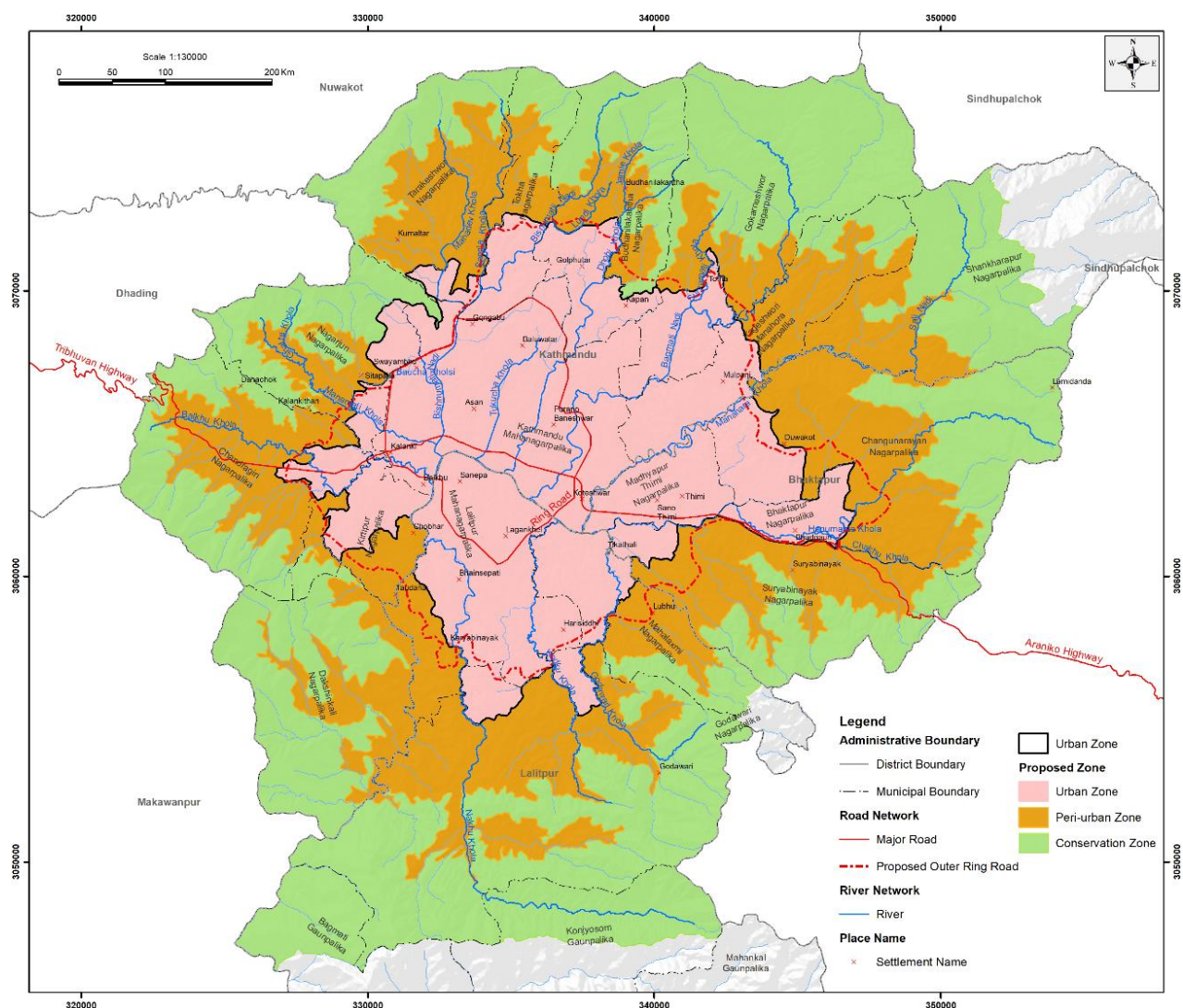


बागमती कार्ययोजना २०८२-२१०२

Bagmati Action Plan (2025-45)



Government of Nepal
Ministry of Urban Development
High Powered Committee for Integrated Development of Bagmati Civilization

October, 2025

ACKNOWLEDGEMENTS

ABBREVIATION

AQMS	:	Air Quality Monitoring Station
BAP	:	Bagmati Action Plan
CBS	:	Central Bureau of Statistics
CIP	:	Capital Investment Plan
DEM	:	Digital Elevation Model
DEWATS	:	Decentralized wastewater treatment System
DHM	:	Department of Hydrology and Meteorology
DoA	:	Department of Agriculture
DoEnv	:	Department of Environment
DoR	:	Department of Road
DoS	:	Department of Survey
DoTM	:	Department of Transport Management
DUDBC	:	Department of Urban Development and Building Construction
FGD	:	Focus Group Discussions
GESI	:	Gender Equity and Social Inclusion
GIS	:	Geographical Information System
GoN	:	Government of Nepal
HH	:	Household
HPCIDBC	:	High-Powered Committee for Integrated Development of Bagmati Civilization
ICIMOD	:	International Center for Integrated Mountain Development
KII	:	Key Informant Interview
Km	:	Kilometer
KVDA	:	Kathmandu Valley Development Authority
LRMP	:	Land Resource Mapping Project
m	:	meter
MoFE	:	Ministry of Forests and Environment
NDVI	:	Normalized Difference Vegetation Index
NPC	:	National Planning Commission
NTNC	:	National Trust for Nature Conservation
NUDS	:	National Urban Development Strategy
O&M	:	Operation and Maintenance
PRA	:	Participatory Rural Appraisal
RUSLE	:	Revised Universal Soil Loss Equation
Sq. Km.	:	Square Kilometer
SNNP	:	Shivapuri Nagarjun National Park
WECS	:	Water and Energy Commission Secretariat

Background

The Bagmati river system, which includes numerous heritage sites and traditional settlements rich in tangible and intangible culture, is collectively termed the 'Bagmati Civilization. Bagmati river originates in the Shivapuri Hills near Baghdwar and flows southward through Gokarna and Pashupati area and ultimately meets Manohara River, Dhobi Khola (Rudramati), Tukucha Khola (Ichhumati), Bishnumati River and Nakhu Khola before it passes through Chobhar George. The sub-tributaries include Hanumante, Godawari, Kodku, Mahadev, Sangla, Bhaucha, Lundi, Jamle, Manamati, Suryamati, Ghatte and Chakhu Khola. Besides, there are other small streams and numerous *kholsis* within the river system.

Bagmati, the holy river and a major source of water for the Kathmandu Valley, has been polluted due to human actions such as settlement along the river, unplanned urbanization in river basin and disposal of untreated sewage and solid waste into the river system. Apart from that, extractions of sand from river bed, construction of public infrastructure in river space and informal squatter settlements along the banks have deteriorated the river environment and the water security. The critical issues of Bagmati River and its tributaries are primarily related to river ecosystem, river side land use change, preservation of culture and heritage and institutional arrangements.

Several efforts were made in the past for the conservation of Bagmati River and its tributaries. The Government of Nepal approved the Bagmati Action Plan (2009-2014) in 2066 B.S with the aim of restoration and conservation in an integrated and coordinated approach. The key issues and challenges identified by BAP 2009-2014 remain largely the same though their scale has increased due to change in urban context with increased built-up density and land use conversions. Since the scenarios within the valley have changed, the previous action plan require some updates and additional interventions to achieve the desired outcomes. In this context, HPCIDBC has initiated to thoroughly revise and update the Action Plan with a planning perspective for the next 20 years. develop new Bagmati Action Plan. It is formulated with the aim to restore and conserve the Bagmati River and its tributaries in an integrated and coordinated approach. The Action Plan covers the Bagmati river system from Shivapuri hill to Katuwal Daha.

Information on the existing infrastructures and services, tangible and intangible heritages, green open spaces and other primary data were collected during field surveys. GIS based inventory system was established based on the field inventory. Environmental studies, socioeconomic studies, geo-technical studies were also performed for the identification of issues related to land, infrastructures, heritages, water ways, hazard risks and vulnerability etc.. Cross section surveys were conducted for hydrological analysis. Series of meetings and discussions were organized with local units, HPCIDBC and its project offices, KVDA, KUKL and other concerned governmental and non-governmental organizations and experts of various thematic areas. Study also critically analyzes previous action plan for the continuation of the priority activities.

Scenario Analysis

Increasing urbanization pressure in the Kathmandu valley has been posing serious environmental consequences in recent years. And the most affected environmental function is on the river system. Because of contemporary socioeconomic development, rivers have been facing growing threats from several quarters-unsustainable withdrawals, pollution, land use conversion and habitat deterioration, among others. The land cover change analysis reveals that Kathmandu valley is facing rapid urbanization with 4.56 % annual increment in built-up during the last decade which is about four times higher than that of the period from 2000 to 2010. The population has reached 2,956,804 in 2021 which is an increment of 1.91% per year since 2011. Considering the floating population this study assumes the inhabitant of about 3.7 million in 2022. So, inhabitants of Kathmandu valley in 2034 and 2044 are predicted 4.39 million and 5.42 million. The gross density is expected to reach around 56 ppha in 2044.

Since the formulation of Bagmati Action Plan 2009-2014, various efforts are made in reconstruction/restoration of monuments and heritage sites, landscaping and river beautification along river corridors, construction and remediation of interceptor and existing sewers, up-gradation/construction of Waste Water Treatment Plants, construction of new sewers in WWTPs service area, river training works, road and green belt along river banks, water storage and increase recharging area like Dhap and Nagmati Dam and others. However, despite several interventions, the Bagmati River and its tributaries remain critically polluted and its space continues to be encroached upon for different purposes. The analysis of water quality shows Dhobi Khola downstream from Ratopul stretch as the most polluted river, followed by Mahadev Khola and Bishnumati downstream from Khusibu stretch. Coherently, these areas also receive higher number of sewage discharges, reflecting the main cause of pollution of the Bagmati river system.

Issues

Much of the current undesirable state in rivers can be attributed to disruptive anthropogenic activities. Because of contemporary socioeconomic development, rivers have been facing growing threats from several quarters-unsustainable withdrawals, pollution, land use conversion and habitat deterioration, among others. The major issues of the Valley Rivers are related to decrease in water discharge and degradation of the river ecosystem. Degradation of water quality and catchment quality, narrowing and deepening of waterway, eroding cultural values, riverside land use change are the critical issues of Bagmati River system. Degradation of catchment quality is mostly associated with the land use conversion through settlement expansion, extensive land plotting and unregulated quarries. Decrease in water discharge is the result of water use, mostly tapping of water from the river/streams for drinking, irrigation and industrial uses along with the degradation of catchment quality. Degradation of water quality is associated with the river use, solid waste dumping, direct discharge of sewer and industrial effluents and use of chemical fertilizers and pesticides in agriculture. River encroachment, unplanned construction of embankments, roads and other infrastructures and sand mining in some cases have caused the narrowing and deepening of the waterways. The narrowing of the waterways has resulted in inundation because of the narrow passage of the river channel. Issues of river bank cutting and river course changing can also be observed in some areas.

The socio-cultural issues among others are associated with the encroachment and deterioration of religious, cultural and historical heritages, restriction in easy access to the rivers due to embankments, roads and other development works, and residential and commercial expansion along the river corridors.

Hydrological Modeling

Hydrological modeling of Bagmati River and its tributaries is used for estimation of basin, sub-basin and river physical characteristics. Peak flood discharge and maximum daily precipitation for 5, 10 and 50 years return period at different river basin, junctions and reaches are estimated using hydrological modeling in HEC-HMS followed by calibration and validation of different hydrological parameters. The results from hydrological modeling are used to estimate minimum waterway width required for Bagmati River and its tributaries based on the Lacey's formula as well as model based flood inundation map. As Bagmati River and its tributaries have varying width and depth (cross-section) within small stretches, the results obtained from the model based flood map for waterway width are more precise, accurate and site specific.

The flood hazard maps based on hydrological model have been validated which shows the area around Gokarneshwar and Guheswori along Bagmati river having moderate flood hazard, while downstream from the confluence of Manohara and Bagmati, the main water course increases to attain deep water level. The high hazard area increases downstream from the Bishnumati confluence, where the flood extent seems higher. The moderately hazardous area gradually increases downstream and the area near the confluence of Manohara and Kodku Khola falls in high

hazard level. Most of the area along the river corridors are covered by low hazard zones, however, parts of the river corridors with small areas fall on moderate hazard zones e.g. in Thimi area of Hanumante Khola, Kalimati area of Karakhusi Khola etc. River stretches with narrow sections in between wider sections are more vulnerable to the flood risk as they result in increase in water depth and cause large flood inundation area mostly in upstream stretches. Similarly, construction of infrastructures such as bridges, culverts, etc. on rivers with the traffic operation area (deck level) below high flood level are observed in few bridges and culverts which affect the bridge structures as well as the built-up area on its bank. Uneven banks and river training works in rivers are also observed due to landscape restriction and corridor road mostly in Dhobi Khola stretches which ultimately result in the built-up area in low flood plain more vulnerable to flood. During flooding, blockage of the sewer lines and drain pipes due to backwater effect and less discharge capacity also increases the vulnerability of many areas.

Zoning

The criticalness of the issues identified varies in different segments of the rivers from upstream to downstream. The issues do not have equal level of significance in upper hills with forest cover and urban area in the valley floor. The hilly forest area surrounding the Kathmandu Valley is the main source of water for Bagmati River and its tributaries. The agricultural lands in the foothills and the valley floor have now been converted to urban areas and are expanding. The urban growth scenario of Kathmandu Valley and new federal system has drastically changed the urban context. In addition, the major urban development projects such as Outer Ring Road, new town concepts have triggered the development outside the core city to periphery. In addition, after the promulgation of the new constitution, the structure of VDCs and municipalities has been dissolved and the new structure of metropolitan, sub-metropolitan, municipalities and rural municipalities are implemented. In this context, the new zonation concept has been developed on the basis of watershed ecology and urban growth scenario of Kathmandu Valley. They are: i) Conservation Zone, ii) Peri-Urban Zone, and iii) Urban Zone.

The Conservation Zone is the forest area surrounding the valley. This area includes the forests of Shivapuri, Phulchowki, Chandragiri and Nagarjun. The Shivapuri Nagarjun National Park lies in this zone. This zone mostly includes forest area which recharges the river system of the Valley and needs to be conserved. The central core of the valley has been categorized in the Urban Zone area which has the highest population density and high urban growth rate. This area has been delineated within the boundary of proposed Outer Ring Road alignment and is planned for dense urban development with developed urban infrastructure to make Bagmati River clean, green and healthy. The area between Conservation Zone and Urban Zone is categorized as Peri-Urban Zone which has the pressure of urban development but the conservation measures has to be maintained in this zone for water recharge. So, these areas have high responsibility to maintain the river system.

Action Plan

The Action Plan has been prepared with an overall vision for restoration and conservation of the Bagmati river system and defined goals, objectives and activities for each of the three zones. The action plan aims to maintain and enhance environmental services in the conservation zone, preserve river ecosystems in peri-urban zones and restoration in urban zones. It also aims to preserve cultural heritage. The activities and actions are proposed under three broad sectors; River Conservation and Management, Cultural/Civilization Rehabilitation and River/Water Quality and Quantity Improvement. Certain activities which are valid in all the zones are included as general activities. These activities are either common or associated with knowledge management that will help to build the capacity of HPCIDBC and other agencies and bolster the restoration and conservation of Bagmati River and its tributaries. This action plan has also incorporated the priority activities that have been recommended by the previous action plan.

The actions for conservation zone prioritizes ecotourism promotion through cycling/hiking trail; water source conservation; enhance groundwater recharge through rainwater storage/harvesting ponds, water reservoir dams; sustainable land use management through terrace improvement; promotion of organic farming; relocation of some settlements; gully control and sediment trapping; and reclamation, rehabilitation and preservation of cultural heritages. Similarly, the actions for peri-urban and urban zone prioritize green development with recreational facility along river corridor; implementation of Right of River Way to conserve river area; river training works with bioengineering; development of corridor transport system along rivers; management of Sewerage to prevent direct disposal into river through construction of interceptors and WWTPs; control of direct disposal of solid waste into river by strict law implementation; sustainable land use management; and reclamation, rehabilitation and preservation of cultural heritages.

Budget

The action plan has been prepared for the next twenty years, and the activities/action and budget are divided in four implementation periods viz; short-term (0-5 years), first mid-term (6-10 year), second mid-term (11-15 year) and finally long-term (16-20 year). The implementation of proposed activities require 68,341 million NPR in the short term; 70,185 million NPR in the first mid-term; 55,315 million NPR in the second mid-term and 31,468 million NPR in long-term implementation period. The total tentative budget required for the twenty year action plan is 225,311.6 million NPR. Zone-wise implementation of proposed activities requires about 73,837 million NPR for Conservation Zone; 48,089 million NPR for Peri-Urban Zone; 1,00,214 million NPR for Urban Zone and 3,169 million NPR for general projects.

Implementation Strategy

The long-term stability of the efforts of Bagmati Action Plan can be ensured through planning and implementation but there is also a range of administrative, management and other supporting elements. These include: policies and laws; institutional arrangements; stakeholder engagement; science, monitoring and research; and tools for giving effect to elements of the action plan's strategy through regulatory controls and other planning systems. For effective implementation of the action plan, the strategies should prioritize; activities and milestones, responsibilities, promotion strategy for private sector and civil society, budget, monitoring and reporting, and strategy review and adaptation. Efforts should be made to strengthen HPCIDBC in terms of technical capacity, financial resources and legal back up. For institutional strengthening this action plan proposes the inclusion of Coordination and GESI unit to minimize dispute of right between development stakeholders; Environment unit with environmental expert, planning unit with geological expert and landscape planner and survey unit with GIS team in current organizational structure of HPCIDBC. More importantly, the government should ensure adequate resources to ensure effective implementation of an action plan in reaching goals and ultimately the vision.

Monitoring Plan

Monitoring against defined and measurable objectives is critical for assessing the effectiveness of the action plan and for guiding adaptive management. The monitoring and evaluation plan should always refer to the overall objectives of the action plan, to specific restoration strategies and to details of specific restoration measures that will be conducted. Regular monitoring is required from the concerned authorities and similarly feedback to the implementers. HPCIDBC must take the responsibility for overall monitoring. Besides, a participatory or joint monitoring system can be established where representatives from concerned stakeholders participate and monitor the programs. This report provides only the means of verification for the activities and actions proposed for Bagmati Action Plan. For effectiveness each implementing agencies have to prepare their own monitoring plans.

दोस्रो बागमती कार्य योजना (२०८२-२१०२) को कार्यकारी सारांश

पृष्ठभूमि

विश्व प्रसिद्ध सभ्यताहरूको विकास नदी किनारमा भएको सन्दर्भमा नेपालको राजधानी काठमाडौं उपत्यकाको संस्कृति र सभ्यता पनि बागमती लगायतका नदी किनारामा विकसित भई अटुट रूपमा समृद्ध र उन्नतशालि हुँदै आएको तथ्य सत्य हो । अनगिन्ती भौतिक र अभौतिक ऐतिहासिक, धार्मिक, सांस्कृतिक र पुरातात्विक सम्पदाहरूले भरिपूर्ण काठमाडौं उपत्यका परम्परागत वस्ती भएको बागमती नदी प्रणालीबाट सिञ्चित भई प्राचीन कालदेखि नै पुर्खाहरूको विरासत र गौरवको सांस्कृतिक केन्द्रको रूपमा रहि आएको छ । बागमती नदी शिवपुरीबाट उद्भव भई गोकर्ण, पशुपति, चोभार र कटुवाल दह भई अघि बढ्ने क्रममा यसको दायाँबायाँ किनार र आसपासका क्षेत्रहरूमा असंख्य तीर्थस्थल, घाट, पाटी पौवा, सत्तल, गुफा, मठ, मन्दिर, शिवालय, देवालय, भकारीहरूको स्थापना गरिएका छन् । यससंगै यहाँ विभिन्न अभौतिक सांस्कृतिक रीतिरिवाज, परम्परा र अभ्यासहरू हुँदै आएका छन् । यसर्थ, काठमाडौं उपत्यकाको संस्कृति र सभ्यतालाई बागमती सभ्यता भनिएको हो । बागमती नदी एउटा भौतिक नदी मात्र नभएर काठमाडौं उपत्यकाको जीवन्त संस्कृति पनि हो । हाम्रा हरेक साँस्कृतिक गतिविधि संस्कारहरू यससँग जोडिएका छन् । जस्तै पवित्र स्नान, गंगाजल आचमनबाट संस्कार शुरु हुने, नदी किनारमा पितृ संस्कार, श्राद्ध कर्म तथा अन्त्येष्टी संस्कारहरू गरिन्छन् । बागमती नदी किनारका विभिन्न स्थानहरू जस्तै उत्तरगयाको नामले प्रसिद्ध गोकर्णेश्वर, पशुपति, थापाथली, चोभार लगायत बागमती किनारका तीर्थस्थलहरूमा परम्परागत रूपमा पितृहरूको नाममा श्राद्ध गर्ने परम्परा कायमै छ ।

बागमती नदी बागद्वार नजिकैको शिवपुरी डाँडाबाट निस्केर गोकर्ण र पशुपति क्षेत्र हुँदै मनोहरा नदी, धोबीखोला (रुद्रमती), टुकुचा खोला (इच्छुमती), विष्णुमती नदी र नख्खु खोलासँग मिसिएर दक्षिणतर्फ चोभार हुँदै काठमाडौं उपत्यकाबाट बाहिरिन्छ । उपसहायक नदीहरूमा हनुमन्ते, गोदावरी, कोडकु, महादेव, साङ्गला, भौचा, लुन्डी, जम्ले, मनोमती, सूर्यमती, घट्टे र चाखु खोला पर्दछन् । यसबाहेक नदी प्रणालीभित्र अन्य स-साना खोला र खोल्सीहरू रहेका छन् ।

नेपाल सरकारले एकीकृत र समन्वयात्मक दृष्टिकोणबाट बागमती नदी प्रणालीलाई पुनर्स्थापना र संरक्षण गर्ने उद्देश्यले २०६६ सालमा बागमती कार्य योजना (ई. २००९- ई.२०१४) स्वीकृत गरेको थियो । बागमती कार्य योजना सन् २००९ - २०१४ को तर्जुमा भएदेखि नै स्मारक र सम्पदा स्थलहरूको पुनर्निर्माण, नदी करिडोरमा ल्याण्डस्केपिङ र नदीको सौन्दर्यीकरण, इन्टरसेप्टर सहितको ढल निर्माण, फोहोर पानीको प्रशोधन केन्द्र निर्माण लगायतका केही कार्यहरू सम्पन्न भई सकेका छन् भने कतिपय कार्यहरू निरन्तर भइरहेका छन् । फोहोर पानी प्रशोधन केन्द्र, थप क्षेत्रमा नयाँ ढल निर्माण, नदी तटबन्ध निर्माण कार्य, नदी किनारमा सडक र हरित क्षेत्र, पानी भण्डारण र रिचार्जिङ क्षेत्र वृद्धि जस्तै धाप डयाम आदि उक्त कार्य योजनाको प्रतिफलको रूपमा लिन सकिन्छ । अघिल्लो कार्य योजनामा समय सापेक्ष अद्यावधिक र थप सवालहरूको सम्बोधन गर्नु पर्ने देखिएकोले अधिकार सम्पन्न बागमती सभ्यता एकीकृत विकास समितिले कार्य योजनालाई सम्पूर्ण रूपमा परिमार्जन र अद्यावधिक गर्दै आगामी २० वर्षको लागि यो बागमती कार्य योजना (२०८२-२१०२) तर्जुमा गरिएको हो ।

क्षेत्र वर्गीकरण

काठमाडौँ उपत्यका वरपरको पहाडी वन क्षेत्र बागमती नदी र यसका सहायक नदीहरूको पानीको मुख्य श्रोत हो । उपत्यकाको फेदीमा रहेका खेतीयोग्य जमिन अहिले शहरी क्षेत्रमा परिणत भई विस्तार हुँदै गएका छन् । शहरी विकास परियोजनाहरू जस्तै बाहिरी चक्रपथ र नयाँ शहर अवधारणाहरूले शहरको भित्री भागभन्दा बाहिरतिर विकासलाई बढावा दिएको छ । साथै नेपालको संविधान २०७२ मा जारी भएपछि गाविस र नगरपालिकाको संरचना विघटन भई महानगरपालिका, उपमहानगरपालिका, नगरपालिका र गाउँपालिकाको नयाँ संरचना कार्यान्वयनमा आएको छ । उपत्यका भित्रका दुई महानगरपालिका १६ वटा नगरपालिका, बागमती र कौन्ज्योसोम गाउँपालिकाका केही वडाहरू यस आयोजना क्षेत्र भित्र परेका छन् । यस योजनाले बागमती नदी र यसका सहायक नदीहरूको जलाधार क्षेत्रले ओगटेको ७१४.२० वर्ग कि.मी क्षेत्रफल समेटेको छ । यो कार्य योजनामा काठमाडौँ उपत्यकाको जलाधार पर्यावरण र शहरी वृद्धि परिदृश्यको आधारमा काठमाडौँ उपत्यकालाई तीन क्षेत्रमा विभाजन गरिएको छ- संरक्षण क्षेत्र, उप-शहरी क्षेत्र र शहरी क्षेत्र ।

संरक्षण क्षेत्र उपत्यका वरपरको वन क्षेत्र हो । यस क्षेत्रमा शिवपुरी, फुलचोकी, चन्द्रागिरि र नागार्जुनको जङ्गल पर्दछ । शिवपुरी नागार्जुन राष्ट्रिय निकुञ्ज पनि यसै क्षेत्रमा पर्दछ । यस क्षेत्रमा प्रायः वन क्षेत्र समावेश छ जसले उपत्यकाको नदी प्रणालीलाई रिचार्ज गर्दछ र यसलाई संरक्षण गर्न आवश्यक छ । उपत्यकाको सबैभन्दा बढी जनघनत्व र उच्च शहरी वृद्धि दर भएको केन्द्रीय भागलाई शहरी क्षेत्रको रूपमा वर्गीकरण गरिएको छ । प्रस्तावित बाहिरी चक्रपथ पङ्क्तिबद्धताको सिमाना भित्रको क्षेत्रनै शहरी क्षेत्र हो र बागमती नदीप्रणालीलाई सफा, हरियाली र स्वस्थ बनाउन विकसित शहरी पूर्वाधारहरू यस क्षेत्रमा प्रस्ताव गरिएको छ । संरक्षण क्षेत्र र शहरी क्षेत्र बिचको क्षेत्रलाई उप-शहरी क्षेत्रको रूपमा वर्गीकृत गरिएको छ जसमा शहरी विकासको दबाव छ तर पानी रिचार्जको लागि यस क्षेत्रमा संरक्षणका उपायहरू अवलम्बन गर्नु पर्ने देखिन्छ ।

सवालहरू

सामाजिक- आर्थिक, भौतिक विकास र मानवजन्य क्रियाकलापका कारण बागमती नदी र यसका सहायक नदीहरूको दयनीय अवस्था सृजना भएको देखिन्छ । उपत्यकाका नदीहरूमा प्रमुख समस्याको रूपमा पानीको बहावमा कमी तथा पानीको गुणस्तर र जलाधार क्षेत्र (Watershed area) को गुणस्तरमा हास, नदी बहाव क्षेत्र साँघुरो र गहिरो बनाउने, साँस्कृतिक मूल्य मान्यतामा हास, नदी किनारको भू-उपयोग परिवर्तन आदि रहेका छन् । बागमती नदी प्रणालीका जलाधार क्षेत्रको गुणस्तरमा हास गराउने मुख्य कारणहरूमा अव्यवस्थित बस्ती विस्तार, व्यापक जग्गा खण्डीकरण र अनियमित उत्खनन मार्फत भू-उपयोग रूपान्तरणसँग सम्बन्धित विषयहरू रहेका छन् । नदी प्रणालीमा पानीको बहावमा कमी गराउने कारणहरूमा अत्यधिक पानीको प्रयोग जस्तै: नदी तथा खोलाबाट खानेपानी, सिँचाई तथा उद्योगका लागि पानीको उपयोग आदि रहेका छन् । पानीको गुणस्तरमा हासको कारणहरूमा नदीमा फोहोरमैला विसर्जन, ढल तथा औद्योगिक फोहोर बिना प्रशोधन नदीमा मिसाउने र कृषिमा रासायनिक मल र कीटनाशकको प्रयोगसँग सम्बन्धित छ । नदी अतिक्रमण हुनुका प्रमुख कारणहरूमा तटबन्ध, सडक र अन्य पूर्वाधारको अनियोजित निर्माण, बालुवा उत्खननले जलमार्गलाई साँघुरो र गहिरो बनाउने आदि रहेका छन् । धार्मिक, साँस्कृतिक र ऐतिहासिक सम्पदाको अतिक्रमण र कमजोर अवस्था, तटबन्ध, सडक र अन्य विकास निर्माणका कारण नदीमा पहुँच प्रतिबन्ध, नदी कोरिडोरमा आवासीय तथा व्यावसायिक विस्तार लगायतका विषयहरू सामाजिक-साँस्कृतिक समस्याहरूसँग जोडिएका छन् ।

कार्य योजना

बागमती नदी प्रणालीको पुनर्स्थापना र संरक्षणका लागि समग्र दूरदृष्टिका साथ काठमाडौँ उपत्यकालाई संरक्षण क्षेत्र, उप-शहरी क्षेत्र र शहरी क्षेत्र गरी तीन क्षेत्रमा विभाजन गरी यो कार्य योजना तर्जुमा गरिएको छ । यस कार्य योजनाले

(१) नदी संरक्षण र व्यवस्थापन (२) साँस्कृतिक/सभ्यता पुनर्स्थापना (३) नदी/जल गुणस्तर र मात्रा सुधार र (४) ज्ञान व्यवस्थापन गर्ने चारवटा रणनीति लिएको छ । यस योजनाको दूरदृष्टि सबैद्वारा पूर्णरूपमा जिवन्त र मुल्यवान मानिएको स्वच्छ सफा र हराभरा नदी (Clean, Green and Healthy River System that is Full of Life and Valued by All) प्राप्ति गर्न लागि देहायको तालिका बमोजिमका रणनीति सहित कार्यनीति तथा क्रियाकलापहरू प्रस्ताव गरीएका छन्।

तालिका - कार्य योजना

क.सं.	रणनीति	कार्यनीति	क्रियाकलाप	क्रियाकलाप संचालन हुने क्षेत्र	कैफियत
१	१. नदी संरक्षण र व्यवस्थापन	पर्यटन प्रवर्द्धन	उपत्यकाको पहाडी फेदीमा साइक्लिङ मार्ग र पदमार्गका लागि अध्ययन तथा विकास	संरक्षण क्षेत्र	
			साइक्लिङ मार्ग र पदमार्गमा फोहोर व्यवस्थापन सुविधाहरूको विकास	संरक्षण क्षेत्र	
		पानी पूनर्भरण अभिवृद्धिका लागि भू-संरक्षण	शिवपुरी-नागार्जुन राष्ट्रिय निकुञ्ज क्षेत्रका बस्ती स्थानान्तरण	संरक्षण क्षेत्र	
			संरक्षण क्षेत्रमा रहेका बस्तीहरूको पहिचान र अध्ययन गरी पहिचान गरिएका बस्तीहरूको विकास अवधारणा तयार गर्ने	संरक्षण क्षेत्र	
		नदी सरसफाई कार्यक्रमलाई सुदृढ गर्ने	आवधिक रुपमा नदी सरसफाई	उप-शहरी क्षेत्र, शहरी क्षेत्र	
			स्थानीय सरकार र समुदायको सहकार्यमा नदी सरसफाईका लागि महाअभियान सञ्चालन	उप-शहरी क्षेत्र, शहरी क्षेत्र	
			प्रत्येक नदीमा कोरिडोरमा वाकाथन सञ्चालन गरी नदी सरसफाई प्रवर्द्धन गर्ने	उप-शहरी क्षेत्र, शहरी क्षेत्र	
		विपद् न्यूनीकरण	उपयुक्तता अनुसार बायोइन्जिनियरिङ (सालिक्स र अन्य प्रजातिको वृक्षारोपण) सहित तटबन्ध वा घाट निर्माण	संरक्षण क्षेत्र, उप-शहरी क्षेत्र, शहरी क्षेत्र	
			नदी किनारमा अतिक्रमण गरिएका जग्गाको प्रमाणीकरण र सूची तयार	उप-शहरी क्षेत्र, शहरी क्षेत्र	

		नदी कोरिडोरमा सार्वजनिक जग्गाको व्यवस्थापन	प्रमाणित गरिएका अव्यवस्थित बस्तीहरूको स्थानान्तरण		
			नदी कोरिडोरका सम्भावित स्थानमा बाल मैत्री पार्क स्थापना र व्यवस्थापन गर्ने (खुला ठाउँ र हरियाली व्यवस्थापन)		
			नदी कोरिडोरका सम्भावित स्थानमा युवा मैत्री पार्क स्थापना र व्यवस्थापन गर्ने (व्ययाम उपकरण सहित)		
			नदी कोरिडोरका सम्भावित स्थानमा वृद्ध (Old age Friendly) मैत्री पार्क स्थापना र व्यवस्थापन गर्ने (योगा मैत्री सहित)		
			नदी कोरिडोर क्षेत्रमा सालिक्स (Salix) प्रजातिको वृक्षारोपण		
		दिगो भू-उपयोग व्यवस्थापन	गरा सुधार तथा बहुवर्षीय खेती प्रवर्द्धन कार्यक्रम	संरक्षण क्षेत्र	
			मापदण्ड तयार गरी जग्गा विकास/प्लटिङ कार्यको नियमन		
			सल्ला प्रजाति भएको वनलाई चौडापाते प्रजातिको वनमा रूपान्तरण (३२९ हे.)		
			गेग्र्यान रोकथामका लागि संरचना (sediment trapping structures) को निर्माण	संरक्षण क्षेत्र, उप-शहरी क्षेत्र, शहरी क्षेत्र	
			सतही जलस्रोतबाट गरिने सिँचाइका लागि वैकल्पिक स्रोतहरू प्रवर्द्धन गर्ने	उप-शहरी क्षेत्र	
२	२. साँस्कृतिक/सभ्यता पुनर्स्थापना	नदी कोरिडोरमा यातायात प्रणालीको विकास	नदीलाई आवश्यक बहाव क्षेत्रभन्दा बाहिर आवश्यक संरचना सहित पैदल यात्री र वातावरण मैत्री स्मार्ट कोरिडोर सडक सञ्जालको निर्माण	उप-शहरी क्षेत्र, शहरी क्षेत्र	

			आवश्यक संरचना निर्माण र चोक सुधार सहित विद्यमान कोरिडोरसडक सञ्जाल (लगभग २५ किलोमिटर) लाई पैदल यात्री र वातावरणमैत्री स्मार्ट कोरिडोर सडकमा स्तरोन्नति		
			विष्णुमती कोरिडोर (नयाँबजार, गोंगबु, बानियाटार, परोपकार), धोबीखोला करिडोर (बिजुलीबजार, चावहिल), नख्खु खोला कोरिडोर (नख्खुडोल), कोङ्कु खोला कोरिडोर (हात्तिवन), र हनुमन्ते कोरिडोर (मध्यपुर थिमी) मा सडकको चोक (Junction) सुधार;		
			कोरिडोर सडक सञ्जालमा ट्राफिक संकेत तथा सूचना बोर्डहरूको स्थापना		
		नदी किनारका साँस्कृतिक तथा सम्पदा स्थलहरूको पुनर्स्थापना र संरक्षण गर्ने	तार्केश्वर महादेव, बज्रयोगिनी, बागद्वार, विष्णुद्वार र महादेव पोखरी लगायतका साँस्कृतिक सम्पदा र स्थलहरूको पुनर्निर्माण	संरक्षण क्षेत्र	
			ऐतिहासिक मणिचुड दह, शंखरापुर र यसका सम्बद्ध विशेषताहरूको पुनरुत्थान र संरक्षण		
			साँस्कृतिक स्मारक तथा स्थलहरू र पहुँच मार्गको पुनर्स्थापना	उप-शहरी क्षेत्र, शहरी क्षेत्र	
			विद्यमान स्मारक र स्थलको संरक्षण गरी नदीको प्रस्तावित बहाव क्षेत्र भन्दा बाहिर परम्परागत निर्माण प्रविधि प्रयोग गरी घाट र भाकरीको विकास	उप-शहरी क्षेत्र, शहरी क्षेत्र	
			साली नदी (माधवनारायण मन्दिर किनार) मा धार्मिक कार्यका लागि जल भण्डारण गर्न सानो बाँध निर्माण	उप-शहरी क्षेत्र	

			हानि भएको स्मारकको पुनर्निर्माण - शंखमुल	शहरी क्षेत्र	
			भस्मेश्वर घाट, पशुपती क्षेत्रमा चाप कम गर्न परम्परागत दाहसंस्कार स्थल विकासका लागि सम्भाव्यता अध्ययन र आवश्यक पूर्वाधार विकास	शहरी क्षेत्र	
			पशुपती विकास गुरुयोजनाको कार्यान्वयन	शहरी क्षेत्र	
		नदी किनारका साँस्कृतिक तथा सम्पदा स्थलहरूको पुनर्स्थापना र संरक्षण गर्ने	धार्मिक जात्राका लागि पैदल पुल निर्माण (नख्खु दोभान); ऐतिहासिक पुलहरूको संरक्षण (जलविनायक खोंच पुल, सुन्दरी घाट पुल, टेकु कालो पुल, कोरी टफु-खोकना, कोटेश्वर महादेवस्थान, कनकेश्वरी पुल)	शहरी क्षेत्र	
			शंखमुल घाट; थापाथली-टेकु दोभान; ब्रह्मयानी मन्दिर घाट- धुम्बाराही मन्दिर घाट (मंगल तीर्थ); गुहेश्वरी - पशुपति; शोभा भगवती मन्दिर - टेकु दोभान क्षेत्रमा धार्मिक कार्यको लागि धार्मिक कार्यका लागि जल भण्डारण गर्न सानो बाँध निर्माण	शहरी क्षेत्र	
		अमूर्त (intangible) साँस्कृतिक सम्पदाको संरक्षण	साँस्कृतिक पदमार्गको पुनरुत्थान र संरक्षण (सुन्दरीजल देखि बागद्वार, कोतवाल दह पदमार्ग, साँखु - बज्रयोगिनी - मणिचुड दह, महादेव पोखरी — नगरकोट पदमार्ग र तारकेश्वर महादेव पदमार्ग लगायत)	संरक्षण क्षेत्र, उप-शहरी क्षेत्र, शहरी क्षेत्र	
			स्मारकलाई नदीसँग जोड्ने जात्रा मार्गको पुनरुत्थान, स्तरोन्नति र व्यवस्थापन; जात्रामा सुविधाका लागि भौतिक संरचनाको व्यवस्था	उप-शहरी क्षेत्र, शहरी क्षेत्र	
			ऐतिहासिक नगर संरक्षणका लागि साँस्कृतिक भू-परिधिको पहिचान, गुरुयोजना तयार र कार्यान्वयन		

३	3. नदी/जल गुणस्तर र मात्रा सुधार	प्राङ्गारिक खेतीलाई प्रोत्साहन गर्ने	उत्पादनमा आधारित अनुदान मार्फत प्राङ्गारिक खेतीलाई प्रवर्द्धन/प्रोत्साहन गर्ने	संरक्षण क्षेत्र, उप-शहरी क्षेत्र	
			रसायनिक मल र विषादीको विकल्पका साथ निरुत्साहित गर्ने		
		जलस्रोतको संरक्षण र व्यवस्थापन	वर्षाको पानी भण्डारण / संकलन पोखरी निर्माण	संरक्षण क्षेत्र, उप-शहरी क्षेत्र	
			नागमती बहुउद्देश्यीय बाँध आयोजनाको कार्यान्वयन	संरक्षण क्षेत्र	
			जल भण्डारण पोखरी तथा बाँध निर्माण गरी जलाशयको विकास	संरक्षण क्षेत्र	
			नदी किनार र धाप क्षेत्रमा सालिक्स वृक्षारोपण	संरक्षण क्षेत्र	
			विद्यमान जलस्रोत तथा पुनर्भरण क्षेत्रको संरक्षण र व्यवस्थापन	संरक्षण क्षेत्र, उप-शहरी क्षेत्र, शहरी क्षेत्र	
			ऐतिहासिक/परम्परागत पोखरी, ढुङ्गेधारा, र राजकुलोको पुनरुत्थान र संरक्षण	संरक्षण क्षेत्र, उप-शहरी क्षेत्र, शहरी क्षेत्र	
			संस्थागत र घरायसी तहमा वर्षाको पानी संकलन र पुनर्भरणलाई प्रवर्द्धन गर्ने	संरक्षण क्षेत्र, उप-शहरी क्षेत्र, शहरी क्षेत्र	
		पानी पुनर्भरण र नदीको बहाव वृद्धि गर्न जलस्रोत संरक्षण	आकाशे पानी संकलन गर्ने पोखरी निर्माण गर्ने	संरक्षण क्षेत्र, उप-शहरी क्षेत्र, शहरी क्षेत्र	
			स्थलाकृति र ढल निकासको मात्रा अनुरूप प्रशोधनको व्यवस्था सहित छुट्टाछुट्टै ढल प्रणालीको निर्माण	उप-शहरी क्षेत्र, शहरी क्षेत्र	
		ढल व्यवस्थापन	टेकु दोभान, कोङ्कु, हनुमानघाटमा ढल प्रशोधन केन्द्रको स्थापना	शहरी क्षेत्र	

		नदीमा प्रत्यक्ष फोहोर विसर्जन कार्यलाई नियन्त्रण गर्ने	नदी करिडोरमा सिसिटिभी जडान गरी नियन्त्रण प्रणाली स्थापना गर्ने	उप-शहरी क्षेत्र, शहरी क्षेत्र	
			१ किलोमिटरको अन्तरालमा नदीमा फोहोर जम्मा गर्ने जाल जडान गर्ने		
4	4. क्षमता विकास	ज्ञान व्यवस्थापन	वैज्ञानिक अनुसन्धान अभिवृद्धि/प्राविधिक क्षमताको स्तरवृद्धि/बागमती सभ्यता र सुधारको सम्बन्धमा नया पिढीको नविन परिकल्पनालाई समाविष्ट गर्ने		
			विद्यालय तहको शिक्षामा बागमती सभ्यता विकास सम्बन्धि पाठ्यक्रम लागु गर्ने		
			बागमती सभ्यता र यसको सुधारसँग सम्बन्धित क्षेत्रका विविध क्षेत्रमा अनुसन्धान गर्न स्नातक तथा स्नातकोत्तर तहका विद्यार्थीहरूलाई अनुदान प्रदान गर्ने		
			डिजिटल डाटाबेस व्यवस्थापन प्रणालीको स्थापना		
			बागमती सभ्यतासँग सम्बन्धित प्राकृतिक तथा सांस्कृतिक सम्पदाको संरक्षणका लागि स्वदेशी प्रविधि विकासमा सहयोग गर्ने		
		बागमती कार्ययोजना कार्यान्वयनमा समुदायको सहभागिता अभिवृद्धि गर्ने	नदी कोरिडोरसँग जोडिएका वडाहरूमा वडा-स्तरीय सामुदायिक संगठन स्थापना गर्ने र यस्ता संगठनहरूको सक्षमता बढाउने		
			सार्वजनिक सम्पत्तिहरूको व्यवस्थापन तथा विकास सम्बन्धि गतिविधिहरूमा स्थानीय समुदायको सहभागिता र स्वामित्व अभिवृद्धि गर्ने		

			उपल्लो तटीय क्षेत्र तथा तल्लो तटीय क्षेत्रहरू बीच परस्पर सम्बन्ध विकास गर्ने		
		संस्थागत सुदृढीकरण	स्थानीय सरकारसँगको सहकार्यमा फोहोर उत्पादन घटाउन रोकथाम, न्यूनीकरण, पुनः प्रयोग, प्रशोधन जस्ता उपायहरू अबलम्बन गर्ने		
			GIS, पूर्वाधारको डिजाइन तथा व्यवस्थापनको लागि क्षमता अभिवृद्धि तालिम		
			GIS, पूर्वाधारको डिजाइन तथा व्यवस्थापनको लागि क्षमता अभिवृद्धि तालिम		
			राष्ट्रिय/अन्तर्राष्ट्रिय भ्रमणको माध्यमबाट ज्ञान साझेदारी तथा अभिवृद्धि गर्ने		
			उपत्यकाभित्रका प्रत्येक स्थानीय सरकारका लागि सहरी डिजाइन निर्देशिका तयार गर्ने		
			सम्पत्ति व्यवस्थापन प्रणालीको विकास र सञ्चालन		
			बागमती कार्ययोजनाको मध्यावधि समीक्षा		
			बागमती कार्ययोजना अद्यावधिक गर्ने		

आवश्यक बजेट

यो कार्य योजना आगामी बीस वर्षको लागि तर्जुमा गरिएको छ । चार अवधिमा कार्यान्वयन गर्ने गरी यस कार्य योजनाका योजनाहरू र बजेटलाई विभाजन गरिएको छ - छोटो अवधि ० देखि ५ वर्ष, पहिलो मध्यावधि ६ देखि १० वर्ष, दोस्रो मध्यावधि ११ देखि १५ वर्ष र अन्तमा दीर्घकालीन १६ देखि २० वर्ष । प्रस्तावित क्रियाकलाप कार्यान्वयनका लागि छोटो अवधिमा रु ६८ अर्ब ३४ करोड १९ लाख, पहिलो मध्यावधिका लागि रु ७० अर्ब १८ करोड ५९ लाख, दोस्रो मध्यावधिका लागि रु ५५ अर्ब ३१ करोड ५४ लाख, र दीर्घकालीन अवधिका लागि रु ३१ अर्ब ४६ करोड ८३ लाख गरी कूल अनुमानित बजेट रु २ खर्ब २५ अर्ब ३१ करोड १६ लाख लाग्ने देखिन्छ । बागमती कार्य योजना (२०८२ - २१०२)मा बहुक्षेत्रगत बहुवर्षिय लगानी योजना देहायको तालिकामा प्रस्तुत गरिएको छ ।

प्रस्तावित क्रियाकलापहरूको क्षेत्रगत कार्यान्वयनको आधारमा संरक्षण क्षेत्रको लागि लगभग रु. ७३ अर्ब ८३ करोड ७६ लाख आवश्यक पर्नेछ, उप-शहरी क्षेत्रका लागि रु. ४८ अर्ब ८ करोड ९६ लाख, शहरी क्षेत्रका लागि रु. १ खर्ब २१ करोड ४५ लाख र सामान्य परियोजनाहरूको लागि रु. ३ अर्ब १६ करोड ९९ लाख आवश्यक हुने देखिन्छ ।

कार्यान्वयन रणनीति

बागमती कार्य योजनाको प्रयासको दीर्घकालीन प्रतिफल योजना तर्जुमा र यसको कार्यान्वयनबाट सुनिश्चित गर्न सकिन्छ । साथै यसको सफल कार्यान्वयनको लागि प्रशासनिक, व्यवस्थापकीय र अन्य सहयोगी तत्त्वहरूको पनि ठुलो भूमिका रहन्छ । यस अन्तर्गत नीति र कानुन; संस्थागत व्यवस्था; सरोकारवालाको संलग्नता; विज्ञान, अनुगमन र अनुसन्धान; नियामक नियन्त्रण र अन्य योजना प्रणालीहरू मार्फत कार्य योजनाको रणनीतिका तत्त्वहरूलाई प्रभाव पार्ने उपकरणहरू समावेश गरिएको छ ।

यस कार्य योजनाको प्रभावकारी कार्यान्वयनका लागि विभिन्न रणनीतिहरू (क्रियाकलाप र लक्ष्य प्राप्ति, जिम्मेवारी, निजी क्षेत्र र नागरिक समाजको लागि प्रवर्द्धन रणनीति, बजेट, अनुगमन र प्रतिवेदन, र रणनीति समीक्षा र अनुकूलन) लाई प्राथमिकता दिइएको छ । अधिकार सम्पन्न बागमती सभ्यता एकीकृत विकास समितिलाई प्राविधिक क्षमता, वित्तीय श्रोत र कानुनी तवरले सुदृढ पार्ने प्रयास गरिएको छ । संस्थागत सुदृढीकरणका लागि यस कार्य योजनामा अधिकार सम्पन्न बागमती सभ्यता एकीकृत विकास समितिको हालको सङ्गठनात्मक संरचनामा विकास सरोकारवालाहरूबीचको अधिकारको विवादलाई न्यूनीकरण गर्न समन्वय तथा लैङ्गिक समविकास एकाइ, वातावरण विज्ञ सहितको वातावरण एकाइ, भूगर्भविद्, ल्याण्डस्केप योजनाविद् सहितको योजना एकाइ, नापी एकाइमा भू-सूचना प्रणाली विज्ञ समावेश गर्ने प्रस्ताव गरिएको छ । अझ महत्त्वपूर्ण कुरा, सरकारले लक्ष्य र अन्ततः दूरदृष्टि प्राप्त गर्न कार्य योजनाको प्रभावकारी कार्यान्वयन सुनिश्चित गर्न पर्याप्त श्रोत साधनको सुनिश्चितता गर्नुपर्छ ।

अनुगमन योजना

कार्य योजनाको प्रभावकारिताको मूल्याङ्कन गर्दै अनुकूलन व्यवस्थापनलाई निर्देश गर्नका लागि परिभाषित र मापनयोग्य उद्देश्य प्राप्तिको अनुगमन गर्नु महत्त्वपूर्ण हुन आउँछ । अनुगमन र मूल्याङ्कन योजनाले सदैव कार्य योजनाको सर्वोपरि उद्देश्य प्राप्तितर्फ, निश्चित पुनर्स्थापना रणनीति तर्फ र कार्यान्वयन गरिने निश्चित पुनर्स्थापनाका प्रयास तर्फ लक्षित हुनु पर्दछ । सम्बन्धित निकायबाट नियमित अनुगमन र त्यसै गरी

कार्यान्वयनकर्तालाई नियमित पृष्ठपोषण आवश्यक हुन्छ । अधिकार सम्पन्न बागमती सभ्यता एकीकृत विकास समितिले समग्र अनुगमनको जिम्मेवारी लिनुपर्ने हुन्छ । यसका साथै सहभागितात्मक वा संयुक्त अनुगमन प्रणाली बसाल्नु पर्ने हुन्छ, जहाँ सम्बन्धित सरोकारवालाका प्रतिनिधिहरूले सहभागी भएर अनुगमन गर्न सकियोस । यो कार्य योजना कार्यान्वयन गर्ने प्रत्येक जिम्मेवार निकायले प्रभावकारिताका लागि आफ्नो अनुगमन योजना तर्जुमा गरी गर्नुपर्ने हुन्छ ।

तालिका:- बहुक्षेत्रगत बहुवर्षिय लगानी योजना

क्र.सं.	क्रियाकलाप/ योजना	आवधिक लक्ष्य (रकम रु लाखमा)				जम्मा (रकम रु लाखमा)
		(०-५) वर्ष	(५-१०)वर्ष	(१०-१५)वर्ष	(१५-२०)वर्ष	
(क)	संरक्षण क्षेत्र					
	नदी संरक्षण र व्यवस्थापन	१०८,६९६.६३	४९,२७५.१७	२७२.२५	२५७.२५	१५८,५०१.३०
	सांस्कृतिक/ सभ्यता पुनर्स्थापना	१,३२५.००	६२५.०	१२५.००	१२५.००	२,२००.००
	नदी/जल गुणस्तर र मात्रा सुधार	९५,८६९.००	१४९,३०६.०	१६६,२५०.००	१६६,२५०.००	५७७,६७५.००
	जम्मा	२०५,८९०.६३	१९९,२०६.१७	१६६,६४७.२५	१६६,६३२.२५	७३८,३७६.३
(ख)	उप-शहरी क्षेत्र					
	नदी संरक्षण र व्यवस्थापन	८५,८२०.७५	१२६,०८८.७५	८७,९६२.००	१६,५४०.०	३१६,४११.५
	सांस्कृतिक/सभ्यता पुनर्स्थापना	३,९५०.००	३,३००.००	५,७५०.००	५,५००.००	१८,५००.००
	नदी/जल गुणस्तर र मात्रा सुधार	३४,१३२.५०	३८,१०२.५०	५८,६५०.००	१५,१००.००	१४५,९८५.००
	जम्मा	१२३,९०३.२५	१६७,४९१.२५	१५२,३६२.००	३७,१४०.००	४८०,८९६.५०
(ग)	शहरी क्षेत्र					
	नदी संरक्षण र व्यवस्थापन	१४१,५५०.९३	९३,९७६.१७	९,८२१.९०	४,०५०.००	२४९,३९९.००
	सांस्कृतिक/सभ्यता पुनर्स्थापना	२६,०३५.००	३०,६७५.००	७,८५०.००	५००.००	६५,०६०.००
	नदी/जल गुणस्तर र मात्रा सुधार	१७५,७४६.००	२०२,४२८.००	२०९,६१२.००	९९,९००.००	६८७,६८६.००
	जम्मा	३४३,३३१.९३	३२७,०७९.१७	२२७,२८३.९०	१०४,४५०.००	१,००२,१४५.००
(घ)	अन्य क्रियाकलाप	१०,२९४.००	८,०८३.००	६,८६१.००	६,४६१.००	३१,६९९.००
	कूल जम्मा	६८३,४१९.८१	७०१,८५९.५९	५५३,१५४.१५	३१४,६८३.२५	२,२५३,११६.८०

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CHAPTER-I

1. INTRODUCTION

1.1. BACKGROUND

Collectively, the Bagmati is the river system in the Kathmandu Valley comprising 57 rivers and rivulets as its tributaries. There are many heritage sites and traditional settlements on its bank that are rich with numerous tangible and intangible heritages. One of the significant sites is the Pashupatinath temple area, which is enlisted as a World Heritage site. Bagmati, the holy river of the Hindus and a major source of water for the Kathmandu Valley, has been polluted due to human actions such as settlement along the river, unplanned urbanization in river basin and disposal of untreated sewage and solid waste into the river system. Apart from that, extractions of sand from river bed, construction of public infrastructure in river space and informal squatter settlements along the banks have deteriorated the river environment and the water security. Joint initiation of citizen and government to make Bagmati a pollution free river resulted in formation of a high-powered Committee for Implementation & Monitoring of Environmental Improvement in Pashupati Area back in 2051 B.S., which is now functioning as High-Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC). It builds on the general public's desire to restore the river environment in the Kathmandu Valley and the Government's efforts to improve irrigation development and mitigate the impact of water induced disasters in the middle and lower reaches of the basin. GoN approved the Bagmati Action Plan (2009-2014) in 2066 B.S, which introduced a concept of zonation of the river system within the Kathmandu valley. It was prepared by HPCIDBC in collaboration with National Trust for Nature Conservation (NTNC). It was established as an important guiding conceptual framework document for scientifically and systematically restoring and conserving the Bagmati River and its tributaries within the Kathmandu valley. It was formulated with the aim to restore and conserve the Bagmati River and its tributaries in an integrated and coordinated approach. The Action Plan covers the Bagmati river system from Shivapuri hill to Katuwal Daha.

Bagmati River originates at Bagdwar 15km northeast of Kathmandu, carves its path from the historic Chovar gorge and flows downward through the Southern Terai plain of Nepal and merges into mighty Ganges in India. It is holy to both Hindus and Buddhists of Nepal. It is one of the important river systems of Nepal with high cultural and aesthetical values. Despite this profound significance, the Bagmati is facing a severe crisis. The absence of planned, coordinated conservation has led to unchecked environmental degradation and the erosion of its cultural legacy. The core challenges are multifaceted, threatening the river's ecosystem, its surrounding land, its cultural heritage, and the institutional frameworks needed to protect it. Restoring the health of this sacred river is not just an environmental issue, but a crucial effort to preserve Nepal's living history.

Several efforts were made in the past for the conservation of Bagmati River and its tributaries. With the formulation of Bagmati Action Plan 2009-2014, a number of its activities have been implemented and are still ongoing till date. With the guidance of BAP 2009-2014, various efforts are made in reconstruction/ restoration of monuments and heritage sites, landscaping and river beautification along river corridors, construction and remediation of interceptor and existing

sewers, up-gradation/ construction of Waste Water Treatment Plants, construction of new sewers in WWTPs service area, river training works, road and green belt along river banks, water storage and increase recharging area like Dhap and Nagmati Dam and others. Despite several interventions by HPCIDBC, Kathmandu Upatyaka Khanepani Limited (KUKL), Kathmandu Valley Development Authority (KVDA), Local Governments, various NGOs/INGOs and other organizations, the Bagmati River and its tributaries remain critically polluted and its space continues to be encroached upon for different purposes.

The issues and challenges identified in the 2009-2014 Bagmati Action Plan (BAP) are similar to those faced today, differing only in their scale. The urban landscape has shifted dramatically, with a significant increase in built-up density and land use conversions. Because of this, the previous action plan needs to be revised and updated with new interventions to achieve the desired outcomes. In this context, Bagmati Action Plan with a planning perspective for next 20 years is prepared.

CHAPTER-II

2. METHODOLOGY

The consultative as well as participatory approach has been adopted for the preparation of Bagmati Action Plan. Field survey and stakeholder consultations were conducted to identify the existing scenario and accordingly the plans and programs were identified to focus on the development of implementing strategies for Bagmati River System. The action plan covers various aspects of the planning area (**Figure 2-1**).

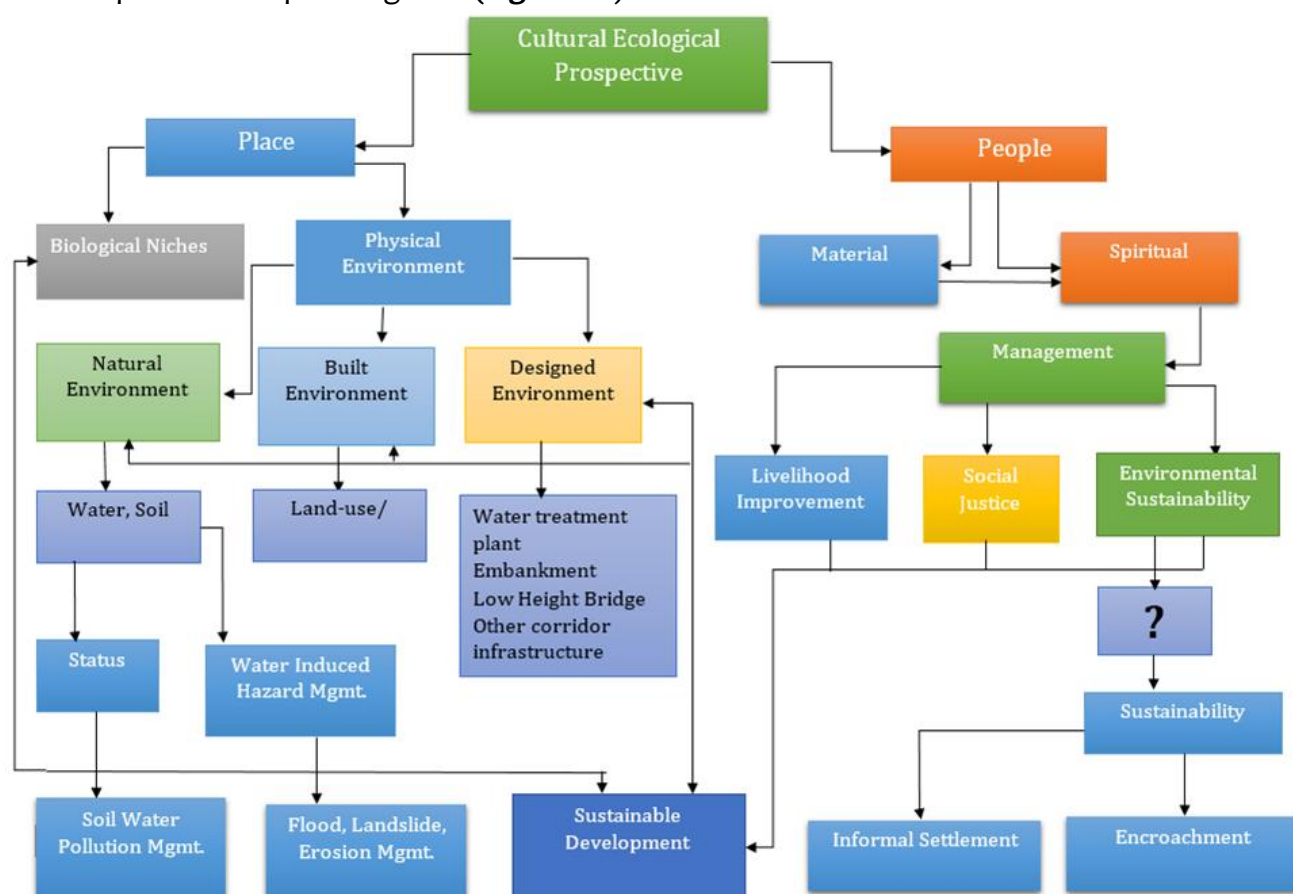


Figure 2- 1: Conceptual Framework for Action Plan

The following approaches were adopted for the preparation of Bagmati Action Plan:

- The foremost step of the planning process was the review of Bagmati Action Plan 2009-2014. Along with this the information about the Kathmandu Valley, Bagmati River and its tributaries available from different sources were reviewed and analyzed. The reports and research papers related to urban development, rivers and water sources, hazard risk analysis, sewerage network and waste water treatment plants, solid waste management, cultural heritage and monuments of Kathmandu valley were reviewed and relevant data and information were collected. Global case studies on river restoration and conservation were also reviewed. Secondary data and information were collected from different agencies including HPCIDBC, KVDA, KUKL, Water and Energy Commission Secretariat (WECS) and

others. Census reports of Central Bureau of Statistics (CBS) were referred for population data. Climate data was obtained from the Department of Hydrology and Meteorology (DHM).

- b) Digital maps and satellite imageries including topographic maps, aerial photographs, geological maps, land use maps and other relevant thematic maps of the study area were obtained from different sources like Department of Survey (DoS), Department of Mines and Geology (DMG), International Center for Integrated Mountain Development (ICIMOD) and others. The collected maps and photographs were studied and collated with respect to the objectives and deliverables of this assignment. Satellite imagery of 5m resolution was acquired from Planet Earth for preparation of digital base map. Cadastral data maintained by concerned agencies were acquired.
- c) Corridor of 100-200m from the existing river channel was delineated on both sides for inventory. Questionnaire and checklists were prepared for data/information collection during field survey, key informant interview, focus group discussions (FGD) and stakeholder meetings.
- d) Intensive field surveys were conducted along the rivers to collect information on the existing infrastructures and services, tangible and intangible heritages, green open spaces and other primary data. Environmental studies, socioeconomic studies, geo-technical studies were also performed for the identification of issues related to land, infrastructures, heritages, water ways, hazard risks and vulnerability etc.
- e) Cross section surveys were conducted using DGPS and Total Station for hydrological analysis.
- f) Series of meetings and discussions were organized with local units (municipal and ward level), HPCIDBC and its project offices, KVDA, KUKL and other concerned governmental and non-governmental organizations and experts of various thematic areas. The key issues, challenges and necessary actions were discussed during the meetings.
- g) GIS based inventory system was established based on the field inventory.
- h) Digital hydrological 3-D model was prepared using Hydrologic Modeling System (HEC-HMS) software with consideration of critical return periods within 50 years. Flood inundation maps were prepared and the required Right of River Ways was recommended.
- i) Complete land inventory was prepared with the integration of cadastral details of land within the Right of River Ways of Bagmati River and its tributaries.
- j) Zoning of Bagmati River System was updated.
- k) Assets Management Plan including Operation and Maintenance plan of built infrastructures was prepared.
- l) SWOT analysis, population trend and projections, vulnerability assessments, spatial analysis and needs assessment are done and necessary actions were identified. Investment plan was prepared with phasing of the activities, estimated costs and possible mode of financing.
- m) Institutional development plan was prepared and implementation plan, monitoring strategy and mechanisms was recommended.

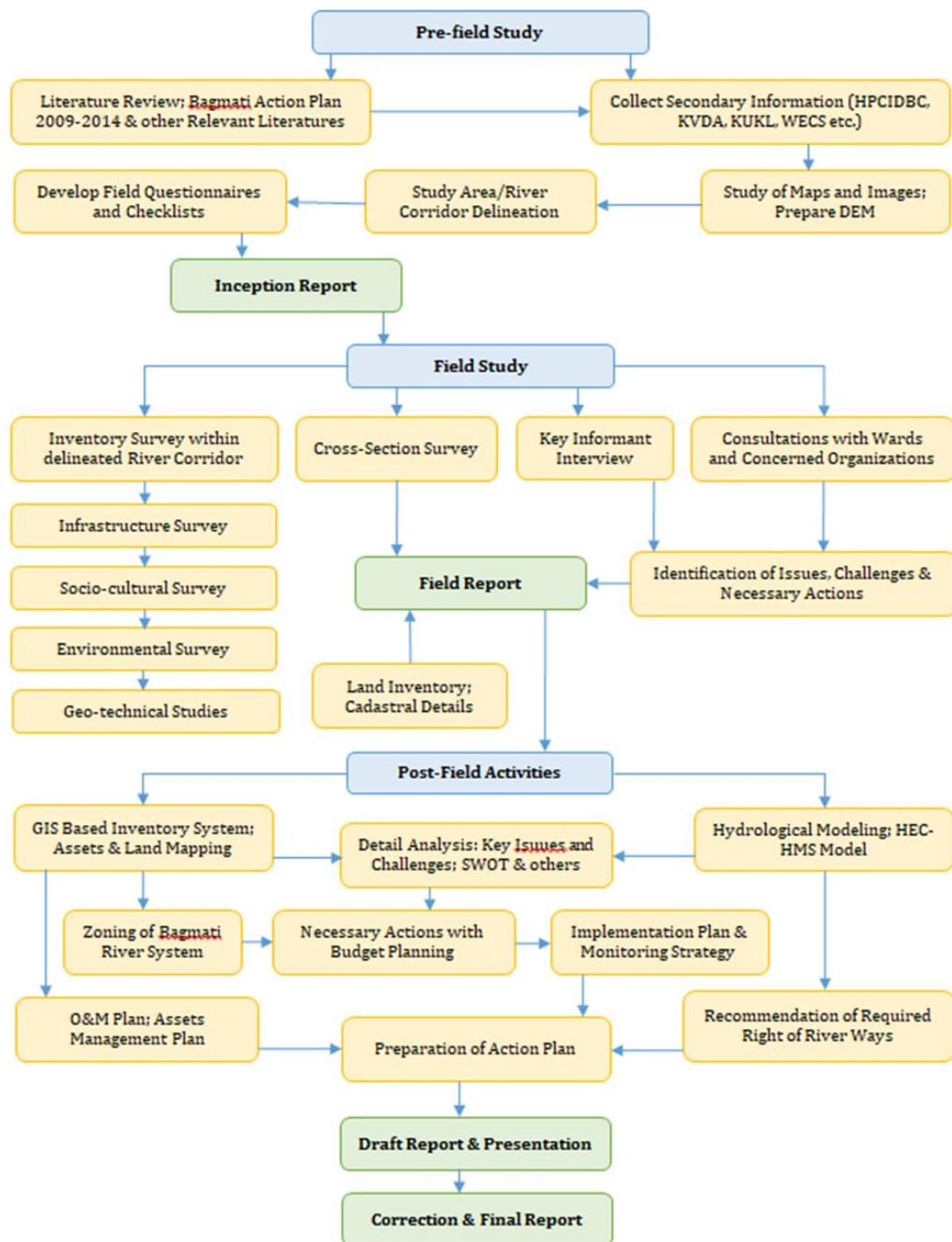


Figure 2- 2: Action Plan Methodology

CHAPTER-III

3. EXISTING SCENARIO OF STUDY AREA

3.1. BACKGROUND

Kathmandu Valley is situated in Bagmati Province of Nepal. The valley floor is roughly elliptical in shape and is dissected by rivers/streams originating from surrounding mountains. Considering the mountain surrounding the valley, it is oval shaped with a radius of around 30 Km. The slope of the surrounding mountain ranges from moderate to steep, however, the valley floor normally is flat land except the river edge. The southern and south-west hill-slope of the valley has a higher slope. The elevation ranges from 1203 m to 2737 m with an average of 1548 m.

The Kathmandu Valley has a mild climate most of the year. The annual mean temperature ranges between 12.36°C to 19.03°C. The annual precipitation ranges from minimum of 1546 mm to maximum of 2121 mm.

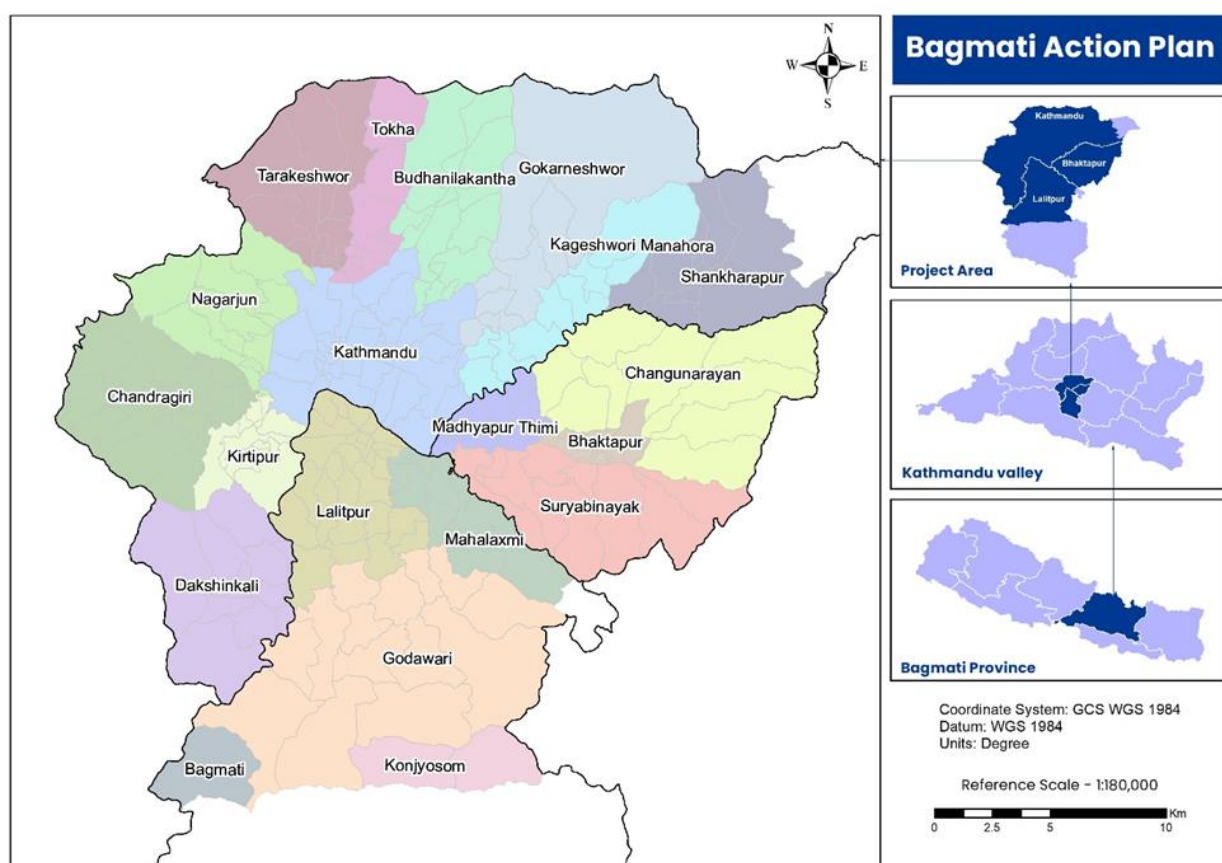


Figure 3- 1: Study Area for Bagmati Action Plan

Administrative Division

Kathmandu valley comprises of 2 metropolitan cities - Kathmandu and Lalitpur, 16 municipalities- Bhaktapur, Budhanilakantha, Chandragiri, Changunarayan, Dakshinkali, Godawari, Gokarneshwor, Kageshwori Manahora, Kirtipur, Lalitpur, Madhyapur Thimi, Mahalaxmi, Nagarjun, Shankharapur, Surya Binayak, Tarakeshwor and Tokha and 2 rural municipalities- Bagmati and Konjyosom.

Historical Background of Kathmandu Valley

The myth has it that Kathmandu valley was once a lake surrounded by hills and that in Satyayuga Vipashwi, the first of the seven mortal Buddhas came to Nepal, took abode in Jamacho hill and sowed the seed in the great lake of the serpents during full moon day of April. A lotus flower appeared from that seed which was later known as “Swayambhu” – the self-existent. This happened on the full moon day of October. People still climb Jamacho on April full moon day to mark the sowing of the seed and on October people throng Swayambhu. In the following era of Tretayuga, Vishvabhu Buddha, who took up abode in Pucva Mountain and offered one lakh flowers to Swayambhu, predicted the drain of lake. Then came Manjushree from China who drained the lake by slashing the rock hill in Chobar by his Pragyakhadga, the sword of wisdom. It is believed that the lake was home to great serpents and with the draining, many left the valley, however Manjushree persuaded Karkotaka (the king of serpents) to reside in a pond known as Tau daha in Chobar and to ensure the prosperity of the valley. Then came Karkuchanda Buddha to take up abode on Sipucva mountain but he did not find water to consecrate his disciples so he thrust his thumb into the rock and there flowed the river Bagmati on the day of vernal equinox. After consecrating his disciples he threw up their hair and where it fell a stream came forth which was called Keshavati, the stream of hair (Bagmati, 1995).

The geographical study of the valley do suggest that it was once a lake and most probably due to the cleavage created to the surrounding mountain caused by the earthquake, the water was slowly drained out creating a habitable space. The fertile soil gave way to lush green grasslands and the cowherd form the higher slopes descended down to feed their cows and thus slowly the valley was inhabited. With time the trade routes developed through the valley connecting southern plains with the northern high plateau of Tibet. This movement was of tremendous importance in the development of culture, art, architecture, literature to name the few.

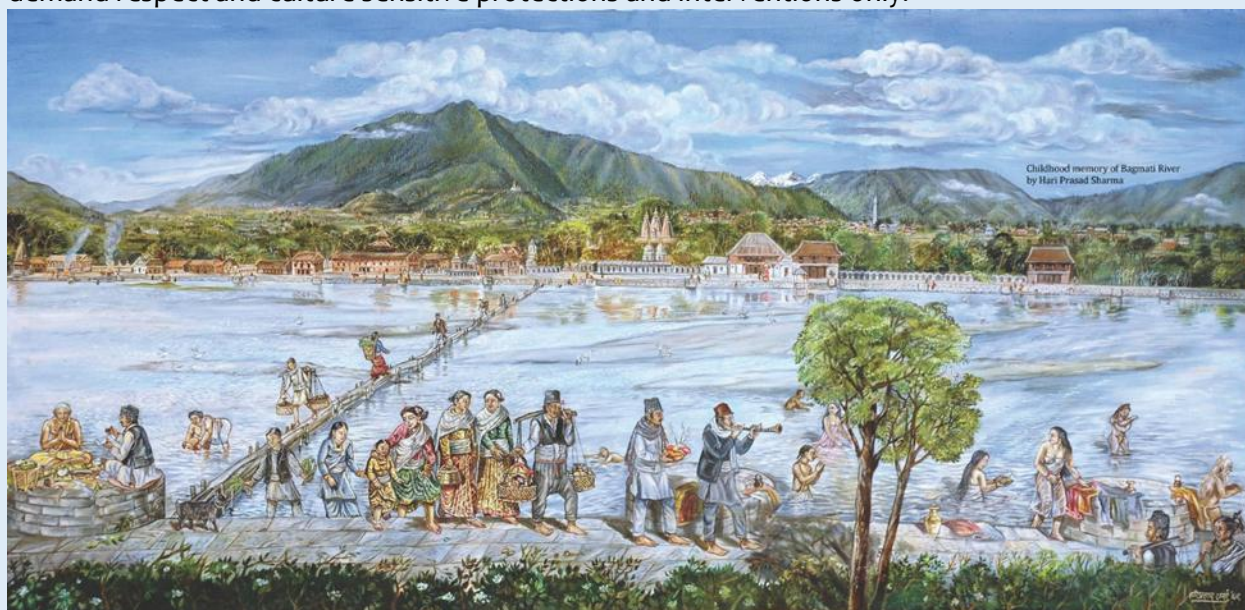
It is clear that the early settlers settled near the river banks. Of all the rivers Bagmati, Bishnumati and Hanumante are of major importance because it's on their banks that the historic settlements of Patan, Kathmandu and Bhaktapur developed. Bagmati and Bishnumati flowing in the Kathmandu Valley are regarded as the holiest of all by Nepalese society. In “Nepal Mahatmaya” Bagmati has been depicted as the holiest river – one gets fruit of Bajpey and Ashwamegh Yagya if one takes dip in their stretch. Likewise, in “Pashupati Puran” it has been said that one gets spiritual, physical and divine power and gets rid of drudgery just by taking bath in Bagmati River. Similary, Bishnumati has been described as being emanating from the feet of Lord Vishnu is purest of pure. Likewise, “Nepal Mahatmaya” states that one is granted for Vishnu Lok after taking holy dip in Bishnumati (S. Amatya, 2003). The river edges are long understood as places to attain salvation and the dying to would desire to die in one of the tirthas in the lure to attain moksa. As such the river edges and mainly confluences of the valley sees many tirthas, temples and ghat development.

There are numerous lakes and ponds in the valley like Indra daha of Dahachowk, Matatirtha daha, Manichuda daha, Mahadev Pokhari, Tau daha to name the few which are natural formations to hold water. As for the manmade ponds, excavation in Satyanarayan temple in Handigaon mentions that there used to be ponds in the area and this could probably date before the Lichavis arrived here. The art of constructing the pond was continued through Lichhavi to Malla and numerous such ponds were created. For example, Rani Pokhari with Balgopaleshwara temple at its center is probably the largest pond constructed in Malla period.

The earliest settlers of the Kathmandu valley are known as Gopals or cowherd followed by Kiratas, after which Lichhavis from Vaishali ruled the valley from 1st cent. A.D. to 8th cent. A.D. The Lichhavi era is of importance because of their contribution in the development of pit conduit water supply system. Although historians agree that the word “Tilamaka” is non-sanskrit word and was probably a Kirat word whose meaning is similar to water canal or a water way which suggest that system of bringing water for far away source to the city was probably in use already in the valley before the Lichhavis arrived. But it is during the Lichhavi period that that system flourished and numerous pit conduits and extensive water canal projects were carried on by the Kings and their future heirs. The oldest inscription relating to the water conduit comes from Manga hiti dated 570 AD by Bharbi, grandson of King Mandeva. These pit conduits mark the cross roads and major public spaces of the town. The pranali or canal systems developed to bring water to these conduits are technical genius of that time. For instance the Raj kulo bringing water from as far as Lele river of Lembatigrama were under the royal jurisdiction as mentioned in the Tanga hiti inscription of Jayadeva II. This canal brought the water which fed the saptapatal pukhu situated around the Lagan thur to the south of ancient Patan city.

From this pond the water was channelized through local underground terracotta canals to feed the pit conduits where the water was allowed to flow through a stone spout. Such raj kulos are to be found in all major settlements of the valley. Within the city of Patan the celebration of rain god Bunga dya or Rato machindranath is closely associated with the water supply system. The myth relates that the god was brought to Nepal from Assam by the King Narendradeva, tantric Bandhudatta and a Rathachakra Jyapu to end the twelve year drought in the valley. Tiwari, 2015 mentions that with the start of the Jatra it was originally mandated that the pukhu in Pulchowk be fully filled and that the water kept running at Patan Sundhara indicating the system of repair and maintenance of these canal systems.

The biggest festival related to water culture is that of Janai purnima, on this day almost all of the residents of the valley irrespective of their caste or creed visit the holy ponds or rivers to take a dip or pay homage to the god. It is the major festival of Gosaikunda tirtha. Similarly another major festival relating to water culture is that of sithi nakha which falls on Jestha shukla sasthi. During this day the newars of the valley clean the water sources like ponds, Jaldronis, pit conduits, wells followed by ritual worship and feasting of delicacies made of lentils. There are environment aspects associated to this festival too as during summers diseases would spread rapidly and mosquitoes would breed in stagnant water and by cleaning them with the advent of summer such misfortunes are prohibited. The rivers, water sources and water culture are the soul and spirituality of the valley as such they demand respect and culture sensitive protections and interventions only.



Picture Credit: Hari Prasad Sharma

Geographically the valley extends from 27°49'4" to 27°31'42" latitude and from 85°11'19" to 85°33'57" longitude in the mid-mountain physiographic region of Nepal. (KVDA)

In this Action Plan, the river system of Bagmati within Kathmandu Valley is the catchment area or influence area of the project which is 672.34 sq.km and for the detail study total administrative area of ward is considered within study area, so the area of study area is 714.20 sq.km. The detail study area covers the following local level.

Table 3- 1: Local unit of study area

S. N.	Local Level	Type	Total Number of Wards	Number of Wards Included in the Study Area	Area of Local Unit (sqkm)	Study area of Local Unit (sqkm)
1	Kathmandu	Metro city	32	32	49.45	49.45
2	Kirtipur	Municipality	10	10	14.76	14.76
3	Dakshinkali		9	9	42.68	42.68
4	Chandragiri		15	15	43.92	43.92
5	Nagarjun		10	10	29.85	29.85

S. N.	Local Level	Type	Total Number of Wards	Number of Wards Included in the Study Area	Area of Local Unit (sqkm)	Study area of Local Unit (sqkm)
6	Tarakeshwor		11	11	54.95	54.95
7	Tokha		11	11	17.11	17.11
8	Budhanilkantha		13	13	34.80	34.80
9	Gokarneshwor		9	9	58.50	58.50
10	Kageshwori Manahora		9	9	27.38	27.38
11	Shankharapur		9	7 (except ward 1 & 2)	60.21	60.21
12	Bhaktapur		10	10	6.89	6.89
13	Surya Binayak		10	10	42.45	42.45
14	Madhyapur Thimi		9	9	11.47	11.47
15	Changunarayan		9	9	62.98	62.98
16	Lalitpur	Metro city	29	29	36.12	36.12
17	Mahalaxmi	Municipality	10	9 (except ward 10)	26.51	26.51
18	Godawari	Municipality	14	14	96.11	96.11
19	Konjyosom	Rural	5	2 (except ward 1-3)	44.16	44.16
20	Bagmati	Municipality	7	1 (except ward 2-6)	111.49	10.84

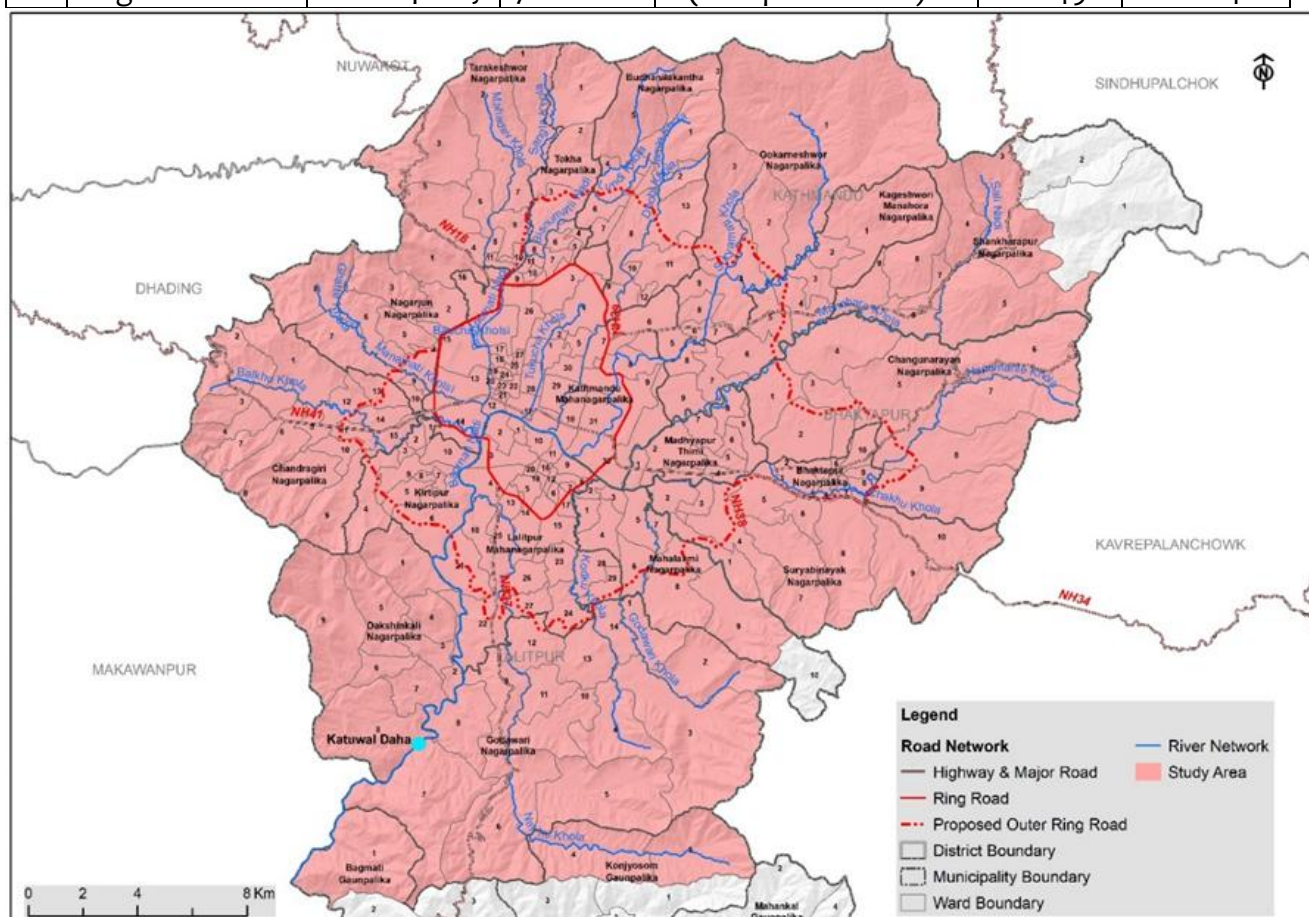


Figure 3- 2: Study Area Map for BAP

3.2. GEOPHYSICAL CONTEXT

3.2.1. Geology and Soil

Kathmandu Valley is an intermontane basin, which comprises unconsolidated sedimentary deposits in central part and is surrounded by bedrocks in the periphery. Thus, the geology of

the valley can be broadly classified into two categories: hard basement rocks and soft sedimentary sequences. The peripheral hilly area of the valley comprises low to medium grade metamorphic rocks and intrusive rocks belonging to Lesser Himalayas as well as sedimentary rocks equivalent to Tibetan Tethys Zone (Stocklin & Bhattacharai, 1977). Stratigraphically, these bedrocks can be divided into two groups namely, the Bhimphedi Group and Phulchauki Group of the Kathmandu Complex (Stocklin & Bhattacharai, 1977; Stocklin, 1980). Underlying Precambrian metamorphic rock sequences are transitionally changed to middle Palaeozoic sedimentary rocks that are equivalent to the Tibetan-Tethys Zone on the upper part (Joran Stöcklin, 1980) in this area. As in the peripheral hills of Kathmandu Valley, bedrocks are also exposed in the form of small isolated hillocks within the soft sediment of basin such as in Balkhu, Swoyambhu, Gokarna, and Pasupatinath. The stratigraphy of basement rocks with main composition is presented in Table 3-2.

Table 3- 2:Stratigraphic subdivisions of the hard rock (Stocklin & Bhattacharai, 1977; Stocklin, 1980)

Rock unit	Group	Formation	Thickness (m)	Main Lithology	Age
Kathmandu Complex	PHULCHAU KI GROUP	Godavari Limestone	300	Limestone, dolomite	Devonian
		Chitlang Formation	1000	Slate	Silurian
		Chandragiri Limestone	2000	Limestone	Ordovician
		Sopyang Formation	200	Slate, Calc-phyllite	Cambrian
		Tistung Formation	3000	Metasandstone	
	T R A N S I T I O N				
	BHIMPHEDI GROUP	Markhu Formation	1000	Marble, Schist	Precambrian
		Kulikhani Formation	2000	Quartzite, Schist	

Source: Stocklin & Bhattacharai (1977); Stocklin (1980)

The central basin part of the valley is filled with soft sedimentary deposit that comprises semi-consolidated fluvio-lacustrine sediments. The depth of valley sediments is more than 650 m. at the central part of the valley, under Baneshwor, which gradually decreases towards the marginal ends (Moribayashi & Maruo, 1980). The oldest sediments found in the basin are reported of Plio-Pleistocene age (~5 to 2.5 million years ago), while the youngest sequence was deposited about 11,000 years ago. The unconsolidated layers of sediments are distributed in the central part of the valley covering about half (~49.4%) of the entire Kathmandu Valley. The valley sediments can be categorized into three units based on their mode of formation: Alluvial fan and talus deposits, Fluvio-lacustrine deposits, and recent floodplain deposits (Table 3-3).

Table 3-3: Lithological succession of the soft sediments in Kathmandu Valley (DMG, 1998)

Table 3- 3:Lithological succession of the soft sediments in Kathmandu Valley (DMG, 1998)

Formation	Thickness (m)	Main Lithology	Age
Alluvial Fan Deposit	Varies	Gravel, sandy gravel, sand, and silt	Pliocene to
Tokha Formation	200	Well-graded sandy gravel, peaty clay and lignite	
Gokarna Formation	300	Fine laminated poorly graded silty sand, gravel	
Chapagaun Formation	110	Silty sandy gravel with occasionally boulder beds	
Kalimati Formation	450	Organic clay, fine sand beds and peat	
Kobgaun Formation	50	Fine sand, silty sand and poorly graded gravel	
Lukundol Formation	80	Sandy, clayey silt with gravel and clayey sand	

Formation	Thickness (m)	Main Lithology	Age
Basal Boulder Bed	100	Boulder conglomerate with sand and silt	Recent

Source: DMG 1998

During the process of Himalayan range formation, a mega geological fold system, called the Mahabharat Synclinorium, was formed. It is a well-known fold system in the geology of Nepal Himalaya, which is the main generator of the Kathmandu basin. The axis of synclinorium trends WNW–ESE and runs parallel to the ridgeline of the Chandragiri Range, but is observed about 500 m south from the ridgeline. This synclinal fold is also named as Chandragiri Syncline (Stocklin & Bhattarai, 1977). There is a local anticline fold observed between Tinthana and Kirtipur trending WNW–ESE, but its western continuation is covered with valley sediments. Besides the folds, there are local faults occurring in the Kathmandu Valley. A large fault named Kalphu Khola Fault runs almost east-west direction through the northern part of the valley. It has produced a faulted topography with horst and graben structure (Sakai, 2001). This Kalphu Khola Fault seems equivalent to the MCT reported by (Rai, 2001). Sakai (2001) has recognized two active local faults in the southwest of the valley, namely the Chandragiri Fault and the Chobhar Fault (Sakai, 2001). Another fault, named as the Chandragiri Fault, passes through the Bosan Khola on the northern foothill of the Chandragiri Range, while the Chobhar Fault passes through the north of the Chobhar and Kirtipur hillocks. In addition, Sakai (2001) presented some more longitudinal faults extending west-east, such as through Pasupatinath, Swayabhu, and Balkhu, and one transform fault near to Danuwargaun (Arita et al., 1973; Saijo et al., 1995; Yagi et al., 2000).

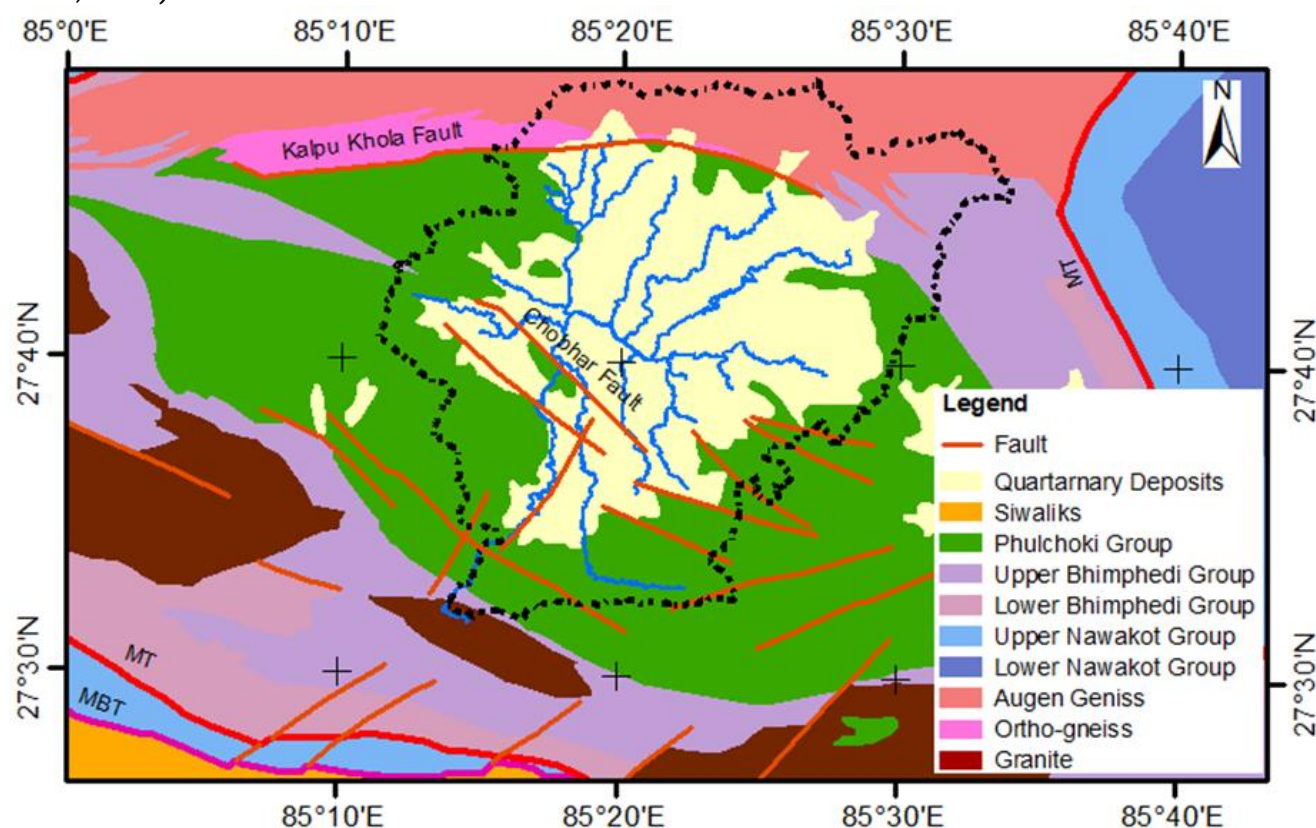


Figure 3- 3: Regional faults along with bedrocks in the vicinity of the Kathmandu Valley

(Map compiled by Irwin et al., 2014)



Figure 3- 4: Weathered augen gneiss bedrock exposed near to Mulkharka



Figure 3-5: Huge gneiss boulders in Nagmati Khola to the north of Sundarijal



Figure 3- 6:Limestone bedrocks exposed near to Lele, Lalitpur



Figure 3- 7:Highly jointed metasandstone exposed near to Muhanpokhari, Bhaktapur

The engineering geological map of the Kathmandu Valley published by the Department of Mines and Geology in 1998 highlighted the presence of different types of soil in the Kathmandu basin and their general geotechnical characteristics. DMG categorized the soft sediments of Kathmandu Valley into 8 different units. Irwin et al. (2014) slightly modified the previous map by adding some field-based information and presented a geological map in an assignment for Kathmandu Valley Development Authority (KVDA).

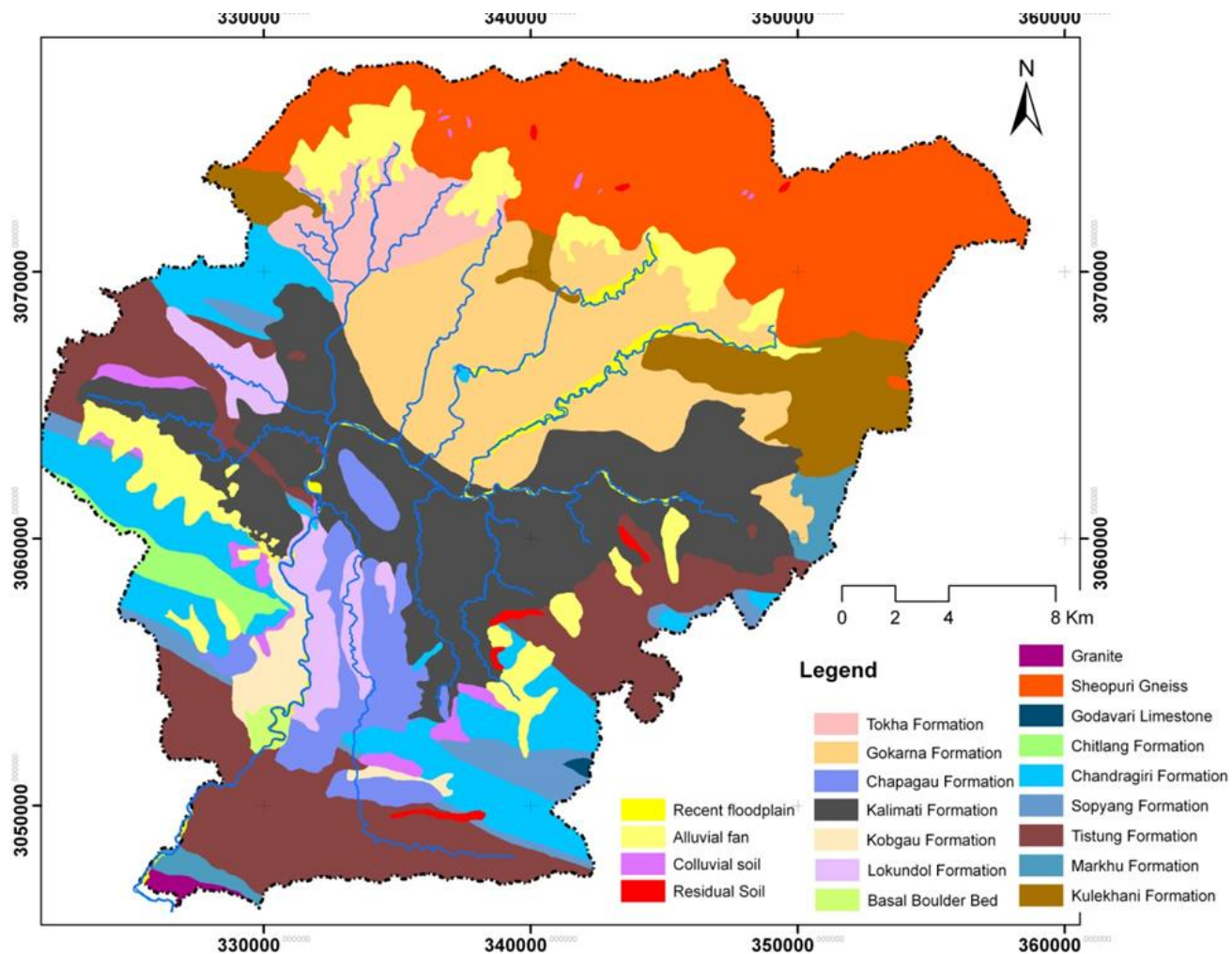


Figure 3- 8: Engineering Geological Map of Kathmandu Valley
(modified by Irwin et al. (2014) after (DMG, 1998))

3.2.2. Soil Pattern and Stability Mapping

In the Kathmandu valley, there are four different types of soil based on their mode of formation. Residual soil is found in the top of peripheral hills. Due to the highly weathering rate of gneiss, the Shivapuri area comprises thick residual soil cover than other parts. The sloping terrains of these hills are composed of colluvial soil that shows the occurrence of landslides in ancient times. The central part of the valley shows lacustrine soil, which is comparatively impermeable at many places and covered by recent alluvial soil. The peripheral hilly area of the Kathmandu valley shows rugged topography and steep sloping terrain. Due to rapid urbanization, most of the sloping terrains and hillocks are being excavated haphazardly. Thus, there is potential for severe gully erosion and landslides in this area. In addition, improperly conducted open stone mining practices have created threat to the slope stability of the valley hills.

The soft soil in the valley has low bearing capacity and shows liquefaction at many places during an earthquake. There were a number of cases of liquefaction reported in Kathmandu Valley, such as in Gongabu, Kalimati, Bungmati during the recent Gorkha earthquake 2015.

The liquefaction potential differs from place to place due to heterogeneity in soil composition, fluctuation in groundwater table, different compactness and age of sediments at different places and the nature of earthquake shaking at a particular place. The subsurface geological setting has a prime role in the calculation of liquefaction potential at a location. The spatial distribution of liquefaction potential values in the soft sedimentary deposits of the Kathmandu Valley shows that the areas in the vicinity of Kalimati, Nakhu, Suryabinayak, Thimi, Lazimpat, and Tokha would experience high to liquefaction. It is also suggested by the cases reported during the 2015 Gorkha Earthquake. In general, most of the valley sediments would be moderately liquefied due to such earthquakes.

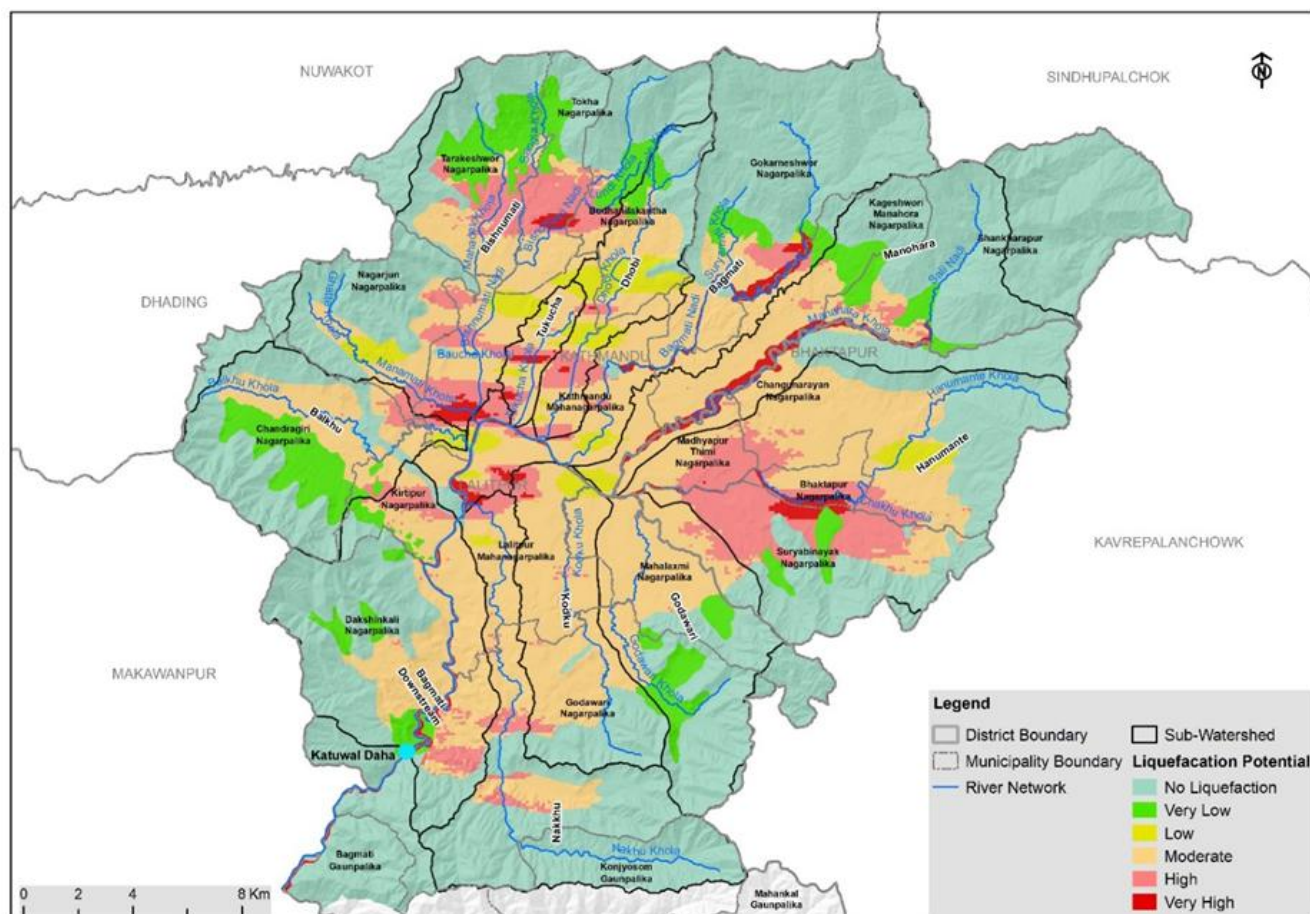


Figure 3- 9: Spatial distribution of liquefaction potential in Kathmandu Valley

3.2.3. Climate Change Scenario

The climatic analysis using Representative Concentration Pathways (RCP) 4.5 and 8.5 based on Global Circulation Models (GCMs) from Coupled Model Inter-comparison Project Phase 5 (CMIP5) datasets of the IPCC's Fifth Assessment Report (AR5) suggest that average annual mean temperature is likely to rise (MoFE, 2019). RCP 4.5 projected the increase by 0.81-0.86 °C and 1.1-1.18 °C in medium-term and long term respectively (Table 3-4 and Figure 3-10). The highest rates of mean temperature increase are expected for the post-monsoon season followed by the winter season. Raising temperature further will create water stress during the dry months through decreasing the agricultural production and thereby increasing food insecurity. Increasing temperature is also likely to contribute to the evolution and spread of crop diseases, pests and weeds (Pandey, 2012; Bhandari et al., 2019).

Table 3- 4: Mean annual temperature scenario

District/ Change Scenario	Change (°C)					
	RCP 4.5			RCP 8.5		
	Ref. Period (1981-2010)	Mid Term (2016-2045)	Long Term (2036-2065)	Ref. Period (1981-2010)	Mid Term (2016-2045)	Long Term (2036-2065)
Kathmandu	16.5	0.86	1.18	16.5	1.02	1.73
Bhatapur	16.4	0.84	1.15	16.4	1.01	1.7
Lalitpur	14.9	0.81	1.1	14.9	1.01	1.68

Source: MoFE, 2019

Average annual precipitation is likely to increase in both the medium-term and long-term periods. It is likely to increase by 7.9-8.03% and 10.38-10.58% in the long period based on RCP 4.5 and RCP 8.5 respectively (**Table 3-5** and **Figure 3-10**). This means precipitation related disasters

such as erosion, landslide and flood will be increased in the future. Alternation of precipitation will impact overall agricultural practices and productivity.

Table 3- 5: Precipitation change scenario

District/ Change Scenario	mm	Change (%)				
	RCP 4.5			RCP 8.5		
	Ref. Period (1981-2010)	Mid Term (2016- 2045)	Long Term (2036- 2065)	Ref. Period (1981-2010)	Mid Term (2016- 2045)	Long Term (2036- 2065)
Kathamndu	2094	2.33	8.03	2094	6.35	10.4
Bhaktapur	2106	2.28	7.97	2106	6.51	10.58
Lalitpur	2056	1.97	7.9	2056	6.1	10.38

Source: MoFE, 2019

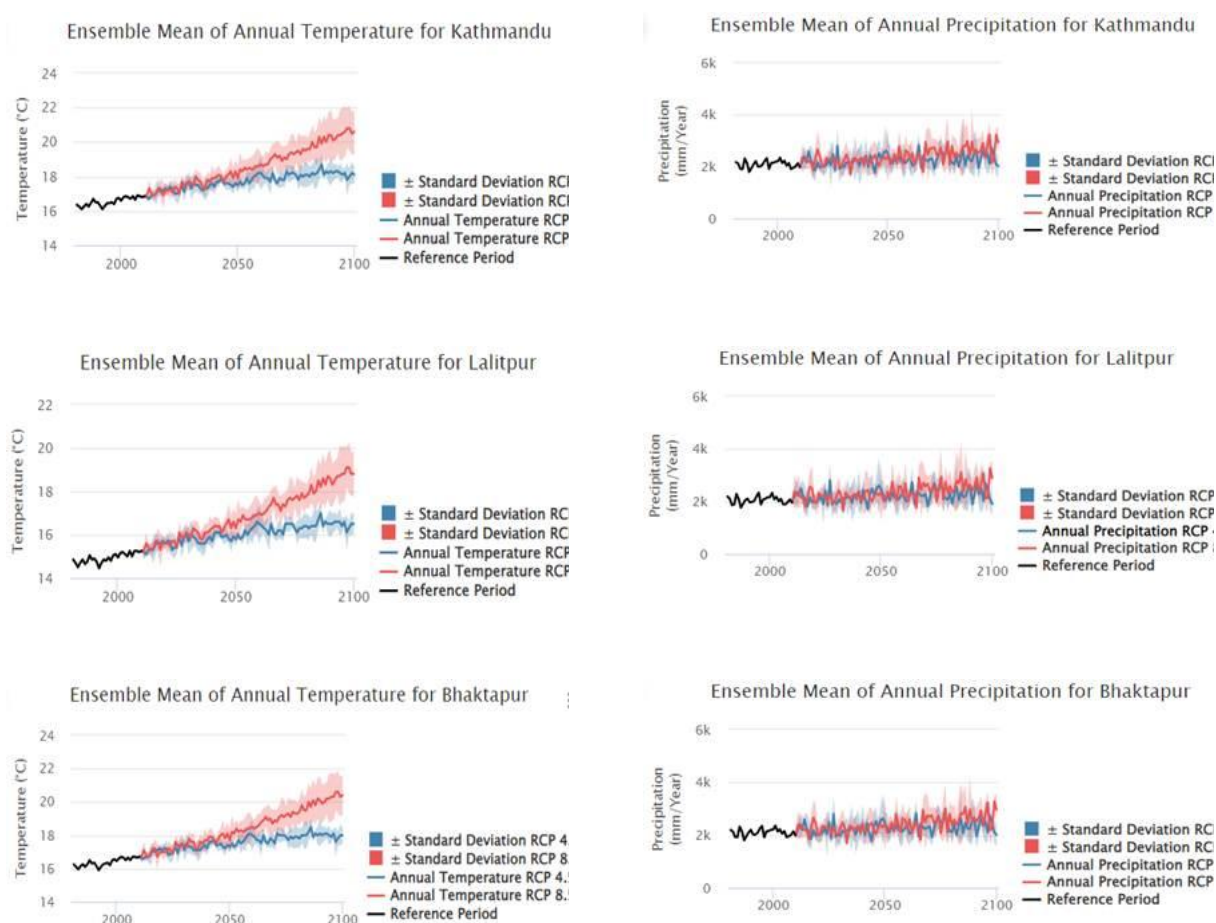


Figure 3-10: Ensemble mean of annual temperature and annual precipitation of project districts
(Source: MoFE, 2019)

3.2.4. Hydrology

Trend analysis of the hydrological and meteorological data represent the variation of the discharge and precipitation over the time period which are crucial parameters to evaluate the impacts of climate change, urbanization and other factors on the hydrology of Bagmati basin. From overall trend analysis, hydro climatological changes are observed in Bagmati basins which are due to regional, global and local effects.

The trend analysis of average seasonal discharge; the average winter discharge in Bagmati river at Khokana and Sundarijal is decreasing whereas at Gaurighat is increasing. For average pre-monsoon discharge the trend analysis shows increasing trend at Khokana and Gaurighat whereas decreasing at Sundarijal. The trend analysis of monsoon discharge which is mostly responsible for flood events in Kathmandu Valley shows decreasing trend in Khokana and Sundarijal whereas increasing trend in Gaurighat region. Average post monsoon discharge at Khokana follows a decreasing trend whereas at Gaurighat follows an increasing trend and at Sundarijal follows uniform non-varying trend. Variation in the trend of river discharge at different stretches is the result of spatial variation of rainfall in different regions of Bagmati Khola basin and its catchment at the same time period.

Trend analysis for seasonal precipitation shows uniform values of winter precipitation, increasing trend in pre-monsoon precipitation, decreasing trend in monsoon precipitation and slightly increasing trend in post-monsoon precipitation values. Maximum Daily Precipitation follows the decreasing trend over the years and annual precipitation in Bagmati basin also follows the decreasing trend.

The details are presented in Supplementary Volume II: Hydrological Modeling Report.

3.2.5. Groundwater Recharge and Water Sources

The northern hilly region of Kathmandu Valley, generally known as Shivapuri area, comprises dominance of **augen** and banded gneiss with frequent mineralized pegmatite veins. The gneiss is highly weathered in many places and plays as a good recharge zone to the groundwater of Kathmandu Valley. The middle and southern peripheral hills including Chobhar area show limestone dipping towards north. These zones are also good aquifers for the groundwater of Kathmandu valley. The surrounding bedrocks with alluvial fan deposits on the foothills are serving as a good recharge zone to the groundwater of the valley.

The groundwater of the Kathmandu Valley is recharged mainly by infiltration of rain water in the surrounding. On the basis of geological and physiographical setting, four different zones of groundwater recharge have been identified. These are:

- i) Northern Recharge Zone-I: It covers the northern foothills composed of coarse sediments, specially made up of alluvial fan deposits. The subsurface materials in this zone have high permeability and porosity, so the surface water quickly infiltrates through this zone.
- ii) Northern Recharge Zone-II: This zone comprises the bedrocks found in the northern part of the valley. The Shivapuri area comprises gneiss, which is a good recharge zone of the Kathmandu Valley. In addition, the bedrocks in the northern part of the valley are contributing to the groundwater in the northern part.
- iii) Southern Recharge Zone-I: The alluvial fan deposits in the southern part of the valley are included in this zone. As in the north, this zone comprises high porosity and permeability.
- iv) Southern Recharge Zone-II: All the bedrocks having different lithology found in the southern part of the valley are included in this zone. This zone recharges the groundwater in the southern part of the valley.

There are more than 70 perennial springs identified in the peripheral foothill of the valley that also shows the surrounding hills are recharge zones of valley groundwater. These springs are also sources of streams in the valley.

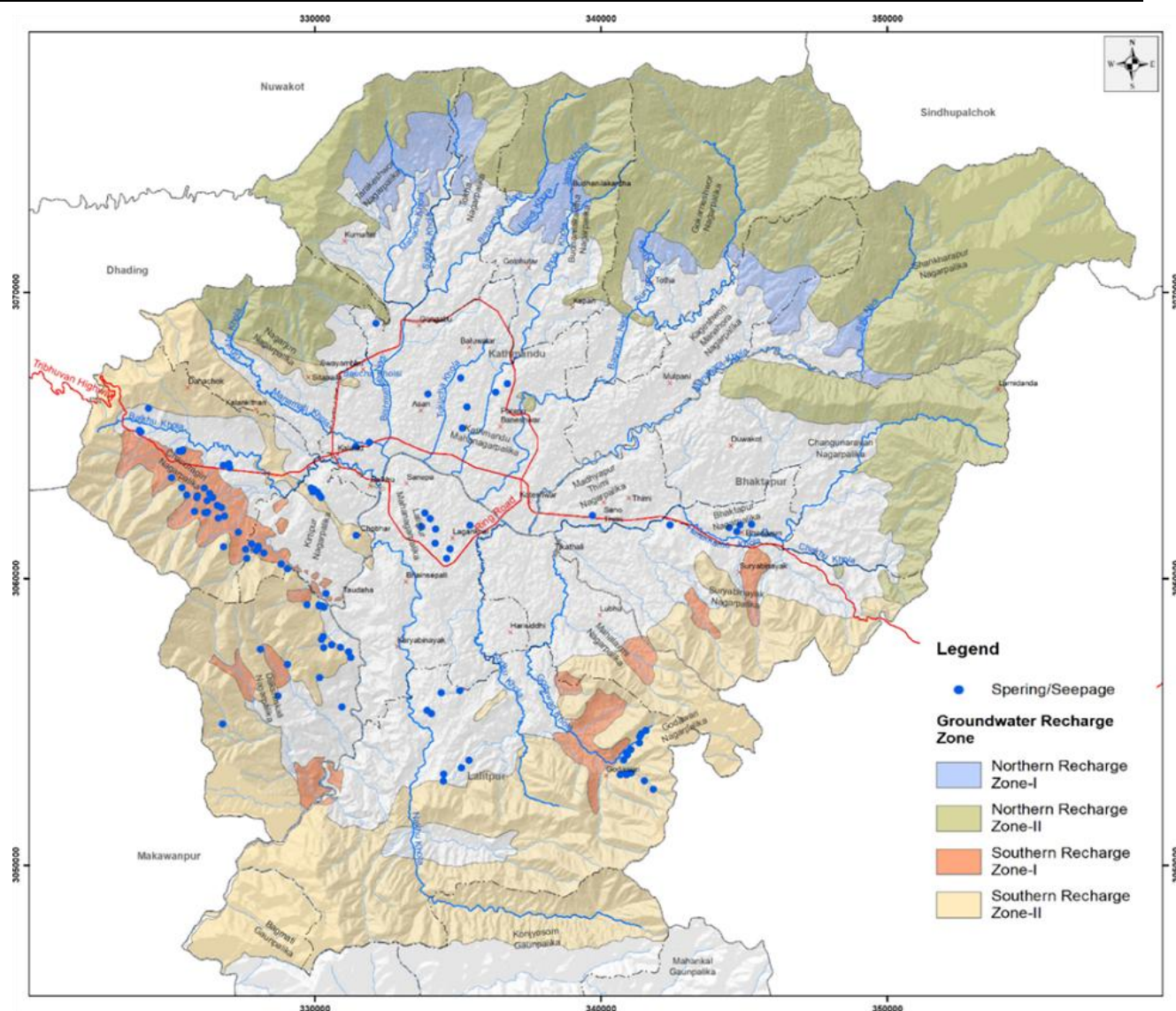


Figure 3- 10: Distribution of prime groundwater recharge zones and springs in the Kathmandu Valley

3.2.6. Traditional and local water storage

There are 52 traditional Newar settlements in the Kathmandu valley and each of the settlements has approx. 6-8 water bodies, numerous hitis (dhunge dharas) and often all have raj kulo (water canals) passing through the settlements. When we look into history we see that often the state took a leading role in the construction of the water system while the community played a key role in the management of such systems under Guthi administration. As many as 27 of about 160 inscriptions known so far during the Lichchhavi rules are exclusively related to water and its usage. (Tiwari, 1998). Besides these historic water infrastructures almost all the traditional settlements have wells within the residential quarters and Jahru (stone water spigot) as sources of drinking water. Major settlements like Bhaktapur has 35 water bodies and 87 hitis within its historic core (Khaniya, 2005). Similarly, Patan has 30 and Kathmandu has 25 water bodies (Adhikari, 2017). Kirtipur, which sits on a hillock, also boasts of six water bodies in its historic core. These water bodies were often associated with numerous functions like washing, cleaning, animal bathing, ritual functions, industrial usage, local climate regulator, water storage for firefighting, and as water collection areas (collecting water from natural sources or raj kulo before feeding the water to local hitis). Besides fulfilling these functional criterions these water bodies also functioned as ground water recharge areas.

Traditionally, water supply of the valley was mostly from Raj kulos which were basically water canals used to bring drinking water from far away sources and are mainly the engineering

achievement of the Lichhavi period which helped bring drinking water inside the residential quarters of traditional settlements which normally lay in highlands. Besides bringing drinking water to urban areas, these kulos also helped in bringing water for irrigation purposes to agricultural lands which lay in elevated plains from the river basin. The water bodies like Sapta patal pukhu of Lagankhel and Palesva pukhu of Pulchowk are such examples where water coming from raj kulo are fed into these ponds which feed the aquifers that in turn feed the hitis.

3.3. POPULATION

The population of Kathmandu valley was 2,446,146 in the year 2011. **The Preliminary Census Report 2021 shows the population of the valley to have increased to 2,956,804 (Table 3-6).**

Table 3- 6: Population size, distribution and density in local units within Kathmandu Valley

Local Bodies	Area (ha)	2011		2021	
		Population	Density (ppha)	Population	Density (ppha)
Kathmandu Metropolitan City	4,945	975,453	197	862,400	174
Lalitpur Metropolitan City	3,612	284,922	79	294,098	81
Bhaktapur Municipality	689	81,748	119	79,136	115
Kritipur Municipality	1,476	65,602	44	81,578	55
Madhyapur Thimi Municipality	1,147	83,036	72	119,756	104
Gokarneshwor Municipality	5,850	107,351	18	149,366	26
Budhanilkantha Municipality	3,480	107,918	31	177,557	51
Kageshwari Manohara Municipality	2,738	60,237	22	130,433	48
Trakeswar Municipality	5,495	81,443	15	151,479	28
Tokha Municipality	1,711	99,032	58	133,755	78
Nagarjun Municipality	2,985	67,420	23	115,437	39
Chandragiri Municipality	4,392	85,198	19	136,860	31
Dakshinkali Municipality	4,268	24,297	6	26,372	6
Shankharapur Municipality	6,021	25,338	4	29,318	5
Changunarayan Municipality	6,298	55,430	9	88,083	14
Suryabinayak Municipality	4,245	78,490	18	140,085	33
Godawari Municipality	9,611	78,301	8	97,633	10
Mahalaxmi Municipality	2,651	62,172	23	123,116	46
Konjyosom Rural Municipality	4,416	9709	2	8,989	2
Bagmati Rural Municipality	11,149	13049	1	11,353	1
Total	87,179	2,446,146	28	2,956,804	34

Source: CBS 2011 and 2021

Population Density

The population density of Kathmandu valley was 28 ppha in 2011 which increased to 34 ppha in 2021 (CBS, 2021). Among the local units, Kathmandu Metropolitan City has the density of 174 ppha while Bhaktapur Municipality has 115 ppha and Madhyapur Thimi Municipality has 104 ppha densities. The rest have the population density below 100 ppha (Figure 3-12: Population density of Kathmandu valley in 2011).

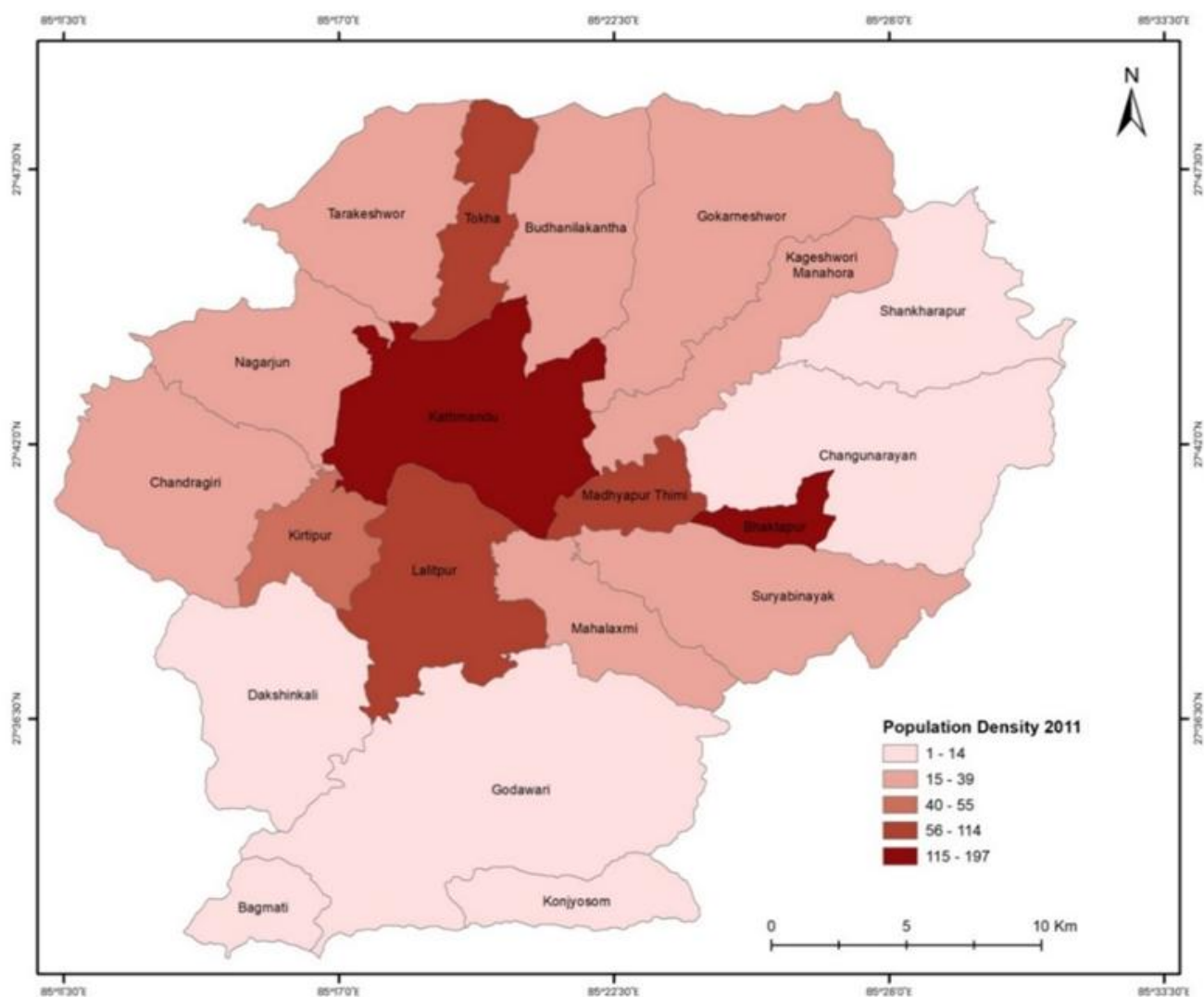


Figure 3- 11: Population density of Kathmandu valley in 2011

The comparative analysis shows the increase in population density at peripheral local units of core urban areas of the valley like Budhanilkantha, Kageshwori Manahara, Mahalaxmi and others.

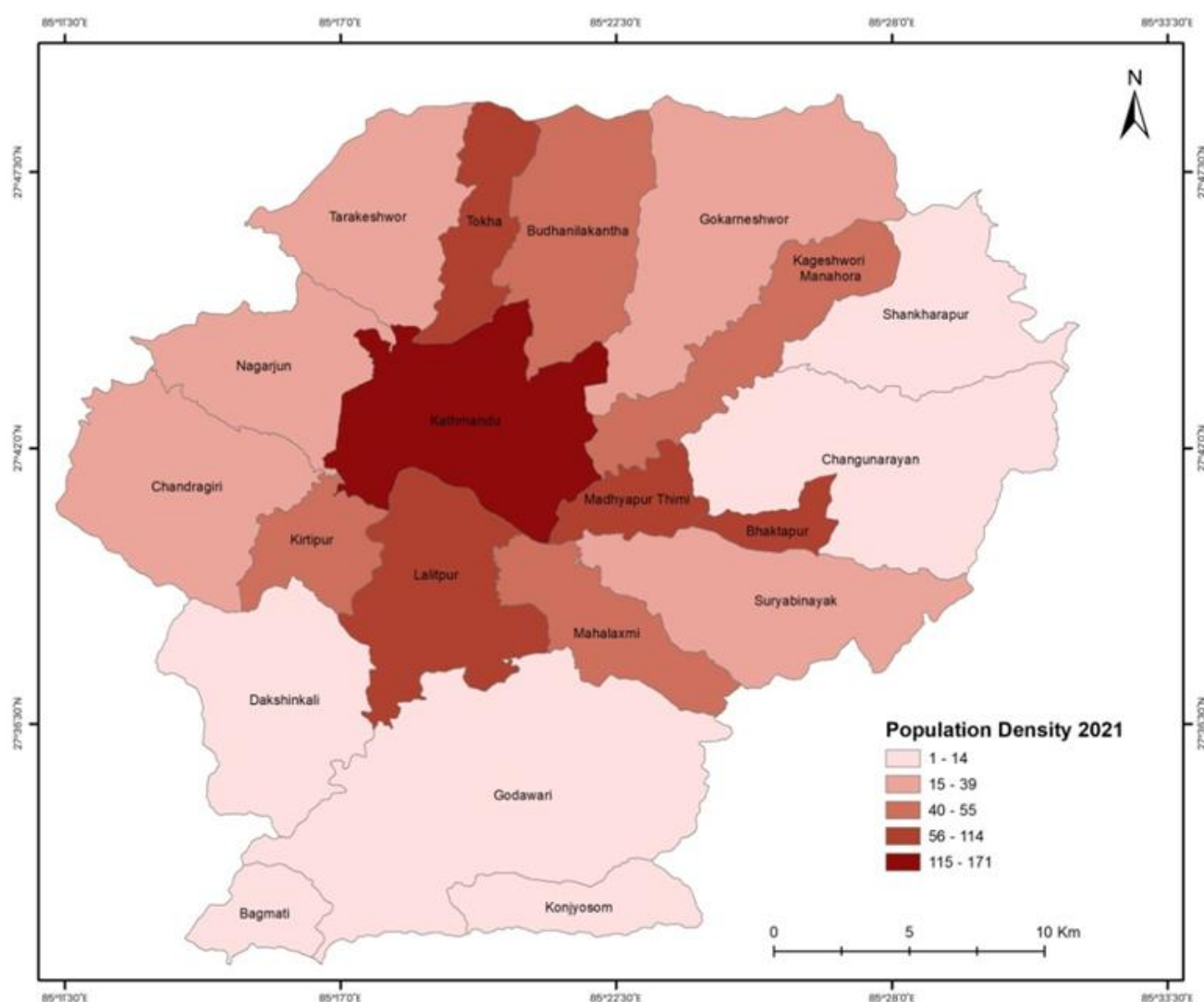


Figure 3- 12: Population density of Kathmandu valley in 2021

3.4. SETTLEMENT PATTERN AND LAND COVER

3.4.1. Settlement Pattern and Urban Growth

The settlement history of Kathmandu valley spans over two thousand years. During the Malla period, the valley developed as a major trade and administrative center and prospered in its rich social fabric and highly developed cultural pattern. The traditional towns have a definitive urban character of compact and dense settlements, with urban spaces organized in a very unique and innovative way (Tiwari, 1989). These compact settlements are surrounded by agricultural fields. The traditional settlements of Kathmandu Valley flourished during Malla period are mostly found on the old trade routes except the three major cities of Kathmandu, Lalitpur and Bhaktapur.

The settlement development during these periods has always had strong connections with the river for daily rituals like bathing to other sacraments like *upanayana*: marriage or ancestor worship. Each traditional settlement had a designated river edge area for their cultural and ritual activities. So, people built many buildings like patis, dharmashalas, and temples and provided guthi lands for their maintenance. The dead bodies were cremated at the bank of the river. (Gutschow, 1995)

Later during Maoist insurgency (1996 – 2005), there has been a huge influx of internally displaced people in recent years in search of security, employment, government aid and shelter. Hence, the urbanizing trend has changed significantly, characterized by haphazard and unplanned development due to lack of effective planning and its implementation. Due to rapid

urbanization, scattered traditional settlements are combined and have formed a single compact settlement.

3.4.2. Land Cover

The land cover of Kathmandu valley consists of built-up area, cultivation, forest grassland, riverbed, and water bodies. The land cover in the year 2020 shows the majority 40.33% area covered by forest. The cultivation land covers 35.95% area whereas, built-up accounts for 22.61% area. Similarly, water bodies and riverbeds represent only 0.04% area (Table 3-7).

Table 3- 7: Land cover change dynamic of Study area

Land cover/ Year	Year 2020	
	Area (Sq. Km)	Percent (%)
Built-up	161.50	22.61
Cultivation	255.61	35.95
Forest	288.01	40.33
Grassland	8.77	1.23
Riverbed	0.07	0.01
Water bodies	0.24	0.03

Source: DoS

3.5. BAGMATI RIVER AND ITS TRIBUTERIES

Bagmati river generates at Shivapuri Hills near Baghdwar and flows southward through Gokarna and Pashupati area and ultimately meets Manohara River, Dhobi Khola (Rudramati), Tukucha Khola (Ichhumati), Bishnumati River and Nakhu Khola before it passes through Chobhar George. The sub-tributaries include Hanumante, Godawari, Kodku, Mahadev, Sangla, Bhaucha, Lundi, Jamle, Manamati, Suryamati, Ghatte and Chakhu Khola. Besides, there are other small streams and numerous kholsis within the river system (**Figure 3-14**).

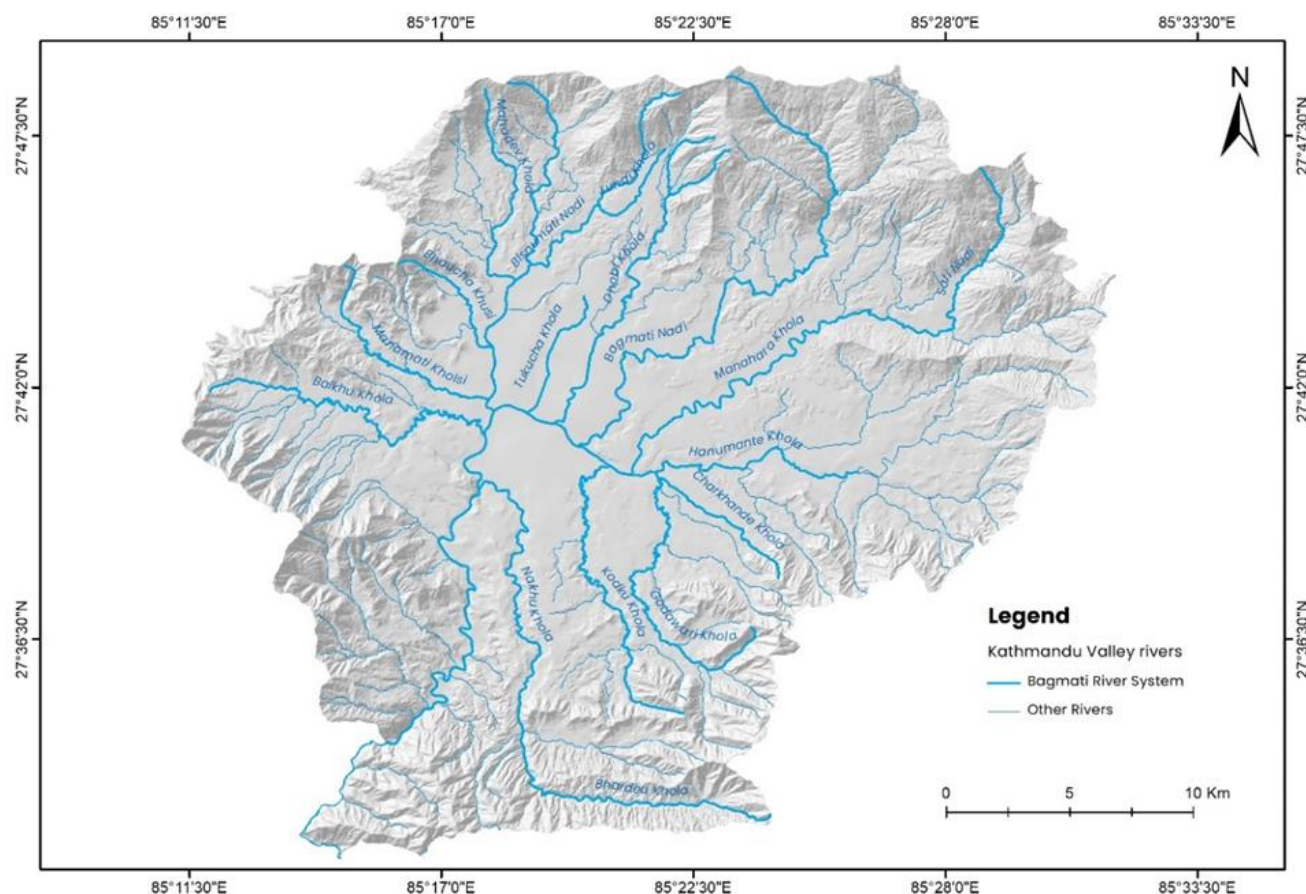


Figure 3- 13: River network of Kathmandu valley

The length of Bagmati River is 48.8 km from its origin at Shivapuri hill (2732 m) to Katuwal daha (1140m). In total, about 267.52 km length of Bagmati River and its tributaries have been included in the study for preparation of the Action Plan. The total catchment area of Bagmati River is about 672.34 sq. km.

Table 3- 8: Rivers studied for preparation of Action Plan

S. N.	Name of River	Stream Order	Length (km)	Location of river (Metro, Sub-metro, Municipality and Rural Municipality)
1	Bagmati River	9	48.8	Bagmati, Dakshinkali, Lalitpur, Kirtipur, Kathmandu, Kageshwori Manahora, Gokarneshwor
2	Bishnumati River	8	18.3	Kathmandu, Tokha, Tarakeswor
3	Manahara Khola	8	29.7	Madhyapur Thimi, Kathmandu, Lalitpur, Changunarayan, Kageshwori Manahora, Shankharapur
4	Hanumante Khola	8	24.38	Madhyapur Thimi, Bhaktapur, Changunarayan, Suryabinayak
5	Balkhu Khola (Indramati)	7	17.05	Nagarjun, Kirtipur, Chandragiri
6	Nakhu Khola	7	26.65	Lalitpur, Godawari, Konjyosom
7	Rudramati (Dhobikhola)	7	15.9	Kathmandu, Budhanilakantha
8	Godawari Khola	7	15	Mahalaxmi, Suryabinayak, Godawari
9	Mahadev Khola	7	8.8	Tarakeswor
10	Sangla Khola	7	8.3	Tarakeswor, Tokha
11	Kodku Khola	7	15.75	Lalitpur, Mahalaxmi, Godawari
12	Bhaucha Khola	7	1.8	Kathmandu, Nagarjun
13	Tukucha (Ichhumati)	6	5.5	Kathmandu
14	Lundi Khola	6	3.75	Budhanilakantha
15	Jamle Khola	6	3.2	Budhanilakantha
16	Manamati Khola	6	10.83	Kathmandu, Nagarjun
17	Suryamati Khola	6	5	Gokarneshwor
18	Ghatte Khola	6	3.3	Nagarjun
19	Chakhu Khola	7	5.46	Bhaktapur, Changunarayan, Suryabinayak

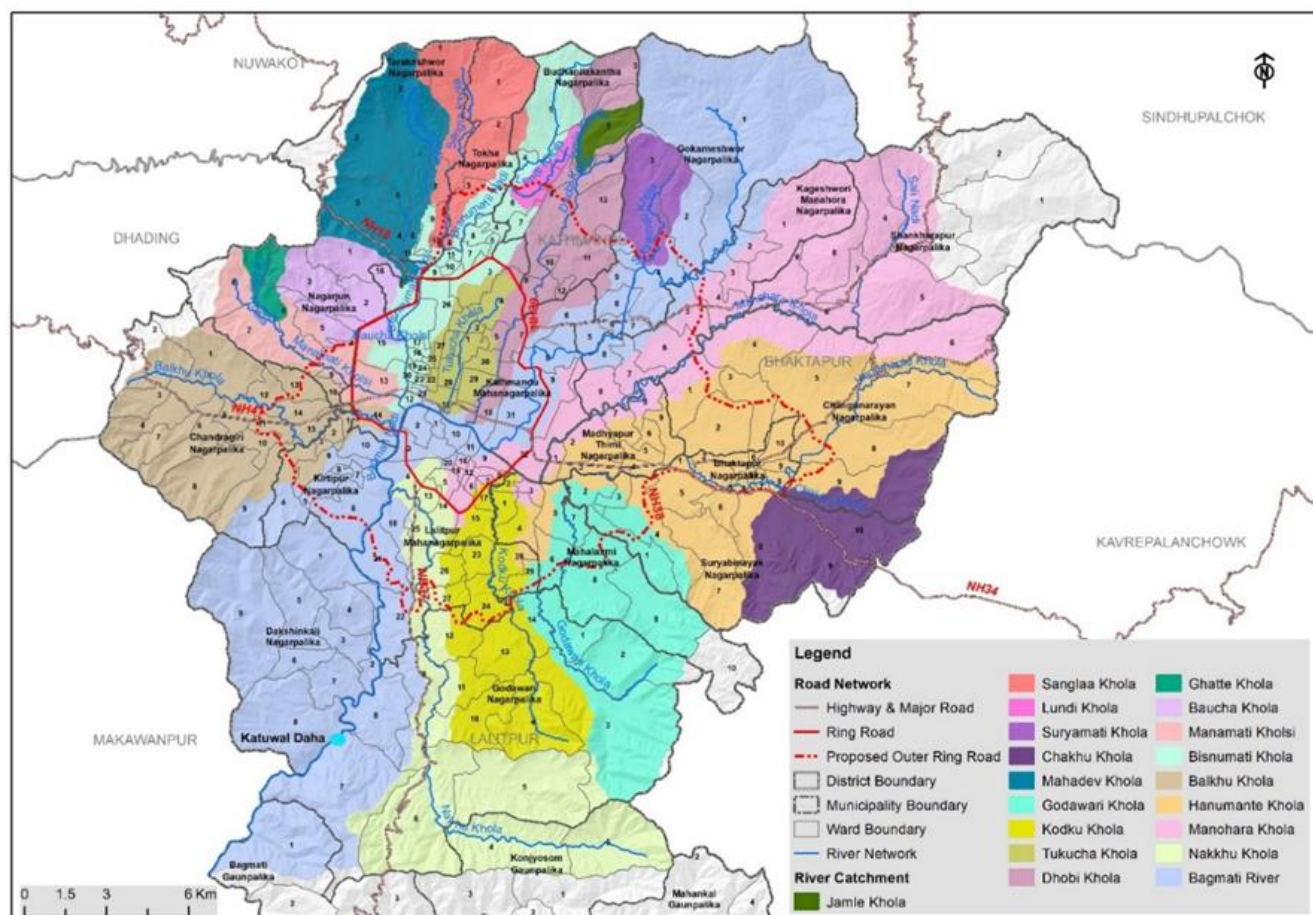


Figure 3- 14:Sub Water-shed of River studied

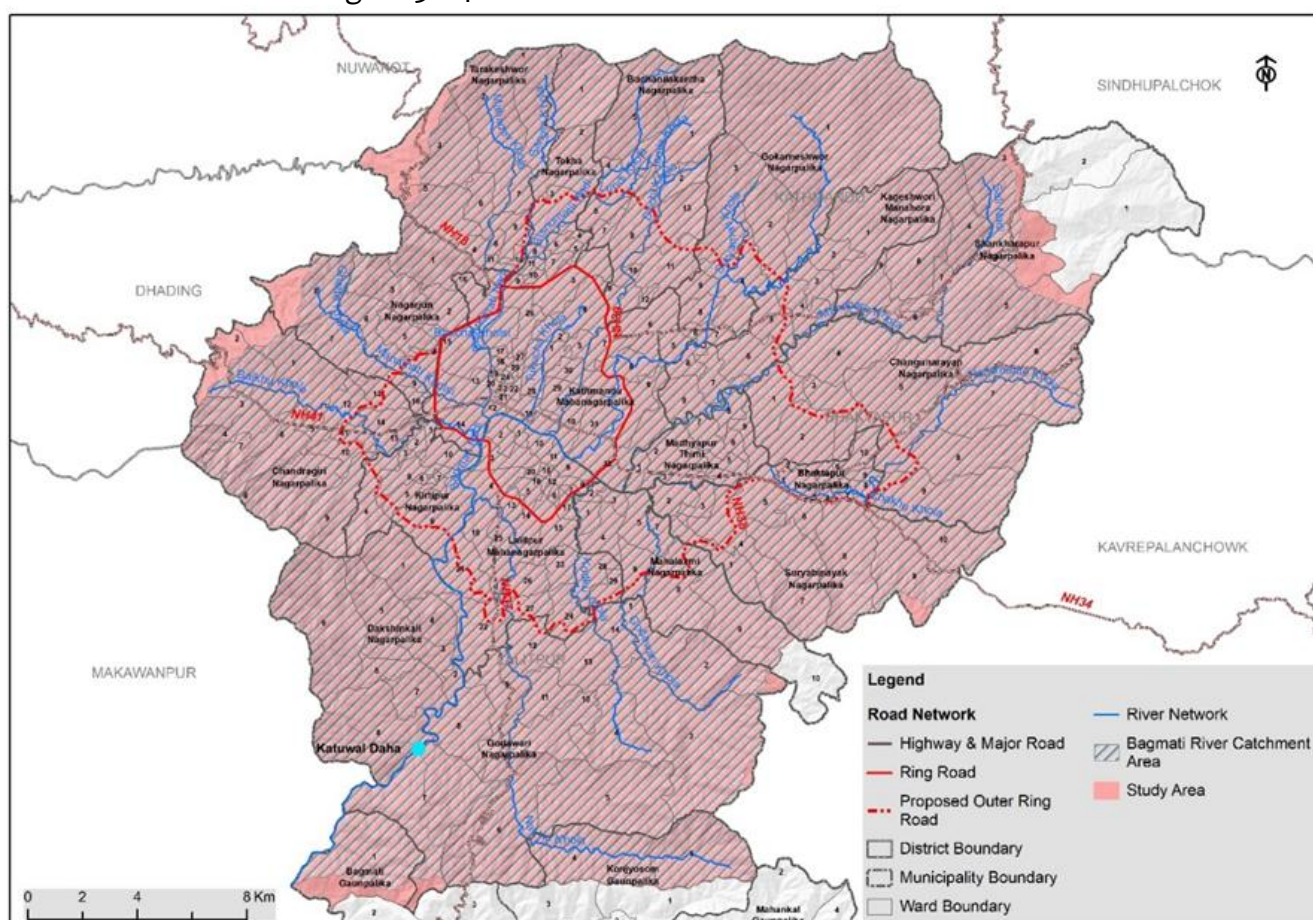


Figure 3- 15:Study area overlaid with Bagmati watershed

3.5.1. Infrastructure Assets

Numerous river improvement projects have been implemented to improve the river health and river bank environment by constructing a large number of infrastructures. River corridor roads, river trainings, sewer network system, WWTPs, infrastructures for river beautification, monuments are some of the major infrastructures which are summarized here. The details are provided in Supplementary Volume I for Inventory.

3.5.1.1. 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, 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.

Table 3- 9: River corridor road and surface types

S. N.	River	Total Length of Corridor Road (m)		Blacktopped Road (m)		Gravel and Earthen Road (m)	
		Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
1	Bagmati	18723.89	16445.35	14066.98	6996.5	4656.91	9448.85
2	Bishnumati	9227.62	10911.94	4879.92	4131.42	4347.7	6780.52
3	Manahara	4948.92	5347.75	1698.08	2647.37	3250.84	2700.38
4	Hanumante	7891.41	9063.33	827.07	1143.47	7064.34	7919.86
5	Balkhu Khola (Indramati)	4705.06	4271.98	1969.87	2444.88	2735.19	1827.1
6	Nakhu	3146.01	13094.88			3146.01	13094.88
7	Rudramati (Dhobikhola)	11796.94	11703.8	11796.94	11703.8		
8	Godawari	2548.45	1147.02			2548.45	1147.02
9	Mahadev	4497.75	4529.93	1379.59	1163.13	3118.16	3366.8
10	Sangla	3293.13	2561.93	3293.13	1904.48		657.45
11	Kodku	2467.97	1954.48	538.1		1929.87	1954.48
12	Bhaucha	1420.95	1163.1	772.12	590.96	648.83	572.14
13	Tukucha (Ichhumati)	274.98				274.98	
14	Lundi		537.92				537.92
15	Jamle						
16	Manamati	1231.87	2334.05		1349.18	1231.87	984.87
17	Suryamati	630.9				630.9	
18	Ghatte						
19	Chakhu		300.6				300.6

Source: Field Survey 2022



Figure 3- 16:Corridor road along Manohara

3.5.1.2. Crossing Structures

To provide ease in transportation numbers of crossing structures are constructed in the rivers of Kathmandu valley. They are either motorable or for pedestrians only.

Table 3- 10: Crossing structures in rivers of Kathmandu valley

S. N.	Name of River	Crossing Structure	
		Type	Number
1	Bagmati River	Motorable Bridge	35
		Pedestrian Bridge	30
2	Balkhu River	Motorable Bridge	39
		Pedestrian Bridge	16
3	Baucha River	Motorable Bridge	14
		Pedestrian Bridge	4
4	Bishnumati River	Motorable Bridge	48
		Pedestrian Bridge	15
5	Chakhu River	Motorable Bridge	7
		Pedestrian Bridge	4
6	Dhobikhola River	Motorable Bridge	26
		Pedestrian Bridge	41
7	Ghatta Khola	Motorable Bridge	13
		Pedestrian Bridge	2
8	Godawari Khola	Motorable Bridge	22
		Pedestrian Bridge	13
9	Hanumante Khola	Motorable Bridge	33
		Pedestrian Bridge	20
10	Jamle Khola	Motorable Bridge	11
		Pedestrian Bridge	4
11	Kodku Khola	Motorable Bridge	27
		Pedestrian Bridge	14
12	Lundi Khola	Motorable Bridge	14
		Pedestrian Bridge	4
13	Mahadev Khola	Motorable Bridge	19
		Pedestrian Bridge	16
14	Manamati Khola	Motorable Bridge	48
		Pedestrian Bridge	26
15	Nakkhu Khola	Motorable Bridge	12
		Pedestrian Bridge	16

S. N.	Name of River	Crossing Structure	
		Type	Number
16	Sangla Khola	Motorable Bridge	20
		Pedestrian Bridge	9
17	Suryamati Khola	Motorable Bridge	6
		Pedestrian Bridge	3
18	Tukucha Khola	Motorable Bridge	7
		Pedestrian Bridge	

Source: Field Survey 2022

3.5.1.3. River Training

Most of the major rivers and their tributaries originate 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.

Table 3- 11: Status of river training works

S. N.	River	Total River Length (km)	Distance to Foothill (km)	River Training Works					
				Total Length (km)		Masonry (km)		Gabion (km)	
				Left	Right	Left	Right	Left	Right
1	Bagmati	48.85	44.4	12.57	10.52	12.33	10.52	0.24	0
2	Suryamati	5	4.5	0.37	0.37	0.19	0.33	0.18	0.05
3	Nakhu	26.65	26	5.78	5.41	4.92	4.86	0.86	0.55
4	Balkhu	17.05	16.75	5.24	5.82	1.87	2.7	3.37	3.12
5	Sangla	8.3	8.1	3.91	2.72	3.7	2.62	0.21	0.1
6	Mahadev	8.8	8.4	3.43	3.35	3.43	3.13	0	0.23
7	Manahara	29.7	29.7	3.61	2.83	0	0	3.61	2.83
8	Hanumante	24.38	19.35	5.76	5.56	5.73	5.42	0.03	0.14
9	Chakhu	5.46	5.46	0.09	0.04	0.09	0.04	0	0
10	Bishnumati	18.3	15	8.79	9.89	8.17	8.74	0.62	1.15
11	Manamati	10.83	10.55	4.58	4.89	4.18	4.68	0.4	0.21
12	Baucha	2.3	2.3	1.2	1.45	1.16	1.45	0.04	0
13	Lundi	3.75	3.75	0.61	0.63	0.53	0.53	0.08	0.1
14	Jamle	3.2	2.75	0	0	0	0	0	0
15	Ghatte	3.3	3.3	0.58	0.42	0.57	0.41	0.01	0.01
16	Dhobi Khola	15.9	15.25	11.59	11.56	11.59	11.56	0	0
17	Tukucha	5.5	5.5	3.28	2.75	3.28	2.75	0	0
18	Kodku	15.75	15.5	3.36	3.97	2.54	3.31	0.83	0.66
19	Godawari	15	14.5	2.31	2.74	1.61	1.15	0.7	1.58

Source: Field Survey 2022



Figure 3- 17:River training works in Manohara

3.5.1.4. Sewer Network and Treatment Systems

A. Existing Sewer Network Systems

Sewage collection networks are developed in the core of metropolitan and municipality areas. The pipes constructed to convey sanitary sewage are also used for storm water either direct from roofs or from lanes and roads. The system is very entrenched and thus nearly all drains are considered as combined sewers. The actual condition of existing sewers is not known as even manhole covers are hard to locate in many locations. Existing sewer materials are mostly concrete pipes, with collar jointed pipes and brick manholes. The Kathmandu Valley has three separate systems to collect domestic sewage. They are separate, combined and partially combined/separate systems. Branch and Tertiary Systems collect sewage directly from households and transfer it to the larger main collector system.

The sewerage system in the Kathmandu valley has mostly turned out to be unmanaged and chaotic. The respective local governments are simply diverting the sewerage through sewer/drainpipes and dislodging in the nearest river. The proportion of houses with septic tanks is very low. Majority houses are connected to municipal sewer pipes that ultimately drain most of the wastewater directly into the river without treatment.

Table 3- 12: Status of sewerage outlet in rivers of Kathmandu valley

S. N.	River	Number of Sewerage Outlet		
		Left	Right	Total
1	Bagmati	51	28	79
2	Suryamati	2	3	5
3	Nakhu	38	42	80
4	Balkhu	23	32	55
5	Sangla	32	22	54
6	Mahadev	121	160	281
7	Manahara	43	38	81
8	Hanumante	49	45	94
9	Chankhu	3	1	4
10	Bishnumati	194	275	469
11	Manamati	39	74	113
12	Baucha	20	17	37
13	Lundi	50	25	75
14	Jamle	-	-	-
15	Ghatte	3	2	5
16	Dhobi Khola	703	659	1362

S. N.	River	Number of Sewerage Outlet		
		Left	Right	Total
17	Tukucha	Not reachable		NA
18	Kodku	17	20	37
19	Godawari	10	5	15

Source: Field Survey 2022

The analysis of sewerage outlet density shows higher density in Rudramati Khola, Bishnumati Khola and Mahadev Khola (Figure 3-19).

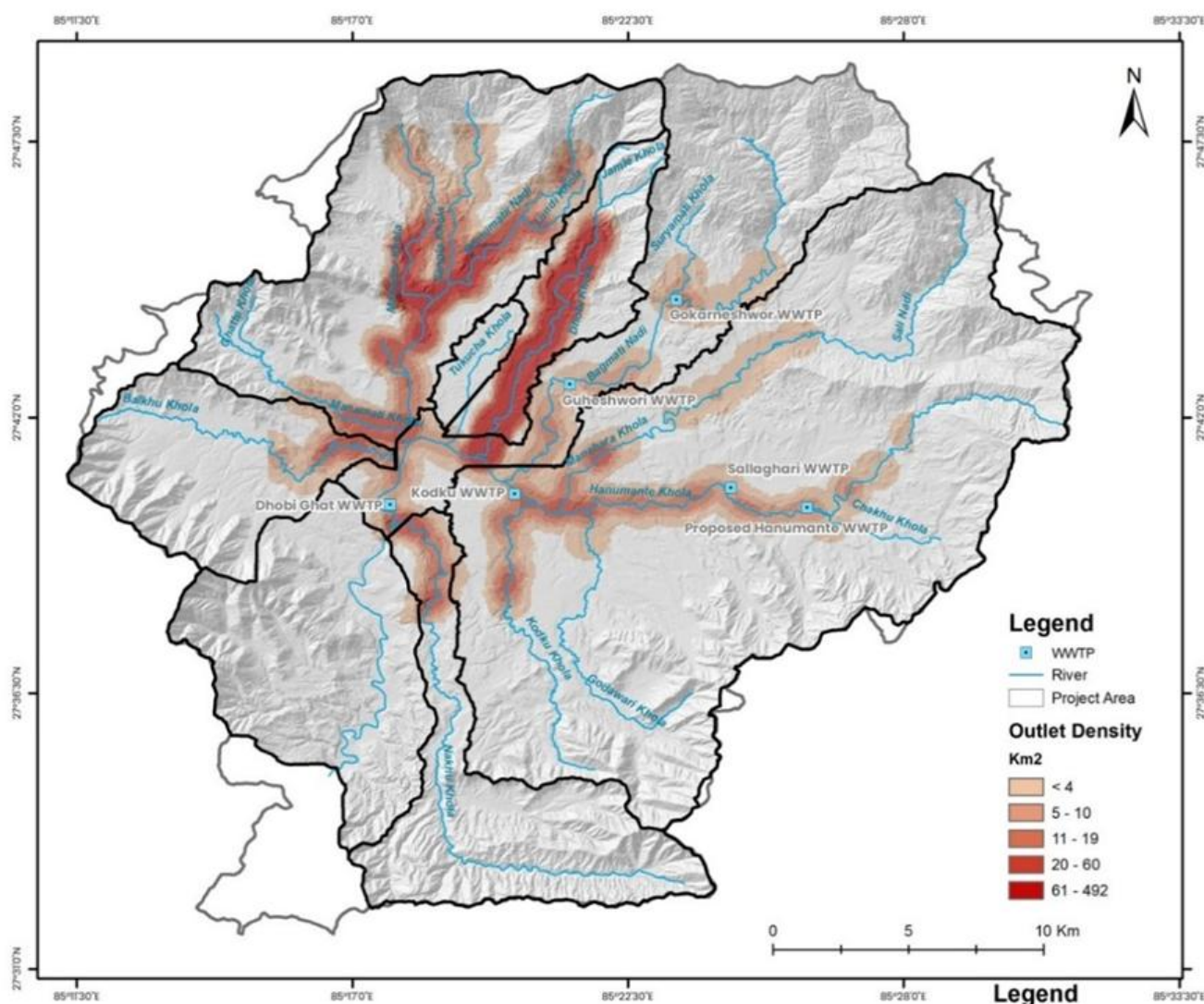


Figure 3- 18:Sewerage outlet density in Bagmati River and its tributaries

The storm water in Kathmandu Valley is drained to rivers through road side drains, storm sewers and combined sewers. There are large number of storm water drains and combined sewers constructed in urban areas of Kathmandu Valley by NWSC/KUKL and the municipalities. Most households are connected to either one or both forms of drainage depending on what type of sewer is closer or most convenient, which means that almost all sewers in Kathmandu Valley are presently operating as combined sewers.

As reported in the Conceptual Wastewater Master Plan for a 15 year planning horizon from 2011 to 2025 and additional information received from the agencies involved in wastewater sector, the details of interceptors along the major rivers and sewer networks are as follows:

Table 3- 13: Details of Sewer Networks

Particulars	Length	Status / Remarks
Kathmandu Metropolitan	856 km	Includes only sewer of municipality area
Lalitpur Municipality	232 km	Includes only sewer of municipality area
Bhaktapur Municipality	69 km	Includes only sewer of municipality area
Thimi Municipality	40 km	Includes only sewer of municipality area
Kirtipur Municipality	71 km	Includes only sewer of municipality area
Total Length of Sewer Network	1,268 km	

Source: KVVMP, KUKL 2022

B. Interceptors

Interceptor sewers are the main trunk sewers which collect sewer from collector systems and they are usually laid along the river banks leading to the treatment plants or sites.

Table 3- 14: Description of existing Interceptors

S. N.	River	Interceptor (km)
1	Bagmati	48.09
2	Dhobikhola	23.26
3	Bishnumati	11.65
4	Nakkhu	12.5
5	Balkhu	4.5
	Total	100.00

Source: HPCIDBC

C. Waste Water Treatment Plant (WWTP)

There are altogether 6 WWTP (Dhobighat, Sallaghari, Hanumante, Kodku, Guheshwori and Gokarna) out of which Dhobighat, Sallaghari, and Hanumante are defunct. The problem with the Dhobighat and Sallaghari Treatment plants are the disruption of pumping stations and lack of institutional capability to operate. All the three defunct WWTPs are subject to the combined flow of sanitary and storm water. The WWTP in Kodku, Dhobighat and Sallaghari are equipped with chlorination plants but were not operated.

Table 3- 15: Summary of Existing WWTPs in Kathmandu Valley

Year established	Hanumanta 1975	Sallaghari 1983	Kodku 1982	Dhobighat 1982	Guheshwori 2001
Original situation					
Design flow(m ³ /d)	500	2,000	1,100	15,400	16,400
Process type	Aerated lagoon	Aerated lagoon	Stabilization pond	Stabilization pond	Oxidation ditch
Situation 2012 (Waste Water Quality of influent)					
Connected people to WWTP	600	100	30,000	0	138,000
Average flow(m ³ /d)	-	-	2,090	0	17,000
Dry weather flow (m ³ /d)	30	5	1,500	0	-
Nominal WW flow (l/inh.D)	50	50	50	-	-
Process type	Stabilization pond	Stabilization pond	Stabilization pond	-	Oxidation ditch
BOD ₅ (mg/l)	253	233	670	-	380

Year established	Hanumanghat	Sallaghari	Kodku	Dhobighat	Guheshwori
	1975	1983	1982	1982	2001
SS (mg/l)	19	1,384	1,070	-	300
CODCr(mg/l)	422	410	1,710	-	720
T-N (mg/l)	40	22	-	-	-
NH ₄ -nitrogen (mg/l)	-	-	127	-	46
T-P (mg/l)	3.3	-	7	-	3
Phosphate P (mg/l)	-	1	-	-	-

Source: KVVMP, KUKL 2022

D. Riverfront Beautification

Several infrastructures have been built along the river, including: Aeration weirs to improve water quality, Aesthetic walls to separate the landscape from the riverine area, Traditional stone-clad Ghats and steps to provide access for religious performances and ceremonies. In addition, a footpath, a cycle track, and green parks have been constructed on the river's middle terraces and alongside pedestrian tracks. These additions aim to improve the riverbank environment for commuters using roads, cycles, and footpaths



Figure 3- 19: Left: Shankha Park constructed on the reclaimed land, also seen are stone steps and bhakaro with few old house along the edge: Right: The width of the river is controlled using vertical walls and seen are the parapet walls along the Sankha Park

3.5.1.5. Water Storage/Recharge Structure

The topographical setting of the peripheral hills of the valley has formed a number of depressions and wetlands. These depressions are generally filled with water in rainy seasons and remain dry in winter. These depressive wetlands are simply called *dhap*. There is high potential to store rainwater in these *dhaps* so that they could contribute to the streams in the lower region. There are a number of *dhaps* identified in the Kathmandu Valley that have potential of developing recharge lakes. Some projects are under construction

Chisapani Dhap Dam

There is one recharge pond being completed in Shivapuri National Park near Chisapani. It is well-known as Dhap in the locality. A concrete faced rock fill dam (CFRD) has been constructed to retain the rain water and aims to recharge the Nagmati Khola, a tributary of Bagmati River. The maximum height of the dam is 24m and the length of the dam crest is 175m. It is designed to store more than 861,000 m³ water in this pond.



Figure 3- 20: Undergoing development of Dhap as a Recharge Lake near to Chisapani in Shivapuri National Park

Nagmati Dam

Another reservoir dam is under the process of construction in the Nagmati Khola at about 3 km. downstream from the Chisapani Dhap Dam. It is called Nagmati Dam. The detailed feasibility study of the project has been prepared. Environmental Impact Assessment (EIA) of the project has also been prepared and under the process of approval from the Ministry of Forests and Environment. A concrete faced rockfill dam (CFRD) of about 94.5m height and 554m length is proposed. It aims to generate hydroelectricity as well as to increase the volume of water in the Bagmati River.



Figure 3- 21: Layout of Nagmati Dam overlayed in Google Earth image
(Source: <https://dhapdam.gov.np/nagmati-maps/>)

3.5.2. Cultural Heritage and Monuments

Bagmati river is considered the most sacred river in the valley 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 offspring, cure from diseases and for good fortune. This clearly indicates the intricate relation the valley dwellers share with their sacred water.

The heritage sites along these rivers do not sit in isolation or oblivion with the settlements lying in their proximity rather there is a complex relationship between 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 in

Table 3-16 and Figure 3-23.

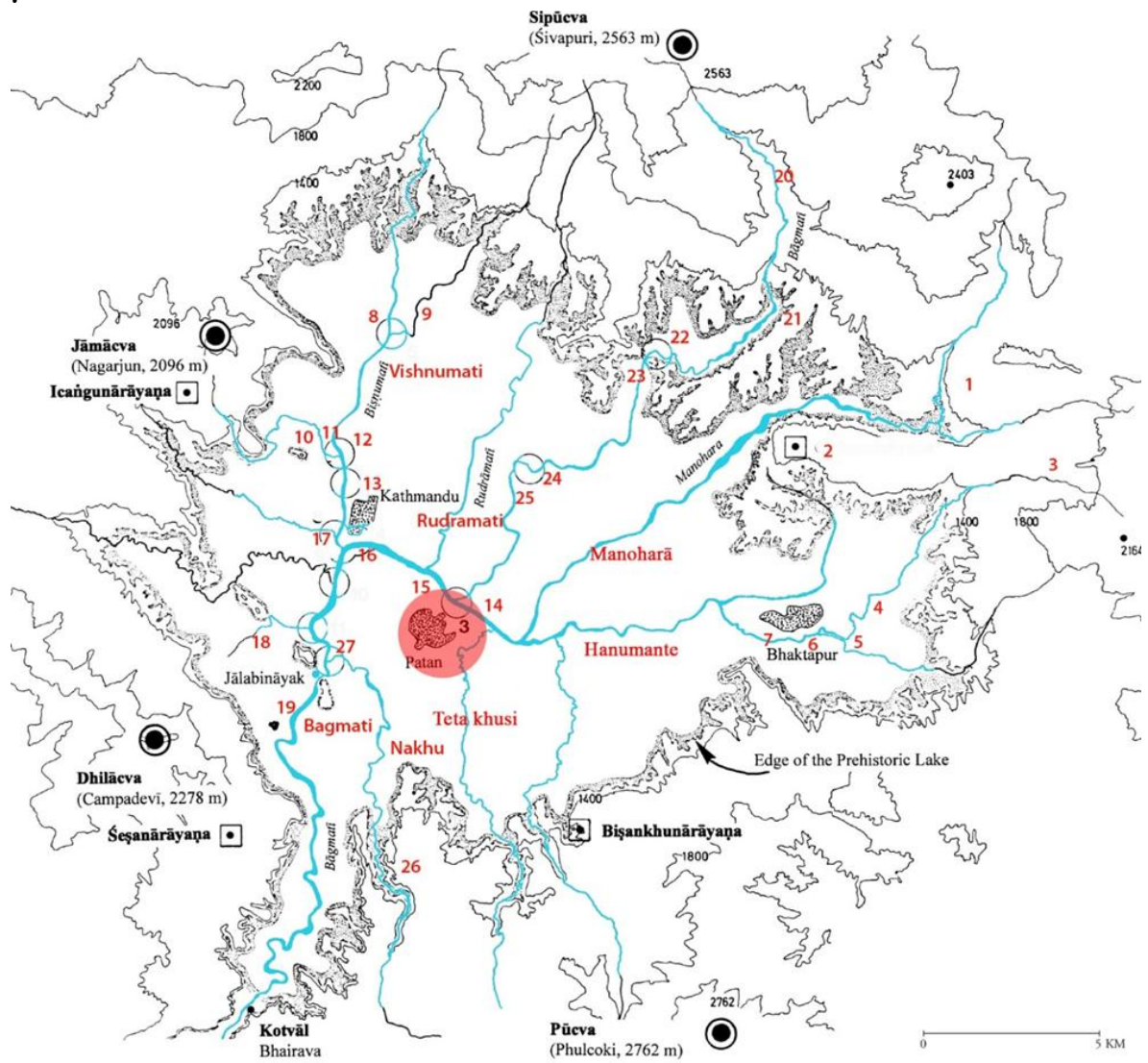


Figure 3- 22: Cultural heritage and monuments along Bagmati River and its tributaries
 Source: Department of Archaeology

Table 3- 16: Cultural heritage and monuments along Bagmati River and its tributaries

Name of Cultural Site	Location	Major Structures/ Monuments	Current Status
Bagmati River			
Bagdwar (20)			
Sundari Mai (19)	Gokarneshwor-1	Main Shrine, Shiva Lingas	The construction of access way and provision of handrails along the trail completed, construction of bridge underway
Gokarneshwor (21)	Gokarneshwor-4	Main Temple, Bhajan Mandapa, Sattal, Cremation Site	The temple is under restoration, its jhingati roof is being changed to gilt copper roof. The ghats on either sides of the river being constructed. There is a plan to create public parks on the eastern banks of the river
Guheshwari (23)	Kathmandu-8	Main Temple, Sattal, Domed Temples, Ghats	The reconstruction of northern and part of western sattal completed, restoration of Tribhuvan-prakesesvara ongoing, restoration of sattal to the north of the mentioned domed temple, the ghat construction on either sides of the river ongoing
Pashupati (24)	Kathmandu-8	Main Temple, Sattals, Patis, Shrines, Ghats, Domed Temples, Tiered Temples, Forest	Restoration of the pinnacle of main temple, reconstruction of Mahasnan ghar, reconstruction of Agnishala, Kotilingesvara,
Shankhamul (13)	Lalitpur-9	Ghat, Cremation Site, Jagat Narayan Temple, Sattlas, Patis	Restoration of Jagat Narayan temple undergoing, Sankha park construction completed and actively used by the public
Kalmochan (14)	Kathmandu-11	Jung Hiranya Hem Narayan Temple Gopal Mandir Bairagi Akhada Udasi Naya Akhada Dash Nami Akhada	Restoration of all the temples and sattals ongoing
Tripureshwor Mahadev Temple	Kathmandu-11	Main Temple, Sattals, Ghat	Restoration of the temple and sattals ongoing with an aim to house the KU school of music in the sattal
Pachali Bhairav	Kathmandu-12	Main Temple, Dya Chen, Sattals	Restoration of Dya Chen completed, restoration of sattals ongoing
Pachali Ghat	Kathmandu-12	Ghat, Rest Houses, Stone Sculptures and Chaityas, Cremation Sites	Reconstruction of new ghats burying the existing ghat ongoing with an aim to create new green spaces

Name of Cultural Site	Location	Major Structures/ Monuments	Current Status
Teku Dovan (Chitamani Tirtha) (15)	Kathmandu-12	Ghat, Cremation Sites, Temple, Chaityas	Kriyaputri ghar restoration completed
Chobaha (17)	Kirtipur-6	Main Temple Quadrangle And Surrounding Sattals as well as the Confluence of Bagmati and Nakhu River	Restoration of the main temple of Adinath completed
Jala Binayaka (18)	Kirtipur-6	Main Temple, Sattals, Ghats, Cremation Sites	Restoration of main temple and surrounding sattals constructed, access road, new ward office and parking areas developed
Manohara			
Salinadi (1)	Sankharapur	Main Temple Area, Park,	Landscaping works under progress, Madhav Narayan temple under construction
Changunarayan (2)	Changunarayan	Main Temple, Kileshwor, Chinnamasta. Krishna Temple, Shiva Temple, Surrounding Sattal	Kileshwor temple reconstruction completed. The reconstruction of surrounding sattal underway.
Bishnumati			
Sapana Tirtha (9)	Tokha-2	Main Temple, Pati, Kunda	The reconstruction of main temple ongoing under municipality budget, a pati to the east of the main Temple is also under construction under municipality budget, the landscaping works are also underway like paving and greenery works
Manamaiju (8)	Tarkeshwor-11	Main Temple, Sattal, Phalcha, Park	Restoration of the north wing of the temple and other phalchas and sattals in the periphery are underway post 2015 earthquake. A park has also been created in a temple land to the west of the temple
Sobha Bhagwati (11)	Kathmandu-15	Main Temple, Bhwy Sattal, Pati, Park	The main temple is standing but the patis are in deteriorated condition.
Bijeshwari (10)	Kathmandu-15	Main Temple, Bahi Quadrangle	The main temple and the sattals were reconstructed post 2015 earthquake
Indrayani (12)	Kathmandu-17	Main Temple, Pati, Cremation Sites	The restoration of main temple is complete, the restoration of the sattals needed; new sattals are under construction to the west of the temple
Kankeshwari (12)	Kathmandu-19	Main Temple, Sattal, Public Library, Cremation Site	The restoration of the main temple completed post 2015 earthquake

Name of Cultural Site	Location	Major Structures/ Monuments	Current Status
Hanumante			
Mahadev Pokhari (3)	Nagarkot	Main Temple, Kunda, Patis	No recent activities recorded
Brahmayani Temple (4)	Bhaktapur	Main Temple, Cremation Site, Sattal	Construction of bridge ongoing and retaining wall construction completed
Ram Mandir	Bhaktapur	Main Temple, Sattals, Ghats	Restoration of sattals completed
Hanuman Ghat (5)	Bhaktapur	Sattals, Small Shrines, Ghats	Restoration of Madhav Narayan sattal, pujari ghar and Krishna Bhajan sattal completed
Dhum Barahi Temple (7)	Bhaktapur	Main Temple, Sattal, Pond, Dhungedhara, Cow Shed	Bridge under construction, water tank to the west of the temple ongoing
Nakhu Khola			
Tika Bhairav (26)	Godavari	Main Temple, Entry Gate, East Phalcha, South Phalcha, Cremation Site on Either Sides of the River, Raj Kulo	The construction of East Phalcha is ongoing, It is new Phalcha. The restoration of the main temple is complete. The river taming works is ongoing.

Source: Field Survey 2022

The details are provided in Supplementary Volume I for Inventory.

3.5.3. Squatters Settlements

In Kathmandu Valley, after the end of the Rana Regime, there was an influx of population from different parts of the country who in-migrated seeking better services and employment. Rural - urban migration for better jobs, health, education and other facilities; rapid escalation of the cost of land, housing units and rents; **limited supply** of adequate land and affordable housing; escalating poverty; unemployment; and low wages have compelled poor and unskilled migrants to squat and built their shelters on public land and other environmentally sensitive areas like riverbanks or flood plains, steep slopes and vacant spaces under high voltage electrical transmission line in Kathmandu Valley. The displacement of people for various reasons, including natural disasters and conflict, are also the major causes for the increase of slums and squatter settlements in the valley.

Table 3- 17: Squatter settlements in Kathmandu Valley

Location	Squatter Settlement
Bagmati River	Kuriyagaun, Sankhamul, Bansighhat, Thapathali, Balkhu, Pragati Tole, Chandani Tole, Sinamangal (Mahabir Galli), Jagriti Nagar, Gairigaun, Shanti Nagar, Dhirghyau Tole, Airport Gairigaun
Bishnumati and Samakhusi River	Buddha Jyoti Marga, Jagriti Tole, Bhimmukteshwar, Dhikure Chauki, Ranibari, Sangam Tole, Narayan Tole, Khandpakha
Manohara River	Maohara, Palpakot
Dhobikhola	Pathivara, Bishalnagar, Kalopul, Devi Nagar, Shanti Binayak, Anamnagar
Other Location	Radhakrishna Chowk, Mulpani, Hattigauda, Pasikot, Sukedhara, Narayantha, Deuwachowk Mahadev Khola, Mahankal, Kumarigal, Kapan DHungen, Kalimatidole, Maijubahal, Golfutar, Khadga Bhadrakali, Subigaun, Mandikhatar, Ramhiti

Source: DUDBC, 2010

Table 3- 18: Growth in Squatter Settlements in Kathmandu

Year	No of Settlement	No of Households	Population	Remarks
1985	17		2,134	
1988	24	348	3,665	
1990	19	859	4,295	
1992	33	1,271	6,355	
1996	47	1,783	8,927	
1998	49	2,021	10,323	
2000	61	2,031	11,862	Source: KMC/WB, 2001
2008	45	2,844	13,243	Source: Tanaka, 2009 Note: At least 4 squatter settlements were evicted for Vishnumati link road project between 1998 and 2008
2010	46	3,227	15,363	Source : DUDBC, Physical Mapping of Squatter
2012	40	2,735	12,726	Source - Lumanti Bulletin, 2069 B.S. Note : On May 2012 squatter in Bagmati was destroyed by GoN, but resettled again after one month
2013	46	NA	24,021	Source: Dangol and Day, 2017



Figure 3- 23:Squatter Settlement in Bagmati

4. REVIEW OF ACTION PLAN 2009-14

4.1. ACTION PLAN 2009-14

The Bagmati Action Plan, BAP (2009-2014) was prepared by the High Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC) in collaboration with National Trust for Nature Conservation (NTNC). BAP served as an important guiding document for scientifically and systematically restoring and conserving the Bagmati River and its tributaries within the Kathmandu valley.

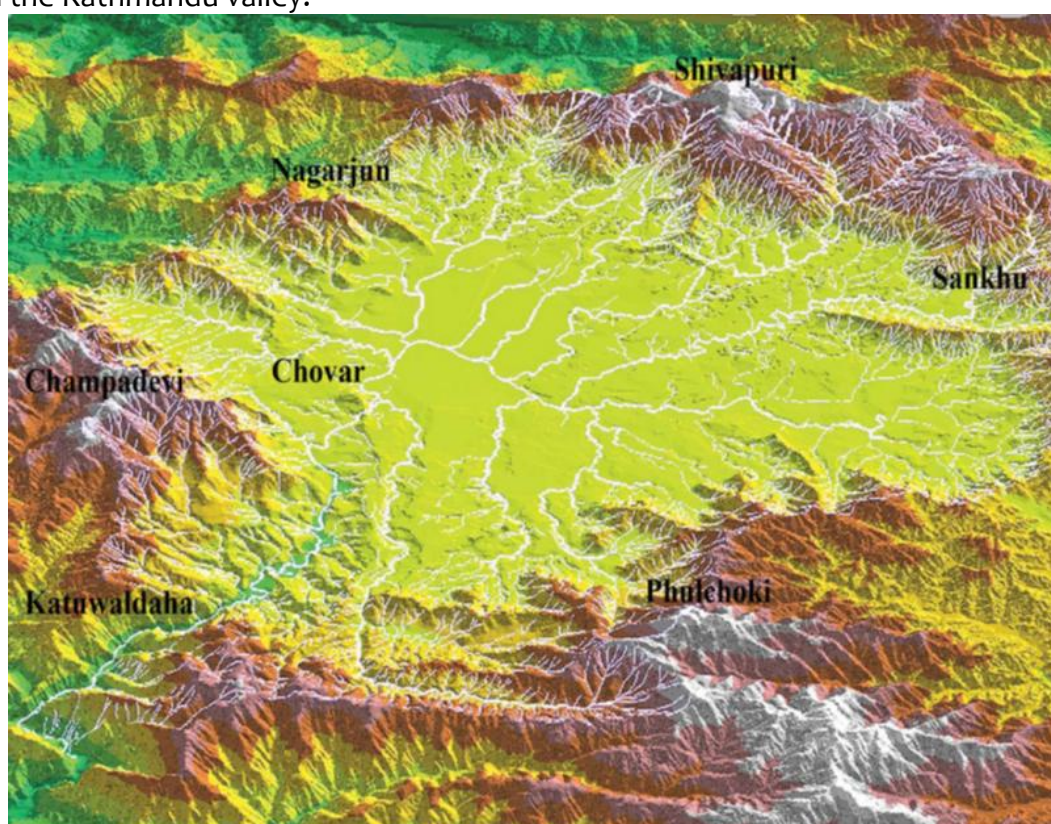


Figure 4- 1: Location Map of Upper Bagmati Basin (Bagmati Action Plan 2009-2014)

The Bagmati Action Plan (2009-2014) was formulated with the aim to restore and conserve the Bagmati River and its tributaries in an integrated and coordinated approach. BAP covers the Bagmati river system from Shivapuri hill to Katuwal Daha. The Bagmati river system includes seven tributaries - Bagmati, Bishnumati, Dhobikhola (Rudramati), Manohara, Nakkhu, Balkhu and Tukucha (Ichhumati) rivers and the five sub tributaries Godavari, Hanumate, Sangla, Mahadev and Kodku Khola.

The critical issues of Bagmati River and its tributaries identified in BAP 2009-14 are primarily related to river ecosystem, river side land use change, preservation of culture and heritage and institutional related arrangements.

- River Ecosystem and waste water describes briefly on the key issues of decrease in water discharge, degradation of river water quality, degradation of catchment quality, narrowing and deepening of water way and depletion of aquatic biodiversity.

- Riverside land use and socio economic condition describes the issues on changes in riverside landuse and eroding aesthetic value.
- Culture and Heritage describes the issues on deteriorating culture and heritage and eroding cultural values and norms.
- Institutional related arrangement deals mainly the issues of integrating conventional planning with ecosystem management, demand management, payment for services and incentives for conservation and enforcement, coordination and stakeholder participation.

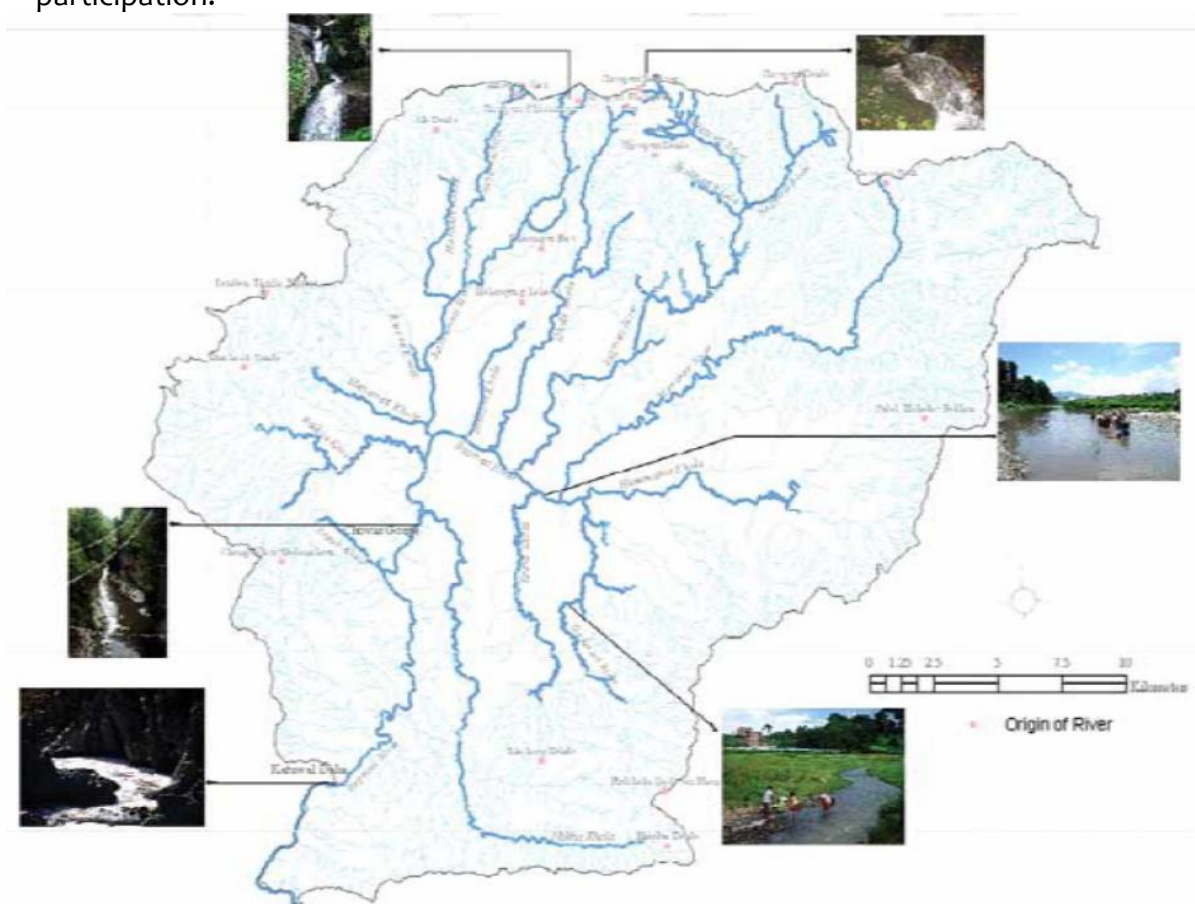


Figure 4- 2:River Network of Kathmandu Valley (Bagmati Action Plan 2009-2014)

BAP was focused on following **activities**:

- Key issues of Bagmati River
- Zoning of the Kathmandu Valley River System
- Legislative arrangements
- Action Plan
- Implementation Strategy and Monitoring Plan
- Budget Plan

Joint initiation of citizen and government to make Bagmati a pollution free river resulted in formation of a high-powered Committee for Implementation & Monitoring of Environmental Improvement in Pashupati Area back in 2051 B.S., which is now functioning as High- Powered Committee for Integrated Development of the Bagmati Civilization (HPCIDBC). It builds on the general public's desire to restore the river environment in the Kathmandu Valley and the Government's efforts to improve irrigation development and mitigate the impact of water induced disasters in the middle and lower reaches of the basin.

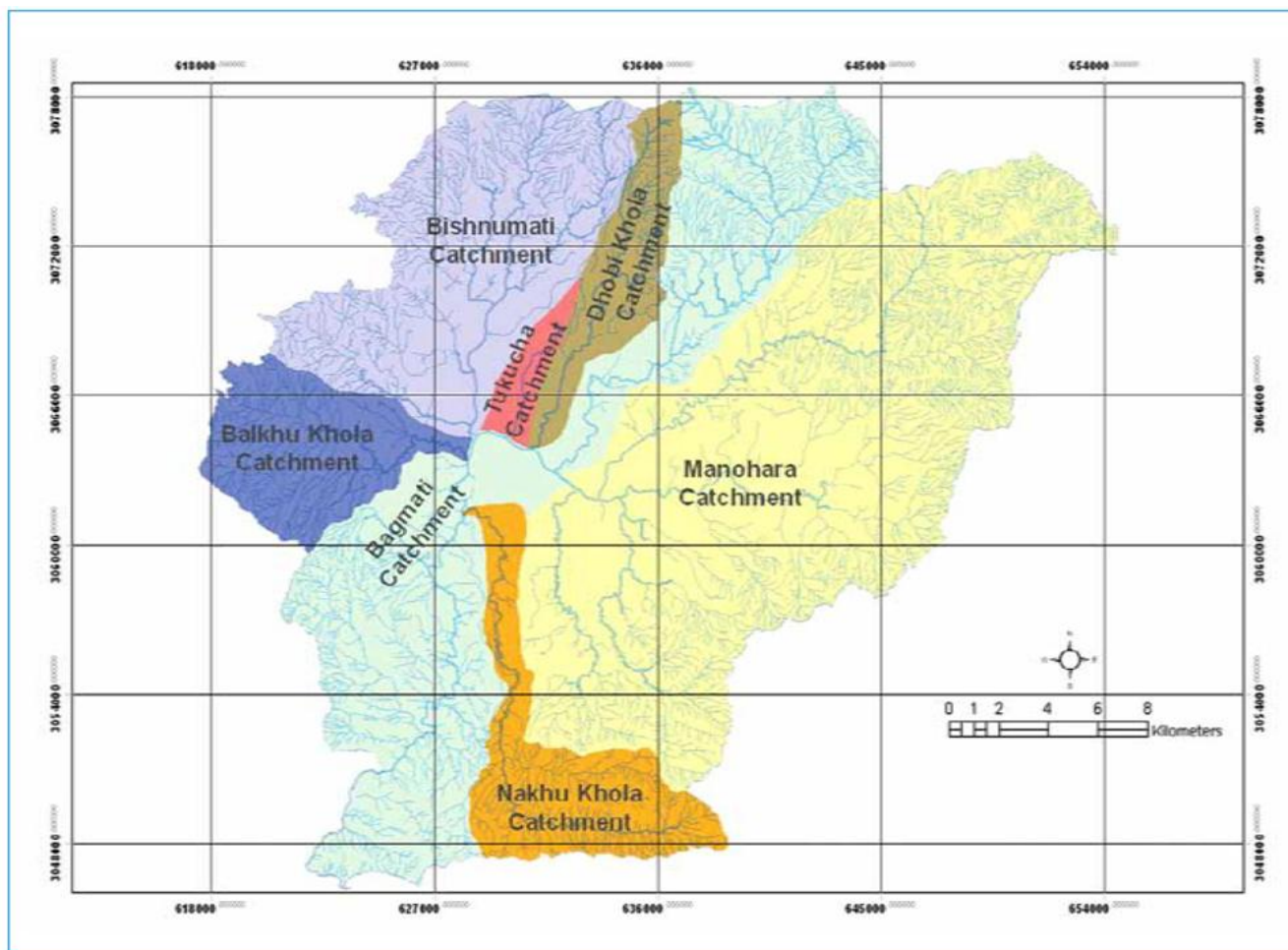


Figure 4- 3: Catchment Map of Major Rivers in Kathmandu Valley (Bagmati Action Plan 2009-2014)
(Ref: Bagmati Action Plan 2009-2014)

The Bagmati River faces different issues along its various segments. To effectively address the key issues at micro level, a concept of zonation of the river system within Kathmandu Valley has been introduced in BAP. Zonation of Kathmandu Valley is classified into five different zones on the basis of water quality and population density such as Natural Conservation Core Zone (Zone 1), Rural Zone (Zone 2), Peri Urban Zone (Zone 3), Urban Zone (Zone 4) and Downstream Zone (Zone 5).

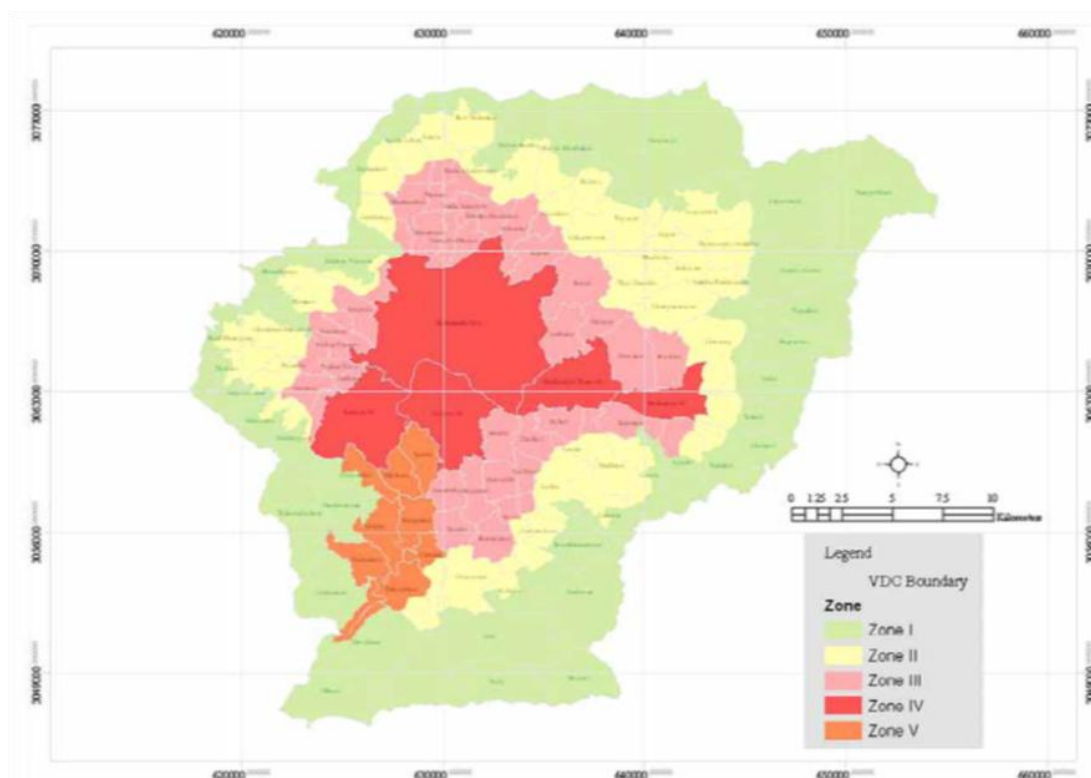


Figure 4- 4: Zonation Map of Kathmandu Valley (Bagmati Action Plan 2009-2014)

- Zone 1 is natural conservation core zone which is 323 sq.km i.e. 45.1% of targeted area which consist of green hill surrounding the Valley Such as Phulchowki, Shivapuri, Chandragiri and Nagarjuna. The population density is very low and hence the river water quality is in natural condition.
- Zone 2 is Rural Zone which is 150 sq.km i.e. 21% of targeted population. Bagmati River and its tributaries flow through this Zone. This zone is dominated through agriculture use and the population density in this zone is higher than Zone 1.
- Zone 3 is Peri Urban Zone which is 113 sq.km i.e. 15.8% of targeted area which is located between rural and core urban city. Population density is comparatively higher than Zone 2 and lesser than Zone 4 in this area.
- Zone 4 is urban Zone which is highly urbanized zone of Kathmandu Valley and consists of five the then municipalities. The water quality is worst in this zone and the population density is highest among all.
- Zone 5 is Downstream Zone which is southern part of Kathmandu Valley from Sundarighat to Katuwal Daha. This zone is mostly covered with agricultural zone and has comparatively low population than peri urban zone but the water system is extremely polluted in this area.

Bagmati Action Plan 2009-14 sets the overall vision for restoration and conservation of Bagmati River and its tributaries. **The Action Plan's vision was –**

“Clean, green and healthy river system that is full of life and valued by all”.

This action plan has given due recognition to the priority activities that have been recommended by previous interventions. One of the major activities and the challenges of each zone is to manage waste (liquid and solid) and to improve the quality of water of rivers. Certain key activities which are valid in all the zones are included as cross cutting activities. These activities are either common for all zones or their outputs help to build the capacity of

HPCIDBC and other agencies working for the restoration and conservation of the Bagmati river and its tributaries.

- For Natural Conservation Core Zone (Zone I), the main goal was to maintain and enhance the upstream river ecosystem through the increasing the water discharge in river. The action also emphasize on maintaining the river water quality and promoting the eco-tourism of the area. Moreover it also focus on renovation and conservation of cultural and heritage sites.
- For Rural Zone (Zone II), the main goal was to restore the river ecosystem through sustainable development approach. The action focus on enhancing water flow in river, conservation of biodiversity and riparian landscape, prevention on discharge of waste water and solid waste in river and promotion sustainable agricultural practice. It also focuses on regulation of urban growth and industrial activities and conservation and promotion of culture and heritage.
- For Peri-Urban Zone (Zone III), the main goal was to restore the river ecosystem through effective management of urban growth. The action focus on improvement of river water quality, protection of river side land use, control and relocation of squatter. It also emphasize on conservation and regeneration of culture and heritage.
- For Urban Zone (Zone IV), the main goal was to upgrade river ecosystem, conserve and regenerate tangible and intangible heritage linked with rivers. The action focus on improvement of water quality through management of waste, relocation of squatter and improvement of riparian landscape. It also focus on the renovation and conservation of cultural and heritage site and promotion of tourism
- For Downstream Zone (Zone V), the main goal was to restore healthy river ecosystem with the capacity for self-purification. The action focus on improvement of river water quality, improvement of self-purification process of river and conservation of terrestrial habitat. It also focus on conservation of cultural and heritage site and promotion of eco-tourism.

Different agencies are involved in promotion and development of different zones along Bagmati River. A strong mechanism was to be established for coordination among these institutions for efficient and sustainable management of Bagmati River. BAP 2009-14 has recommended HPCIDBC as key coordinating and leading agency to address the issues and activities highlighted in the plan. All other stakeholders and partners such as CBOs, local government, KVDA, NGOs, DWSS etc must take permission for any activity to be carried out in and around the Bagmati River and it's tributaries aimed at maintaining consistency and avoiding duplication of activities and to bring all the stakeholders under one umbrella.

On the basis of the action plan prepared, the total estimated budget for five years was Rs. 15,028 million. Zone 4 required the maximum budget i.e.46.28% of total budget because this zone covers the urban core area where major activities were proposed. Similarly, Zone 1 required the least budget ie. 1.47% of total budget. However, 10.98% of the total budget was proposed for cross cutting activities.

4.2. MAJOR PROJECTS IDENTIFIED BY ACTION PLAN 2009-14 AND THEIR CURRENT STATUS

- **Protect and manage wetlands in areas such as Phulchowki and Shivapuri National Park:** Current Status: Nagmati Dam was identified within Shivapuri National Park and study is on EIA Stage. After the approval of EIA, the construction will be initiated. Wetland studies on other area are not seen in progress.
- **Construct embankment in dhap (Shivapuri National Park) to increase water recharging capacity:** Current Status: Dhap Dam is in completion phase and rain water collection will be started from this monsoon in Dhap dam area
- **Rehabilitation of existing ponds to recharge groundwater through rainwater harvesting :** Current Status: Some ponds have been rehabilitated and some are under process through local bodies such as Rani Pokhari, Kamal Pokhari, Gahana Pokhari, Ikha Pukhu etc in Kathmandu, Pimbaha Pukhu, Saptapatal Pokhari, Na Pukhu, Balkumari Pukhu etc in Lalitpur, Nhu Pukhu, Rani Pokhari, Bhaju Pukhu, Siddha Pokhari etc in Bhaktapur. All these rehabilitation of ponds has not been accomplished from traditional technology, so objective of recharge of groundwater has not been fulfilled as expected. Most of the ponds are rehabilitated for beautification purposes.
- **Prepare and implement land use plan:** Current Status: There is no progress in this proposed intervention from the aspects of Watershed Conservation.
- **Construct community managed DEWATS System:** Current Status: No much progress is observed in this proposed intervention. However some community managed DEWATS System has been constructed.
- **Construct intercepting sewerage system along both the banks of the rivers:** Current Status: 71.7km of Interceptor has been laid on Bagmati, Bishnumati, Balkhu, Dhobikhola and Nakkhu. But since WWTP or DEWATS are not in operation phase, sewerage is disposed directly into river.
- **Rehabilitation of existing WWTP and construction of additional WWTP:** Current Status: Existing WWTP are under construction for up gradation and additional WWTP are under construction for Tukucha khola.
- **Verification and relocation of all squatters from the river banks:** Current Status: Most of the squatters residing along the river banks in 27 different locations has been identified from HPCIDBC. Relocation of squatters has been succeeded in some areas such as Dobikhola Corridor etc from the initiation of the project. Though the relocation seems negligible to the present status.
- **Control encroachment of the river banks by squatter and others:** Current Status: Encroachment is minimal but the records have not been updated and verified. No specific program seems proposed.
- **Construct access roads/foot trails along both the banks of the rivers:** Current Status: River corridor has been prioritized and developed with footpath along most of river corridors. Road corridors has been developed along Bagmati, Bishnumati, Rudramati (Dhobikhola) etc. Analysing the present scenario, 161 Km of road corridors have been developed along the river within KV.
- **Prepare and implement landscape plan of riparian land to maintain green corridor;** Current Status: Development of river corridor has focused on landscape and green areas which add up the open green park such as UN Park, Sankha Park, Art of Living etc at different areas which are under management of different organizations. However, the riparian concept has not be advocated.

- **Carry out bank protection works using bioengineering:** *Current Status: 160.5 km river training wall has been constructed but these protection works do not follow bioengineering concept and fails to recharge the water in river.*
- **Prepare an inventory of existing heritage sites:** *Current Status: No specific projects are designed for inventory of existing heritage sites*
- **Prepare restoration plans of existing culture and heritage sites and associated cultural activities:** *Current Status: No specific projects are designed for inventory of heritage sites and identification of existing status of existing culture and heritage site. But after Gorkha earthquake 2015, restoration plan for some structures along Bagmati were identified and restored.*

4.3. CRITICAL ANALYSIS OF ACTION PLAN 2009-14

The Action Plan 2009-14 was prepared with the objectives;

- cleaning Bagmati and its tributaries
- increasing water discharge in rivers,
- preservation of tangible and intangible cultural/historical heritage within the valley

Plan had identified problems and key issues related with river & heritage and had proposed activities to resolve problems associated. DEWATS, WWTPs, interceptors, conservation & rehabilitation of existing water sources/ponds, restoration of tangible and intangible heritages, biodiversity conservation and restoration were major activities to resolve problems. The plan had given equal emphasis to cleanliness of rivers and restoration of water & forest biodiversity within the valley. The activities proposed were very important and appropriate to resolve identified problem but some issues which hindered effective implementation of proposed activities are identified as;

- Activities proposed were more conservation oriented but implementation inclined toward development needs of the valley.
- Unstable government, irregular/unpredictable source of funds hinder timely execution of projects proposed like DEWATS, WWTPs, dhap dam, interceptor development etc.
- Priority of right between implementation partners also slows down implementation pace of projects.
- Specified project targets and project location were not detailed which hinder expected results from the plan.

Similarly, at one side number of projects proposed remains unimplemented due to obstacle but at the same time there were some externalities too which create obstacle in goal achievement,

- **The population** growth and settlement expansion in the valley was more than that was expected by plan.
- Development needs of the valley created adverse environmental impact on Valley Rivers.
- Water conservation was the priority but the water recharge mechanism was not addressed in the report.
- Urban and rural areas are found with different impacts in rivers, uniform strategies provided along rivers minimizes impacts on project objectives.

5. SITUATION ANALYSIS AND KEY ISSUES

5.1. DEMOGRAPHIC ANALYSIS

5.1.1. Population Growth Trend and Projection

According to the 2011 census, the population of Kathmandu Valley was 2,446,146. The 2021 census shows that the valley's population has increased to 2,956,804, with an annual growth rate of 1.91%. This represents a decrease from the previous decade's annual growth rate of 4.23% (CBS, 2001 & 2011).

A comparison of the 2011 and 2021 census data reveals that the population growth rate of Kathmandu Metropolitan City (KMC) decreased, with a growth rate of -1.18%, indicating a trend of transformation from residential to commercial use. Similarly, a decreasing population was also observed in Bhaktapur Municipality, which had a growth rate of -0.32%. In addition, Konjyosom Rural Municipality and Bagmati Rural Municipality also experienced decreasing population rates of -0.74% and -0.02%, respectively (Annex II).

The analysis of population growth trend during 2001-2021 periods shows the reduction in growth rate in 2011-2021 decade, compared to that in 2001-2011 decade (**Table 5-1**).

Table 5- 1: Population growth rate in different census period

Year	Population	Growth Rate
2001	1,616,413	-
2011	2,446,146	4.23%
2021	2,956,804	1.91%

Source: CBS 2001, 2011 and 2021 (Preliminary Report)

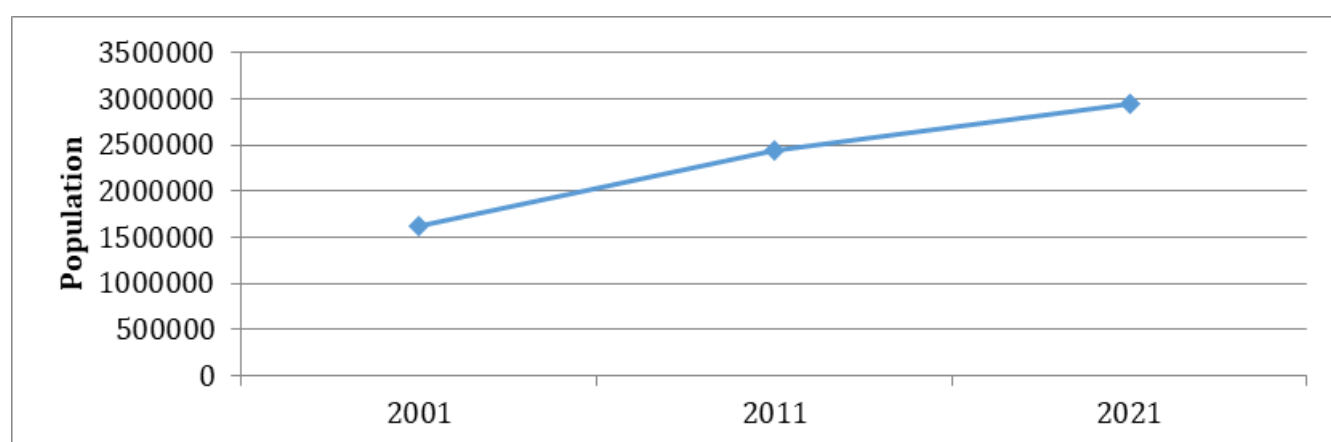


Figure 5- 1: Population growth trend of Kathmandu Valley

Looking at the growth rates of local units within the valley, the growth rate is higher in the peripheral local units of core urban areas. Future growth will also be channeled to these areas

where large available built-up land can still be observed. However, not all of these areas can be developed due to constraints such as steep slopes, monument zones, historical ponds, forests, and other ecological factors.

The population projection is thus made with the assumptions that the minimum growth rates in the local bodies will be 0.3% per annum (Annual growth rate of hilly region- 2011-2021) and the maximum growth rate of 3.52% per annum (Average population of municipal area). For the remaining municipalities, same growth rate has been adopted till next 20 years period. With the growth rate of 2.13% per annum, the population of Kathmandu valley is projected to reach 3,890,678 and 4,922,593 by 2034 and 2044 (**Figure 5-2**).

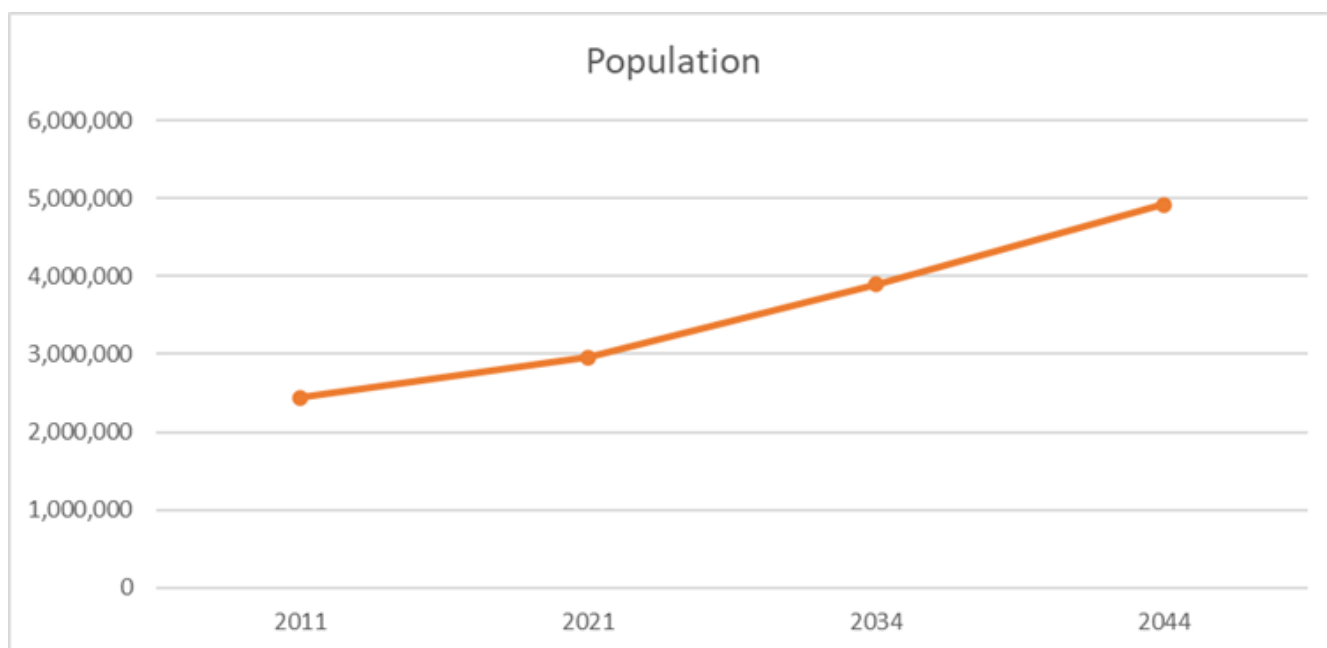


Figure 5- 2: Projected population till 2044

ADB, 2017 study has considered 750,000 floating population in Kathmandu Valley who temporarily migrate for better urban services. After decentralization of development of Nepal, people will have lots of options for better services other than KV, so the floating population of 500,000 has been adopted for 2034 and 2044. So, for planning inhabitant of KV in 2034 and 2044 are predicted 4.39 million and 5.42 million.

5.1.2. Population Density

The gross density of Kathmandu valley is expected to reach around 56 ppha in 2044. The computation of projected population densities of the local unit shows the higher density in Madhyapur Thimi municipality (231 ppha), followed by Kathmandu Metropolitan City (187 ppha), Tokha Municipality (156 ppha), Bhaktapur Municipality (123 ppha), Budhanilkantha Municipality (113 ppha), Kageshwori Manohara Municipality (106 ppha) and Mahalaxmi Municipality (103 ppha). All other local units will have population densities below 100 ppha. The details are presented in Annex II.

5.2. LAND COVER CHANGE

Land use and land cover change is one of the major drivers that alter the ecosystem function in the region. The rapid urbanization can cause serious depletion of the ecosystem services (W. Wang et al., 2020) through depletion in regulating services of climate, air, water and land (Peng, 2018); deteriorate the cultural services (Brosius & Michaels, 2020); hinders in provisional services by reducing the forest and open space (Pokhrel, 2019) and misbalancing the supporting services such as nutrient cycle, water cycling, soil formation and photosynthesis (S. W. Wang et al., 2020; Rijal et al., 2021). The land cover change of Kathmandu valley over the last two decades is evaluated from the land cover database of

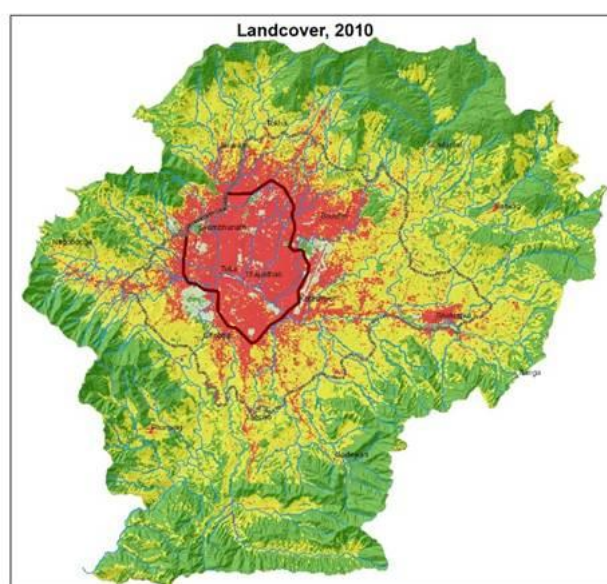
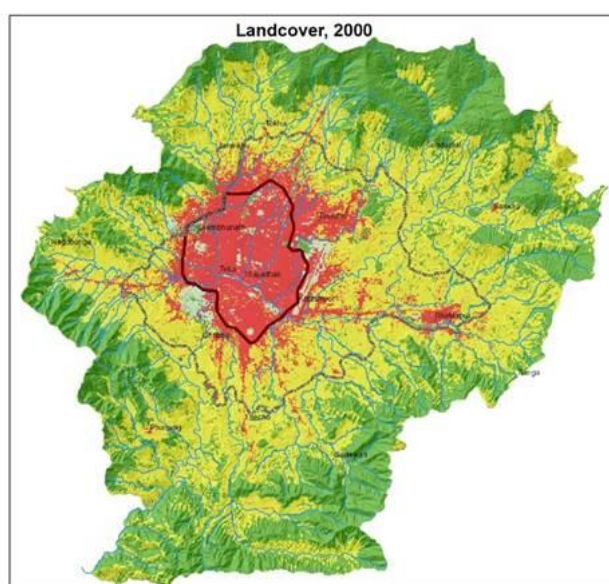
ICIMOD. The result revealed that the valley is facing rapid urbanization with an annual increment in built-up of about 4.56 percent during the last decade which is about four times higher than that of the period from 2000 to 2010 (**Table 5-2**).

Table 5- 2: Land cover change dynamic of Kathmandu valley

Land cover/ Year	Year 2000		Year 2010		Year 2020		Area change (Sq. Km)	
	Area (Sq. Km)	Percent (%)	Area (Sq. Km)	Percent (%)	Area (Sq. Km)	Percent (%)	2000- 2010	2010- 2020
Built-up	87.22	12.25	102.53	14.40	161.50	22.69	15.31	58.98
Cultivation	333.92	46.91	298.90	41.99	255.91	35.95	- 35.02	- 42.98
Forest	277.37	38.96	299.51	42.07	285.34	40.08	22.14	-14.17
Grassland	13.15	1.85	10.71	1.50	8.80	1.24	-2.44	-1.91
Riverbed	0.06	0.01	0.11	0.01	0.07	0.01	0.04	-0.04
Water bodies	0.15	0.02	0.12	0.02	0.24	0.03	-0.03	0.12

Source: ICIMOD 2020

Understanding the spatial pattern and direction of the urban growth is essential for the river system management plan. During the 2000's, urban form inside the ring road was dense which readily expanded outer circular over the period of 2000 to 2010. Further outward expansion urban/built-up has evidenced in recent decades resulting in conversion of prime agricultural land in the valley floor (**Figure 5-3**). Due to ever increasing urbanization pressure, the valley has been facing serious environmental consequences in recent years. And the most affected environmental function is the river system.



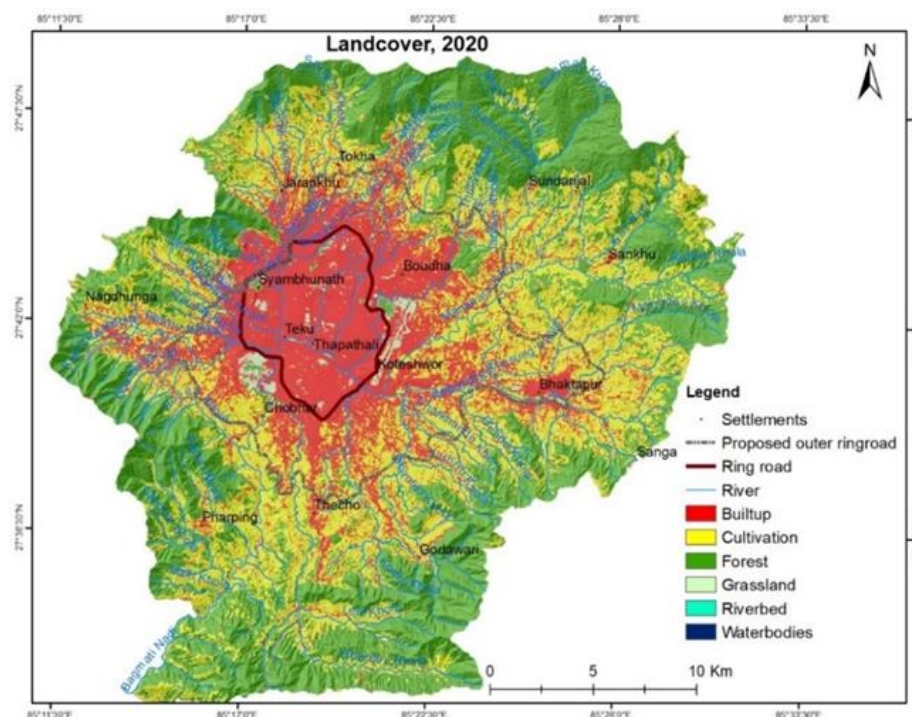


Figure 5- 3:Land cover change during last two decades

5.3. URBAN GROWTH TREND

5.3.1. Settlement Development Scenario

The Valley experienced its highest growth in previous decades mainly between **1999 and 2009**, fueled by a real estate boom and an influx of migrants displaced by political turmoil. While the growth rate has slightly slowed since 2009 which is illustrated in Figure 5-4., it remains substantial.

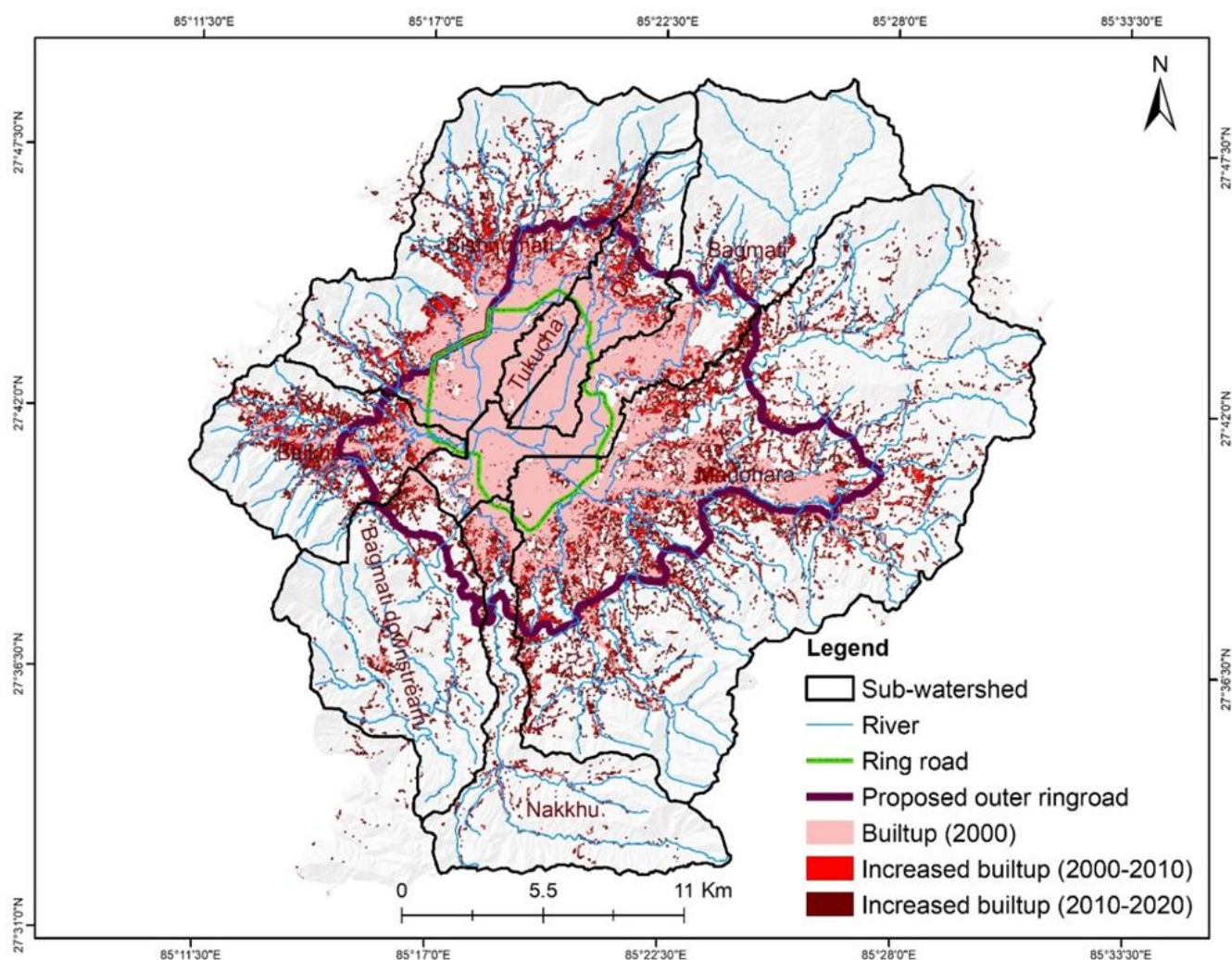


Figure 5- 4: Built-up change in Kathmandu Valley 2000– 2020

According to the Central Bureau of Statistics (CBS), the resident population grew from 2,446,146 in 2011 to 2,953,731 in 2021, marking an average annual increase of 1.90%. Population growth is not uniform across the valley. A distinct pattern has emerged: Newer municipalities on the outskirts are expanding rapidly. For instance, Kageshwari Manohara Municipality has recorded a growth rate as high as 8.27%. This sprawl is often driven by new development projects and land speculation. In contrast, the dense urban core areas, such as Kathmandu Metropolitan City (KMC) and Lalitpur Metropolitan City (LMC), have seen a decline in their resident populations.

Despite a decrease in residents, the core cities host a large floating population—individuals who commute into the valley for work, education, and services without being permanent residents. Past studies estimated this number to be between 500,000 and 1,000,000.

An Asian Development Bank (ADB) study from 2017 estimated the floating population at 750,000. When added to the 2021 census data, the total number of inhabitants in the valley in 2022 was approximately 3.7 million.

5.3.2. Current Major Urban Development Projects of Kathmandu Valley

For the development of KV, KVDA aims to prepare and implement an integrated physical development plan for KV which encompasses 2 metropolitan cities, 16 municipalities and 3 rural

municipalities. The major development projects, which were prepared and are being prepared, that could guide the road map for future development, **have** been summarized below.

- **Outer Ring Road**

Outer Ring Road of around 72 km in length was proposed to expand the urban areas for homogeneous development of the valley. Contrary to the objective of ORR, the project has boosted the land speculation in the proposed alignment area of the ORR. Remarkable urban growth can be noticed around the alignment area (Figure 5-5).

- **Strategic Development Master Plan**

The Strategic Development Master Plan(draft) proposed the schematic layout of the proposed land use zones in the valley in four different sections as urban central, periphery to urban central, urban extension and suburbs depending upon population density, land use, risk sensitivity, nature of the urban structure and constraints free land use for development.

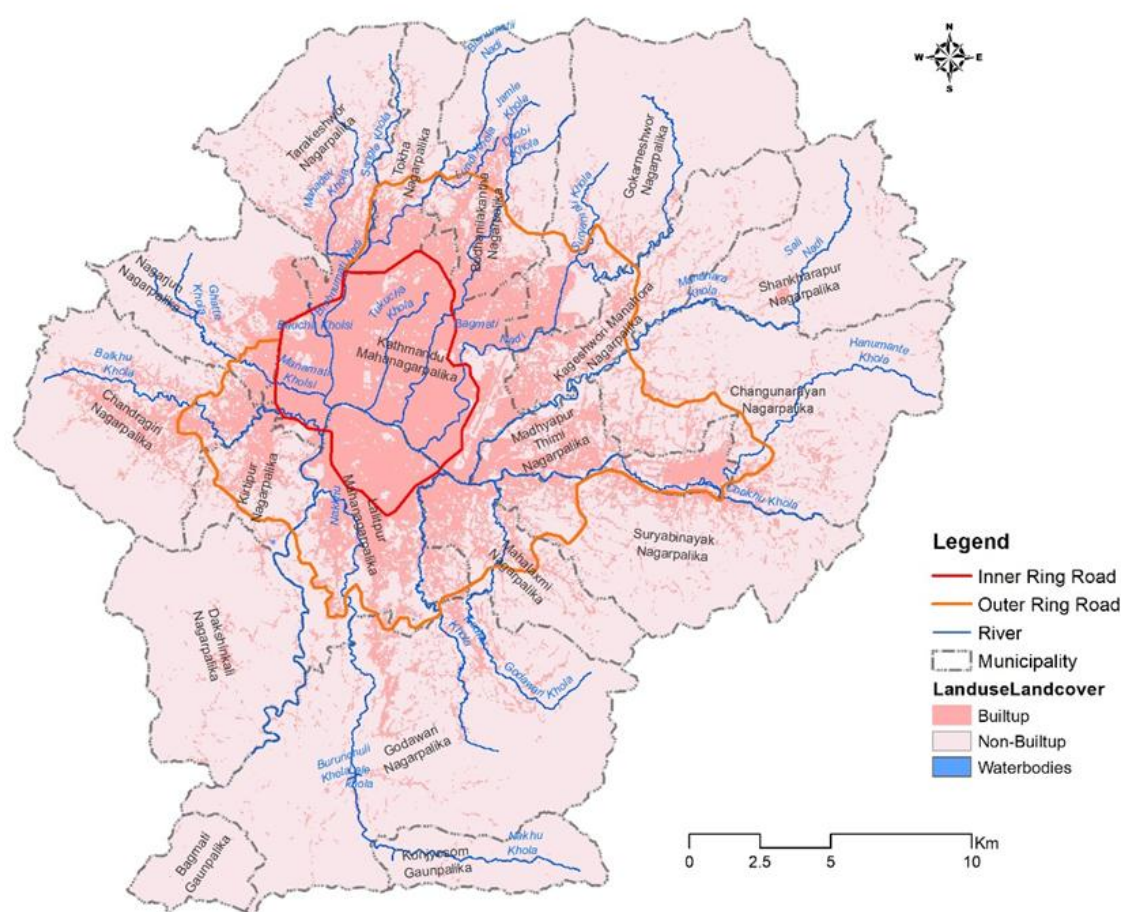


Figure 5- 5: Proposed Outer Ring Road Alignment in Kathmandu Valley

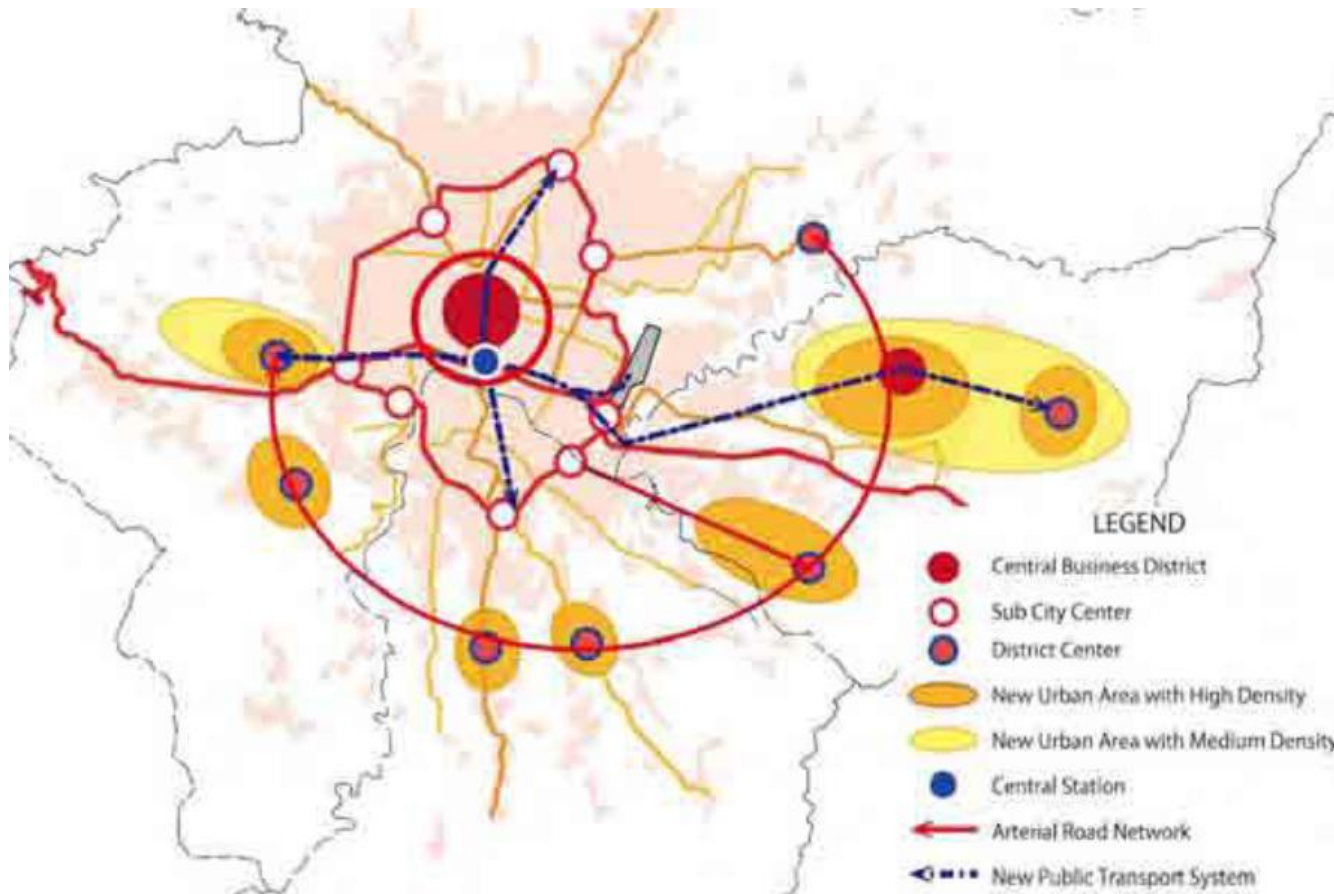


Figure 5- 6:Conceptual Urban Development linking with urban mobility

The project has envisaged the urban extension area for next 20 years and the link road has been planned connecting to these proposed development area. The major affect from the plan is not noticed on ground (**Figure 5-6**).

- **New Town Project**

Four different new towns (smart cities) are proposed in four corners of the valley (**Figure 5-7**).

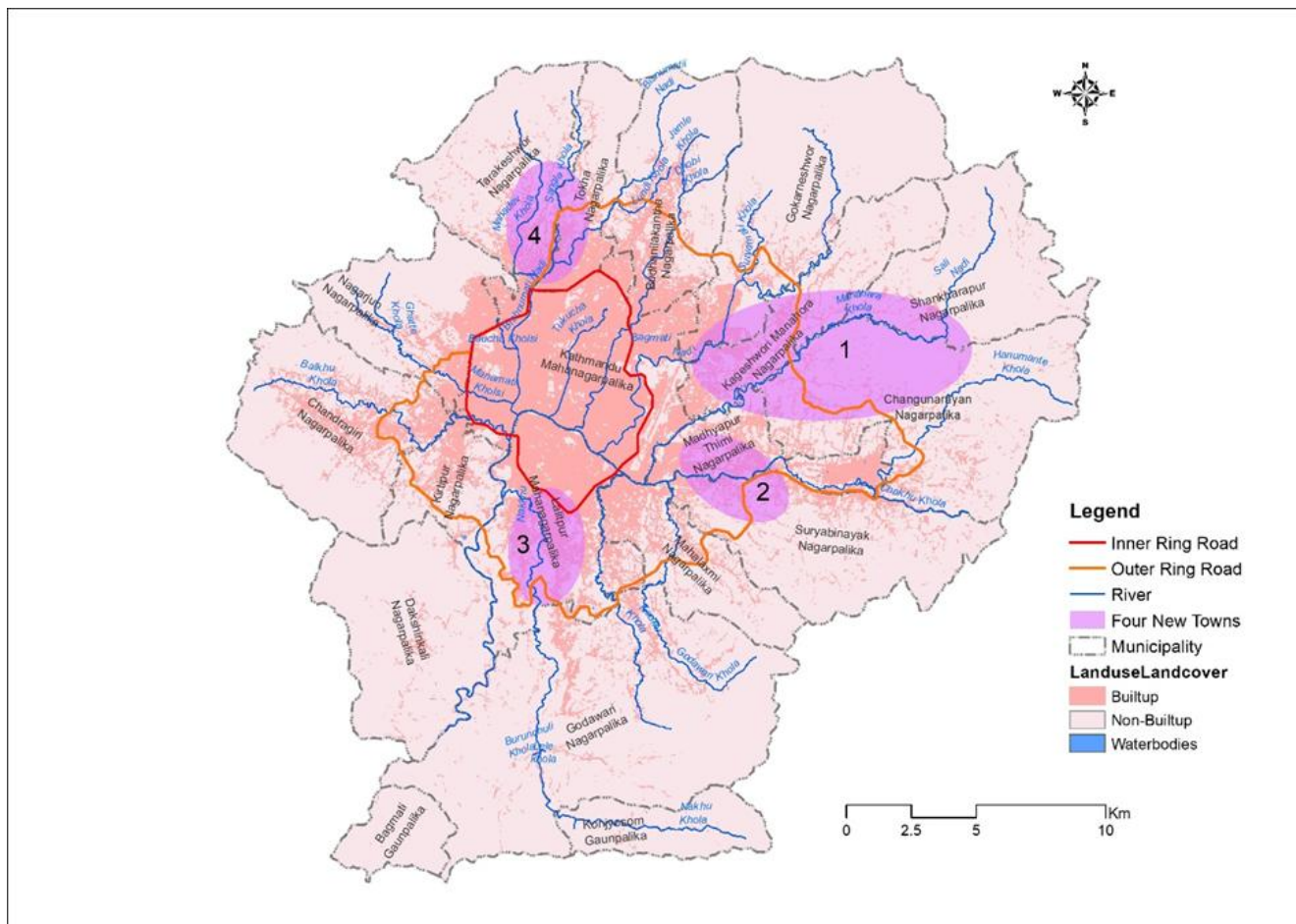


Figure 5- 7: Proposed New Town area at Kathmandu Valley

- **(1) Kathmandu Ishaan** – It is proposed on North-East Side of KV with vision to develop planned settlement within 100,000 ropanies of land. This project includes the area of Nagarkot and Telkot area of Bhaktapur, Sankhu, Jorpati, Mulpani and Gothatar of Kathmandu
- **(2) Kathmandu Agneya** – It is proposed on South-East Side of KV with vision to develop planned settlement within 10,000 ropanies of land. This project includes the area of Suryabinayak, Balkot, Biruwa, Thimi and Anantalingeshwor of Bhaktapur
- **(3) Kathmandu Nairitya** – It is proposed on South West Side of KV with vision to develop planned settlement within 10,000 ropanies of land. This project includes the area of Sainbu, Khokana and Bungamati
- **(4) Kathmandu Uttar** – It is proposed on the North Side of KV with the vision to develop planned settlement within 10,000 ropanies of land. This project includes the area of Samakhushi, Tokha, Bypass, Malung and Kavresthali area

5.4. ENVIRONMENTAL AND DISASTER ISSUE

Much of the current undesirable state in rivers can be attributed to disruptive anthropogenic activities. Because of contemporary socioeconomic development, rivers have been facing growing threats from several quarters-unsustainable withdrawals, pollution, landuse conversion and habitat deterioration, among others.

5.4.1. Degradation of Water Quality

Degradation of water quality is associated with the river use, solid waste dumping, direct discharge of sewer and industrial effluents and use of chemical fertilizers and pesticides in agriculture.



Figure 5- 8: Effluent discharge from dying industry in Mahadev Khola

Rivers in the Kathmandu valley are used for various purposes like washing clothes, domestic animals, vehicles, vegetables, cultural rituals, bathing and disposing remains after rituals, sewerage discharge, solid waste dumping and others. With rapid urbanization informal settlements along the river banks and industries have increased. Number of small industries such as cattle farms, poultry, piggery, concrete, dying, saw mills, paper mills, etc. are established. There is no systematic sewage treatment system till date. A huge volume of waste water generated from the households and industries is directly discharged into the rivers. Disposing municipal waste in the river banks is still very common. Despite the establishment of door to door waste collection system and landfill site solid waste problems and the discarding of waste along river banks and river itself still continues. It is common problem in almost all the rivers of Kathmandu valley. The problem is worst in the dense urban cores. The waste segregation and transfer points are established at the bank of some rivers like Bagmati, Rudramati, and Bishnumati among others.

5.4.1.1. Water Quality Analysis

Pollution level on different stretch of Bagmati, Dhobi Khola, Bishnumati and Hanuumanthe were evaluated and found that upstream areas are less polluted. Considering the Bagmati sub-watershed, pollution level is increased along the downstream except at Gaurighat and Aryaghat stretch. Existing waste water treatment facilities at Gaurighat has contributed to lowering the pollution level and it again increase in the downstream. Similar pattern of pollution level is observed further downstream from confluence of Bagmati and Manohara. Similar pattern is seen in Dhobi Khola sub-watershed and Ratopul stretch found to be most polluted area, which slightly decrease in downstream along the Budhanagar and at the confluence of Dhobi Khola and Bagmati. Moreover, pollution in Mahadevkhola is at higher level in Busnupati, accompanies with moderate level pollution in Tokha stretch whereas, Hanuumanthe sub-watershed is relatively less polluted.

Considering the monthly pollution status, pollution has increase in driest month in all studied stretch, which indicates the discharge in river has significant role in determining the pollution status. Moreover, the total suspended solid play an important role for increasing turbidity in the month of Asadh,

During the study period, Dhobi Khola downstream from Ratopul stretch is found as most polluted river, followed by Mahadev Khola and Bishnumati downstream from Khusibu stretch. Coherently, these areas also receive higher number of sewage discharge, reflecting the main cause of pollution of the Bagmati river system.

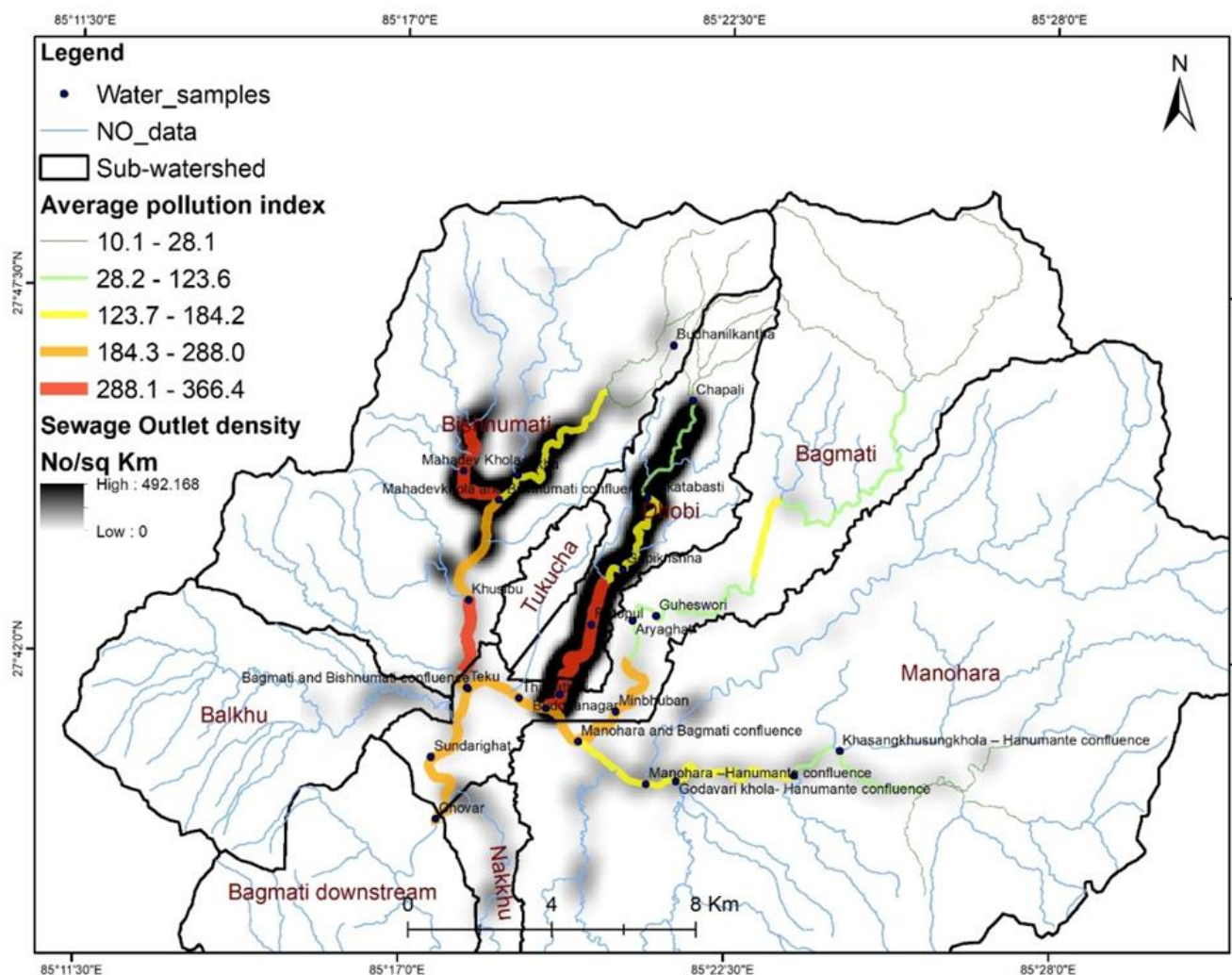


Figure 5- 9: Average water pollution index

(Data Source: <https://bagmati.gov.np/np/download-types/bagmati-river-water-quality-test-report/>)

5.4.2. Degradation of Catchment Quality

Degradation of catchment quality is mostly associated with the landuse conversion through settlement expansion, extensive land plotting and unregulated quarries. The upstream areas have significant forest cover and are conserved but still there exists settlement areas and are expanding for housing and agriculture. The land cover change analysis of last decade also shows the decrease in forest cover (**Table 5-2**). Rapid and unplanned urbanization has led to concretization of the valley floor and is expanding towards the peripheral hillslopes. There are more than 550 such land plotting and half of them has average slope more than 15 degree. Similarly, more than 20% of such plotting are situated on marginal land having slope more than 20 degree (**Figure 5-13**). Besides there are some quarry sites in the upstream areas. These activities have reduced the water recharge areas and degraded the catchments of

Bagmati

River

and

tributaries.



5.4.3. Decrease in Water Discharge

A primary cause for the decreasing water discharge in Kathmandu Valley's rivers is extensive water abstraction for drinking, irrigation, and industrial purposes. The water use is mostly related with tapping of water from the river/streams for drinking, irrigation and industrial uses. Water is tapped every day from rivers such as Bagmati, Bishnumati and other small streams originating from the Shivapuri hills. Sundarijal, upstream Bagmati, Bishnudwar of Bishnumati, Sangla river, Chapagaun of Nallu river, Godavari river, Mahadev Khola are major locations where huge volume of water has been diverted daily for drinking and irrigation purposes. Further downstream, rivers such as the Manahara, Nakkhu, and Balkhu are heavily tapped for agriculture and industrial activities. Moreover, a large volume of water is transported to city centers by tankers. The tapping of water from main sources of rivers is a root cause of decreasing water discharge.

The other associated causes are associated with climate change impacts like drying up of water sources. Decrease in water discharge is also linked with the ground water extraction. The excessive ground water extraction to meet the growing urban water demand results in the lowering of the ground water table. The likelihood of lowering the ground water table is high because of the increasing trend of extracting underground water, channelization of rivers and urban expansion in the hillslope. With lowering the ground water table, rivers may turn into losing streams, resulting in the decrease in surface discharge in future. Moreover, alluvial soils of the flood plain have higher infiltration rate which were largely invaded in Kathmandu valley through the channelization of river and expansion of settlements. Additionally, expansion of land development (plotting) in colluvial hillslope surrounding the valley is directed towards destruction of recharge zones.

As expected, the forested land in upper and mid hillslope of Bagmati river system will contain the surface runoff and contribute to infiltration rates but surely this will not be sufficient to sustain the river quantity and quality in the downstream.

Decrease in water discharge exerts enormous impact in overall river ecosystem by reducing the self-cleaning mechanism, enhancing pollution concentration, damaging the habitat of aquatic biodiversity, exposing the river banks and channeling of flow.

5.4.4. Narrowing and Deepening of Waterways

Narrowing and deepening of the waterways are the results of river encroachment, unplanned construction of embankments, roads and other infrastructures and excessive mining of sands. Though regulated sand mining still exists in upstream areas of Majority Rivers. Sand mining is also done in downstream areas of Bagmati River. The river training works have resulted both in the protection and risk to flood events. These works have

confined a definite channel course providing bank protection as well as from human encroachment but at the same time the narrowing of the river channel have resulted in inundating because of narrow passage of river channel. This suggests proper planning to river training works while maintaining certain river widths in reducing flood risks.



Balkhu Khola

5.4.5. Depletion of Aquatic Biodiversity

The diversity of fish fauna in the rivers of Kathmandu valley was once quite rich. A survey by Tribhuvan University in 1979 reported 54 fish species in the river system. With the degradation of the water quality the number of fish species decreased. The survey conducted by the Melamchi Water Supply Project in 2000 reported only 12 fish species. Freshwater species are seen only in the upstream section of the Bagmati River and its tributaries. Since most of the river's water is diverted for water supply, irrigation and industrial use there is little fresh water flowing in the river channel during the dry season. As the river flows downstream, it receives a considerable amount of domestic and industrial wastewater highly depleting its DO level. Only pollution-tolerant fish such as catfish are present in the slightly too moderately polluted sections. Freshwater fish are completely absent in the extremely polluted sections.

5.4.6. Natural Hazard

Kathmandu Valley is prone to different types of natural hazards: earthquake, landslide, flood and urban fire and its built environment is very vulnerable.

A. Flood Hazard

The major causes of the flood in the valley are the river bank encroachment, high sinuosity of river, narrow outlet, increase in riverside settlements etc. With the rapid urban expansion in the Kathmandu Valley, the settlements have expanded even along the banks of rivers and streams. This has also affected the natural path of the river by altering the river channels and diverting the flow. Though there seems to be a nonexistent flooding problem during the low flow period in the pre-monsoon season, the flooding situation in the monsoon period has threatened the lives and properties. River bank cutting, channel shifting and inundation are the major flood related problems.

According to the study conducted in 2009, high flood vulnerable areas were situated near Jorpati, Gaurighat, Tilganga, Subidhanagar, Thapathali, Teku confluence and Balkhu confluence of Bagmati River. Likewise, the high vulnerable area was found near the confluence of Manohara and Hanumante rivers, Katubahal and Anamnagar of Rudramati, around the confluence of Mahadev Khola and Bishnumati, Mhaipi and Khusibu of Bishnumati River, Kalanki-Bulkhu area of Balkhu Khola.

Low vulnerable areas were noted at upstream from Gothatar of Manohara River, upstream from Jorpati of Bagmati River, upstream from Katubahal of Rudramati, upstream of Mahadev and Bishnumati rivers, upstream from Kalanki of Balkhu Khola, and the river corridors of Nakhu and Godawari.

Wide coverage of moderate vulnerable areas was noted in Guheswori-Gokarna segment and area around Sankhamul of Bagmati River, river sector between Magargaon to Chhapro of Manohara River, around Maitidevi in the Rudramati sector, around Balaju, Banasthali and downstream from Dhalko of Bishnumati and Thimi to Lohakinthali of Hanumante Khola.

The high risk area were situated at Thapathali, around Bishnumati and Balkhu confluences along the river corridor of Bagmati River, small strip at downstream from confluence of Manohara and Hanumante, downstream from confluence of Karakhusi and Bishnumati, while the moderately risk areas occurred at Gaurighat, Tilganga, Shankmul, Thapathali along the sector of Bagmati River, around and downstream from confluence of Manohara and Hanumante, around Anamnagar of Dhobi Khola, downstream of Mhaipi and around Khusibu of Bishnumati, around Balkhu of Balkhu Khola and Thimi to the confluence of Godavari Khola along the Hanumante (DWIDP, 2009).

The present scenario of flood vulnerability is more or less the same, with only the river training works improved along the rivers preventing the bank cutting. In turn the river training works along with the bank encroachment have resulted in narrowing and deepening of the river channel. Field evidence and historical data illustrate that flooding of these rivers is also inundating considerable distance from the river course because of narrow passage of river channel, strong river encroachment by private building etc. and highly meandered river morphology with low bank height.



Figure 5- 10:River bank cutting by Manohara River

B. Soil Erosion

Many factors are responsible for soil erosion of Kathmandu valley, among which topography, geology, soil composition and land use play leading roles. Tillage farming in the marginal slope also causes the surface soil erosion, however, intensity of such loss has decreased in recent years. The larger volume of soil loss is contributed by the ever-expanding land plotting in the hill-slope. There are more than 550 such land plots and half of them have an average slope more than 15 degree. Similarly, more than 20% of such plots are situated on marginal land having slopes more than 20 degree (**Figure 5-13**).

This enormously increasing land conversion in the hill-slope also poses a threat to tremendous decrease in ground water infiltration from the region, which ultimately decreases long term water availability of Kathmandu valley.

The erosion process has also accelerated from road construction and hill-slope excavation for sand, stone and gravel.



Figure 5- 11: Road network in Manohara upstream



Figure 5- 12: Hillslope excavation in Nakhu upstream

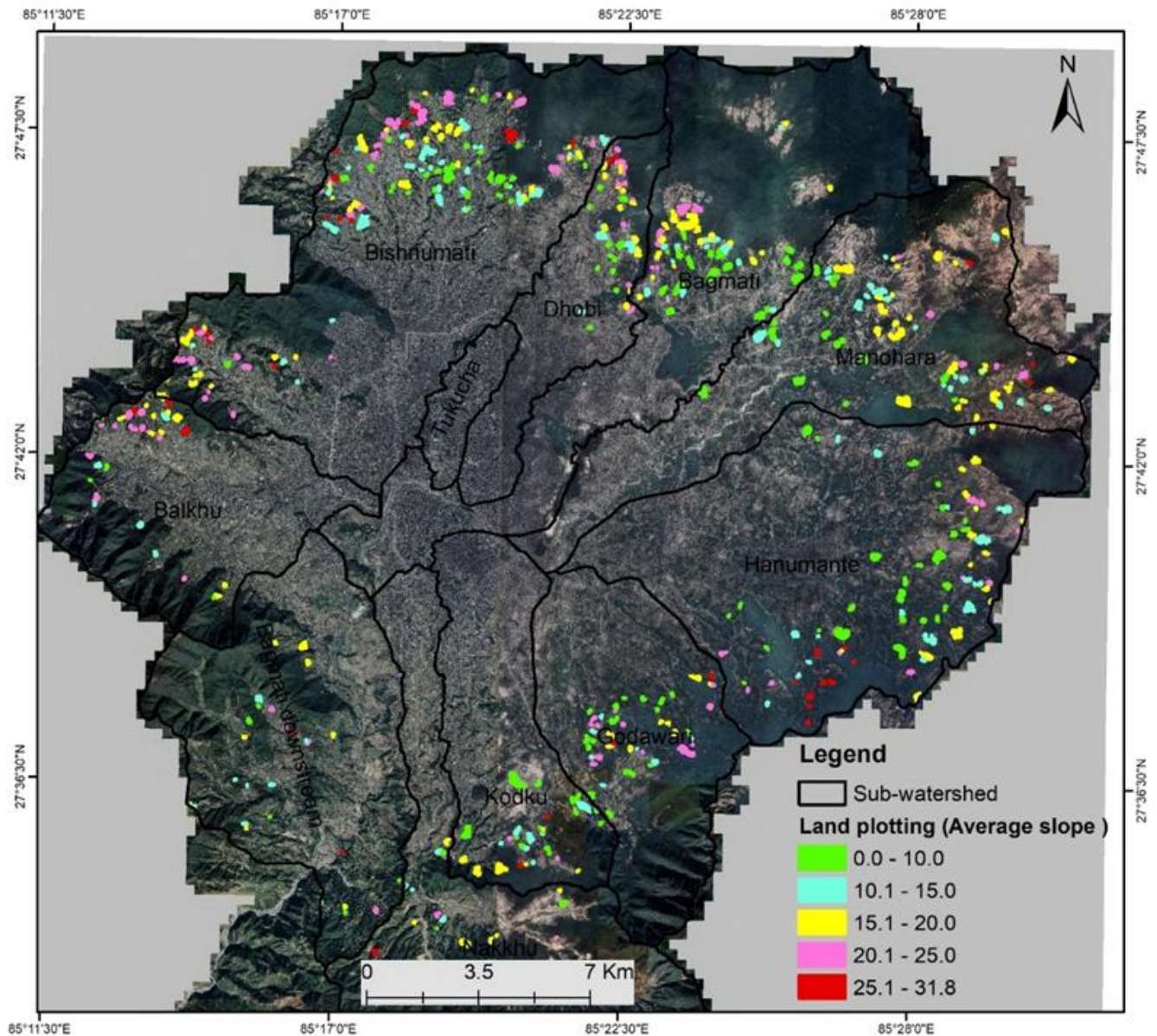


Figure 5- 13: Land plotting area vs average slope in degree

Revised Universal Soil Loss Equation (RUSLE) has used for predicting of the long-term average annual rate of soil erosion by combining several factors having a bearing on the erosion rate, namely; rainfall erosivity (Figure 5-14), soil erodibility (Figure 5-15), steepness and length of the slope (topography) (Figure 5-16) vegetation cover and conservation support practices.

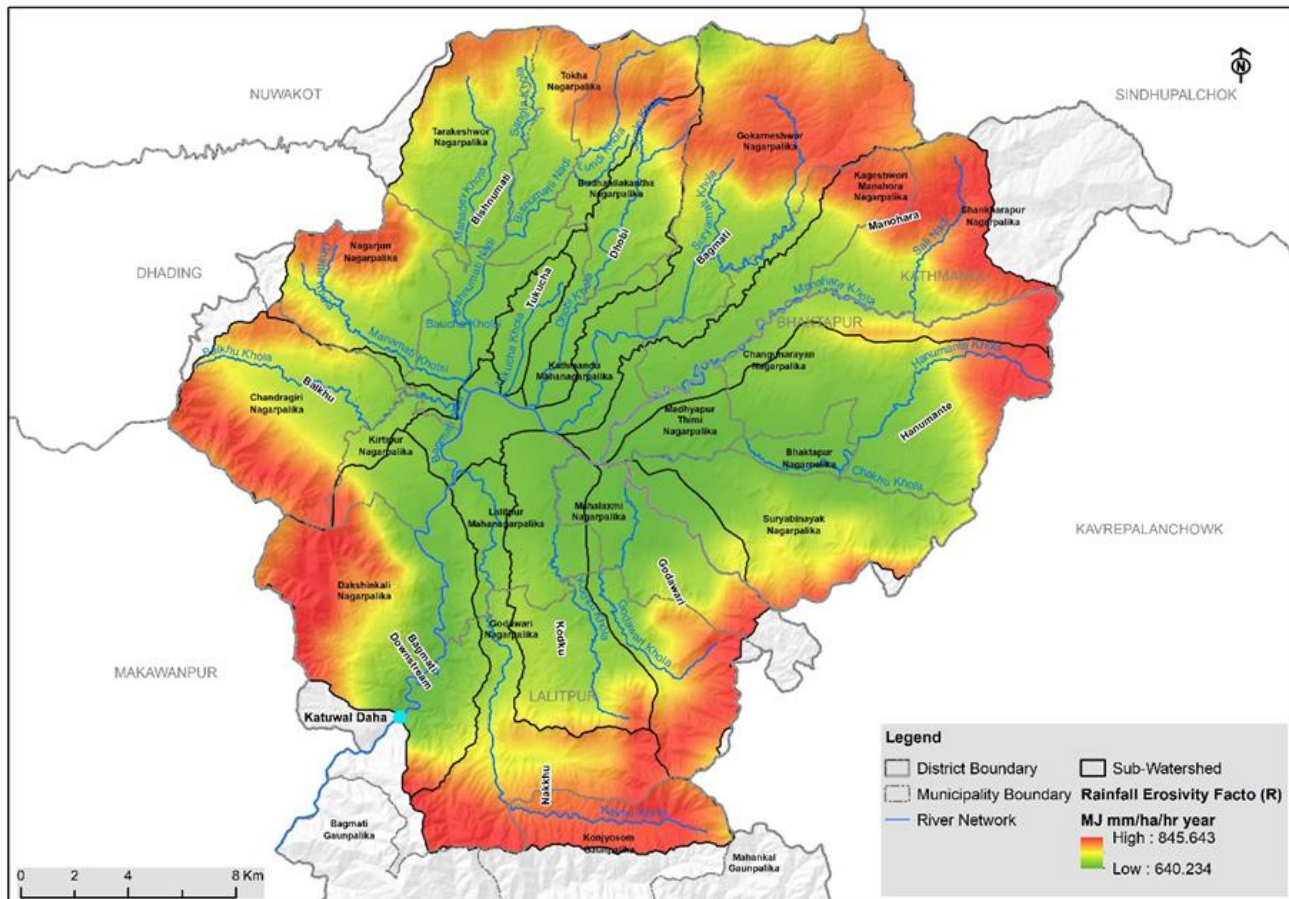


Figure 5- 14: Rainfall erosivity factors of the Bagmati river system in Kathmandu valley

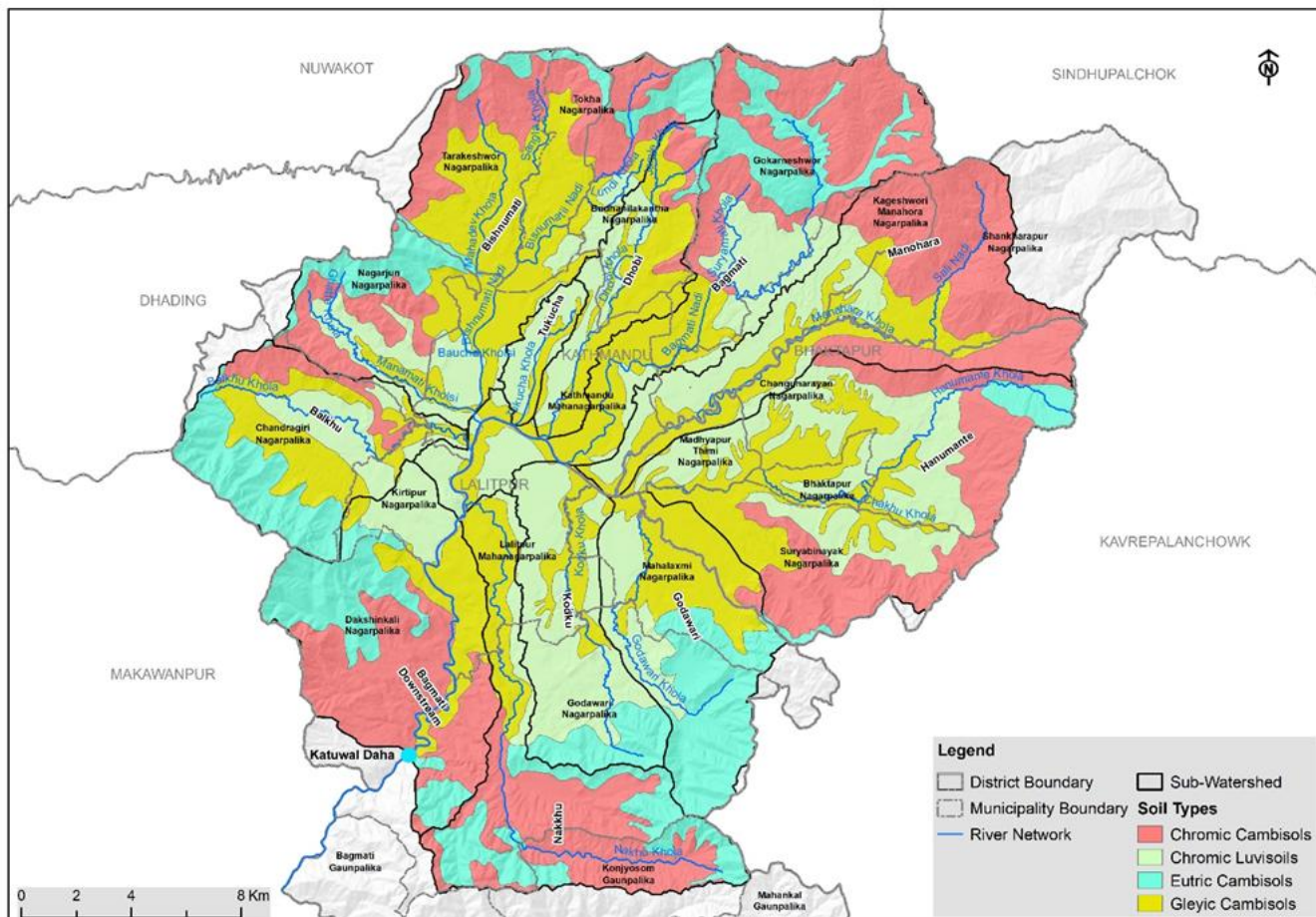


Figure 5- 15: Soil types in study area

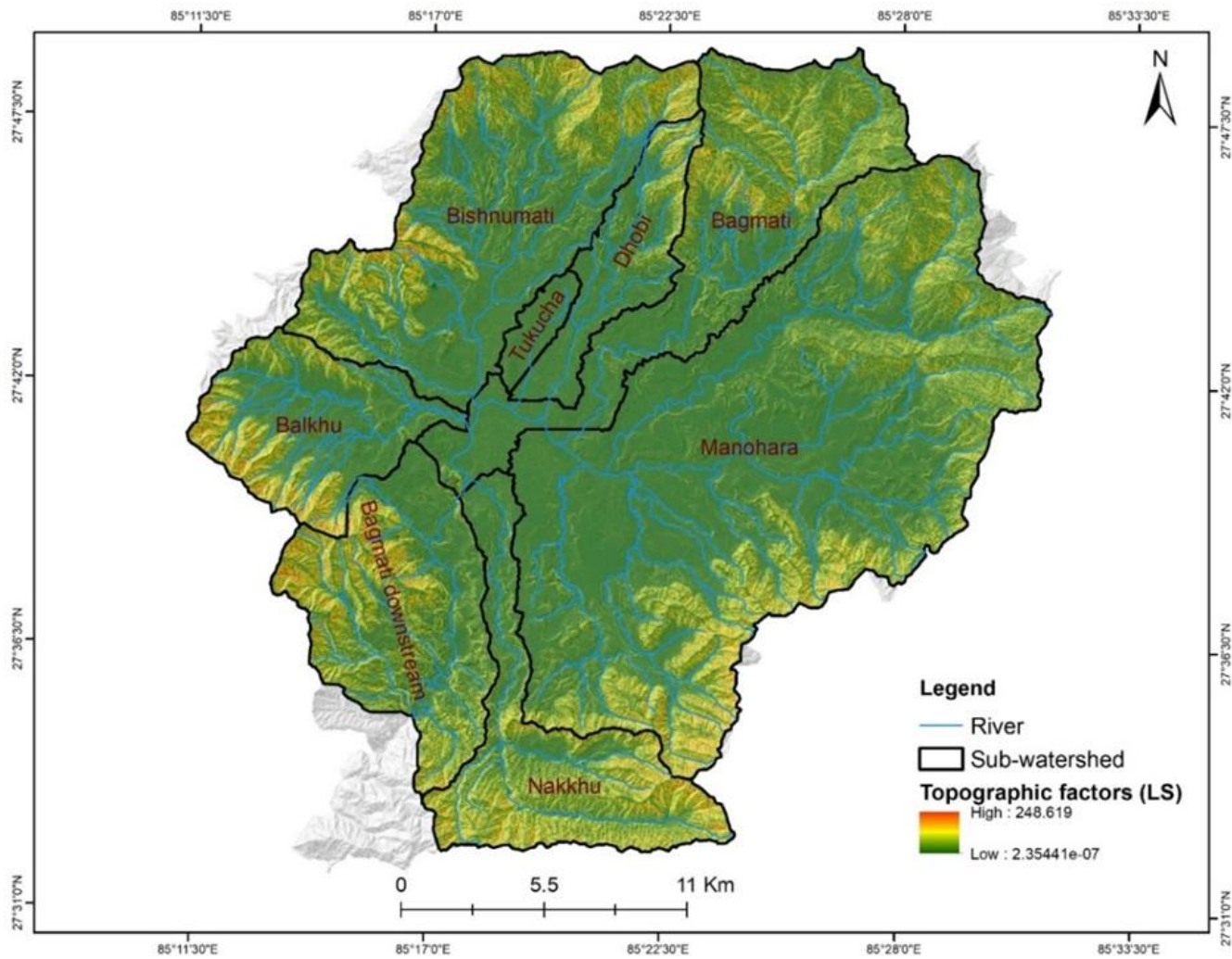


Figure 5- 16: Distribution of topographic factor (LS)

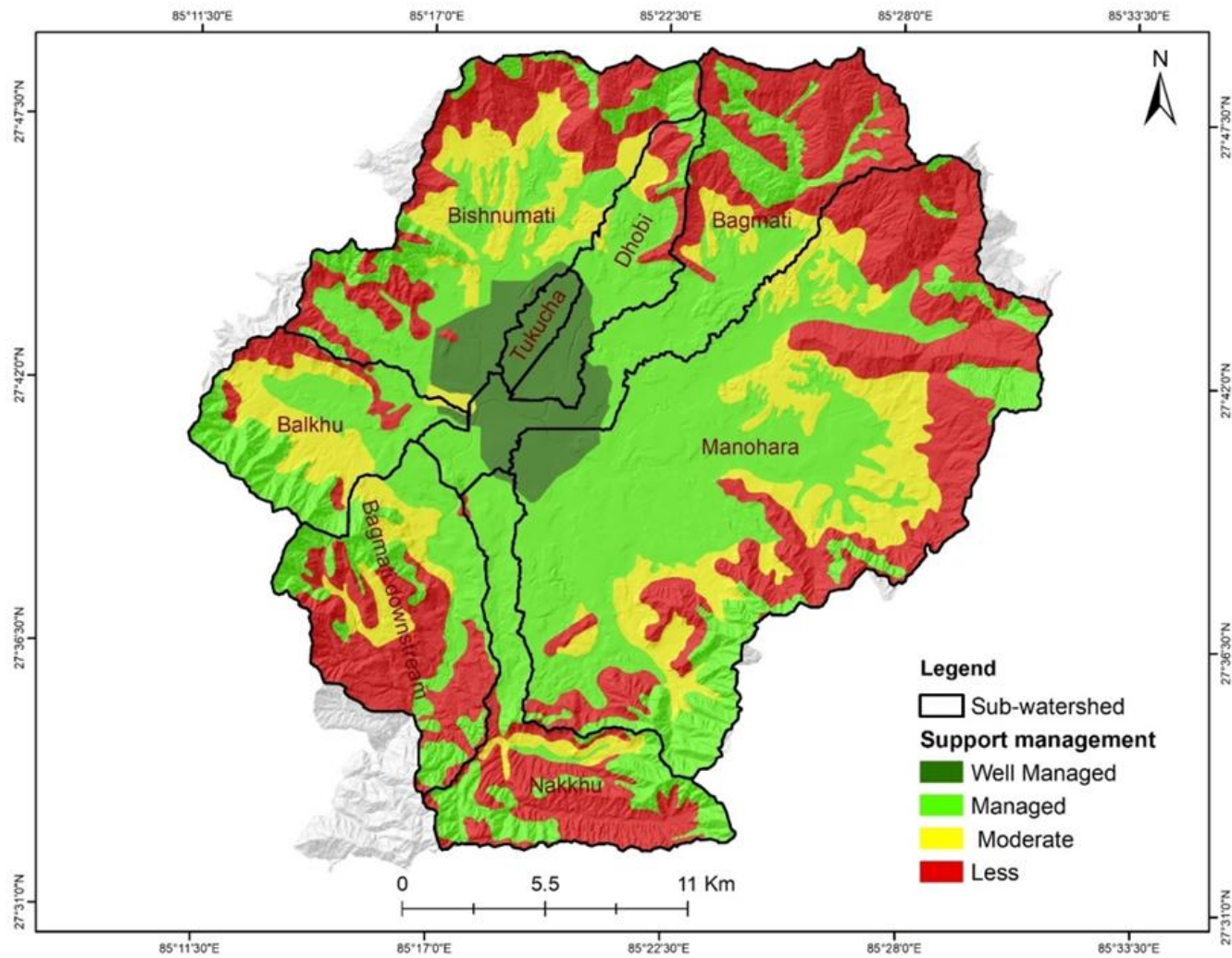


Figure 5- 17: Level of supportive management

The RUSLE model, estimated annual soil loss of the area ranges between 0.001 -148.3 tons/ha/yr. with an average of 6.6+-26.5 tons/ha/yr (Figure 5-18).

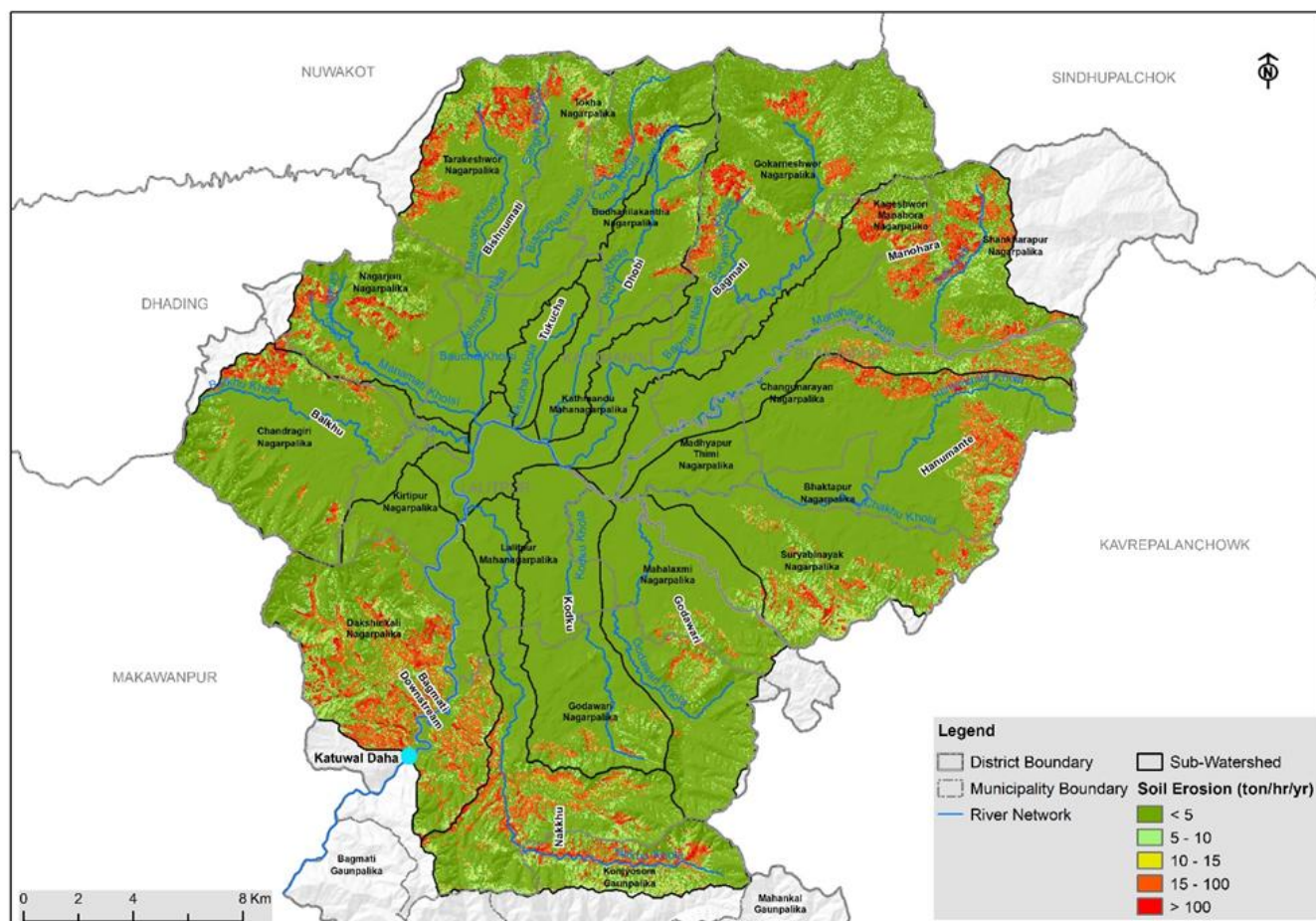


Figure 5- 18: Slope erosion susceptibility

Total soil loss of the Bagmati basin is estimated as 5.7 million tons/yr., among which Bagmati downstream, Bishnumati, Manohara, Hanumante and Nakhku contributes larger volume (Table 5-3).

Table 5- 3: Estimated Soil loss in Bagmati basin and sub-watersheds

Sub watershed	Rate of Soil erosion (ton/ha)	Total Soil loss (million tons/yr.)
Bagmati	5.7	0.48
Dhobi	3.1	0.09
Bishnumati	8.9	0.94
Balkhu	5.7	0.26
Tukucha	0.0	0.00
Nakkhu	11.7	0.66
Kodku	1.4	0.05
Godawari	2.4	0.11
Hanumante	7.6	0.74
Manohara	11.9	0.88
Bagmati downstream	14.5	0.95
Total		5.17

C. Gully Erosion Susceptibility

Gully erosion occurs when water is concentrated in narrow runoff paths and washes away the soil along the drainage lines. The first and second order streams generated from ALOS DEM (5m) along with landcover, slope of terrain and soil depth were used to evaluate potential gully advancement in hillslope of Kathmandu valley.

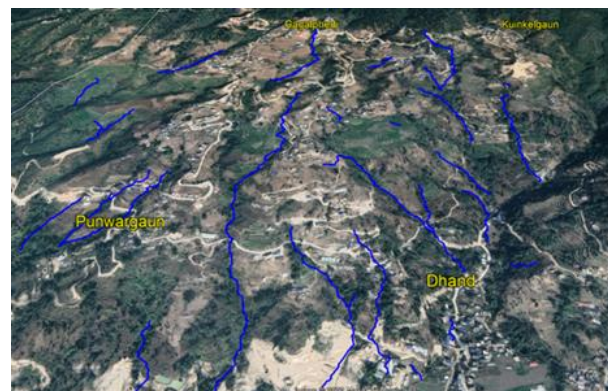
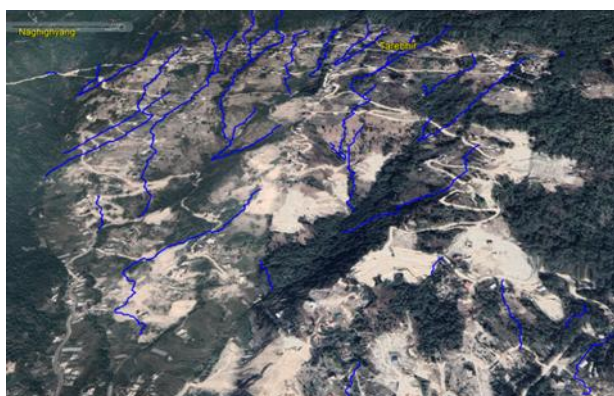


Figure 5- 19:Observed Gully erosion in hillslope

In many places, land plotting has altered the slope of the terrain and thereby accelerated the gully erosion process (Figure 5-20).

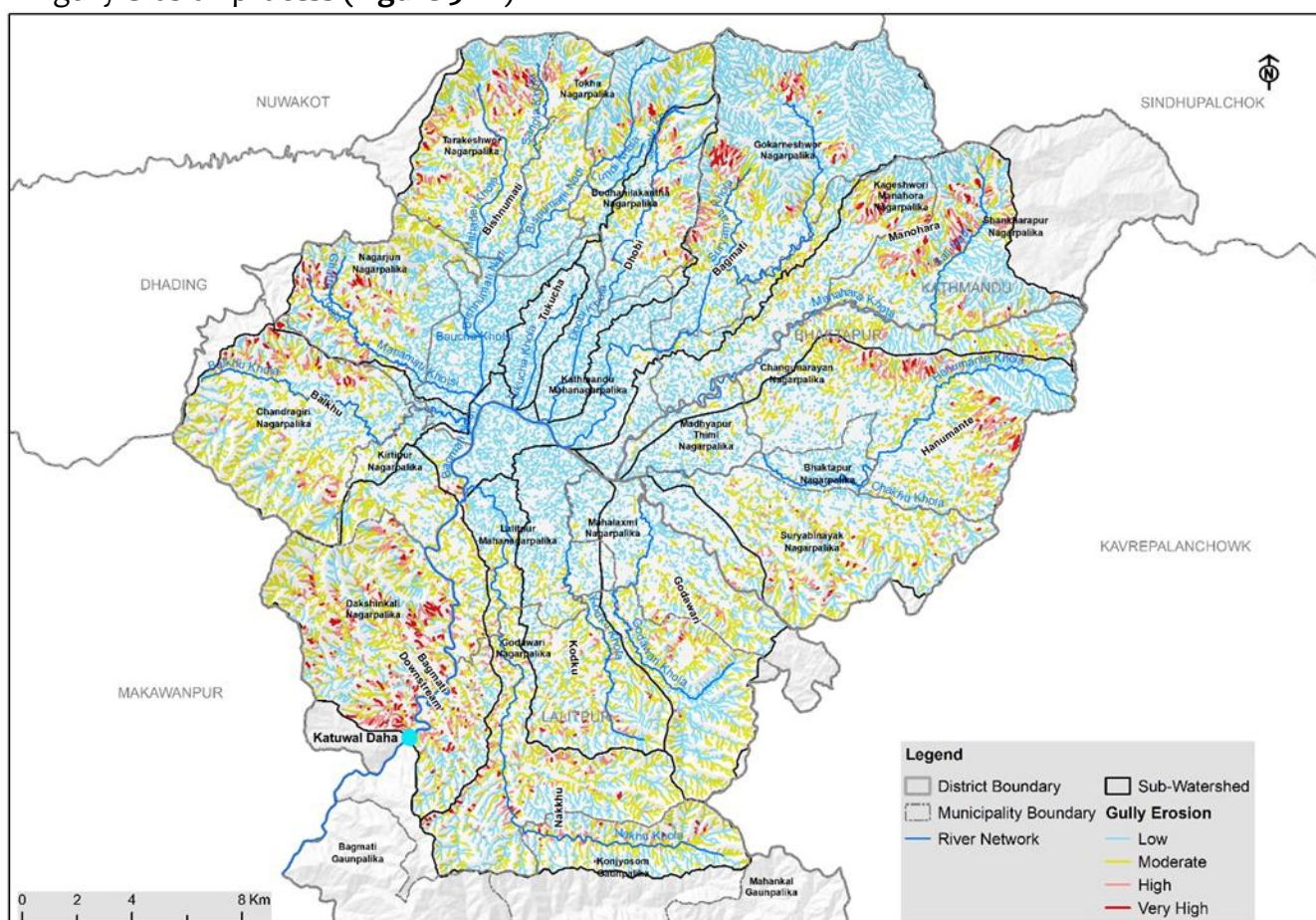


Figure 5- 20:Gully erosion susceptibility
The high and very high erosion susceptible area should be prioritized to stabilize the gullies and their numbers as well as length are estimated as in **Table 5-4**.

Table 5- 4: Gullies erosion in sub-watershed of Bagmati basin

S. N.	Name	Number	Length (Km)
1	Bagmati	191	35.1
2	Dhobi	75	12.3
3	Bishnumati	449	66.4
4	Balkhu	206	30.1
6	Nakkhu	277	33.1

S. N.	Name	Number	Length (Km)
7	Kodku	96	10.5
8	Godawari	101	10.9
9	Hanumante	382	53.9
10	Manohara	326	54.9
11	Bagmati downstream	685	92.4

D. Landslide Susceptibility

The occurrence of landslides in the valley is mostly near the foot hills of the valley and most of them were debris flow. The major landslide events occurred in 1993, 2002, 2007 and 2012; however, occurrences of small-scale landslides are frequent and spreading throughout the hillslope of Kathmandu valley. Expansion of the road network is causing numerous acute landslides in several places and the likelihood of causing chronic landslides is also high. Moreover, expansion of land development (plotting) in the hillslope also invaded the previously slope failure area. Detailed study should be performed for risk evaluation.



Figure 5- 21: Landslide and fragile terrain in and around Baluwa, 2003; Down: Land development evidence, 2020

In positive notes, several landslides occurred during 1993 and 2002 have been revegetated in natural processes and few were controlled using structures measures.



Figure 5- 22:Revegetated landslide area 2003 (left) and 2020 (right)

Landslide hazard is represented by susceptibility, which is the likelihood of a potential damaging landslide and erosion occurring within the Bagmati basin in Kathmandu valley and assessed through weight of evidence (WoE) method. According to the analysis; 8.09%, 11.25%, 11.87%, 19.94% and 48.85% of total areas lie on very high, high, moderate, low and very low zone respectively (**Table 5-5** and **Figure 5-23**).

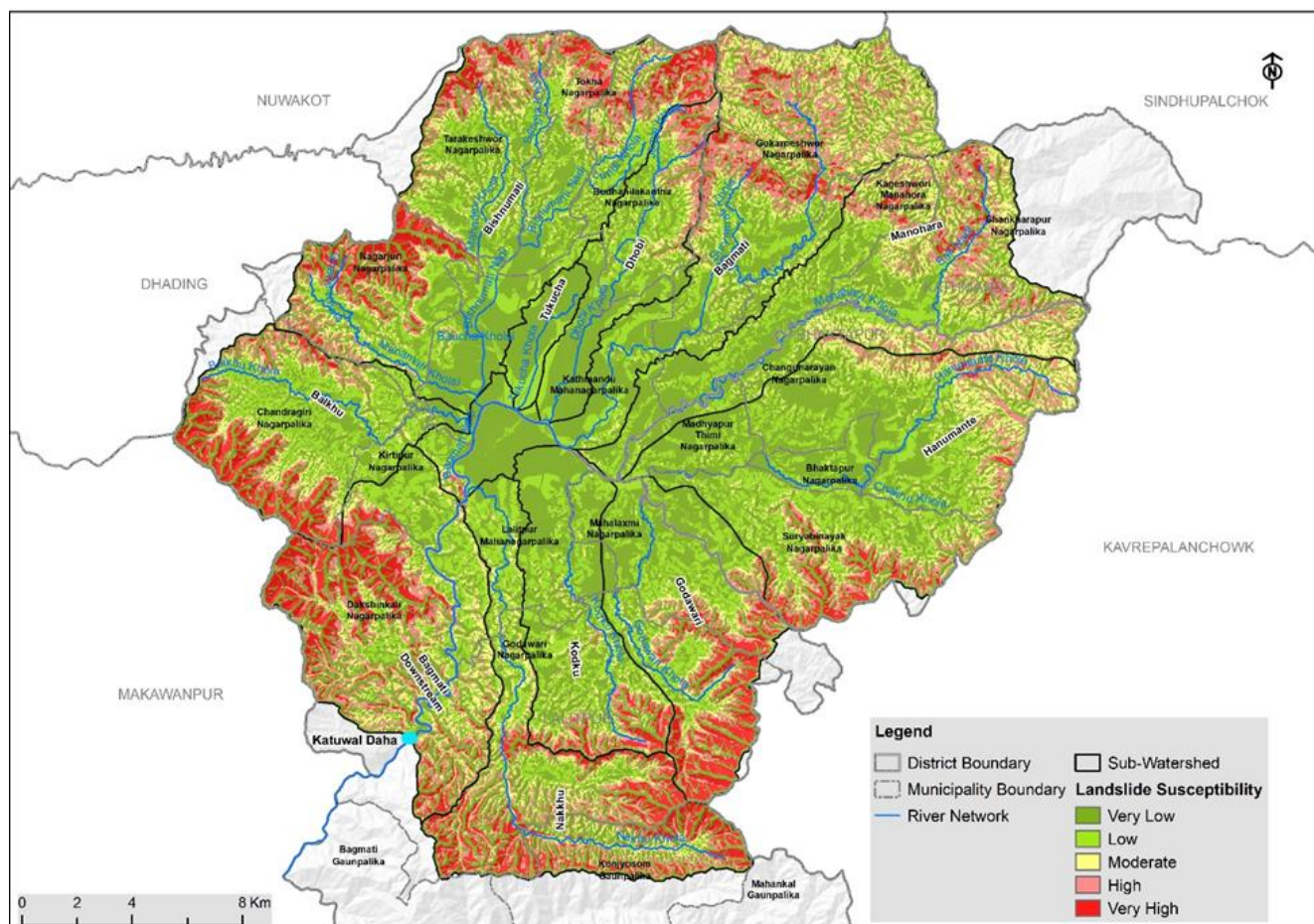


Figure 5- 23: Landslide susceptible area

Table 5- 5: Distribution of landslide susceptible area in sub-watershed of Bagmati basin

Sub-watershed/ Landslide susceptibility	Very low	Low	Moderate	High	Very high
	Area (Sq Km)				
Bagmati	44.07	13.15	12.87	11.83	2.50
Dhobi	16.44	6.45	2.11	2.24	0.78
Bishnumati	50.87	20.86	11.06	12.91	9.72
Balkhu	18.84	11.75	4.57	3.84	6.74
Tukucha	5.43	1.99	0.00	0.00	0.00
Nakkhu	24.62	8.08	6.40	8.22	9.17
Kodku	22.16	10.45	2.83	1.92	1.80
Godawari	22.48	10.69	3.29	4.46	7.41
Hanumante	50.18	23.52	11.52	8.20	3.44
Manohara	37.21	12.89	13.25	9.53	1.35
Bagmati downstream	25.98	10.10	9.45	10.19	9.84
Total Katmandu valley	318.30	129.93	77.34	73.34	52.74
Landslide susceptibility (%)	48.85	19.94	11.87	11.25	8.09

5.5. SOCIO-ECONOMIC ISSUES

5.5.1. Social Issues

Construction of corridor road, river training, revitalizing cultural heritages and monuments has impacted local society significantly. Road development increases settlements along corridors and hence growth in population growth, change in social composition etc. Cultural and historical monuments along the river corridor are protected and reconstructed which helps to preserve valley civilization. Corridor roads at one side help to minimize flood impacts

and control encroachment along river banks but at the same time it also restricts free access to rivers. Though recent construction started stair incorporation but previously completed corridor development have narrowed river flow area significantly and are left with limited space for development. Study discussed about the social issue and problems related with project development as follow;

a. Encroachment of Religious, Cultural and Historical Heritage

With increase in population and commercial activities, historical, religious and cultural locations within the valley are increasingly facing encroachment incidents. Numbers of location have been used for businesses, housing, community institutions by the individual, institution and community. Limited land availability, increase in land prices, hidden financial interests, etc. are some possible reasons behind encroachment of public spaces within the valley along the rivers. This study discussed and identified encroachment of the historical, religious, cultural locations and other public lands along the river corridor area.

b. River Culture and current status within neighborhood society

Cultural connection of the local people with rivers for *dev karma*, *pitri karma*, religious bathing, and cultural celebration are major attributes of valley civilization. In recent years degradation of River quality has significantly impacted belief systems of society related with Rivers. This study found, increases in migrant population, expansion of commercial activities are major reasons for change in people connection. Similarly corridor development has controlled access of the people to rivers for multiple cultural and festivals. River training construction directly restricted the access of people to rivers and whereas change of river water quality indirectly made people avoid the river.

c. Migration & Changes in Social Composition

High migration after the 1990s, population within the valley increased significantly. Initially settlement expansion took place within the ring road area but later it expanded along outer areas with road facilities. Developments of corridor roads are evident, helping settlement expansion in areas adjacent and along river corridors. This expansion of settlements consequently changes the social composition in historical settlements and river corridors. Native communities in Kathmandu valley are directly linked with rivers of the valley for multiple cultural and religious activities. But change in social composition highly influences the relation with rivers and heritages along rivers. Historically Dalit communities from Newar Ethnicity used to reside along the river especially along the Bagmati and Bishnumati but majority of households from the community are displaced with development activities along river corridors. Increase in facilities also attracts squatter settlement along the river bank and abandoned flood plain and emerges as a big problem for the valley.

d. Health Consequences

Increase in population and commercial activities within the valley deteriorated the river's health and health of the surrounding people of Kathmandu valley. Decrease in aquatic lives and river biodiversity, increase in health expenditure, increase in number of hospitals and clinics provide evidence for change in river water quality and its impacts on public health. Though the impact of river quality on public health is a serious issue, segregation of causes of illness particularly due to poor water quality in rivers is not possible this time.

e. Food habit/lifestyle changes in new social composition:

New urban lifestyle also impacted the local culture of the valley significantly. Changes in the lifestyle of the people change food habits, waste generation, number of restaurants, and so dumping of waste into rivers, and direct draining of liquid waste into rivers are major issues related with river quality. With the expansion of settlements along rivers, hotel, restaurants also have been increasing and the waste generated by them is increasing waste in rivers.

5.5.2. Economic Issues

Development of corridor roads has been facilitating bypass to vehicles to avoid traffic congestion in major valley locations. Storage houses, vegetable markets, distribution centers, go-downs etc. are popular commercial structures expanding along river corridor areas. With increase in transportation access, industries, hotels, restaurants, hospitals, also are expanding services in these areas. Previously lowland areas along rivers in the valley, which was declared less suitable for habitat now, can be seen used for residential construction with conditional improvement in bylaws. There has been a cyclical effect between population increase and commercial activities in most of the river corridor after the development of river corridors.

a. Road and Transportation

Development of corridor road has improved the transportation access of the distant settlement in the valley, along the river, which were previously not well connected with road transportation. Increase in road access has promoted transportation businesses and employment along corridors, educational and health access of the people. Increase in economic activities has increased the volume of intra commercial transactions but at the same time is also promoting waste generation, pollution, congestion, encroachment of public lands, etc.

b. Increase in land price/Value

As transportation, sewage lines, and other facilities increased and expanded outwards, so did the land value in the valley's more distant settlements. While this benefits landowners and real estate businesses, it also leads to land fragmentation and subdivision (plotting), which ultimately promotes the conversion of agricultural land to other uses.

c. Residential Expansion

Opening of corridor roads shorten the travel distance between valley central area and distance settlement within valley that finally help to expand residential development along corridors. Such development has been helping to minimize population pressure; demand of urban services (water, sewerage, and other) within the ring road of the valley.

d. Commercial Expansion

With the increased access of transportation and increase in population, commercial activities along the corridor are increasing. Groceries stores, restaurants, hotels, hospital, school & colleges, farming, retail & wholesale businesses are major activities that have been expanding outside the ring road area along river corridors. Such increase in commercial activities has promoted investment in the expanding area of the valley.

e. Income and Employment Opportunities

Increases in commercial activities along corridors outside ring road, more people have been facilitated with employment and income opportunities. Bagmati action plan has expanded land spaces to production houses, industries, school & colleges, restaurants, hotels, restaurants etc. in the valley. Now more people from the valley and even outside the valley are involved in commercial activities within the valley. Segregation of BAP impact in socio-economic development of the valley is almost impossible but looking at increase in economic activities along especially corridors, it can be said that BAP has significant impact in development along different river corridors of the valley.

f. Tourism Infrastructure

Mainly religious centers are tourism destinations within the valley. Pashupati nath, Guheswari, Gokarneswar, Teku, Budhanilkantha, Bhadrakali, Hanuman Ghat, Sankhmul, Aadinath Chobhar, etc. are major destination along Bagmati and its tributaries within valley.

Pashupatinath, Guheswari, Budhanilkanth and Gokarneswar are major famous destinations among pilgrims from outside the valley. The majority of people visit these destinations during their journey in the valley.

g. Future Possibility

The primary objective of the plan is to improve the river and cultural ecosystem of the valley associated with Bagmati River and its tributaries. National priority of the government, legal complexity, budget deficiencies, authority right dispute between development partners etc. have slowed the speed of attaining plan objectives. Increase in population, political changes, new constitutional arrangement, under-specified bylaws, unplanned/unexpected/uncontrolled/profit motivated residential expansion also hindered the goal achievement. A number of projects and programs along rivers are under construction to improve river ecosystems and to promote and preserve Bagmati civilization. Completions of these projects are expected to improve quality and quantity of rivers, and preserve Bagmati civilization in the future. Similarly these activities will also support economic development of 19 local governments within the valley.

5.6. ISSUES OF CULTURAL HERITAGE AND MONUMENTS

The issues are listed in detail in all the studied cultural heritage and monuments in **Table 5-6**.

Table 5- 6: Issues of cultural heritage and monuments

Name of cultural site	Issues
Bagmati	
Sundari Mai	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The construction of concrete steps by removing stone steps and using metal handrails painted bright blue is hampering the spiritual environment, the construction of steel bridge nearby makes the experience of taking a long trail to reach the temple diminish
Gokarneshwara	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The ongoing restoration works is being carried without expert advices and without following standard protocols leading to loss of authenticity. For example, the plinth stones are replaced with new ones, and the original struts are being replaced with new ones. Similarly, the tiled roofing is replaced with gilt copper roofing. Waste flowing in the river polluting the ambience, hard core surfaces being added and extended. Jatra route from Gokarneshwor village to the temple needs upgradation.
Guheshwari	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. There is possibility of land erosion along the northern edge where the sattals are standing and are supported by retaining walls mainly during monsoon, the khat jatra needs to cross the river at the location of Gaurighat and not use the existing bridge and there is no provision of proper access to reach the river
Pashupati	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The retaining walls along the Gaurighat eastern bank that retains the area of Kirateshwara needs to be maintained to prevent land erosion of blocking of the river, the retaining walls along the eastern bank of Arya ghat has visible cracks and the area of Pandhra shivalaya sees major settlement issues, similarly the steps of ghats leading to the river in the western bank also has settlement issues, The 2022 A.D. Shivaratri saw collapse

Name of cultural site	Issues
	of the wall of one of the bridges across the river which shows the need of periodic inspection and maintenance.
Shankhamul	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. Large construction in proximity of the ghat area is bringing visual disturbance in lack of any guiding or monitoring principle. During summer foul smell makes it impossible to stay in the park for a long time. There are many intangible cultural activities that extends the cultural landscape to as far as Krishna temple in darbar square but there is lack of master plans to preserve the historic ensembles and city plan
kalmochan	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. Currently restoration works of the temple and sattals are ongoing but there are still many small monuments in the periphery that needs to be restored in the second phase. The water pollution and foul smell is deteriorating the environment.
Tripureshwor Mahadev temple	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. Currently restoration works of the temple and sattals are ongoing but there are still many small monuments in the periphery that needs to be restored in the second phase. The water pollution and foul smell is deteriorating the environment.
Pachali Bhairav	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. Currently restoration works of the temple and sattals are ongoing but there are still many small monuments in the periphery that needs to be restored in the second phase. The water pollution and foul smell is deteriorating the environment. The approach road to the temple needs to be upgraded and blacktopped. There are issues regarding cleanliness and management of the temple periphery.
Pachali ghat	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The water pollution and foul smell is deteriorating the environment. Recent creation of new ghats is narrowing the river and there are patis that needs to be restored.
Teku dovan (Chitamani tirtha)	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The water pollution and foul smell is deteriorating the environment. Construction of toilets along the river on an encroached land to the east of Krishna temple, cleanliness and management issues. Approach road to the tirtha needs to be upgraded.
Chobaha	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. Currently restoration works of the temple is complete and that of sattals needs to be restored in the second phase. The confluence area is highly polluted and the access road is not properly developed. There are patis and sattals in the confluence area are in deteriorated condition.
Jala binayaka	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The establishment of dry port in the vicinity is a threat to the serenity of the temple premises.

Name of cultural site	Issues
	There is an old pedestrian suspension bridge at teh gorge point which holds historic value and needs to be preserved.
Manohara	
Salinadi	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The ongoing beautification works like painting retaining walls is actually degrading the natural beauty of the area, similarly the construction of Madhav Narayan temple as RC structure in one of the holiest Hindu sites defies the issues of authenticity, cutting of the hillock to create an access road is harming the natural terrain. Besides the nearby hills along the way to Bajrayogini are being extensively used for sand mining and as a result forest area is also decreasing.
Changunarayan	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The restoration of monuments are ongoing but has issues of quality control mechanism. The intangible heritage are slowly disconnecting due to lack of funds allocation, for example there used to be 6-7 types of musical instruments played during nitya puja of the main deity on a daily basis but due to lack of funds only one type of music is played. The khat jatra of Chinnamasta and Bhiarav crosses the Manohara river to visit the adjoining villages but the jatra route needs upgradation. The main temple is located in hillock and has issues of proper drainage management mainly with solid wastes.
Bishnumati	
Sapana tirtha	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. Some 7 to 8 years ago cremation sites were added to the southern periphery of this site under the pressure of the local residents but the temple committee and local of tokha are not satisfied. The wastewater flowing through the rivulets is polluting the temple ambience. The approach road to the site is unpaved and gets muddy during monsoon
Manamaiju	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The main temple needs restoration and maintenance works to be carried out. There is a park to the west of the temple whose periodic maintenance needs to be carried out, a dhungedhara is existing which needs to be restored, similarly a phalcha next t the entry gate to the historic settlement needs to be restored
Sobha Bhagwati	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The main temple, surrounding patis and a bhwoye chen to the west needs to be restored. The temple periphery is not clean and the sattals are also not well managed, the parks in the front is not accessible to public.
Bijeshwari	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. Every 12 years the goddesses are carried to the Vishnumati river for ritual bathing, the route leading to the temple which includes steps, the road (vehicular) and the place near the river needs to be maintained. There are important and historic sculptures lying along the vehicular road to the

Name of cultural site	Issues
	east of temple which needs to be documented and protected from vehicular damages
Indrayani	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. A sattal to the north of the temple needs to be restored. The area is not clean while the park needs maintenance. There are cremation sites which also need maintenance and proper management. Recently new sattals are built along the west of the temple which was not originally there such activities tend to encroach the temple premises and needs to be carefully studied before implementing.
Kankeshwari	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The vehicular road causes disturbance to the temple ambience and river pollution makes it uncomfortable to stay in the temple premises for a long period especially in summer season, vehicle parking is currently being done along the road causing traffic jam. The khat which used to be originally carried into the river water during the jatra and purified with pure water has been stopped, similarly the jatra route extending from the temple premises to Yatkha baha needs to be upgraded and protected from encroachment.
Hanumante	
Mahadev pokhari	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The residential structures of gurujis needs to be restored. The area sees large numbers of devotees during major festivals like Janai purnima and during such times there is lack of rest houses and toilets.
Brahmayani temple	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The site has open spaces around it which needs protection from encroachment. There is a phalcha and hiti to the other side of the river which has been encroached by the vehicular road and needs to be restored and protected from probable damage. The Nava Durga gods visit the temple during dashain festival and the approach road needs upgradation.
Ram mandir	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The approach road to the temple complex is via a busy vehicular road which needs upgradation. The phalcha at the entry is in deteriorated condition and needs restoration. There is an access from the southern sattal to the river via series of brick steps and pose risk of flooding requiring interventions through construction of ghats.
Hanuman ghat	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The polluted water makes it difficult for devotees to do rituals mainly during Madhav Narayan brata. There are small shrines with vegetative growth and cracks. The stones of ghat steps become loose and scattered.
Dhum barahi temple	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The open space to the west of the temple is being used to construct underground water tank. There is a sattal and hiti to the north of the temple which are in

Name of cultural site	Issues
	deteriorated condition, this is also used as a cow shed. There are numerous stone sculptures along the street from this temple leading to the river which are of high aesthetic and historic value but are deteriorated by pollution and human use.
Nakhu	
Tika Bhairav	There is no complete detail documentation of tangible and intangible heritage associated with this cultural site. The khat jatra crosses the river and the khat is allowed to rest on the other side of the river for a whole day, but the access to river is difficult as there are no steps to access the river and there are no physical platforms to easily place the khats. The cremation sites located on either sides of the river are in dilapidated condition and are vulnerable to damage due to flooding and ongoing current river taming works. The temple square has hard core PCC finish, there is a south phalcha with RC slab and do not lend historic character to the area. The river taming work is disturbing the temple ambience and the location of cremation sites. The heavy duty vehicle parking area and the river corridor road is also disturbing the area. Area is the starting point of the raj kulo which brings water to the hitis of Patan but is in dilapidated condition. The local infrastructures like "Pani ghatta" do not exist.

5.7. SWOT ANALYSIS

SWOT analysis is done to portray the strength, weakness, opportunities and threats in various sectors like physical amenities, socio-cultural, environment & disaster, water quality & conservation, settlement pattern & urban scenario and others relating to the Bagmati River system (Table 5-7).

Table 5- 7: SWOT analysis for Bagmati River System

Sector	Sub-sector	Strength	Weakness	Opportunity	Threats
Physical Amenities	Corridor Road Development	– River corridors with urban sub-arterial roads in the urban road network – 162.17 Kilometer road network – Has conserved river land from encroachment. – Has supported the traffic management	– Discontinuity in river corridor roads due to encroachment – Lack of coordination among local units and other stakeholders – No regular and periodic maintainance – Turning of road is minimum without extra widening, which may create safety issue – Footpath of corridor road has not followed standard so it create pedestrian move from roadway instead of footpath (Low level of Pedestrian mobility footpath) – Non-standard footpath has green belt, which create no space for Pedestrian mobility	– Expansion of urban settlements & private investment along river corridor – Management interventions like BAP	– In migration, waste generation, river pollution in upstream area also. – Encroachment of public and cultural land area. – Congestion along river corridors due to high transport demand – Footpath encroached by NEA and other services agencies, which create no space for pedestrian mobility
	Interceptor development	– Interceptors are developed in some locations and are under construction and plan in other locations	– Inadequate coverage of interceptor in the valley.	– International sources of fund	– Disturbance of river corridor land
	Wastewater treatment plant	– 6 WWTP (Dhobighat, Sallaghari, Hanumante, Kodku, Guheshwori and Gokarna) – Upgradation works ongoing	– Weak operation and maintenance of WWTP	–	–

Sector	Sub-sector	Strength	Weakness	Opportunity	Threats
	River training	– 151.98 km river training along both sides of the Valley Rivers.	– Structure are made haphazardly by different stakeholders – River narrowed by road, training and other along the river	–	– Encroachment of river corridor land – Over flooding and inundation in low land area due to narrow space of rivers.
Socio-cultural Amenities	Tangible and Intangible assets	– Pashupatinath, Guheswari, Gokarneswar, Budhanilkantha, Shankhmool, Teku, Hanumanghat like internationally recognize, included in world heritage, monuments are along river corridor areas. – Jatra routes, celebration connected with rivers, mela location, religious journeys are along majority of rivers. – Diversity of religious beliefs	– Insufficient documentation of large number of historical, cultural and religious monuments along river in valley. – Condition of large number of structure along river is under threat after 2072 earthquake – No proper conservation plan for existing monuments. – Poor upkeep of the site and encroachment – Lack of master plan	– Religious tourism, – Meditation, and Baidik knowledge sharing	– Encroachment of rivers, monuments and intangible assets along corridors. – Monetary valuation (assets used for generating financial resource and jobs) of historical assets – Decreasing social belief system of people in the valley – Degradation of serenity of the site caused by corridor roads and heavy traffic throughout the day
	Demographic composition	– Increasing economically sound population in valley. – Increase in number of stakeholder of historical assets in valley.	– Migrated people neglected cultural Heritage, monuments and assets. – Local communities are continuously displacing by migrant people and impacting civilization assets.	–	– Organization and institutions concerning festivals and rituals of river has been decreasing.. – No knowledge, skill, ritual transfer from generation to generation in mixed communities.

Sector	Sub-sector	Strength	Weakness	Opportunity	Threats
					– Decrease in social value of even local children in mixed society.
Economy	Tourism	– World class pilgrim places; Pashupatinath, Budhanilkantha, Hanumanghat etc. – Forest cover, trekking trails, hiking in river catchments.	– Weak waste management, polluted water, encroachment, along major religious and historical destination.	– Large Hindu community around the world. – Attraction of global people toward culture, architect and are of the valley.	– Cultural invasion. – Monetization
Environment and Disaster	Forest and Environment	– Around 40%, 285.34 sq. km land covered by forest area within valley – Flora and faunal diversity – Availability of water resources; rivers, streams, springs along with groundwater resource – Established municipal waste collection system within valley – Availability of dumping site – Mandatory bylaws of septic tank for toilet in houses	– Lack of sanitary landfill site – Inadequate management of drainage and sewerage lines – 2846 sewerage outlets draining waste water into rivers. – Not all the households have facility of septic tank toilets in their house – Insufficient Public toilets – Solid waste dumping into rivers. – Lack of public awareness regarding solid and waste water management.	– Energy generation form solid and waste water – Eco-tourism in surrounding forest.	– Forest and river encroachment
	Water and conservation	– 19 major rivers and their tributary supplying water to Bagmati from different catchments.	– Decreasing water discharge as a result of Water tapping by KUKL and others from Bagmati, Bishnumati,	– Private investment in multipurpose	– Over extraction ground water within valley. – Deepening level of ground water

Sector	Sub-sector	Strength	Weakness	Opportunity	Threats
		– Multipurpose recharge dam constructed at Dhap area. – Under construction Melamchi project for water supply – Number of Pokhari/ recharge pond within valley – 285.34 sq. km forest cover in surrounding hill slopes.	Rudramati, Sangla, Nallu, Godavari, Mahadev Khola and others for drinking, irrigation, industrial and other uses – Budget limitation for constructing more recharge dam in hill slopes and foothills. – Concretization of ponds and land use change of water supply system (Rajkulo) and recharge system in valley.	recharge dam construction. – Water and adventure tourism investment for water conservation and tourism promotion.	– Increasing haphazard plotting and deforestation surrounding hills of Kathmandu Valley.
	Flood risk and Soil erosion	– Institutionalization of DRM – Availability of physical infrastructure; road, river training, open space, health centers. – Rich forest cover in hill slopes of valley.	– Encroachment and narrowing of river areas. – Land plotting, sand and soil extraction from sloppy land around foothills. – Lack of common multi-sectoral vision for disaster management & related framework	–	– Flooding, inundation, and rise of river bed.
Settlement Pattern and Urban Scenario		- Upcoming commercial activities along the river bank. - Public land being planned and utilized for urban park such as UN Park, Sankha park etc.	- Encroachment of public land by squatters along the bank of river at core area - Encroachment of waterway for development of private property. - Narrow channeling of river way causing flooding and inundation during rainy season	-	- Increasing numbers of squatters over a period of time

Sector	Sub-sector	Strength	Weakness	Opportunity	Threats
			- Masonry wall along the river making river inaccessible during accidents and for cultural activities.		
Institutional arrangement		– Federal government, province government and 20 local governments and government stakeholder for supporting conservation and development activities. – One dedicated institution HPCIDBC with KVDA, KUKL, and different line agencies and international development partners.	– Limited role of local governments. – Less coordination between development partners. – Budget deficiency for program implementation. – Less transparent structure even within development partners. – Lack of documentation multiple baseline information and other.	– Technological, financial and human assistance from international partners. – Voluntary participation of local partners (individuals and institutions)	– Contradictory policies of three Governmental units, and implementation agencies. – Influences of donor agencies

- HPCIDBC has focused on development of physical amenities along the river way of Bagmati such as river training and river corridor for conservation of river land from encroachment and support of traffic, interceptors for waste water management supporting wastewater treatment plants but these structures need to be planned properly in an integrated way. Waste water of KV has to be treated before disseminating to the river, so it should be planned to cover the whole valley and its WWTP needs to be operated and maintained properly.
- Kathmandu Valley's tangible and intangible cultural assets are along the river banks and are internationally recognized as well. These assets need to be documented and developed with proper master plans. These assets also have touristic values, so need to be developed in an integrated way for proper upkeep of the site with local communities' involvement.
- River resilience needs to be considered while development along Bagmati River Basin. The informal settlements along the river way need to be managed and for the new developments also proper policies and bylaws have to be prepared.
- River beautification refers to the urban environment and touristic economic value, so the cleaning campaign of Bagmati and public awareness need to be continued for better urban environment and for development of eco-tourism.

6. VISION AND LAND ZONING

6.1. VISION

The vision statement of this Action Plan is:

“Clean, green and healthy river system that is full of life and valued by all”

THIS VISION IS THE CONTINUATION OF THE BAP 2009-2014.

6.2. LAND ZONING

For this action Plan, the new zonation concept has been developed on the basis of Kathmandu Valley watershed ecology and its urban growth scenario.

The hilly forest area surrounding the KV is the main source of water of Bagmati River which needs to be conserved. The flat lands are the agricultural land which is now converting to urban areas at a rapid pace. So, analyzing the current scenario, for the BAP 2024-44, KV has been planned in 3 Zones as;

- i) Conservation Zone,
- ii) Peri-Urban Zone, and
- iii) Urban Zone.

6.2.1. Conservation Zone

The Conservation Zone is the forest area surrounding the hill-shade of KV. This area includes the forest such as Shivapuri, Phulchowki, Chandragiri and Nagarjun. The Shivapuri Nagarjun National Park lies in this zone. This zone mostly includes forest area which recharges the river system of the Valley. This zone also consists of important wetlands as *dhap* with high recharging potentiality. This zone needs to be conserved for the recharge of water sources.

The major issues identified in this zone are:

- Expansion of settlement.
- Unregulated land subdivision and development and thereby excessive erosion.
- Associated impacts from forest land conversion to agricultural lands, new constructions (road, monasteries, buildings and other infrastructures), commercial & tourism activities and forest resource use (fuelwood and others).
- Decrease in water discharge due to water diversion.
- Increasing pollution due to poor sanitation, use of chemical fertilizers and river use as washing, bathing and others.

6.2.2. Peri-urban Zone

The area between Conservation Zone and Urban Zone is categorized as Peri-Urban Zone which has the pressure of urban development but the conservation measures have to be maintained in this zone for sustaining water quality and water recharge. So, these areas have a high responsibility to maintain the river system.

The major issues identified in this zone are:

- Urban expansion
- Degrading water quality due to untreated sewage disposal, industrial effluents, solid waste disposal and river use.

- Loss of vegetation resulting in loss of biodiversity and aesthetic values of the river.
- Sand extraction and associated impacts.
- Haphazard disposal of construction material along the river corridor
- Narrowing and deepening of waterway due to river training works, road construction, land plotting and other development works.
- Decreasing water discharge due to excessive water tapping for irrigation, industrial use and others.
- Excessive extraction of ground water for industrial use
- Degradation of catchment quality due to land use conversion and land development.

6.2.3. Urban Zone

The central core of the KV has been categorized in the Urban Zone area which has the highest population density and high urban growth rate. This area has been delineated within the boundary of proposed ORR alignment. This area is planned for dense urban development with developed urban infrastructure to make Bagmati River clean, green and healthy.

The major issues identified in this zone are:

- Degrading water quality due to direct discharge of huge volume of untreated sewage disposal, industrial effluents, solid waste disposal, and waste disposed from slaughter houses and other wastes.
- Narrowing and deepening of waterway due to river training works, road construction, land plotting and other development works.
- River encroachment and squatter settlements.
- Deterioration of traditional and local water storage systems like Pokhari, Dhunge Dhara, Rajkulo and others.
- Degradation of catchment quality due to land use conversion and land development.
- Deteriorating cultural and heritage assets due to lack of conservation, management and encroachment.
- Haphazard disposal of construction material along the river corridor

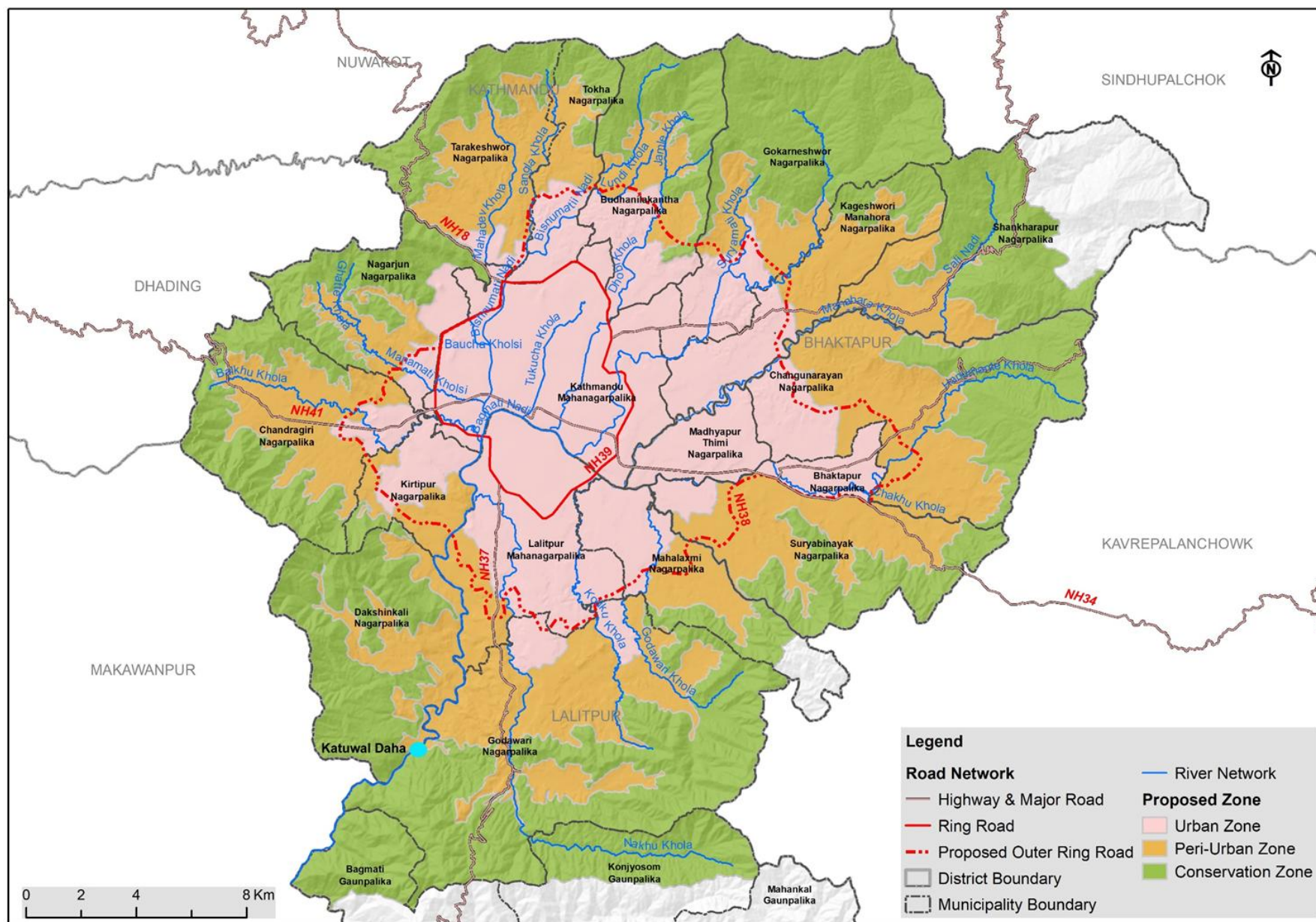


Figure 6- 1: Proposed Land use Zonation of Kathmandu valley



Figure 6- 2: Proposed Land use Zonation of Kathmandu Valley overlaid with administrative boundary

Table 6- 1: Proposed Land use Zonation of Kathmandu Valley

S N	Municipality Name	Municipality Area (SqKm)	Unit	Proposed Zone Name and Area			Total study area (SqKm)	Catchment area (SqKm)
				Conservation Zone	Peri-Urban Zone	Urban Zone		
1	Bagmati Gaunpalika	111.49	Sqk m	10.84	0.00	0.00	10.84	8.09
			%	9.72	0.00	0.00	9.72	7.26
2	Bhaktapur Municipality	6.89	Sqk m	0.00	0.00	6.89	6.89	6.89
			%	0.00	0.00	100.00	100.00	100.00
3	Budhanilkantha Municipality	34.80	Sqk m	15.84	8.93	10.03	34.80	34.80
			%	45.52	25.66	28.82	100.00	100.00
4	Chandragiri Municipality	43.92	Sqk m	21.23	19.12	3.57	43.92	40.48
			%	48.34	43.53	8.13	100.00	92.17
5	Changunarayan Municipality	62.98	Sqk m	23.60	30.89	8.49	62.98	62.98
			%	37.47	49.05	13.48	100.00	100.00
6	Dakshinkali Municipality	42.68	Sqk m	30.09	12.59	0.00	42.68	42.68
			%	70.50	29.50	0.00	100.00	100.00
7	Godawari Municipality	96.11	Sqk m	55.99	34.53	5.59	96.11	94.38
			%	58.26	35.93	5.82	100.00	98.20
8	Gokarneshwor Municipality	58.50	Sqk m	39.68	9.32	9.50	58.50	58.50
			%	67.83	15.93	16.24	100.00	100.00
9	Kageshwari Manohara Municipality	27.38	Sqk m	5.31	11.19	10.88	27.38	27.38
			%	19.39	40.87	39.74	100.00	100.00
10	Kathmandu Metropolitan City	49.45	Sqk m	0.00	0.00	49.45	49.45	49.45
			%	0.00	0.00	100.00	100.00	100.00

S N	Municipality Name	Municipality Area (SqKm)	Unit	Proposed Zone Name and Area			Total study area (SqKm)	Catchment area (SqKm)
				Conservation Zone	Peri-Urban Zone	Urban Zone		
11	Konjyosom Rural Municipality	44.16	Sqk m	15.85	0.00	0.00	15.85	15.85
			%	35.89	0.00	0.00	35.89	35.89
12	Kritipur Municipality	14.76	Sqk m	1.45	6.83	6.48	14.76	14.76
			%	9.82	46.27	43.90	100.00	100.00
13	Lalitpur Metropolitan City	36.12	Sqk m	0.00	7.06	29.06	36.12	36.12
			%	0.00	19.55	80.45	100.00	100.00
14	Madhyapur Thimi Municipality	11.47	Sqk m	0.00	0.00	11.47	11.47	11.47
			%	0.00	0.00	100.00	100.00	100.00
15	Mahalaxmi Municipality	26.51	Sqk m	5.41	7.58	9.03	22.02	22.02
			%	20.41	28.59	34.06	83.06	83.06
16	Nagarjun Municipality	29.85	Sqk m	17.13	7.24	5.48	29.85	27.52
			%	57.39	24.25	18.36	100.00	92.19
17	Shankharapur Municipality	60.21	Sqk m	24.77	11.30	0.00	36.07	30.32
			%	41.14	18.77	0.00	59.91	50.36
18	Suryabinayak Municipality	42.45	Sqk m	17.47	22.14	2.84	42.45	41.60
			%	41.15	52.16	6.69	100.00	98.00
19	Tarakeshwar Municipality	54.95	Sqk m	34.40	18.46	2.09	54.95	29.94
			%	62.60	33.59	3.80	100.00	54.49
20	Tokha Municipality	17.11	Sqk m	4.82	5.75	6.54	17.11	17.11
			%	28.17	33.61	38.22	100.00	100.00
Total (SqKm)		871.79		323.88	212.93	177.39	714.20	672.34

6.3. GOALS AND OBJECTIVES OF ZONE

6.3.1. Conservation Zone

❖ **Goal:**

Maintain and enhance the environmental and cultural ecosystem services of Rivers

❖ **Objectives:**

- i) To conserve and enhance water resources and increase water discharge into rivers;
- ii) To conserve and enhance forest biodiversity;
- iii) To promote sustainable land use practices;
- iv) To mitigate impact of geo-hazards in upstream areas;
- v) To rehabilitate and conserve the cultural and heritage sites; and
- vi) To promote sustainable nature base eco-tourism

6.3.2. Peri-urban Zone

❖ **Goal:**

Preserve river and cultural ecosystem with sustainable urban development

❖ **Objectives:**

- i) To promote Sustainable Urban Development;
- ii) To maintain and improve water quality and quantity;
- iii) To increase water use efficiency to ensure sustainable withdraw;
- iv) To renovate and conserve the cultural and heritage sites;
- v) To mitigate impact of flood-hazards in river system;
- vi) To revive Urban Ecosystem/Biodiversity; and
- vii) To develop lively built-environment along River corridors

6.3.3. Urban Zone

❖ **Goal:**

Restore river ecosystem and preserve cultural heritage

❖ **Objectives:**

- i) To improve water quality and sustain water discharge in rivers;
- ii) To preserve historical, cultural and religious heritage;
- iii) To mitigate impact of flooding and inundation;
- iv) To revive encroached land and conserve natural course/flood plains; and
- v) To develop lively built-environment along river corridors

CHAPTER-VII

7. STRATEGIES AND ACTIONS

7.1. STRATEGY

In context of the current situation and the vision of “Clean, green and healthy river system that is full of life and valued by all”, four strategies have been formulated and are presented in Table 7-1.

Table 7- 1: Strategy for accomplishing the vision

Strategy no.	Major Strategy	Sub Strategies
Strategy-1	River conservation and Management	Sustainable land use management
		Promote Ecotourism
		Conservation of the land use to recharge water source
		Strengthen River Cleaning Program
		Management of Public Land along the River Corridor
		Disaster mitigation
		Development of corridor transport system along rivers
		Management of settlements residing within the Conservation Zone (Hill Shade Area of Kathmandu Valley)
Strategy-2	Cultural/ Civilization rehabilitation	Reclaim, Rehabilitate and conserve the cultural and heritage sites along river
		Preservation of intangible heritage
Strategy-3	River/Water Quality and quantity improvement	Encourage organic farming
		Water source conservation to Increase ground water recharge and river discharge
		Management of Sewerage to prevent direct disposal into river
		Management of Solid waste disposal directly into river system
		Conservation and management of water sources
Strategy-4	Capacity building	Knowledge management
		Institutional strengthening
		Enhance community participation in BAP implementation

7.1.1 RIVER CONSERVATION AND MANAGEMENT

7.1.1.1 Sustainable Land use Management

The land's position, geology, soil type and slope determine how land can manage effectively and efficiently to ensure it's sustainably. For instance, haphazard excavation of sand, stone and gravel can cause wider environmental impact, which instead can mitigate through proper Environmental impact assessment. Strengthening the monitoring mechanism will create an environment to regulate the haphazard mining.

Expansion of the land development (Plotting) in the marginal and fragile peripheral hill slope of the valley has increased the erosion susceptibility for the short term and also increasing risk on settlement in the long-term. Such development should be regulated with proper bylaws. Similarly, intense tillage farming in the hill slope can accelerate the soil loss process. On-farm erosion processes can be mitigated using proper farming practices (Figure 7-1 and Table 7-2). Farming methods that can reduce soil erosion include terracing, contour cropping, windbreaks, and no-till planting or agroforestry. The afforestation programme shall be launched with the involvement of the community.

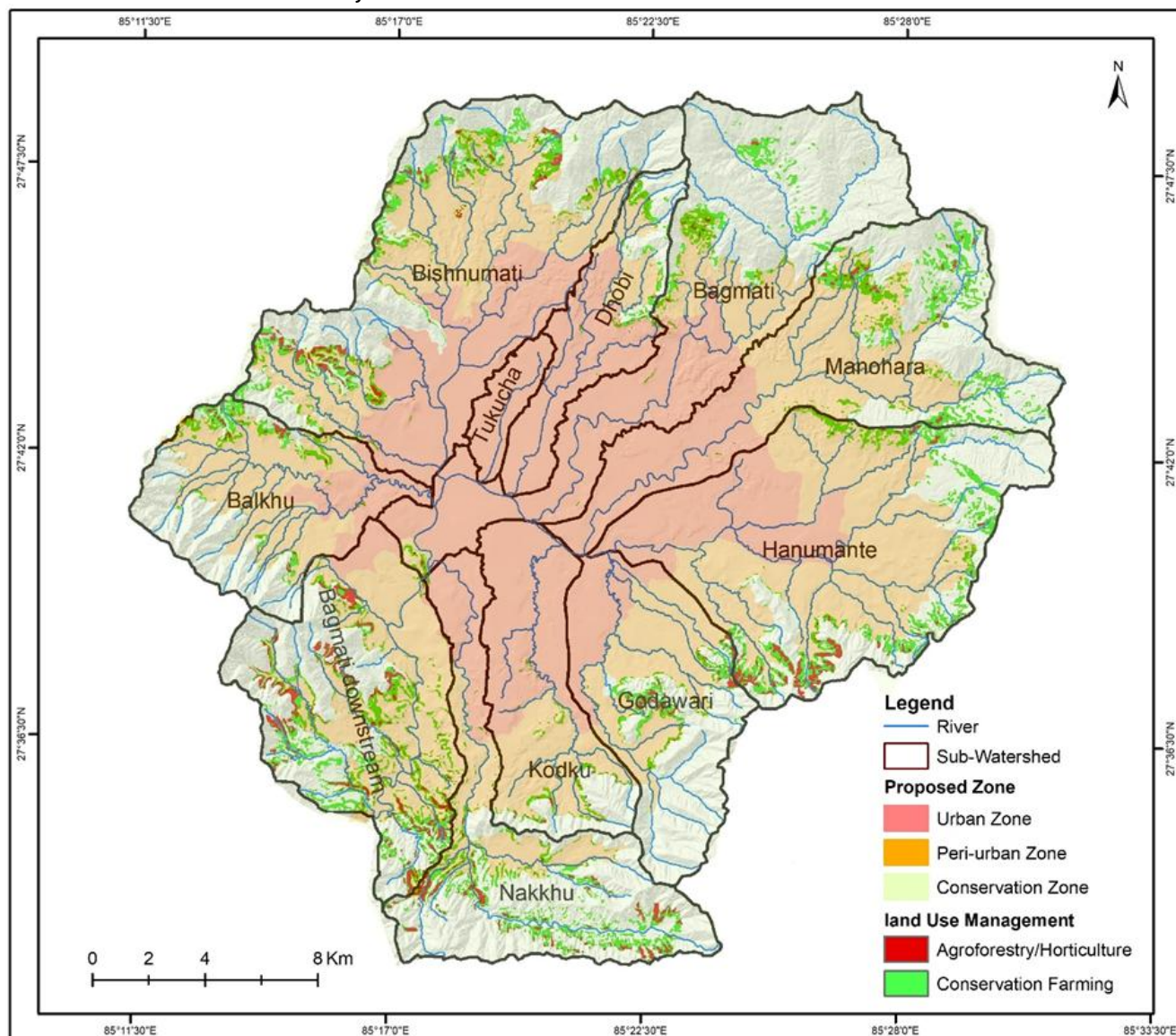


Figure 7- 1: Proposed Conservation Farming Area

Table 7- 2: Proposed Location of conservation farming area

Name of River	Area (ha)					
	Conservation farming			Agroforestry		
	Conservation	Peri Urban	Total	Conservation	Peri Urban	Total
Bishnumati River	528.444	226.476	754.92	942.84	628.56	1,571.40
Balkhu Khola	175.014	75.006	250.02	315.9	35.10	351.00
Dhobi Khola	114.57	-	114.57	40.5	-	40.50
Hanumante Khola	632.853	70.317	703.17	1402.92	155.88	1,558.80
Nakkhu Khola	364.266	156.114	520.38	1202.58	212.22	1,414.80

Name of River	Area (ha)					
	Conservation farming			Agroforestry		
	Conservation	Peri Urban	Total	Conservation	Peri Urban	Total
Bagmati downstream	166.014	664.056	830.07	574.2	2,296.8	2,871.00
Bagmati Khola	174.735	174.735	349.47	71.1	71.10	142.20
Kodku Khola	25.812	60.228	86.04	20.88	83.52	104.40
Manahara River	310.275	310.275	620.55	190.35	190.35	380.70
Godawari Khola	174.024	43.506	217.53	55.8	502.20	558.00

Since surface discharge of rivers is in decreasing trend and likelihood of further reduction is higher under business as-usual case, it will be mindful to shift the surface irrigation to alternatives in the peri-urban zone. Moreover, conservation of existing water sources is equally important.

Control and mitigations of soil erosion, gullies advancement and landslide are the prime strategies for disaster risk reduction in the conservation areas whereas, focus should be given to sediment management and flood mitigation in peri-urban zones. Urban flooding is the key issue in urban zones.

Sustainable land management will also contribute to reduce soil erosion, whereas, both preventing and controlling measures should be implemented to mitigate gully erosion (Figure 7-2, Table 7-3). In most cases gullies can be prevented by good land management practices aimed at maintaining even infiltration rates and a good plant cover whereas, structures measures might also be required to prevent damaging water flow and head ward erosion.

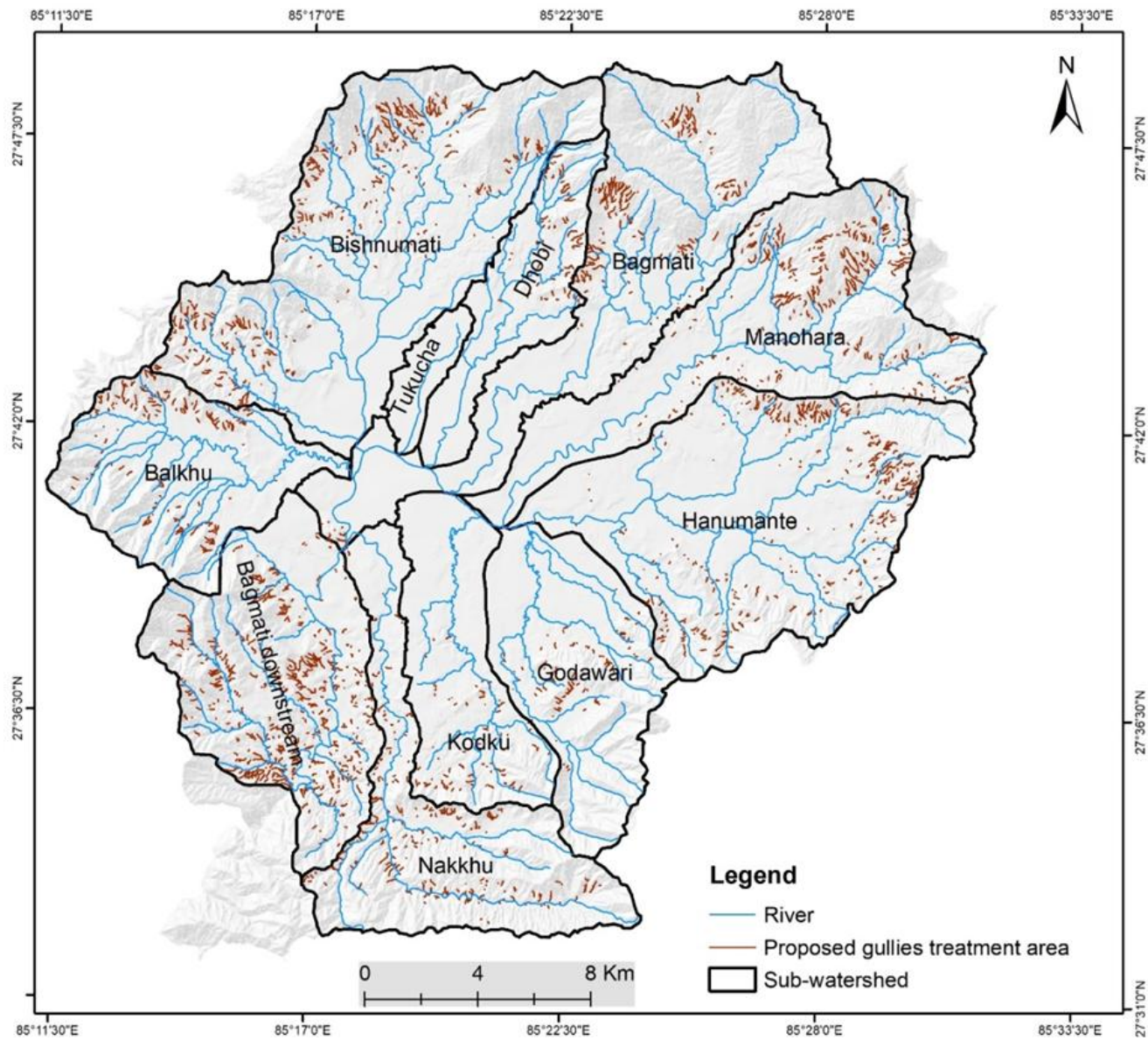


Figure 7- 2:Proposed gullies treatment area

A variety of options such as grass chutes, pipe structures, rock chutes, drop structures, check dams and others can be used to mitigate gullies erosion. But focus should also be given to enhance the infiltration capacity because the same region is also the source of ground water of Kathmandu valley.

Table 7- 3: Proposed gullies treatment area

Row Labels	Priority (P1)		Priority (P2)		Priority (P3)		Count	Total length (m)
	Coun t	Length (m)	Coun t	Length (m)	Coun t	Length (m)		
Bagmati River	34	7571.61	74	13273.24	66	12268.25	174	33113.10
Bagmati River downstream	142	18091.27	163	24780.23	262	39342.51	567	82214.02
Balkhu Khola	31	4283.78	57	8517.22	105	14894.73	193	27695.74
Bishnumati River	85	11811.44	134	20234.64	200	28897.27	419	60943.35
Dhobi Khola	12	1344.33	13	2435.25	46	7798.84	71	11578.43
Godawari Khola	6	526.128	22	1905.39	58	6994.68	86	9426.20

Row Labels	Priority (P1)		Priority (P2)		Priority (P3)		Count	Total length (m)
	Count	Length (m)	Count	Length (m)	Count	Length (m)		
Hanumante Khola	43	7018.16	94	15423.84	167	26474.79	304	48916.80
Kodku Khola	10	881.57	18	1701.35	49	6295.67	77	8878.60
Manohara River	61	8835.09	84	15574.38	129	26483.29	274	50892.77
Nakkhu Khola	36	3866.22	62	7531.18	111	17219.07	209	28616.48
Grand Total	460	64229.62	721	111376.75	1193	186669.15	2374	362275.5₂

Considering the soil erosion and landslide susceptibility in the upstream, sedimentary trappers were proposed in the following locations (Figure 7-3 and Table 7-4).

Table 7- 4: Proposed Location of sedimentary trappers

S. n.	Lat	Lon	Municipality	Ward	ZONE	Sub-watershed	Priority
1	27.55214	85.32458	Konjyosom Gaunpalika	4	Conservation Zone	Nakkhu Khola	P2
2	27.56591	85.34554	Godawari Nagarpalika	5	Conservation Zone	Nakkhu Khola	P2
3	27.57004	85.31266	Godawari Nagarpalika	6	Peri-urban Zone	Nakkhu Khola	P1
4	27.58918	85.2752	Dakshinkali Nagarpalika	8	Conservation Zone	Bagmati downstream	P2
5	27.6048	85.264	Dakshinkali Nagarpalika	8	Conservation Zone	Bagmati downstream	P2
6	27.60622	85.36816	Godawari Nagarpalika	3	Peri-urban Zone	Godawari Khola	P2
7	27.61184	85.27638	Dakshinkali Nagarpalika	6	Peri-urban Zone	Bagmati downstream	P2
8	27.65084	85.27514	Dakshinkali Nagarpalika	1	Conservation Zone	Bagmati downstream	P2
9	27.65966	85.4604	Suryabinayak Nagarpalika	10	Peri-urban Zone	Hanumante Khola	P2
10	27.66143	85.44175	Suryabinayak Nagarpalika	8	Peri-urban Zone	Hanumante Khola	P2
11	27.68224	85.2612	Chandragiri Nagarpalika	15	Urban Zone	Balkhu Khola	P2
12	27.70495	85.48221	Changunarayan Nagarpalika	6	Conservation Zone	Hanumante Khola	P1
13	27.70596	85.50125	Changunarayan Nagarpalika	6	Conservation Zone	Hanumante Khola	P2
14	27.72182	85.49423	Shankharapur Nagarpalika	5	Conservation Zone	Manahara River	P1
15	27.72745	85.4401	Shankharapur Nagarpalika	9	Peri-urban Zone	Manahara River	P2

S. n.	Lat	Lon	Municipality	Ward	ZONE	Sub-watershed	Priority
16	27.72795	85.51239	Shankharapur Nagarpalika	5	Conservation Zone	Manahara River	P2
17	27.74185	85.39073	Gokarneshwor Nagarpalika	4	Urban Zone	Bagmati River	P2
18	27.7443	85.47968	Shankharapur Nagarpalika	5	Peri-urban Zone	Manahara River	P1
19	27.75209	85.42275	Gokarneshwor Nagarpalika	1	Peri-urban Zone	Bagmati River	P2
20	27.7643	85.36472	Budhanilakantha Nagarpalika	2	Conservation Zone	Dhobi Khola	P1
21	27.78311	85.35664	Budhanilakantha Nagarpalika	5	Peri-urban Zone	Bishnumati River	P2
22	27.78762	85.32447	Tokha Nagarpalika	1	Peri-urban Zone	Bishnumati River	P2
23	27.79216	85.41529	Gokarneshwor Nagarpalika	1	Conservation Zone	Bagmati River	P1

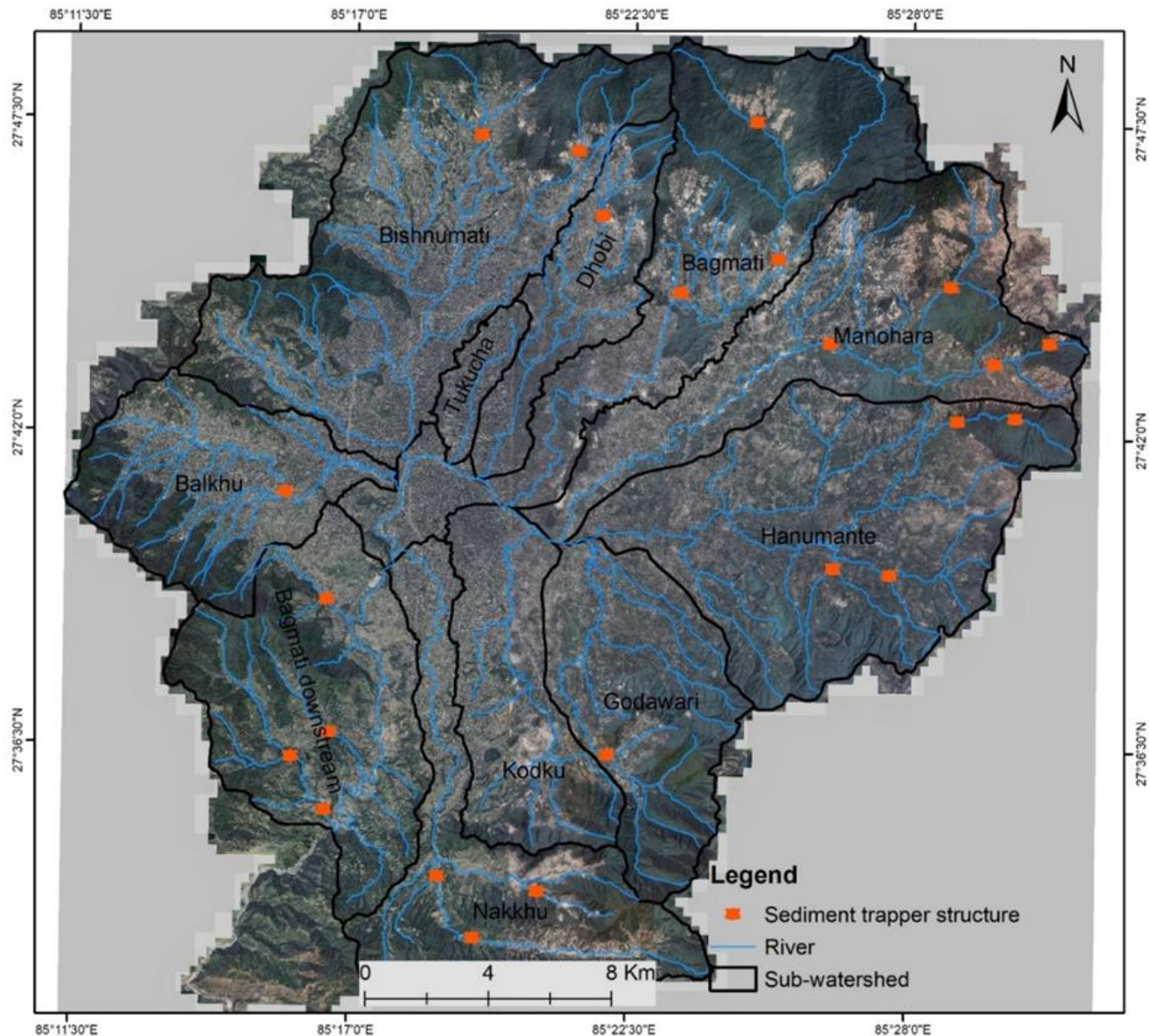


Figure 7- 4: Proposed locations for sedimentary trappers

7.1.1.2 Strengthen River Cleaning Program

Following recommendation are made for strengthening the River cleaning program

- Continuing the Periodic cleaning and dredging of rivers in collaboration with different partners, organizations and different levels of government.
- Mass movement for cleaning campaign in collaboration with local government and community: The '**Bagmati Safai Maha Abhiyan**' is still in operation every Saturday. The campaign has contributed to making Bagmati more pollution-free than in the past. Bagmati cleanup campaign commenced from 19th May, 2013 and is continuing till date. It is recommended to continue the cleanup campaign of Bagmati River and start the campaign in new rivers with mass movement in collaboration with local government and communities.
- Promote corridor walkathon in each river
- Strengthen the rafting programme and development of supporting infrastructures
- Development of small dam across the Nakhu, Kodku, Godawari and Dhobi Khola with introducing water recreation activities and corridor beautification

7.1.1.3 Management of Public Land along the River Corridor

A. Management of informal settlement

Rural-urban migration has resulted in rapid growth of slums and squatter settlements in KV. Marginalized groups and pro-poor population have forced for encroachment of prime land of urban core for better urban services. The squatter settlement in Kathmandu started early in the 1950s when rural migrants moved into the city for employment and better services. With the pace of urbanization, squatters also have increased and these squatters have resided mostly along the river bank. The squatter settlements along the river bank have encroached on the riparian land along the river which has affected ecology as well the environmental condition of the area.

For minimizing the growth of informal settlement and for conservation of riparian land, river banks need to be cleared and green area needs to be developed along the flood prone areas (i.e. ROR) of these river banks for recharging the water. Different approaches for management of informal settlements are described briefly below –

- **Forced Evictions**
This involves clearance through violent force and large-scale slum demolition without any alternative or choice of population. This process of approaching leaves them homeless and hopeless aggravating the circle of poverty, discrimination and social exclusion.
But in some cases, if the informal settlement has been developed to occupy valuable land in the city center this approach can be applied with better study of the condition.
- **Clearance and Relocations**
This process involves clearance of the settlements which are usually located in the center of the cities for the beautification of the area and movement of the settlement to a new location usually miles away from their original location. The settlement in the flood prone areas is at risk, so the area can be relocated to a safe area and the area can be developed for conservation of riparian land.
- **On-Site upgrading**
This approach includes the on site upgradation of the informal settlement. This might be done from different methods such as site and services, on site redevelopment or land sharing concept. In this approach, the site will be managed with better infrastructures and services. In most of the cases, the land is planned to be shared with the concept of multistorey apartments, so that more lands can be cleared and planned for the better uses.

The detailed inventory of existing informal settlements needs to be verified with previous data and updated. Informal squatter settlements need to be managed through different approaches based on each situation.

B. River Bank Beautification and Park Development

Riverfront not only plays important ecological roles but also supply bases of stability, comfort, and sustainability in urban development. Following concepts are recommended for River Bank Beautification and Park Development.

- Recreational Public Universal Green Park - Waterfront walkway, wooded trails, trailheads, community gathering places, public access corridors, streetscapes, view areas/viewpoints etc.
- Urban Green Forest – Enhancing more vegetation in the form of urban forestry
- Water Recreation Zone: Development of small dam across the water bodies with introducing water recreation activities and corridor beautification



Figure 7- 5: Proposed Recreational Public Universal Green park at Uttar Bahini section of Bagmati River
Source: DUDBC, 2023

7.1.1.4 Management of settlements residing within the Conservation Zone

Besides the squatters in urban areas, in rural areas also the hill slopes and the forest area have been encroached for settlement development. Before the declaration of National Park, four settlements were residing within the forest area of SNNP which was not resettled after overtaking the area from the national park. The expansion of population in these settlements have resulted in encroachment of forest and negatively impact the ecology of forest. So, these settlements need to be relocated.

Table 7- 5: Proposed settlements for relocation

Settlement	HH
Mulkharka	187
Okharein	167
Kunegaun	45
Chilaune	70
Total	469

7.1.1.5 Disaster mitigation

The hydrological model system of Bagmati River and its tributaries prepared for computation of 50 years return period flood discharge on HEC-HMS modelling software is presented in Figure 7-5 (See Supplementary Volume II: Hydrological and Flood Modelling Report).

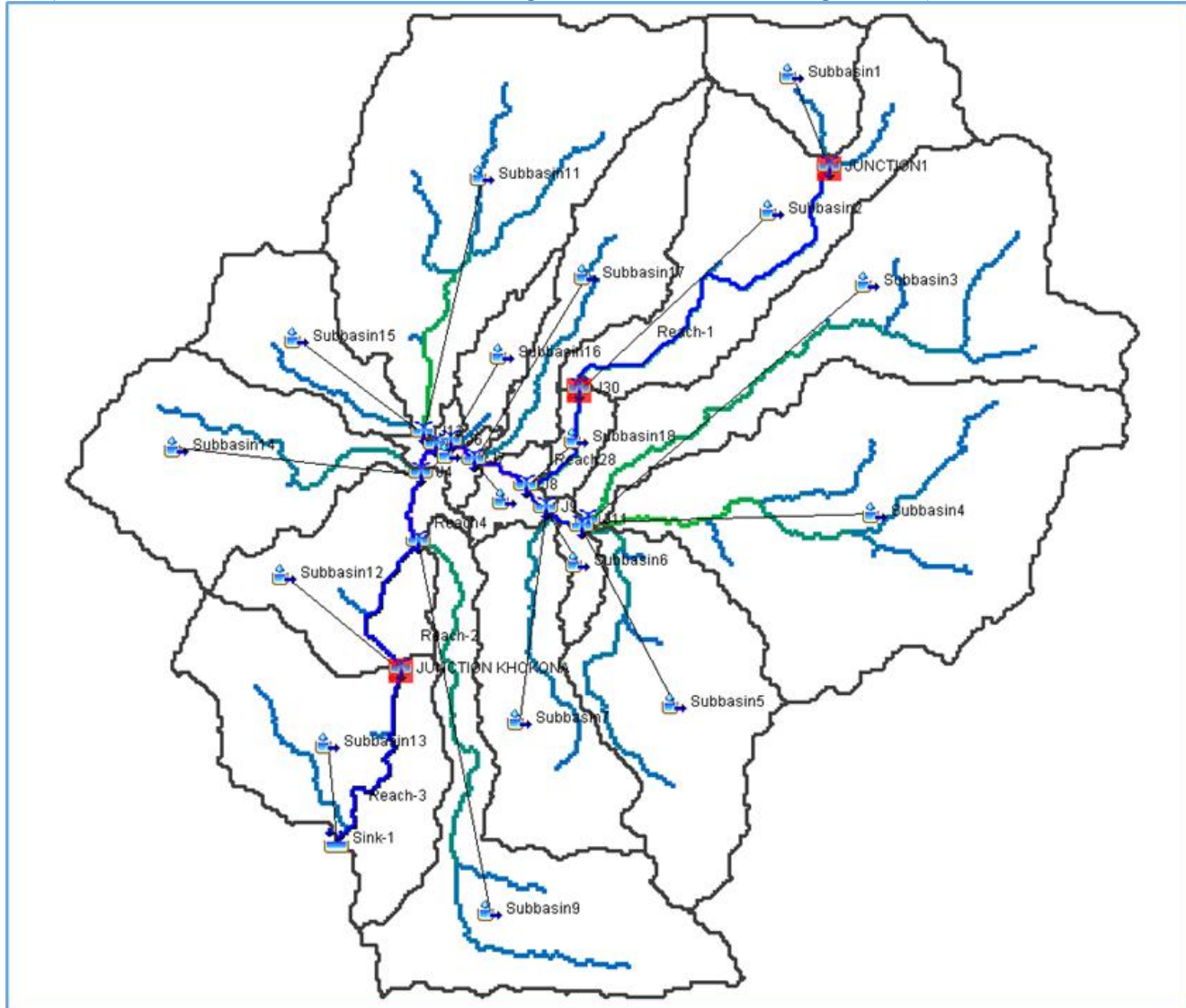


Figure 7- 6: Hydrological System of Bagmati River and its Tributaries based on 3D modeling in HEC-HMS Software

Minimum width of natural waterway of the river should be preserved with the hydraulic consideration for the river to allow its flood to pass unhindered with sufficient space. The recommended waterway width shall incorporate natural river channel and floodway over the banks (Table 7-6).

Table 7- 6: Summary of 5, 10 and 50 Years Return Period Precipitation, Flood Discharge and Required Waterway Width

S. N.	River	River Stretch	Sub basins	50 yrs Return Period Precipitation (mm)	50 yrs Return Period flood discharge (m ³ /s)	Required waterway for 50 years return period flood (m)	10 yrs Return Period flood discharge (m ³ /s)	Required waterway for 10 years return period flood (m)	5 yrs Return Period flood discharge (m ³ /s)	Required waterway for 5 years return period flood (m)
1	Bagmati Khola	Baghdwar to Nagmati Khola Junction	Sub-basin 1	156.21	30.30	26.15	21.87	22.21	18.04	20.18
		Nagmati Khola Junction to Suryamati Khola Junction	Sub-basin 2	157.34	90.28	45.13	64.12	38.04	52.23	34.33
		Suryamati Khola junction to Manohara Khola Junction	Sub-basin 2 & 18		132.80	54.74	97.85	46.99	81.97	43.01
		Manohara Khola Junction to Dhobi Khola Junction	Sub-basin 8	140.50	626.90	118.93	472.90	103.29	402.94	95.35
		Dhobi Khola Junction to Tukucha Khola Junction	Sub-basin 10	138.94	677.20	123.61	509.95	107.26	433.95	98.95
		Tukucha Khola Junction to Bishnumati Khola Junction			688.40	124.63	518.38	108.15	441.13	99.76
		Bishnumati Khola Junction to Balkhu Khola Junction			867.40	139.90	653.17	121.40	555.84	111.99
		Balkhu Khola Junction to Nakkhu Khola Junction	Sub-basin 12	209.08	971.50	148.05	692.24	124.97	565.36	112.94
		Nakkhu Khola Junction to Katuwal Daha	Sub-basin 12 & 13		1097.50	157.36	779.01	132.58	634.30	119.63
2	Bishnumati Khola	Origin to Lundi Khola Junction	Sub-basin 11	142.81	16.05	19.03	11.83	16.33	9.91	14.95
		Lundi Khola Junction to Sangla Khola Junction			49.31	33.36	36.34	28.64	30.45	26.21
		Sangla Khola Junction to Mahadev Khola Junction			86.28	44.12	63.59	37.88	53.28	34.67

S. N.	River	River Stretch	Sub basins	50 yrs Return Period Precipitation (mm)	50 yrs Return Period flood discharge (m ³ /s)	Required waterway for 50 years return period flood (m)	10 yrs Return Period flood discharge (m ³ /s)	Required waterway for 10 years return period flood (m)	5 yrs Return Period flood discharge (m ³ /s)	Required waterway for 5 years return period flood (m)
		Mahadev Khola Junction to Baucha Khola Junction		138.94	144.46	57.09	106.47	49.01	89.20	44.86
		Baucha Khola Junction to Manamati Khola Junction			160.70	60.21	118.44	51.69	99.23	47.32
		Manamati Khola Junction to Bagmati Khola Junction	Sub-basin 10		205.80	68.14	154.97	59.13	131.88	54.55
3	Manohara Khola	Origin to Salambu Devi Temple area	Sub-basin 3	144.12	58.68	36.39	43.06	31.17	35.97	28.49
		Salambu Devi Temple area to Hanumante Khola Junction	3	212.06	125.90	53.30	92.39	45.66	77.17	41.73
		Hanumante Khola Junction to Kodku Khola Junction	Sub-basin 6		394.40	94.33	292.60	81.25	246.35	74.55
		Kodku Khola Junction to Bagmati Khola Junction	Sub-basin 8	140.50	495.40	105.72	373.70	91.82	318.41	84.76
4	Hanumante Khola	Origin to Chakku Khola Junction	Sub-basin 4	151.13	38.49	29.47	28.30	25.27	23.67	23.11
		Chakku Khola Junction to Godavari Khola Junction			163.70	60.77	120.36	52.11	100.67	47.66
		Godavari Khola Junction to Manohara Khola Junction	Sub-basin 5	177.25	289.10	80.76	211.26	69.04	175.89	63.00
5	Dhobi Khola	Origin to Jamle Khola Junction	Sub-basin 17	143.09	6.26	11.89	4.60	10.19	3.85	9.31
		Jamle Khola Junction to Bagmati Khola Junction			46.60	32.43	34.24	27.79	28.62	25.41
6	Suryamati Khola	Origin to Bagmati Khola Junction	Sub-basin 2	157.34	30.10	26.06	21.38	21.96	17.41	19.82

S. N.	River	River Stretch	Sub basins	50 yrs Return Period Precipitation (mm)	50 yrs Return Period flood discharge (m ³ /s)	Required waterway for 50 years return period flood (m)	10 yrs Return Period flood discharge (m ³ /s)	Required waterway for 10 years return period flood (m)	5 yrs Return Period flood discharge (m ³ /s)	Required waterway for 5 years return period flood (m)
7	Nakkhu Khola	Origin to Bagmati Khola Junction	Sub-basin 9	188.35	104.70	48.60	76.74	41.61	64.04	38.01
8	Balkhu Khola	Origin to Balambu area	Sub-basin 14	237.93	91.57	45.45	64.44	38.13	52.11	34.29
		Balambu Area to Bagmati Khola Junction			134.30	55.05	94.51	46.18	76.43	41.53
9	Sangla Khola	Origin to Bishnumati Khola Junction	Sub-basin 11	142.81	39.43	29.83	29.06	25.61	24.35	23.44
10	Mahadev Khola	Origin to Bishnumati Khola Junction	Sub-basin 11	142.81	44.70	31.76	32.95	27.26	27.61	24.96
11	Chakku Khola	Origin to Hanumante Khola Junction	Sub-basin 4	151.13	48.38	33.04	35.57	28.33	29.75	25.91
12	Manamati Khola	Origin to Bishnumati Khola Junction	Sub-basin 15	162.07	45.10	31.90	32.92	27.25	27.39	24.86
13	Bauchha Khola	Origin to Bishnumati Khola Junction	Sub-basin 11	142.81	19.07	20.74	14.06	17.81	11.78	16.30
14	Lundi Khola	Origin to Bishnumati Khola Junction	Sub-basin 11	142.81	5.68	11.32	4.19	9.72	3.51	8.90
15	Jamle Khola	Origin to Dhobi Khola Junction	Sub-basin 17	143.09	3.22	8.52	2.37	7.31	1.98	6.68
16	Tukucha	Origin to Bagmati Khola Junction	Sub-basin 16	154.29	16.50	19.29	12.17	16.57	10.20	15.17
17	Kodku Khola	Origin to Manohara Khola Junction	Sub-basin 7	166.93	97.00	46.78	72.29	40.38	61.06	37.12

S. N.	River	River Stretch	Sub basins	50 yrs Return Period Precipitation (mm)	50 yrs Return Period flood discharge (m ³ /s)	Required waterway for 50 years return period flood (m)	10 yrs Return Period flood discharge (m ³ /s)	Required waterway for 10 years return period flood (m)	5 yrs Return Period flood discharge (m ³ /s)	Required waterway for 5 years return period flood (m)
18	Godavari Khola	Origin to Hanumante Khola Junction	Sub-basin 5	177.25	106.40	49.00	77.75	41.88	64.73	38.22

The waterway width computed in Table 7-6 for respective rivers in different stretches shall be left without construction and is required to set the width of the river to avoid the flooding. Waterway for 50 years return period flood is critical waterway and waterway for 5 years return period flood is minimal waterway.

Based on detailed site assessment and model based flood map, areas with higher risk and vulnerability of 50 years return period flood event are identified. Due to increased urbanization, land use and land cover pattern has changed over the years resulting in encroachment along Bagmati river tributaries. This has increased the threat and risks of urban flooding in KV. The hydraulic simulation tool (HEC-RAS) has been used to prepare the flood inundation map of Kathmandu valley river system for 50 years flood discharge computed using a hydrological model which has been presented in **Figure 7-6**.

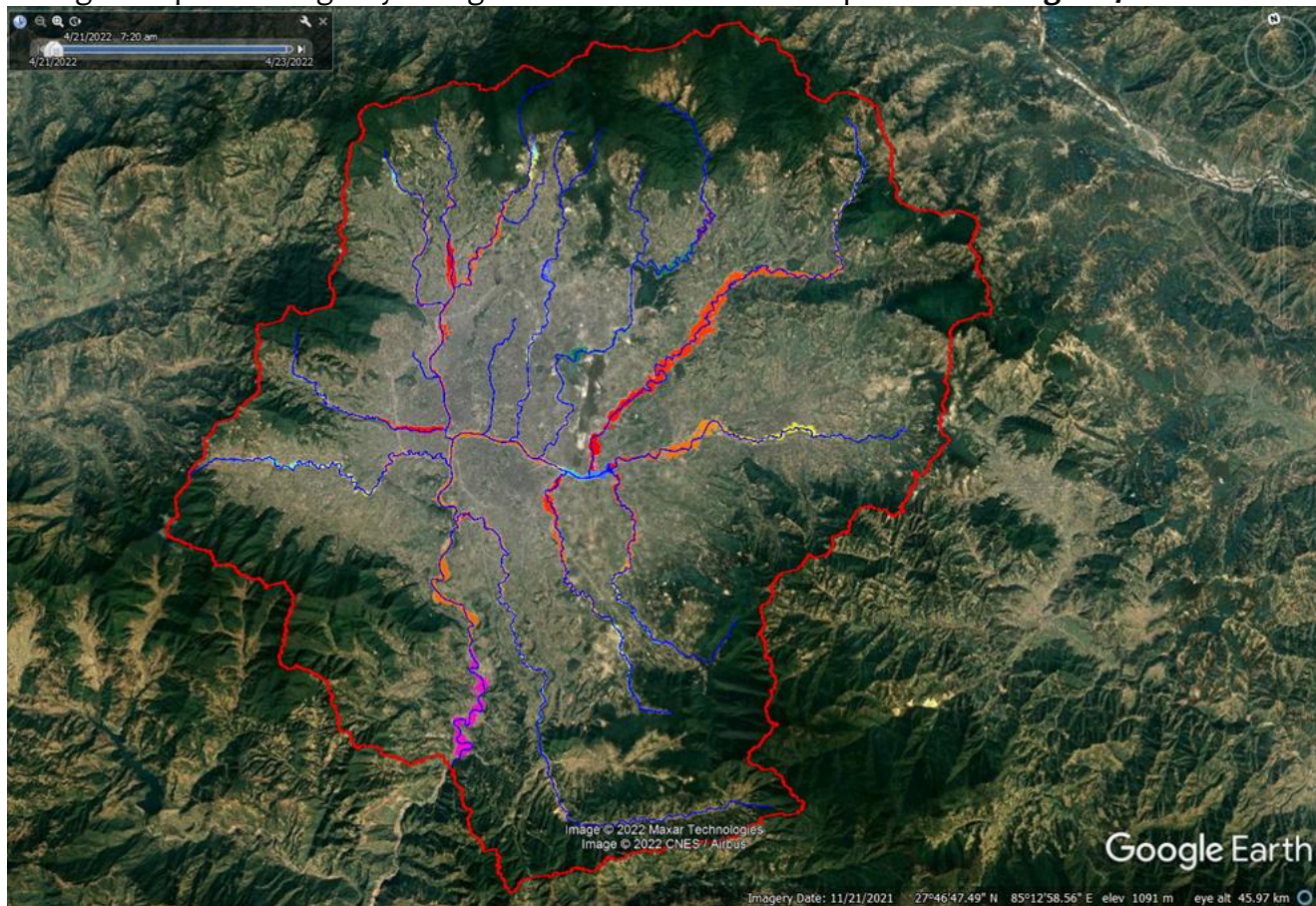


Figure 7- 7: Model Based Flood Inundation Map for 50 years return period flood of Bagmati River System in Kathmandu Valley

Based on hydrological modeling, field surveys, and site visits, most of the tributaries of the Bagmati river system in the peri-urban and urban zones are not of sufficient width and depth to safely accommodate even a 5-year return period flood. This poses a critical issue for accommodating floods with a return period greater than 5 years.

In the present condition, it is not feasible in most places to expand the waterways to handle a flood with a return period greater than 5 years due to urban pressure and land ownership issues along the riverbanks. In places where river and river based public land is available those sections can be cleared to accommodate the floods of more the 5 year return period. The expansion of waterways to accommodate a flood with a return period greater than 5 years would only be possible if there are mechanisms for land swapping and compensation for landowners. Therefore, the following recommendations are made to address the aforementioned issues.

- To adopt waterway for 5 years return period flood with constructing extensive river training structures and flood embankments to confine the flood discharge within limited width of river

waterway, which needs to be finalized and designed with detailed survey and planning in particular stage.

- To construct the short time detention pond along the foothill of Kathmandu valley for preventing the immediate impact of the flood at peri-urban and urban zones.
- To increase the river width where backwater effect exist due to the narrower river width. Detail contour and cross section survey and river flow hydraulic simulation shall require before planning and designing the river training works in any river stretch to consider confluence effect at the confluence region and backwater effect due to narrow and non-uniform river sections, culvert and bridge pier foundations in different rivers.
- For management of short time flooding, guidelines for the use of water percolating pavements, high plinth in buildings, perforated boundary walls for easy flow of water for short term etc needs to be proposed in private constructions.

Based on the GIS inventory system of constructed river training works in Bagmati river system and site assessment, the tentative length of river training works to be carried out in different rivers as per the zoning are presented in Table 7-7.

Table 7- 7: Estimated Length of River Training Works in Different River System of Bagmati Basin

S.n.	River	Estimated length of River Training Works					
		Zone					
		Urban		Peri-Urban		Conservation	
		Left (km)	Right (km)	Left (km)	Right (km)	Left (km)	Right (km)
1	Hanumante River	8.17	8.06	3.74	3.64	0.19	0.19
2	Manohara River	7.34	8.03	9.04	9.34	-	-
3	Godawari Khola	7.22	7.17	2.36	1.98	0.13	0.13
4	Nakkhu Khola	1.19	1.19	9.16	9.42	8.21	8.39
5	Suryamati Khola	1.00	0.90	2.47	2.57	-	-
6	Bishnumati River	2.36	1.36	1.20	1.35	-	-
7	Dhobi Khola	-	-	1.95	1.93	-	-
8	Sangla Khola	-	-	2.50	3.83	-	-
9	Mahadev Khola	0.19	0.20	3.70	3.96	-	-
10	Manamati Khola	1.16	0.72	3.51	3.96	0.24	0.24
11	Balkhu Khola	5.06	4.07	5.87	6.69	-	-
12	Bagmati River	6.67	8.93	18.75	19.07	-	-
13	Jamle Khola	-	-	2.46	2.46	-	-
14	Lundi Khola	0.75	0.66	2.27	2.30	-	-
15	Kodku Khola	4.76	4.68	6.59	6.19	-	-
16	Baucha Khola	0.46	0.29	-	-	-	-
17	Ghatte Khola	-	-	0.79	0.80	-	-
18	Chakhu Khola	1.15	0.13	1.46	1.46	-	-

Based on the detailed assessment of narrow width sections in critical areas of Bagmati Khola and its tributaries, the recommended height of the river training works (stone masonry wall on river banks) from river ground level in Bagmati Khola and its tributaries are presented Table 7-8.

Table 7- 8: Recommended for River Training Works

S.N.	River Name	Recommended Height of River Training Works (Meters)	Remarks
1	Hanumante Khola	2.5-4.2	Based on Detail Hydrological Modeling and Cross Section Survey of
2	Manohara Khola	1.7-4.8	
3	Godawari Khola	2.34-3.8	
4	Kodku Khola	1.2-5.2	

5	Nakhu Khola	1.93-4.26	Narrow Section and River Confluence Area
6	Suryamti Khola	1.58-3	
7	Bishnumati Khola	1.5-3.75	
8	Dhobi Khola	1.53-3.8	
9	Sangla Khola	1.21-3.13	
10	Mahadev Khola	1.75-3.1	
11	Manamati Khola	1.5-4.06	
12	Balkhu Khola	2.45-3.46	
13	Bagmati Khola	1.78-4.94	

Urban flood management in the Kathmandu Valley requires a comprehensive strategy that addresses the complex challenges arising from rapid urbanization, inadequate drainage systems, and vulnerability to climatic events. Here are key strategies to manage urban floods in the Bagmati River system:

1. Flood-resilient urban planning and implementation

- Detail inventories of river systems and restoration of encroachment area: Explore the historical Khola/kholchi and Raj Kulo and map in detail using the inventories. Monitor changes over time to detect new encroachments. Identify instances of illegal construction or land use violating established guidelines and restore the original channel flow.
- Land use planning: Implement and enforce zoning regulations to prevent construction in flood-prone areas with a provision of allocated space for green infrastructure and water retention zones.
- Infrastructure Planning: Plan and implement infrastructure projects that restore the river's natural flow while meeting the needs of the community, considering sustainable urban development practices that integrate with restoration efforts.
- Promote Climate-Resilient Infrastructure: Ensure critical infrastructure is climate-resilient by enforcing construction standards that consider climate change impacts on extreme weather events.

2. Improved Drainage Systems

- Stormwater Management: Regularly clean and maintain existing drains and waterways together with investment in modern stormwater drainage systems to efficiently manage rainfall runoff.
- Citizen Reporting Systems: Encourage community involvement in monitoring and maintaining local drainage systems. Also, implement platforms for citizens to report drainage issues, blockages, and potential flood risks.
- Riparian Zone Protection: Protect and restore natural riparian zones along rivers and water bodies, through the implementation of green belts and buffer zones to absorb excess water.

3. Waste Management

- Proper Waste Disposal: Implement effective waste management practices to prevent blockages in drains together with regular cleaning of stormwater drains and sewer systems.
- Reduce Single-Use Plastic: Promote initiatives to reduce the use of single-use plastics to prevent clogging of drains in combination with community engagement in waste reduction campaigns.

4. Cross-Boundary Collaboration

- Regional Cooperation: Collaborate with neighboring areas and municipalities on shared flood management strategies through effective river management hubs to share information, resources, and best practices for effective flood control.
- Government and NGO Partnerships: Foster partnerships between government agencies, non-governmental organizations (NGOs), and local communities for integrated flood management.

7.1.1.6 Development of corridor transport system along rivers

The functional hierarchy of the river corridor road (Motorable or pedestrian) network is mainly concerned with the idea of the preservation of river corridors in the conservation zone and the utilization of river corridors for mobility means in the urban zone and peri urban zone. Road development is always related to the creation of new places of business which results in the increasing

environmental overburden to the river ecology as well as the disturbance of the river morphology. Therefore, the strategy shall include the restrictions on the development of the road corridors along river banks. On the other hand, the existing river corridor roads have been considered as the means of provisions for easing the traffic flow hence reducing the congestion along major roads in urban zones. The strategy shall be aimed at the management of these roads so as to curb the negative impact on the river ecology.

Roads along the river corridors in Kathmandu Valley have been increasingly developed in the past decades. The total length of the road along these river corridors is about 162 km. The existing road length along the river corridors located in the conservation, peri-urban and urban zones are shown in Figure 7-7.

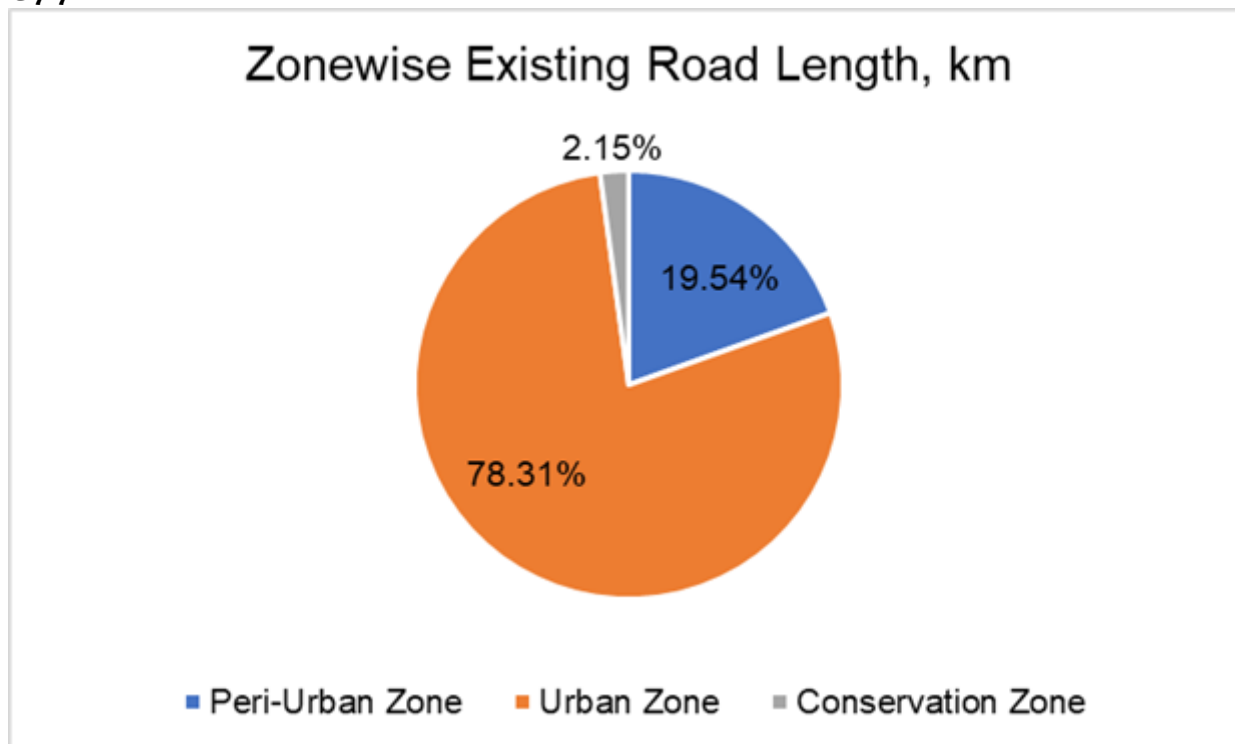


Figure 7- 8: Percentage of the road length located in the zones

In line with the development of river-corridor roads in Kathmandu, most of them have been heavily congested. Furthermore, these corridors have become places of traffic attraction due to the new development of the built environment. This newly opened built environment includes restaurants, vehicle repairing workshops, markets as well as other recreational centers. These circumstances are gradually becoming a threat to the river ecology. The newly developed physical environment would not support the vision of the Bagmati Action Plan, i. e. preservation of river systems with a green environment.

The concentration of human activities along the river corridor is primarily caused by the development of road corridors. The zoning of the Kathmandu Valley for the purpose of conservation of river systems thereafter the overall Bagmati civilization shall be considered during the planning of river corridor roads in those zones. The river corridor road network, within the urban zone, is more functional for providing mobility. In the rural zone, river corridor roads shall be considered for the provision of connectivity to the nearby heritage sites, and historical settlements. The roads along with the river corridors in the conservation zone are not desirable. Most of the river corridors in the conservation zone have a steep gradient (river profile). Therefore, road development would require more physical intervention in terms of huge earthwork as well as massive construction for slope protection. These would be an alarming environmental threat to the river system. Therefore, river corridors in the conservation zone shall be free from any river corridor roads. This zone is the major environmental asset of the Kathmandu valley. The physical development in this zone may be limited to the construction of foot trails and cycle lanes with due compliance with the environmental regulations. The river corridor road network hierarchy can be developed with the proposed zoning system in this initiative as shown in the figure below.

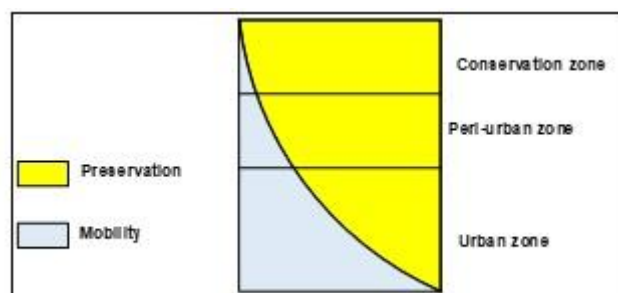


Figure 7- 9: Hierarchy of River Corridor Road Network and functions

Proper asset management plans shall be developed and implemented for these roads in the future. Similarly, BAP shall include the discouraging statements for the development of industrial setup including the vehicle repairing workshop along the entire river corridors. At the same time, BAP shall support the concerned local authorities in the development of river bank greenery initiatives.

Another aspect of the accessibility to the cultural heritage sites shall also be addressed in the formulation of the BAP. The river corridor roads shall be developed as the means of connectivity to such places. However, these heritage routes shall be specifically managed for the objectives of reliable access by the provision of public transport.

Road development along the river corridors in Kathmandu has been carried out by the Department of Roads (Road Division Offices), and Municipalities and High-Powered Committee for Integrated Development of the Bagmati Civilization (HPCIDBC). The multi-sectoral coordination among the stakeholder is one of the major challenges for the development and management of the road assets along with the river systems. Therefore, the issues of coordination and the investment strategy development for the development of the smart corridor roads is considered the main task in the proposed action plan.

The study found that most of the road along the river corridors has been developed without consistent geometric standards and cross-sections. Therefore, the improvement of road geometry, as well as cross-section, may be taken as one of the actions for the better functional requirement of corridor roads. Road design must follow the urban road standard-2076 & Nepal Road Standard-2070 for geometric design and Flexible Pavements design Guideline- 2021 (MoPIT) & Rigid Pavements design Guideline – 2021 (MoPIT) must follow for Pavement design. All the services like electricity, telephone, water supply, sewer waste shall be made underground in the corridor road.

The pedestrian sidewalks, and cycle lanes could be taken as important elements for the road cross-section. Similarly, the pedestrian rest places and toilet facilities could be an essential item of the roadside development. **The footpaths along the corridor road fail to meet basic standards. They are deficient in critical aspects such as footpath width, kerb stone height, and the inclusion of kerb ramps. Service utilities (e.g., NEA cabinets) have encroached upon most of these footpaths. Additionally, a green belt has been constructed on some of these already non-standard footpaths. This combination of issues leads to the following problems:**

- No space for Pedestrian
- Congestion in road way
- Un-safety Road
- Low level of pedestrian mobility footpath
- Non universal friendly footpath

Footpath design must follow the IRC: 103-2012 and Guidelines for facilities for Blind and Vision Impaired Pedestrians-2018 (MoPIT).

Following river corridor (Table 7-9) will be proposed for developing and upgrading within 20 years as per standard.

Table 7- 9: Proposed River Corridor

River Corridor	New Construction (km) including Both Side		Upgrading (km) including Both Side	
	Urban Zone	Peri Urban Zone	Urban Zone	Peri Urban Zone
Bagmati River	14.00	33.00	10.00	8.45
Bishnumati River	5.00	5.00	9.00	2.54
Manahara Khola	18.00	22.00	6.00	-
Hanumante Khola	12.00	10.00	12.00	3.50
Balkhu Khola (Indramati)	12.00	14.00	2.00	3.00
Nakhu Khola	4.00	14.00	13.00	-
Rudramati (Dhobikhola)	-	3.00	-	-
Godawari Khola	12.00	10.00	2.00	2.24
Mahadev Khola	-	8.00	3.00	4.22
Sangla Khola	-	10.00	-	-
Kodku Khola	16.00	9.00	4.00	-
Bhaucha Khola	-	-	2.00	-
Jamle Khola	-	13.00	-	-
Manamati Khola	5.00	-	2.00	1.00
Suryamati Khola	5.00	-	-	-
Total	103.00	151.00	65.00	24.95



Figure 7- 10: Proposed Ecology based Smart River Corridor Development (Example)

Typical cross section of corridor roads are recommended as following

S. n.	Width of Roadway	Cross section
1	4m	Private Property line + Shoulder (1m) + Carriage way (3m) + River Edge
2	5m	Private Property line + Footpath (1.5m) + Carriage way (3.5m) with one side surface drain + River Edge
3	6m	Private Property line + Footpath (1.5m) + Carriage way (4.5m) with one side surface drain + River Edge

S. n.	Width of Roadway	Cross section
4	7m	Private Property line + Footpath (1.5m) + Carriage way (5.5m) with one side surface drain + River Edge
5	8m	Private Property line + Footpath (2m) + Carriage way (6m) with one side surface drain + River Edge
6	9m	Private Property line + Footpath (2m) + Carriage way (7m) with one side surface drain + River Edge
7	10m	Private Property line + Footpath (2.5m) + Carriage way (7.5m) with one side surface drain + River Edge

For cycle lane along river corridor, extra space is required as per IRC: 11 - 1962: The design and Layout of Cycle Track.

Following provisions are recommended for traffic management along the river corridor.

- Installment of Traffic Sign, Signal and information Board along corridor road network
- Uni-directional or multi-directional traffic permission as per carriage way width and traffic volume with crossing structures at fixed interval.
- Installment of Street light along corridor road network and sufficient lighting on underpass.
- Not provide to route permit for public vehicle, required bus stop at 300m to 500m interval if provide the route permit for public vehicle.
- Permission of movement of vehicles and speed limit as per carriage way width as per following.

S. n.	Width of carriage way	Allowable Vehicle Type	Speed Limit (km/hr)
1	6m or less than 6m	Light Vehicles and Medium Vehicles	20
2	More than 6m	Heavy Vehicles	30

7.1.2 Cultural/Civilization rehabilitation

This Action Plan has considered 30 holy places and tirthas along these rivers for detailed study to understand the context of their sitting, their relation with the other cultural sites and settlements as well as to understand the intangible attributes associated with these sacred places. 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 places to seek blessings in the form of offspring, cure from diseases and for good fortune. This clearly indicates the intricate relation the valley dwellers share with their sacred water.

Building on the intricate relationship between the physical heritage sites and the intangible cultural practices of the surrounding communities, this action plan aims to strengthen the conservation and promotion of these assets. By engaging local residents and integrating traditional festivals and jatras into our preservation efforts, we will ensure these sites remain vibrant hubs of cultural activity, fostering a deeper connection between the heritage, the settlements, and the people.

This tangible – intangible interrelationships clearly indicate that the built features when seen in isolation do not convey meaning of its sitting in a larger context and also when addressing its issues in isolation will not help in addressing the cultural issues of the larger context, as such it becomes essential to identify, understand and address the issues of the cultural landscape as a whole. These cultural landscapes are often understood as areas that have evolved through time and represent the combined activity of nature and man. In Kirata period, the sitting of the pringga and pitha is a good example of culture and landscape relationship. Cultural historians see the yearly festivals like Khat jatras were carried out to address the issues of urban and natural resources of pringga and pitha respectively. The jatra of Kankeshwari of Kathmandu, Balkumari of Patan are such examples which try to illustrate the interdependency of urban culture and natural hinterlands. Similarly the landscape extending from Shankhamul ghat to Kumbeshwara temple is a conglomeration of cultural heritage of different religions and time periods as well as the expressions of people who inhabited the area. In general the cultural sites and their intangible expressions spread over space and time lend regional identity.

The cultural landscape are areas that have evolved through time and represent the combined activity of nature and man. In Kirata period, the sitting of the pringga and pitha were such that the yearly

cultural activities were carried out to address the issues of urban and natural resources of pringga and pitha respectively. In our current context, these landscapes have various built features which come alive with socio-cultural activities in different times of the year. The built features when seen in isolation do not convey meaning of its sitting in a larger context and also when addressing its issues in isolation will not help in addressing the cultural issues of the larger context, as such it becomes essential to identify, understand and address the issues of the cultural landscape as a whole.

Since Ne Muni, the hermit after whom Nepal is believed to have been named, initiated a 17-day pada yatra (heritage walk) from Katuwal to Bagdwar undertaken as penance and to pay homage to the sacred Bagmati River according to the pre-recorded history (1400-800 BC) (Bagmati Promenade, British Council). Bagmati Tirtha Yatra or Bagmati Pilgrimage has been conducted for the purpose of earning merit and fulfilling one's desires without any disease in the body parts. As part of the journey, pilgrims will reach 166 shrines along the Bagmati river corridor and offer worship there. In the book 'Hamro Bagmati Sanskriti' (2004), the late historian and cultural expert Madan Mohan Mishra documents the process, route and significance of Bagmati Yatra in great detail. The pilgrimage had stopped since 2034 BS after the Bagmati River got polluted due to human encroachment. The Bagmati Tirtha Yatra or Bagmati Pilgrimage has begun after 40 years from 2018. The Pashupati Area Development Fund has resumed the Bagmati Yatra to preserve the Bagmati civilization.

This very idea of identity associated with cultural practices even in contemporary society can be a guiding force to restore and revitalize the cultural landscapes and their attributes. In this aspect the strategy should focus on reviving the local guthis and committees to ensure the regular maintenance, sustainable use and conservation of tangible and intangible heritage. It also recommended creating a heritage utilization strategy and implementing through encouraging the local bodies and coordinate for UNESCO listing campaigns of tangible and intangible heritage along with heritage intervention campaigns from local to global level.

Identification of Heritage corridors is recommended for the conservation of large-scale cultural landscapes, linear cultural landscapes with the characteristics of special culture clusters. Such a corridor has an obvious economic center and a developed tourist industry, and engages in the reuse of historical buildings, as well as in environmental improvement.

7.1.3 River/Water Quality and quantity improvement

7.1.3.1 Conservation and management of water sources

To maintain the ground water aquifer in the valley floor, water conservation across the foothill and upper hill slope is crucial. There are several measures which can help to retain the surface runoff for a certain period and improve infiltration capacities. The present study has figured out some potential sites for water sources development and these are mainly located in the peripheral hilly terrain of the valley. There are five different types of potential interventions identified for the upgradation of surface and groundwater in the valley:

- i) Rain water harvesting ponds in small scale
- ii) Water retaining reservoirs/ponds
- iii) Reservoir dams along large rivers
- iv) Artificial groundwater recharge wells or ponds
- v) Revitalization of traditional and local water storage

A. Rain Water Harvesting Ponds (Detention Pond)

The process of rainwater harvesting involves the collection and the storage of rainwater that run off naturally through creating small storage structures along the flow path. These ponds are small in size but can contribute nearby stream flow, wells, stone spouts, etc. Similarly, these types of ponds constructed at streambeds also help to retain flash floods during rainy seasons. The potential sites for the rain water harvesting ponds have been selected based on the following characteristics:

- a) Naturally depressed area or suitable for excavation in highland
- b) Streambed of ephemeral stream or close to stone spouts
- c) Moderate to high capacity of reservoir with low height of dam
- d) Bare and swampy land

- e) Non-disturbing places even within residential area
- f) Strong and fresh rock/soil type at the proposed site of dam construction

Owing to these facts, forest edges surrounding the valley and having 3-5th order streams are selected as potential sites for rainwater harvesting ponds (**Figure 7-10**). Since rainwater harvesting ponds require regular maintenance, ownership from local stakeholders is essential. For this, a 258km long cycle lane connecting proposed ponds is recommended which will not only promote eco-tourism but also improve ownership from local peoples including local governments. This integrated approach might also help to conserve and enhance local biodiversity.

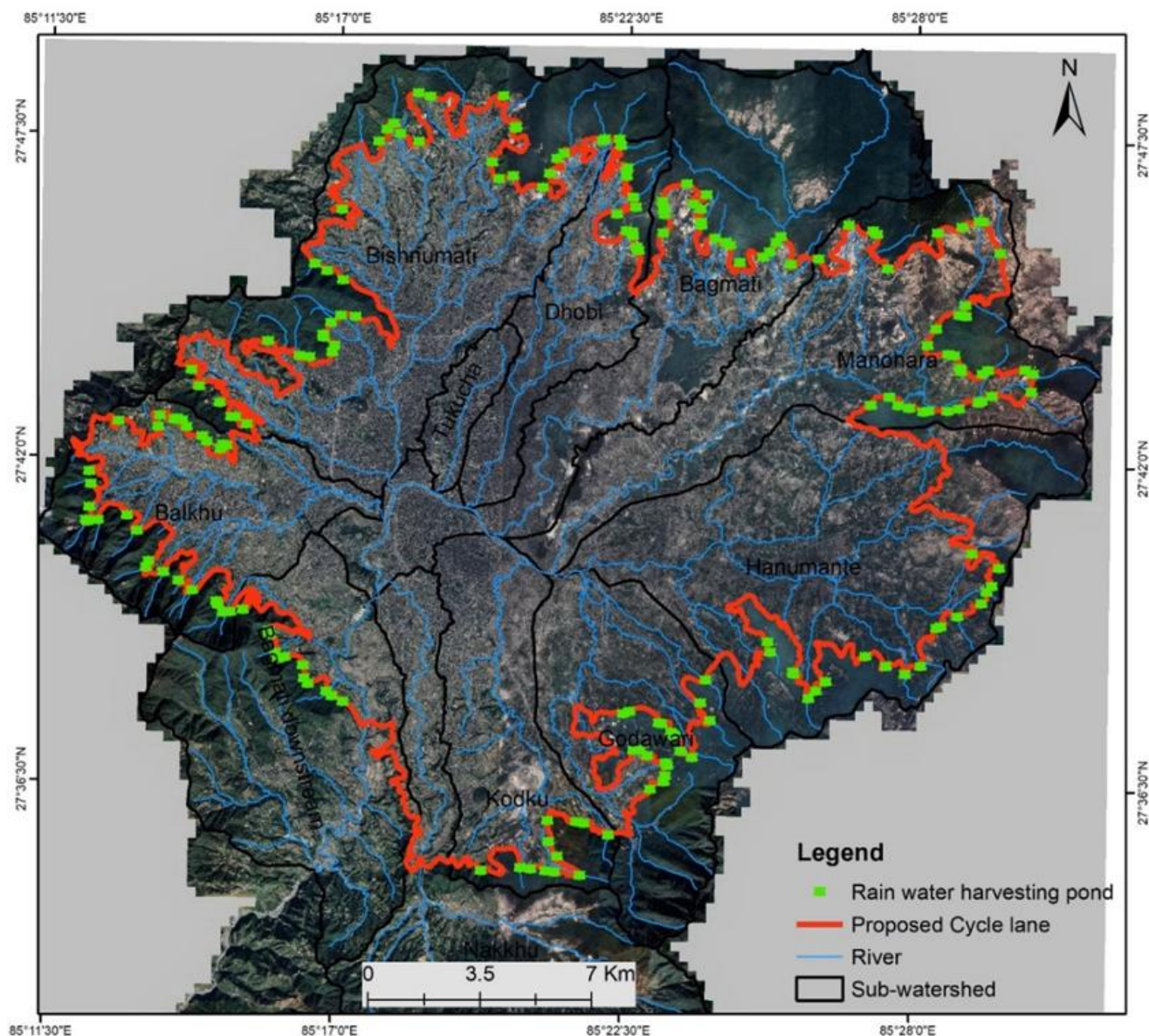


Figure 7- 11: Proposed Rain water harvesting ponds

B. Water Retaining Ponds/Reservoir

The potential sites for the water retaining reservoirs have been selected based on the following characteristics:

- a) Naturally depressed area in highland
- b) Flat to very low slope ratio in the upstream of the proposed dam site
- c) Large capacity of reservoir with low height of dam
- d) Bare and swampy land
- e) Distant from the residential area
- f) Narrow gorge like outlet bounded by bedrocks
- g) Strong and fresh rock/soil type at the proposed site of dam construction

There are 15 potential sites identified from the field for the water retaining reservoirs (**Figure 7-11 and Table 7-10**).

C. Water reservoir dam

The potential sites for the reservoir dams along rivers have been selected based on the following characteristics:

- a) Moderate to large catchment of the river
- b) Perennial streams in highland
- c) Flat to very low slope ratio in the upstream of the proposed dam site
- d) Large capacity of reservoir with low height of dam
- e) Bare, grassy, or rocky terrain
- f) Distant from the residential area
- g) Narrow gorge like outlet bounded by bedrocks
- h) Strong and fresh rock/soil type at the proposed site of dam construction

There are 8 potential sites identified from the field for the reservoir dams along rivers (**Figure 7-11**). A summary table describes the salient features of these potential sites.

D. Artificial Groundwater Recharge Wells or Ponds

The construction of artificial groundwater recharge wells is essential to contribute to the shallow and deep aquifers of the valley in an effective way. These types of wells can be constructed differently to recharge the shallow and deep **aquifers separately**. The potential sites for the construction of artificial groundwater recharge wells have been selected on the basis of following characteristics:

- a) Old floodplain near to major river channel
- b) Foothill of peripheral mountains
- c) Naturally groundwater recharge zone
- d) Distant from dense residential area
- e) Distant from highly polluted water and dumping sites

There are 8 potential sites for the construction of artificial groundwater recharge wells identified from the field (**Figure 7-11 and Table 7-11**).

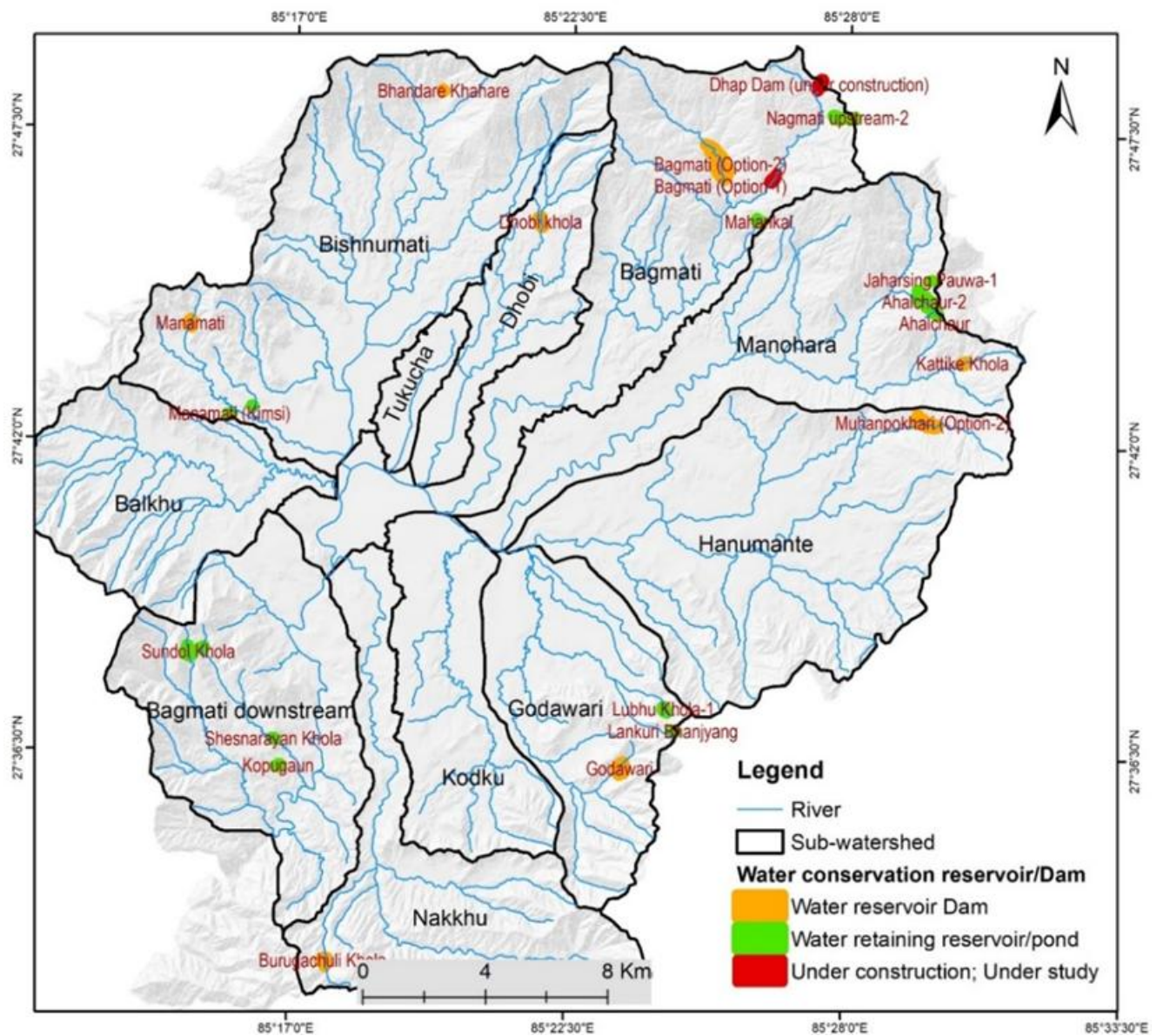


Figure 7- 12: Potential sites for water recharge structures

Table 7- 10: Location of Proposed Water Reservoir/ pond and Reservoir dam

S. n.	Khola	Lon	Lat	Area (ha)	Volume (m ³)	Height (m)	Max Width (m)	Land cover	Activities	Priority	Remarks
1	Bagmati	85.423399459	27.782734001	24.0	5485592.3	80	200.0	Forest	Water reservoir Dam	P1	Shivapuri Nagarjune National Park
2	Nagmati upstream-1	85.467387521	27.796650849	1.5	55000.0	20	80.0	Wetland & forest	Water retaining reservoir/pond	P3	Shivapuri Nagarjun NP
3	Nagmati upstream-2	85.462300775	27.796954149	2.5	179987.6	30	80.0	Forest	Water retaining reservoir/pond	P3	
4	Mahankal	85.436582701	27.766199774	1.3	78048.7	20	60.0	Forest	Water retaining reservoir/pond	P2	
5	Dhobi khola	85.364306723	27.765088420	3.6	238452.4	25	70.0	Park and private land	Water reservoir Dam	P1	Existing park will be inundated partially & some issues of private land
6	Bhandare Khahare	85.331397816	27.803421612	0.6	43298.0	24	40.0	Forest	Water reservoir Dam	P2	Shivapuri Nagarjun NP
7	Manamati	85.248663845	27.734068899	3.4	569961.8	50	160.0	Occupied land/ Cultivation and some houses	Water reservoir Dam	P3	Private land shall be acquired and reservoir lies on National park
8	Manamati (Kimsi)	85.262180510	27.707571720	0.7	18870.5	12	50.0	Forest	Water retaining reservoir/pond	P1	
9	Sitapaila	85.269593285	27.709985533	0.3	6284.8	10	30.0	Forest	Water retaining reservoir/pond	P1	
10	Sundol Khola	85.249480143	27.637302864	4.7	862675.8	50	120.0	Forest & Wetland	Water retaining reservoir/pond	P2	
11	Panim Khola	85.254071971	27.638339215	1.2	33782.9	20	70.0	Forest	Water retaining reservoir/pond	P1	
12	Shesnarayan Khola	85.278102153	27.612064131	0.8	65706.5	20	60.0	Forest	Water retaining reservoir/pond	P1	
13	Kopugaun	85.279856969	27.604132453	1.1	34136.9	10	70.0	Forest	Water retaining	P1	

S. n.	Khola	Lon	Lat	Area (ha)	Volume (m ³)	Height (m)	Max Width (m)	Land cover	Activities	Priority	Remarks
									reservoir/pond		
14	Burugachuli Khola	85.295877690	27.546793399	3.6	537134.0	50	140.0	Forest	Water reservoir Dam	P3	
15	Godawari	85.393032179	27.604472377	8.6	101132.3	40	200.0	Grazing land and forest	Water reservoir Dam	P2	Reservoir enlarge through excavation & artificial waterfall at inlet
16	Lankuri Bhanjyang	85.410353394	27.615696234	0.8	137145.8	30	60.0	Forest	Water retaining reservoir/pond	P1	
17	Lubhu Khola-1	85.407291886	27.622099280	1.9	100993.3	40	90.0	Forest	Water retaining reservoir/pond	P2	
18	Muhanpokhari	85.492598024	27.707274627	10.9	1682836.1	60	170.0	Forest	Water reservoir Dam	P2	
19	Kattike Khola	85.504962596	27.724954741	1.3	192463.5	50	60.0	Forest	Water reservoir Dam	P2	Series of siltation dams are required in the upstream
20	Ahalchaur	85.495393072	27.740133946	2.6	150721.7	18	70.0	Forest & Wetland	Water retaining reservoir/pond	P1	
21	Ahalchaur-2	85.492101254	27.743042911	7.4	558834.5	30	90.0	Abandoned cultivated land, Wetland & Forest	Water retaining reservoir/pond	P1	Drinking water supply and private land
22	Jaharsing Pauwa-1	85.493975179	27.749198294	0.2	4569.9	6	25.0	Forest	Water retaining reservoir/pond	P1	
23	Jaharsing Pauwa-2	85.489836880	27.746061919	0.7	31473.1	1	40.0	Abandoned cultivated land & forest	Water retaining reservoir/pond	P2	

Table 7- 11: Location of Proposed Recharge Well

S. n.	Name	Municipality	Ward	Longitude	Latitude	Priority
1	Bagmati River	Gokarneshwor Nagarpalika	1	85.421616	27.753105	P1
2	Bishnumati River	Nagarjun Nagarpalika	8	85.247533	27.732093	P1
3	Bishnumati River	Tokha Nagarpalika	1	85.330838	27.802748	P1
4	Godawari Khola	Mahalaxmi Nagarpalika	9	85.386112	27.635970	P2
5	Godawari Khola	Godawari Nagarpalika	3	85.379799	27.597252	P2
6	Hanumante Khola	Suryabinayak Nagarpalika	4	85.405140	27.647386	P2
7	Hanumante Khola	Changunarayan Nagarpalika	7	85.470123	27.696099	P2
8	Manahara River	Changunarayan Nagarpalika	6	85.480812	27.717681	P1

A summary table in **Annex V** describes the salient features of these potential sites.

E. Revitalization of traditional and local water storage

The disruption of Raj kulo is mainly caused by road construction (for e.g the construction of ring road) and construction of houses in the land through which these raj kulo passed. This disruption in turn led to the drying up of water bodies and consequently the drying of hitis. The other cause of decay of water bodies is encroachment, for instance a ward office building is built over a water body in Thimi historic settlement, similarly in Sunakothi, Kvey Lachi water body was buried and a sattal was constructed over it. The hitis are also encroached in the name of development like in case of Bhotahiti where the hiti was buried during the road construction. Looking into the sensitivity of the issue, the World Monument Fund (WMF) has put hitis on its 2022 World Monument watch list.

Besides mourning the loss of such important historic infrastructure, there is an urgent need to form strategies to preserve what is left with us. This not only complies with the conservation philosophy but the revitalization of such water related infrastructure can actually help address the present day social and environmental problems. For instance, in the current scenario the urban areas are facing acute shortage of drinking water and the restoration of raj kulo will not only help bring water for irrigation purpose but will bring the hitis back to life fetching good supply of drinking water to the residential quarters of historic cities. Such situations will lessen the dependency of these historic settlements on new water sources like Melamchi for drinking water supply. On the other side the recognition of these ancient sources of water means policies will be put in place to protect the watershed.

Similarly in case of water bodies, its revitalization will not only add to urban aesthetics, for e.g. Pimbahal Pokhari of Patan but can also function as a local climate regulator to minimize the impact of urban heat island effect. In cases of historic areas that are interconnected by narrow alleys that prohibit the access of vehicles like fire brigades, these water bodies are reliable sources of water for fire fighting purposes. Such indicators verifying the usefulness of these historic infrastructures in contemporary society are guiding forces to identify major water infrastructure within the valley and restore them to revitalize the traditional core areas.

The other important aspect of these historic water infrastructures is its sustainable water management system. In this aspect the strategy should focus on reviving the local guthis and committees to ensure the regular maintenance and sustainable use of these infrastructures.



Figure 7- 13: Revitalization Master Plan of Saptapatal Pokhari at Lagankhel

Source: Lalitpur Metropolitan City



Figure 7- 14: Revitalization Master Plan of Paleswan Pokhari at Pulchowk
Source: Lalitpur Metropolitan City

7.1.3.2 Management of Sewerage to prevent direct disposal into river

Total Sewerage Generation

The sewage generation consists of i) Domestic sewage, ii) Non-domestic sewage consisting of industrial and commercial sewage and iii) infiltration. The total quantity of sewage generation is the sum of domestic, non-domestic and infiltration. Based on the population forecast for 2042, total sewerage flow, existing WWTP serving discharge and net inflow (lit/day, after

deduction) have been calculated (**Annex IV**). The calculation is made for separate sewerage system (excluding storm water) with following assumptions:

Water consumption rate	120	lpcd
Sewage flow (80% of water consumption)	96	lpcd

Source: KVVMP, KUKL 2022

With the population forecast of 5.89 million, the total sewerage generation in Kathmandu valley service area is 679.11 MLD in 2042 (Table 7-12).

Table 7- 12: Total sewerage generation of Local Unit for 2042

Local Unit	Total sewerage generation (MLD)
Kathmandu Metropolitan City	135.59
Lalitpur Metropolitan City	48.07
Bhaktapur Municipality	12.64
Kritipur Municipality	17.15
Madhyapur Thimi Municipality	34.28
Gokarneshwor Municipality	40.97
Budhanilkantha Municipality	54.05
Kageshwari Manohara Municipality	40.10
Trakeshwar Municipality	45.57
Tokha Municipality	34.74
Nagarjun Municipality	34.74
Chandragiri Municipality	41.19
Dakshinkali Municipality	4.32
Shankharapur Municipality	5.89
Changunarayan Municipality	26.65
Suryabinayak Municipality	41.50
Godawari Municipality	22.71
Mahalaxmi Municipality	35.71
Konjyosom Rural Municipality	1.45
Bagmati Rural Municipality	1.79
Total	679.11

The following location is proposed for centralized municipal level WWTP based on topography, discharge point and population catchment. DEWATs are recommended within the community level upto 1 MLD capacity as per land availability and topography, which decreases the load in centralized municipal level WWTP. It is recommended that 20% of the sewage generated shall be treated by DEWATs. DEWATs provide the possibility of a nature-based, low-cost and sustainable wastewater treatment.

Table 7- 13: Proposed New centralized municipal level WWTP

S N	Municipality	Local Unit Level	Ward No.	Zone	Lat	Long
1	Dakshinkali	Nagarpalika	3	Peri-urban Zone	27.61	85.28
2	Lalitpur	Mahanagarpalika	22	Peri-urban Zone	27.61	85.30
3	Godawari	Nagarpalika	12	Urban Zone	27.62	85.31
4	Godawari	Nagarpalika	14	Urban Zone	27.63	85.35
5	Kirtipur	Nagarpalika	6	Peri-urban Zone	27.65	85.29
6	Mahalaxmi	Nagarpalika	5	Urban Zone	27.66	85.36
7	Mahalaxmi	Nagarpalika	2	Urban Zone	27.67	85.34
8	Madhyapur Thimi	Nagarpalika	1	Urban Zone	27.67	85.35

S N	Municipality	Local Unit Level	Ward No.	Zone	Lat	Long
9	Suryabinayak	Nagarpalika	2	Urban Zone	27.67	85.36
10	Kirtipur	Nagarpalika	4	Peri-urban Zone	27.67	85.26
11	Suryabinayak	Nagarpalika	5	Peri-urban Zone	27.67	85.40
12	Changunarayan	Nagarpalika	2	Urban Zone	27.68	85.41
13	Chandragiri	Nagarpalika	15	Urban Zone	27.69	85.27
14	Kageshwori	Nagarpalika	9	Urban Zone	27.70	85.37
15	Manahora	Nagarpalika	9	Urban Zone	27.70	85.28
16	Nagarjun	Nagarpalika	9	Urban Zone	27.70	85.28
17	Kathmandu	Mahanagarpalika	16	Urban Zone	27.73	85.31
18	Budhanilakantha	Nagarpalika	9	Urban Zone	27.73	85.35
19	Shankharapur	Nagarpalika	9	Peri-urban Zone	27.73	85.44
20	Tokha	Nagarpalika	9	Urban Zone	27.74	85.31
21	Tarakeshwor	Nagarpalika	4	Urban Zone	27.74	85.30
22	Budhanilakantha	Nagarpalika	6	Urban Zone	27.76	85.34
22	Kathmandu	Mahanagarpalika	11/12	Urban Zone		

Land Requirement for Sewerage Treatment Plant

With the estimation of total sewerage generation in Kathmandu valley service area for 2042, the total land requirements for sewerage treatment plants have also been calculated for each Metropolitan City, Municipality and Rural Municipality within the valley (**Annex IV**).

The total land requirement for sewerage treatment plant is estimated to be 76.9 ha (768,768 m²). WWTP has been proposed based on the topographic features of the land. An assumption has been made to propose at least one WWTP at each municipality. Area required for WWTP has been calculated considering the whole municipal population in the forecasted year. Tentative location has been marked in the map, before implementation exact location is to be worked out for further DPR. Land acquired for WWTP is a very challenging job at present, as per the availability of land small scale WWTP can also be constructed and for the small scale community level on site sanitation like septic tank at house level or community level can also be constructed.

7.1.3.3 Management of Solid waste disposal directly into river system

Following recommendation are proposed for Management of Solid waste disposal directly into river system

- i) Discourage dumping of garbage, plastics, construction wastes and other unused items in the rivers through awareness campaigns and strengthening of the waste management system.
 - Strengthen waste management system at municipal level
 - Established Bagmati Police for monitoring and management of river system including discourage the dumping of waste to river directly

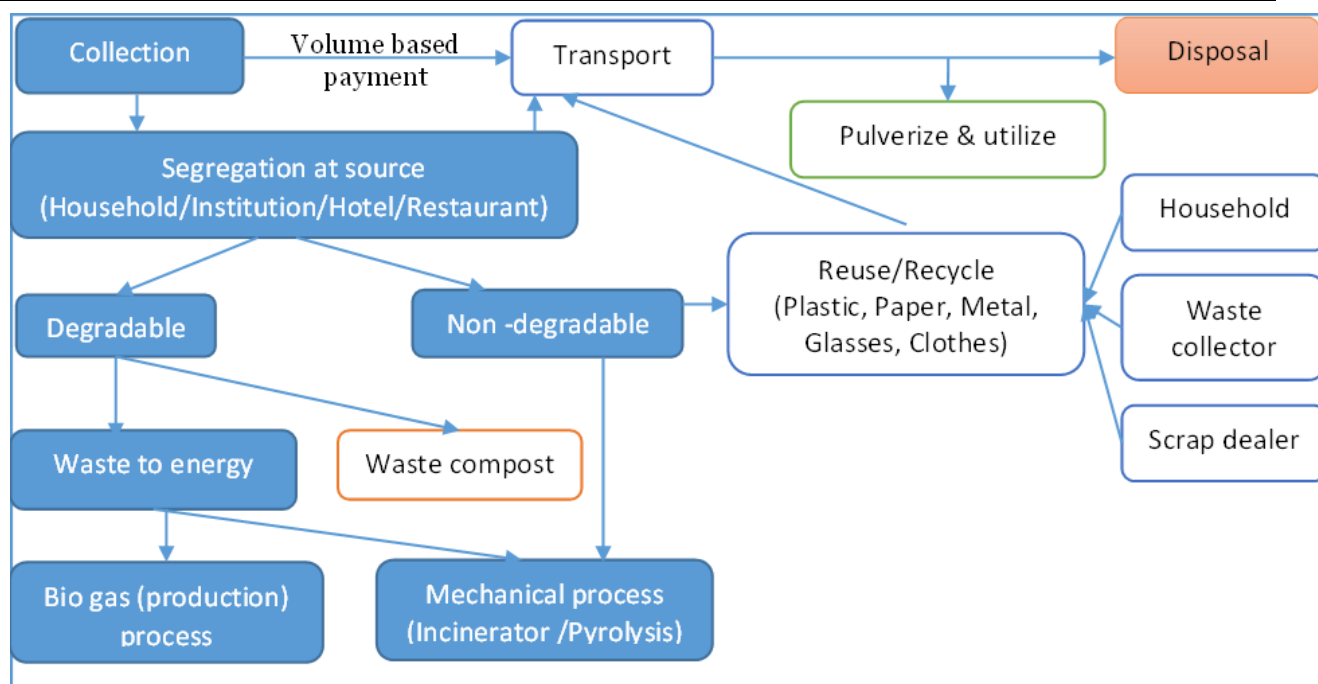


Figure 7- 15:General solution for municipal waste management

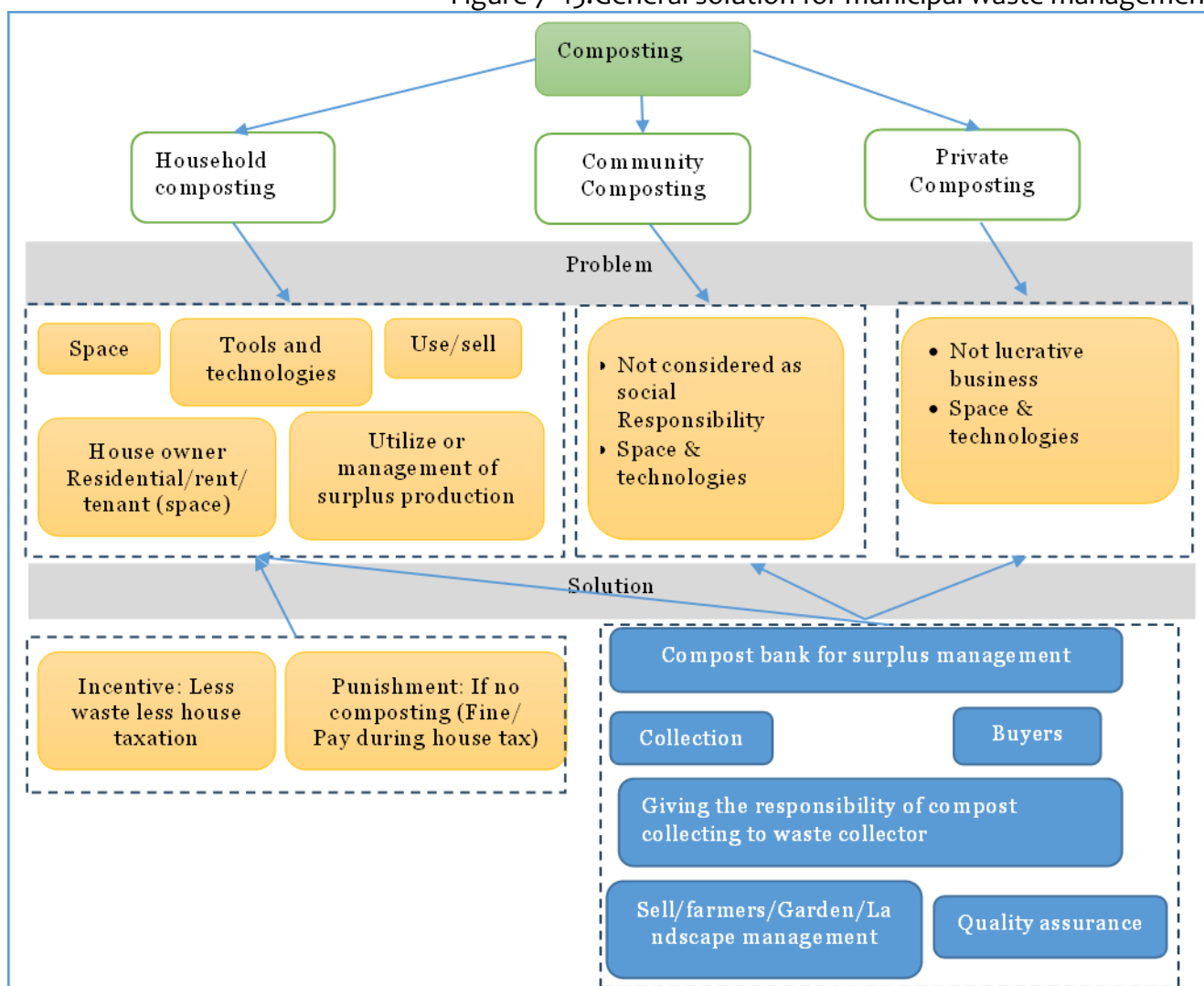


Figure 7- 16: Composting technologies

- Promote household and community level waste management systems including composting with the involvement of the private sector. Adoption of segregation of waste at source. Campaign on “My waste my responsibility”.

- Public awareness programs for waste management and avoid discharge of garbage, plastics, construction wastes and other unused items directly into the rivers through creation and activation of different groups as eco-clubs, youth club, women group etc., developing and disseminating advocacy messages and materials. The awareness programs should be conducted periodically at different locations.
- ii) Ensure the provision of waste water treatment system for all commercial buildings and housing colonies
- iii) Discourage settlement development/expansion in the upstream region of Bagmati River and its tributaries. Carry out restoration activities at degraded landscapes.
- iv) City Sanitation Plan should be prepared covering the entire local area, including new expansion areas, zoning for different sanitation technologies and phased approaches; cost recovery mechanism; and O&M costs for waste water, sewerage and solid waste management.

7.1.4 Capacity building

The following actions are recommended for capacity building.

1. Knowledge management

- Enhance scientific research/ upgrade technical capacity/recognize the innovativeness of youth in related field of Bagmati Civilization and improvement
- Development curricula on Bagmati Civilization for school level
- Provide research grants in related field of Bagmati Civilization and improvement for graduate and post graduate students
- Establishment of digital database management system
- Support domestic technology development for preservation and conservation of natural cultural heritage of Bagmati

2. Institutional strengthening

- Reduce waste generation through prevention, reduction, recycling, reuse in collaboration with local government
- Training for capacity improvement for procurement, GIS, design & management of infrastructure
- Exposure visit (national/International) for knowledge sharing
- Preparation of urban design guideline for each local government in the valley
- Development and Operation of Assets Management System
- Mid Term review of Bagmati action plan

3. Community Engagement

- Community Meetings: Conduct regular meetings with local communities residing along the Bagmati River to seek feedback, discuss concerns, and involve residents in decision-making processes.
- Awareness Campaigns: Implement awareness campaigns to educate the community about the importance of river cleanliness.
- Formation of Community Groups: Establish community-based groups dedicated to river cleanliness and cultural activities. Provide training on waste management practices and river conservation. Offer incentives, such as recognition or small rewards, for active community involvement in river cleaning/ dredging initiatives.

4. Ward Office Collaboration

- Joint Planning Sessions: Collaborate with ward offices in the development of a comprehensive plan for river cleaning/ dredging and cultural activities. These will identify specific roles and responsibilities for both the community and ward offices.
- Resource Mobilization: Work with ward offices to explore potential funding sources and partnerships in mobilizing resources for cleaning tools, waste disposal infrastructure, and cultural event organization.

- Regular Coordination Meetings: Schedule regular coordination meetings between community leaders, residents, and ward office representatives.
- Periodic River Cleaning: Plan regular, scheduled river cleaning events in collaboration with community groups and ward offices and ensure proper waste segregation and disposal.

5. Cultural and Recreational Activities

- Community Festivals: Organize cultural festivals and events along the Bagmati River to promote a sense of community and pride. Showcase local talent, traditions, and art.
- Collaborative Events: Foster a sense of community through shared cultural experiences through partnering with local artists, musicians, and cultural groups for collaborative events.
- Public Art Installations: With the involvement of the communities, install public art along the river, showcasing local creativity and promoting cultural identity.
- Communication and Outreach: Use various communication channels to disseminate information about upcoming events, achievements, and ongoing initiatives. For this, both traditional and digital media can be employed for wider reach.

6. Long-term Sustainability

- Capacity Building Programs: Foster a sense of ownership for the sustained success of initiatives through implementing programs for continuous capacity building, empowering community leaders and local authorities.
- Partnerships and Networking: Foster partnerships with NGOs, environmental organizations, and governmental bodies to enhance resources and expertise. Join municipal or valley networks focused on river conservation, shall be formulated.
- Research and Innovation: Encourage research on sustainable practices for river cleaning/ dredging and community engagement. Also, embrace innovative solutions and technologies to improve the efficiency of initiatives.

7.2 BYLAWS

River channels, riverbank areas, and floodplains are rich ecological areas, providing habitat for a diverse array of birds, fish, plants, and animals. Floodplains are important natural flood storage areas that if left undeveloped, can help prevent flood damages and save lives in the event of a major flood. However, rivers are under considerable development pressure for a variety of uses, including housing developments, dams and hydroelectric facilities, and recreational activities. So, for protection of river control and flood protection assets, bylaws for rivers need to be developed based on the hydrological study.

From the hydrological study, the minimum waterway width on the basis of 5 years return period flood has been recommended (Refer Study report). The water width has been calculated from hydrological analysis, so the width of the right of way of the river has been adopted similar to Bylaws, 2064. But if water width in cadastral is less than proposed water width then the land acquisition is recommended for river and flood protection.

Table 7- 14: Proposed waterways and ROW from river edge

S. N.	River Name	River Stretch	Proposed Water Way (m)	ROW from river edge (m)
1	Bagmati Khola	Baghdwar to Nagmati Khola Junction	20.18	20
		Nagmati Khola Junction to Suryamati Khola Junction	34.33	
		Suryamati Khola junction to Manohara Khola Junction	43.01	
		Manohara Khola Junction to Dhobi Khola Junction	95.35	
		Dhobi Khola Junction to Tukucha Khola Junction	98.95	
		Tukucha Khola Junction to Bishnumati Khola Junction	99.76	
		Bishnumati Khola Junction to Balkhu Khola Junction	111.99	
		Balkhu Khola Junction to Nakkhu Khola Junction	112.94	
		Nakkhu Khola Junction to Katuwal Daha	119.63	
2	Bishnumati Khola	Origin to Lundi Khola Junction	14.95	20
		Lundi Khola Junction to Sangla Khola Junction	26.21	
		Sangla Khola Junction to Mahadev Khola Junction	34.67	
		Mahadev Khola Junction to Baucha Khola Junction	44.86	
		Baucha Khola Junction to Manamati Khola Junction	47.32	
		Manamati Khola Junction to Bagmati Khola Junction	54.55	
3	Manohara Khola	Origin to Salambu Devi Temple area	28.49	20
		Salambu Devi Temple area to Hanumante Khola Junction	41.73	
		Hanumante Khola Junction to Kodku Khola Junction	74.55	
		Kodku Khola Junction to Bagmati Khola Junction	84.76	
4	Hanumante Khola	Origin to Chakku Khola Junction	23.11	20
		Chakku Khola Junction to Godavari Khola Junction	47.66	
		Godavari Khola Junction to Manohara Khola Junction	63.00	
5	Dhobi Khola	Origin to Jamle Khola Junction	9.31	9
		Jamle Khola Junction to Bagmati Khola Junction	25.41	
6	Suryamati Khola	Origin to Bagmati Khola Junction	19.82	4
7	Nakkhu Khola	Origin to Bagmati Khola Junction	38.01	12
8	Balkhu Khola	Origin to Balambu area	34.29	10
		Balambu Area to Bagmati Khola Junction	41.53	
9	Sangla Khola	Origin to Bishnumati Khola Junction	23.44	10
10	Mahadev Khola	Origin to Bishnumati Khola Junction	24.96	10

S. N.	River Name	River Stretch	Proposed Water Way (m)	ROW from river edge (m)
11	Chakku Khola	Origin to Hanumante Khola Junction	25.91	4
12	Manamati Khola	Origin to Bishnumati Khola Junction	24.86	4
13	Bauchha Khola	Origin to Bishnumati Khola Junction	16.30	4
14	Lundi Khola	Origin to Bishnumati Khola Junction	8.90	4
15	Jamle Khola	Origin to Dhobi Khola Junction	6.68	4
16	Tukucha	Origin to Bagmati Khola Junction	15.17	4
17	Kodku Khola	Origin to Manohara Khola Junction	37.12	10
18	Godavari Khola	Origin to Hanumante Khola Junction	38.22	4

Note:

- If waterway width in cadastral is less than proposed waterway width then the land acquisition is recommended to maintain the waterway width.
- The ROW from river edge means from the edge of the river training wall if waterway width in cadastral map is less than Proposed waterway. If the waterway in the cadastral map is more than the proposed waterway, the ROW is from the edge of the river mentioned in cadastral map or NADI UKAS land.
- For public information and awareness, flood inundation area by 50 years return period flood discharge shall be reflected in land use map.
- None of the rivers or streams is allowed to cover.
- ~~In case of developed River Channel, if the water width is less than proposed water width then additional 20m set back is required (Supreme Court Decision, 2078/11/29).~~

Besides the byelaws for Right of River based on hydrological modelling, the byelaws proposed should also address for planning permit and building bye- laws. Some of the issues to be addressed in Planning and Building Byelaws on aspects of conservation and management of Bagmati are mentioned below.

- Urban design concepts should be studied and introduced in bylaws along river corridors so as to preserve cultural heritage landscape and design.
- Building types generating heavy quantities of solid and liquid waste such as vehicle workshops and garages, industries, hospitals etc should be closely monitored. These types of buildings should have their own waste management system within their premises.
- For new construction, building byelaws have made it compulsory for the planning of septic tank and soak pit for management of sewerage but it is not monitored and the majority of households have directly connected the sewer line resulting in more waste pressure to the river. So, local bodies shall strictly monitor the construction of septic tanks and soak pits before providing Completion Certificates to the buildings.
- Plotting permit should be restricted in sloppy land of conservation zone so it supports water recharge of the valley area.
- Regulate sand/stone/soil (quarry site) mining from the KV area.

7.3 ACTION PLAN

7.3.1 Activities/Actions

The activities and actions are proposed for; conservation zone, peri-urban zone and urban zone.

7.3.1.1 Conservation Zone

The strategies and actions for Conservation zone prioritizes ecotourism promotion through cycling/hiking trail; water source conservation; enhance groundwater recharge through rainwater storage/harvesting ponds, water reservoir dams; sustainable landuse management through terrace improvement; promotion of organic farming; relocation of some settlements; gully control and sediment trapping; and reclamation, rehabilitation and preservation of cultural heritages.

Table 7- 15: Actions for Conservation zone

Strategy	Sub Strategies	Action	Indicator
River conservation and Management	Promote ecotourism	Study and development of Cycling/Hiking trail (258km) along the foot hill of the valley	Cycling Track and Hiking Trail along the foot hill of the valley constructed
		Establishment of waste management services along trekking/cycling routes	Waste management services established along trekking/cycling routes
	Conservation of the land use to recharge water source	Relocation of existing settlement of SNP area - Mulkharka Settlement (187 HH), Thulo/Sano Chilaune (70 HH), Okhreni (167 HH) and Kunegaun (45 HH)	No settlements seen within SNP
		Identify and study the existing settlement within Conservation Zone area and prepare the development modality of identified settlements.	Upgraded the development status/level of Settlement within conservation zone
	Sustainable land use management	Terrace improvement and promote multiyear crop cultivation	Multiyear crop cultivation increased
		Regulate land development/plotting through bylaws	Followed the bylaws by land development/plotting project
		Replacement of pine with broad leave forest 321Ha; Godawari-75 Ha, Hanumante-210 Ha , Nakkhu-23 Ha, Bagmati downstream-13 Ha	Covered by Broad leave forest increased
		Construction of check dams for Gully control	Number of check dams for Gully control increased
		Construction of sediment trapping structures	Number of sediment trapping structures increased
	Disaster mitigation	Construction of river training structure with bioengineering (salix and other plantation) or Ghat structure along river corridor area as per appropriate	Length of River protected and number of Ghat structure increased

Strategy	Sub Strategies	Action	Indicator
Cultural/Civilization Rehabilitation	Reclaim, rehabilitate and conserve the cultural and heritage sites along river	Restoration of cultural monuments and sites including approach trail - Tarkeshwar Mahadev, Bajrayogini, Bagdwar, Vishnu dwar and Mahadev Pokhari	Restored and conserved the cultural monuments and sites
		Revival and preservation of Historic Manichud daha, Shankharapur including associated features	Historic daha revived
	Preservation of intangible heritage	Revival and preservation of cultural trails (Sundarijal to Bagdwar, Kotval daha trail, Sankhu to Bajrayogini to Manichud daha, Mahadev Pokhari - Nagarkot trail and Tarkeshwar Mahadev trail	Cultural trails functioned and preserved
River/Water Quality and Quantity Improvement	Encourage organic farming	Promote/encourage urban organic farming through production based subsidy	Urban organic farming increased
		Discourage chemical fertilizer and chemical pesticide with alternatives	Used organic fertilizer
	Conservation and management of water sources	Construction of rain water storage/ harvesting ponds	Number of rain water storage/ harvesting ponds constructed
		Implementation of Nagmati Multipurpose dam Project	Completed the Nagmati Multipurpose dam Project
		Development of Water reservoir dam and water retaining ponds/reservoir	Number of Water reservoir dam and water retaining ponds/reservoir constructed
		Salix plantation along river banks and dhap areas	Length of Salix plantation increased
		Conservation and management of existing water sources	Existing water sources protected

7.3.1.2 Peri-urban Zone

The strategies and actions for Peri-Urban zone prioritize river cleaning/dredging; management of public land; enhance water recharge; promotion of organic farming; implementation of Right of River Way to conserve river area; river training works with bioengineering; development of corridor transport system along rivers; management of Sewerage to prevent direct disposal into river through construction of interceptors and WWTPs; control of direct disposal of solid waste into river by strict law implementation; sustainable landuse management; and reclamation, rehabilitation and preservation of cultural heritages.

Table 7- 16: Actions for Peri-Urban zone

Strategy	Sub Strategies	Action	Indicator
River conservation and Management	Strengthen River Cleaning Program	Periodic cleaning/dredging of rivers	Solid waste and sludge reduced in river
		Mass movement for cleaning campaign in collaboration with local government and community	Activities of cleaning campaign increased
		Promote corridor walkathon in each river	Corridor walkathon route and infrastructure developed
	Management of Public Land along the River Corridor	Verification and Inventory of illegally encroached land along river banks	Illegally encroached land along river banks recorded
		Management of verified informal settlement along the river bank at Khandpakha, Palpakot, Narayanthan, Maijubahal, Khadgabhadrakali, Mandikhatar, Ramhiti	Number of informal settlement resettled and managed
		Identify the Space and establish and maintain Child friendly park along River (Open Space & greenery management)	Number of Child friendly park constructed
		Identify the Space and establish and maintain Youth Friendly Park along river (with Gym equipment)	Number of Youth friendly park constructed
		Identify the Space and establish and maintain Old age friendly park along River (Open Space with Yoga facility)	Number of Old age friendly park constructed
		Salix plantation along river corridor area	Length of Salix plantation increased
		Construction of river training structure with bioengineering (salix and other plantation) or Ghat structure along river corridor area as per appropriate	Length of River protected and number of Ghat structure increased
	Sustainable land use management	Construction of sediment trapping structures	Number of sediment trapping structures constructed
		Promote alternative practices to surface water irrigation	New practices for surface water irrigation observed
	Development of corridor transport system along rivers	Construction of pedestrian and environment friendly smart corridor road network (about 151 km) including road furniture and junction improvement along rivers beyond Proposed Waterway	New pedestrian and environment friendly river road corridor constructed Mobility increased
		Upgrading of existing corridor road network (about 25 km) to pedestrian and environment friendly smart corridor road including road furniture and junction improvement	All existing river road corridor upgraded to pedestrian and environment friendly with high mobility
		Construction of Universal Smart pedestrian bridges at maximum 500m interval in Bagmati River (27), Bishnumati	Number of of Universal Smart pedestrian bridges constructed

Strategy	Sub Strategies	Action	Indicator
		River (1), Hanumante River (1), Nakhu Khola (8), Balkhu Khola (3), Manahara Khola (15), Khodku Khola (2), Mahadev Khola (1), Godawari Khola (2), Manamati Khola (3), Sangle Khola (3), Suryamati Khola (3)	
Cultural/ Civilization Rehabilitation	Reclaim, rehabilitate and conserve the cultural and heritage sites along river	Restoration of cultural monuments and sites including approach trail	Number of cultural monuments and sites restored
		Development of Ghat and Bhakari including metal chain using traditional construction technology beyond the proposed waterway with conserving the existing monuments and sites	Number of Ghat and Bhakari constructed
		Construction of infrastructure with small dam across the river for storage of water of river surface for ritual activities at Salinadi based on Master Plan (Madhav Narayan Temple Bank)	Small dam across the river constructed at Salinadi
	Preservation of intangible heritage	Revival, upgradation and management of Jatra route linking the monument with river, arrangement of physical structures for facilitating the Jatras (Changunarayan Chinnamasta Jatra; Rato Machindranath Jatra - Kotval daha; 12 year festival chariot festival; Tika bhairav jatra)	Number of Jatra route restored
		Revival and preservation of cultural trails/Heritage Trails	Number of cultural trails restored
		Identification, development, implementation of Master plan of cultural landscape to preserve the historic city plan-Tika bhairav to Lele and Chapagaon, Sankhu to Bajrayogini	Cultural landscape restored
River/Water Quality and Quantity Improvement	Management of Sewerage to prevent direct disposal into river	Construction of separate sewerage Treatment System including interceptor network in different location as per topography and load	Number of separate sewerage Treatment System including interceptor network constructed
		Consutruction of DEWATs in community level for upto one MLD capacity based on City Sanitation Plan	Number of DEWATs constructed
	Management of Solid waste disposal directly into river system	Establishment of Control system with installation of CCTV along river corridor	Control system with installation of CCTV established
		Installation of soild waste collection netting across into river at 1km interval	Number of netting across into river for soild waste collection installed

Strategy	Sub Strategies	Action	Indicator
	Encourage organic farming	Promote/encourage urban organic farming through production based subsidy	Urban organic farming increased
		Discourage chemical fertilizer and chemical pesticide with alternatives	Organic fertilizer used
	Conservation and management of water sources	Construction of rain water storage/ harvesting ponds	Number of rain water storage/ harvesting ponds constructed
		Development of Water reservoir dam along rivers and water retaining ponds/reservoir	Number of Water reservoir dam along rivers and water retaining ponds/reservoir constructed
		Conservation of water recharge zone of existing water sources	water recharge zone of existing water sources conserved
		Revival and preservation of Historic/traditional Pokhari	Number of Historic/traditional Pokhari rehabbed
		Revival and preservation of dhungedhara	Number of dhungedhara rehabbed
		Revival and preservation of Raj kulo (Kathmandu, Bhaktapur, and Lalitpur)	Length of Raj kulo rehabbed
		Support and participation of local communities in improving water use efficiency	Water recharge zone conserved
		Promote rainwater harvesting and reverse boring at institutional and household level	Increased number of household with rainwater harvesting and water recharge

7.3.1.3 Urban Zone

The strategies and actions for Urban zone prioritize river cleaning/ dredging; green development with recreational facility along river corridor; implementation of Right of River Way to conserve river area; river training works with bioengineering; development of corridor transport system along rivers; management of Sewerage to prevent direct disposal into river through construction of interceptors and WWTPs; control of direct disposal of solid waste into river by strict law implementation; sustainable landuse management; and reclamation, rehabilitation and preservation of cultural heritages.

Table 7- 17: Actions for Urban zone

Strategy	Sub Strategies	Action	Indicator
River conservation	Strengthen River Cleaning Program	Periodic cleaning/ dredging of rivers	Solid waste and sludge reduced in river
		Mass movement for cleaning campaign in collaboration with local government and community	Activities of cleaning campaign increased

and Management		Promote corridor walkathon in each rivers	Corridor walkathon route and infrastructure developed
		Strengthen the rafting programme and development of supporting infrastructures	Rafting programme operated
		Development of small dam across the Nakhu, Kodku, Godawari and Dhobi Khola with introducing water recreation activities and corridor beautification	Recreation activities operated
	Management of Public Land along the River Corridor	Salix plantation along river corridor area	Length of Salix plantation increased
		Identify the Space and establish and maintain Child friendly park along River (Open Space & greenery management)	Number of Child friendly park constructed
		Identify the Space and establish and maintain Youth friendly park along River (with Gym equipment)	Number of Youth friendly park constructed
		Identify the Space and establish and maintain Old age friendly park along River (Open Space with Yoga facility)	Number of Old age friendly park constructed
		Verification and Inventory of illegally encroached land along river banks (P1)	Illegally encroached land along river banks recorded
		Managment of verified informal settlement along the river bank at Kuriyagaun, Sankhamul, Bansighhat, Thapathali, Balkhu, Pragati Tole, Chandani Tole, Sinamangal (Mahabir Galli), Jagriti Nagar, Gairigaun, Shanti Nagar, Dhirghyau Tole, Airport Gairigaun, Buddha Jyoti Marga, Jagriti Tole, Maoohara, Palpakot, Pathivara, Bishalnagar, Kalopul, Devi Nagar, Shanti Binayak, Anamnagar etc(P1)	Number of informal settlement resettled and managed
	Sustainable land use management	Construction of sediment trapping structures	Number of sediment trapping structures constructed
	Disaster mitigation	Construction of river training structure with bioengineering (salix and other plantation) or Ghat structure along river corridor area as per appropriate	Length of River protected and number of Ghat structure increased
	Development of corridor transport system along rivers	Construction of pedestrian and environment friendly smart corridor road network (about 103 km) including road furniture and junction improvement along rivers beyond Proposed Waterway	New pedestrian and environment friendly river road corridor constructed No traffic congestion at junction

		Upgrading of existing corridor road network (about 25 km) to pedestrian and environment friendly smart corridor road including road furniture and junction improvement	All existing river road corridor upgraded to pedestrian and environment friendly with high mobility
		Construction of Universal Smart pedestrian bridges at maximum 500m interval in Bagmati River (11), Bishnumati River (1), Hanumante River (4), Nakhu Khola (16), Manahara Khola (13), Khodku Khola (3), Godawari Khola (1), Manamati Khola (1)	Number of of Universal Smart pedestrian bridges constructed
		Improvement of Junctions of Bishnumati River Corridor Road at Nayabazaar, Gongabu, Baniyatar, Paropakar; Dhobi Khola Corridor Road at Bijulibazaar, Chabahil; Nakhu Khola Corridor Road at Nakhudole; Khodku Khola Corridor Road at Hattiban; Hanumanre River Corridor Road at Madhyapur Thimi	Mobility increased
		Installment of Traffic Sign, Signal, information Board along corridor road network	Mobility increased
Cultural/ Civilization Rehabilitation	Reclaim, rehabilitate and conserve cultural heritage along river and the sites	Restoration of cultural monuments and sites including approach Trail	Number of cultural monuments and sites restored
		Reconstruction of lost monuments - Shankhamul	Lost monuments of Shankhamul restored
		Development of Ghat and Bhakari including metal chain using traditional construction technology beyond the proposed waterway and conserving the existing monuments and sites	Number of Ghat and Bhakari constructed
		Feasibility study and Development of traditional cremation site and necessary infrastructure - as per demand to minimize the pressure in Bhasmeshwar ghat, Pashupati khetra	Traditional cremation site constructed
		Pedestrian Bridge construction (Nakhu dovan) for ritual procession	Pedestrian Bridge constructed at Nakhu dovan
		Preservation of historic bridges (Jalbinayak gorge bridge, Sundari Ghat Bridge, Teku kalo pul, Kori tafu-Khokana, Koteswor Mahadevsthan, kankeshwari bridge)	Historic bridges preserved and maintained
		Construction of small dam across the river for storage of water of river surface for ritual activities at Shankhamul	Number of Small dam across the river constructed

		Ghat area; Thapathali-Teku Dovan; Brahmayani temple ghat-Dhum Barahi temple ghat (Mangal Tirtha); Guheshwori - Pashupati; Shova Bhagwati temple - Teku dovan	
	Preservation of intangible heritage	Revival, upgradation and management of Jatra route linking the monument with river, arrangement of physical structures for facilitating the Jatras - Rato Machindranath Jatra - Nakhu dovan, , Kankeshwari Jatra, Bijeshwari 12 year jatra, Madhav narayan jatra, Hanuman ghat	Number of Jatra route restored
		Revival and preservation of cultural trails/Heritage Trails	Number of cultural trails restored
		Identification, development, implementation of master plan of cultural landscape to preserve the historic city plan - Shankhamul to Kumbeshwor area, Kankeshwari to Yatkha area, Dhum barahari to Bhaktapur darbar square, Pashupati to Siphel, Gokarneshwor temple to Gokarneshwar village, Balkumari to Tyagal Patan, Shobabhagwati to Swayambhu	Cultural landscape restored
River/Water Quality and Quantity Improvement	Management of Sewerage to prevent direct disposal into river	Construction of separate sewerage Treatment System including interceptor network in different location as per topography and load	Number of separate sewerage Treatment System including interceptor network constructed
		Consutruction of DEWATs in community level for upto one MLD capacity based on City Sanitation Plan	Number of DEWATs constructed
		Construction of WWTP at Teku Dovan	Complete constructed WWTP at Teku Dovan
		Construction of WWTP at Kodku	Complete constructed WWTP at Kodku
		Construction of WWTP at Gokarna	Complete constructed WWTP at Gokarna
		Construction of WWTP at Humumanghat	Complete constructed WWTP at Humumanghat
	Management of Solid waste disposal directly into river system	Establishment of Control system with installation of CCTV along river corridor	Control system with installation of CCTV established
		Installation of soild waste collection netting across into river at 1km interval	Number of netting across into river for soild waste collection installed
	Conservation and management of water sources	Conservation of water recharge zone of existing water sources	Water recharge zone conserved
		Revival and preservation of Historic Pokhari including associated features like well, Jahru, shrines	Number of Historic/traditional Pokhari rehabbed

		Revival and preservation of Raj kulo (Kathmandu, Bhaktapur, and Lalitpur)	Length of Raj kulo rehabbed
		Revival and preservation of dhungedhara	Number of dhungedhara rehabbed
		Promote rainwater harvesting and reverse boring at institutional and household level	Increased number of household with rainwater harvesting and water recharge

7.3.1.4 Other General Action

Certain activities which are valid in all the zones are included as general activities. These activities are either common or associated with knowledge management that will help to build the capacity of HPCIDBC and other agencies and bolster the restoration and conservation of Bagmati River and its tributaries.

Table 7- 18: General actions for strengthening implementation of action plan

Strategy	Sub Strategies	Action	Indicator
River conservation and Management	Sustainable land use management	Amendment of bylaws and endorsement	Amended bylaws and endorsed for preservation of RoR, management of building use, sewerage management, maintaining river water quality, rain water harvesting and sustainable land use practices within valley
		Promotion and support sustainable land management in valley	Sustainable land management project increased
	Management of Public Land along the River Corridor	Reclaim the encroached land along Rivers	Land encroached decreased
		Preparation of master Plan for Preserve and restore river course to minimize flood hazard impact	Master Plan for Preserve and restore river course to minimize flood hazard impact prepared
	Disaster mitigation	Conduct impact assessment of river corridors development (within RoR)	Impact assessment of river corridors development prepared
		Establishment of water gauge station	Number of water gauge station increased
		Installation of flood EWS based on citizen science based model for flood hazard in all study river	Number of flood EWS based on citizen science based model for flood hazard installed
		Detailed Study for implementation of proposed RoR	RoR finalized in 100m interval of each river
Cultural/ Civilization rehabilitation	Reclaim, Rehabilitate and conserve the cultural heritage sites along river	Detail documentation and publication of tangible and intangible heritage	Document of tangible and intangible heritage published
		Creating a heritage utilization strategy and implementing through encouraging the local bodies	Implemented the heritage utilization strategies
		Coordinate for UNESCO listing campaign of tangible and intangible heritage	New tangible and intangible heritage on UNESCO List

Strategy	Sub Strategies	Action	Indicator
		Heritage intervention campaign from local to global level	Decreased the Heritage intervention
		Identification, strategy development and implementation for development of heritage corridors	Identified heritage corridors
		Preparation of river front design guidelines for Kathmandu valley	River front design guideline prepared
		Training to produce skilled manpower for	Skilled human resource available
		a) Production of traditional materials and tools	
		b) Traditional carvings and construction works	
River/Water Quality and quantity improvement	Management of Solid waste disposal directly into river system	Establishment of Control system for CCTV	Control system with installation of CCTV established
		Establishment of structure of Bagmati Police and development of mechanism for operation	Bagmati Police operated
		Study and coordinate for implementation of relocation of waste transfer station from river corridor area	Waste transfer station relocated from river corridor area
		Coordinate with municipalities for promotion of HH level waste management	Decreasing percentage of organic solid waste at landfill site
		Establishment of Vehicle washing center at entry point of KV especially for truck	Vehicle washing center established at entry point of KV
	Management of Sewerage to prevent direct disposal into river	Monitoring and implementation of septic tank at Residential Level	On site sanitation level improved
		Monitoring and implementation of waste water treatment in industries, hotel, hospital and Colony level	Waste water treatment in industries, hotel, hospital and Colony level improved
		Preparation of City Sanitation Plan	City Sanitation Plan prepared by each local unit
	Water source conservation to Increase ground water recharge and river discharge	Monitoring and implementation of water infiltration well/system in all institutions	Number of water infiltration well/system increased
		Monitoring and implementation of rain water harvesting system in all institutional buildings and promotion to residential buildings	Number of rain water harvesting system increased
		Mapping and reclaim encroached water sources area	Encroached water sources area preserved

Strategy	Sub Strategies	Action	Indicator
		Detail documentation and mapping of Rajkulo, Hiti system and Well system within Kathmandu Valley	Detail documentation of Rajkulo, Hiti system and Well system prepared
	Strengthening river quality monitoring system	Establishment of real time monitoring system in all 19 tributaries of Bagmati river system	Real time monitoring system established
		Development of quick response mechanism for pollution management and implementation	Quick response mechanism for pollution management developed
Capacity building	Knowledge management	Enhance scientific research/ upgrade technical capacity/recognize the innovativeness of youth in related field of Bagmati Civilization and improvement	Number of scientific research increased in related field
		Development curricula on Bagmati Civilization for school level	Bagmati Civilization topic studied in school level
		Provide research grants in related field of Bagmati Civilization and improvement for graduate and post graduate students	Number of research grants for graduate and post graduate students increased
		Establishment of digital database management system	Digital database management system established
		Support domestic technology development for preservation and conservation of natural cultural heritage of Bagmati	Improved domestic technology and implemented
	Enhance community participation in BAP implementation	Establish and capacitate ward-level community organization along the river corridor	Strengthen the ward-level community organization along the river corridor
		Develop up-stream and downstream linkages	Interaction between up-stream and downstream increased
		Increase community participation and ownership in asset management and development activities	Community participation increased
		Encourage community involvement in monitoring and maintaining local infrastructures through Citizen Reporting System	Citizen Reporting System operated
	Institutional strengthening	Reduce waste generation through prevention, reduction, recycling, reuse in collaboration with local government/s	Decreasing percentage of organic solid waste at landfill site
		Training for capacity improvement for procurement, GIS, design & management of infrastructure	Skilled human resource for procurement, GIS, design & management of infrastructure increased

Strategy	Sub Strategies	Action	Indicator
		Exposure visit (national/International) for knowledge sharing	Number of Exposure visit done
		Preparation of urban design guideline for each local government within the valley	Urban design guideline for each local government within the valley prepared
		Development and Operation of Assets Management System	Assets Management System operated
		Mid Term review of Bagmati action plan	Mid Term review report prepared
		Updating the Bagmati action Plan	Bagmati action Plan updated

7.4 INVESTMENT PLAN

The activities and actions are proposed under three broad sectors; River Conservation and Management, Cultural/Civilization Rehabilitation and River/Water Quality and Quantity Improvement. Certain activities which are valid in all the zones are included as general activities. For effective implementation, the activities/action and budget are grouped in short-term (0-5 years), first mid-term (6-10 year), second mid-term (11-15 year) and long-term (16-20 year) periods. The implementation of proposed activities requires 68,341 million NPR in the short term, 70,185 million NPR in the first mid-term, 55,315 million NPR in the second mid-term and 31,468 million NPR in the long-term implementation period. The total tentative budget required for the twenty year action plan is 225,311 million NPR. Zone-wise implementation of proposed activities requires about 73,837 million NPR for Conservation Zone; 48,089 million NPR for Peri-Urban Zone; 1,00,214 million NPR for Urban Zone and 3,169 million NPR for general projects. Detailed budget summary is presented in Table 7-19. The detailed investment plan is attached in the annex.

Table 7- 19: Investment Plan for 20 years

S. N .	Activities/Plan	Periodical Target (Budget in Lakh)				Total (NRs.)
		0-5	5-10	10-15	15-20	
A	Conservation Zone					
	River conservation and Management	108,696.63	49,275.17	272.25	257.25	158,501.30
	Cultural/Civilization rehabilitation	1,325.00	625.00	125.00	125.00	2,200.00
	River/Water Quality and quantity improvement	95,869.00	149,306.00	166,250.00	166,250.00	577,675.00
	Sub Total	205,890.63	199,206.17	166,647.25	166,632.25	738,376.30
B	Peri-Urban Zone					
	River conservation and Management	85,820.75	126,088.75	87,962.00	16,540.00	316,411.50
	Cultural/Civilization rehabilitation	3,950.00	3,300.00	5,750.00	5,500.00	18,500.00
	River/Water Quality and quantity improvement	34,132.50	38,102.50	58,650.00	15,100.00	145,985.00
	Sub Total	123,903.25	167,491.25	152,362.00	37,140.00	480,896.50
C	Urban Zone					
	River conservation and Management	141,550.93	93,976.17	9,821.90	4,050.00	249,399.00
	Cultural/Civilization rehabilitation	26,035.00	30,675.00	7,850.00	500.00	65,060.00
	River/Water Quality and quantity improvement	175,746.00	202,428.00	209,612.00	99,900.00	687,686.00
	Sub Total	343,331.93	327,079.17	227,283.90	104,450.00	1,002,145.00
D	General	10,294.00	8,083.00	6,861.00	6,461.00	31,699.00
	Sub Total	10,294.00	8,083.00	6,861.00	6,461.00	31,699.00
	Total	683,419.81	701,859.59	553,154.15	314,683.25	2,253,116.80

7.4.1 Programs/Projects for Short-Term

In the short-term, implementation of projects and programs require 68,341 million NPR in total, 20,589 million NPR in the Conservation zone, 12,390 million NPR in Peri-Urban zone, 34,333 million NPR in Urban zone and 1,029 million NPR for general projects. The majority of short-term activities are focused with the Conservation area in catchment improvement and conservation of water sources. The activities in Peri-Urban and Urban Zone are associated with green open space, road development, rehabilitation of monuments, and water treatment activities.

7.4.2 Programs/Projects for First Mid-Term

For the implementation of projects and programs within first mid-term period there require 70,185 million NPR in total; 19,920 million NPR in Conservation zone; 16,749 million NPR in Peri-Urban zone; 32,707 million NPR in Urban zone and 808 million NPR for general projects. A large portion of first mid-term activities are focused within the urban zone in corridor development, rehabilitation of monuments, and water treatment activities. The activities associated with Peri-urban are river cleaning, water treatment and enhancing water recharge while activities in the Conservation zone are landuse management and catchment improvement.

7.4.3 Programs/Projects for Second Mid-Term

Implementation of projects and programs within second mid-term period requires 55,315 million NPR in total; 16,664 million NPR in Conservation zone; 15,236 million NPR in Peri-Urban zone; 22,728 million NPR in Urban zone and 686 million NPR for general projects. Second mid-term activities centralize around activities in urban zones that will focus continuously in implementation of cleaning and water treatment related activities.

7.4.4 Programs/Projects for Long-Term

For long-term time intervals, projects and programs implementation requires 31,468 million NPR in total; 16,663 million NPR in Conservation zone; 3,714 million NPR in Peri-Urban zone; 10,445 million NPR in Urban zone and 646 million NPR for general projects. Long-term activities centralize around activities in Urban and Peri-Urban zones that will focus on maintaining cleaning and water treatment related activities.

8. IMPLEMENTATION PLAN

8.1 IMPLEMENTATION STRATEGY AND MONITORING PLAN

The long-term stability of the efforts of Bagmati Action Plan can be ensured through planning and implementation but there is also a range of administrative, management and other supporting elements. For example, by ensuring long-term revenue streams to maintain or refresh capital works, by establishing appropriate institutional arrangements to ensure alignment with long-term development plans, and through regulatory arrangements that protect the gains made through actions and avoid undermining of those efforts through ecologically harmful practices within the river system.

Administrative, management and other supporting elements beyond the technical and practical aspects of developing and implementing the Bagmati Action Plan includes:

- Policies and laws to define the overarching objectives and principles for actions, as well as to provide a head of power for certain actions
- Institutional arrangements to establish the mandate and accountability for action plan, and to coordinate between different institutions
- Stakeholder engagement to ensure different views are considered as part of the planning process and to strengthen political support, at all levels, for action
- Funding to ensure that the financial resources are available to support implementation as well as to manage ongoing costs
- Science, monitoring and research to provide a basis for rational decision making, as well as to assess compliance and impact (through monitoring) and to support adaptive management
- Tools for giving effect to elements of the action plan's strategy, particularly through regulatory controls and other planning systems.

The implementation strategies for the Bagmati Action Plan are broadly categorized under the following headings:

8.1.1 Activities and Milestones

The Action Plan has provided a number of activities to achieve the goal in the next twenty years. These activities are bounded with a time frame and target indicator. It is expected that with minimum hurdle these activities will be completed smoothly, though there can appear problems which may hinder speed of execution. It is expected that HPCIDBC will meet each target projected but in case of unforeseen obstacle study suggest to analyze reasons behinds; budget deficiency, political/social obstacle, legal conflict, and other, in periodic meetings, so that impact of such obstacle can be minimized in coming years.

8.1.2 Role and Responsibilities

There are different governmental, non-governmental and civil society organizations, and other stakeholders working in restoration, enhancement and management of Bagmati River and its tributaries. HPCIDBC is the institution with strong legislative power and the most capable institution for planning, policy and decision-making and also for controlling and regulating

activities in the Bagmati River and its tributaries. Ministry of Physical Infrastructure and Transport, Ministry of Forests and Environment, Ministry of Federal Affairs and General Administration, Department of Urban Development and Building Construction, Department of Land Management and Archive, Department of Archeology, Department of Water Induced Disaster Prevention, KVDA, KUKL, Department of Water Supply and Sewerage Management, Department of Water Resources and Irrigation, WECS, Shivapuri Nagarjun National Park, Pashupati Area Development Trust, Kathmandu Valley Water Supply Management Board, Melamchi Water Supply Board are among other government line agencies that are implementing many activities which help in protecting river ecosystem. Besides, the local governments of Kathmandu valley, User committees and community based organizations, NGOs and private sectors are also among the stakeholders working for the improvement of rivers in Kathmandu valley.

For the effective implementation of the Bagmati Action Plan:

- All these stakeholders should have strong coordination and collaboration and the role of each should be defined to avoid conflict and duplication of works and optimize the resources.
- All the stakeholders must be involved in an integrated and coordinated fashion both during the planning and implementation of activities.

Roles of different agencies working for improvement of rivers in the valley have to be specified clearly to avoid conflict and duplication of the work and optimizing the resources. Agencies identified as potential stakeholders and their roles for implementation of the action plan are presented below.

Table 8- 1: Working agencies and role & responsibilities

Agencies/ Institutions	Role and responsibilities
Municipalities	• Coordination with local stakeholders and political groups for implementation of action Plan • Review, Supervision & monitoring • Implementing efficiently the laws, bylaws and codes that could help directly or indirectly the river ecosystems in the valley • Manage the solid waste and waste water generating within local unit, which impact in the river environment through awareness campaigns and strengthening of waste management system • Discourage settlement development/expansion in upstream region of Bagmati River and its tributaries. • Regulate & monitoring the sand/stone/soil (quarry site) mining
Pashupati Area Development Trust	• Develop and implement the Master Plan of Pashupati area incorporating the Bagmati action Plan • Management of cremation waste and other generating waste within Pashupati area • Review, Supervision & monitoring • Coordination with stakeholders for implementation of Master Plan aligned with Bagmati action plan
KVDA	• Implementation of comprehensive master plan of KV aligned with Bagmati action plan • Review, Supervision & monitoring • Coordination with stakeholders for implementation of Master Plan aligned with Bagmati action plan • Development of riverfront spaces for recreational and other public activities, with disaster management aligned with Bagmati action plan

Agencies/ Institutions	Role and responsibilities
Kathmandu Upatyaka Khanepani Limited (KUKL)	• KUKL should follow the norms and regulations for using water from rivers and groundwater so that the impact of use of such natural resources has minimal impact on the river ecosystem. • KUKL should also manage the sewerage network and make sure the waste water discharge into the river should meet the national quality standard. • KUKL should develop, operate and maintain major waste water treatment systems in the valley
NGOs and private sector	• NGOs and private sector can play significant roles in activities such as awareness campaign, community based waste management, cleaning/dredging campaign, plantation, protection of river side cultural and heritage, management of parks and other public utilities along the river banks
Shivapuri National Park (SNP)	• SNP's role should be implementing activities identified by action plan inside SNP's area. These activities are the activities concerned with water discharge increment, protecting and maintaining biodiversity, managing waste produced by tourists and picnikers and settlements inside the national park, etc.
Local guthis and committees	• Regular maintenance, sustainable use and conservation of tangibal and intangible heritage.

8.1.3 Promotion Strategy for Private Sector and Civil Society

The private sector had proved itself more efficient globally in management of projects and effective service delivery. By involving private sector investment, it can improve operating efficiency through new technologies, innovation and transparency in organizational structures. Private sector investment guided by the motto of the profit making, so not all projects are suitable for public private partnership (PPP). There should exist specific conditions that entice private sector to deliver infrastructure assets and provision of services. But when the private sector is involved in execution of the project, historically it is found that efficiency and transparency procured. In other words it can be said that the benefits of involving the private sector in the delivery of infrastructure includes (i) efficient use of the resources, (ii) improved asset and service quality, (iii) improved public sector management, and (iv) overall improvement in public sector procurement. (ADB 2012). In the present state of government responsibility, the role of the private sector is inevitable for development activities in the society. To increase the role of PPP, investment activities have proposed as:

- PPP model can be implemented in development and operation of Sewerage treatment plant and multipurpose reservoir/storage project, or operational management contract method can be best suitable for this type with ownership to public sector. The private sector can be given incentives of tax exemption of 10% and benefit sharing of 80-20%.
- Open public spaces can be given on lease for 10-30 years to the private sector to develop multipurpose parks etc. depending on the location.
- Small scale projects can be given to community level for development and operation

8.1.4 Budget

Tentative budgets for activities implementation are proposed in the report, though actual investment only can be realized after a real field scenario. As HPCIDBC has been working with unpredicted annual budget size, and similar activities also executed by other development partners (municipalities, NGOs, KUKL, KVDA, DWRI, DECS, Archeological department, etc.) in such situation it can execute activities in partnership with sustainable budgets. In the long term all projects are handed over to line agencies, it also can develop partnership with stakeholders from implementation phase. However, international sources of funds are unstable, but they also can contribute for the development of selected projects.

8.1.5 Monitoring and Reporting

Monitoring against defined and measurable objectives is critical for assessing the effectiveness of river restoration and conservation measures and for guiding adaptive management. Monitoring programs should validate (or disprove) the scientific assumptions that underpin the restoration and conservation strategy and should provide evidence about whether the projects have been successful. Monitoring should be built into the design of river restoration and conservation.

Projects at the start, and monitoring should begin at an appropriate time period before restoration and conservation actions begin. An appropriate scale of monitoring that will detect the impacts of actions over a relevant timeframe is required and should continue long after the actions have been completed.

The monitoring and evaluation plan should always refer to the overall objectives of the river restoration and conservation project or program, to specific strategies (including theories of change) and to details of specific measures that will be conducted. The key feature of any plan is the list of what is being monitored, how that monitoring is to take place, who is responsible for undertaking the monitoring and the frequency and time-scale over which monitoring should happen. Typically, a monitoring plan will provide a table of proposed locations, dates and methods of data collection.

The monitoring plan should consider the following:

- **Baseline Monitoring:** Characterizes the existing physical, ecological and socio-economic conditions for planning or future comparison
- **Activity Monitoring:** Determines if project was implemented as planned
- **Financial Monitoring:** Helps to assess cost-effectiveness and value for money and facilitates accountability
- **Impact Monitoring:** Determines if actions had desired effects on priority areas, river function, river health and catchment processes; and whether the hypothesized cause and effect relationship between action and response were correct
- **Surveillance Monitoring:** Determines changes in conditions over time, including changes not attributable to river rehabilitation

Regular monitoring is required from the concerned authorities and similarly feedbacks to the implementers. HPCIDBC must take the responsibility for overall monitoring. Besides, a participatory or joint monitoring system can be established where representatives from concerned stakeholders participate and monitor the programme. This report provides only the means of verification for the activities and actions proposed for Bagmati Action Plan. For effectiveness each implementing agencies have to prepare their own monitoring plans.

8.1.6 Strategy Review and Adaptation

Study has provided implementation strategies for next twenty years, if there will be minimal change in political, socio-economic and technological scenario within the country. Generally plan documents are reviewed at five year interval, but here due to multi-stakeholder participation, short term review can be conducted between two and three year. Technology has been creating remarkable differences in saving cost and time of project implementation globally, so latest verified technological adaptation are also suggested for each term plan review.

8.2 OWNERSHIP, OPERATION, MANAGEMENT AND MAINTENANCE

Metropolitan cities & municipalities are local stakeholders of infrastructures developed along the river corridor. These local units are not capable (financial resource and human resources) to handle all developed infrastructures. So based on the following classification of infrastructure, ownership, operation, management and maintenance of infrastructures should be handed over to the capable institutions.

Table 8- 2: Classification of Projects

Project classification	Description
Beautification and Recreation Projects	● Park ● River side Beautification ● Pedestrian Bridge ● Pokhari/ Dhungedhara/Well ● Rajkulo
Water Storage Projects	● Multipurpose dam Project ● Water reservoir dam and water retaining ponds/reservoir
Transport Project	● Road Corridor along River ● Motorable Bridge across river
Waste Management Project	● Waste water treatment System ● Sewerage network (Trunk Line)
Tangible & intangible Heritage Projects	● Temple and supporting infrastructures ● Cremation and supporting infrastructures

Systematic maintenance is essentially required to ensure the quality of structures. Therefore, inspections, maintenance, and repairs must be continued at the operation and maintenance stages. Regular, Periodic and recurrent maintenance should be done based on the annual inventory report and annual asset management plan. These activities extend the longevity of infrastructures. Structure present in Figure 8-1 is proposed for Repair and Maintenance of Infrastructures.

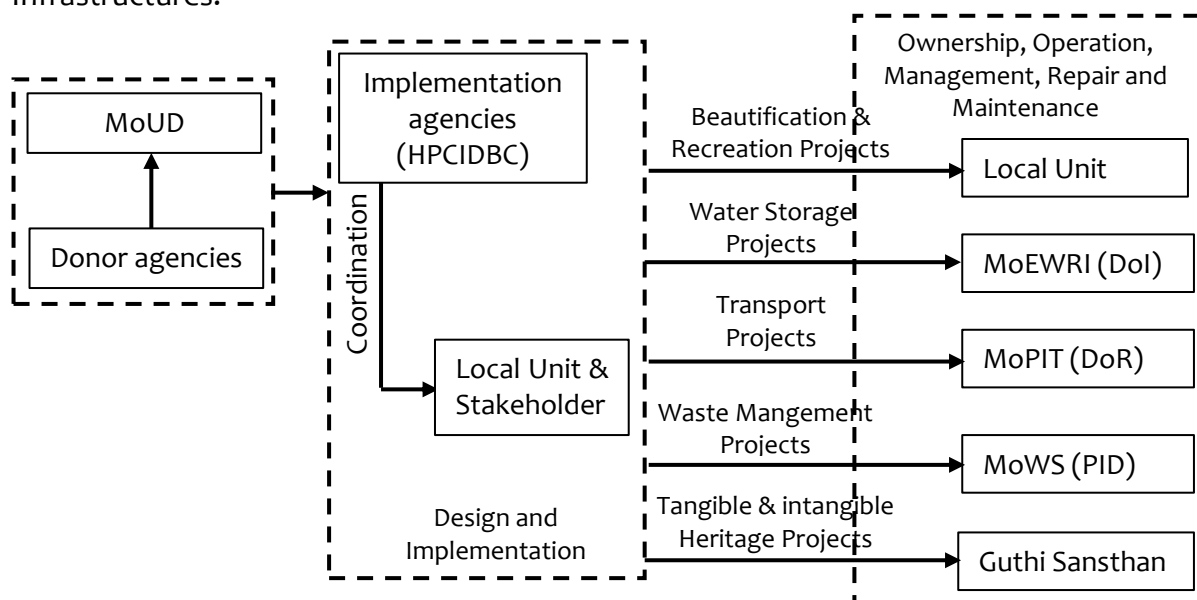


Figure 8- 1: Proposed Structure for Ownership, Operation, Management, Repair and Maintenance of Infrastructures

Except emergency maintenance, the integrated annual and fifth year maintenance plan shall be prepared by respective agencies creating the maintenance committee. Permission shall be needed with the committee to construct or repair any infrastructures along the river corridor by other agencies.

8.3 INSTITUTIONAL DEVELOPMENT PLAN

The plan identifies the needs for HPCIDBC to be responsible for monitoring activities taking place in and around the Bagmati River and its tributaries. However, strengthening of HPCIDBC is important to achieve this priority. The plan recommends reforming the existing organizational structure of HPCIDBC to address the issues and activities highlighted in the plan.

8.3.1 Proposed Institutional Structure

HPCIDBC is an authorized organization for the implementation of activities for conservation and development along Bagmati and its tributaries for the preservation of Bagmati civilization. The institution has been working for the improvement of the river water quality and quantity and at

the same time preservation of monuments & heritage along river banks since it was established. Due to the existence of multiple development partners and line agencies, conflict of right between multiple stakeholders hindered smooth implementation & operation of projects, though, there has been improvement in coordination between development partners in recent years.

Currently HPCIDBC is preparing an action plan targeting vision for the next twenty years. GIS inventory, improvement of river ecosystem, conservation of valley ecosystem, development of river banks, etc. by making strong coordination with its development partners and local and national line agencies are major objectives of the plan. For the smooth operation of an action plan, a strong institutional setup is prerequisite. HPCIDBC has a strong and full of expertise institutional setup, but for the smoother running of the new action plan, some subjective experts and sections can be included in the existing institutional frame.

- ❖ Coordination and GESI units can be added to minimize dispute of rights between development stakeholders.
- ❖ Environment unit with Environmental Expert, Planning unit with Geological Expert and Landscape Planner can be added in institutional frame.
- ❖ GIS inventory system requires regular updates, so either one GIS unit or GIS team in Survey section can be added for the implementation of current action Plan.

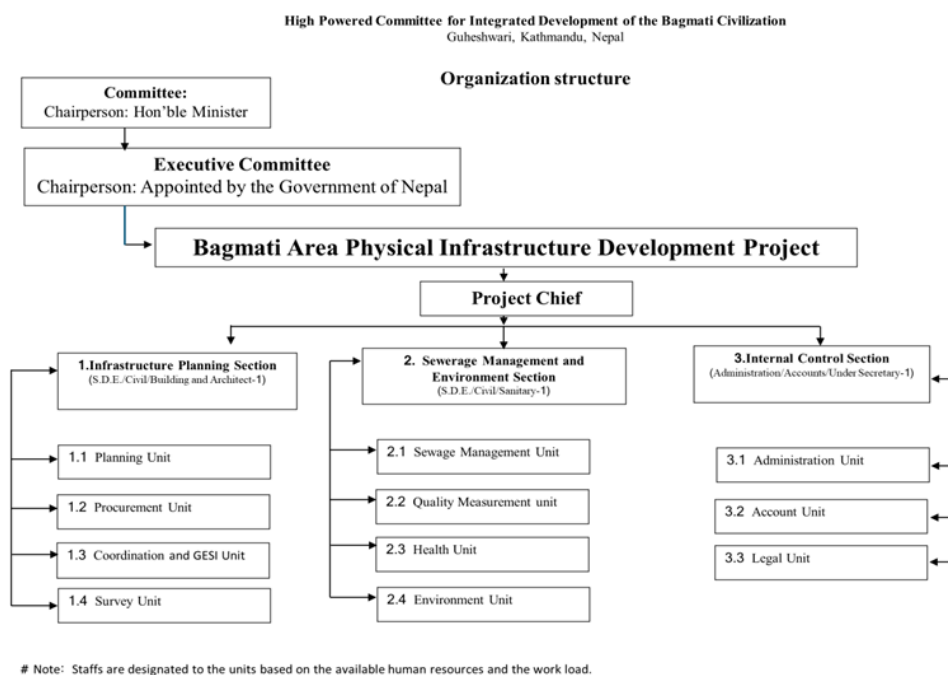


Figure 8- 1: Proposed Institutional Structure

9. CONCLUSION AND RECOMENDATION

9.1 CONCLUSION

The High Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC) has been working for the restoration of Bagmati civilization in the Kathmandu Valley. Major objectives are to ensure cleanliness of Bagmati River and its tributaries, improving river flow and restoration of cultural and historical shrines/heritages in river banks of Kathmandu valley. Prior to 2009, HPCIDBC was working for the improvement of the environment in Bagmati river system, including construction, monitoring and supervision in demand based systems. The Bagmati Action plan 2009-14 then provided a structural working frame to the institution guiding most river restoration activities. However, despite several interventions, the Bagmati River and its tributaries remain critically polluted and its space continues to be encroached upon for different purposes. This twenty-year action plan is prepared acknowledging the necessity for further interventions.

This plan comprises GIS inventory of 19 rivers including Bagmati River in the valley, hydrological modeling of these rivers and actions for restoration and conservation of river ecosystem and cultural heritage.

GIS inventory system of the 19 rivers provides current information regarding land use, infrastructure development, tangible and intangible cultural heritages, green open spaces and water sources. Besides the inventory of the structures, the existing scenario of project area in aspects of urban development scenario, environmental and disaster issues, aquatic biodiversity, natural hazard and socio-economic issues are analysed. Development of Physical amenities along Bagmati River Basin for conservation and **preventing** encroachment of river land is undergoing under HPCIDBC which needs sectoral and institutional integration.

This report also provides hydrological modeling with possible flood inundation area and proposes River Right of Way of each river for 5, 10 and 50 years return period. Based on hydrological modeling, field survey and site visit, most of the Valley Rivers are found with insufficient width and depth for safe passage of 5 years return period flood. Construction of infrastructures and expansion of settlements in the River Right of Way area are mainly responsible for shrinking river waterways. Soil erosion, gully erosion, and increasing land plotting and agriculture in sloppy land are responsible for rise in river beds. Solid waste dumping, direct discharge of sewer and industrial effluents and use of chemical fertilizers and pesticides in agriculture are found responsible for water pollution which is enhanced by depletion of water discharge caused by catchment degradation. Increasing population, expanding settlements, exploitation of ground water, increasing commercial/industrial activities and decreasing water conservation systems are degrading water quality and quantity in rivers of Kathmandu valley. Changing population/ethnic composition, decreasing cultural beliefs/values, and increasing longings for monetary assets are found major responsible influences for degradation and encroachment of physical and intangible heritage associated with rivers. Increase in population, expansion of settlements along rivers increases

development need of the area which are found influencing heritages and river ecosystem negatively within the valley.

The land cover change in KV reveal the rapid urbanization with 4.56% annual increment in built up during last decade which is about four times higher than that of the period from 2000 to 2010. From the trend of population growth, the population of KV is projected 4.39 million and 5.42 million for year 2034 and 2044.

The new zonation concept has been developed on the basis of watershed ecology and urban growth scenario of Kathmandu Valley: i) Conservation Zone, ii) Peri-Urban Zone, and iii) Urban Zone. Conservation Zone is forest area surrounding the valley while the Urban Zone includes the urban core area of valley within the boundary of ORR. The area between the Conservation Zone and Urban Zone is defined as Peri-Urban Zone. Based upon requirement of each zone, action plan has been proposed. The activities and actions are proposed under three broad sectors; River Conservation and Management, Cultural/Civilization Rehabilitation, River/Water Quality and Quantity Improvement and Capacity building. Certain activities which are valid in all the zones are included as general activities. For effective implementation, the activities/action and budget are grouped in short-term (0-5 years), first mid-term (6-10 year), second mid-term (11-15 year) and long-term (16-20 year) periods. The total tentative budget required for twenty year action plan is 2,25,311 million NPR. Zone-wise implementation of proposed activities requires about 73,837 million NPR for Conservation Zone; 48,089 million NPR for Peri-Urban Zone; 1,00,214 million NPR for Urban Zone and 3,169 million NPR for general projects.

The Bagmati Action Plan 2024-2044 is prepared for restoration and conservation of Bagmati River system in integrated and coordinated approach. The successful implementation of the Action Plan not only brings the river back to life but also enhances the overall urban environment of the Kathmandu valley. Besides planning and implementation, a range of administrative, management and other supporting elements should also be considered to ensure stability of the efforts of Bagmati Action Plan. These are policies and laws; institutional arrangements; stakeholder engagement; science, monitoring and research; and tools for giving effect to elements of the action plan's strategy through regulatory controls and other planning systems.

Regular monitoring is very essential from the concerned authorities to identify how effectively and efficiently the proposed activities are implemented. Short term review can be conducted at every five-year interval for creating remarkable differences in saving cost and time of project implementation. HPCIDBC is an authorized organization for implementation of the proposed activities for conservation and development along Bagmati and its tributaries for preservation of Bagmati civilization on the basis of prepared action plan. For the smooth operation of the action plan, strong institutional setup is prerequisite. HPCIDBC has strong and full of expertise institutional setup, but for smoother running of new action plan, some of subjective expert and sections such as environment unit with Environmental Expert, Geological Expert and Landscape Planner, GIS Unit with GIS Expert, IT Expert needs to be added in institutional arrangement.

9.2 RECOMMENDATION

Based on the inventory, stakeholder consultations, hydrological modeling, and various analyses, the following recommendations are made for the successful implementation of the Bagmati Action Plan 2024-2044 and to support the goals and vision for the restoration of the Bagmati River and its tributaries:

- Restoration of RoRW, periodic cleaning/dredging of river bed, provision of river training structures, retaining wall and flood embankments are effective measures for flood mitigation in the areas.
- Adoption of disaster mitigation measures; bio engineering, gully control, sediment trapping, siltation management are necessary steps to manage rivers and watershed.
- Management of Informal settlements along the river corridor for conservation of riparian land.

- Amendment of bylaws and endorse for sewerage management, maintaining river water quality, rain water harvesting and sustainable land use practices within valley.
- Preservation of tangible and intangible cultural heritage through Reclaim, Renovation and Reconstruction.
- Development of sewerage system; interceptor, WWTP, DEWATS along rivers in the valley and implement sewerage and waste water treatment plant in institution/housing of the valley.
- Develop infrastructure and promote activities for water conservation/harvesting and ground water recharge in the valley.
- Promote ecotourism to increase ownership over resources by the people from valley.
- Involve the community and ward offices for periodic river cleaning/ dredging, cultural and recreational activities to be encouraged in urban zone.
- Develop information system to provide current status of assets associated with rivers such as infrastructure, heritages, land availability, water discharge and quality, and catchment area.
- Land subdivision (plotting) and settlement development to be discouraged in the conservation zone.
- Afforestation programme to be launched with the involvement of community.
- Urban agriculture, terrace farming and urban forestry to be encouraged in peri-urban zone.
- Management of solid waste at the household and community level to be emphasized. Reduce, reuse and recycle (3R) concept to be applied in solidwaste management
- River management should adapt to changing social conditions
- Systematic maintenance is required to ensure long-term quality of infrastructures.
- To promote private sector and civil society;
 - PPP model can be implemented in development and operation of Sewerage treatment plant and multipurpose reservoir/storage project, or operational management contract method can be best suitable for this type with ownership to public sector. Private sector can be given incentives of tax exemption of 10% and benefit sharing of 80-20%.
 - Open public spaces can be given on lease for 10-30 years to private sector to develop multipurpose parks etc. depending on the location.
 - Small scale projects can be given to community level for development and operation.
- Coordination and collaboration among governmental, non-governmental and civil society organizations, and other stakeholders working in restoration, enhancement and management of Bagmati River and its tributaries. Role of the each should be defined to avoid conflict and duplication of works and optimize the resources. All the stakeholders must be involved in an integrated and coordinated fashion both during the planning and implementation of activities.
- HPCIDBC must take the responsibility for overall monitoring. A participatory or joint monitoring system can also be established where representatives from concerned stakeholders participate and monitor the programs. For effectiveness each implementing agencies have to prepare their own monitoring plans.
- Efforts should be made to strengthen HPCIDBC in terms of technical capacity, financial resources and legal back up. For institutional strengthening this action plan proposes the inclusion of Coordination and GESI unit to minimize dispute of right between development stakeholders; Environment unit with environmental expert, planning unit with geological expert and landscape planner and survey unit with GIS team in current organizational structure of HPCIDBC.
- The government should ensure adequate resources to ensure effective implementation of action plan in reaching goals and ultimately the vision.

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Annex I: Methodology for Soil Erosion and Landslide Hazard Mapping

A. Methodology for Estimation of Soil Erosion

Several empirical models have been developed for estimating soil erosion in watersheds; among these, the most used during the past 30 years is the Universal Soil Loss Equation (USLE). Its revised version, i.e., Revised Universal Soil Loss Equation (RUSLE), has been employed in preparation of this report. The RUSLE is an empirical model for the prediction of the long-term average annual rate of soil erosion (expressed in tons/ha/yr), by combining several factors having a bearing on the erosion rate, namely; rainfall erosivity, soil erodibility, steepness and length of the slope (topography), vegetation cover and conservation support practices. The input parameters were generated in the GIS platform in various thematic maps used in equation (1) (Renard et al., 1997).

$$A = R * K * L S * C * P$$

Where,

A: computed annual soil loss per unit area [ton/ha/year]

R: Rainfall erosivity factor, an erosion index for the given storm period in [MJ mm·ha⁻¹·hr⁻¹·year⁻¹]

K: Soil erodibility factor

LS: Topographic factors

C: Cover-management factor-ratio of soil loss P: Support practice factor-ratio of soil loss with a support practice contour tillage, strip cropping, terracing to soil loss with row tillage parallel to the slope.

Rainfall erosivity factor (R): The rainfall-runoff erosive factor, R, is calculated from the following relationship (Morgan, 1984):

$$R = 79 + 0.363p$$

Where, p is the average annual rainfall, mm. The annual rainfall was obtained from the WorldClim database that provided 1 km spatial resolution climatic data (Fick and Hijmans, 2017).

Soil erodibility factor (K): The soil erodibility factor K is a measure of erodibility for a standard condition. Since soil erodibility factor K represents soil's susceptibility to erosion and the amount and rate due to runoff effect. Soil data of project area for both Nepal and China were obtained from the Soil and Terrain Database (SOTER), compiled and prepared by World Food Organization (FAO). Similarly, K factors were initially extracted from the monograph published by the US Department of Agriculture (USDA, 2000) with necessary modification referring to the past studies on similar mountain regions (Gardner and Gerrard, 2003; Maqsoom et al., 2020; Veerananarayana, Raju and Wuletaw, 2019).

Characteristics and K factors of soil types

Soil types	Sub units	Characteristics	K (tons ha ⁻¹ h ha ⁻¹ MJ ⁻¹ mm ⁻¹)	Justification
Combisols	Eutric Combisols	Eutric Combisols are developed in medium and fine-textured materials derived from a wide range of rocks, mostly in colluvial.	0.25	These soils are present on steep slopes are best kept under forest
	Gleyic cambisols	The Gleyic Combisols of alluvial plains are highly productive 'paddy soils'	0.25	These soils are present on flat to gentle slopes

Soil types	Sub units	Characteristics	K (tons ha h ha ⁻¹ MJ-1mm-1)	Justification
	Chromic Cambisols	Soils are developed in medium and fine-textured materials with Triassic and Cretaceous limestones are investigated	0.5	These soil though less fertile, are used for (mixed) arable farming and as grazing and forest land
Luvisols	Chromic luvisols	Characterized by a dark coloured sandy clay loam texture and moderately well drained	0.3	

Topographic Factors (LS)

The topographical factor constitutes two factors named slope length (L) and slope steepness (S). Slope length (L) is the effect of slope length on erosion. The slope length is a function of flow accumulation that is defined as the distance from the point of origin of overland flow to the point where either the slope decreases to the extent that deposition begins or runoff water enters a well-defined channel. Slope steepness (S) represents the effect of slope steepness on erosion (Smith and Wischmeier, 1957). The effects of slope steepness have a greater impact on soil loss than slope length. Steeper the slope, the greater is the erosion.

Land Cover

The land cover factor, C, affects the erosion rate through vegetation cover, cropping, and management practices. C factor for the different land cover classes is assigned according to Koirala, et al., 2019.

Expanding plotting (land development) in the hillslope is causing the high to severe erosion through removing the vegetation and disturbing the compactness of the soil. These areas have been incorporated in land cover as barren land while evaluating the erosion potentiality.



Support Management

Support management factor accounts for control practices that reduce the erosion potential of runoff by their influence on drainage patterns, runoff concentration, runoff velocity, and hydraulic forces exerted by the runoff on the soil surface (Renard et al., 1991). The river banks within the ring

road are well protected through the corridor development and other protection infrastructures. Such embankments are also found in gentle to moderate valley slope within proposed outer ring road area. However, agriculture on the hill slope is less managed and erosion in the form of sheet, rill and gullies are very common.

B. Methodology for Landslide Hazard Mapping

Landslide Inventory

The inventory of landslides is the entry point for evaluating the hazard which will be done by using high-resolution multi-temporal images (2001-2022) provided by Google Earth. The 3D view and the history slicer (allowing to shift to images from different dates) combined with the relief exaggeration will be used to interpret landslides and their type. The morphological signatures representing various landslides and erosional features will be identified with shape, size, texture, color, topographic location, and vegetation characteristics revealed in an image vis-a-vis expert judgment.

The topographic maps also be used to identify the probable creep sites or subsistence sites through contour crenulation patterns showing hummock or irregular topography in conjunction with satellite imagery. These features are typical of slow mass movement, landslides scarps, lobate-shaped flow deposits, flow scars and bulges, and vegetation patterns. The interpretation of lithological and geological structures shown in the map vis-a-vis the topographic map aids in interpreting the potential landslide area.

Generation of Landslide Contributing Parameters

There are several factors contribute on landslide occurrence directly as well as indirectly. For instances, factors can be broadly categorized into four domains: i) Topographic domain (Aspect, Elevation, Relief range, Slope gradient, Solar illumination and Topographic position index), ii) Hydrological domain (Annual rainfall, and Topographic wetness index), iii) Anthropogenic domain (Land-use/ Land-cover, Road networks and NDVI), and iv) Geological domain (Lithology and Structures).

Among them, some factors are more crucial and have high impact on landslide triggering. Since, the role of different parameters is not uniform; the weightage was calculated using the Landslide index method.

Proposed Landslide susceptibility mapping parameters and their justification

Theme / Domain	Parameters/ Variables	Data types and sources	Descriptions & Justifications
Topographic	Slope Aspect	Digital Elevation Model (DEM): https://search.asf.alaska.edu/ ; Survey Department/GoN	Aspect played a dominant role in controlling the spatial distributions of the landslides. For instance, north facing slope in Nepal effect on landslide due to their shadier, colder, and more humid conditions. In contrast, the east-south-facing slopes are very prone to landslides because they are affected by intense wetting and drying cycles.
	Ground Elevation		Elevation influences to landslide are often displayed as an indirect relationship or by means of other factors. The weathering factor that plays an important role in land sliding is closely related with elevation. Another important aspect relating relief and landslide hazard is that construction activities like roads are preferentially built along the same relief.
	Slope gradient		Slopes in combination with the slope material cohesion, angle of repose and moisture conditions normally determine slope stability conditions. It is a very important parameter in the slope stability analysis, and it is frequently used in preparing landslide susceptibility maps (Ercanoglu, 2005; Chalkias, Ferentinou, & Polykretis, 2014; Budimir et al., 2015).
	Relief range		Elevation-relief ratio is defined as mean elevation minus minimum elevation divided by relief. This variable can capture the overall morphology of an area which is also good descriptors of landslide terrain (Carrara et al., 1991, 1995; Lee and Min, 2001).
	Topographic position index		The TPI is calculated as the difference between the cell elevation and the mean elevation of neighboring cells, is calculated using Jenness et al. (2011).
	Solar illuminations		Solar illuminations combine sun angle (slope dependence) and its direction (aspect dependence) influences on moisture and thereby vegetation (Pawluszek & Borkowski, 2016).
Hydrological	Topographic wetness index	DEM	Topographic wetness index (TWI) is a complex geo-hydrological calculation which can capture the hydro-morphological response.

Theme / Domain	Parameters/ Variables	Data types and sources	Descriptions & Justifications
	Annual average rainfall	Department of Hydrology and Meteorology/GoN of Nepal	Landslides do not occur until field capacity is exceeded, a certain amount of rain must fall to initially wet the regolith such that a future rainfall may produce a positive pore pressure to trigger landslides (Campbell, 1975; Crozier, 1999). Dahal and Hasegawa (2008) concludes that when daily rainfall amount exceeds 144 mm, there is always risk of landslides in Himalayan slopes.
Anthropogenic domain	Normalized difference vegetation index (NDVI)	Image analysis of Landsat 8	It reflects the quality of forest. The areas with lesser vegetation or devoid of any vegetation give a negative value or a value close to zero whereas a value close to positive one represents luxurious vegetation.
	Land use/ Land cover	Topographic Survey and Land Use Management Division (TSLUMD)/GoN	Land use/Land cover help to accrue knowledge on information necessary for landslide susceptibility modeling in a specific area or region.
	Road distance	Department of road (DoR)/ Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR); field observation and update	Increased erosion rates from road building have been well documented and considered as one of the most critical human impacts in the Himalaya (McAdoo.. et.al, 2018; Rieux, et.,al, 2019).
Geology	Geological formation	Department of Mines and Geology/GoN, field observation and update	Different lithological units have different landslide susceptibility values, it is very important to consider the individual unit contributions for susceptibility mapping. For this reason, it is essential to group the lithological properties properly.
	Structures		Geological structure is structural discontinuities such as folds, faults, joints, orientation and inclination of bedrocks, which influence in shaping the

Theme / Domain	Parameters/ Variables	Data types and sources	Descriptions & Justifications
			landscape (Chorley et al. 1984). Many of these are related to tectonic movement, which trigger landslides in the Himalayas (Burbank 2003).

Landslide Hazard Mapping

Landslide hazard is represented by susceptibility, which is the likelihood of a potential damaging landslide and erosion occurring within the province. The weight of evidence (WoE) method was applied. This method is considering both the presence of a certain landslide causative factor class and the absence of remaining classes, which will be used for determining a clearly spatial correlation between a landslide occurrence and the causative factors (Regmi et al., 2010).

The inventory landslide was cross tabulated on factor classes and weights were calculated using the statistical procedures containing both prior probabilities and posterior probabilities. Prior probability measures the likelihood that a terrain factor contains the landslides (L) before taking classes of terrain factor (F) into account, and its estimation is based on the landslide density (S) for the study area.

$$P_{prior} = P(L) = \frac{\text{pixel(landslides)}}{\text{Pixel(Total)}} \dots\dots\dots \text{i}$$

$P(L)$ = Probability of having a landslide,

Pixel (landslide) = Number of pixels with landslides in the map

Pixel (total) Total number of pixels in the map

Posterior probability is to be measured according to the S density for each class of the F. It is a modification of an earlier estimate of probability, which can be expressed as:

$$P(F) = \frac{P(S \cap F)}{P(F)} = \frac{\text{Grids}(S \cap F)}{\text{Grids}(F)} \dots\dots\dots \text{ii}$$

$P(F)$ = the posterior probability of occurrence of landslides in each class of F

Considering this concept, the weight of a class of factors, i.e., multiple class factor map based on the presence or absence of the landslides (L) within the area (Bonham-Carter G. 1994) will be calculated in log linear form.

$$W_{i+} = \ln\left(\frac{P\{S\}}{P\{\bar{S}\}}\right) \dots\dots\dots \text{iii}$$

$$W_{i-} = \ln\left(\frac{P\{S\}}{P\{\bar{S}\}}\right) \dots\dots\dots \text{iv}$$

Where, P is the probability and ln is the natural log F is the presence of class of factor, and $\bar{F}$ is the absence of a class of factor for landslides occurrence, L is the presence, and $\bar{L}$ is the absence of the landslides.

W_{i+} is used for those pixels of a class in a multi-class factor map (F) to indicate the importance of the presence of the factor for the occurrence of landslides (S). If W_{i+} is positive, the presence of the factor is favorable for the occurrence of landslides, and if W_{i+} is negative, it is not favorable. Similarly, W_{i-} is those for grids of a factor class to indicate the importance of the absence of factors. If W_{i-} is positive, the absence of the factor is favorable for the occurrence of landslides, and if W_{i-} is negative, it is not favorable. The final weight is then calculated as:

$$W = W_i^+ + [\sum_{j=i}^n W_j^-] - W_i^- \dots\dots\dots \text{v}$$

After computation of weight of each parameter based on WoE, landslide susceptibility index (LSI) will be calculated through summing of indexes of all parametric classes.

Annex II: Population Growth Trend and Projection

Population Growth Trend and Projected Population and Density for 20 years (till 2044)

Local Bodies	Area (ha)	Population Growth Rate	Adopted Population Growth Rate	Year 2034		Year 2044	
				Projected Population	Density (ppha)	Projected Population	Density (ppha)
Kathmandu Metropolitan City	4,945	-1.22%	0.30%	896,646	181	923,911	187
Lalitpur Metropolitan City	3,612	0.32%	0.30%	305,777	85	315,075	87
Bhaktapur Municipality	689	-0.32%	0.30%	82,278	119	84,780	123
Kritipur Municipality	1,476	2.20%	2.20%	108,299	73	134,673	91
Madhyapur Thimi Municipality	1,147	3.73%	3.52%	187,764	164	265,372	231
Gokarneshwor Municipality	5,850	3.36%	3.36%	229,473	39	319,284	55
Budhanilkantha Municipality	3,480	5.11%	3.52%	278,390	80	393,456	113
Kageshwari Manohara Municipality	2,738	8.03%	3.52%	204,505	75	289,032	106
Trakeshwar Municipality	5,495	6.40%	3.52%	237,502	43	335,668	61
Tokha Municipality	1,711	3.05%	3.05%	197,699	116	267,017	156
Nagarjun Municipality	2,985	5.53%	3.52%	180,992	61	255,802	86
Chandragiri Municipality	4,392	4.85%	3.52%	214,581	49	303,274	69
Dakshinkali Municipality	4,268	0.82%	0.82%	29,337	7	31,842	7
Shankharapur Municipality	6,021	1.47%	1.47%	35,441	6	41,008	7
Changunarayan Municipality	6,298	4.74%	3.52%	138,104	22	195,187	31
Suryabinayak Municipality	4,245	5.96%	3.52%	219,638	52	310,420	73
Godawari Municipality	9,611	2.23%	2.23%	130,069	14	162,183	17
Mahalaxmi Municipality	2,651	7.07%	3.52%	193,032	73	272,818	103
Konjyosom Rural Municipality	4,416	-0.77%	0.30%	9,346	2	9,630	2
Bagmati Rural Municipality	11,149	-1.38%	0.30%	11,804	1	12,163	1
Total	87,179	1.91%	2.13%	3,890,678	45	4,922,593	56

Annex III: Water Quality Analysis

Water Quality Analysis of Bagmati River and its Tributaries

The river water quality for 2077 B.S is evaluated based on data, acquired from HPCIDBC website (<https://bagmati.gov.np/np/download-types/bagmati-river-water-quality-test-report/>). A composite pollution was prepared through involvement of officials of Department of Environment under Ministry of Forest and Environment, which is also authorized institution for pollution management in Nepal. For this, multi-criteria method called Analytical Hierarchy Process (AHP) (Saaty 1980) was used to calculate the weight of the individual variable with an objective of obtaining visually clear with less odor water in Bagmati river system.

AHP evaluates variables by comparing them pairwise according to the importance of a variable over others in determining turbidity and odor of the river. Input values for comparison are based on expert judgments, whereas the output comes from systematic mathematical calculation. The comparisons are made using a scale of judgments that represents how much one element (variable) has an intensity of importance over another with respect to a given attribute. Here, four intensity types of importance: equal, slight, moderate, high and very high denoted by the ordinal values 1, 2, 3, 4 and 5, respectively, were used as scale of judgment. By normalizing the pairwise matrix, the weight value for each variable was determined (Erden and Coşkun 2010). A consistency ratio is calculated using the following method to verify the degree of credibility of the relative weights.

$$CR = CI/RI \dots\dots\dots \text{equation 1.}$$

Where,

(RI) is the random consistency index for n (Variables) =16, RI= Random index value

The consistency index (CI) is determined using the following equation

$$CI = (\lambda_{\max} - n)/n-1 \dots\dots\dots \text{equation 2.}$$

Where,

$\lambda_{\max}$ is the maximum value of the eigenvector, and (n) is the criteria number. If the value of consistency rate is above (0.10), then there are inconsistencies in the evaluation process, but if the value is less than (0.10) indicates consistency in the evaluation process.

Comparative matrix for water quality analysis

	Turbidity (NTU)	TSS mg/l	TDS mg/l	DO mg/l	BOD mg/l	COD mg/l	Total phosphate mg/l
Turbidity (NTU)	1	1	4	2	1	1	3
TSS mg/l	1	1	2	1	0.5	0.5	3
TDS mg/l	0.25	0.5	1	1	0.25	0.25	1
DO, mg/l	0.5	1	1	1	0.2	0.2	0.5
BOD, mg/l	1	2	4	5	1	2	4
COD, mg/l	1	2	4	5	0.5	1	3
Total phosphate mg/l	0.3	0.3	1	2	0.25	0.3	1
	5.1	7.8	17	17	3.7	5.3	15.5

Normalized matrix and weight for water quality analysis

	Turbidity (NTU)	TSS mg/l	TDS mg/l	DO mg/l	BOD mg/l	COD mg/l	Total phosphate mg/l	Weight
Turbidity (NTU)	0.20	0.13	0.24	0.12	0.27	0.19	0.19	0.19
TSS mg/l	0.20	0.13	0.12	0.06	0.14	0.09	0.19	0.13
TDS mg/l	0.05	0.06	0.06	0.06	0.07	0.05	0.06	0.06
DO (mg/l)	0.10	0.13	0.06	0.06	0.05	0.04	0.03	0.07

	Turbidity (NTU)	TSS mg/l	TDS mg/l	DO mg/l	BOD mg/l	COD mg/l	Total phosphate mg/l	Weight
BOD (mg/l)	0.20	0.26	0.24	0.29	0.27	0.38	0.26	0.27
COD (mg/l)	0.20	0.26	0.24	0.29	0.14	0.19	0.19	0.21
Total phosphate (mg/l)	0.07	0.04	0.06	0.12	0.07	0.06	0.06	0.07

Eigen value-7.32; Ci-0.05; R-1.33; CR-0.04

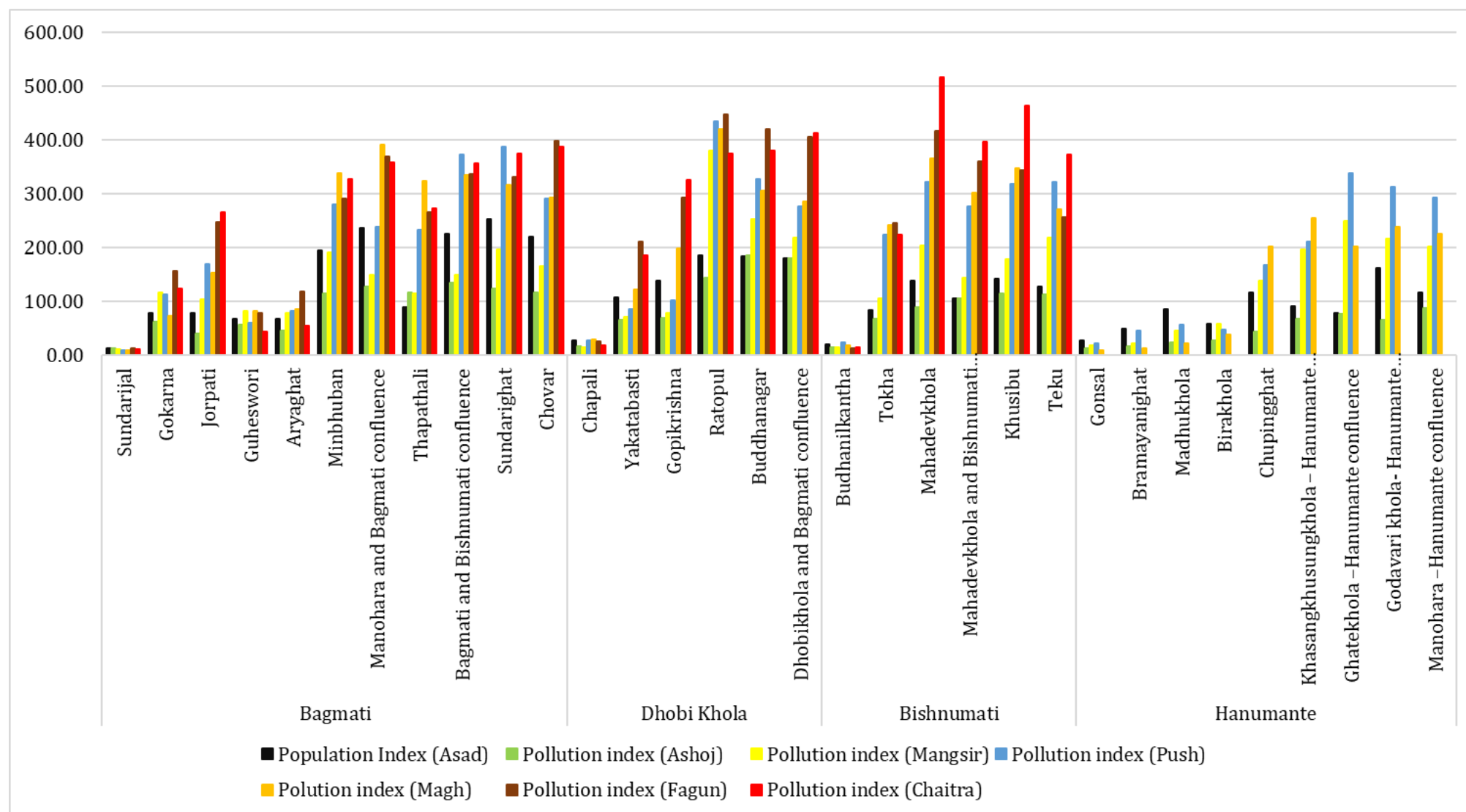
Finally, a composite pollution index was produced through summing of the product of weight and pollution value of each variable;

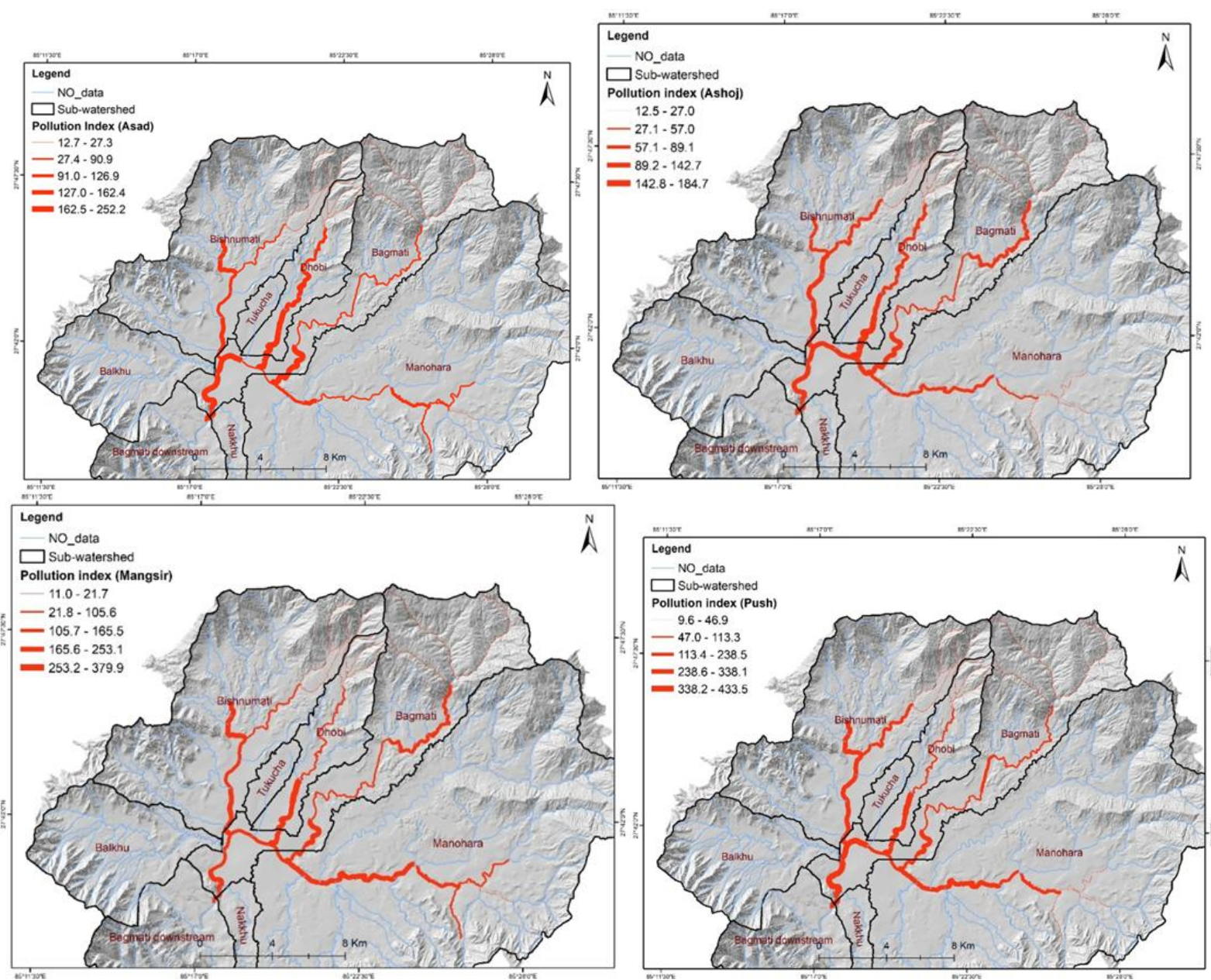
$$\text{Pollution index} = \sum V_i W_i \dots \dots \text{equation 3.}$$

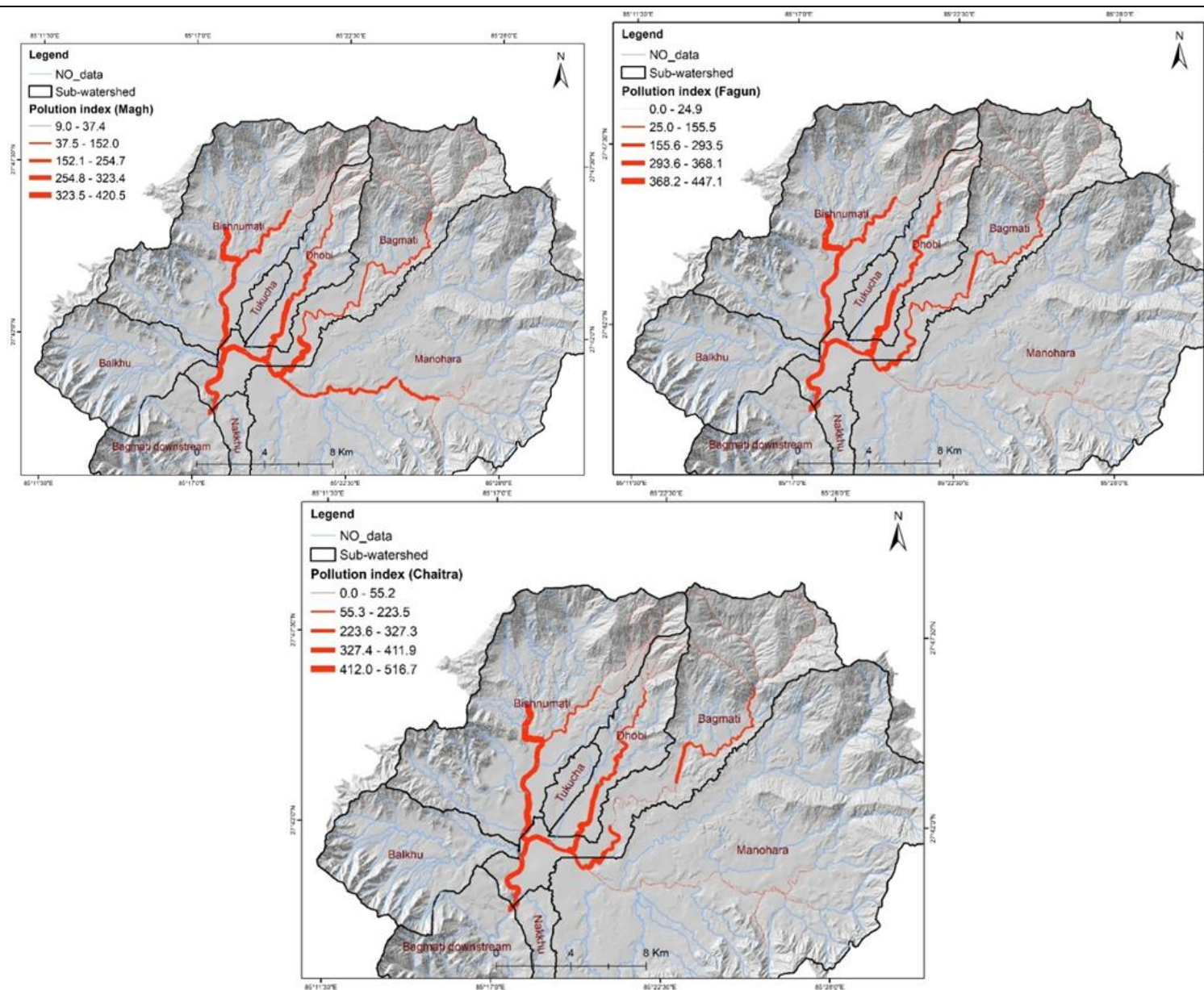
Where,

V_i = Pollution value of variables and W_i = Weight of each variable

Monthly Water Pollution Index







Annex IV: Total Sewerage Generation and Land Requirement for Sewerage Treatment Plant

The estimation of land requirement for sewerage treatment plant is made on the basis of the following:

Design Water Quality

Item	Influent	Effluent	Removal rate (%)
BOD (mg/l)	300	30	0.9
SS (mg/l)	300	60	0.8

Design Assumptions

Grit chamber	Surface loading, m ³ /m ² /day	2160
Oxidation ditch	Hydraulic detention time, hr	15
Sedimentation basin	Surface loading, m ³ /m ² /day	15
Sand filtration tank	Filtration rate, m ³ /m ² /day	200
Disinfection tank	Retention time, min	15
Sludge thickening tank	Dry solid load, kgDS/m ² /day	30
Sludge digestion tank	Sludge retention time, day	14
Sludge moisture		97%

Population forecast and total sewerage generation in year 2044

Local Bodies	Population forecast	Total domestic sewage quantity (lit/day)	Non domestic sewage quantity (10%) (lit/day)	Infiltration rate (10%) (lit/day)	Total sewerage flow (lit/day)	Existing WWTP serving discharge (lit/day)	Net Inflow after deduction (lit/day)
	Design Population of 2044						
Kathmandu Metropolitan City	923,911	88,695,456.00	8,869,545.60	8,869,545.60	106,434,547.20	16,400,000.00	90,034,547.20
Lalitpur Metropolitan City	315,075	30,247,200.00	3,024,720.00	3,024,720.00	36,296,640.00	16,500,000.00	19,796,640.00
Bhaktapur Municipality	84,780	8,138,880.00	813,888.00	813,888.00	9,766,656.00	2,500,000.00	7,266,656.00
Kritipur Municipality	134,673	12,928,608.00	1,292,860.80	1,292,860.80	15,514,329.60		15,514,329.60
Madhyapur Thimi Municipality	265,372	25,475,712.00	2,547,571.20	2,547,571.20	30,570,854.40		30,570,854.40
Gokarneshwor Municipality	319,284	30,651,264.00	3,065,126.40	3,065,126.40	36,781,516.80		36,781,516.80
Budhanilkantha Municipality	393,456	37,771,776.00	3,777,177.60	3,777,177.60	45,326,131.20		45,326,131.20

Local Bodies	Population forecast	Total domestic sewage quantity (lit/day)	Non domestic sewage quantity (10%) (lit/day)	Infiltration rate (10%) (lit/day)	Total sewerage flow (lit/day)	Existing WWTP serving discharge (lit/day)	Net Inflow after deduction (lit/day)
	Design Population of 2044						
Kageshwari Manohara Municipality	289,032	27,747,072.00	2,774,707.20	2,774,707.20	33,296,486.40		33,296,486.40
Trakeshwar Municipality	335,668	32,224,128.00	3,222,412.80	3,222,412.80	38,668,953.60		38,668,953.60
Tokha Municipality	267,017	25,633,632.00	2,563,363.20	2,563,363.20	30,760,358.40		30,760,358.40
Nagarjun Municipality	255,802	24,556,992.00	2,455,699.20	2,455,699.20	29,468,390.40		29,468,390.40
Chandragiri Municipality	303,274	29,114,304.00	2,911,430.40	2,911,430.40	34,937,164.80		34,937,164.80
Dakshinkali Municipality	31,842	3,056,832.00	305,683.20	305,683.20	3,668,198.40		3,668,198.40
Shankharapur Municipality	41,008	3,936,768.00	393,676.80	393,676.80	4,724,121.60		4,724,121.60
Changunarayan Municipality	195,187	18,737,952.00	1,873,795.20	1,873,795.20	22,485,542.40		22,485,542.40
Suryabinayak Municipality	310,420	29,800,320.00	2,980,032.00	2,980,032.00	35,760,384.00		35,760,384.00
Godawari Municipality	162,183	15,569,568.00	1,556,956.80	1,556,956.80	18,683,481.60		18,683,481.60
Mahalaxmi Municipality	272,818	26,190,528.00	2,619,052.80	2,619,052.80	31,428,633.60		31,428,633.60
Konjyosom Rural Municipality	9,630	924,480.00	92,448.00	92,448.00	1,109,376.00		1,109,376.00
Bagmati Rural Municipality	12,163	1,167,648.00	116,764.80	116,764.80	1,401,177.60		1,401,177.60
Total	5,895,065.00	472,569,120.00	47,256,912.00	56,592,624.00	567,082,944.00	35,400,000.00	531,682,944.00

Land requirement for sewerage treatment plant in year 2044

Location	Daily average flow, (m³/day)	Peak factor	Peak flow (m³/day)	Land requirements (m²)											Total area required (m²)	Total area required (ha)
				Gr it ch a m b e r	Oxid ation ditch	Sedi ment ation basin	Sa nd filt rat ion tan k	Disi nfec tion tank	Slud ge thic keni ng tank	Sludg e diges tion tank	Slud ge dew ateri ng	Total area (m²)	Area for office, lab, road, parking, maintenance (2.0 x total area) (m²)			
Kathmandu Metro City	90,034.55	3	270,103.64	141.60	21,237.40	6,796.00	509.70	1,061.90	815.50	475.10	7,759.30	38,796.50	77,593.00	116,389.50	11.64	
Lalitpur Metro City	19,796.64	3	59,389.92	35.40	5,302.90	1,696.90	127.30	265.10	203.60	159.30	1,947.60	9,738.10	19,476.20	29,214.30	2.92	
Bhaktapur Municipality	7,266.66	3	21,799.97	11.90	1,777.70	568.90	42.70	88.90	68.30	279.40	709.40	3,547.20	7,094.40	10,641.60	1.06	
Kritipur Municipality	15,514.33	3	46,542.99	20.80	3,118.30	997.90	74.80	155.90	119.70	558.50	1,261.50	6,307.40	12,614.80	18,922.20	1.89	
Madhyapur Thimi Municipality	30,570.85	3	91,712.56	41.60	6,233.20	1,994.60	149.60	311.70	239.40	667.50	2,409.40	12,047.00	24,094.00	36,141.00	3.61	
Gokarneshwor Municipality	36,781.52	3	110,344.55	49.70	7,449.50	2,383.80	178.80	372.50	286.10	880.50	2,900.20	14,501.10	29,002.20	43,503.30	4.35	
Budhanilkantha Municipality	45,326.13	3	135,978.39	65.50	9,827.20	3,144.70	235.90	491.40	377.40	653.30	3,698.80	18,494.20	36,988.40	55,482.60	5.55	
Kageshwari Manohara Municipality	33,296.49	3	99,889.46	48.60	7,291.70	2,333.30	175.00	364.60	280.00	742.40	2,808.90	14,044.50	28,089.00	42,133.50	4.21	
Trakeshwar Municipality	38,668.95	3	116,006.86	55.20	8,286.00	2,651.50	198.90	414.30	318.20	566.00	3,122.50	15,612.60	31,225.20	46,837.80	4.68	
Tokha Municipality	30,760.36	3	92,281.08	42.10	6,316.70	2,021.30	151.60	315.80	242.60	566.00	2,414.00	12,070.10	24,140.20	36,210.30	3.62	
Nagarjun Municipality	29,468.39	3	88,405.17	42.10	6,317.10	2,021.50	151.60	315.90	242.60	671.00	2,440.40	12,202.20	24,404.40	36,606.60	3.66	
Chandragiri Municipality	34,937.16	3	104,811.49	49.90	7,488.60	2,396.40	179.70	374.40	287.60	70.40	2,711.80	13,558.80	27,117.60	40,676.40	4.07	
Dakshinkali Municipality	3,668.20	3	11,004.60	5.20	785.20	251.30	18.80	39.30	30.20	96.00	306.50	1,532.50	3,065.00	4,597.50	0.46	
Shankharapur Municipality	4,724.12	3	14,72.36	7.10	1,071.10	342.70	25.70	53.60	41.10	434.20	493.90	2,469.40	4,938.80	7,408.20	0.74	
Changunarayan Municipality	22,485.54	3	67,456.63	32.30	4,846.20	1,550.80	116.30	242.30	186.10	676.10	1,912.50	9,562.60	19,125.20	28,687.80	2.87	
Suryabinayak Municipality	35,760.38	3	107,281.15	50.30	7,545.70	2,414.60	181.10	377.30	289.80	370.00	2,807.20	14,036.00	28,072.00	42,108.00	4.21	
Godawari Municipality	18,683.48	3	56,050.44	27.50	4,129.80	1,321.50	99.10	206.50	158.60	581.70	1,631.20	8,155.90	16,311.80	24,467.70	2.45	
Mahalaxmi Municipality	31,428.63	3	94,285.90	43.30	6,492.30	2,077.50	155.80	324.60	249.30	23.60	2,341.60	11,708.00	23,416.00	35,124.00	3.51	
Konjyosom RM	1,109.38	3	3,328.13	1.80	263.60	84.30	6.30	13.20	10.10	29.20	102.10	510.60	1,021.20	1,531.80	0.15	
Bagmati R M	1,401.18	3	4,203.53	2.20	326.40	104.40	7.80	16.30	12.50	10,403.10	2,718.20	13,590.90	27,181.80	40,772.70	4.08	
Total	531,682.94													697,455.0	69.75	

Annex V: Salient Features of the Potential Sites for Water Retaining Ponds/Reservoir

S.N	Longitude	Latitude	Municipality	Location/ Stream	Proposed Dam Height (m)	Proposed Dam Crest Length (m.)	Covering Area (ha)	Reservoir Capacity (m3)	Topographical characteristics	Existing land use/land cover	Rock/Soil characteristics	Remarks
A. Potential Sites for Water Retaining Reservoirs												
1	85.2695932 8470	27.7099855 3310	Nagarjun-6	Sitapaila	10.0	30.0	0.33	6284.81	The elevation of the place ranges from 1309 to 1317 m and average slope is 3.5 %. The slope of Adjacent hills is gentle to moderate	Forest	Thick sedimentary deposits mainly sandy clay soil of Lukundol Formation	
2	85.4365827 0070	27.7661997 7430	Kageshwori Manahara-1	Mahankal	20.0	60.0	1.30	78048.74	The elevation of place ranges from 1700 to 1720 m and average slope is 11.5 %. The slope of Adjacent hills is gentle to moderate	Forest	Moderately weathered Gneiss with thick soil cover	
3	85.49397517 890	27.7491982 9410	Shankharapur- 3	Jaharsing Pauwa-1	6.0	25.0	0.22	4569.90	The elevation of river centre line ranges from 1788 to 1794 m and average slope is 5 %. The slope of Adjacent hills is flat to gentle	Forest	Moderately weathered Gneiss and thick residual soil	
4	85.4953930 7210	27.7401339 4620	Shankharapur- 3 & 5	Ahalchaur	18.0	70.0	2.57	150721.70	The elevation of the palce ranges from 1748 to 1764 m and average slope is 5-10 %. The slope of Adjacent hills is flat to gentle	Forest & Weland	Moderately weathered Gneiss and thick residual soil	
5	85.49210125 380	27.74304291 050	Shankharapur- 3 & 5	Ahalchaur- 2	30.0	90.0	7.39	558834.51	The elevation of river centre line ranges from 1720 to 1742 m and average slope is 11.5 %. The slope of Adjacent hills is gentle to moderate	Abandoned cultivated land, Wetland & Forest	Moderately weathered Gneiss and thick residual soil	Drinking water supply and private land (need to be confirmed)

S.N	Longitude	Latitude	Municipality	Location/ Stream	Proposed Dam Height (m)	Proposed Dam Crest Length (m.)	Covering Area (ha)	Reservoir Capacity (m3)	Topographical characteristics	Existing land use/land cover	Rock/Soil characteristics	Remarks
6	85.4898368 8010	27.74606191 900	Shankharapur- 3	Jaharsing Pauwa-2	15.0	40.0	0.65	31473.07	The elevation of river centre line ranges from 1710 to 1722 m and average slope is 1- 5 %. The slope of Adjacent hills is gentle to moderate	Abandoned cultivated land & forest	Moderately weathered Gneiss and thick residual soil	
7	85.2486638 4470	27.7340688 9900	Nagarjun-3, 6 & 8	Manamati	50.0	160.0	3.44	569961.80	The elevation of river centre line ranges from 1450 to 1480 m and average slope is 7%. The slope of Adjacent hills is moderate to steep	Occupied land/Cultivat ion and some houses	Fractured and jointed limestone and slate with thin soil cover	Private land shall be acquired and reservoir lies on National park
8	85.26218050 960	27.70757172 040	Nagarjun-7	Manamati (Kimsi)	12.0	50.0	0.70	18870.53	The elevation of the place ranges from 1312 to 1326 m and average slope is 5.5 %. The slope of Adjacent hills is gentle to moderate	Forest	Thick sedimentary deposits mainly sandy clay soil of Lukundol Formation	
9	85.41035339 350	27.6156962 3420	Mahalakshmi-9	Lankuri Bhanjyang	30.0	60.0	0.84	137145.77	The elevation of place ranges from 1926 to 1958 m and average slope is 5-8 %. The slope of Adjacent hills is gentle to moderate	Forest	Moderately weathered metasandstone covered by thick soil layer	
10	85.39303217 920	27.6044723 7720	Godawari-2 & 3	Godawari	40.0	200.0	8.58	101132.31	The elevation of river centre line ranges from 1590 to 1640 m and average slope is 12.5 %. The slope of Adjacent hills is gentle to moderate	Grazing land and forest	Moderately weathered limestone covered by thick soil layer	Reservoir enlargement through excavatio n & artificial waterfall at inlet
11	85.2798569 6940	27.6041324 5340	Dakshinkali-7	Kopugaun	10.0	70.0	1.08	34136.89	The elevation of the place ranges from 1350 to 1370 m and average slope is 7 %.	Forest	Sedimentary deposits comprising fine sand and silty	

S.N	Longitude	Latitude	Municipality	Location/ Stream	Proposed Dam Height (m)	Proposed Dam Crest Length (m.)	Covering Area (ha)	Reservoir Capacity (m3)	Topographical characteristics	Existing land use/land cover	Rock/Soil characteristics	Remarks
									The slope of Adjacent hills is gentle to moderate		sand with gravel	
12	85.24948014 310	27.6373028 6390	Dakshinkali-5 & 9	Sundol Khola	50.0	120.0	4.71	862675.81	The elevation of river centre line ranges from 1920 to 1966 m and average slope is 13.9 %. The slope of Adjacent hills is gentle to moderate	Forest & Wetland	Moderate to highly weathered slates covered with thin soil layer	
13	85.25407197 090	27.63833921 510	Dakshinkali-5	Panim Khola	20.0	70.0	1.16	33782.88	The elevation of river centre line ranges from 1775 to 1805m and average slope is 12.5 %. The slope of Adjacent hills is gentle to moderate	Forest	Moderate to highly weathered slates covered with thin soil layer	
14	85.40729188 600	27.6220992 7990	Mahalakshmi-9	Lubhu Khola-1	40.0	90.0	1.94	100993.32	The elevation of river centre line ranges from 1700 to 1740 m and average slope is 10.7 %. The slope of Adjacent hills is moderate to steep	Forest	Moderately weathered metasandstone covered by thick soil layer	
15	85.46230077 480	27.7969541 4880	Gokarneshwor- 1	Nagmati upstream- 2	30.0	80.0	2.46	179987.59	The elevation of river centre line ranges from 1994 to 2016 m and average slope is 12.5 %. The slope of Adjacent hills is gentle to moderate	Forest	Moderately weathered Gneiss and thick residual soil	
16	85.46738752 090	27.7966508 4880	Gokarneshwor- 1	Nagmati upstream-1	20.0	80.0	1.47	55000.00	The elevation of river centre line ranges from 2028 to 2040 m and average slope is 9.5 %. The slope of Adjacent hills is flat to gentle	Wetland & forest	Moderately weathered Gneiss and thick residual soil	Shivapuri Nagarjun NP
B. Potential Sites for River Water Dam and Reservoirs												

S.N	Longitude	Latitude	Municipality	Location/ Stream	Proposed Dam Height (m)	Proposed Dam Crest Length (m.)	Covering Area (ha)	Reservoir Capacity (m3)	Topographical characteristics	Existing land use/land cover	Rock/Soil characteristics	Remarks
17	85.33139781 550	27.80342161 190	Tokha-1	Bhandare Khahare	24.0	40.0	0.55	43298.00	The elevation of river centre line ranges from 1522 to 1552 m and average slope is 8.4 %. The slope of Adjacent hills is gentle to moderate	Forest	Moderately weathered Gneiss and thick residual soil	Shivapuri Nagarjun NP
18	85.49229473 310	27.7072505 2220	Changunaraya n-6 & 7	Muhanpok hari (Option-1)	50.0	130.0	6.80	807911.18	The elevation of river centre line ranges from 1535 to 1578 m and average slope is 13.4 %. The slope of Adjacent hills is moderate to steep	Forest	Moderate to highly weathered schist and fractured quartzite with thick soil cover	
19	85.5049625 9580	27.7249547 4100	Shankharapur- 5 & Changunaraya n-6	Kattike Khola	50.0	60.0	1.26	192463.51	The elevation of river centre line ranges from 1516 to 1531 m and average slope is 14.6 %. The slope of Adjacent hills is moderate to steep	Forest	Moderately weathered Gneiss and thick residual soil	Series of siltation dams are required in the upstream
20	85.42372875 450	27.7819395 8100	Gokarneshwor- 1	Bagmati (Option-1)	65.0	150.0	13.05	2546604.8 3	The elevation of river centre line ranges from 1630 to 1690 m and average slope is 14 %. Adjacent hillslope is moderate to steep.	Forest	Moderately weathered Gneiss and thick residual soil	Shivapuri Nagarjune National Park
21	85.4233994 5900	27.7827340 0110	Gokarineshwor -1	Bagmati (Option-2)	80.0	200.0	24.01	5485592.3 0	TTThe elevation of river centre line ranges from 1630 to 1690 m and average slope is 14 %. Adjacent hillslope is moderate to steep.	Forest	Moderately weathered Gneiss and thick residual soil	Shivapuri Nagarjune National Park
22	85.4925980 2400	27.7072746 2710	Changunaraya n-6 & 7	Muhanpok hari (Option-2)	60.0	170.0	10.93	1682836.11	The elevation of river centre line ranges from 1994 to 2016 m and average slope is 12.5 %. The slope of Adjacent hills is gentle to moderate	Forest	Moderate to highly weathered schist and fractured quartzite with thick soil cover	

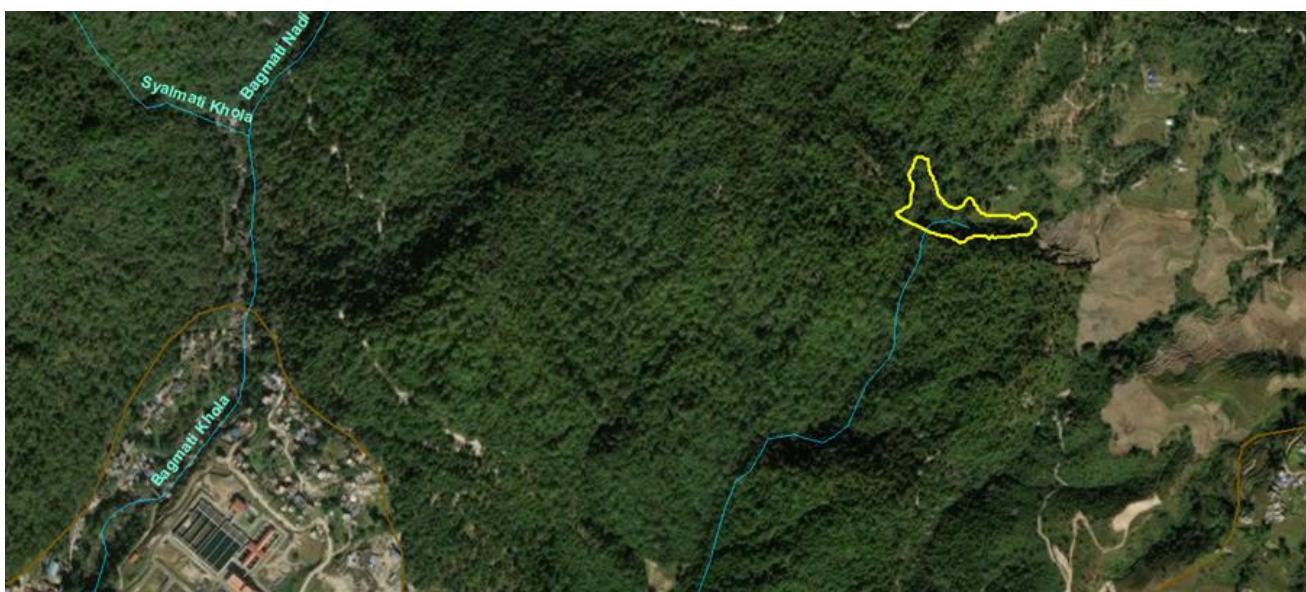
S.N	Longitude	Latitude	Municipality	Location/ Stream	Proposed Dam Height (m)	Proposed Dam Crest Length (m.)	Covering Area (ha)	Reservoir Capacity (m3)	Topographical characteristics	Existing land use/land cover	Rock/Soil characteristics	Remarks
23	85.2958776 8990	27.5467933 9890	Godawari-6	Burugachu li Khola	50.0	140.0	3.64	537134.00	The elevation of river centre line ranges from 1841 to 1871 m and average slope is 15 %. The slope of Adjacent hills is moderate to steep	Forest	Moderately weathered metasandstone covered by thick soil layer	
24	85.27810215 270	27.61206413 100	Dakshinkali-3, 6 & 7	Shesnaray an Khola	20.0	60.0	0.78	65706.54	The elevation of the place ranges from 1420 to 1444 m and average slope is 10%. The slope of Adjacent hills is gentle to moderate	Forest	Sedimentary deposits comprising fine sand and silty sand with gravel	
25	85.3643067 2330	27.7650884 1950	Budhanilkanth a-2 & 8	Dhobi khola	25.0	70.0	3.62	238452.35	The elevation of river centre line ranges from 1350 to 1370 m and average slope is 8.4 %. The slope of Adjacent hills is gentle to moderate	Park and private land	Sedimentary deposits comprising sandy gravel, peaty clay	Existing park will be inundated partially & some issues of private land

Potential sites for water retaining reservoirs

There are 16 potential sites identified from the field for the water retaining reservoirs. A brief description of these potential sites is presented here.

1. Mahankal

The potential site of Mahankal lies in Ward no. 1 of Kageshwori Manahara Municipality. It is proposed at the top of a small tributary, named Mahankal Khola that feeds the Bagmati River to the northeast of Sundarijal. At present, the proposed site is covered by sparse forest and grassland. It covers about 1.29 ha of area and can hold approximately 78048 m³ of water after construction of 20m high dam. The vicinity of the proposed reservoir site shows presence of moderately weathered gneiss bedrock showing stable sloping terrain.

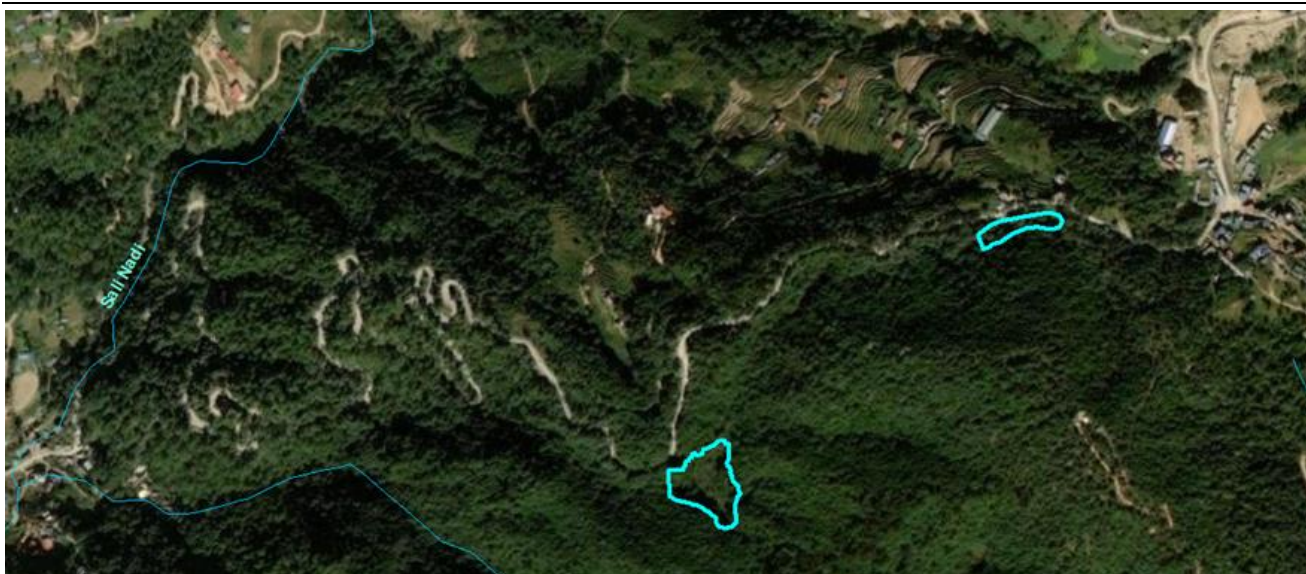


Potential site for water retaining reservoir at Mahankal

2. Jaharsing Pauwa (2 sites)

There are two potential sites for medium-sized water retaining reservoir at near to Jaharsing Pauwa. They lie in Ward no. 3 of Shankharapur Municipality. One of the proposed sites is elongated and small depression gully adjacent to an entrance gate built on Jaharsing Pauwa-Sankhu road. There are some sparse trees of rhododendron and mixed species. It covers about 0.22 ha and can hold 4570 m³ water after construction of only 6m high dam. It will also be an attractive center for tourism.

The second proposed site lies at about 2 km from previous site towards Sankhu along the road. There is a depression surrounded by moderately weathered bedrocks covered by sparse forest. There is potentiality of constructing a water retaining reservoir covering an area of about 0.65 ha that can hold about 31473 m³ water after construction of 15m high dam. Both of the sites lie in gneiss bedrock and residual soil and seem geologically stable.



Potential sites for water retaining reservoir near Jaharsing Pauwa



A depression below the road from Jaharsing Pauwa - Sankhu, identified as a potential site for water retaining reservoir

3. Ahalchaur (2 sites)

There is a small streamlet flowing through the boarder between Ward no. 3 and Ward no. 5 of Shankarapur Municipality, which feeds the Shali Nadi. There are two potential sites for large-sized water retaining reservoir along that stream. Both of these sites show relatively flat and swampy land. Thus, there is possibility of two reservoirs in a series in an effective way. The first site covers about 2.57 ha and can hold 150721 m³ water after construction of only 18m high dam. It is surrounded by rhododendron and pine forest. The reservoir will also be an attractive center for tourism.

The second proposed site lies at immediate downstream of the first site. There is a wide swampy depression surrounded by moderately weathered gneiss bedrocks covered by sparse forest. There is potentiality of constructing a water retaining reservoir covering an area of about 7.39 ha that

can hold about 558834 m³ water after construction of 30m high dam. Both of the sites lie in gneiss bedrock and residual soil and seem geologically stable.



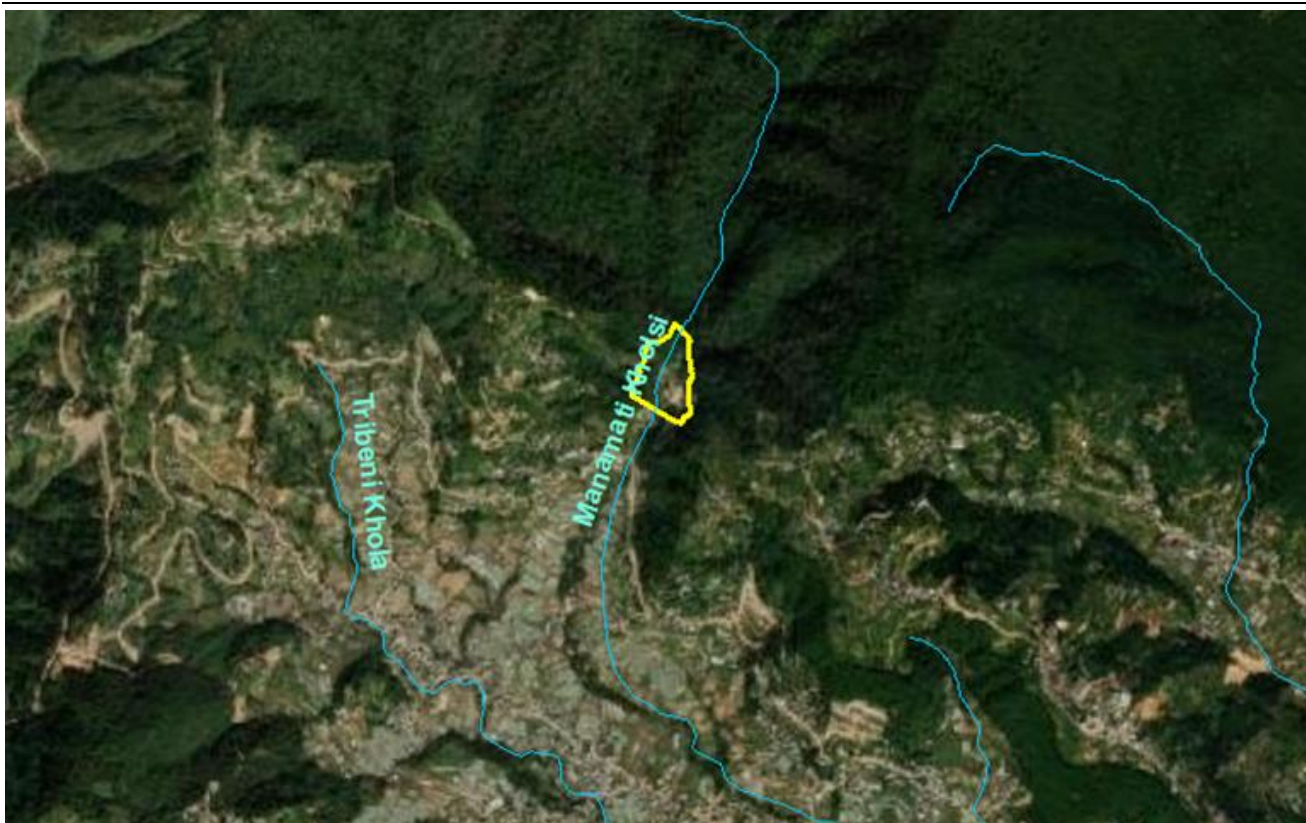
Potential sites for construction of water retaining structures in Ahalchaur



Flat and swampy land surrounded by forest in Ahalchaur, a potential site for water retaining reservoir

4. Manamati Kholsi, Ramkot

There is a potential site for water retaining reservoir in Ramkot, which lies in boarder among Ward no. 3, Ward no. 6, and Ward no. 8 of Nagarjun Municipality. There is deep valley walled by very steep rocky terrain on both banks and sloping hills in the upstream side. The surrounding area is covered by forest but the valley is occupied by local residents. There is quarry of limestone aggregates in the proposed site at present. Due to presence of limestone and slate, the site is geologically stable. The proposed reservoir covers about 3.43 ha and can hold about 569962 m³ water after construction of 50m high dam.



Potential site for the water retaining reservoir at Ramkot along the Manmati Kholsi

5. Manamati Kholsi, Kimsi

There is a potential site for water retaining reservoir in a small depressed gully flowing through west of Sitapaila. It lies near to Hasantar, Ward no. 7 of Nagarjun Municipality. The proposed site is situated in sandy clay deposits of Lukundol Formation belonging to Kathmandu Valley sedimentary deposits. It covers about 0.7 ha of an area and can hold 18870 m³ of water after construction of 12m high dam. There is local forest cover in the site at present.

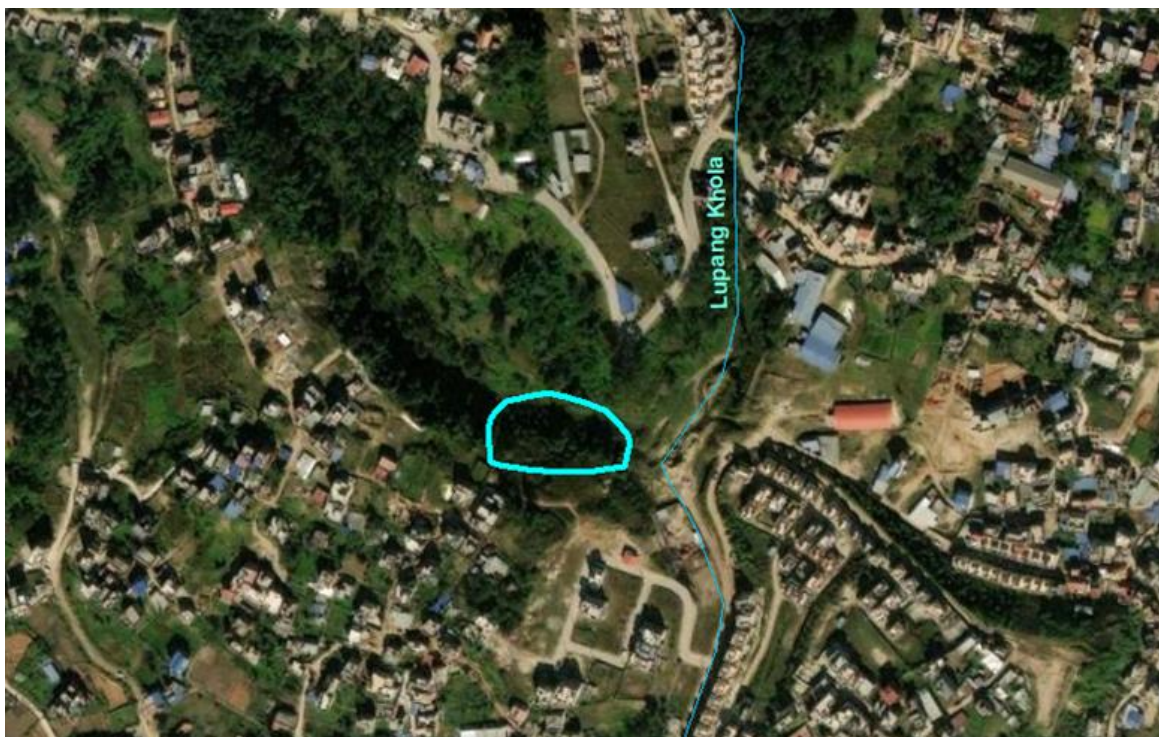


Potential site for water retaining reservoir near to Hasantar, Kimsi

6. Sitapaila

A potential site for water retaining reservoir has been identified behind the Civil Housing of Sitapaila. It lies in the Ward no. 6 of Nagarjun Municipality. There is a confluence of two small streamlets and have made a deep depression valley. The proposed site shows sandy clay deposits of Lukundol Formation of Lacustrine valley sedimentary deposits. There is possibility of

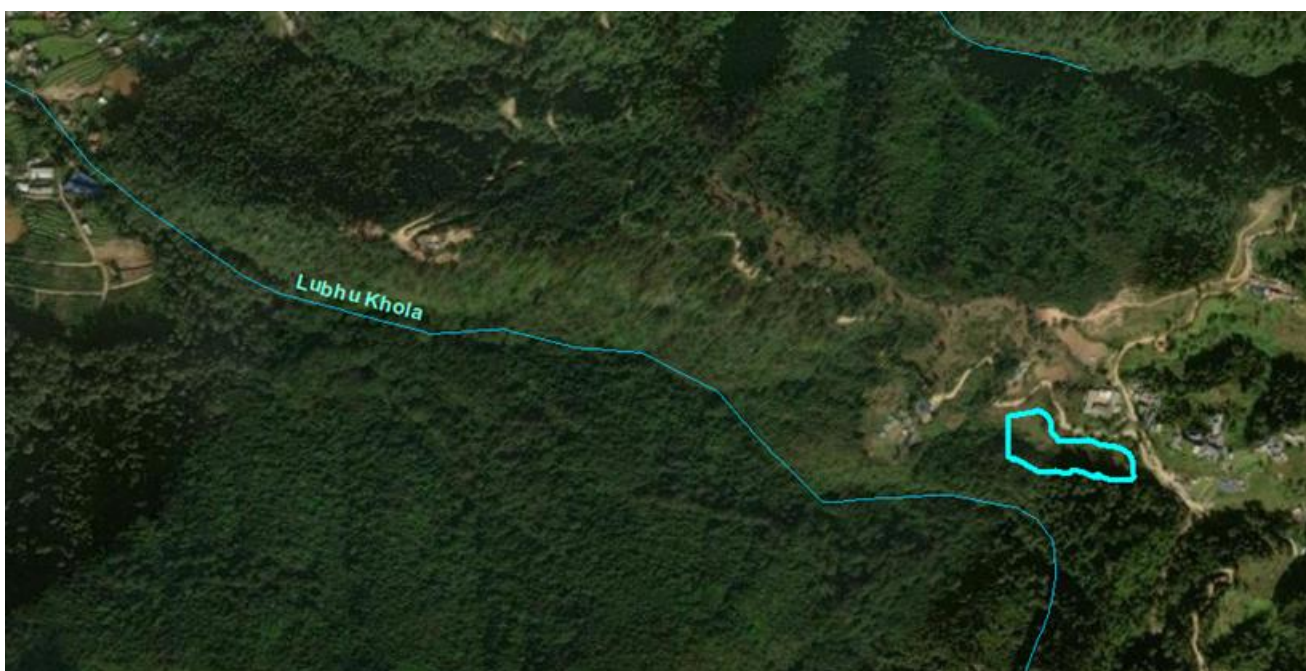
constructing a reservoir of about 0.33 ha and it can hold 6284 m³ of water after construction of 10 m. high dam. There are sparse trees in the valley and surrounded by dense residence. It can be developed as a recreation center.



Potential site for water retaining reservoir near to Civil Homes, Sitapaila

7. Lakuri Bhanjyang

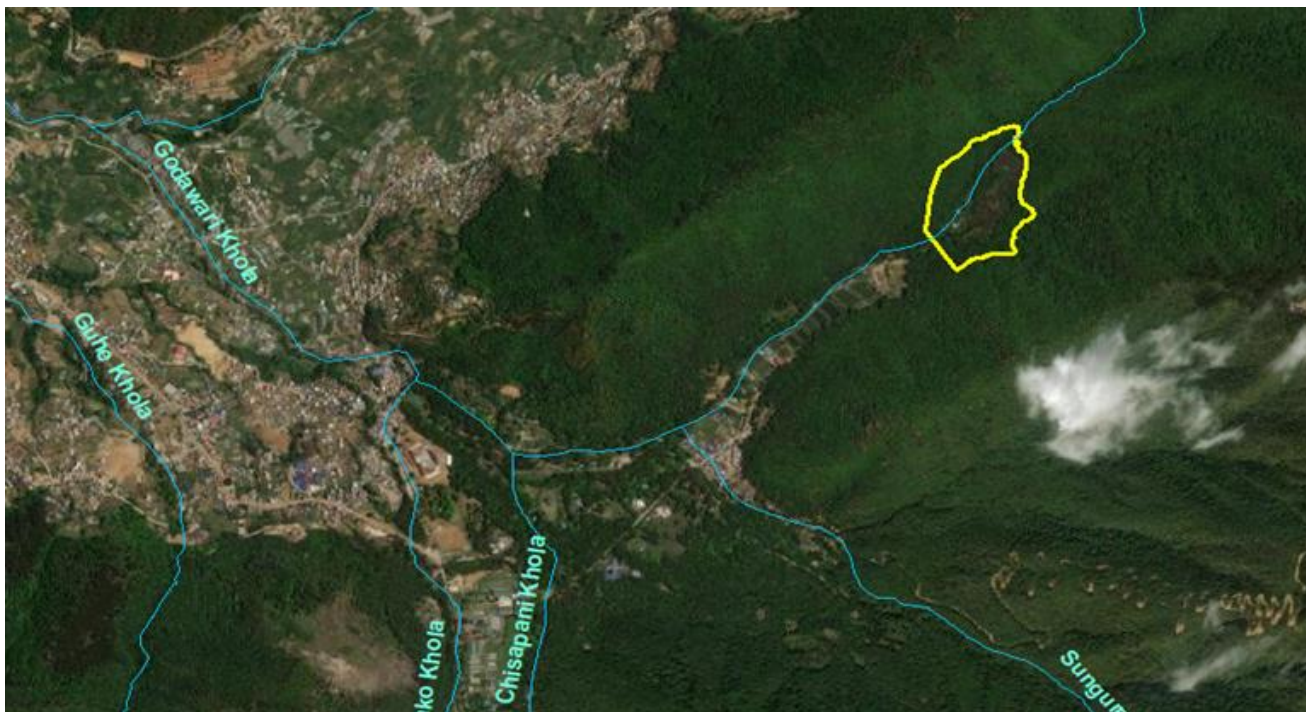
There is a small streamlet that meets the Lubhu Khola near to Lakuri Bhanjyang. A potential site for the water retaining reservoir has been identified in that streamlet, where it makes a depression valley. The proposed site lies in Ward no. 9 of Mahalakshmi Municipality. There is forest and grassland in the proposed site, which is very close to a residential area. Moderately weathered metasandstone is found in the vicinity of the proposed site that is covered by thick soil cover. The proposed reservoir covers about 0.84 ha and it can hold 137145 m³ after construction of 30 m high dam.



Potential site for water retaining reservoir near to Lakuri Bhanjyang and Lubhu Khola

8. Godawari

A potential site for the water retaining reservoir has been identified in the head of Godawari Khola, which lies at the border of Ward no. 2 and Ward no. 3 of Godawari Municipality. At present, the identified site covers forest and grass land and lies far from the residential area. The terrain is composed of moderately weathered limestone covered by thick soil. The proposed reservoir covers about 8.58 ha of area and it can hold about 101132 m³ water after construction of 40 m. high dam.



Potential site for water retaining reservoir in the Godawari Khola

9. Kopugaun

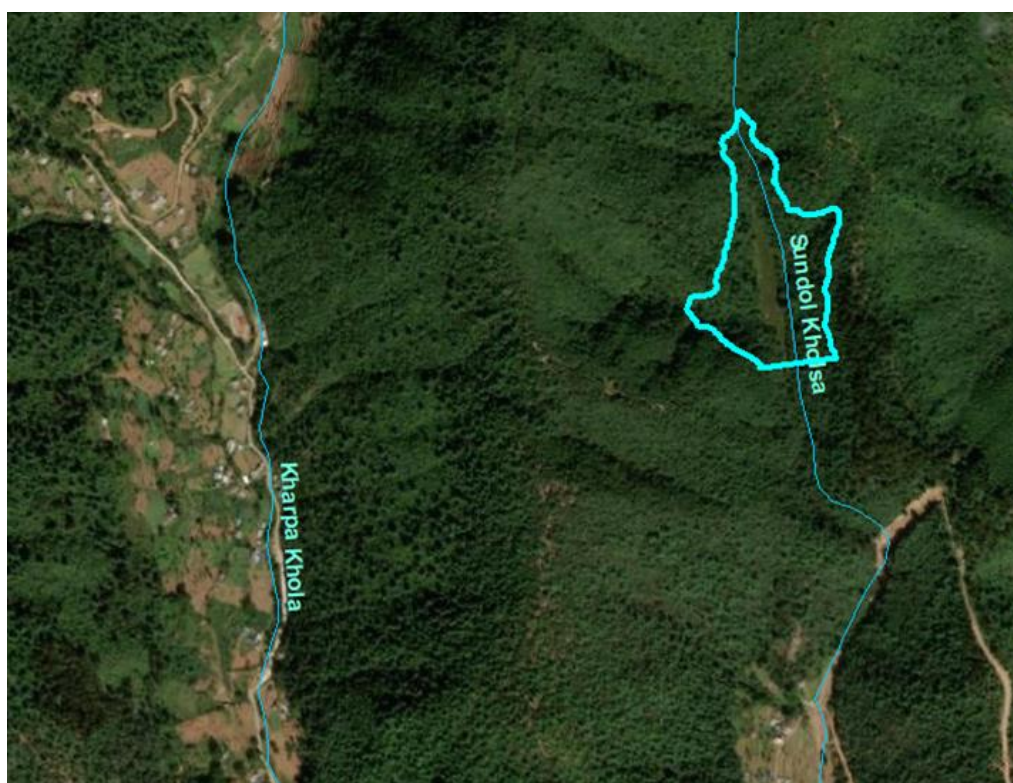
There is a potential site for water retaining reservoir near to Kopugaun village. It lies in Ward no. 7 of Dakhsinkali Municipality. There are two small streamlet flow from hillock and meet at a point, where the terrain is suitable to develop a reservoir. The proposed site comprises sedimentary deposits mainly dominant of fine sand and silty sand with rare gravels belonging to Kobgaun Formation. The site has been covered by sparse forest and grassland. It covers about 1.08 ha of an area that can hold about 34136 m³ after construction of 10 m. high dam.



Potential sit for water retaining reservoir near to Kopugaun village in Dakshinkali-7

10. Sundol Khola

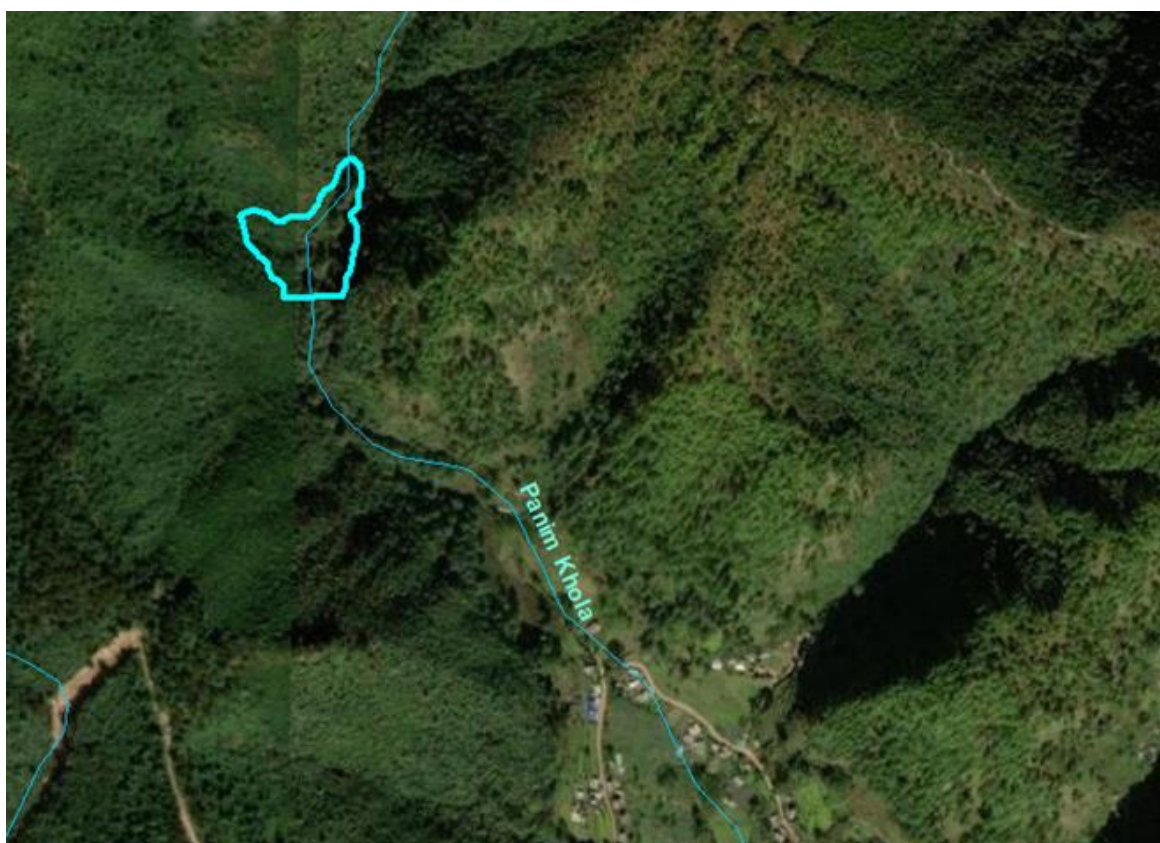
The identified potential site lies in the border between Ward no. 5 and Ward no. 9 of Dakshinkali Municipality. There is a depressed valley formed by the Sundol Khola, which can be developed as a water retaining reservoir. The valley is bare and swampy land and surrounded by dense forest. Moderately weathered slate bedrocks are exposed in the vicinity of the proposed site. There is geologically stable terrain around the proposed site. There is possibility of constructing a large reservoir of a surface area of about 4.7 ha, when a dam of 50m height is constructed. The reservoir can hold 862675 m³ water as its maximum capacity.



Potential site for water retaining reservoir in Sundol Khola in the border of Dakshinkali-5 and Ward no. 9

11. Panim Khola

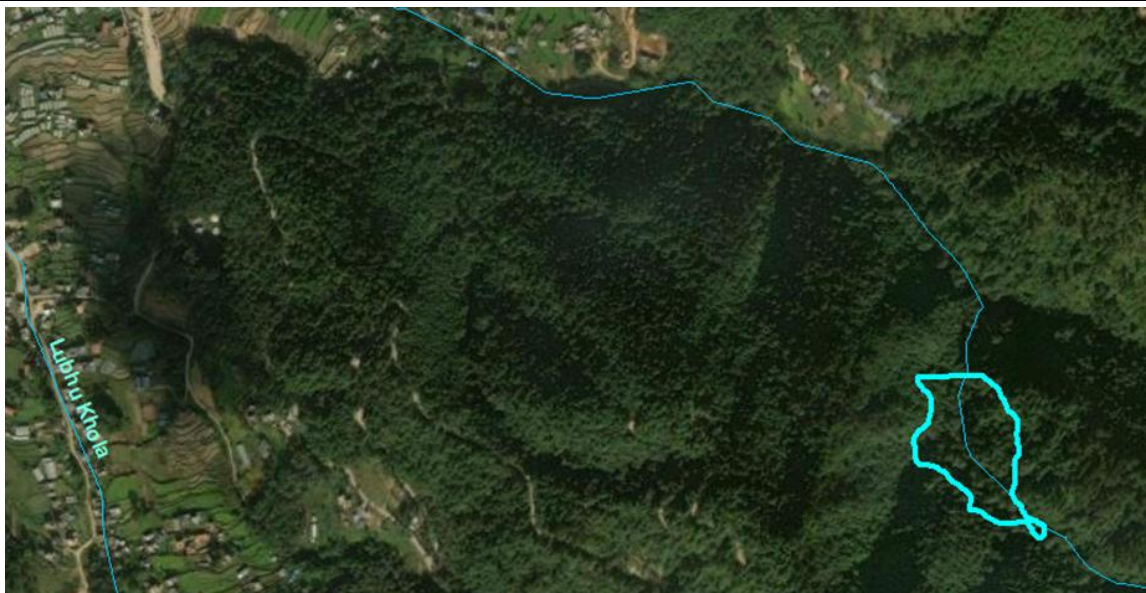
The potential site for water retaining reservoir lies in the Ward no. 5 of Dakshinkali Municipality. There is a depressed valley formed by the Panim Khola, which can be developed as a water retaining reservoir. The valley is bare and swampy land and surrounded by dense forest. Moderately weathered slate bedrocks are exposed in the vicinity of the proposed site. There is geologically stable terrain around the proposed site. There is possibility of constructing a medium-sized reservoir of a surface area of about 1.2 ha, when a dam of 20m height is constructed. The reservoir can hold 33782 m³ water as its maximum capacity.



Potential site for water retaining reservoir in Panim Khola, Dakshinkali Municipality Ward no. 5

12. Lubhu Khola

There is a potential site for water retaining reservoir near to Lubhu village. It lies in Ward no. 9 of Mahalakshmi Municipality. There is a small streamlet flowing from southeastern hills and meet the Lubhu Khola. The proposed reservoir site is situated at head of the stream. The proposed site comprises moderately weathered metasandstones with thick soil layer on surface belonging to Tistung Formation. The site has been covered by dense forest. After construction of 40 m high dam, the reservoir will cover an area of about 1.94 ha and can hold about 100993 m³ of water.



Potential site for water retaining reservoir in Lubhu Khola, Mahalakshmi Municipality Ward no. 9

13. Nagmati Upstream (2 sites)

There are two potential sites for water retaining reservoir at near to Chisapani within Shivapuri National Park. They lie in Ward no. 1 of Gokarneshwor Municipality. One of the proposed sites is small elongated depression gully adjacent to a road from Sundarijal to Chisapani. A small streamlet flows from east to west to meet Nagmati Khola. These sites are proposed along that small streamlet. There are some sparse trees of rhododendron and mixed forest species.

The first site will cover an area of about 1.47 ha after construction of 20 m high dam. It can hold 55000 m³ water. The second proposed site lies at about 200 m downstream from the previous site. There is a depression surrounded by moderately weathered bedrocks covered by sparse forest. There is potentiality of constructing a water retaining reservoir covering an area of about 2.46 ha that can hold about 179987 m³ water after construction of 30m high dam. Both of the sites lie in gneiss bedrock and residual soil and seem geologically stable.



Potential sites for water retaining reservoir in Nagmati Khola, Gokarneshwor Municipality Ward no.

Potential sites for reservoir dams along rivers

There are 8 potential sites identified from the field for the reservoir dams along rivers. A summary brief description of these potential sites is presented here.

1. Bhandare Khahare

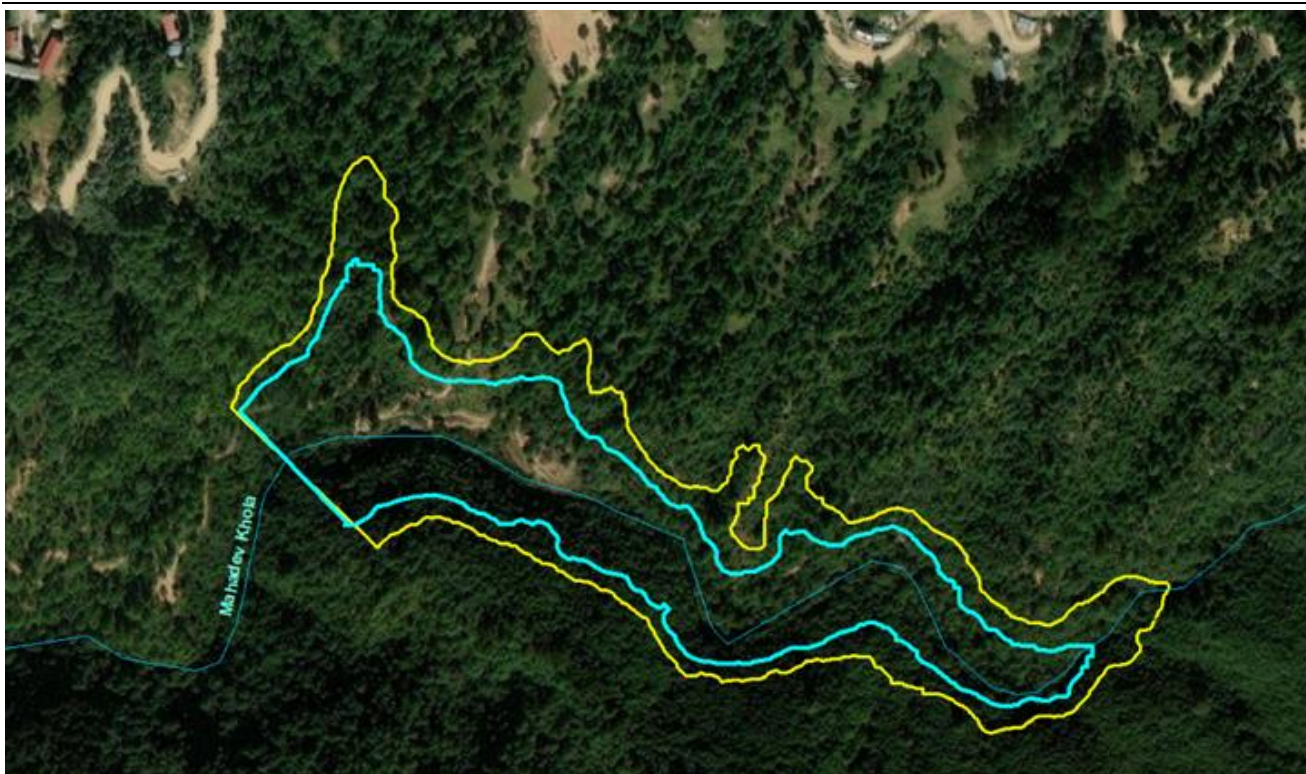
The Bhandare Khahare originates in Shivapuri National Park and flows towards south as a tributary of Sangla Khola, which finally feeds the Bishnumati River. The stream is perineal and flows making narrow valley with steep banks. A potential site for the construction of dam has been identified near to Jhor of Tokha -1. A 40 m long dam of height 24 m can block the stream water to form a river dammed reservoir. The reservoir will spread within an area of 0.55 ha having capacity of 43298 m³.



Potential site for construction of river dammed reservoir in Bhandare Khahare, Tokha-1

2. Muhanpokhari

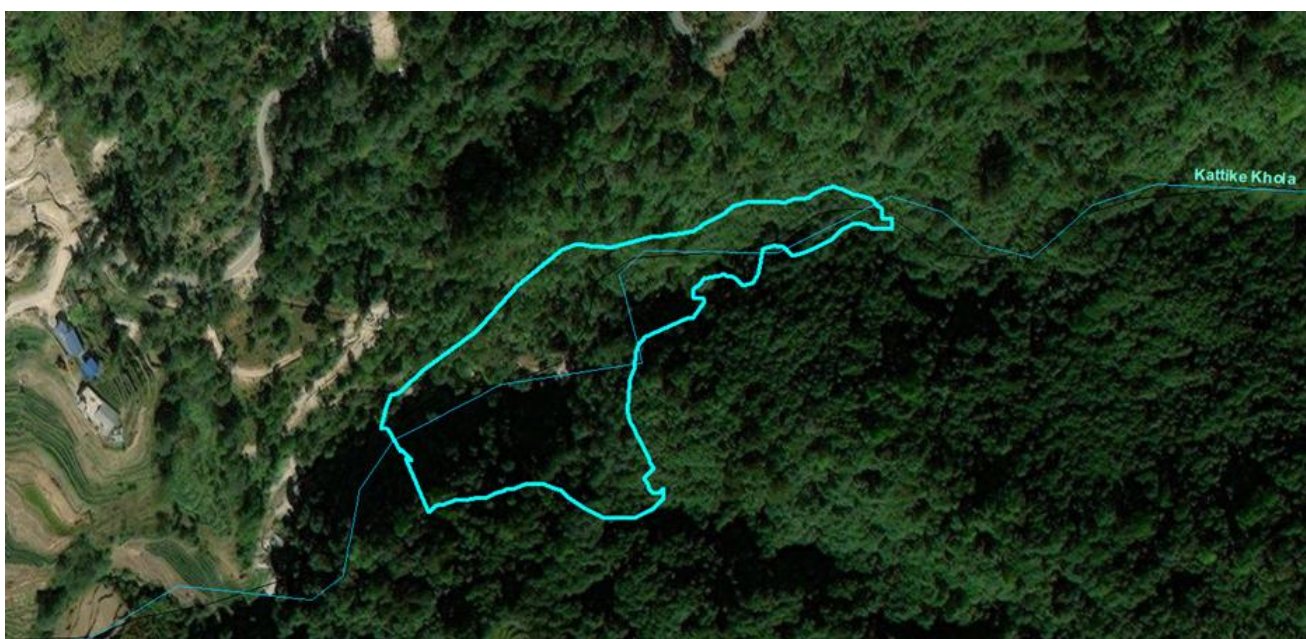
The Muhanpokhari is one of the drinking water sources for Bhaktapur, which taps water from the Mahadev Khola, a tributary of Hanumante Khola. There is existing intake structure for drinking water in the Mahadev Khola that taps water as run-of-river form. If this stream is dammed to make a reservoir, it will contribute significantly to the residents of Bhaktapur. The stream is perineal and comprises forest in its upper catchment. A potential site has been identified for construction of dam to get a reservoir in Mahadev Khola at about 1 km upstream from the present intake location at Muhanpokhari. The proposed site lies in Ward no. 6 and Ward no. 7 of Changu Narayan Municipality. The height of dam determines the capacity of reservoir. So, there are two options of raising dam height. In first option, a 50m high dam will give a large reservoir with an aerial expansion of about 6.8 ha and capacity will be 807911 m³. In the second option, the 60m high dam will make about two-times larger reservoir with an area of 10.93 ha. In that case, the reservoir can hold about 1682836 m³.



Potential site for construction of river dammed reservoir in Muhanpokhari, Mahadev Khola showing two alternatives

3. Kattike Khola

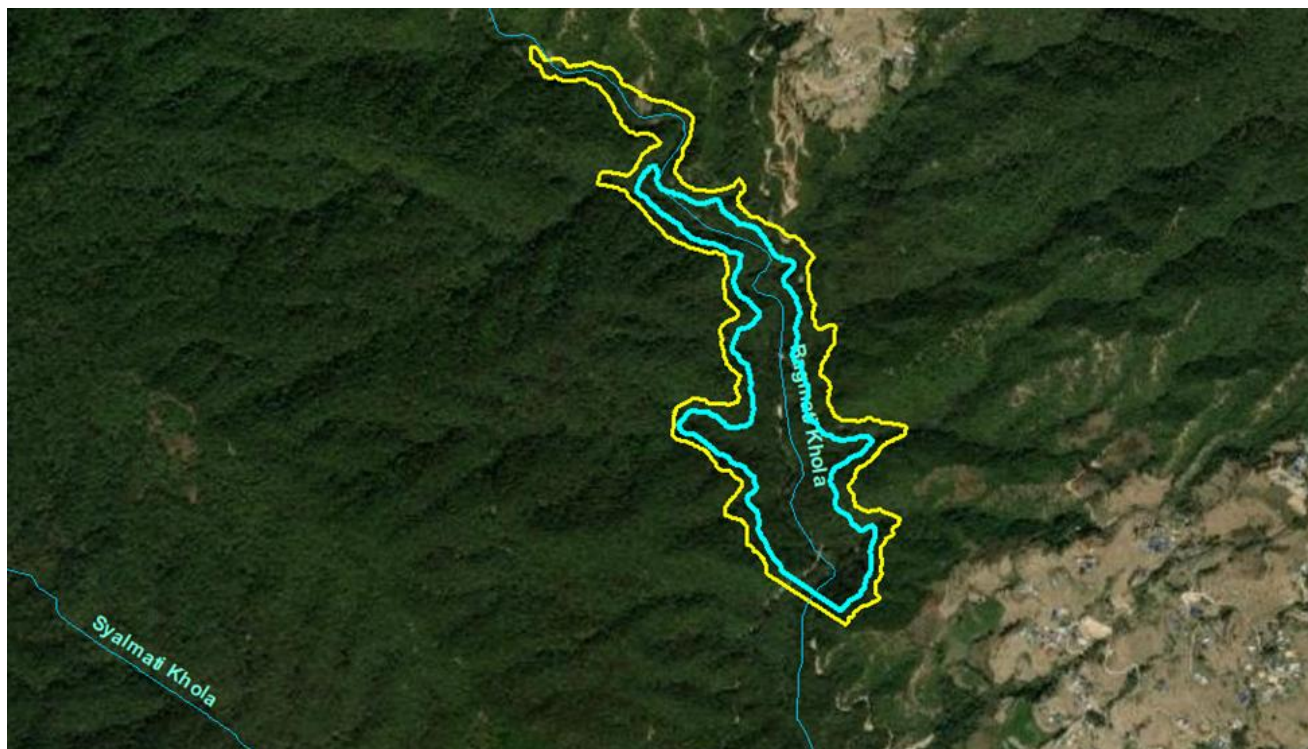
The Kattike Khola is one of the tributaries of Manahara Khola that flows being border between Ward no. 6 of Changuarayan Municipality and Ward no. 5 of Shankharapur Municipality. The stream is perineal and comprises forest in its upper catchment. A potential site has been identified for construction of dam to get a reservoir in Kattike Khola. The height of dam determines the capacity of reservoir. A 50m high dam will give a medium-sized reservoir with an aerial expansion of about 1.26 ha and capacity will be 192463 m³.



Potential site for construction of river dammed reservoir in Kattike Khola

4. Bagmati River

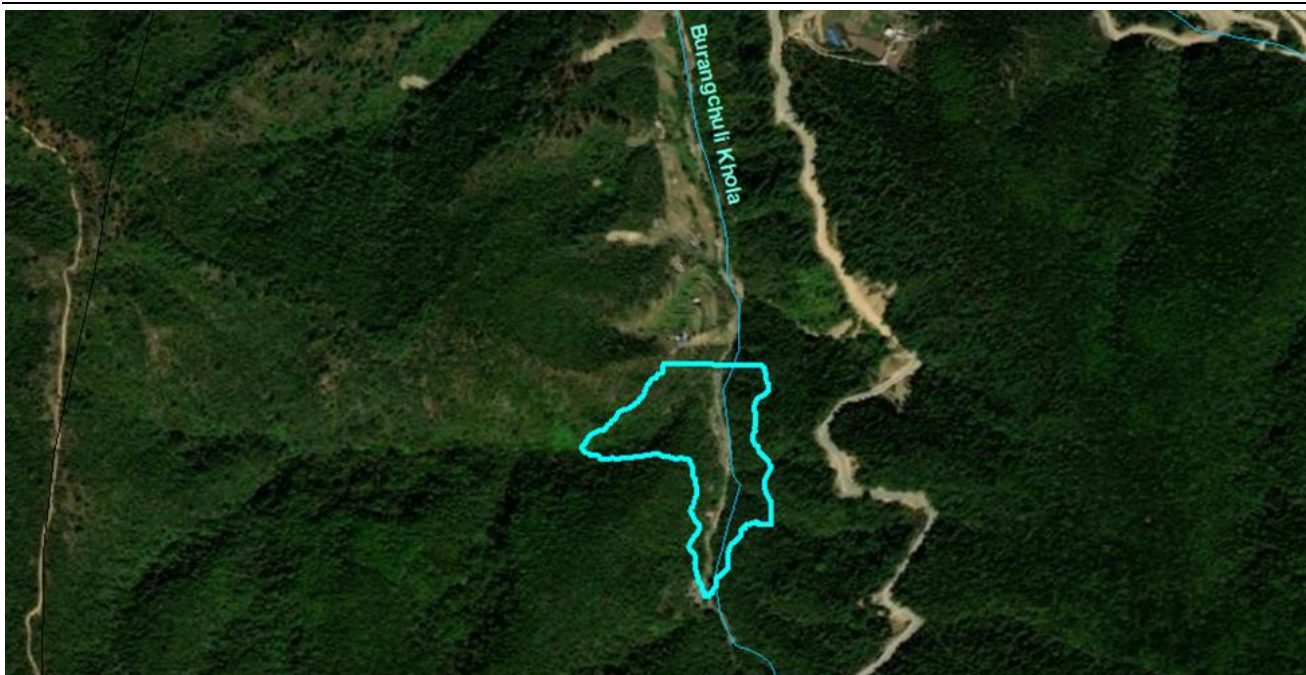
The upstream channel of Bagmati River flows through a narrow course but having a wide valley before meeting with Nagmati Khola. If this stream channel is dammed to make a reservoir, it will contribute significantly to the residents of Bhaktapur. The stream is perineal and comprises forest in its upper catchment. A potential site has been identified for construction of dam to get a reservoir in Bagmati River within Shivapuri National Park. The proposed site lies in Ward no. 1 of Gokarneshwor Municipality. The height of dam determines the capacity of reservoir. So, there are two options of raising dam height. In first option, a 65m high dam will give a large reservoir with an aerial expansion of about 13.05 ha and capacity will be 2546604 m³. In the second option, the 80m high dam will make about two-times larger reservoir with an area of 24.01 ha. In that case, the reservoir can hold about 5485592 m³.



Potential site for construction of river dammed reservoir in Bagmati Nadi showing two alternatives

5. Burungchuli Khola

The Burungchuli Khola is one of the tributaries of Nakkhu Khola that flows through south to north in Ward no. 6 of Godawari Municipality, Lalitpur. The stream is perineal and comprises forest in its upper catchment. A potential site has been identified for construction of dam to get a reservoir in Burungchuli Khola. The height of dam determines the capacity of reservoir. A 50m high dam will give a medium-sized reservoir with an aerial expansion of about 3.64 ha and capacity will be 537134 m³.



Potential site for construction of river dammed reservoir in Burangchuli Khola, Godawari-6

6. Sheshnarayan Khola

The Sheshnarayan Khola is one of the tributaries of Bagmati River that flows through west to east near to Pharping. It lies in the boundary of three wards 3, 6, and 7 of Dakshinkali Municipality, Kathmandu. The stream is perineal and comprises forest in its upper catchment. A potential site has been identified for construction of dam to get a reservoir in Sheshnarayan Khola. The height of dam determines the capacity of reservoir. A 20m high dam will give a small reservoir with an aerial expansion of about 0.78 ha and capacity will be 65706 m³.



Potential site for construction of river dammed reservoir in Sheshnarayan Khola, Pharping

7. Dhobi Khola

The Dhobi Khola that flows from north to south through Budhanilkantha. There are dense residential areas along both bank of the stream. It is being highly polluted too. A potential site for construction of river damming reservoir has been identified in Dhobi Khola. It lies in the boundary of Ward no. 2 and Ward no. 8 of Budhanilakantha Municipality. The height of dam determines the capacity of reservoir. A 25m high dam will give a medium-sized reservoir with an aerial expansion of about 3.62 ha and capacity will be 238452 m³.



Potential site for construction of river dammed reservoir in Dhobi Khola

S. N.	Activities/Plan	Periodical Target (Budget in Lakh)																				Total Budget (in Lakh)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
A	Conservation Zone																					
	River conservation and Management	4,185.83	18,478.45	21,008.45	32,557.45	32,466.45	25,734.37	23,171.45	151.45	51.45	166.45	51.45	51.45	51.45	51.45	66.45	51.45	51.45	51.45	51.45	51.45	158,501.30
	Cultural/Civilization rehabilitation	-	425.00	300.00	300.00	300.00	525.00	100.00	-	-	-	125.00	-	-	-	-	125.00	-	-	-	-	2,200.00
	River/Water Quality and quantity improvement	119.00	5,960.00	24,784.00	30,128.00	34,878.00	34,278.00	43,778.00	23,750.00	23,750.00	23,750.00	33,250.00	33,250.00	33,250.00	33,250.00	33,250.00	33,250.00	33,250.00	33,250.00	33,250.00	33,250.00	577,675.00
	Sub Total	4,304.83	24,863.45	46,092.45	62,985.45	67,644.45	60,537.37	67,049.45	23,901.45	23,801.45	23,916.45	33,426.45	33,301.45	33,301.45	33,301.45	33,316.45	33,426.45	33,301.45	33,301.45	33,301.45	33,301.45	738,376.30
B	Peri-Urban Zone																					
	River conservation and Management	7,340.75	20,685.00	18,985.00	19,430.00	19,380.00	19,148.75	19,098.00	22,028.00	25,162.00	40,652.00	40,552.00	21,270.00	12,820.00	9,220.00	4,100.00	4,100.00	4,100.00	4,100.00	4,100.00	140.00	316,411.50
	Cultural/Civilization rehabilitation	400.00	1,155.00	1,105.00	765.00	525.00	990.00	540.00	810.00	480.00	480.00	1,350.00	1,100.00	1,100.00	1,100.00	1,100.00	1,100.00	1,100.00	1,100.00	1,100.00	1,100.00	18,500.00
	River/Water Quality and quantity improvement	3,960.00	7,664.50	6,802.00	6,976.00	8,730.00	6,472.50	7,540.00	9,430.00	8,130.00	6,530.00	14,030.00	11,530.00	19,030.00	7,030.00	7,030.00	2,330.00	2,230.00	3,563.33	3,563.33	3,413.33	145,985.00
	Sub Total	11,700.75	29,504.50	26,892.00	27,171.00	28,635.00	26,611.25	27,178.00	32,268.00	33,772.00	47,662.00	55,932.00	33,900.00	32,950.00	17,350.00	12,230.00	7,530.00	7,430.00	8,763.33	8,763.33	4,653.33	480,896.50
C	Urban Zone																					
	River conservation and Management	5,586.00	26,287.23	33,187.23	36,925.23	39,565.23	29,015.23	24,715.23	18,381.90	13,581.90	8,281.90	8,181.90	410.00	410.00	410.00	410.00	410.00	410.00	810.00	1,210.00	1,210.00	249,399.00
	Cultural/Civilization rehabilitation	500.00	5,800.00	6,300.00	6,887.50	6,547.50	6,747.50	6,297.50	6,010.00	5,810.00	5,810.00	6,650.00	300.00	400.00	400.00	100.00	100.00	100.00	100.00	100.00	100.00	65,060.00
	River/Water Quality and quantity improvement	21,252.00	32,306.00	34,172.00	45,130.00	42,886.00	46,386.00	31,686.00	41,902.00	41,902.00	40,552.00	40,552.00	37,020.00	40,680.00	48,180.00	43,180.00	37,680.00	44,680.00	15,180.00	1,180.00	1,180.00	687,686.00
	Sub Total	27,338.00	64,393.23	73,659.23	88,942.73	88,998.73	82,148.73	62,698.73	66,293.90	61,293.90	54,643.90	55,383.90	37,730.00	41,490.00	48,990.00	43,690.00	38,190.00	45,190.00	16,090.00	2,490.00	2,490.00	1,002,145.00
D	General	2,552.20	2,549.70	1,935.70	1,723.20	1,533.20	2,128.20	1,503.20	1,477.20	1,487.20	1,487.20	1,822.20	1,257.20	1,257.20	1,267.20	1,257.20	1,422.20	1,257.20	1,267.20	1,257.20	1,257.20	31,699.00
	Sub Total	2,552.20	2,549.70	1,935.70	1,723.20	1,533.20	2,128.20	1,503.20	1,477.20	1,487.20	1,487.20	1,822.20	1,257.20	1,257.20	1,267.20	1,257.20	1,422.20	1,257.20	1,267.20	1,257.20	1,257.20	31,699.00
Total		45,895.78	121,310.88	148,579.38	180,822.38	186,811.38	171,425.55	158,429.38	123,940.55	120,354.55	127,709.55	146,564.55	106,188.65	108,998.65	#####	90,493.65	80,568.65	87,178.65	59,421.98	45,811.98	41,701.98	2,253,116.80

General Action

S. N.	Sector		Activities/Action	Total Budget (in Lakh)	Periodical Target (in lakh)																				Budget and source				
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Local	Central	Others		
1	River conservation and Management	Sustainable land use management	Amendment of bylaws and endorsement	80		20				20					20					20						Municipality	HPCIDBC/ KVDA		
			Promotion and support sustainable land management in valley	1,000	300					300					400											Municipality	HPCIDBC/ KVDA		
		Management of Public Land along the River Corridor	Reclaim the encroached land along Rivers	50		25	25																			Municipality	HPCIDBC, MoLMCPA		
			Preparation of master Plan for Preserve and restore river course to minimize flood hazard impact	200	100	100																					HPCIDBC, DWIDP		
		Implementation of RoR to conserve river area	Detailed Study for implementation of proposed RoR	1,000	20	100	100	100	100	110	110	120	120	120													HPCIDBC		
		Disaster mitigation	Conduct impact assessment of river corridors development (within RoR)	100		25				25					25					25							Municipality	HPCIDBC, DHM	
			Establishment of water gauge station	105		52.5	52.5																				Municipality	HPCIDBC, DHM	
			Installation of flood EWS based on citizen science based model for flood hazard in all study river	504	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	Municipality	HPCIDBC		
2	Cultural/Civilization rehabilitation	Reclaim, Rehabilitate and conserve the cultural and heritage sites along river	Detail documentation and publication of tangible and intangible heritage	450	225	225																			Municipality	HPCIDBC/ DOA	Donar agencies		
			Creating a heritage utilization strategy and implementing through encouraging the local bodies	10,000	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	Municipality	HPCIDBC/ DOA	Donar agencies		
			Coordinate for UNESCO listing campaign of tangible and intangible heritage	50	10	10	10	10	10																	Municipality	HPCIDBC/ DOA		
			Heritage intervention campaign from local to global level	50	10	10	10	10	10																	Municipality	HPCIDBC/ DOA		
			Identification, strategy development and implementation for development of heritage corridors	10,000	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	Municipality	HPCIDBC/ DOA	Donar agencies	
			Preparation of river front design guidelines for Kathmandu valley	20	20																						HPCIDBC, DUDBC		
			Training to produce skilled manpower for																							Municipality	HPCIDBC/ DoA/ DUDBC		
			a) Production of traditional materials and tools	600	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30				
b) Traditional carvings and construction works	600	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30							
3	River/Water Quality and quantity improvement	Management of Solid waste disposal directly into river system	Establishment of Control system for CCTV	100	40					20					20					20							HPCIDBC		
			Establishment of structure of Bagmati Police and development of mechanism for operation	30		30																					HPCIDBC		
			Study and coordinate for implementation of relocation of waste transfer station from river corridor area	50		25	25																			Municipality	HPCIDBC		
			Coordinate with municipalities for promotion of HH level waste management	1,000	100	100	100	100	100	100	100	100	100	100												Municipality	HPCIDBC		
			Establishment of Vehicle washing center at entry point of KV especially for truck	450		450																					DoTM		
		Management of Sewerage to prevent direct disposal into river	Monitoring and implementation of septic tank at Residential Level	100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Municipality	HPCIDBC			
			Monitoring and implementation of waste water treatment in industries, hotel, hospital and Colony level	100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Municipality	HPCIDBC			
			Preparation of City Sanitation Plan	380			190	190																		Municipality	HPCIDBC/ DUDBC	Donar agencies	
		Water source conservation to Increase ground water recharge and river discharge	Monitoring and implementation of water infiltration well/system in all institutions	100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Municipality	HPCIDBC			
			Monitoring and implementation of rain water harvesting system in all institutional buildings and promotion to residential buildings	100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Municipality	HPCIDBC			
			Mapping and reclaim encroached water sources area	100	20	20	20	20	20																	Municipality	HPCIDBC		
			Detail documentation and mapping of Rajkulo, Hiti system and Well system within Kathmandu Valley	300	100	100	100																			Municipality	HPCIDBC/ DoA	Donar agencies	

		Strengthening river quality monitoring system	Establishment of real time monitoring system in all 19 tributaries of Bagmati river system and implementation	800	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40		HPCIDBC	Donar agencies		
			Development of quick response mechanism for pollution management and implementation	300	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15		HPCIDBC	Donar agencies		
4	Capacity building	Knowledge management	Enhance scientific research/ upgrade technical capacity/recognize the innovativeness of youth	500	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25		HPCIDBC			
			Development curricula on Bagmati Civilization for school level	40	20					10				10											Municipality	HPCIDBC		
			Provide research grants for graduate and post graduate students	200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		HPCIDBC		
			Support domestic technology development for preservation and conservation of natural cultural heritage of Bagmati	200	100					100															Municipality	HPCIDBC		
			Enhance community participation in BAP implementation	Establish and capacitate ward-level community organization along the river corridor	200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Municipality	HPCIDBC	
			Develop up-stream and downstream linkages	200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Municipality	HPCIDBC	
			Increase community participation and ownership in asset management and development activities	200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Municipality	HPCIDBC	
			Encourage community involvement in monitoring and maintaining local infrastructures through Citizen Reporting System	100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		HPCIDBC	Donar agencies	
				Institutional strengthening	Reduce waste generation through prevention, reduction, recycling, reuse in collaboration with local government	100	50				50															Municipality	HPCIDBC	
		Training for capacity improvement for procurement, GIS, design & management of infrastructure			100	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		HPCIDBC		
		Exposure visit (national/International) for knowledge sharing			200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		HPCIDBC		
		Preparation of urban design guideline for each local government of KV			360	180		36	36	36	36	36													Municipality	HPCIDBC, DUDBC		
		Development and Operation of Assets Management System			240	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		HPCIDBC	Donar agencies	
		Mid Term review of Bagmati action plan			40			10						10					10				10				HPCIDBC	
		Updating the Bagmati action Plan			300						100					100					100						HPCIDBC	
		Total				31,699	2,552	2,550	1,936	1,723	1,533	2,128	1,503	1,477	1,487	1,487	1,822	1,257	1,257	1,267	1,257	1,422	1,257	1,267	1,257	1,257		

Urban Zone																																				
S. N.	Sector	Activities	Action	Qty	Unit	Unit Rate, NRs. (in 000)	Total Budget (in Lakh)	Periodical Target (in Lakh)																				Budget and source								
								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Local	Centr al	Others						
1	River conservation and Management	Strengthen River Cleaning Program	Periodic cleaning/dredging of rivers	20	Year	100	2,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Municip ality	HPCI DBC						
			Mass movement for cleaning campaign in collaboration with local government and community	20	Year	20	400	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	Municip ality	HPCI DBC					
			Promote corridor walkathan in each rivers	20	Year	20	400	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	Municip ality	HPCI DBC					
			Strengthen the rafting programme and development of supporting infrastructures	1	LS	1,500	1,500	300	300	300	280	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	Municip ality	HPCI DBC					
			Development of small dam across the Nakhu, Kodku and Godawari Khola with introducing water recreation activities and corridor beautification	3	No.	800	2,400		400	400	400	400	400	400															Municip ality	HPCI DBC	Donar agenci es					
			Development of small dam across the Dhobi Khola with introducing water recreation activities and corridor beautification	1	LS	2,000	2,000																			400	800	800	Municip ality	HPCI DBC	Donar agenci es					
		Managemen t of Public Land along the River Corridor	Salix plantation along river corridor area	10	Year	100	1,000	100	100	100	100	100	100	100	100	100	100												Municip ality	HPCI DBC						
			Identify the Space and establish and maintain Child friendly park Along River (Open Space & greenery management)	1	LS	2,000	2,000	400	400	400	400	400																	Municip ality	HPCI DBC						
			Identify the Space and establish and maintain Youth friendly park Along River (with Gym equippment)	1	Ls	3,000	3,000	600	600	600	600	600																	Municip ality	HPCI DBC						
			Identify the Space and establish and maintain Old age friendly park Along River (Open Space with Yoga facility)	1	Ls	2,000	2,000	400	400	400	400	400																	Municip ality	HPCI DBC						
			Verification and Inventory of illegally encroached land along river banks (P1)	1	Ls	100	100	100																					Municip ality	HPCI DBC						
			Managment of verified informal settlement along the river bank at Kuriyagaun, Sankhamul, Bansighhat, Thapathali, Balkhu, Pragati Tole, Chandani Tole, Sinamangal (Mahabir Galli), Jagriti Nagar, Gairigaun, Shanti Nagar, Dhirghyau Tole, Airport Gairigaun, Buddha Jyoti Marga, Jagriti Tole, Maoohara, Palpakot, Pathivara, Bishalnagar, Kalopul, Devi Nagar, Shanti Binayak, Anamnagar etc(P1)	1	Ls	16,500	16,500		1,650	4,950	4,950	4,950																	Municip ality	HPCI DBC						
			Sustainable land use managemen t	Construction of sediment trapping structures																										Municip ality	HPCI DBC					
		a) Bagmati River		1	No.	50	50		50																											
		b) Balkhu Khola		1	No.	50	50			50																										
		Disaster mitigation	Construction of river training structure with bioengineering (salix and other plantation) or Ghat structure along river corridor area as per appropriate	94	km	800	75,200		7,520	7,520	7,520	7,520	7,520	7,520	7,520	7,520	7,520												Municip ality	HPCI DBC/ MoE WRI						
		Developmen t of corridor transport system along rivers	Construction of pedestrian and environment friendly smart corridor road network (about 108 km) including road furniture and junction improvement along rivers beyond Proposed Waterway																										Municip ality	HPCI DBC, DoR						
			a) Road Corridor along Bagmati River (Both Side - 14km)	14	km	1,200	16,800		2,400	2,400	2,400	2,400	2,400	2,400																						
			b) Road Corridor along Bishnumati River (Both Side-5km)	5	km	800	4,000				2,000	2,000																								
			c) Road Corridor along Hanumante River (Both Side-12km)	12	km	800	9,600		1,200	1,200	1,200	1,200	1,200	1,200	1,200																					
			d) Road Corridor along Nakhu Khola (Both Side-4km)	4	km	800	3,200					800	800	800	800																					
			e) Road Corridor along Balkhu Khola (Both Side-12km)	12	km	800	9,600				1,600	1,600	1,600	1,600	1,600	1,600																				

			f) Road Corridor along Khodku Khola (Both Side-16km)	16	km	800	12,800		2,133	2,133	2,133	2,133	2,133																		
			g) Road Corridor along Manahara River (Both Side-18km)	18	km	800	14,400	1,600	1,600	1,600	1,600	1,600	1,600	1,600																	
			h) Road Corridor along Godawari Khola (Both Side-12km)	12	km	800	9,600			1,600	1,600	1,600	1,600	1,600																	
			i) Road Corridor along Manamati Khola (Both Side-5km)	5	km	800	4,000						2,000	2,000																	
			j) Road Corridor along Suryamati Khola (Both Side-10km) including three motorable bridges (nearby hanuman chowk, border of ward-2 & 3 and nearby Jaldevi temple)	10	km	848	8,480	1,696	3,392																						
			Upgrading of existing corridor road network (about 25 km) to pedestrian and environment friendly smart corridor road including road furniture and junction improvement																								Municipality	HPCI DBC, DoR			
			a) Road Corridor along Bagmati River (10km)	10	km	800	8,000		1,600	1,600	1,600	1,600																			
			b) Road Corridor along Bishnumati River (9km)	9	km	600	5,400			1,800	1,800	1,800																			
			c) Road Corridor along Hanumante River (12km)	12	km	600	7,200		900	900	900	900	900	900	900																
			d) Road Corridor along Nakhu Khola (13km)	13	km	600	7,800		1,200	1,200	1,200	1,200	1,800																		
			e) Road Corridor along Balkhu Khola (2km)	2	km	600	1,200				1,200																				
			f) Road Corridor along Khodku Khola (4km)	4	km	600	2,400			1,200	1,200																				
			g) Road Corridor along Manahara River (6km)	6	km	600	3,600			1,200	1,200	1,200																			
			h) Road Corridor along Mahadev Khola (3km)	3	km	600	1,800				900	900																			
			j) Road Corridor along Baucha Khola (2km)	2	km	600	1,200			1,200																					
			k) Road Corridor along Godawari Khola (2km)	2	km	600	1,200				1,200																				
			l) Road Corridor along Manamati Khola (2km)	2	km	600	1,200					1,200																			
			Construction of Universal Smart pedestrian bridges at maximum 500m interval in Bagmati River (11), Bishnumati River (1), Hanumante River (4), Nakhu Khola (16), Manahara Khola (13), Khodku Khola (3), Godawari Khola (1), Manamati Khola (1)	50	No.	100	5,000	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	Municipality	HPCI DBC, DoR		
			Improvement of Junctions of Bishnumati River Corridor Road at Nayabazaar, Gongabu, Baniyatar, Paropakar; Dhobi Khola Corridor Road at Bijulibazaar, Chabahil; Nakhu Khola Corridor Road at Nakhudole; Khodku Khola Corridor Road at Hattiban; Hanumanre River Corridor Road at Madhyapur Thimi	9	No.	200	1,800			200	200	200	200	200	200	200											Municipality	HPCI DBC, DoR			
			Installment of Traffic Sign, Signal, information Board along corridor road network	173	km	3	519		52	52	52	52	52	52	52	52											Municipality	HPCI DBC, DoR			
Sub Total							249,399	5,586	26,287	33,187	36,925	39,565	29,015	24,715	18,382	13,582	8,282	8,182	410	410	410	410	410	810	1,210	1,210					
2	Cultural/ Civilization rehabilitation	Reclaim, Rehabilitate and conserve the cultural and heritage sites along river	Restoration of cultural monuments and sites including approach Trail																							Municipality	HPCI DBC, DoA	Donar agencies			
			a. Bagmati river -Shankhamul (P1), Kalmochan (remaining), Teen dewal (remaining), Tripureshwor mahadev (remaining) (P2), Pachali bhairav- Pachali ghat (P1), Chitamani Tirtha (P1)	6	Place	4,000	24,000		2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400															

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			b) Tapa hiti, Thapa hiti, Guita hiti, Chyasal hiti, Misa hiti, Konti hiti, Swara hiti, Alko hiti, Tyagal hiti, Tangal hiti, Saugal hiti, Sincha hiti, Na tole hiti, Nag bahal hiti, Badegaon hiti, Jawalakhel hiti, Sundhara hiti, Dhobighat within Lalitpur District	17	No.	100	1,700		85	85	170	170	170	170	170	170	170														
			c) Chyasalin mandap hiti, Pulan hiti, Sundhara hiti, sala ganesh hiti, Baku hiti - Hanumanghat, Bhimdyo hiti, Dhauwa hiti - indrayani pith, Brahmayani pith hiti, Dhum barahi pith hiti, khauma hiti, Nasamana tol hiti, Ga hiti -taumadhi, Byasi gate hiti, hiti at Nagadesh, Hiti at Bode, Hlti at Thimi within Bhaktapur District	17	No.	100	1,700		85	85	170	170	170	170	170	170	170														
Sub Total							687,686	21,252	32,306	34,172	45,130	42,886	46,386	31,686	41,902	41,902	40,552	40,552	37,020	40,680	48,180	43,180	37,680	44,680	15,180	1,180	1,180				
Total							1,002,145	27,338	64,393	73,659	88,943	88,999	82,149	62,699	66,294	61,294	54,644	55,384	37,730	41,490	48,990	43,690	38,190	45,190	16,090	2,490	2,490				

Peri Urban Zone																																			
S · N ·	Sector	Activities	Action	Qt y	Uni t	Unit Rate, NRs. (in Lakh)	Total Budge t (in Lakh)	Periodical Target (in Lakh)										Periodical Target (in Lakh)										Budget and source							
								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Local	Centra l	Other s					
1	River conserv ation and Manage ment	Strengthen River Cleaning Program	Periodic cleaning/dredging of rivers	20	yea rs	100.0 0	2,000	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Municip ality	HPCID BC					
			Mass movement for cleaning campaign in collaboration with local government and community	20	yea rs	20.00	400	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	Municip ality	HPCID BC				
			Promote corridor walkathan in each rivers	20	yea rs	20.00	400	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	Municip ality	HPCID BC				
		Managemen t of Public Land along the River Corridor	Verification and Inventory of illegally encroached land along river banks (P1)	1	Ls	10,00 0	10,000	5,000	5,000																					Municip ality	HPCID BC				
			Management of verified informal settlement along the river bank at Khandpakha, Palpakot, Narayanthan, Maijubahal, Khadgabhadrakali, Mandikhatar, Ramhiti (P1)	1	Ls	16,50 0	16,500		1,650	4,95 0	4,95 0	4,950																		Municip ality	HPCID BC				
			Identify the Space and establish & maintain Child friendly park along River (Open Space & greenery management)	1	LS	2,000	2,000	400	400	400	400	400																		Municip ality	HPCID BC				
			Identify the Space and establish and maintain Youth friendly park along River (with Gym eqquippment)	1	Ls	3,000	3,000	600	600	600	600	600																		Municip ality	HPCID BC				
			Identify the Space and establish and maintain Old age friendly park along River (Open Space with Yoga facility)	1	Ls	2,000	2,000	400	400	400	400	400																		Municip ality	HPCID BC				
			Salix plantation along river corridor area	10	Yea r	100.0 0	1,000. 00	100.0 0	100.0 0	100.0 0	100.0 0	100.0 0	100.0 0	100.0 0	100.0 0	100.0 0	100.0 0													Municip ality	HPCID BC				
		Sustainable landuse managemen t	Construction of sediment trapping structures																											Municip ality	HPCID BC, DoFSC				
			a) Bagmati River	1	No.	50	50	50																											
			b) Bagmati downstream River	1	No.	50	50					50																							
			c) Bishnumati River	2	No.	50	100	100																											
			d) Hanumante Khola	2	No.	50	100	100																											
			e) Manohara River	2	No.	50	100				100																								
			f) Nakkhu Khola	1	No.	50	50							50																					
			Promote alternative practices to surface water irrigation	1	LS	200	200		50	50	50	50																		Municip ality	HPCID BC, DoI				
			Terrace improvement and promote multiyear crop cultivation																											Municip ality	HPCID BC, DoFSC				
			a)Bishnumati Watershed	85 5	ha	0.15	128	64.13					64.13																						
			b) Balkhu Watershed	110	ha	0.15	17	8.25					8.25																						
			c) Hanumante Watershed	23 0	ha	0.15	35	17.25					17.25																						
			d) Nakkhu Watershed	37 0	ha	0.15	56	27.75					27.75																						

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			daha (P2); 12 year festival chariot festival (P3); Tika bhairav jatra (P2))																											
			Revival and preservation of cultural trails/Heritage Trails	1	pck	2,000.00	2,000.00	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Municipality	HPCID BC	
			Identification, development, implementation of Master plan of cultural landscape to preserve the historic city plan - Tika bhairav to Lele(P4) and Chapagaon,Sankhu to Bajrayogini (P3)	2	No.	3,500.00	7,000.00										700	700	700	700	700	700	700	700	700	700	700	Municipality	HPCID BC	
Sub Total							18,500	400	1,155	1,105	765	525	990	540	810	480	480	1,350	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100			
3	River/Water Quality and quantity improvement	Management of Sewerage to prevent direct disposal into river	Construction of separate sewerage Treatment System including interceptor network in following location																									Municipality	HPCID BC	
a) Dakshinkali Municipality-03			1	LS	4,000	4,000																		1,333.33	1,333.33	1,333.33				
b) Shankharapur Municipality-09			1	LS	6,000	6,000					2,000.00	2,000.00	2,000.00																	
c) Lalitpur Metropolitan City-22			1	LS	25,000	25,000										7,500.00	7,500.00	10,000.00												
d) Kirtipur Municipality-6			1	LS	7,500	7,500								3,750.00	3,750.00															
e) Kirtipur Municipality-4			1	LS	7,500	7,500										2,250.00	2,250.00	3,000.00												
f) Suryabinayak Municipality-05			1	LS	20,000	20,000													8,000.00	6,000.00	6,000.00									
Consutruction of DEWATs in community level for upto one MLD capacity based on City Sanitation Plan			1	LS	32,000	32,000		3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200											Municipality	HPCID BC	
Management of Solid waste disposal directly into river system		Establishment of Control system with installation of CCTV along river corridor																										Municipality	HPCID BC	
		a) Bagmati River	420	No.	0.20	84		84																						
		b) Bishnumati River	80	No.	0.20	16		16																						
		c) Dhobi Khola	60	No.	0.20	12		12																						
		d) Manahara River	220	No.	0.20	44			44																					
		e) Hanumante Khola	140	No.	0.20	28			28																					
		f) Nakhu Khola	200	No.	0.20	40			40																					
h) Balkhu Khola	160	No.	0.20	32				32																						
i) Godawari Khola	180	No.	0.20	36				36																						
j) Manamati Khola	120	No.	0.20	24				24																						

			k) Khodku Khola	150	No.	0.20	30				30																			
			l) Mahadev Khola	120	No.	0.20	24				24																			
			Installation of soild waste collection netting across into river at 1km interval	1	Ls	2,600	2,600	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	Municipality	HPCID BC	
		Encourage organic farming	Promote/encourage urban organic farming through production based subsidy (Location/Area)	1	LS	500	500		100		100		100	100	100													Municipality	HPCID BC, DoA	
			Discourage chemical fertilizer and chemical pesticide with alternatives	1	LS	50	50	10	10	10			10	10														Municipality	HPCID BC, DoA	
		Conservatio n and managemen t of water sources	Construction of rain water storage/ harvesting ponds	8	No.	30	240	120					120															Municipality	HPCID BC, KUKL	
			Development of Water reservoir dam along rivers and water retaining ponds/reservoir (3 nos.)	1	LS	12500	12500	2500	2500	2500	2500	2500																Municipality	HPCID BC, DoED, DoI	Donar agenc ies
			Conservation of water recharge zone of existing water sources	1	LS	500	500		50	50	50	50	50	50	50	50	50	50										Municipality	HPCID BC, DoFSC	
			Revival and preservation of Historic/traditional Pokhari																									Municipality	HPCID BC, DoA	Donar agenc ies
			a) Tau daha, Kritipur (P1)	1	No.	200.00	200.00			200.00																				
			b) Saraswati Kund (P4), Lele Kunda, Pyangaon Fongasi Pokhari, Pauli Pukhu - Bulu (P4) , Ta Pukhu - Bhansar tol - Chapagaon (P4), Bhaorav pukhu - chapagaon, Bajrabarahi Pokhari (P1), Kamal Pokhari - Singenyah Pukhu -Jhyalipati (P2) within Lalitpur District	9	No.	1,200.00	10,800.00	1,200.00	1,200.00				1,200.00	1,200.00								1,200.00	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00			
			Revival and preservation of dhungedhara																									Municipality	HPCID BC, DoA	Donar agenc ies
			a) Dhungedhara at Sankhu historic settlement (P1), Tokha lachi hiti (P3), Manamaiju hiti (P2), Baise dhara - balaju (P1) within Kathmandu district	4	No.	100.00	400.00		100.00	100.00					100.00							100.00								
			b) Chapagaon hiti (P1), Harisiddhi hiti dhalko, siddhipur hiti, Lubhu hiti, (P2) Godavari nau dhara (P1),Hitiphusa - Dholahiti - Sunakothi (P1) within Lalitpur district	6	No.	100.00	600.00			100.00	100.00	100.00	100.00	100.00	100.00															
			c) Hiti at changunarayan area (P1), Hiti at Suryabinayak area (P1) within Bhaktapur district	2	No.	100.00	200.00		100.00	100.00																				
			Revival and preservation of Raj kulo (Kathmandu, Bhaktapur, and Lalitpur)	1	Pck	15,000.00	15,000.00		150.00	300.00	750.00	750.00	750.00	750.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	750.00	Municipality	HPCID BC, DoA, DoI	Donar agenc ies
			Support and participation of local communities in improving water use efficiency	1	LS	25	25		12.50				12.50															Municipality	HPCID BC, DoFSC	
Sub Total							145,985	3,960	7,665	6,802	6,976	8,730	6,473	7,540	9,430	8,130	6,530	14,030	11,530	19,030	7,030	7,030	2,330	2,230	3,563	3,563	3,413			
Total							480,897	11,701	29,505	26,892	27,171	28,635	26,611	27,178	32,268	33,772	47,662	55,932	33,900	32,950	17,350	12,230	7,530	7,430	8,763	8,763	4,653			

Conservation Zone																																			
S. N.	Sector	Activities	Action	Qty	Unit	Unit Rate, NRs. (in 000)	Total Budget (in Lakh)	Periodical Target (in Lakh)																				Periodical Target (in Lakh)			Budget and source				
								1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Local	Central	Others					
1	River conservation and Management	Promote Ecotourism	Study and development of Cycling/Hiking trail along the foot hill of the valley	258	km	100	25,800	516	3,870	6,450	6,450	6,450	2,064															Municipa lity	HPCIDBC, SNNP						
			Establishment of waste management services along trekking/cycling routes	1	Ls	60	60	15				15					15					15							Municipa lity	HPCIDBC					
		Conservation of the land use to recharge water source	Relocation of existing settlement of SNNP area - Mulkharka Settlement (187 HH)(P3), Thulo/Sano Chilaune (70 HH)(P1), Okhreni (167 HH)(P2) and Kunegaun (45 HH)(P1)	1	Ls	115,350	115,350		11,535	11,535	23,070	23,070	23,070	23,070															Municipa lity	HPCIDBC					
			Identify and study the existing settlement within Conservation Zone area and prepare the development modality of identified settlements. (P1)	1	No.	50	50	50																					Municipa lity	HPCIDBC					
		Disaster mitigation	Construction of river training structure with bioengineering (salix and other plantation) or Ghat structure along river corridor area as per appropriate	18	km	800	14,400	2,880	2,880	2,880	2,880																	Municipa lity	HPCIDBC/ MoEWRI						
		Sustainable landuse management	Construction of check dams for Gully control in following river																										Municipa lity	HPCIDBC, DoFSC					
			a) Bagmati River	77	No.	1	77	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4								
			b) Bagmati downstream River	220	No.	1	220	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11								
			c) Balkhu Khola	68	No.	1	68	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3								
			d) Bishnumati River	165	No.	1	165	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8								
			e) Dhobi Khola	22	No.	1	22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
			f) Godawari Khola	32	No.	1	32	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2								
			g) Hanumante Khola	161	No.	1	161	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8								
			h) Kodku Khola	19	No.	1	19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
			i) Manohara River	156	No.	1	156	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8								
			J) Nakkhu Khola	109	No.	1	109	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5								
			Construction of sediment trapping structures																									Municipa lity	HPCIDBC, DoFSC						
			a) Bagmati River	1	No.	50	50		50																										
			b) Bagmati downstream River	3	No.	50	150						50		50		50																		
			c) Dhobi Khola	1	No.	50	50			50																									
			d) Hanumante Khola	2	No.	50	100		50				50																						
			e) Manohara River	2	No.	50	100				50					50																			
			f) Nakkhu Khola	2	No.	50	100							50			50																		
			Terrace improvement and promote multiyear crop cultivation												50														Municipa lity	HPCIDBC, DoFSC					
			a)Bishnumati Watershed	1,470	ha	0.15	221	132						88																					
			b) Balkhu Watershed	490	ha	0.15	74	44						29																					
			c) Dhobi Watershed	155	ha	0.15	23	14						9																					
			d) Hanumante Watershed	2,035	ha	0.15	305	183						122																					

			e) Nakkhu Watershed	1,570	ha	0.15	236	141				94																		
			f) Bagmati downstream Watershed	740	ha	0.15	111	67				44																		
			g) Bagmati Watershed	245	ha	0.15	37	22				15																		
			h) Kodku Watershed	47	ha	0.15	7	4				3																		
			i) Manohara Watershed	500	ha	0.15	75	45				30																		
			j) Godawari Watershed	230	ha	0.15	35	21				14																		
			Replacement of pine with broad leave forest 321Ha; Godawari-75 Ha, Hanumante-210 Ha , Nakkhu-23 Ha, Bagmati downstream-13 Ha	1	LS	140	140		42	42	56																Municipa lity	HPCIDBC, DoFSC		
Sub Total							158,501	4,186	18,478	21,008	32,557	32,466	25,734	23,171	151	51	166	51	51	51	51	66	51	51	51	51	51			
2	Cultural/ Civilization rehabilitation	Reclaim, Rehabilitate and conserve the cultural and heritage sites along river	Restoration of cultural monuments and sites including approach trail - Tarkeshwar Mahadev (P3), Bajrayogini (P1), Bagdwar (P2), Vishnu dwar (P4) and Mahadev Pokhari (P2)	5	place	100	500		125			125											125				Municipa lity	HPCIDBC, DoA	Donar agencie s	
Revival and preservation of Historic Manichud daha, Shankharapur including associated features			1	place	200	200				100	100															Municipa lity	HPCIDBC	Donar agencie s		
Preservation of intangible heritage		Revival and preservation of cultural trails (Sundarijal to Bagdwar (P1), Kotval daha trail (P1), Sankhu to Bajrayogini to Manichud daha (P1), Mahadev Pokhari - Nagarkot trail (P2) and Tarkeshwar Mahadev trail (P3)	5	No.	300	1,500		300	300	300	300	300															Municipa lity	HPCIDBC, DoA	Donar agencie s	
Sub Total							2,200	-	425	300	300	300	525	100	-	-	-	125	-	-	-	-	125	-	-	-	-			
3	River/Water Quality and quantity improvement	Encourage organic farming	Promote/encourage urban organic farming through production based subsidy	1	LS	500	500	100	100	100	100																Municipa lity	HPCIDBC, DoA		
Discourage chemical fertilizer and chemical pesticide with alternatives			1	LS	15	15	9	6																		Municipa lity	HPCIDBC, DoA			
Water source conservation to Increase ground water recharge and river discharge		Construction of rain water storage/ harvesting ponds	198	No.	30	5,940		594	594	1,188	1,188	1,188	1,188													Municipa lity	HPCIDBC, KUKL			
		Implementation of Nagmati Multipurpose dam Project	1	No.	94,200	94,200			18,840	18,840	18,840	18,840	18,840													Municipa lity	HPCIDBC	Donar agencie s		
		Development of Water reservoir dam and water retaining ponds/reservoir (21 nos.)	1	Ls	475,000	475,000		4,750	4,750	9,500	14,250	14,250	23,750	23,750	23,750	33,250	33,250	33,250	33,250	33,250	33,250	33,250	33,250	33,250	33,250	Municipa lity	HPCIDBC, DoED, Dol	Donar agencie s		
		Salix plantation along river banks and dhap areas	1	LS	2,000	2,000		500	500	500	500															Municipa lity	HPCIDBC, DoFSC			
		Conservation and management of existing water sources	1	LS	20	20	10	10																		Municipa lity	HPCIDBC, DoFSC			
Sub Total							577,675	119	5,960	24,784	30,128	34,878	34,278	43,778	23,750	23,750	23,750	33,250	33,250	33,250	33,250	33,250	33,250	33,250	33,250					
Total							738,376	4,305	24,863	46,092	62,985	67,644	60,537	67,049	23,901	23,801	23,916	33,426	33,301	33,301	33,301	33,426	33,301	33,301	33,301					