

The enforcement of these setback regulations plays a vital role in maintaining environmental integrity while accommodating urban growth in a planned manner. However, challenges remain in implementation due to unauthorized settlements, land use conflicts, and the need for stricter monitoring mechanisms.

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### **3.7 Cultural Heritage and Monuments**

The sacred landscape of Kathmandu valley is intertwined with its riverine culture. Water is venerated in Nepal Mandala as divine, life giving, and life maintaining substance. It is regarded as the counterpart on earth of amrita, the immortalizing elixir of the gods. This relation with sacred water is especially visible in innumerable tirthas often located near water - on the banks and confluences, at ponds and pools, at springs and even at seemingly mundane wells. Pilgrimage to these tirthas and bathing in these waters are considered the most compelling religious activities.

Of all the valley rivers Bagmati is considered the most sacred and is studded with holy places and tirthas. The other illustrious rivers with wondrous legends and endowed with numerous holy places are mainly Vishnumati, Manohara and Hanumante. The cultural sites situated along the river are often places of cremation where the dying and dead come to be in communion with the sacred water. Besides its association with death rituals, these are the places to seek blessings in the form of offsprings, cure from diseases and for good fortune. This clearly indicate the intricate relation the valley dwellers share with their sacred water. Heritage sites along these rivers do not sit in isolation or oblivion with the settlements lying in their proximity rather there is complex relationship of these sites with the settlements and the people living there. These relationships often come alive when people move through these spatial arrangements, and during jatras and festivals. The important cultural sites and monuments are listed below. (HPCIDBC, 2022)

### **3.8 Corridor Road**

Several government agencies have been collaborating to build various corridor roads on the banks of Kathmandu's rivers, namely Bagmati, Bishnumati, Dhobikhola (Rudramati), Hanumante, Nakkhu, Balkhu, Manohara, Mahadev Khola and others. Underpasses are also being built below the river bridges. Many of them are already in operation while some are under construction. These corridor roads have been helpful in mitigating the issues of nasty jams and traffic holdups and to divert vehicles away from the main lanes.

In some places, the roads only exist on one side of the river, whereas there are roads on both sides of the river in other places. Different types of road exist, such as black topped, graveled and earthen. In some areas the roads are black topped and in good condition. In other places,

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the roads are either graveled or earthen types and are poorly maintained. Due to water logging during heavy rains, it becomes very difficult to commute along these roads, especially the earthen roads. (HPCIDBC, 2022)

### **3.9 River Training**

Most of the major rivers and their tributaries have been originated from the surrounding hills of the Kathmandu Valley. The major hilly areas are Nagarjung, Sivapuri, Nagarkot and Phulchauki. The rivers in the Kathmandu valley have been the subject to the flood disasters in the past and ongoing. River training works have been done to cope with the flood risk and vulnerability especially bank cutting and providing security to the vulnerable settlements and agricultural lands. River training works can be observed both in the upstream and downstream of the rivers. (HPCIDBC, 2022)

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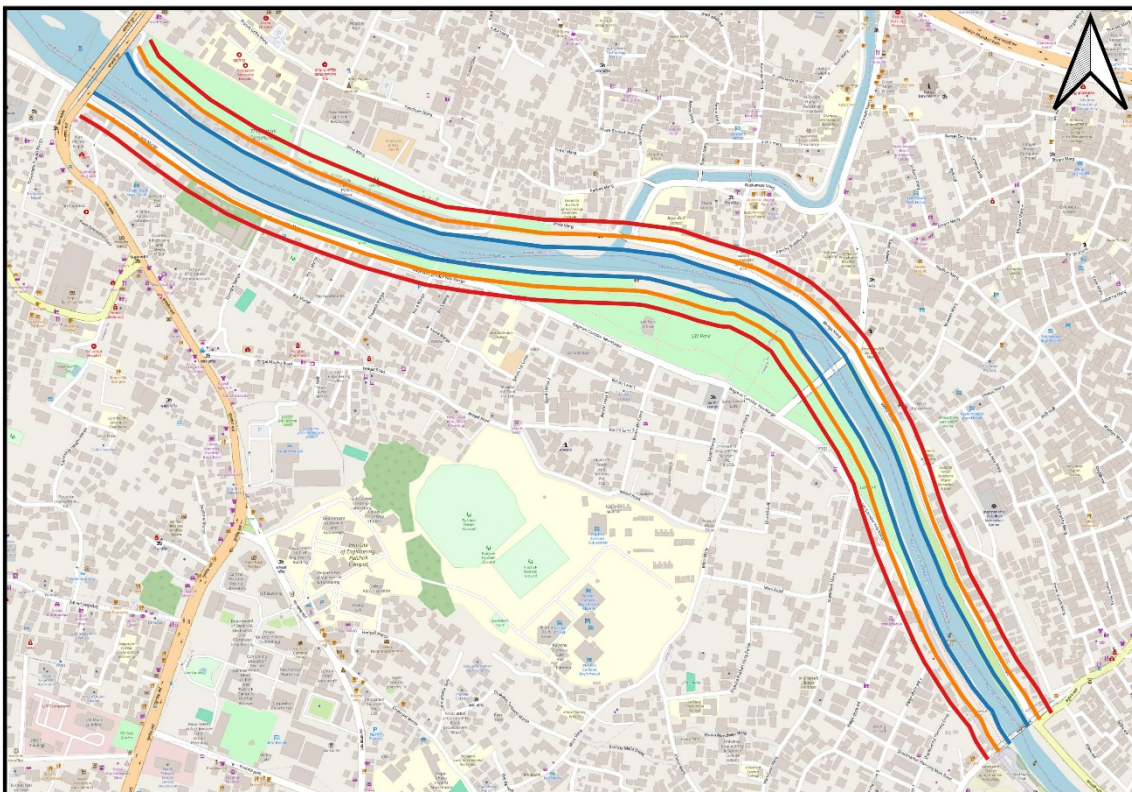
## 4. Study Area

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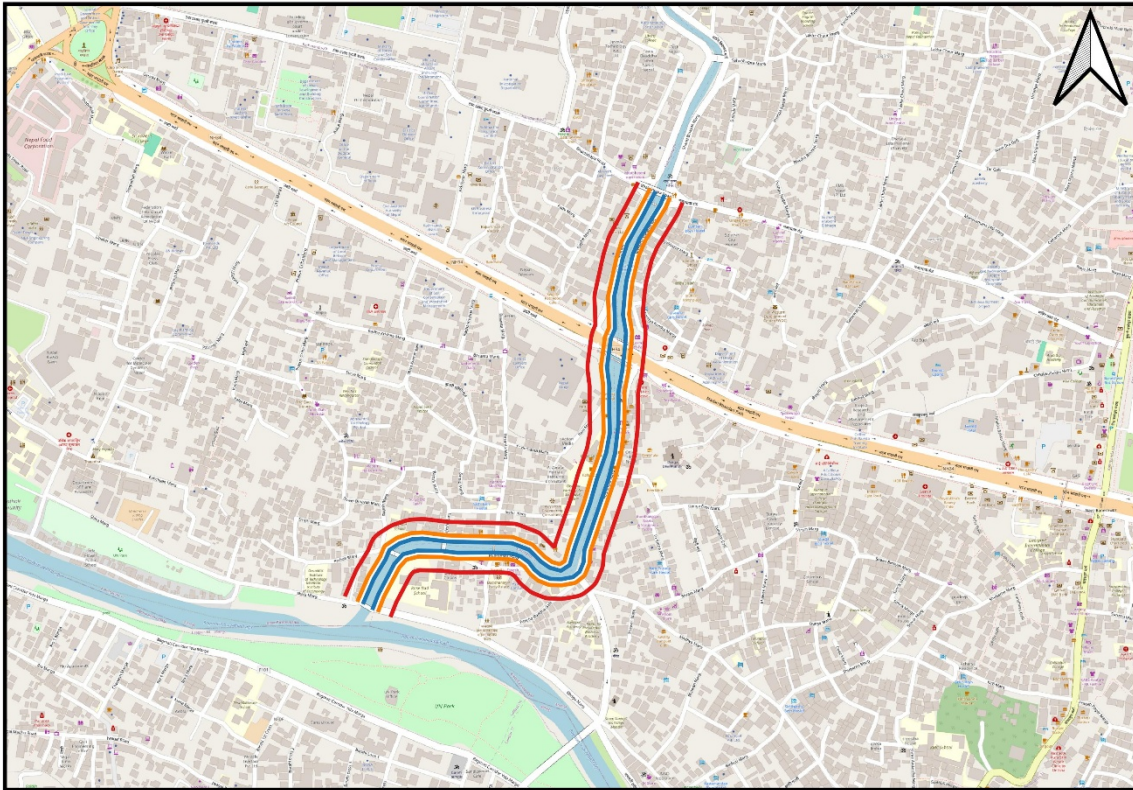
Kathmandu Valley, comprising Kathmandu, Lalitpur, and Bhaktapur, has experienced rapid and unregulated urban expansion, putting immense pressure on its river systems. The Bagmati and Dhobikhola Rivers, which serve as critical drainage channels, groundwater recharge zones, and ecological corridors, are facing severe challenges due to encroachments, pollution, and ineffective enforcement of setback regulations.

To comprehensively evaluate the effectiveness of river setback policies, this study focuses on two specific river stretches:

- Bagmati River (Shankhamul Small Bridge to Thapathali Bridge)-1.8 km Stretch
- Dhobikhola River (Anamnagar Bridge to Budhanagar Bridge)-0.94 km Stretch



*Figure 1: Bagmati Stretch-Study area*



*Figure 2: Dhobi Khola Stretch- Study area*

The Bagmati (Shankhamul Small Bridge to Thapathali Bridge) and Dhobikhola (Budhanagar Bridge to Anamnagar Bridge) stretches were selected because they highlight critical urban-river interactions, including:

#### Diverse Encroachment Patterns

The Bagmati River stretch reflects long-standing informal and commercial encroachments, while the Dhobikhola stretch showcases infrastructure expansion.

#### High Socio-Economic and Policy Relevance

These areas involve residential, commercial, and infrastructure development conflicts, making them ideal for studying the economic impact of setbacks.

The findings from these stretches can inform policy decisions and help identify practical solutions for balancing urban development and river conservation.

#### Flood Risk and Environmental Impact

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Both river stretches are prone to seasonal flooding, erosion, and environmental degradation, making them valuable case studies

### Governance and Policy Implementation Challenges

The selection of these areas allows an in-depth examination of regulatory gaps, enforcement failures, and stakeholder conflicts, providing insights into how river setback policies can be strengthened for better urban water management.

By analyzing these two stretches, the study will generate context-specific recommendations for improving river setbacks, minimizing urban flood risks, and ensuring sustainable land use planning in Kathmandu Valley.

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## 5. Data Analysis

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### 5.1 Grid-Based Land Cover Mapping

The analysis combines grid-based land cover mapping with socio-economic factors to provide insights into the challenges and opportunities for defining appropriate river setback guidelines.

A grid-based classification approach was employed to systematically assess the land cover types within the setback zones of Bagmati Khola and Dhobi Khola. The research area was segmented into two zones for each river:

- Bagmati Khola: A 20m + 20m additional setback, resulting in a 20m × 20m grid system.
- Dhobi Khola: A 9m + 20m additional setback, leading to a combination of 9m × 20m and 20m × 20m grids.

Each grid was visually assessed, and land cover categories were assigned based on direct observations, yielding a clear understanding of how the land in these zones is utilized.

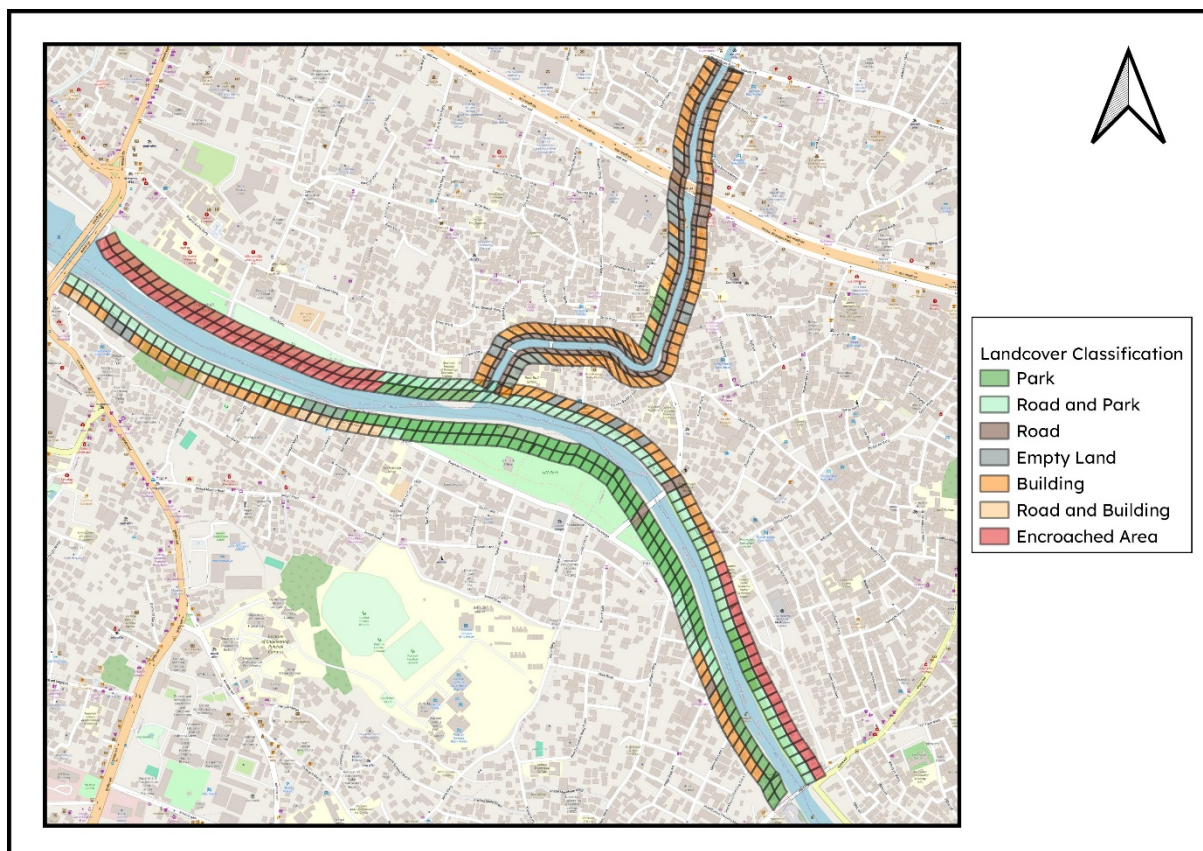


Figure 3: Grid-Based Land Cover Mapping

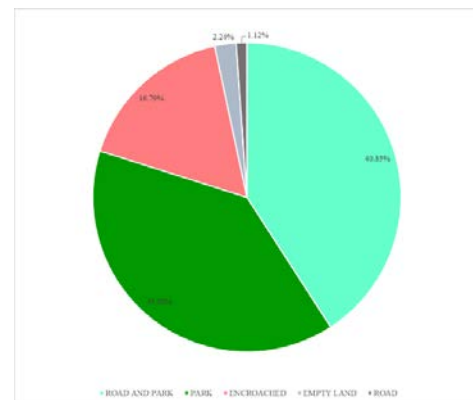
### 5.1.1 Land Cover Analysis

#### 1. Bagmati Khola - 20m Setback Zone

In the 20m setback zone, the primary land cover features include:

*Table 1: Land Cover Analysis of Bagmati River of 20m Setback Zone*

LANDCOVER	AREA	
Road and Park	40.85%	
Park	39.00%	
Encroached	16.79%	16.79%
Empty Land	2.24%	
Road	1.12%	
Building	0.00%	0.00%
Road and Building	0.00%	0.00%
	Total Builtup-	16.79%



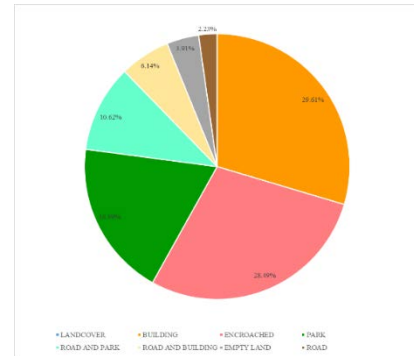
- **Road and Park (40.85%):** The 20m setback zone includes a large portion of mixed-use areas with roads interspersed with parkland, suggesting that the region serves both as a transport corridor and a recreational space.
- **Park (39.00%):** A significant amount of space is dedicated to parks, which offer ecological benefits, improve urban aesthetics, and provide recreational opportunities for local communities.
- **Encroached (16.79%):** Encroachment into the setback area represents a major concern, as unauthorized development reduces the ability of the setback zone to serve its environmental purpose, particularly in terms of flood control and water quality protection.
- **Road (1.12%):** The relatively small percentage of land dedicated to roads reflects a balance of infrastructure and natural areas in the 20m setback zone.
- **Building (0.00%):** There were no buildings observed in the 20m setback zone, which is a positive sign in terms of preserving the river’s ecological functions.
- **Total Built-Up Area: 16.79%** — This percentage is low, which is beneficial for preserving natural features in the setback zone. However, encroachment remains a significant challenge.

## 2. Bagmati Khola - 40m Setback Zone

In the 40m setback zone, the analysis indicates:

Table 2: Land Cover Analysis of Bagmati River of 40m Setback Zone

LANDCOVER	AREA	
Building	29.61%	29.61%
Encroached	28.49%	28.49%
Park	18.99%	
Road and Park	10.62%	
Road and Building	6.14%	6.14%
Empty Land	3.91%	
Road	2.23%	
	Total Builtup-	64.25%



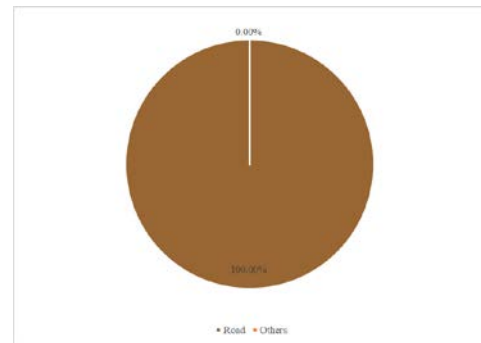
- **Building (29.61%):** The area shows substantial urbanization, with nearly 30% of the land occupied by buildings. This trend suggests increased development pressures, which may affect flood management and river ecosystem health.
- **Encroached (28.49%):** Encroachment is a major issue, with nearly 29% of the area overtaken by unauthorized structures. This undermines the river's natural capacity to handle floods and pollution.
- **Park (18.99%):** Although green spaces are still significant, they make up a smaller proportion of the land in comparison to the 20m zone. Reducing green space in favor of urban development could lead to negative environmental consequences.
- **Road and Park (10.62%):** Mixed-use areas, including both roads and parks, highlight the need for integrated urban planning that balances infrastructure with natural spaces.
- **Road and Building (6.14%):** Roads combined with buildings reflect further urban sprawl, which increases the built-up area in the setback zone.
- **Empty Land (3.91%):** Vacant land represents an opportunity for future development or conservation, though its small proportion in this zone suggests limited space for new initiatives.
- **Total Built-Up Area: 64.25%** — The higher percentage of built-up land in the 40m setback zone calls for a more stringent approach to setback guidelines, as urbanization threatens the river's ecological functions.

## 3. Dhobi Khola - 9m Setback Zone

The 9m setback zone along Dhobi Khola shows the following characteristics:

Table 3: Land Cover Analysis of Dhobi Khola of 9m Setback Zone

Landcover	Area
Road	100.00%
Others	0.00%



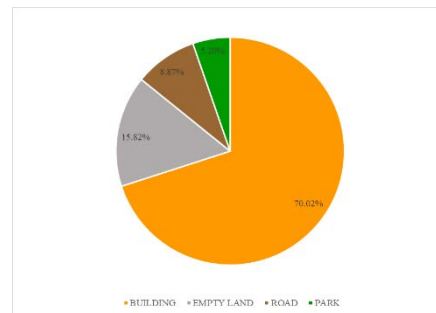
- Road (100.00%): The entire 9m setback zone is dominated by roads, leaving no space for parks, buildings, or other land cover types. The absence of natural areas in this zone is concerning, as it eliminates the river’s potential for natural flood control, water filtration, and habitat support.

#### 4. Dhobi Khola - 29m Setback Zone

The 29m setback zone along Dhobi Khola displays the following land cover pattern:

Table 4: Land Cover Analysis of Dhobi Khola of 29m Setback Zone

Landcover	Area
Building	70.02%
Empty Land	15.82%
Road	8.87%
Park	5.29%



- Building (70.02%): The dominant land cover in this zone is buildings, accounting for over 70% of the area. This suggests that urbanization has significantly encroached into the setback zone, which could exacerbate flood risks and disrupt the natural flow of the river.
- Empty Land (15.82%): Despite the high level of urbanization, vacant land remains in this zone, representing potential areas for future green spaces or flood management initiatives.

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- Road (8.87%): Roads contribute to a smaller proportion of the land cover, indicating that transportation infrastructure is an important but secondary factor in this zone compared to buildings.
  - Park (5.29%): Green spaces are still present, though in limited amounts. Expanding these areas would enhance the river's ability to mitigate flood risks and improve local environmental conditions.
  - Total Built-Up Area: 70.02% — This high level of urbanization calls for urgent attention to planning and policy enforcement to prevent further encroachment and to integrate green infrastructure into the river setback zones.

### **5.1.2 Findings**

#### High Urbanization and Encroachment in Setback Zones

The research reveals significant urbanization and encroachment in the river setback zones, especially along Bagmati Khola and Dhobi Khola. In the 40m setback zone of Bagmati Khola and the 29m setback zone of Dhobi Khola, over 60% of the land is developed. This urban expansion disrupts the rivers' natural functions, including their ability to mitigate floods, maintain water quality, and preserve ecosystems. Encroachment, in particular, obstructs the river's ability to absorb stormwater, increases flood risks, and diminishes the river's capacity to filter pollutants. Such encroachments highlight the urgent need for stricter enforcement of setback regulations to protect these vital zones.

#### Lack of Green Infrastructure

A critical issue identified in the research is the absence of green infrastructure in many setback zones, particularly the 9m setback zone along Dhobi Khola, which is dominated entirely by roads. Green spaces such as parks and natural land cover are essential for maintaining ecological balance, reducing flood risks, and supporting biodiversity. However, rapid urban development is consuming these green spaces, making it harder for rivers to fulfill their ecological functions. The loss of green infrastructure is exacerbating the environmental challenges facing the rivers and underscores the need for integrated green solutions alongside urban growth.

#### Socio-Economic Pressures and Development

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Socio-economic pressures are a driving force behind the development of river setback zones. The demand for residential and commercial spaces often leads to encroachment into these sensitive areas. While such development can bring economic benefits, it frequently comes at the cost of environmental health. The research highlights how, despite the socio-economic value of maintaining parks and recreational areas, the encroachment of urban growth diminishes these benefits. For instance, Bagmati Khola's 20m setback zone offers valuable recreational spaces that improve residents' quality of life. However, urbanization threatens to erode these spaces, underscoring the need to balance development with environmental protection.

### Environmental Risks and Flood Vulnerability

Urbanization within setback zones poses significant environmental risks, particularly in terms of flood vulnerability. As natural land cover is replaced by infrastructure, the river's ability to act as a natural flood buffer is weakened, increasing the potential for flooding. Moreover, the river's capacity to filter pollutants is reduced, leading to degraded water quality. These changes not only threaten the environment but also pose risks to public health and safety. The loss of ecological functions, such as stormwater absorption and pollutant filtration, highlights the need for strong regulations to prevent further degradation of the river ecosystems.

### Challenges in Implementing Additional 20m Setback

Enforcing an additional 20m setback on both rivers would present significant challenges, particularly in urbanized areas such as Dhobi Khola, where nearly 70% of the area is occupied by buildings. Relocating built-up areas would be a major undertaking and could face considerable social and economic resistance, particularly in high-density commercial and residential zones. The Supreme Court ruling on setback expansion would need to consider site-specific urban development conditions to prevent mass displacement and the resulting socio-economic disruption. This highlights the complex balance between enforcing environmental protection measures and mitigating the impacts on existing communities and urban infrastructure.

This analysis examines the socio-economic factors surrounding the construction, ownership, and use of buildings situated near rivers, particularly in areas potentially affected by flooding and other river-related risks. The data provided includes various building characteristics such

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as the type of construction, ownership status, building materials, foundation types, and the impact of proximity to rivers, which are vital in assessing the need for river setback guidelines.

## 5.2 Questionnaire Survey

Questionnaire survey was conducted to assess the socio-economic conditions of buildings located near riverbanks, with a particular focus on flood-prone areas. The primary objective was to gather data on building characteristics, usage patterns, ownership status, construction materials, regulatory compliance, and the impacts of river proximity on businesses and residents. The findings of this survey will serve as a crucial basis for formulating effective river setback guidelines to mitigate flood risks, ensure sustainable development, and promote resilient urban planning.

The survey collected responses from property owners, tenants, and business operators in river-adjacent areas to understand their experiences with flooding, pollution, and economic activities. The data covers key aspects such as building permit compliance, construction methods, rental trends, and the frequency of flood events. Additionally, it highlights the challenges faced by commercial and residential establishments due to their proximity to the river, including economic losses, structural vulnerabilities, and operational disruptions.

### 5.2.1 Survey Analysis

#### Building Category & Use

Most of the buildings are categorized as commercial 66.7% (shops, offices, businesses) or mixed-use 33.3% (both residential and commercial). Commercial properties dominate the dataset, highlighting the significant economic activity in these areas.

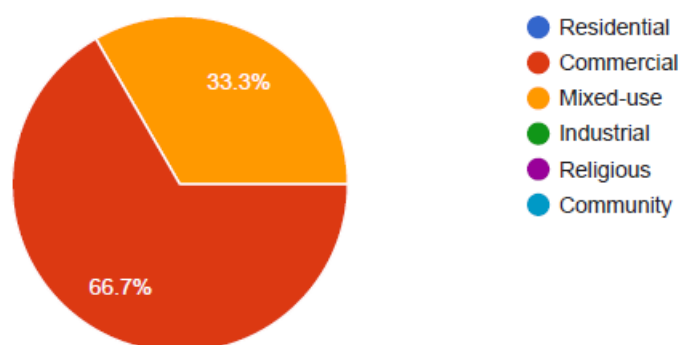


Figure 4: Building Category

The primary use of these buildings includes retail (29.2%), food and beverage (20.8%) and services (20.8%), which often attract foot traffic or require proximity to major transport routes.

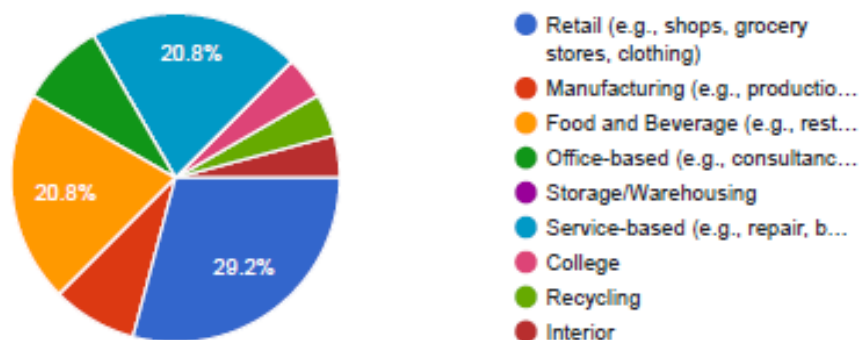


Figure 5: Building Use

A significant number of buildings are rented (58.3%) and leased (25%) indicating the potential for fluctuating ownership and short-term business use, with a smaller portion being owned by individuals or cooperatives.

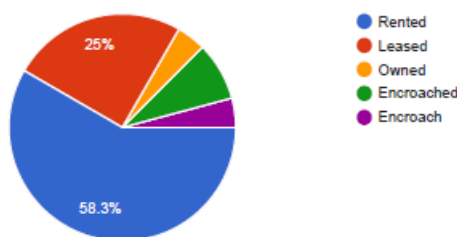


Figure 6: Building Ownership

### Construction Period & Builder

Most buildings (69.6%) were constructed between 2070-2080 BS (2013-2023 AD), with only a few (21.7%) dating back to 2060-2070 BS (2004-2014 AD). The construction trends indicate recent developments in these areas, with a majority of construction done by self-builders or entities like cooperatives.

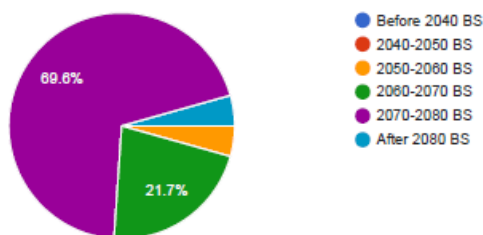


Figure 7: Construction Period

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### Building Material & Structural System

A majority of the buildings have metal structures (63%) with CGI sheet roofs, which are preferred due to their low construction cost, flexibility for future modifications, and faster construction times.

Reinforced concrete (RCC) structures (37%) are also common, particularly in more commercial buildings with more than two floors, showing a preference for durability in more substantial investments.

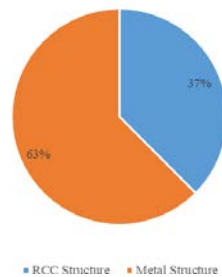


Figure 8: Building Material

Shallow foundations (footings, strip) are widely used, although a few properties, particularly multi-story commercial buildings, employ deep foundations (piles, raft), likely due to the need for additional stability in areas at risk of flooding or soil instability.

### Building Permit and Compliance

A notable portion of buildings (20%), particularly informal structures, were constructed without building permits. Many of these structures, often located in areas with uncertain land ownership or on encroached land, are non-compliant with local building by-laws.

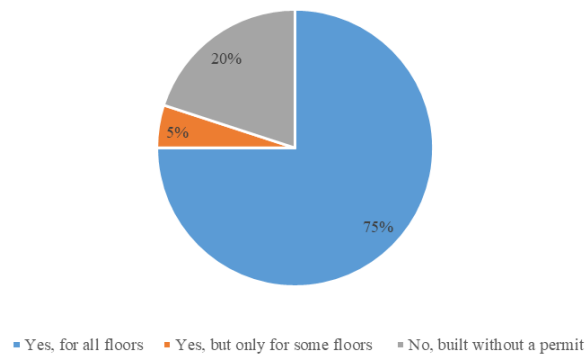


Figure 9: Building Permit

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The formal buildings generally comply with local building regulations, with permits obtained, especially in cases where developers are larger commercial entities or cooperatives. Compliance with the setback policy is less clear, as only a few respondents are certain about whether they followed required setbacks when constructing their buildings.

### Impact of River Proximity on Business

Proximity to rivers presents both opportunities and challenges for businesses, particularly in flood-prone areas. Among the most significant concerns are flood risks and pollution, which can severely impact business operations, infrastructure, and financial stability.

#### Flood Exposure

A substantial 66.7% of buildings have experienced flooding, with businesses in sectors like food and beverage being particularly vulnerable. Many of these establishments have faced at least one major flood event in the past five years.

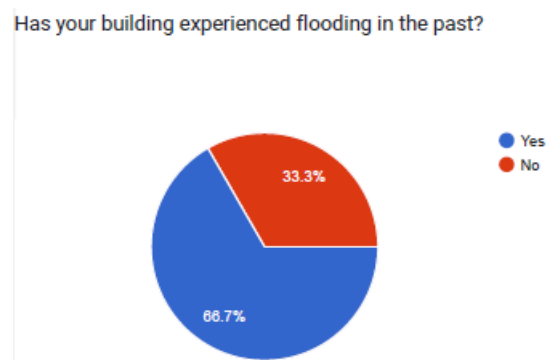


Figure 10: Flood Exposure

#### Flood Levels

Among affected businesses, 62.5% reported floodwaters reaching between 3 to 5 feet, causing extensive damage to properties and inventory.

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What was the estimated water level during the most recent flood?

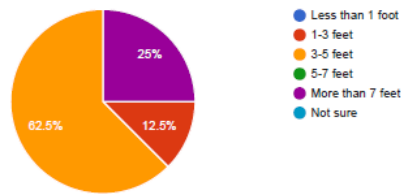


Figure 11:Flood Levels

## Financial Losses

The financial impact of flooding is considerable, with 43.8% of affected buildings incurring estimated losses between Rs. 1 lakh and Rs. 5 lakh. These losses stem from repair costs, damage to goods, and operational disruptions.

Frequent flooding not only increases financial burdens but also threatens business continuity, livelihoods, and the overall socio-economic stability of the area. Effective flood management strategies and resilience planning are essential to mitigate these risks and ensure sustainable business operations.

What were your estimated financial losses from the most recent flood?

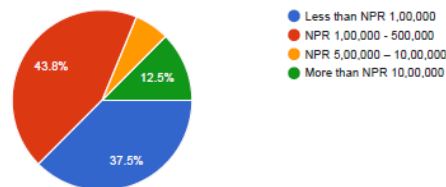


Figure 12:Financial Losses

## Socio-Economic Characteristics

Ownership status of the building plays a significant role in the building's use. Many owners also rent or lease the property, indicating a reliance on rental income as a secondary revenue stream.

The average monthly rent for commercial properties varies significantly, ranging from NPR 5,000 to NPR 50,000, with businesses such as retail shops, food services, and manufacturing sectors.

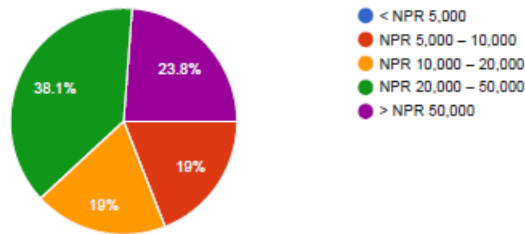


Figure 13: Average monthly rent

Income sources primarily stem from businesses operating on-site, with retail and service-based businesses (e.g., workshops, repair services) being common.

Location preferences for businesses and renters were influenced by factors such as affordability, accessibility (including public transport and road access), and proximity to markets, though concerns about flood risk and pollution are notable.

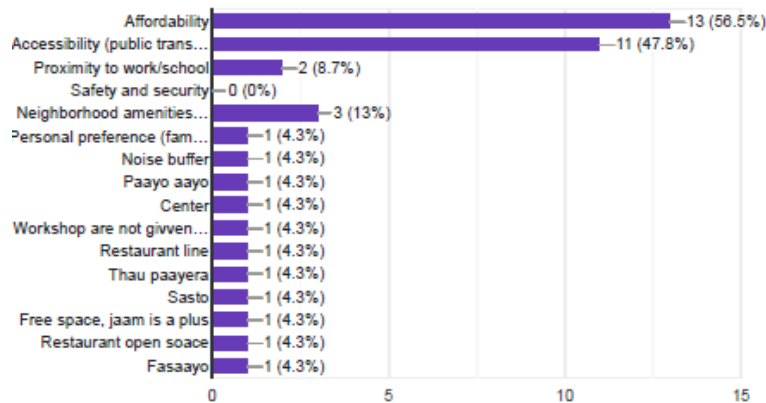


Figure 14: Location preferences

### Building and Site Factors

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The average number of floors across buildings is 1-2(29.2% and 29.2%), with some multi-story buildings (20.8%) employing higher construction standards (reinforced concrete, deeper foundations) in flood-prone areas.

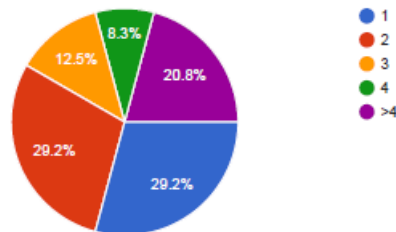


Figure 15: No. of Floors

The foundation type and structural material appear to be responsive to the potential for flood risk in the region. For example, deep foundations and RCC slabs are often employed in areas with known flooding history or poor soil conditions.

## 5.2.2 Findings

### Socio-Economic Importance vs. Flood Risks

The survey highlights that while riverfront areas offer significant advantages for businesses, such as accessibility and visibility, they are also highly vulnerable to flooding. This dual nature presents both opportunities and risks for businesses operating in these areas.

### Need for Stronger Enforcement

A high prevalence of informal construction and non-compliance with regulations underscores the need for stricter enforcement of setback guidelines. Strengthening regulatory oversight can help mitigate flood risks and promote safer business environments.

### Comprehensive Setback Guidelines

River setback regulations should extend beyond defining physical boundaries. They must also address critical aspects such as land use planning, sustainable construction practices, and flood resilience measures to ensure long-term safety and stability in riverfront business zones.

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### 5.3 Key Informant Interview

The Key Informant Interviews (KII) were conducted to gather insights from key stakeholders involved in urban planning and river management in Kathmandu Valley. These interviews aimed to understand the policies, challenges, and future directions related to river setback regulations. By engaging with officials from the Kathmandu Valley Development Authority (KVDA), the High-Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC), Kathmandu Metropolitan City (KMC), and Lalitpur Metropolitan City (LMC), the study explored the perspectives of various agencies responsible for planning and enforcement.

The discussions focused on the roles of these institutions, the effectiveness of existing setback policies, the implications of the Supreme Court's 2081 ruling mandating an additional 20-meter open space along riverbanks, and the challenges of balancing urban development with river conservation. Each interview provided valuable insights into policy enforcement, inter-agency coordination, socio-economic impacts, and recommendations for sustainable riverfront development in Kathmandu Valley.

The first interview was conducted with Saurab Dhakal, an Engineer and Information Manager at KVDA. This discussion covered KVDA's role in the master planning process, integration of river management and conservation, and the challenges in implementing setback policies. The interview also explored KVDA's stance on the Supreme Court ruling, the government's review petition, and strategies to balance urban development with river conservation.

The second interview was conducted with Udhav Nepal, an Engineer and Deputy Head of Information at HPCIDBC. This discussion focused on river conservation policies, existing setback regulations, and urban planning integration. The interview addressed the Supreme Court ruling, its implications, and concerns about displacement and economic consequences. HPCIDBC emphasized the need for a hydrological approach to setbacks and improved inter-agency coordination.

The third interview was conducted with Baburam Bhattarai from Kathmandu Metropolitan City (KMC), focusing on municipal-level enforcement of river setback policies. The discussion covered challenges related to urbanization, legal conflicts arising from the Supreme Court

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ruling, and socio-economic impacts on landowners and businesses. KMC highlighted the need for clearer regulatory alignment and innovative solutions for sustainable river management.

The fourth interview was conducted with Pradip Paudel from Lalitpur Metropolitan City (LMC), examining local urban planning strategies, policy alignment with federal directives, and enforcement hurdles. The discussion addressed the Supreme Court ruling's influence on LMC's planning approach, concerns about displacement, and the importance of flood-based zoning and green infrastructure. LMC emphasized the need for a balanced approach to setbacks that considers both environmental and socio-economic factors.

### **5.3.1 Analysis of Key Informant Interview – Kathmandu Valley Development Authority (KVDA)**

The interview with Saurab Dhakal, an engineer and information manager at KVDA, provided insights into the agency's role in urban planning and river management within Kathmandu Valley. KVDA is responsible for preparing the Comprehensive Physical Master Plan, which integrates urban development and river conservation. The discussion highlighted policy conflicts, enforcement challenges, and necessary improvements in river setback regulations.

#### Need for Stricter Enforcement of Existing Bylaws

KVDA emphasizes the importance of strictly enforcing the bylaw amendments made in 2064 and revised in 2065, which were formulated based on detailed studies. However, one major challenge is the lack of archived documentation of these studies, making it difficult to justify enforcement decisions and evaluate their effectiveness.

Despite these bylaws, weak enforcement mechanisms and political interference have prevented their full implementation. KVDA stresses the need for stronger regulatory oversight to prevent further encroachment and ensure compliance with setback rules.

#### Integration of Flood Modeling in River Setback Planning

KVDA incorporates flood modeling analysis to determine appropriate river setbacks, ensuring that planning decisions are based on scientific hydrological assessments. This approach helps in:

- Identifying flood-prone areas,

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- Establishing suitable buffer zones, and
  - Reducing the risk of riverbank erosion and infrastructure damage.

However, the lack of coordination among various government agencies has significantly hindered the effective implementation of these flood-based setback plans. Disjointed efforts between KVDA, municipalities, and HPCIDBC have led to inconsistent enforcement, making urban river management challenging.

### Comprehensive Physical Master Plan and Land Pooling Approaches

KVDA is currently developing the Comprehensive Physical Master Plan of Kathmandu, which aims to provide a structured approach to urban development, integrating land use planning with environmental sustainability.

In land pooling projects, KVDA determines river setbacks through a thorough analysis:

- 6–10 meters of setbacks are applied in standard projects,
- 20 meters is allocated in New Town Plans, ensuring greater flood resilience and green buffer zones.

This approach ensures that urban expansion along riverbanks is controlled, reducing the likelihood of flood damage while maintaining economic viability.

### Bagmati Action Plan: Under Review and Finalization

KVDA is actively involved in the Bagmati Action Plan, which is currently under review and is in the process of being finalized. This plan focuses on:

- Restoring and preserving riverbanks,
- Mitigating flood risks, and
- Developing sustainable urban strategies for the Bagmati corridor.

Once finalized, the plan is expected to serve as a guiding framework for riverfront management in Kathmandu, aligning urban growth with environmental sustainability.

KVDA plays a crucial role in balancing urban expansion with river conservation, but weak enforcement and coordination issues continue to hinder effective policy implementation.

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Moving forward, scientific flood modeling, stricter enforcement, and improved agency collaboration are necessary to establish sustainable and practical river setback regulations.

### **5.3.2 Analysis of Key Informant Interview – High-Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC)**

The interview with Udhab Nepal, an engineer and information officer at HPCIDBC, provided insights into the agency’s role in river conservation, policy enforcement, and infrastructure development. Unlike KVDA, which focuses on planning, HPCIDBC is responsible for implementing and enforcing river setback policies. The discussion emphasized the impracticality of the Supreme Court’s ruling, economic and social impacts, and the need for a revised policy framework.

#### Supreme Court Ruling: Implementation Challenges and Economic Implications

HPCIDBC considers the Supreme Court’s decision to impose a 20m additional setback impractical, as it affects:

- Schools, hospitals, and commercial buildings,
- Over 8,000 houses, and
- Economic assets worth NPR 21 Kharab, leading to massive financial losses.

Enforcing this decision without proper planning would trigger social protests due to mass displacement and disruption to livelihoods. Instead of introducing new setback requirements, HPCIDBC suggests:

- Strictly enforcing existing setbacks,
- Removing encroachments gradually, and
- Adopting alternative approaches like flood zoning rather than a complete rollback of developments.

#### Need for a Hydrology-Based Setback Policy

Rather than imposing arbitrary legal mandates, HPCIDBC recommends determining river setbacks through hydrological analysis. However, given the existing urban structures along riverbanks, a complete rollback is not feasible.

Instead, the approach should focus on:

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- “Living with Floods” strategies, allowing controlled urbanization with flood-resilient infrastructure,
  - Risk-sensitive zoning, ensuring that high-risk areas have proper flood defenses, and
  - Integrating social considerations, avoiding displacement without compensation.

### Revising the Legal Framework for a Practical Approach

HPCIDBC highlights the need for a review of the legal framework governing river setbacks.

The current system lacks:

- Flexibility for urban areas,
- Adequate compensation mechanisms, and
- Clear guidelines on enforcement priorities.

Instead of imposing rigid setbacks, the legal framework should incorporate scientific research and socio-economic realities to create a more balanced and enforceable policy.

### Green Infrastructure and Flood Management Strategies

HPCIDBC advocates for zoning regulations that prioritize:

- Retention and detention ponds,
- Green infrastructure along riverbanks, and
- Sustainable drainage systems to reduce flood risks.

By integrating these measures, river setbacks can be designed not just as legal mandates but as functional, climate-resilient solutions.

### Strengthening Stakeholder Coordination

As the primary enforcement body, HPCIDBC is responsible for coordinating with relevant agencies, including:

- KVDA,
- Municipal governments, and
- Community stakeholders.

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However, weak inter-agency communication and conflicting regulations have hindered effective implementation. HPCIDBC suggests forming a dedicated coordination body to ensure a unified approach to river management.

HPCIDBC acknowledges the importance of river conservation and flood management but emphasizes that current setback policies need revision to reflect urban realities. Instead of forcing mass displacement, the agency advocates for:

- Hydrology-based setback determination,
- A legal framework review, and
- The integration of risk-sensitive zoning and green infrastructure.

Moving forward, a more practical, data-driven, and community-oriented approach is necessary to ensure effective riverfront management without disrupting urban livelihoods.

### **5.3.3 Analysis of Key Informant Interview – Kathmandu Metropolitan City (KMC)**

#### Policy & Regulation

KMC highlighted that river setbacks in Kathmandu Valley are governed by existing municipal regulations, national environmental policies, and Supreme Court rulings. However, enforcement remains a challenge due to high urbanization pressure, lack of coordination among agencies, and resistance from affected landowners and businesses.

#### Supreme Court Decision & Policy Conflict

The Supreme Court's ruling on Shrawan 11, 2081, mandating an additional 20-meter setback, has significantly influenced municipal policies. The local government acknowledges the authority of the Supreme Court and has temporarily halted new construction permits along riverbanks until a final decision is reached.

Regarding the federal government's challenge to the ruling on Bhadra 30, 2081, KMC emphasized that local government policies cannot contradict federal regulations or Supreme Court decisions. While awaiting further clarity, the municipality is reviewing its own regulatory framework to ensure alignment with national directives

#### Socio-Economic Considerations

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River setbacks have both positive and negative impacts on local communities, businesses, and informal settlements. While they contribute to environmental conservation and flood risk reduction, they also pose challenges for landowners and developers.

### Closing Remarks

KMC emphasized the importance of honoring Supreme Court decisions while ensuring pragmatic policy implementation. The municipality remains committed to sustainable river management and is actively working on innovative solutions to address enforcement challenges.

While awaiting the final decision on the additional 20-meter setback, the local government has suspended construction permits along riverbanks. Further discussions and stakeholder consultations are needed to develop a comprehensive, balanced approach to river setbacks in Kathmandu Valley.

## **5.3.4 Analysis of Key Informant Interview – Lalitpur Metropolitan City (LMC)**

### Policy & Regulation

Lalitpur Metropolitan City emphasized that river setbacks are crucial for sustainable urban development, flood management, and environmental conservation. The city's policies align with federal and provincial guidelines, ensuring that local regulations do not conflict with national laws.

Enforcement, however, remains a challenge due to urban expansion, and resistance from landowners. While the local government recognizes the importance of river setbacks, implementation hurdles often slow down progress.

### Supreme Court Decision & Policy Conflict

The Supreme Court's ruling on Shrawan 11, 2081, mandating an additional 20-meter setback, has prompted local governments to reassess their urban planning strategies. Lalitpur Metropolitan City has acknowledged this ruling and temporarily halted new construction permits along riverbanks until further governmental discussions take place.

Regarding the federal government's challenge to the ruling on Bhadra 30, 2081, the city engineer stated that local government laws cannot override federal regulations. The municipal

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authorities are awaiting further clarity on the legal framework while ensuring compliance with the existing directives.

### Socio-Economic Considerations

The impact of river setbacks on local communities, businesses, and informal settlements is a critical concern. While necessary for flood prevention and ecological preservation, setback enforcement disrupts livelihoods and requires careful resettlement planning.

### Closing Remarks

LMC concluded by emphasizing the importance of honoring Supreme Court decisions while ensuring practical implementation. While the final decision on the additional 20-meter setback is under review, the municipality has paused construction permits along riverbanks to avoid potential legal conflicts.

Flood-based zoning, green infrastructure development, and inter-agency collaboration remain key priorities. The engineer reiterated that setbacks are necessary for long-term urban resilience, but their implementation must be carefully planned to minimize social and economic disruptions.

## **5.4 Land Value**

Land value is a crucial factor in urban planning and policy formulation, particularly when implementing river setback regulations. The economic significance of land near river corridors influences real estate development, environmental conservation, and urban expansion. Understanding the financial implications of setback policies is essential for creating a balanced approach that integrates both economic and environmental considerations. This analysis evaluates land prices in key locations of Kathmandu Valley and their impact on river setback policies.

### Sources of Land Price Data

The land price data used in this study were gathered from multiple online real estate platforms that provide property listings in Kathmandu. These platforms include Nepal Home Search (nepalhomesearch.com), 99 Aana (99aana.com), Lalpurja Nepal (lalpurjanepal.com.np), Hamrobazaar (hamrobazaar.com), and eProperty Nepal (epropertynepal.com). These sources

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provide insights into market rates based on location, size, and demand, reflecting the economic landscape of land near river corridors.

### Land Prices in Key Urban Areas

Significant variations in land prices were observed in two major locations near river corridors. In Anamnagar, which is adjacent to the Dhobi Khola, the price per aana ranges from NPR 70 lakh (7 million) to NPR 1.5 crore (15 million), with an average price of NPR 1.03 crore (10.33 million) per aana. Similarly, in Shankhamul, which is located near the Bagmati Khola, the price per aana varies between NPR 75 lakh (7.5 million) and NPR 90 lakh (9 million), with an average price of NPR 83.67 lakh (8.37 million) per aana. These variations indicate the high demand for urban land near riverfronts, reflecting their strategic importance in Kathmandu's real estate market.

### Land Value in River Setback Zones

To assess the economic impact of river setbacks, the estimated total land value in designated river setback areas was calculated.

For the Bagmati River (40-meter setback zone):

- Total Land Area: 48,797.58 sq.m. (Private Property from Grid Based Analysis)
- Average Land Price per sq.m.: NPR 2.90 lakh (From average of 92 lakh per aana)
- Estimated Total Land Value: NPR 14.15 Arba (14.15 billion)

For the Dhobi Khola (29-meter setback zone):

- Total Land Area: 32,422.72 sq.m. (Private Property from Grid Based Analysis)
- Average Land Price per sq.m.: NPR 2.90 lakh (From average of 92 lakh per aana)
- Estimated Total Land Value: NPR 9.40 arba (9.40 billion)

The total land value for both river setback zones amounts to NPR 23.55 Arba (23.55 billion). This substantial economic valuation highlights the financial stakes involved in implementing river setback policies, as such regulations could significantly impact property owners, real estate developers, and urban land use patterns.

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## 5.5 Average Monthly Rent

The analysis of rental prices from the survey responses indicates a diverse range of monthly rent amounts, categorized into four groups: NPR 5,000 – 10,000, NPR 10,000 – 20,000, NPR 20,000 – 50,000, and more than NPR 50,000.

By taking the midpoint of each range, we estimated the rent values for calculation. The NPR 5,000 – 10,000 category accounts for 21.05% of the total responses, indicating that a significant portion of the surveyed individuals are paying lower rent amounts. Similarly, the NPR 10,000 – 20,000 category also makes up 21.05%, representing another group paying moderate rent.

The NPR 20,000 – 50,000 category constitutes 36.84% of the total responses, making it the most common rental range among respondents. Meanwhile, the highest rent category (above NPR 50,000) represents 21.05%, showing that a notable share of residents are paying premium rental prices.

The rental market exhibits a varied distribution, with 42.1% of respondents paying less than NPR 20,000, while the remaining 57.9% pay NPR 20,000 or more.

After summing up all values and dividing by the total number of responses, the calculated average monthly rent was found to be NPR 29,211. This suggests that while lower and moderate rent categories exist, the significant presence of higher rent values (NPR 20,000 and above) pushes the overall average upward.

In the context of evaluating river setback policies in the Kathmandu Valley, the rent analysis provides valuable insight into the economic factors influencing land use, particularly in proximity to river corridors. The average rent price in the valley is NPR 29,211 per month for a 1,000 square-foot space, translating to a price of NPR 29.211 per square foot. This is equivalent to approximately NPR 314.42 per square meter.

The analysis highlights the rental values for two key river areas:

- Bagmati River (40-meter setback zone): The total rent area for properties within this zone amounts to 1,597.947 Sq. m included from the from Built up area of Grid Based Analysis
- Dhobi Khola (29-meter setback zone): The total rent area in this area is NPR 26,445.832 sq. m. from Built up area of Grid Based Analysis

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Together, these areas contribute a total rental area of 68,043.779 sq. m.

Furthermore, considering a Floor Area Ratio (FAR) of 1.5, the total rent for the entire area under study reaches approximately NPR 32,091,924.63 per month. (3.20 crores)

This data underscores the socio-economic significance of riverfront properties in Kathmandu, where rental values can influence land use decisions. Evaluating these economic factors is crucial in formulating effective river setback policies that balance urban development needs with environmental and social considerations. By integrating rent prices and other socio-economic factors into policy development, authorities can ensure that the design and enforcement of setback regulations support sustainable urban growth while maintaining the integrity of river ecosystems

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## 6. Discussion

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The analysis of the study stretch area reveals that the riverfront land holds an estimated value of NPR 23.55 Arba and generates approximately NPR 3.20 crores in monthly rent. This underscores the substantial economic value of the riverfront for local businesses and the overall urban economy. However, this economic potential is accompanied by a significant vulnerability to flooding, which poses a major risk to both property and business continuity. These conditions necessitate a careful and balanced approach to urban development that includes strong disaster mitigation strategies.

According to the study, 66.7% of buildings in the riverfront area experience flooding, resulting in considerable structural damage and financial loss. Among these buildings, 43.8% face financial losses ranging from NPR 1 to 5 lakh. The overall economic impact of flood-related damage and business disruptions is estimated to be between NPR 1 to 2 Arba. This clearly highlights the urgent need for effective and comprehensive flood management strategies aimed at safeguarding infrastructure and maintaining the area's economic productivity.

Managing flood risk requires navigating a complex trade-off between development and safety. While strict building setbacks can significantly reduce flood risk by preventing construction in vulnerable zones, they also result in a loss of usable land and a decline in revenue from riverfront properties. On the other hand, permitting unchecked development in flood-prone areas increases exposure to flood damage and endangers human lives and economic assets. Therefore, a strategic zoning system that carefully balances these competing priorities is essential for achieving sustainable and resilient urban development.

Given these findings, it is necessary to implement a flood-based zoning system that can harmonize urban development with disaster risk reduction. Such a system would enable local authorities to mitigate the risks posed by frequent and intense flooding, while still preserving the economic benefits of the riverfront area. Zoning based on flood recurrence intervals can help define appropriate setbacks and construction guidelines that support both safety and economic use.

One approach is to adopt models like those used in the Pune and Nashik Municipal Regulations (2015). These regulations employ a system based on flood recurrence data to determine construction zones. The Blue Flood Line represents the area at risk during a 1-in-25-year flood

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event, where construction is strictly prohibited. Between the Blue and Red Flood Lines—corresponding to a 1-in-100-year event—development is allowed, provided structures are built at elevated levels to avoid flood damage.

The implementation of such a zoning system requires a comprehensive set of data inputs. Hydrological data is essential and includes rainfall records, catchment area characteristics, land use patterns, soil types, slope gradients, and river discharge data. In addition, hydraulic data such as river cross-sections, riverbed and bank materials, water level records, and the presence of any structural barriers must also be considered. Accurate geospatial and topographical information, including elevation models and floodplain boundaries, is also critical for effective flood modeling and zoning.

Much of the required data can be sourced from the Bagmati Action Plan, which provides detailed hydrological and flood modeling for the Bagmati River Basin. This plan includes critical parameters such as precipitation levels, flood discharge rates, and the physical dimensions of waterways. It also offers flood data for various return periods, supporting the development of a scientifically informed and locally appropriate flood zoning system.

## **6.1 Minimum Width Requirement– Bagmati Action Plan Context**

According to the Bagmati Action Plan (BAP), the minimum width required for the natural flow of rivers is calculated using Lacey’s empirical formula for regime width:

$$\text{Regime Width (W)} = 4.75\sqrt{Q},$$

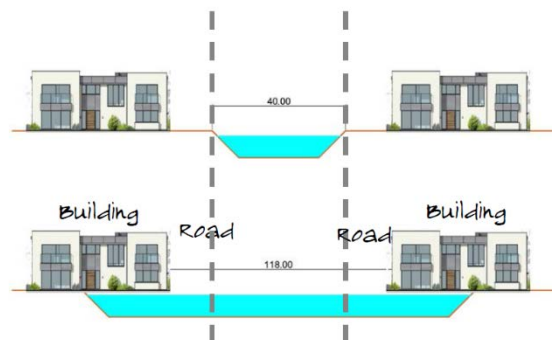
where Q represents the maximum discharge (in cubic meters per second) corresponding to a given return period.

For wide streams or rivers—such as the Bagmati River and its major tributaries—the wetted perimeter (P) is approximately equal to the width of the river. Based on this assumption, the BAP applies Lacey’s formula to determine the required regime width for accommodating peak discharges with a 50-year return period. This gives an estimate of the ideal or natural channel width needed to safely convey floodwaters without overtopping or flooding.

However, while this approach provides a scientific basis for understanding the natural flow capacity of the river, it presents significant challenges when applied in practice. In urbanized areas—such as the study stretch of the Bagmati River—the surrounding river corridor has

already been extensively developed. Buildings, roads, and other infrastructure occupy large portions of the river’s theoretical flow regime. For example, the Bagmati River in the study area has an average width of approximately 40 meters, whereas the BAP recommends a minimum regime width of 118 meters based on a 50-year return period discharge. The additional width required, as per Lacey’s formula, is already occupied by urban infrastructure, making full-scale implementation unfeasible without large-scale demolition or resettlement.

Therefore, the practical objective of this study is not to redesign or excavate the river channel



*Figure 16: Calculation of Minimum Width Requirement for Natural Waterways in Bagmati Action Plan*

to meet the full theoretical width. Instead, the conceptual focus is to understand how much water the river can realistically accommodate during various flood return periods—such as the 20-year and 100-year events—within the current channel and built environment. This approach aims to assess the actual flow behavior of the river under existing conditions.

Based on these realistic flow assessments, the surrounding river corridor can be divided into different zones depending on flood risk levels. These zones will help guide future land use planning, flood mitigation, and development control in a way that acknowledges the limitations of existing infrastructure while enhancing resilience to flood hazards. Such a zoning strategy represents a balanced and context-sensitive method for integrating disaster risk reduction into urban planning.

## **6.2 Formation of Return Period Peak Discharge Lines**

The peak discharge ( $Q$ ) is the maximum rate of flow that occurs during a rainfall event. Estimating peak discharge is crucial for flood modeling and zoning, as it directly influences how much water the river must accommodate during various return period events (e.g., 20-year, 50-year, 100-year floods).

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One of the simplest and widely used approaches to estimate peak discharge is the Rational Method, given by the formula:

- $Q = CIA$  (U.S. units), or
- $Q = 0.0028 CIA$  (S.I. units)

Where:

- $Q$  = Peak discharge (in  $m^3/s$ )
- $C$  = Runoff coefficient (depends on land use, soil type, and surface conditions)
- $I$  = Rainfall intensity (mm/hr)
- $A$  = Area of the watershed (in hectares or  $km^2$ )
- Rainfall intensity ( $I$ ) is derived using the formula:
  - $I = P / t$
  - Where:
    - $P$  = Precipitation amount (mm)
    - $t$  = Duration of rainfall (usually the time of concentration for the watershed)

### 6.3 Peak Discharge Analysis for Different Return Periods

The Bagmati Action Plan (BAP) provides critical precipitation data and computed peak discharges for a 50-year return period. Using this known data point, and assuming other parameters (such as runoff coefficient and watershed area) remain constant, it is possible to estimate peak discharges for other return periods.

This is typically done by using precipitation data from the BAP for 2-year, 10-year, 20-year, 50-year, and 100-year return periods. The intensity values ( $I$ ) for these periods are calculated using their respective rainfall durations, and then substituted into the Rational Method equation to derive the corresponding peak discharges.

The peak discharge for different return periods, as derived from the Bagmati Action Plan, is presented in the table below:

Table 5: Peak discharge for different return periods

Sub-basin	5 Yrs (m <sup>3</sup> /s)	10 Yrs (m <sup>3</sup> /s)	20 Yrs (m <sup>3</sup> /s)	50 Yrs (m <sup>3</sup> /s)	100 Yrs (m <sup>3</sup> /s)
Sub-basin-8	402.96	472.92	540.03	626.9	692
Sub-basin-17	28.62	34.24	39.63	46.6	51.83

#### 6.4 Cross-Sectional Area and Its Role in Flood Analysis

The cross-sectional area (A) of a river is a critical parameter that reflects the river's flow-carrying capacity. It is measured as the area of the river channel perpendicular to the direction of flow and plays a central role in hydraulic modeling, flood level estimation, and the design of river training and protection structures.

In hydraulic analysis, several parameters are used to compute flow characteristics and determine how water behaves under different return periods. One of the fundamental inputs is the median grain size ( $D_{50}$ ) of riverbed material, which influences the silt factor (f). The silt factor is calculated using the empirical formula:

$$f = 1.75 \times \sqrt{D_{50}},$$

where  $D_{50}$  is in millimeters. The silt factor helps characterize the resistance offered by the riverbed, which in turn affects flow velocity.

The discharge (Q), measured in cubic meters per second (m<sup>3</sup>/s), varies according to the return period of interest. For instance, data for the Bagmati River and Dhobi Khola shows increasing discharge for higher return periods—540.03 m<sup>3</sup>/s and 692 m<sup>3</sup>/s for Bagmati's 20-year and 100-year events, respectively, and 39.63 m<sup>3</sup>/s and 51.83 m<sup>3</sup>/s for Dhobi Khola.

Using the silt factor and discharge, velocity (V) is calculated using the empirical formula:

$$V = ((Q \times f^2) / 140)^{(1/6)}$$

This provides the average flow velocity in meters per second. Finally, the cross-sectional area (A) is derived using:

$$A = Q / V,$$

which gives the flow area in square meters (m<sup>2</sup>) necessary to accommodate the discharge at the given velocity.

Table 6: Cross-Sectional Area for different return periods

Parameter	Formula	Unit	Bagmati (20-Yr)	Bagmati (100-Yr)	Dhobi Khola (20-Yr)	Dhobi Khola (100-Yr)
Median Grain Size (D50)	Data from ( Sayami, 2007)	mm	1.44	1.44	0.84	0.84
Silt Factor (f)	$f = 1.75 * \text{SQRT}(D50)$	–	2.11	2.11	1.61	1.61
Discharge (Q)	–	m <sup>3</sup> /s	540.03	692	39.63	51.83
Velocity (V)	$V = ((Q * f^2) / 140)^{(1/6)}$	m/s	1.61	1.67	0.95	0.99
Cross-Sectional Area (A)	$A = Q / V$	m <sup>2</sup>	336.1	413.25	41.7	52.15

These calculated cross-sectional areas are directly applied to cross-section drawings sourced from the Bagmati Action Plan. Each drawing shows surveyed river profiles, including bank geometry, bed elevation, and side slopes. By plotting a horizontal flood level line across the cross-section such that the area enclosed under the line equals the calculated cross-sectional area (A), the expected flood elevation for each return period can be visualized. This method allows for precise flood level estimation under existing topographic conditions, which is essential for identifying high-risk zones and designing flood mitigation infrastructure.

## 6.5 Flood-Based Zoning System for Bagmati River

The proposed flood-based zoning system for the Bagmati River integrates hydrological analysis with existing land use to guide safer and more sustainable development along the river corridor. This zoning is informed by flood level estimations for various return periods and is

marked using distinct reference lines and corresponding land use restrictions.

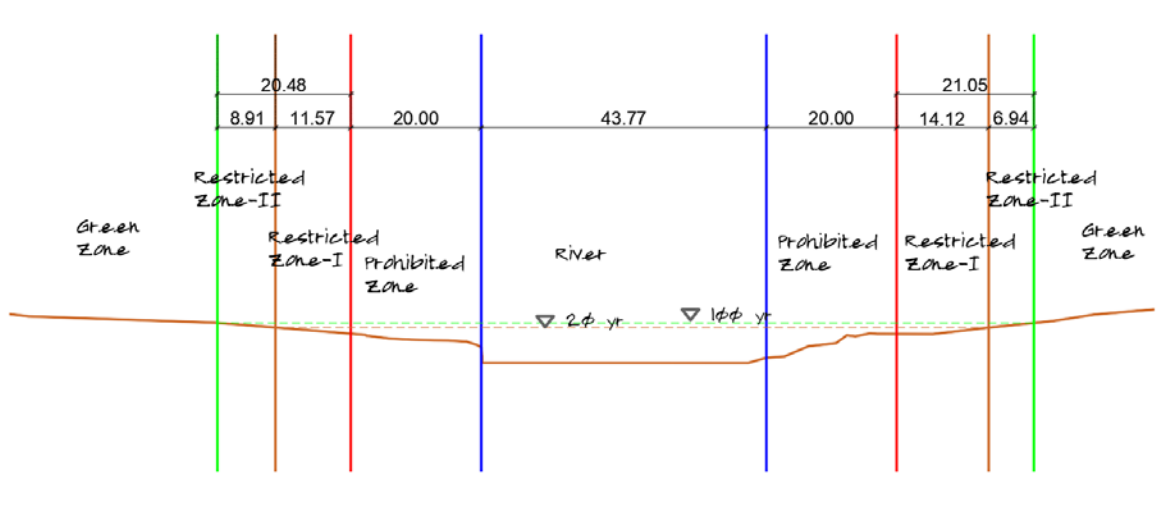


Figure 17: Flood-Based Zoning System for Bagmati River

- The Blue Line represents the river edge, indicating the natural boundary of the watercourse.
- The Red Line denotes the existing 20-meter setback line, as prescribed by 2065 Byelaws regulations
- The Yellow/Brown Line corresponds to the flood level for a 20-year return period
- The Green Line represents the flood level for a 100-year return period, showing the maximum expected flood extent under severe conditions

Based on these lines, the river corridor is divided into four distinct zones:

- Prohibited Zone: This is the area between the Blue Line (river edge) and the Red Line (setback line).
- Restricted Zone I: This zone lies between the Red Line and the Yellow/Brown Line and/or between the Red Line and the 100-year flood level (Green Line) where the water depth is expected around 2 meters.
- Restricted Zone II: This area lies between the Yellow/Brown Line (20-year level) and the Green Line (100-year level) where the flood depth ranges upto 1m.
- Green Zone: This zone lies beyond the Green Line, where the 100-year flood level is at or near 0 meters of depth.

Widths from River Edge

- Prohibited Zone: 0–20 m in Left side and Right side
- Restricted Zone-I: 20–31.57m in Left side and 20–34.12m in Right side
- Restricted Zone-II: 31.57- 40.48 m in Left side and 34.12–41.06m in Right side
- Green Zone: Beyond 40.48 m in Left side and 41.06m in Right side

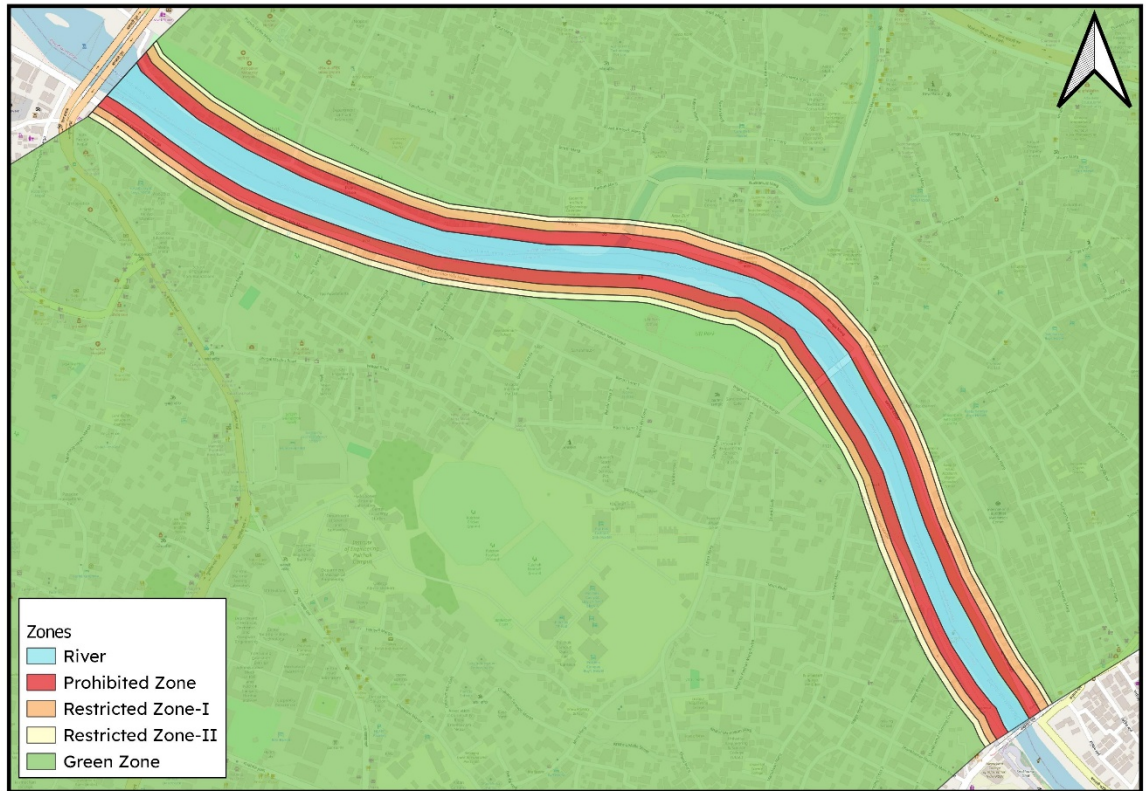


Figure 18: Flood-Based Zones for Bagmati River

## 6.6 Flood-Based Zoning System for Dhobi Khola

For Dhobi Khola, a similar zoning methodology is applied, with parameters adjusted for the river’s smaller scale and different setback regulations:

- The Blue Line marks the river edge.
- The Red Line indicates the existing 9-meter setback from the river.
- The Green Line represents the flood level for a 100-year return period, based on peak discharge analysis.

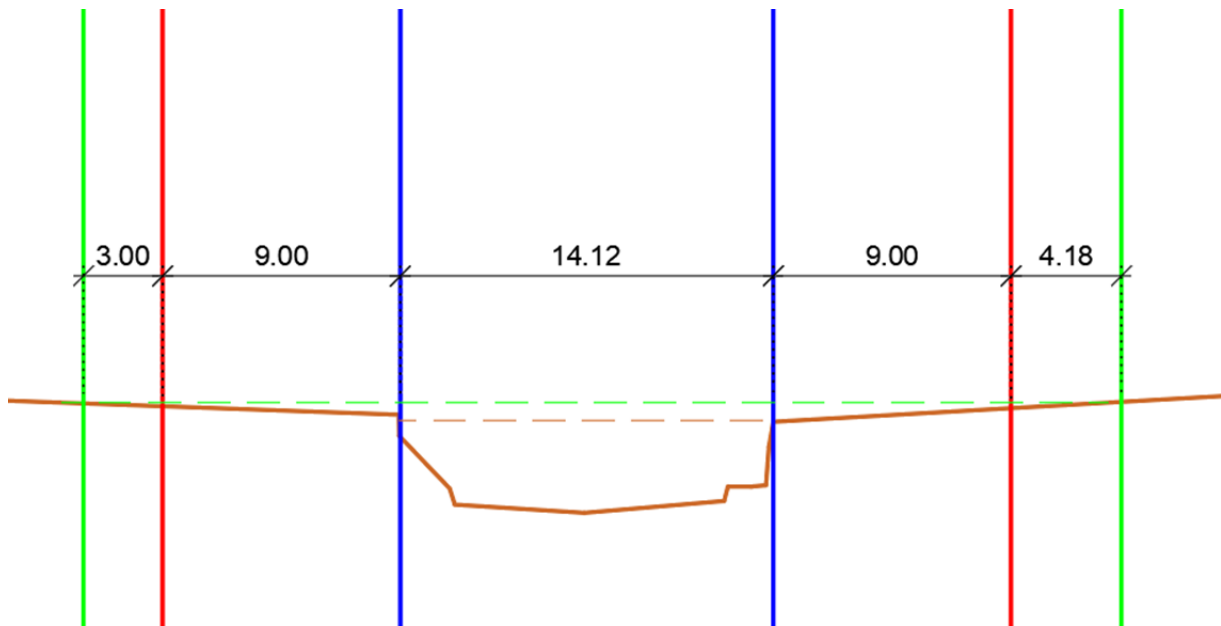


Figure 19: Flood-Based Zoning System for Dhobi Khola

The zoning system defines three land use zones:

- Prohibited Zone: Located between the Blue Line (river edge) and the Red Line (9-meter setback)
- Restricted Zone: This is the area between the Red Line and the Green Line (100-year flood level), where floodwater depth is expected to be around 1 meter.
- Green Zone: Found beyond the Green Line, this area is considered safe from major flood events, with 0-meter expected flood depth even during a 100-year event.

Widths from River Edge

- Prohibited Zone: 0–9 m in Left side and Right side
- Restricted Zone-I: 9-12m in Left side and 9–13.18m in Right side
- Green Zone: Beyond 12 m in Left side and 4.18 m in Right side

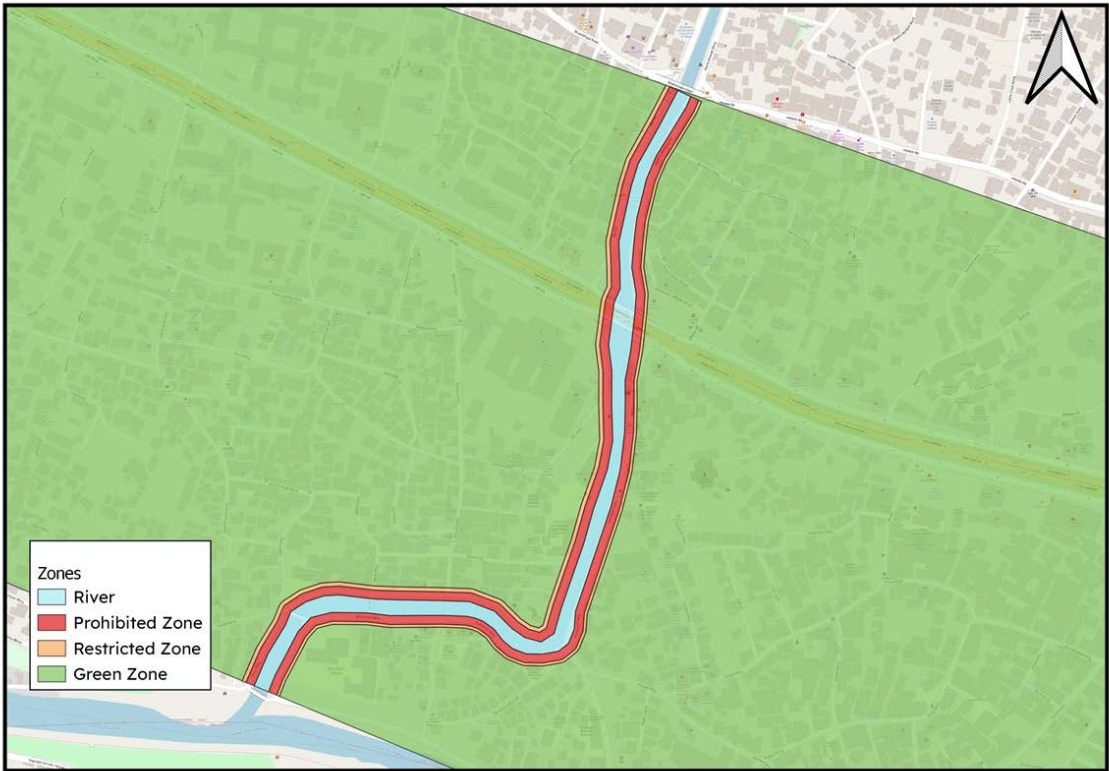


Figure 20: Flood-Based Zones for Dhobi Khola

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## 7. Recommendation

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### 7.1 Zoning-Based Byelaws for Flood-Prone Areas

#### 7.1.1 Prohibited Zone

This zone, located between the river edge and the setback line, is the most vulnerable to flooding. It is designated primarily for protective and low-impact uses.

Prohibited:

- All private construction
- Permanent residential, commercial, or industrial structures

Permitted (with flood-resilient design features):

- Public open spaces such as parks and gardens
- Religious and cultural monuments, provided they are elevated or flood-resistant
- Flood control infrastructure like embankments, levees, and retention ponds

#### 7.1.2 Restricted Zone

This zone covers the area between the setback and the 100-year flood line, subdivided based on flood depth into:

- Restricted Zone I (flood depth - 2m)
- Restricted Zone II (flood depth - 1m)

Prohibited:

- Critical infrastructure, including hospitals, schools, and emergency services
- Hazardous or large-scale commercial developments

Permitted:

- Elevated residential and commercial buildings (floor level above 100-year flood level)
- Non-hazardous public infrastructure
- Low-risk economic developments, if flood-proofed

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### 7.1.3 Development Regulations for Restricted Zones

General Requirements:

- Flood-resilient design standards mandatory
- No basements permitted
- Ground floors should not include essential services or habitable spaces
- Use of waterproof or water-resistant materials
- Maximum ground coverage: 50% of the plot
- Installation of advanced stormwater drainage systems
- Permeable surfaces encouraged to reduce surface runoff
- Minimum Plinth Level Requirements:
- Bagmati River:
  - Restricted Zone I: 2 meters above ground level
  - Restricted Zone II: 1 meter above ground level
- Dhobi Khola:
  - Restricted Zone: 1 meter above ground level

### 7.1.4 Emergency Preparedness Measures

To enhance safety and minimize damage during flood events, the following systems should be in place:

- Flood early warning systems for timely alerts
- Designated emergency access routes and elevated safe zones
- Community-level evacuation plans
- Promotion of flood insurance for properties in restricted and green zones

### 7.1.5 Maintenance Byelaws

To ensure ongoing protection and system efficiency:

- All structures within flood-prone zones must undergo regular structural checks and timely repairs
- Drainage and barrier systems must be cleaned and inspected annually

- 
- Emergency systems (like alarms and signage) should be tested regularly, and evacuation plans updated annually

## **7.2 Recent Flood Event Validation – Bagmati River**

A significant flood event occurred in September 2024, providing a real-world basis for validating the proposed flood-based zoning system for the Bagmati River corridor. Observations from the event offer critical insights into the accuracy of flood level predictions and the appropriateness of the designated zoning categories.

During the flood certain areas experienced inundation of up to 3 feet (0.9 meters). These areas fall within the Restricted Zone-II, which is defined for regions expected to experience flood depths up to 1 meters. This confirms that Zone-II appropriately represents moderate flood risk zones where water levels approach or exceed 1 meter.

In other parts of the river corridor, floodwaters rose to 7 feet (2.1 meters). These areas are located within the Restricted Zone-I, designated for flood depths exceeding 2 meters. This alignment further validates the classification of Zone-I as a high-risk area.

The actual flood levels observed during the September 2024 event correlate closely with the modeled return-period flood extents and their associated zones. This consistency supports the accuracy of the flood risk mapping and reinforces the need to implement zoning-based regulations, as the designated zones reflect real flood behavior on the ground.

## **7.3 Further Application: Flood-Based Zoning for Other Rivers**

Building on the methodology and validation from the Bagmati River, the flood-based zoning system can be effectively applied to other rivers in the region to guide resilient development and flood risk management. The same principles—based on flood modeling, return period analysis, and setback regulations—are adapted to the context of each river.

### 7.3.1 Bishnumati River: Proposed Flood-Based Zoning

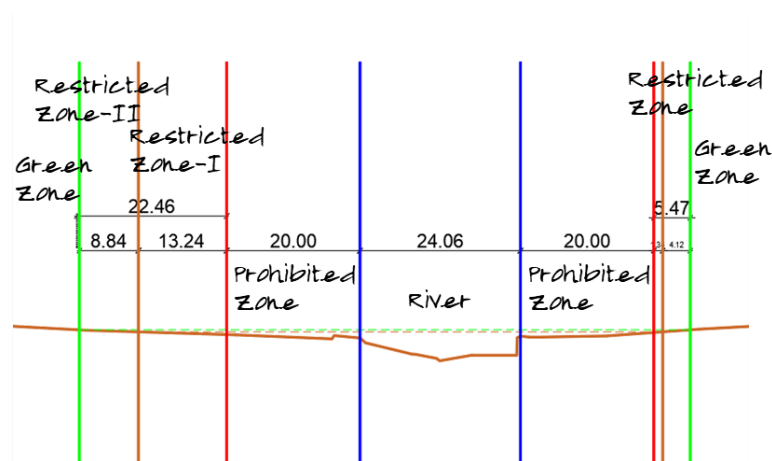


Figure 21: Flood-Based Zoning System for Bishnumati River

#### Widths from River Edge

- Prohibited Zone: 0–20 m in Left side and Right side
- Restricted Zone-I: 20–33.24 m in Left side and 20–21.34 m in Right side
- Restricted Zone-II: 33.24- 42.08 m in Left side and 21.34–25.47m in Right side
- Green Zone: Beyond 42.08 m in Left side and 25.47m in Right side

### 7.3.2 Mahadev Khola: Proposed Flood-Based Zoning

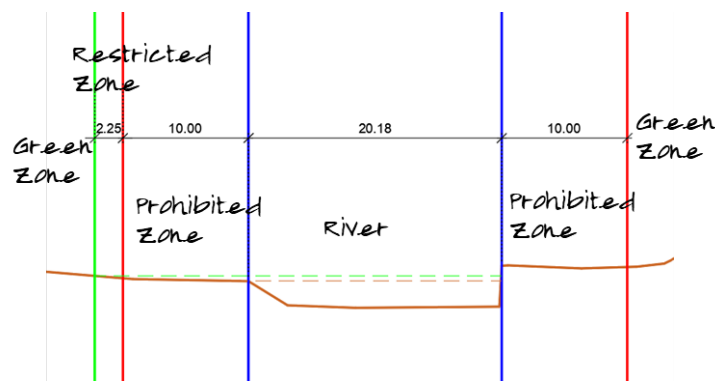


Figure 22: Flood-Based Zoning System for Mahadev River

#### Widths from River Edge

- Prohibited Zone: 0–10 meters in Left side and Right side
- Restricted Zone-I: 10–12.25 m in Left side and No Restricted Zone in Right side
- Green Zone: Beyond 12.25 m in Left side and 10m in Right side

### 7.3.3 Manohara River: Proposed Flood-Based Zoning

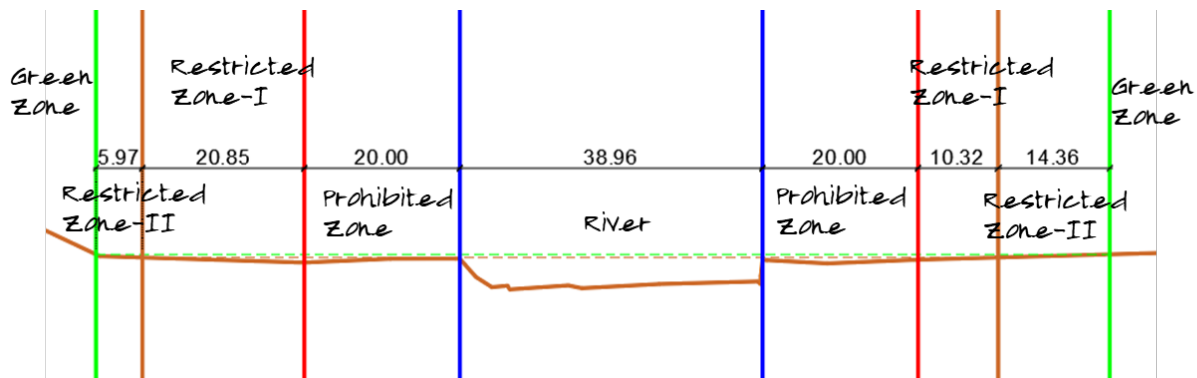


Figure 23: Flood-Based Zoning System for Mahadev River

Widths from River Edge

- Prohibited Zone: 0–20 m in Left side and Right side
- Restricted Zone-I: 20–40.85 m in Left side and 20–30.32 m in Right side
- Restricted Zone-II: 40.5- 46.82 m in Left side and 30.32–44.68m in Right side
- Green Zone: Beyond 46.82 m in Left side and 44.68 m in Right side

### 7.3.4 Hanumante River: Proposed Flood-Based Zoning

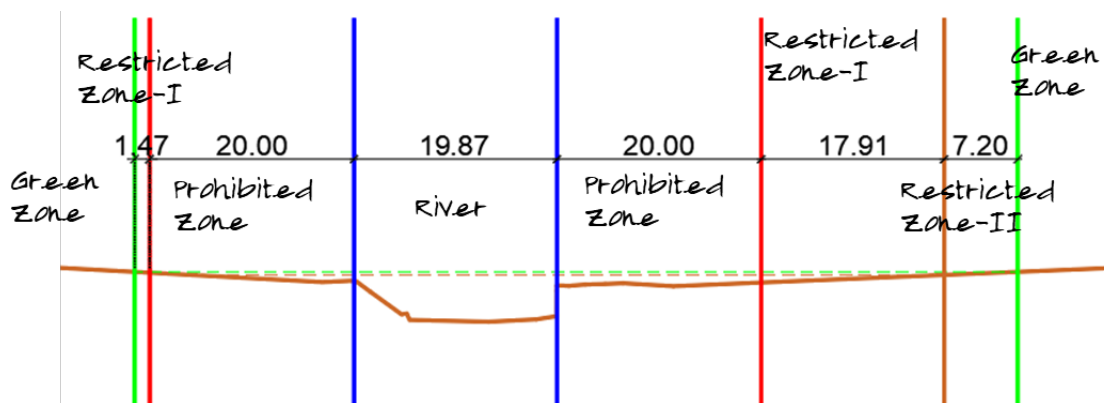


Figure 24: Flood-Based Zoning System for Hanumante River

Widths from River Edge

- Prohibited Zone: 0–20 m in Left side and Right side
- Restricted Zone-I: 20–21.47 m in Left side and 20–37.91 m in Right side
- Restricted Zone-II: 37.91–45.11m in Right side
- Green Zone: Beyond 21.47 m in Left side and 45.11 m in Right side

### 7.3.5 Balkhu River: Proposed Flood-Based Zoning

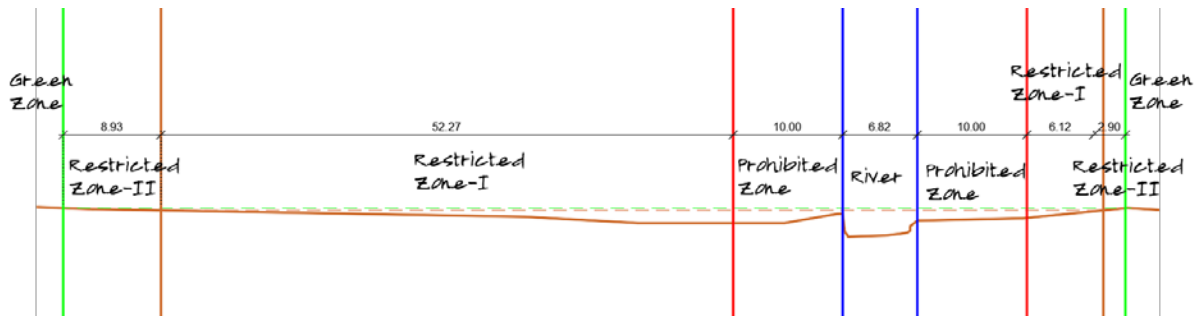


Figure 25: Flood-Based Zoning System for Balkhu River

Widths from River Edge

- Prohibited Zone: 0–10 m in Left side and Right side
- Restricted Zone-I: 10–62.27 m in Left side and 10–16.12 m in Right side
- Restricted Zone-II: 62.27–71.2 m in Left side and 16.12- 19.02m in Right side
- Green Zone: Beyond 71.2 m in Left side and 19.02 m in Right side

### 7.3.6 Nakhu River: Proposed Flood-Based Zoning

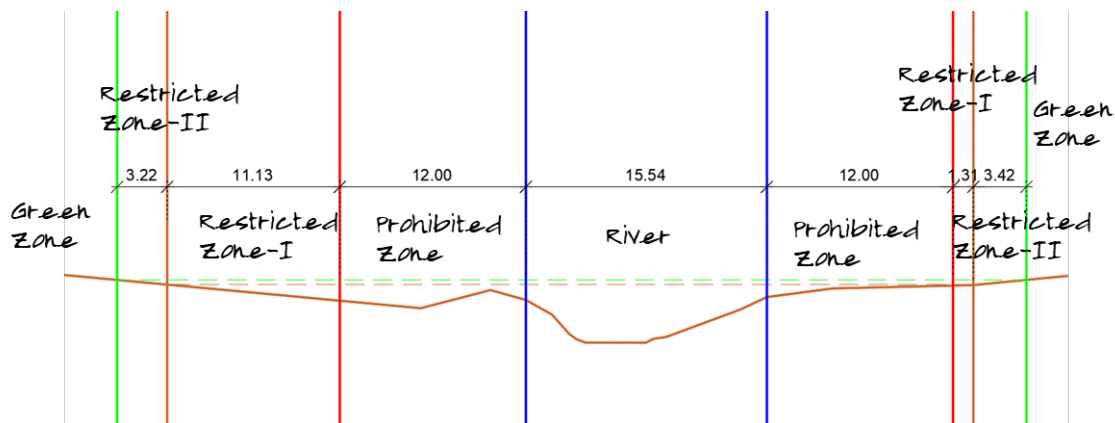


Figure 26: Flood-Based Zoning System for Nakhu River

Widths from River Edge

- Prohibited Zone: 0–12 m in Left side and Right side
- Restricted Zone-I: 12–23.13 m in Left side and 12–13.31 m in Right side
- Restricted Zone-II: 23.13–26.35m in Left side and 13.31- 16.73m in Right side
- Green Zone: Beyond 26.35m in Left side and 16.73 m in Right side

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## 7.4 Further Research

This study primarily relies on secondary data sources and rational estimation methods to evaluate flood risk and propose zoning strategies. While these methods offer valuable preliminary insights from a planner's perspective, they may not fully capture the complex hydrological behavior and variability specific to the local terrain and climate.

To improve the accuracy, reliability, and scientific rigor of flood-based zoning and risk management strategies, future research should incorporate the following:

- **Comprehensive Hydrological Assessments**  
In-depth analysis of catchment characteristics, infiltration rates, and watershed behavior will offer a more precise understanding of flood generation and movement.
- **Advanced Flood Modeling Techniques**  
Application of tools such as HEC-RAS (Hydrologic Engineering Centers River Analysis System) and HEC-HMS (Hydrologic Modeling System) will allow simulation of both hydraulic and hydrologic processes. These tools can provide detailed outputs for flood depth, extent, velocity, and timing across varying return periods.
- **Use of Real-Time Flood Data**  
Integration of real-time rainfall and river discharge monitoring can support dynamic flood forecasting and enhance emergency response mechanisms. Incorporating such live data can also validate and refine predictive models and zoning boundaries over time.

Transitioning from a planner-centric to a hydrologist-integrated approach will ensure that flood-based zoning systems are not only practical but also scientifically robust and resilient to future changes in climate and land use.

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## 8. Conclusion

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This study set out to evaluate existing river setback policies by examining both their effectiveness and the socio-economic value of riverfront areas. It also aimed to propose a more adaptive and resilient system for regulating development in flood-prone zones. While the 2065 Setback Policy was originally developed through a proper technical study, its implementation has been hampered by weak enforcement, overlapping institutional jurisdictions, and increasing economic pressure to utilize valuable riverfront land. These limitations have rendered the policy ineffective in protecting high-risk areas from repeated flood damage.

The findings reveal that riverfront zones, particularly along the Bagmati River and its tributaries, hold significant economic importance, contributing substantially to local business revenues and rental incomes. However, these same areas are highly vulnerable to frequent flooding, with many buildings incurring recurring financial losses. The existing setback approach fails to reflect this dual reality—overlooking both the socio-economic stakes and the actual flood risks—which has led to unregulated growth in hazardous zones and cumulative economic losses.

To address this challenge, the study proposes a flood-based zoning system informed by hydrological data and return period flood levels. This system introduces zoning classifications based on the 20-year and 100-year flood levels, dividing riverfront land into Prohibited, Restricted, and Green Zones. This approach allows for controlled and resilient development while ensuring that critical infrastructure and high-risk construction are excluded from vulnerable areas. It creates a framework that respects both safety and the economic utility of urban river corridors.

In conclusion, the study emphasizes the urgent need to shift from static, blanket setback policies to a dynamic, flood-responsive zoning framework. Such a system would provide a scientifically grounded basis for urban planning that is sensitive to both environmental risks and developmental needs, ultimately contributing to a safer, more sustainable urban future.

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काठमाडौं उपत्यका भित्रका नगरपालिका र नगरोन्मुख गा. वि. स. हरूमा गरिने निर्माण सम्बन्धि मापदण्ड, २०६४

काठमाडौं उपत्यका भित्रका नगरपालिका र नगरोन्मुख गा.वि.स.हरुमा गरिने निर्माण सम्बन्धी मापदण्ड, २०६४ (संसोधन)

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काठमाडौं महानगरपालिका भवन निर्माण मापदण्ड २०८०

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## **ANNEX**

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## Byelaws

काठमाण्डौ र ललितपुर नगर पालिका क्षेत्र तथा  
काठमाण्डौ उपत्यकाको शहर विस्तार  
क्षेत्र भित्र गरिने निर्माण सम्बन्धि

### मापदण्ड

नयाँ तथा ठारो निर्माण विषय ।

को मापदण्ड विषय ।

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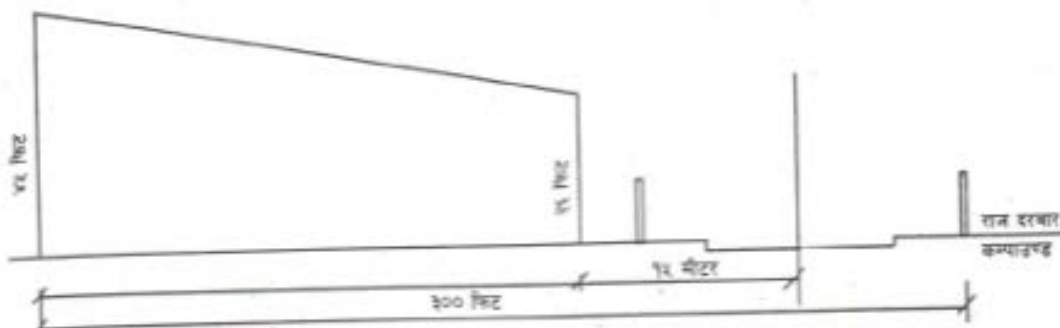
को मापदण्ड विषय ।

श्री ५ को सरकार

काठमाण्डौ उपत्यका नगर विकास समिति

२०५०

हुन्छ त्यही बमोजिमको उचाईमा घर निर्माण गर्न दिन सकिने छ । यसको स्केच निम्न बमोजिम हुने छ ।



फ्लोर एरिया रेसियो र ग्राउण्ड कभरेज र अधिकतम उचाई निम्न अनुसार छ

फ्लोर एरिया रेसियो	-	२०
ग्राउण्ड कभरेज	-	७० प्रतिशत

अधिकतम उचाई माथि दिइएको स्केच अनुसार हुने छ ।

११. खोला किनारामा निर्माण गर्ने सम्बन्धमा:-

बागमती, विष्णुमती, घोबीखोला, मनोहरा आदिका दायाँ बायाँ खोला छेउबाट २० मीटर छाडी मात्र निर्माण गर्न पाइने छ ।

१२. अपार्टमेन्ट बिल्डिङ निर्माण गर्ने सम्बन्धमा:- — ?

रिडरोड बाहिर आवासीय वा शहर विस्तार क्षेत्र भित्र कसले अपार्टमेन्ट बिल्डिङ कम्प्लेक्स ( कन्डोमिनियम) बनाउन चाहन्छ भने त्यस्ता जग्गा धनीहरूले निम्न अनुसार ग्राउण्ड कभरेज, FAR अधिकतम उचाई न्यूनतम पार्किङ स्थल र ओपन स्पेस हुनु पर्ने छ ।

- जग्गाको न्यूनतम क्षेत्रफल ... २ रोपनी — ?
- अधिकतम ग्राउण्ड कभरेज ... ४० प्रतिशत
- अधिकतम FAR (फ्लोर एरिया रेसियो)- ३
- अधिकतम बनाउन पाउने क्षेत्रफल - ३ गुना प्लटको क्षेत्रफल
- न्यूनतम पार्किङ स्थल - जम्मा जग्गाको १५ प्रतिशत
- न्यूनतम ओपन स्पेस - ४५ प्रतिशत जम्मा जग्गाको ।
- न्यूनतम सेटब्याक (दायाँ बायाँ र पछाडी पट्टी) ६ मीटर — २
- न्यूनतम सेटब्याक अगाडि पट्टी ... ८ मीटर

यसरी बनिने कन्डोमिनियमको भूईतला, बेस मेन्ट वा सेमी बेसमेन्ट आवासीय प्रयोजनको लागि नभै स्टोर, पार्किङ तथा अन्य सुविधाहरू जस्तै लिफ्ट बेल, इलेक्ट्रिकल रूप, पानी टंकी आदि राख्ने प्रयोजनको

(५१)

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काठमाडौं उपत्यका भित्रका नगरपालिका र  
नगरोन्मुख गा.वि.स.हरुमा गरिने निर्माण सम्बन्धी  
मापदण्ड  
२०६४



नेपाल सरकार  
भौतिक योजना तथा निर्माण मन्त्रालय  
काठमाडौं उपत्यका नगर विकास समिति  
अनामनगर ।

८. विमान स्थल क्षेत्र :- यो क्षेत्रमा त्रिभुवन अन्तर्राष्ट्रिय विमान स्थल क्षेत्र र सो बाट प्रमाणित क्षेत्रलाई जनाउँदछ । यस क्षेत्रमा विमान स्थलको विकास सम्बन्धी कार्य गर्न पाइनेछ ।
९. खेलकुद क्षेत्र :- यस क्षेत्रमा खेलकुद विकासका लागि तयार गरिएको दशरथ रंगशाला सानो गौचर आदि पर्दछन् । खेलकुद सम्बन्धी निर्माण कार्यको स्वीकृति सम्बन्धित निकायबाट लिनु पर्नेछ ।
- १० नारायणहिटी दरवार एरियाको मापदण्ड :-
- १०.१ नारायणहिटी दरवार कम्पाउण्डदेखि ३०० फिट सम्मको दूरीभित्र गरिने निर्माण सम्बन्धी मापदण्ड देहाय बमोजिम हुनेछ र सो बाहेकको क्षेत्रको हकमा जुन उपक्षेत्र भित्र पर्दछ, सो उपक्षेत्रको मापदण्ड लागू हुनेछ।
१. भईरहेको भवन भत्काई नयाँ भवन बनाउँदा भईरहेको भवन मर्मत गरी तल्ला थप गर्दा वा खाली रहेको जग्गामा नयाँ भवन निर्माण गर्दा अधिकतम उचाई ३० फिटसम्म राख्न सकिनेछ ।
  २. आफ्नो जग्गाको छेउबाट २ मिटर सेटब्याक छोडी निर्माण गर्न पाइनेछ ।
  ३. नयाँ भवन निर्माण गर्दा अधिकतम ग्राउण्ड कभरेज ८० प्रतिशत कायम गरिएको छ ।
  ४. नारायणहिटी दरवार कम्पाउण्ड देखि ६०० फिटसम्मको दूरीभित्रको कलकारखाना, वर्कसप ( ग्रील निर्माण मोटर तथा मोटरसाइकल मर्मत आदि कार्यको लागि ), खुल्ला माछा मासु पसल तथा पशुवधशाला, पेट्रोल पम्प तथा ग्याँस, मट्टीतेल जस्ता प्रज्वलनशील पदार्थहरूको भण्डार तथा ध्वनी र वायु प्रदूषण हुने खालको प्रयोग निषेध गरिएको छ ।
११. खोला किनारामा निर्माण गर्ने सम्बन्धमा :-
- वाग्मती, विष्णुमती, मनोहरा आदिका दायाँ बायाँ खोला छेउबाट २० मिटर छाडी मात्र निर्माण गर्न पाइने छ ।  
धोवीखोलाको हकमा धोविखोला आयोजना भएको स्थानमा Project को Planning अनुसार हुनेछ ।  
अन्य खोलाको हकमा अध्ययन प्रतिवेदन पेश गरिसकेपछि तोकिनेछ ।
१२. विविध :-
- नगर योजना लागू भएको क्षेत्रमा निर्माण (सुधार वा नयाँ निर्माण) गर्नको लागि सम्बन्धित नगरपालिका वा कार्यान्वयन समितिको लिखित स्वीकृत लिन अनिवार्य हुनेछ ।
  - कुनै व्यक्ति वा संस्थाले प्रस्तावित विकास कार्यको लागि आवश्यक परेमा सम्बन्धित कार्यान्वयन समितिबाट के कस्तो नियन्त्रण, निर्देशन इत्यादी हुन सक्नेछ भन्ने बारे जानकारी लिन सकिनेछ ।
  - हाल भएको घर, बाटो, ढल इत्यादी देखाइएको साइट प्लान सहित नक्सामा प्रस्तावित घर रहने जग्गा र मूल बाटोसँग कस्तो सम्बन्ध रहने छ, सो समेत देखाउनु पर्नेछ । उदाहरणको निमित्त बाटोको लाइन, चौडाई दायाँ बायाँ रुख रोप्ने हो भने यस्ता रुखहरू साथै ढल नाली इत्यादी भए सो समेत देखाउनु पर्नेछ ।
  - प्रस्तावित घरको साइट प्लान, प्लान, इलिभेसन तथा सेक्सन आदि खुलाइएको नक्सा दरखास्त पत्रसाथ पेश गर्नु पर्नेछ ।



नेपाल सरकार  
भौतिक योजना तथा निर्माण मन्त्रालय

काठमाण्डौ उपत्यका नगर विकास समिति, अनामनगर काठमाण्डौ

फोन नं. ४७७०२१९,  
४७७०२५८

काठमाण्डौ उपत्यका भित्रका नगरपालिका र नगरोन्मुख गा.वि.स.हरुमा गरिने  
निर्माण सम्बन्धी मापदण्ड, २०६४ मा संशोधन (पाना नं ३७)

(क) परिच्छेद २ को प्रकरण नं ११ र सोही परिच्छेदको प्रकरण ६.२ को देहाय १ र २ मा देहाय बमोजिम संशोधन गर्न नेपाल सरकार (मन्त्रिपरिषद्) बाट मिति ०६५।८।१ मा निर्णय भएको छ।

“खोला किनारामा निर्माण गर्ने सम्बन्धमा देहायको खोलाको नापीको नक्साबाट कायम रहेको छेउबाट दाँयाबाँया देहायका दुरी छोडी निर्माण गर्न पाइने छ” ।

- १) वरगमती, विष्णुमती र मनहरा खोलामा २० मीटर
- २) धोवीखोलाको हकमा धोवीखोला आयोजना भएको स्थानमा प्रोजेक्टको प्लानिङ अनुसारको दुरी र प्लानिङ बाहेकका स्थानमा -९ मीटर
- ३) नख्खु खोलामा -१२ मीटर
- ४) बल्खु, कर्मनासा, कोइकु, साङ्ले र महादेव खोलामा -१० मीटर
- ५) करखुसी खोलामा -६ मीटर
- ६) टुकुचा, सामाखुसी र उपत्यकामा बग्ने अन्य खोलामा ४ मीटर र कुनै पनि खोला, खोल्छी र राजकुलो छोप्न पाइने छैन।
- ७) हनुमन्ते खोला बग्ने क्षेत्रका नगरोन्मुख गा.वि.स.हरुमा समेत खोलाको किनारबाट २० मीटर छाडी निर्माण गर्न पाइने साथै मापदण्डको परिच्छेद २ को प्रकरण नं ६.२ को देहाय १ र २ मा रहेको FAR १.२५ को सट्टा १.५ कायम गर्ने” ।

(ख) नेपाल सरकार मन्त्रिपरिषद्को मिति ०६७।३।१४ को निर्णयानुसार देहाय बमोजिम संशोधन भएकोछ।

१. परिच्छेद २ को प्रकरण १२ को बुँदा ४ पछि देहायको बुँदा ४ क थप गरीएको छ।  
“ ४ क FLOOR AREA RATIO - (FAR) ३ (तीन) लिन चाहेमा चक्रपथ भित्रमा लागि निर्धारण गरिएको मापदण्डको अनुसरण तथा पालना गर्नु पर्नेछ।”
२. परिच्छेद २ को प्रकरण १२ को बुँदा ५ पछि देहायको बुँदा ६ थप गरिएको छ।  
“६ प्रवेशमार्गको हकमा परिच्छेद १ को खण्ड २ मा उल्लिखित प्रावधान अनुसार नै हुनेछ।”

## Review Letter of Supreme Court Decision

**श्री सर्वोच्च अदालतमा चढाएको  
पुनरावलोकनको निवेदन**

मार्फत: श्री महान्यायाधिवक्ताको कार्यालय, रामशाहपथ, काठमाडौं।

विषय: न्याय-प्रशासन ऐन, २०७३ को दफा ११(२) तथा मुलुकी देबानी कार्यविधि संहिता, २०७४ को दफा २२०(२) अन्तर्गत मुद्दा पुनरावलोकन गरी पाउँ।

संख्त २०६७ सालको रिट नं.-----WO-१००२/०६८-WO-००७४  
नेपाल सरकार, प्रधानमन्त्री तथा मन्त्रिपरिषद्को कार्यालयका तर्फबाट ऐ.का  
सचिव फणीन्द्र गौतम ----- पुनरावलोकनकर्ता  
प्रत्ययी

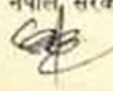
**विस्तर**

जम्हिल संरक्षण मञ्च प्रो.पब्लिकको तथा आफ्नो हकमा समेत काठमाडौं जिल्ला काठमाडौं महानगरपालिका बडा  
नं.१० बस्ने अधिवक्ता प्रकाशमणी शर्मा ----- विपक्षी  
रिट निवेदक

**मुद्दा: उत्प्रेषण, परमादेश**

यस कार्यालय समेतलाई विपक्षी बनाई सम्मानित अदालतमा दिनुभएको रिट नं.०६७- WO-१००२/०६८- WO-००७४ निवेदनमा मिति २०८०।०९।०३ गते परमादेशको आदेश जारी हुने गरी भएको फैसला मिति २०८१।०४।११ मा यस कार्यालयमा जानकारी प्राप्त हुन आएको हुँदा न्याय प्रशासन ऐन, २०७३ को दफा ११ को उपदफा (२) तथा मुलुकी देबानी कार्यविधि संहिता, २०७४ को दफा २२०(२) को अवस्था विद्यमान भएकोले नेपाल सरकार प्रधानमन्त्री स्तरको मिति २०८१।०५।३० को निर्णय अनुसार प्रस्तुत मुद्दा पुनरावलोकन गरी हेरी पाउन म्यादभित्रै निम्न प्रकरणहरुमा खुलाई यो पुनरावलोकन निवेदन पेश गर्दछु।

१. उल्लिखित रिट निवेदनमा काठमाडौं उपत्यकाभित्र रहेका पवित्र नदी जगमती र यसका सहायक नदीहरुमा प्रदुपण नियन्त्रण र अतिक्रमण हटाउने सन्दर्भमा तथा नदीको बहाव क्षेत्र, सीमा क्षेत्र समेतको सीमाङ्कन, सार्वजनिक क्षेत्रको संरक्षण गर्ने सम्बन्धमा भएको आदेशमा अन्य कुराका अतिरिक्त मुख्य गरी "जागमती र यसका सहायक नदीहरुको किनारामा के कति जग्गा दायाँ बायाँ छाड्ने भन्ने सम्बन्धमा नेपाल सरकार, मन्त्रिपरिषद्द्वारा मिति २०६५।०८।०१ मा निर्धारित दूरी बाहेक नै सबै खोलाको हकमा दायाँ बायाँ न्यूनतम अर्को थप २० मिटर छाडेर मात्र निर्माणको अनुमति प्रदान गर्ने, सो दूरीभित्र सरकारी जग्गा अतिक्रमण गरी बनाइएका संरचनाहरु हटाउने, कुनै नदी खोलाको हकमा सीमा नतोकिएको भएमा किनाराबाट दायाँ बायाँ न्यूनतम २० मिटर सीमा निर्धारण गर्ने, वप गरिएको दूरीमा हालसम्म कुनै संरचना नबनिसकेको अवस्था भए उक्त दूरीभित्र पर्ने जग्गालाई निर्माण निषेधित क्षेत्र घोषणा गरिएको हुँदा अब कुनै निर्माणको अनुमति प्रदान नगर्ने र कानून बमोजिम नक्सापास गरी पहिले नै भवन आदि संरचनाहरु निर्माण भइसकेको भए नदी किनारा क्षेत्रमा सडक, ढल वा प्रशोधन केन्द्र आदि संरचनाहरु निर्माण गर्न र नदी तथा खोलाहरुको सहज प्रवाहको लागि आवश्यक पर्ने जग्गा कानून बमोजिम क्षतिपूर्ति प्रदान गरी प्राप्त गर्ने" भनी परमादेशको आदेश जारी गर्ने गरी फैसला भएकोमा विषयमा नेपाल सरकारका निकायहरुलाई सो आदेशको



कार्यान्वयनमा संवैधानिक, कानूनी र व्यवहारिक समस्या सिर्जना हुने तथ्यहरू जानकारी हुन आएकोले उक्त फैसला देहायका कारण र आधारमा कार्यान्वयन गर्न नसकिने प्रकृतिको भएकाले न्याय प्रशासन ऐन, २०७३ को दफा ११ को उपदफा (२) को खण्ड (क) र (ख) तथा मुलुकी देवानी कार्याविधि संहिता, २०७४ को दफा २२० को उपदफा (२) बमोजिम पुनरावलोकन हुनका लागि देहायका तथ्यगत विवरण, कानूनी तथा सिद्धान्तिक आधारहरू पेश गर्दछु:-

(क) आदेशमा रहेका ईन्साफमा तात्त्विक असर पर्ने तथ्यहरू:

- (१) संवैधानिक सीमाभित्र रही सरकारले नागरिकको हित र मुलुकको विकासका लागि स्रोत र साधनको समुचित व्यवस्थापन गर्दै कमश कार्यान्वयन गर्नु पर्ने विषयमा कुनै विशेष नगरी, प्रभाव, असर सम्बन्धमा कुनै तथ्य, तथ्याङ्क पत्ता नसगाई भएको आदेश कार्यान्वयन गर्दा के कस्तो असर/प्रभाव पर्छ? के कति घरहरू, जग्गाहरू अधिग्रहण गर्नुपर्ने हुन्छ? यसरी अधिग्रहण गर्दा सोको क्षतिपूर्ति बापत के कति रकम आवश्यक पर्छ? सो कार्य गर्दा त्यस क्षेत्रमा बसोबास गर्ने जनता, बैंक तथा वित्तीय संस्था तथा सरकारलाई के कस्तो प्रभाव/असर पर्छ भन्ने सम्बन्धमा मिति २०८१।०५।१६ मा गठन भएको कार्यदलले मिति २०८१।०५।२५ मा दिएको प्रतिवेदन बमोजिम काठमाडौं उपत्यकामा १९ वटा खोलाहरू रहेको हुनाले ती खोलाको दायाँबायाँ अक्षात्को आदेश बमोजिमको क्षेत्रभित्र करीव ८,३०४ घर तथा टहराहरू र करीव ३० हजार रोपनी जग्गा समेटिने देखिन्छ। करीव ८,३०४ घर टहरामा आश्रित करीव ४२ हजार नागरिकहरू विस्थापनमा परी तिनीहरूको दैनिक जीवन तथा जिविकोपार्जनमा समेत प्रत्यक्ष नकारात्मक प्रभाव पर्ने र सोबाट राष्ट्रलाई आर्थिक रूपमा कटिनाई मात्र हुने नभई सामाजिक रूपमा समेत सो कार्य अस्वीकार्य हुने देखिन्छ। अदालतको आदेश वा फैसला पालना नहुनु वा सोका कारण समाजमा आर्थिक तथा सामाजिक विश्रुद्धिबलता शुरू हुनु न्यायपालिका स्वयंको हितमा समेत हुँदैन। अतः उक्त परमादेशको आदेश जारी हुने गरी भएको फैसला पुनरावलोकन हुन साधर निवेदन गर्दछु।
- (२) सम्मानित अदालतको आदेश कार्यान्वयन गर्दा यस सम्बन्धी प्राविधिकहरूबाट भएको प्रारम्भिक अध्ययनबाट उल्लिखित संरचना तथा जग्गाको मूल्य बमोजिम अधिग्रहण गर्न मात्र करीव रु.२१ खर्ब २६ अर्ब रकम लाग्ने, जुन रकम वर्तमान वार्षिक पुँजीगत खर्चको हिसाबले झण्डै सात वर्षको विकास बजेट बराबर हुने अनुमान गरिएको छ।
- (३) जाल सो क्षेत्रको घर जग्गालाई वैड तथा वित्तीय संस्थामा धरोट राखी धेरै व्यक्तिले कर्जा लिएको अवस्था छ। ती वैड तथा वित्तीय संस्थाको रकम समेत संकटमा पर्ने, सो क्षेत्रमा बसोबास गर्ने ठूलो संख्याका जनता पुनर्वास सम्बन्धी समस्यामा पर्ने, सरकार र सम्बद्ध निकायबाट प्रचलित कानून, मापदण्ड बमोजिम स्वीकृति, मान्यता दिएकोमा पुनः फरक मापदण्डका आधारमा सोही स्थानका जमिन तथा संरचना अधिग्रहण गर्नाले राज्यप्रति तीव्र असन्तोष उत्पन्न हुन सक्ने देखिन्छ। विगत केही समयपता हुँदै आएका विरोध प्रदर्शन, हस्ताक्षर संकलन लगायतका जनस्तरका स्वतः स्फूर्त अभियानहरूबाट यस कुराको पूर्वाभास भएको छ। साथै सात वर्षको विकास बजेटको रकम अन्य क्षेत्रमा विकासका लागि बाँडफाँट नगरी उपत्यकाको नदीको तटीय क्षेत्रको अधिग्रहणका लागि मात्र छुट्टयाउँदा देशका अन्य भू-भाग एवं क्षेत्रका नागरिकहरू विकासको अधिकारबाट वञ्चित हुन पुग्ने अवस्था सिर्जना भई नागरिकमा तीव्र असन्तुष्टि समेत पैदा हुन्छ। साथै उक्त कार्य सन्तुलित एवं समावेशी विकासको सिद्धान्त विपरित समेत हुन जान्छ। मुलुकको आर्थिक क्षमता



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भन्दा बाहिरको कार्य गर्नु भन्ने परमादेश कायम रहिरहने देखिँदैन। अतः देशको सात बर्षको विकास बजेट जस्तो विशाल धनराशी एउटै योजनाको लागि खर्च गर्न सम्भव नभएको तथ्य उल्लिखित समितिको प्रतिवेदन प्राप्त भएपछि अबगत हुन आएको कारण सम्मानित अदालतको उल्लिखित इन्साफमा नै तात्त्विक असर पर्ने देखिएको छ। उक्त आदेश "Quia impotentia excusat legem" अर्थात् (Because the performance is impossible, law releases the obligation) "परिपालना गर्न असम्भव भएमा कानूनले दायित्वबाट छुटकारा दिन्छ" भन्ने प्रसिद्ध कानूनी सूक्तिसमेतको विपरित छ। अतः सो परमादेशको आदेश जारी हुने गरी भएको फैसला पुनरावलोकन गरी पाउन निवेदन गर्दछु।

**(ख) स्थापित नजिर वा कानूनी सिद्धान्त प्रतिकूलको आदेश**

(१) नदी/खोला किनारामा के कति तटीय क्षेत्र छोड्ने भन्ने विषय नितान्त रुपमा कार्यपालिकाको कार्यक्षेत्रभित्र पर्ने विषय हो। यस्ता विषयमा भौगोलिक अवस्था, जनघनत्व, जग्गा तथा संरचना अधिग्रहण गर्दा लाग्ने अनुमानित लागत, झोबाट व्यक्ति संस्था, समुदाय, निकायलाई पर्ने प्रभाव/ असर समेतलाई मूल्याङ्कन, विश्लेषण गरी कार्यपालिकाले निर्णय गर्नुपर्नेमा उल्लिखित आदेश सो को प्रतिकूल छ। यस सम्बन्धमा रामकृष्ण काफ्ले, विरुद्ध प्रधानमन्त्री तथा मन्त्रिपरिषदको कार्यालय समेत भएको (ने.का.प.२०६७ नि.नं. ८३९०) मुद्दामा सम्मानित अदालतबाट प्रतिपादित, "सबै प्रकारका निर्णयमा अदालतले हस्तक्षेप गर्ने हो भने ती निकायको कार्य प्रणालीमा एकातर्फ अदालतको अनावश्यक हस्तक्षेप हुन पुग्दछ भने अर्को तर्फ अदालतको आदेश सधैं र सबै अवस्थामा कार्यान्वयनयोग्य हुन नसकी यस्तो विषय न्यायिक व्यवस्थापकीय मापदण्ड (Judicially manageable Standard) भन्दा बाहिर समेत पर्न आउने हुँदा नेपाल सरकार लगायत अन्य स्वायत्त निकायले लिने र लिनुपर्ने नीतिगत निर्णयका विषयमा अदालतले हस्तक्षेप नगरी स्वेच्छिक रुपमा न्यायिक आत्मसंयम (Judicial Self Restraint) अपनाउन बाञ्छनीय देखिन आउँछ" भन्ने सिद्धान्त विपरीत छ।

(२) उपर्युक्त आदेश सर्वोच्च अदालतबाट सन्दिप शाह समेत विरुद्ध काठमाडौं उपत्यका नगर विकास समिति समेत भएको मुद्दा (०७९-८१-०५२८) मा प्रतिपादित, "राज्यले नागरिकको बसोबासको अधिकारको सकारात्मक कार्यान्वयनको लागि संविधानले नै दायित्व सृजना गरिराखेको अवस्थामा कुनै नागरिकले आफ्नो सामर्थ्यबाट सृजना गरेको बसोबाससँग सम्बन्धित साम्प्रतिक हकमा अतिक्रमण गर्ने कुरा सामान्य अवस्थामा कल्पनासमेत गर्न सकिँदैन। नागरिकको मौलिक हकको रुपमा संविधानले स्थापित गरेको यस्तो अधिकार कार्यान्वयन गर्न राज्यलाई केही पूर्व तयारी आवश्यक पर्नु एउटा पक्ष हुन सक्छ तर भइरहेको बसोबास माथि हस्तक्षेप गरी यो हकको निर्बाध रुपमा उपभोगमा असर पुऱ्याउने काममा राज्य क्रियाशील हुन नहुने" भनी प्रतिपादित सिद्धान्त समेतको प्रतिकूल रहेको हुँदा सो परमादेशको आदेश जारी हुने गरी भएको फैसला पुनरावलोकन गरी पाउँ।

(३) सम्मानित अदालतबाट देवी महर्जन समेत विरुद्ध सडक विभाग (०७३-७०-०८५३) समेतको मुद्दामा मिति २०८०।०६।२२ मा आदेश हुँदा अन्य कुराका अतिरिक्त "विकास निर्माणका क्रममा विस्थापनलाई न्यूनतम गरिनु पर्ने र कम भन्दा कम व्यक्तिहरूलाई क्षति पुऱ्नेगरी विकास निर्माणका कार्यहरू गरिनुपर्छ" .....! विकल्पविहीन अवस्थामा बाहेक व्यक्तिको आश्रमको सुरभालाई असर

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पने गरी कुनै कार्य गर्नु हुँदैन" भन्ने समेत सिद्धान्त प्रतिपादन भएको छ। यस सिद्धान्तको सापेक्षतामा समेत उपर्युक्त परमादेशको आदेश जारी हुने गरी भएको फैसला पुनरावलोकनयोग्य छ।

(४) न्यायापालिका तथा कार्यपालिका बीचको अधिकार तथा अन्तरसम्बन्धताका विषयका सम्बन्धमा भारतीय सर्वोच्च अदालतले Divisional Manager, Aravali Vs. Chander Hass (2008)(1 SCC 683) को मुद्दामा न्यायापालिकाको अधिकारको सीमा तोक्दै भनेको छ: "We are compelled to make these observations because we are repeatedly coming across cases where judges are unjustifiably trying to perform executive or legislative functions. In our opinion, this is clearly unconstitutional. In the name of judicial activism, judges cannot cross their limits and try to take over functions which belong to another organ of the state.....Judges must know their limits and must not try to run the government." त्यसैगरी Indian Drugs and Pharmaceuticals Limited Vs. Workman (2007)(1 SCC408) को मुद्दामा भारतीय सर्वोच्च अदालतले बजारमा उपलब्ध रोजगारीका अवसरहरू सीमित भएको कारण हरेक व्यक्तिले रोजगारी पाउने पर्दछ भनी भारतीय संविधानको धारा २१ (जीवनको हक) लाई व्याख्या गर्न सकिँदैन र यसमा न्यायिक आत्मसंयमता अपनाउनु पर्छ भनी स्पष्ट गरेको छ। भारतीय राजधानी दिल्लीलाई सफा बनाउन भनी दायर भएको अर्को एक मुद्दा (Almitra H. Patel Vs. Union of India, 2000) मा भारतीय सर्वोच्च अदालतले भनेको छ, "..... Court could only assign authorities to carry out the duty assigned as per law. It is not for the Supreme Court to direct them on how to carry out their essential functions and resolve their difficulties."

(५) अमेरिकन सर्वोच्च अदालतले Colegrove Vs. Green (1946) मा "We are of opinion that the petitioners ask of this court what is beyond its competence to grant. This is one of those demands on judicial power which cannot be met by verbal fencing about "Jurisdiction". It must be resolved by consideration on the basis of which this court, from time to time, has refused to intervene in controversies." भनेको छ।

२. प्रस्तुत रिट निवेदनमा सम्मानित अदालतबाट आदेश हुँदा रिट निवेदकले दावी जिकिर नै नलिएको विषयमा प्रवेश गरी आदेश हुन पुगेको छ। नदी किनाराका दायाँ बायाँ थप २० मिटर छोड्ने गरी आदेश गराई पाउँ भन्ने मागदावी नै रहेको छैन। यो आदेश सम्मानित अदालत स्वयंबाट प्रतिपादित तथा माथि उल्लिखित सिद्धान्त समेतको प्रतिकूल छ।
३. खोला वा नदी किनाराको तटीय क्षेत्र कायम गर्ने सम्बन्धी प्रचलित कानूनी व्यवस्थाबाट कुनै नकारात्मक प्रभाव नपरिरहेको वर्तमान सन्दर्भमा सम्मानित अदालतको उपर्युक्त आदेशबाट थप सकारात्मक प्रभाव पर्ने समेत नदेखिएको हुँदा सो आदेश पुनरावलोकन गरी पाउँ।
४. अतः माथि प्रकरण-प्रकरणमा उल्लिखित आधार र कारण एवं नजिर समेतका आधारमा सम्मानित सर्वोच्च अदालतबाट भएको परमादेशको आदेश जारी हुने गरी भएको फैसला पुनरावलोकन गरिपाउन सादर निवेदन गर्दछु।
५. यस कार्यालयको तर्फबाट उपस्थित हुने विद्वान सरकारी वकिलको बहस पैरवीलाई यसै पुनरावलोकनको अभिन्न अङ्ग मानी पाउँ।
६. सम्बन्धित फैसलाको प्रतिलिपि यसैसाथ संलग्न छ।



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(फणीन्द्र गौतम)  
सचिव

इति संवत् २०८१ साल भदौ महिना ३१ गते रोज ०२ शुभम्।

# Questionnaire Survey



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## Site Photos





## Bagmati River



## Dhobi Khola



# Key Informant Interview



Figure 28:KII with Saurab Dhakal, an engineer and information officer at KVDA



Figure 27:KII with Udhav Nepal, an engineer and information officer at KVDA



Figure 30: KII with Baburam Bhattarai, an architect and member of City Planning Commission at KMC



Figure 29:KII with Pradip Paudel, an engineer and head of Infrastructure Division at LMC

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## **IOE Graduate Conference Letter and Paper**



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फोन: ०१-५३३९७६६

Date: April 21, 2025

To Whom It May Concern:

This is to certify that the paper titled "Evaluating River Setback in Kathmandu Valley: Integrating Socio-Economic Factors into Policy Development" (Submission# 217) submitted by Binisha Shahi as the first author, which had been accepted for presentation after the peer-review process, has successfully been presented at the 16<sup>th</sup> IOE Graduate Conference held during April 18 - 20, 2025. Kindly note that the final revision of the papers and publication process of the conference proceedings is still underway and hence inclusion of the accepted manuscript in the conference proceedings is contingent upon timely response to further edits during the publication process.



*Raj Kumar Chaulagain*

Dr. Raj Kumar Chaulagain,  
Convener,  
16<sup>th</sup> IOE Graduate Conference



# Evaluating River Setback in Kathmandu Valley: Integrating Socio-Economic Factors into Policy Development

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## Abstract

Evaluation of river setback policies in Kathmandu Valley reveals significant challenges due to rapid urbanization and encroachments on riverbanks, particularly along the Bagmati and Dhobikhola rivers. Existing setbacks, ranging from 4 to 20 meters, are inconsistent and poorly enforced, exacerbating flood risks and environmental degradation. High land values and rental rates in riverfront areas complicate enforcement, with some areas showing significant urbanization and infrastructure development. A flexible, hydrology-based approach to setback regulations is necessary, integrating flood risk assessments, green infrastructure, and socio-economic factors. Strengthened coordination among agencies and revised legal frameworks are crucial for effective implementation and balancing urban development with environmental conservation.

## Keywords

River Setback, River Buffer, Socio-economic factors, River Regulation, Legal framework

## 1. Introduction

Rivers have historically been central to human settlements, providing essential resources such as water, navigation routes, and livelihoods. Ancient cities such as those along the Nile, Ganga and Huang-Ho, and modern cities such as London, Paris, and Delhi, have thrive because of use of their proximity to rivers. This symbiotic relationship offers tangible and intangible benefits, including water supply, biodiversity, recreation, and religious significance. [1] Nowadays, rivers are the life force that can make our cities sustainable. However, rapid urbanization along riversides, if not managed sustainably, can threaten ecosystems, biodiversity, and overall environmental health. Also, due to their intrinsic ties with nature, human settlements on rivers are particularly vulnerable to climate change, facing strong environmental and socioeconomic consequences of natural disasters, floods, wildfires, and droughts, which exacerbate issues such as food and water security, as well as air quality. [2]

Nepal is rich in water resources with more than 6000 rivers and rivulets distributed in different river basins.[3]. Bagmati a holy river of the Hindus and a major source of water for the Kathmandu Valley, has been deteriorated due to human activities such as settlement along the river side, unplanned urbanization in the river, the construction of public infrastructure in river space, and illegal settlements of squatters along the bank.[4]

A river buffer or setback is a defined area along a watercourse that is to be protected from development for the purpose of preserving the natural benefits and reducing the hazards risks of such areas. They help preserve stream banks and natural vegetation. Buffers and setbacks are enforced through local ordinances and codes and are used to limit or prohibit certain types of (or all) development within them. [5]

The Kathmandu Valley, home to an expanding urban population, is increasingly vulnerable to environmental

hazards like flooding, land erosion, and habitat loss, especially along its rivers. Every year, during the monsoon season, most of the rivers pose great threat to such people and sometimes cause widespread damage to the life and property.[6] The development of appropriate river setback policies is critical to mitigate these risks and protect both the environment and the socio-economic well-being of its residents. Finding the right balance between the natural character of the river, and the introduction of city structures into its course, leads to the creation of a balanced space, naturally utilized by city dwellers .[7]

## 2. Problem Statement

Rapid urbanization and the increasing demand for land in the Kathmandu Valley have led to significant encroachments on riverbanks, exacerbating environmental degradation, increasing flood risks, and undermining the ecological balance of the region. Various legal and policy frameworks have been introduced to establish and enforce river setbacks, but inconsistencies in implementation, overlapping jurisdictions, and varying setback requirements have limited their effectiveness.

The Building Byelaws 2050 of Kathmandu and Lalitpur states that “Construction is prohibited within 20 meters on either side of rivers like Bagmati, Bishnumati, and Dhobikhola.” [8] The Kathmandu Valley Building Byelaws 2064 reaffirmed this but allowed variations for others such as 9 meters for Dhobikhola under project-specific planning [9]. A subsequent amendment to the 2064 guidelines standardized these setback distances with specific measures like Bagmati, Bishnumati, Manohara, and Hanumante Rivers: 20 meters, Dhobikhola: In the area of Dhobikhola Project Planning, according to Dhobikhola Project Planning and other area 9 m, Nakhhu River: 12 meters, Balkhu, Karmanasha, Kodku, Sangle, and Mahadev Rivers: 10 meters, Karkhushi River: 6 meters, Tukucha, Samakhushi, and others:

4 meters. [10]

The Supreme Court issued a landmark ruling requiring an additional 20-meter open space along riverbanks on Shrawan 11, 2081, to strengthen conservation efforts. However, this decision was challenged by the government on Bhadra 30, 2081, citing procedural irregularities and potential conflicts with existing laws. The government also raised concerns about “the practicality of implementing such broad measures in densely urbanized areas.

Despite the establishment of various legal and policy frameworks to regulate river setbacks in the Kathmandu Valley, inconsistencies in implementation, overlapping jurisdictions, and varying setback requirements have led to ineffective enforcement, resulting in continued riverbank encroachment, environmental degradation, and increased flood risks.

### 3. Research Objective

The primary objective of this study is to evaluate the existing river setback policies in Kathmandu Valley by considering socio-economic factors. Specifically, the research aims to:

- Assess the effectiveness of current river setback policies by determining the economic value of riverfront area
- Propose an effective system for river setback regulation

### 4. Methodology

This research develops a framework to evaluate river setback policies in Kathmandu Valley, integrating socio-economic factors to inform evidence-based guidelines. The conceptual framework operates within a pragmatic paradigm, acknowledging both scientific data and local socio-economic realities by integrating multiple analytical approaches. It focuses on utilizing grid-based land cover mapping, questionnaire surveys, Key Informant Interviews (KIIs), and land value and rent analysis to create evidence-based, context-sensitive river setback guidelines. The study is grounded in a pragmatic paradigm that combines quantitative and qualitative methods, allowing for both scientifically robust data and in-depth community insights to inform policy development.

### 5. Literature Review

River setback is a tool for standardised development within the river zone. It is defined as a defined area along a watercourse that is to be protected from development for the purpose of preserving the natural benefits and reducing hazards risks of such areas. Setbacks help reduce or eliminate the adverse effects of land development on the natural and beneficial functions of the water course and provide many other benefits. [5]

Study of Evaluation of Buffer Zone in Haraz River, Iran provides a comprehensive methodology for determining river buffer zones, with an emphasis on integrating environmental and socio-economic factors. The combination of technical

factors, such as hydrology and morphology, with human-induced parameters, like land use and socio-economic activities, creates a balanced approach for river management.[11]

The international approaches used to determine required buffer zone widths varied considerably, with three generic approaches identified: Fixed-width, which applies a standard buffer width to a particular water resource type; Modified fixed-width, which uses a matrix of factors to categorize wetlands and land uses with category-specific standard buffer widths; and Variable width, which requires site-specific factors such as wetland type, adjacent land use, vegetation, soils, wildlife habitats, slope, and other characteristics to calculate buffer widths. [12]

Dynamic zonation is a key principle in river setback regulations, where setbacks are adjusted based on the type of river, flood risks, and the surrounding topography. For example, floodplain rivers often require larger setbacks than mountain rivers with steeper gradients, where the flood risk is lower. The River Regulation Zone (RRZ) of India, 2016 categorizes rivers by type and flood risk, with setbacks ranging from 500 meters in unembanked floodplain areas to 5 meters to 50 meters for mountain rivers .[1]

Activity classification involves regulating the types of activities permitted in different setback zones through a tiered approach that allows low-impact activities in sensitive areas while restricting high-impact developments. The Draft River Conservation Zone Rules of India, 2012 divides riverfronts into zones such as the No Development Zone (NDZ) and High Impact Zones (HIZ) and Medium Impact Zones (MIZ) .[1]

Flood mitigation through flood recurrence data is essential for reducing the risk of flood damage. The Pune and Nashik Municipal Corporation Development Regulations, 2015 establish Blue Flood Lines (for a 1-in-25-year flood event) and Red Flood Lines (for a 1-in-100-year event), with construction prohibited within the Blue Flood Line .[1]

Public use and conservation of riverfronts enhance socio-economic value by integrating green spaces, recreational areas, and public amenities. The Bihar Building Bye-Laws, 2013 set 200-meter setbacks from the Ganges River, limiting development to government-led conservation efforts, such as parks and beautification projects .[1]

### 6. Study Area

This study focuses on two specific river stretches: Bagmati River (Shankhamul Small Bridge to Thapathali Bridge)-1.8 km Stretch and Dhobikhola River (Budhanagar Bridge to Anamnagar Bridge)-0.94 km Stretch. These stretches were selected because they highlight critical urban-river interactions. The Bagmati River stretch reflects long-standing informal and commercial encroachments, while the Dhobikhola stretch showcases infrastructure expansion. Both areas involve residential, commercial, and infrastructure development conflicts, making them ideal for studying the economic impact of setbacks.

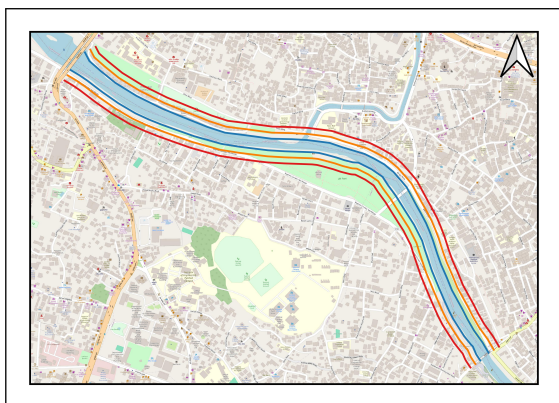


Figure 1: Bagmati Stretch

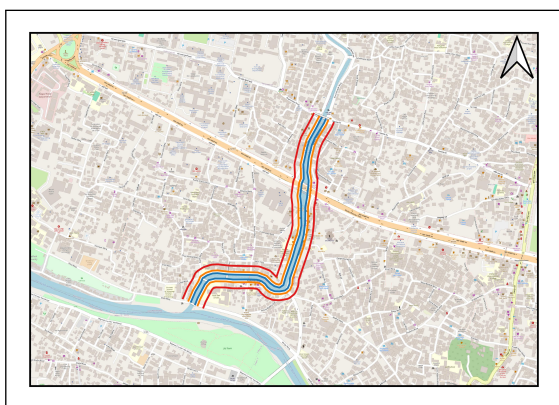


Figure 2: Dhobikhola Stretch

## 7. Data Analysis

### 7.1 Grid-Based Land Cover Mapping

The analysis combines grid-based land cover mapping with socio-economic factors to provide insights into the challenges and opportunities for defining appropriate river setback guidelines. Grid-based model is an effective and new approach for urban land use classification, which can be flexibly extended and applied to various cities. [13]. Each grid was visually assessed, and land cover categories were assigned based on direct observations, yielding a clear understanding of how the land in these zones is utilized.

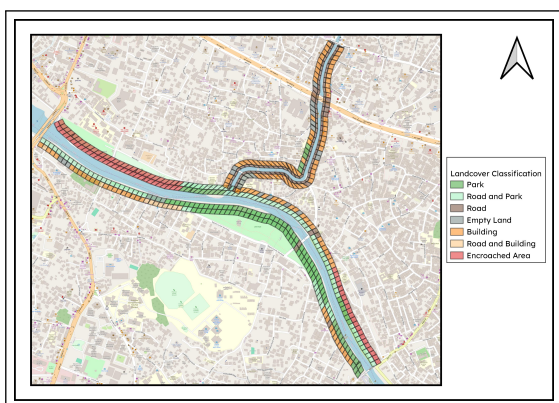


Figure 3: Grid-Based Land Cover Mapping

In the 20m setback zone of Bagmati Khola, the primary land

cover features include Road and Park (40.85%), Park (39.00%), and Encroached (16.79%), indicating mixed-use areas and significant encroachment concerns. The 40m setback zone shows substantial urbanization with Building (29.61%) and Encroached (28.49%), highlighting increased development pressures. The 9m setback zone of Dhobi Khola is dominated by Road (100.00%), reflecting the absence of natural areas, while the 29m setback zone has Building (70.02%) as the dominant land cover, signifying significant urban encroachment. The research reveals significant urbanization and encroachment in the river setback zones, especially along Bagmati Khola and Dhobi Khola. In the 40m setback zone of Bagmati Khola and the 29m setback zone of Dhobi Khola, over 60% of the land is developed, disrupting the rivers' natural functions. A critical issue identified is the absence of green infrastructure, particularly in the 9m setback zone along Dhobi Khola, which is dominated entirely by roads. Socio-economic pressures are a driving force behind the development of river setback zones, with the demand for residential and commercial spaces often leading to encroachment into these sensitive areas.

Urbanization within setback zones poses significant environmental risks, particularly in terms of flood vulnerability, as natural land cover is replaced by infrastructure. Enforcing an additional 20m setback on both rivers would present significant challenges, particularly in urbanized areas such as Dhobi Khola, where nearly 70% of the area is occupied by buildings

### 7.2 Questionnaire Survey

The questionnaire survey focused on assessing the socio-economic conditions of buildings near riverbanks. The primary objective was to collect data on building characteristics, usage, ownership, and construction materials. It also evaluated adherence to building regulations and examined the effects of river proximity on businesses and residents.

#### Building Category and Usage

Most of the buildings in the survey area are categorized as either commercial (66.7%), including shops, offices, and businesses, or mixed-use (33.3%), combining residential and commercial purposes. The dominance of commercial properties highlights the significant economic activity in these areas. A substantial proportion of the buildings are rented (58.3%) or leased (25%), indicating that the area is more business-oriented than residential. The primary uses of these buildings include retail (29.2%), food and beverage (20.8%), and services (20.8%), which typically attract foot traffic and benefit from proximity to major transport routes. Notably, 17.4% of the buildings are classified as informal, meaning they encroach on the riverbank.

#### Building Structure

In terms of building structure, 69.6% of the buildings were constructed between 2070-2080 BS, indicating recent development in these areas. The majority (63%) have metal structures with CGI sheet roofs, which are favored for their low construction costs, flexibility for future modifications, and faster construction times. The average number of floors across

buildings is one to two (29.2% each), with 20.8% comprising multi-story buildings that employ higher construction standards.

### Socio-Economic Character

The socio-economic character of the area reveals a strong commercial focus. Approximately 79.2% of property owners do not reside on the premises, reinforcing the area's commercial dominance. Business revenues vary significantly, with 30.4% of businesses earning Rs. 50,000 to Rs. 1,00,000 monthly, 26.1% earning Rs. 1 to Rs. 5 lakh, 13% earning Rs. 5 to Rs. 10 lakh, and 17.4% exceeding Rs. 10 lakh per month. This indicates a diverse economic base, ranging from small-scale to high-revenue businesses. Additionally, 38.1% of buildings generate Rs. 20,000 to Rs. 50,000 in monthly rental income, reflecting strong demand for commercial rental spaces.

### Flood Impact

Flooding poses a significant threat to the area. The survey found that 66.7% of buildings have experienced flooding, with 62.5% reporting flood levels between three to five feet. Among the affected buildings, 43.8% faced financial losses estimated between Rs. 1 to Rs. 5 lakh. Frequent flooding leads to substantial financial losses, increased repair costs, disruptions in business operations, risks to livelihoods, and threatens the overall socio-economic stability of the area.

### Socio-Economic Importance vs. Flood Risks

The survey underscores the tension between the socio-economic importance of riverfront areas and their vulnerability to flooding. While these areas are attractive for businesses due to their accessibility, they are highly susceptible to flood damage. There is also a high prevalence of informal construction and non-compliance with building regulations, highlighting the need for stricter enforcement of setback guidelines. Comprehensive river setback policies should extend beyond physical boundaries to address land use, construction practices, and flood resilience, ensuring a balanced approach to urban development and disaster risk management.

## 7.3 Key Informant Interview

The Key Informant Interviews (KII) were conducted with officials from Kathmandu Valley Development Authority (KVDA), High-Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC), Kathmandu Metropolitan City (KMC) and Lalitpur Metropolitan City (LMC) to gain insights into the policies, challenges, and future directions of river setback regulations in Kathmandu Valley. The interviews focused on understanding the roles, perspectives, and challenges faced by these institutions in planning and enforcing river setbacks.

The first interview with Saurab Dhakal, an Engineer and Information Manager at KVDA, explored the agency's role in urban planning and river conservation within Kathmandu Valley. It discussed the Comprehensive Physical Master Plan, which integrates urban development and river conservation, and highlighted policy conflicts, enforcement challenges, and necessary improvements in river setback regulations. KVDA emphasized the need for stricter enforcement of bylaws and

better coordination with other agencies. Additionally, the use of flood modeling to determine appropriate setbacks was discussed, along with KVDA's efforts in developing a more structured approach to urban development through the Comprehensive Physical Master Plan and land pooling projects. The Bagmati Action Plan was also reviewed as an ongoing initiative to restore riverbanks and mitigate flood risks.

The second interview with Udhav Nepal, an Engineer and Deputy Head of Information at HPCIDBC, focused on river conservation policies, existing setback regulations, and urban planning integration. HPCIDBC emphasized the challenges posed by the Supreme Court's ruling requiring a 20-meter additional setback, which it deemed impractical due to economic and social implications, such as the displacement of thousands of residents and loss of economic assets. HPCIDBC suggested enforcing existing setbacks, removing encroachments gradually, and adopting alternative approaches like flood zoning. It also recommended using hydrological analysis to determine setbacks, rather than relying on arbitrary legal mandates. The interview stressed the importance of revising the legal framework to incorporate scientific research, socio-economic considerations, and flexible urban strategies. HPCIDBC also advocated for the integration of green infrastructure and flood management strategies to reduce flood risks and promote sustainable urban development. Furthermore, it highlighted the need for stronger coordination among relevant agencies to improve the effectiveness of river setback policies.

The third interview was conducted with Baburam Bhattarai from Kathmandu Metropolitan City (KMC), focusing on municipal-level enforcement of river setback policies. The discussion covered challenges related to urbanization, legal conflicts arising from the Supreme Court ruling, and socio-economic impacts on landowners and businesses. KMC highlighted the need for clearer regulatory alignment and innovative solutions for sustainable river management.

The fourth interview was conducted with Pradip Paudel from Lalitpur Metropolitan City (LMC), examining local urban planning strategies, policy alignment with federal directives, and enforcement hurdles. The discussion addressed the Supreme Court ruling's influence on LMC's planning approach, concerns about displacement, and the importance of flood-based zoning and green infrastructure. LMC emphasized the need for a balanced approach to setbacks that considers both environmental and socio-economic factors.

## 7.4 Land Value

Land value plays a crucial role in urban planning, particularly when it comes to implementing river setback regulations. When it comes to urban areas, land values increase will be much related to strategic site (location factor) that associated with the ease of broad range or access to transportation system and its location to other land uses or urban configuration. [14] The economic importance of land near river corridors directly influences real estate development, environmental conservation, and urban expansion. Understanding the financial implications of setback policies is vital for creating a balanced approach that integrates both

economic and environmental considerations.

For this analysis, land price data were gathered from multiple online real estate platforms such as Nepal Home Search, 99 Aana, Lalpurja Nepal, Hamrobazaar, and eProperty Nepal. These platforms offer insights into market rates based on location, size, and demand, reflecting the economic landscape of land near river corridors.

In Kathmandu Valley, significant variations in land prices were observed in two major locations near river corridors. In Anamnagar, which is adjacent to the Dhobi Khola, the price per aana ranges from NPR 70 lakh to NPR 1.5 crore, with an average price of NPR 1.03 crore per aana. Similarly, in Shankhamul, located near the Bagmati Khola, the price per aana varies between NPR 75 lakh and NPR 90 lakh, with an average price of NPR 83.67 lakh. These price variations reflect the high demand for urban land near riverfronts and their strategic significance in Kathmandu's real estate market.

To assess the economic impact of river setbacks, the total land value in designated setback areas was estimated. For the Bagmati River, with a 40-meter setback zone, the total land area is 48,797.58 sq.m., with an average land price of NPR 2.90 lakh per square meter, resulting in an estimated total land value of NPR 14.15 Arba. For the Dhobi Khola, with a 29-meter setback zone, the total land area is 32,422.72 sq.m., with the same average price per square meter, leading to an estimated total land value of NPR 9.40 Arba.

In total, the combined land value for both river setback zones amounts to NPR 23.55 Arba. This significant economic valuation underscores the financial implications of implementing river setback policies, as such regulations could greatly impact property owners, real estate developers, and the overall land use patterns in the area.

## 7.5 Average Monthly Rent

The analysis of rental prices from survey responses reveals a range of monthly rent amounts categorized into four groups: NPR 5,000 – 10,000, NPR 10,000 – 20,000, NPR 20,000 – 50,000, and more than NPR 50,000. The NPR 5,000 – 10,000 category accounts for 21.05% of responses, representing those paying lower rents. The NPR 10,000 – 20,000 category also makes up 21.05%, indicating moderate rent payments. The NPR 20,000 – 50,000 category, at 36.84%, is the most common, while the above NPR 50,000 category also represents 21.05% of responses, showing premium rent payments.

The market distribution shows that 42.1% of respondents pay less than NPR 20,000, while 57.9% pay NPR 20,000 or more. The calculated average monthly rent is NPR 29,211, suggesting that higher rent values (above NPR 20,000) influence the overall average. With that average the rent price is NPR 29.211 per square foot, which is equivalent to approximately NPR 314.42 per square meter.

Key river areas like the Bagmati River (40-meter setback zone) and Dhobi Khola (29-meter setback zone) contribute rental areas of 1,597.947 sq. m. and 26,445.832 sq. m. respectively, totaling 68,043.779 sq. m. Considering a Floor Area Ratio (FAR) of 1.5, the total rent for the area under study reaches approximately NPR 32,091,924.63 (3.20 crores) per month.

This data emphasizes the socio-economic significance of riverfront properties, where rental values can impact land use decisions. Integrating such economic factors into the development of river setback policies is essential to balancing urban growth and environmental preservation.

## 8. Discussion

The analysis of the study stretch area reveals that the riverfront land holds an estimated value of NPR 23.55 Arba and generates approximately NPR 3.20 crores in monthly rent. This underscores the substantial economic value of the riverfront for local businesses and the overall urban economy. However, this economic potential is accompanied by a significant vulnerability to flooding, which poses a major risk to both property and business continuity.

According to the study, 66.7% of buildings in the riverfront area experience flooding, resulting in considerable structural damage and financial loss. Among these buildings, 43.8% face financial losses ranging from NPR 1 to 5 lakh. The overall economic impact of flood-related damage and business disruptions is estimated to be between NPR 1 to 2 Arba.

Managing flood risk requires navigating a complex trade-off between development and safety. While strict building setbacks can significantly reduce flood risk by preventing construction in vulnerable zones, they also result in a loss of usable land and a decline in revenue from riverfront properties. On the other hand, permitting unchecked development in flood-prone areas increases exposure to flood damage and endangers human lives and economic assets. Therefore, a strategic zoning system that carefully balances these competing priorities is essential for achieving sustainable and resilient urban development.

The approach is to adopt models like those used in the Pune and Nashik Municipal Regulations (2015). These regulations employ a system based on flood recurrence data to determine construction zones. The Blue Flood Line represents the area at risk during a 1-in-25-year flood event, where construction is strictly prohibited. Between the Blue and Red Flood Lines—corresponding to a 1-in-100-year event—development is allowed, provided structures are built at elevated levels to avoid flood damage.

The implementation of a flood zoning system requires comprehensive data inputs, including hydrological data such as rainfall records, catchment characteristics, land use patterns, soil types, slope gradients, and river discharge rates, as well as hydraulic data like river cross-sections, materials, water levels, and structural barriers. Accurate geospatial and topographical information, such as elevation models and floodplain boundaries, is also crucial. Much of this data can be sourced from the Bagmati Action Plan, which provides detailed hydrological and flood modeling for the Bagmati River Basin, including critical parameters like precipitation levels, flood discharge rates, and waterway dimensions, along with flood data for various return periods, supporting the development of a scientifically informed and locally relevant flood zoning system.

### 8.1 Minimum Width Requirement for Natural Waterways – Bagmati Action Plan Context

The Bagmati Action Plan (BAP) calculates the minimum required width for natural waterways using Lacey’s empirical formula for regime width:  $W = 4.75Q$ , where  $Q$  is the maximum discharge corresponding to a given return period. This formula is applied to estimate the ideal width needed to accommodate peak discharges, such as those from a 50-year return period. For wide rivers like the Bagmati, the wetted perimeter is approximately equal to the river’s width. However, urbanization in areas like the study stretch of the Bagmati River poses a significant challenge, as buildings and infrastructure occupy the space required for the theoretical flow regime. For example, the river’s actual width of 40 meters contrasts with the recommended minimum regime width of 118 meters based on a 50-year discharge. The practical objective of this study is not to redesign the river channel to meet theoretical width requirements but to assess how much water the river can realistically accommodate under current conditions during various flood return periods. This will inform the creation of flood risk zones in the river corridor, helping to guide future land use planning, flood mitigation, and development control while considering existing infrastructure and improving flood resilience.

### 8.2 Formation of Return Period Peak Discharge Lines

Peak discharge ( $Q$ ) refers to the maximum flow rate during a rainfall event and is crucial for flood modeling and zoning, influencing how much water a river must accommodate during different return periods (e.g., 20-year, 50-year, 100-year floods). The Rational Method is commonly used to estimate peak discharge with the formula:

- $Q = CIA$

Where:

- $Q$  = Peak discharge ( $m^3/s$ )
- $C$  = Runoff coefficient (depends on land use, soil type, and surface conditions)
- $I$  = Rainfall intensity ( $mm/hr$ )
- $A$  = Area of the watershed (hectares or  $km^2$ )

Rainfall intensity ( $I$ ) is calculated as:

$$I = P / t$$

- $P$  = Precipitation amount ( $mm$ )
- $t$  = Duration of rainfall (time of concentration for the watershed)

### 8.3 Peak Discharge Analysis for Different Return Periods

The Bagmati Action Plan (BAP) provides precipitation data and computed peak discharges for the 50-year return period. This data, along with assumptions about other parameters, can be used to estimate peak discharges for other return periods. The intensity values for the 2-year, 10-year, 20-year, 50-year, and

100-year return periods are calculated and used in the Rational Method to derive corresponding peak discharges. The peak discharge values for various return periods in different sub-basins are as follows:

**Table 1:** Data given in Bagmati Action Plan II [15]

S.N.	River	Sub-basin	50-YRP Precipitation (mm)	50-YRP Flood Discharge ( $m^3/s$ )	Required Waterway (m)
1	Bagmati Khola	Sub-basin 8	140.5	626.9	118.93
2	Dhobi Khola	Sub-basin 17	143.09	46.6	32.43

### 8.4 Cross-Sectional Area and Its Role in Flood Analysis

The cross-sectional area ( $A$ ) of a river represents its flow-carrying capacity and is crucial for hydraulic modeling and flood level estimation. The median grain size ( $D$ ) of the riverbed material influences the silt factor ( $f$ ), calculated using the formula:

$$f = 1.75 \times D$$

The silt factor helps determine the riverbed’s resistance, which affects flow velocity. The discharge ( $Q$ ), measured in cubic meters per second ( $m^3/s$ ), varies depending on the return period. For instance, peak discharges for the Bagmati River during the 20-year and 100-year floods are  $540.03 m^3/s$  and  $692 m^3/s$ , respectively, and for Dhobi Khola, they are  $39.63 m^3/s$  and  $51.83 m^3/s$ .

The average flow velocity ( $V$ ) is calculated using:

$$V = ((Q \times f^2) / 140)^{1/6}$$

The cross-sectional area ( $A$ ) is then derived from:

$$A = Q / V$$

This provides the flow area in square meters ( $m^2$ ) necessary to accommodate the discharge at the given velocity.

### 8.5 Flood-Based Zoning System for Bagmati River

The proposed flood-based zoning system for the Bagmati River integrates hydrological analysis with existing land use to guide safer and more sustainable development along the river corridor. This zoning is informed by flood level estimations for various return periods and is marked using distinct reference lines and corresponding land use restrictions.

- The Blue Line represents the river edge, indicating the natural boundary of the watercourse.
- The Red Line denotes the existing 20-meter setback line, as prescribed by 2065 Byelaws regulations
- The Yellow/Brown Line corresponds to the flood level for a 20-year return period

- The Green Line represents the flood level for a 100-year return period, showing the maximum expected flood extent under severe conditions

Based on these lines, the river corridor is divided into four distinct zones: The Blue Line represents the river edge, indicating the natural boundary of the watercourse.

- Prohibited Zone: This is the area between the Blue Line (river edge) and the Red Line (setback line).
- Restricted Zone I: This zone lies between the Red Line and the Yellow/Brown Line and/or between the Red Line and the 100-year flood level (Green Line) where the water depth is expected around 2 meters.
- Restricted Zone II: This area lies between the Yellow/Brown Line (20-year level) and the Green Line (100-year level) where the flood depth ranges up to 1m.
- Green Zone: This zone lies beyond the Green Line, where the 100-year flood level is at or near 0 meters of depth.

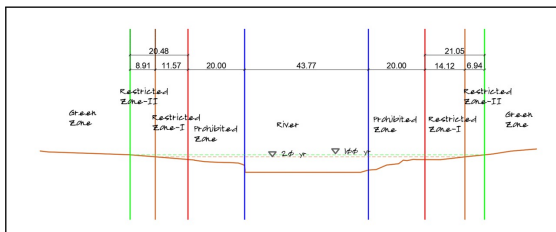


Figure 4: Flood-Based Zoning System for Bagmati River

Widths from River Edge

- Prohibited Zone: 0–20 m
- Restricted Zone-I: 20–31.57m in Left side and 20–34.12m in Right side
- Restricted Zone-II: 31.57- 40.48 m in Left side and 34.12–41.06m in Right side
- Green Zone: Beyond 40.48 m in Left side and 41.06m in Right side

## 8.6 Flood-Based Zoning System for Dhobi Khola

For Dhobi Khola, a similar zoning methodology is applied, with parameters adjusted for the river's smaller scale and different setback regulations:

- The Blue Line marks the river edge.
- The Red Line indicates the existing 9-meter setback from the river.
- The Green Line represents the flood level for a 100-year return period, based on peak discharge analysis.

The zoning system defines three land use zones:

- Prohibited Zone: Located between the Blue Line (river edge) and the Red Line (9-meter setback)
- Restricted Zone: This is the area between the Red Line and the Green Line (100-year flood level), where floodwater depth is expected to be around 1 meter.

- Green Zone: Found beyond the Green Line, this area is considered safe from major flood events, with 0-meter expected flood depth even during a 100-year event.

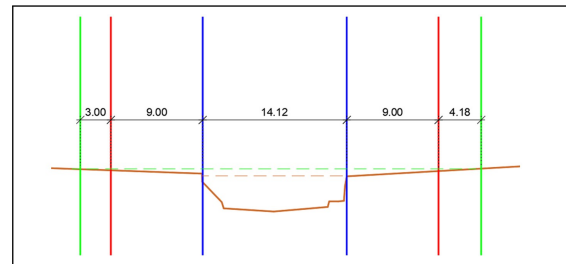


Figure 5: Flood-Based Zoning System for Dhobi Khola River

Widths from River Edge

- Prohibited Zone: 0–9 m
- Restricted Zone-I: 9-12m in Left side and 9–13.18m in Right side
- Green Zone: Beyond 12 m in Left side and 4.18 m in Right side

## 9. Recommendation

### 9.1 Zoning-Based Byelaws

#### Prohibited Zone

This zone, located between the river edge and the setback line, is the most vulnerable to flooding. It is designated primarily for protective and low-impact uses. All private construction and permanent residential, commercial, or industrial structures are prohibited. Public open spaces such as parks and gardens, religious and cultural monuments (provided they are elevated or flood-resistant), and flood control infrastructure like embankments, levees, and retention ponds are permitted with flood-resilient design features.

#### Restricted Zone

This zone covers the area between the setback and 20 and 100-year flood line, subdivided based on 20 and 100-year flood line, Restricted Zone I (flood depth - 2m) and Restricted Zone II (flood depth - 1m). Critical infrastructure, including hospitals, schools, and emergency services, along with hazardous or large-scale commercial developments, are prohibited. Elevated residential and commercial buildings (floor level above the 100-year flood level), non-hazardous public infrastructure, and low-risk economic developments, if flood-proofed, are permitted.

Flood-resilient design standards are mandatory in these zones. No basements are permitted, and ground floors should not include essential services or habitable spaces. Waterproof or water-resistant materials must be used, with a maximum ground coverage of 50% of the plot. Advanced stormwater drainage systems must be installed, and permeable surfaces are encouraged to reduce surface runoff. Minimum plinth levels are specified: for the Bagmati River, Restricted Zone I requires 2 meters above ground level and Restricted Zone II requires 1 meter above ground level; for Dhobi Khola, the Restricted Zone requires 1 meter above ground level.

## 10. Limitations

It is important to note that the analysis presented in this study is based on secondary data, with calculations derived from rational estimation methods rather than detailed hydrological modeling. While these estimations offer useful insights into flood risks and assist in determining appropriate flood-based zoning system for urban planning, they may not capture all the nuances of local hydrological conditions. A more accurate and reliable approach would involve conducting comprehensive hydrological assessments, utilizing advanced modeling techniques, real-time flood data, and considering the potential impacts of climate change. This limitation highlights the need for further, more in-depth research by hydrologists to establish scientifically sound and contextually relevant flood-based zoning system.

## 11. Conclusion

The findings reveal that riverfront zones, particularly along the Bagmati River and its tributaries, hold significant economic importance, contributing substantially to local business revenues and rental incomes. However, these same areas are highly vulnerable to frequent flooding, with many buildings incurring recurring financial losses. The existing setback approach fails to reflect this dual reality—overlooking both the socio-economic stakes and the actual flood risks—which has led to unregulated growth in hazardous zones and cumulative economic losses.

To address this challenge, the study proposes a flood-based zoning system informed by hydrological data and return period flood levels. This system introduces zoning classifications based on the 20-year and 100-year flood levels, dividing riverfront land into Prohibited, Restricted, and Green Zones. This approach allows for controlled and resilient development while ensuring that critical infrastructure and high-risk construction are excluded from vulnerable areas. It creates a framework that respects both safety and the economic utility of urban river corridors.

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