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THE ROLE OF WATER BODIES IN ENVIRONMENTAL ENHANCEMENT AND LOCAL DEVELOPMENT

(A case study of Bagmati Fishery Pond)

by
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A THESIS
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Certificate of Thesis Approval

This is to certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis report titled **"The Role of Waterbodies in Environmental Enhancement and Local Development : A Case of Bagmati Fishery Pond"** submitted by **Mr. Yuvaraj Timalsina (078-MSURP-020)** in the partial fulfillment of the requirements for the degree of **Master of Science in Urban Planning**.

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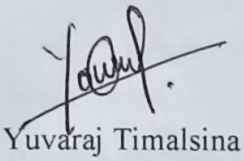
DECLARATION

I hereby declare that the thesis entitled "**The role of water bodies in environmental enhancement and local development: A case study of Bagmati Fishery Pond**" which is submitted to the Department of Architecture, Pulchowk Campus, Institute of Engineering, Tribhuvan University in partial fulfilment of the requirements for the degree of Master of Science in Urban Planning, is a research work carried out by me, under the supervision of **Prof. Dr. Jiba Raj Pokheral**. I declare that the work is my own and has not been submitted for a degree of another University.



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ABSTRACT

The increases in urbanization have kept tremendous pressure on environment resulting in need of proper plan to protect the environment. Similarly, with urbanization there is need for potential economic generating sectors and sustainable development of such area. During such instances, Lake ecosystems can be used as one of the incentives to foster environment balance as well as promote economic and physical development surrounding the area. This paper is conducted not only to understand but also to validate that an artificial lake can enhance environment and local development around the vicinity of lake. For this, an artificial lake located in Bagmati municipality of Sarlahi district, Bagmati Fishery Pond, also commonly known as Bharat Lake, is consideredas the study area.

This research used various techniques such as survey, interview, through observation, municipality data etc. in order to analyze environment, economic development, physical development as well as understand people's perspective of lake enhancing environment and developing urban areas. Therefore, both qualitative as well as quantitative method of data and information collection were used. The development of locality before and after construction of lake was also studied to observe the change brought by lake. The study showed that although the lake is still in construction phase, it has been able to provide employment opportunity, enhance economy of overall municipality, increase development around the area as well as make the surrounding climate and environment much more livable. Number of shops, food stalls, various recreational activities etc. have been constructed around the boundary of lake. people of the municipality have been able to make their loving dur to the presence of the lake. Through survey it was found that not only the people residing around the lake area observed that the temperature during summer is cooler around lake than other nearby area but also the participants believed that the winter temperature is slightly warmer around lake. Finally, new trend of developments activities has emerged in around the municipality. There has been construction of small zoo, Bagmati ghat, Bagmati fun park etc. Hence, this Lake have been able to enhance the environment as well as promote development round the area where there was barren land with no infrastructure at past.

Keywords: Urbanization, Environment, Artificial, Development, Recreational

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Table of Contents

List of Figures

Acronyms and Abbreviations

CBS= Central Bureau of Statistics

GIS=Geographical Information system

IACD= The International Association for Community Development

KII= Key Informant Interview

LULC= Land Use and Land Cover

NLCDC= National Lake Conservation Development Committee

SDG= Sustainable Development Goal

UN= United Nation

VDC= Village Development Community

Chapter 1: Introduction

1.1 Background

Water is one of the most essential elements of life. Water is necessary for a variety of development processes, including socio-economic development, the production of food and energy, a healthy environment, and human survival. The source of water can be surface and sub surface water. Surface water can be obtained through river, pond, stream, lake, reservoir etc. A lake is also a source of surface water and contains fresh water. A lake is a large depression of freshwater on Earth that is bordered by land and may be standing still or moving slowly. In addition to being an essential hydrological and ecological component that helps manage a region's microclimate, lakes also play a regulatory, functional, and social role. Lakes also offer recreational opportunities such as parks developed in the area, fishing, boating, etc. Lake water can also be used for drinking, irrigation, industrial use etc. (Birawat et al., 2021)

Lake is also an essential part of an ecosystem and helps in enhancing the environment of the lake surrounding. Environment is anything and everything which surrounds us which may be biotic components (all living beings) and abiotic components (non-living beings) (Dr. Mayank Pandey, 2020). The Environment Protection Act, 2019 defines environment as "The interaction and inter-relationship among the components of natural, cultural and social systems, economic and human activities and their components." Bodies of water like lakes change the atmospheric environment around the surrounding vicinity. Small bodies of water cause local modification to the atmospheric environment which are generally insignificant while large bodies of water such as lakes, cause major significant effect on climate ranging from the microscale to the synoptic scale (Schmidlin, n.d.).

For people residing on developing countries, their major source of social well beings, economic dependencies and livelihood depends upon the goods and services available from ecosystem like wetland, forest and other ecosystem. (Gebremedhin & Belliethathan, 2019) Among these, Lake Ecosystem is one of them and is considered to be one of the most important ecosystems which contribute to the development of local as well as national development by producing wide range of goods and services like food, water, recreational benefit, aesthetic benefit etc. Following the identification of importance of Lake Ecosystem to local and national develoment, there have been increased interests in development of new artificial ecosystem like lake and wetlands for supporting livelihood surrounding the water ecosystem.(George Halkos & Steriani Matsiori, 2012)

Lake constructed by human to fulfill their needs and demands are artificial lakes, also known as man-made lakes or reservoirs. These lakes are constructed for a variety of reasons. Mostly, artificial lakes are constructed for hydropower generation purpose. A part from this, these lakes is also constructed for water storage, agriculture, irrigation, naturalistic purposes and recreational

activities. These lakes can be used for hobbies like fishing, boating, and other outdoor pursuits including natural history, bird watching, painting, walking and hiking with the right regulations in place. These reservoirs can be just as beautiful as their natural counterparts. They can control the water flow in rivers and streams as well as act as habitats for wildlife.

These uses of artificial lake help in local development of an area. Local development is the process of utilizing local resources and opportunities while remaining within the jurisdiction of the local government and carrying out tasks in a variety of areas that benefit the local community's residents. Lake helps in changing physical state of the locality through improvement and transformation of the built environment via construction of new structures such as roads, bridges, buildings, parks etc. Similarly, lake attracts new population which results in accumulation of different culture as a result of which the local culture may get changed. Also, lake helps in improving social well-being and quality of life of people residing in the local community through inclusivity and improving lifestyle. Finally, lake also helps in improving the economy of local people.

Lake as well as artificial lake can produce huge benefit to the surrounding livelihood as well as national economy but assessing the economic value of these lakes are very hard as a result of which these services are overlooked in decision making majorly by private landowner residing around the lake. Since a lake is undervalued, these lakes lack proper management and maintenances which further decline its economic potential reducing the new development of the area.

The benefit of Lake Ecosystem can be direct benefit as well as indirect benefits. Direct benefits are visible benefits that directly arises from lake ecosystem which can be income generated from recreational activities done on lake ecosystem to income generated from tourist residing on surrounding area of lake. Indirect benefits are benefits which cannot be observed directly but have huge influence on local development and new market development. According to Roberts and Leitch (1997), there are at least four different ways to value wetlands, resulting in four different sorts of values: owner, user, region, and society. Owner values are derived from marketable wetland goods and services, like food, water, and aquatic plants. Owner value consists of the market return (financial or nonfinancial) from wetland outputs as well as the owner's own usage (or nonuse) values. User values are the benefits from consuming or using wetland-related outputs (such as recreation or improved water quality). The sum that consumers are ready to pay for the satisfaction that a wetland's outputs (i.e., products or services) bring is known as the wetland's net worth. Regional values are derived from wetland-related business activity (e.g., gross business volumes, employment). Social value can be measured by aggregating user values and owner values. These benefits from Lake Ecosystem help in developing locality surrounding the lake.

In a nutshell, a new artificially created lake helps in changing the environment of the surrounding positively while the accumulation and frequent use of lake can degrade the lake environment. Similarly, lake helps in changing the physical, social, cultural and economic aspect of locality through lakes ecosystem benefit. The areas where new artificial lakes have been constructed have different market then previous when there was no lake. New market emerges in the area related to

Lake Ecosystem resulting in change in social lifestyle, cultural change. There have been huge changes in around Bharat Lake surrounding after the construction of Bharat Lake. So, in this research, we are going to study the role of Bharat Lake on environmental enhancement and local development.

1.2 Need

With maximum temperatures rising at a quicker rate (0.05°C/year) than minimum temperatures (0.03°C/year), Nepal has seen a general trend of rising temperatures. Notably, the maximum temperature in the tarai region declined during the course of the winter. In the tarai belt, the mean annual maximum temperature exceeded 30°C but gradually dropped toward the north. Temperatures ranged from 22°C to 26°C in the intermediate hills, from 26°C to 30°C in the Siwalik range, and from 22°C to 22°C in the Himalayas and high hills. (Marahatta at all, 2009)

Tranquility, coolness, and beauty of water make people feel a profound emotional connection to water. As a result, the majority of bodies of water within developments can be utilized as marketing tools to establish the new emerging market. The value of land and properties increases near water bodies resulting in change in land use around the surrounding water bodies. ("Constructed Wetlands: The Economic Benefits of Runoff Controls," n.d.) Same can be observed after the construction of Bharat Lake in Bagmati municipality of Sarlahi district. There have been subsequent changes in market. New market has arises revolving around the benefits obtained through lake ecosystem that are recreational activities, tourism etc. Similarly, SDG's goal 6 related to water and sanitation sub goal 6.6 states to protect water related ecosystem including mountain, forests, wetlands, rivers, aquifers and lakes. Also, SDG goal state to support and strengthen the participation of local communities in improving water and sanitation management. Hence, a study is necessary to understand the role of water in environmental enhancement and local economy taking Bharat Lake which is artificial lake as an case study

1.3 Importance

There are few artificial lakes constructed in our country in past and after observing the success of these artificial lake, there have been planning of construction of new artificial lake to promote economy of the surrounding livelihood. Hence this study is important for all those new upcoming artificial lake projects designed to improve economy through Lake Ecosystem. Similarly, people residing surrounding lake can benefit from this research as they can observe the shift in market economy and make economic decision as per the market change and growth. This research can be benefited by business organization to further improve their business growth. Similarly, policy makers can use this research as a guideline to make new policies to enhance the emerging market and further improve the economy of the sector. Also, this research can work as a model for generating population in new upcoming town through employment opportunity generation.

Similarly, this research can be utilized by students and researchers who are further willing to improve in this sector of research can take this study as a step to move closure toward the goal.

1.4 Problem Statement

Lake Ecosystem not only plays a vital role in improving quality of life of surrounding people but also provide us with various environmental benefits and when needed can be used to lessen the effect of flood and drought by holding vast amount of water and releasing it when needed. Additionally, lakes help to replenish groundwater, improve the water quality of watercourses downstream, and maintain the local biodiversity and ecosystem. Also, lake can be used as source of water supply, irrigation, tourism, cottage or resident living and recreational (*The Importance of Lakes*, n.d.). Lake also provides source of economic generation through these benefits making lake a valuable natural resource. The same benefits also can be obtained through artificial lake after construction of the lake.

Artificial Lake ecosystems also influence the economy of the area through change in market around the lake area by producing various goods and services resulting in increase in transaction of land around the area which further helps in increasing price of lands around lake area. Though these lakes provide us with these immense benefits, the values of lakes are still undervalued. These lakes are common resources (positive externalities), hence people tend to use these resources collectively but are not willing to pay for these resources either collectively or individually making it undervalued. The undervalued of these lakes makes them vulnerable toward loss in Lake Ecosystem. The same effect can be observed around artificial lakes as they are undervalued and becoming unmanaged and unaesthetic resulting in degradation of lake and benefit generated from lake (Bill Jones, 2010).

The economic benefits generated through Lake Ecosystem could be local as well as regional. But when an artificial lake is constructed with the purpose of boosting the local economy of the area, sometime local people may not get as much benefit as intended resulting in conflicts in lake area. A new artificial lake tends to attract new population due to economic activities around the lake and aesthetic of the lake. In most cases, the new population are economically stronger then the local residing population. Hence, new population starts investing more than local people and gain more benefits from lake then local people residing around lake. This can cause frustration to local people and may result in conflicts.

Also, when new population starts move into the lake area, if they are not from nearby surrounding then they bring out new culture along with them. These new cultures are adapted by the local people or local people culture are adopted by new population or anew mixed culture is formed in the area. This change in culture may not be in liking to all the local population residing in the area. Similarly, when a change in market occurs in an area, lifestyle of people around the area changes which automatically brings change in social dynamics around the area. Hence, the shift in market

economy, incoming of new population etc. is needed to be understood for further social and economic development of the area.

1.5 Objectives

The major objective of this paper is to analyze the role of water bodies in environmental enhancement and local development taking case of Bagmati fishery pond.

Other minor objectives are: -

- To investigates people perspective about effect of lake.
- To understand the linkage of market economy with lake site activities.
- To analyze the change in environmental situation around the lake.

1.6 Scope of Research

This research tends to study the change in market nearby the surrounding area of Lake Bharat before and after construction of the artificial lake. The output of this study will be helpful for resident nearby the lake area to understand the upcoming new market and invest accordingly to improve their economy. Further this study will be helpful to all those policymakers making policy related to market and Bharat Lake to make research-based policy to improve Bharat Lake influence on economy. Also, this research can be helpful to understand relation between lakes and market economy.

1.7 Limitation of Research

This research is limited to only one artificial lake which is Bharat Lake. As a result, the findings of the research may be site specific and may not be completely applicable to other artificial lake. Also, the negative impact of artificial lake is not considered in the research which could deviate the output of the research but can be used as opportunity for further research.

Chapter 2: Research Methodology

2.1 Conceptual Framework

Research is about examining closely and carefully over again and again into a subject to test and try, or to prove, or to discover facts and principles. Research is an art of systematic investigation to determine information and knowledge on a particular subject so as to find out fats and realities that are unknown or that has not been exposed yet. Methodology is a science of studying how a researcher conducts research systematically. Methodology is a method and principles for doing something (Dr. Shanti Bhushan Mishra & Dr. Shashi Alok, 2017).z

Research process

Research processes are sequence of steps or actions necessary to effectively perform research and to obtain the desired result.

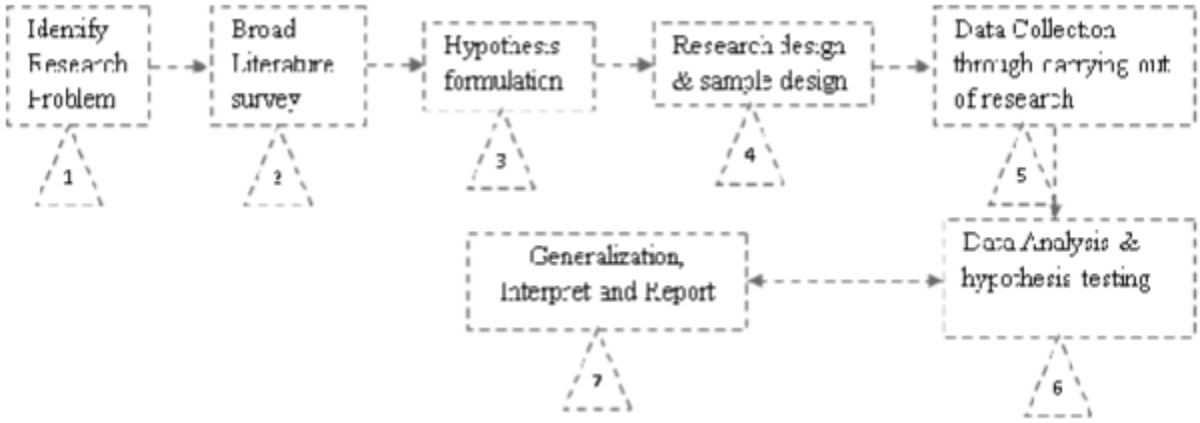


Figure 1 research Process

Analyzing the emerging market and economy of the surrounding area of Bharat Lake after the construction of Bharat Lake is carried out with help of various methods supported by literature and theory.

2.2 Research Paradigm

Research paradigm is researchers view on how research should be conducted both in specific and general to the study purpose. The paradigm is used to guide the selection of research methodologies, the conduct of research projects, and the type and applicability of results that are afterwards reached (Gannon et al., 2022). Positivist believes that the reality can be measured perfectly, quantitatively and the result obtained can be used by other researcher for their research as well as they are conducted under conditional boundary conditions. Since, in this research researcher uses interpretivism technique to people opinions. So, positivist method cannot be used

in this research. Similarly, in interpretivism, realities cannot be measured not quantified but can be interpreted only which is qualitative in nature. But, during the research, researcher uses quantitative method to obtain data such as in from of survey and observation. Therefore, interpretivism method cannot only used to justify the research. So, this research method uses pragmatic paradigm which as described by Uprety believes that the reality is constantly debated, renegotiated, interpreted and therefore the best method to use is the one that solves the problem. Pragmatic way of solving research is not a single philosophical paradigm but uses a mixture of both qualitative and quantitative methods.

Pragmatic method observes multiple realities to answer a research question. In our study, to analyze the emerging market and economic development surrounding around the new constructed lake area both qualitative as well as quantitative data were analyzed. Qualitative data include the interview, group discussion etc. and quantitative data were obtained through survey, observations etc. Both these qualitative and quantitative data are used to understand people view toward the growing economy around lake.

2.3 Ontology

Ontology is the initial steps of every research which can be defined as an image of the social realities upon which a theory is based with claim and assumptions about what exists, what it look like, what units makes it up and how these units interact with each other.

The ontological position of the research is that a new market arises after the construction of lake following the advantages distributed by the lake. The distribution may not be even among the stakeholders making limited stakeholders obtaining maximum benefit to be satisfied while other stakeholders unsatisfied creating conflicts in the area.

2.4 Epistemology

Epistemology is the second stage of every research which is branch of philosophy concerned with the nature, origin, methods and limits of knowledge. Epistemology is process of gathering knowledge for developing new models or theory.

The epistemology position of the research is that the study of social science about understanding influence of artificial lake on market can be obtained through direct interaction with people as in interview to obtaining knowledge through survey, observation etc.

2.5 Methodology

Methodology is a system of methods and principles for doing research to demonstrate the knowledge we obtained through vigorous purpose is valid and acceptable. In this research, the emerging markets and economic development which arises after the construction of Bharat Lake

in Bagmati municipality is going to be analyzed. As a social science study, this research gathers knowledge from people and interprets their knowledge as well as obtains measured data through different sources. Hence, this research is based on pragmatic paradigm. Pragmatic method believes that there are no single but multiple realities and multiple methods to solve one problem. This paradigm has been presented as the alternative of positivism and interpretivism which combine both positivism and interpretivism to solve a research problem. Hence, this method suggests mixed method approach to the research. A mixed method means the combination of both qualitative and quantitative method. In quantative method of study, a generalized knowledge is obtained which can be further replicated by other researcher as they are obtained under control conditions. Similarly, in qualitative study, contextual, real-world knowledge or shared belief of specific group of people is obtained through less controlled condition using interpretivism.

2.6 Methods

Since, the research is based on pragmatic paradigm, research uses mixed method which is both quantative and qualitative method to obtain data and information. Quantative methods use survey, observation, and literature reviews while qualitative methods include interview, key informant interview, group discussion etc.

Table 1Method Used for research

Research Method	**Primary or Secondary**	**Qualitative or Quantitative**	**Use**
Household Survey	Primary	Quantitative	To understand general characteristics of population
Key Informant and Users Interview	Primary	Quantitative	To gain more in depth understanding of topic
Observation	Primary	Either	To understand how something occurs in its natural settings.
Literature Review	Secondary	Either	To situate research in an existing body of work or to evaluate trends within a research topic

Chapter 3: Literature Review

3.1 Introduction

Water is basic need for human being and is essential to survive. UN described water as the core of sustainable development and is necessary for energy, socio-economic development, food production, healthy ecosystem and for human as well. So, Sustainable Development Goal (SDG) goal number 6, Clean Water and Sanitation is oriented toward water. Therefore, water can be considered as an important asset for human life. Water is divided as salt water and freshwater. Salt water are generally found in ocean and seas and covers around 97% of all the water in the world. Freshwater is about 1% of total world's water and are found in lakes, rivers, stream, wetlands, reservoirs, glaciers etc. Although, freshwater is about 1% but yet supports 10% of all known animals and 40% of all known fish species. Similarly, water can be available as surface water and Sub surface or ground water. Ground water is that water found under the ground such as aquifers, springs, wells etc. Similarly, water that is found in surface of earth is known as surface water. Stream, lake, impounded reservoirs; ponds etc. are example of surface water. Among them, lake is one of the major sources of surface water.

3.2 Lake

Lake is a natural depression that is surrounded by land from most sides and contains freshwater. Generally, in mountain region, at some place natural basin are formed with impervious beds. Water from springs and streams generally flows toward the basin ad lake are formed. Lakes in Nepal are commonly called Pokhari, Tal, Rah, Dah, Kund etc. Additionally, a lake may be isolated, with no apparent direct water input and, occasionally, no apparent direct discharge. These remote lakes are frequently salty as a result of groundwater intrusions or evaporation. Anywhere in a river basin, may have a lake depending on its source. A headwater lake is fed by numerous tiny tributary streams, direct surface precipitation, and groundwater influx rather than a single river. These lakes usually always have just one river outlet. Lakes in river basins further downstream have one major output and one major input, with the water balance from input to output fluctuating depending on other water sources.

3.2.1 Types of lakes

There are large number of lakes in the planets and are classified into various types. The simplest classification is based on the dimension of a lake, whether a lake is small, big or very large. A part from these, lakes are classified on the basis of:-

- Origin
- Trophic levels
- Mixing of water.

- Nature of Inflow-outflow

Hutchinson (1957) classified major types of lakes on Earth into 11 major groups with sub division of 76 types. The major types of lakes are:-

- Tectonic lakes
- Volcanic lakes
- Landsides lakes
- Glacial lakes
- Solution lakes
- Fluvial lakes
- Aeolian lakes
- Shoreline lakes
- Organic lakes
- Anthropogenic lakes
- Meteorite lakes

Additionally, lakes and ponds are also classed under the Ramsar convention according to their size, seasonality, and whether they are freshwater or saline. A lake is typically described as an open water body with distinct littoral and limonitic zone and area greater than eight hectares. Ponds, however, are shallow-depth open water basins that solely comprise the littoral zone and have a surface size of less than eight hectares.

Taking about Nepal context, Nepal's permanent lakes are broadly categorized into three main categories based on their geological origin and they are:-

- Glacial or Himalayan lakes e.g. Rara, Gosainkunda, Shey Phoksundo
- Tectonic or sub Himalayan lakes e.g. Phewa, Begnas, Rupa
- Ox-bow or Terai lakes e.g. Ghodaghodi tal, Bishazaree tal, Rani tal (Sharma, 1977 as cited in kunwar,2008)

Apart from all these types of natural lakes, lakes are also artificial in nature.

3.3 Artificial lake

An artificial lake is a type of lake that was intentionally excavated and built by humans, as opposed to being created in a natural setting. Humans build artificial lakes, also known as man-made lakes or reservoirs, for a variety of reasons. These uses can include everything from water storage and recreation to hydroelectric power generation and irrigation. Communities can also enjoy leisure activities including fishing, swimming, boating, and camping at man-made lakes. They can control the water flow in rivers and streams as well as act as habitats for wildlife.

Although, man-made lakes have many advantages, yet they can also harm the ecology. The loss of the natural habitat for plants and animals that existed in the region before the lake was built is one of the largest effects. These lakes can also alter the course of rivers and streams, which has an impact on the local ecology. Additionally, fish population disruption and river or stream water quality changes might result from the construction of dams.

3.4 Lake and its importance

Lakes are important ecosystems that contribute significantly to regional and societal progress by offering a wide variety of products and services. These ecosystems provide necessary resources including food, water, and recreational advantages, promoting the health of both people and wildlife. Additionally, lakes perform a regulatory function by controlling regional weather patterns and microclimates. Additionally, they play a critical hydrological and biological role in flood control, groundwater recharge, and biodiversity preservation. Lakes act as economic engines for neighboring communities thanks to their many commercial applications, such as irrigation, transportation, and fishing. Additionally, lake water is used for a variety of things, including drinking, industrial, and agricultural needs, making it a vital resource for supporting life and promoting socioeconomic development.

Beyond their obvious advantages, lakes significantly improve the surroundings' natural beauty. Lakes regulate river flow and maintain ecosystem stability by retaining water, reducing the effects of floods and droughts. These bodies of water also enhance the landscape's natural beauty and temper regional climates, fostering a more comfortable habitat for both people and wildlife. Numerous aquatic and semi-aquatic plants and animals can be found in lakes, where they interact with one another to create a complex web that supports biodiversity. As a result, they offer a plentiful source of food for organisms on land, thereby enhancing the ecology as a whole. Lakes are essential to maintaining the ecological balance of the region and promoting sustainable development because of the complex interactions between geology, climate, hydrology, and biodiversity that have an impact on the entire drainage basin.

Smaller bodies of water like ponds, in addition to larger lakes, are essential for addressing environmental issues. In highland areas, ponds efficiently absorb rainwater, lowering the possibility of floods downstream. As rainwater flow is slowed by their presence, fast landslides are also prevented. Regularly spaced ponds can help to reduce temperatures and raise humidity, which helps to reduce the likelihood of wildfires. Additionally, the wet surroundings of forests around ponds keep wild animals away from habitations since they have access to enough food and water in their native habitat. Ponds also divert lightning strikes away from dry communities, reducing the possibility of wildfires and potential harm to populated areas. Societies may develop thorough disaster relief plans and build more durable and sustainable habitats by comprehending and utilizing the advantages of both lakes and ponds.

Lake ecosystem, is regarded as one of the most significant ecosystems that supports local and national development by generating a variety of goods and services, including food, water, recreational benefits, aesthetic benefits, and other benefits. Lakes play a regulatory, functional, and social role in addition to being a crucial hydrological and biological element that aids in managing a region's microclimate. Lakes are used by humans for a range of commercial purposes, including irrigation, transportation, recreation, and fishing. Lakes also provide access to local parks, boating, and other leisure activities. Additionally, lake water can be used for agriculture, drinking, industrial purposes, etc. Water is essential for maintaining a healthy environment, producing food and energy, socioeconomic development, human existence, and many other development activities. A lake contributes to the improvement of the environment around the lake and is a crucial component of an ecosystem. By storing water, they can minimize the effects of floods and draughts and control river flow, recharge groundwater, increase natural beauty, moderate local climates, maintain biodiversity, and enhance local beauty. By providing home to aquatic and semi-aquatic plants and animals, which in turn provide food for many terrestrial creatures, they also add to the environmental richness. In general, lakes serve more purposes than only holding water. They are rich, dynamic ecosystems with complex interactions between geology, climate, hydrology, and biodiversity that have an impact on the entire drainage basin. Lakes and other large bodies of water alter the local atmospheric conditions. Large quantities of water, like lakes, have considerable effects on climate that range from the microscale to the synoptic scale. Small bodies of water have localized effects on the atmospheric environment that are typically minor. (Birawat et al., 2021, George Halkos & Steriani Matsiori, 2012, Munoth & Nagaich, 2015)

Utilizing a single solution for all calamities will be quite practical. One such entity that handles these catastrophes on its own is the pond. Due to the absorption of rainwater in the highlands, it causes less flooding. Because some of the storm water is prevented from making a rapid descent, it also results in fewer landslides. The interruption caused by the ponds dampens it. Regularly spaced ponds result in lower temperature rise and higher humidity, which discourage wildfires. Because there is water and food in the forest, wild animals do not come to the settlement. Due to its damp environment, the forest receives lightning strikes rather than the settlements, which are fairly dry. (Jibraj, unpublished)

3.5 Economic value of lake

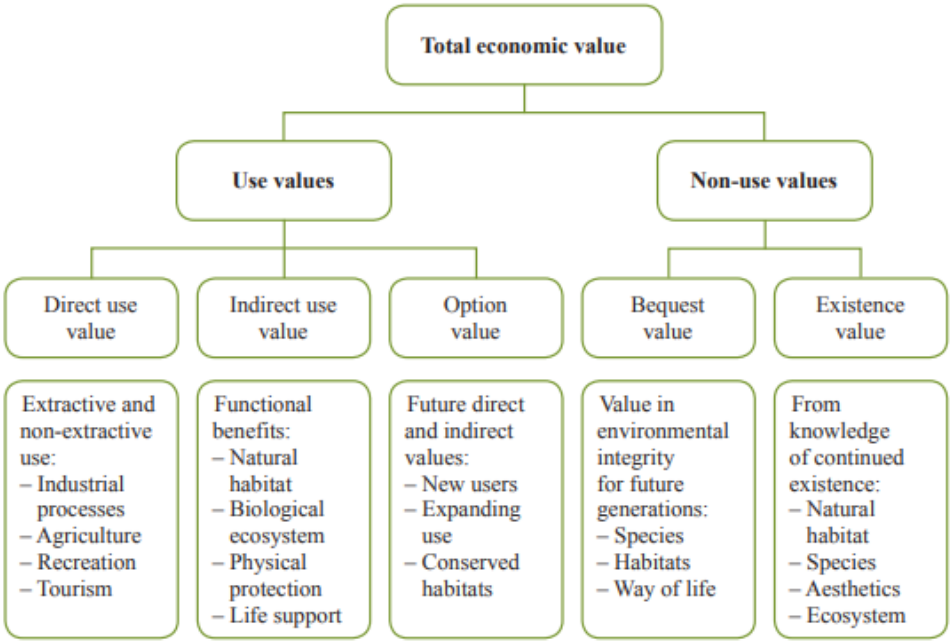


Figure 2 Economic value of lake

Lake has both direct that is visible and indirect that is invisible economic benefits. Visible benefits are the benefits obtained such as employment opportunity, recreational etc. while indirect benefits are protection of natural habitats, ecosystem protection, continuation of knowledge etc.

3.6 Lake as common resources

Any resource that offers people tangible benefits but that nobody in particular owns or has exclusive claim to is considered a common resource. It is free products, such as those that are commonly held by no one. These resources can be natural such as water, forest, lake, ponds, wetlands etc.to artificial such as highway, roads, public parks etc. Joshi claims that pure common goods have two special character and they are:-

- Non-rivalrous

It can be enjoyed by an extra person at the same time without reducing the enjoyment it gives to others.

- Non-excludable

Once it is provided, no one can be [costlessly] excluded from consuming it.

Since, these resources can be consumed by anyone without any discrimination makes these resources vulnerable toward over consumption resulting toward depletion. Joshi states that it is almost impossible to find individual demands for public goods (people will not reveal them). So the government cannot make each consumer pay a price that equals the marginal benefit s/he gets

Every person has an incentive to use a resource at the expense of every other person, and there is no means to prevent anyone from doing so. This leads to excessive consumption, inadequate investment, and ultimately resource depletion. Every individual who consumes an additional unit immediately damages others who can no longer benefit from the resource because demand exceeds supply. In general, everyone has easy access to the resource of interest; the tragedy of the commons happens when people put their own interests ahead of the welfare of society.

Externalities and common resources

An externality arises when a person engages in an activity that influences the well-being of a bystander and yet neither pays nor receives any compensation for that effect. When externalities are present, society's interest in a market outcome goes beyond the welfare of buyers and sellers in the market to include the welfare of affected bystanders. The market equilibrium is inefficient when there are externalities because buyers and sellers fail to consider the consequences of their decisions when determining how much to demand or provide. In other words, the equilibrium falls short of maximizing the total benefit to society causing market failure. There are two kinds of externality and they are:

Positive Externality

If the impact on the bystander is beneficial then it is called as Positive externalities.

Negative Externality

If the impact on the bystander is adverse, it is called a negative externality.

Common resources are used and benefitted by every individual user of the resources. This means that the impacts of the resources are beneficial to user so, common resources are positive externalities. Hence, In the presence of a positive externality to production, the social cost of producing is less than the private cost. Therefore, the optimal quantity, QOPTIMUM is greater than the equilibrium quantity, QMARKET.

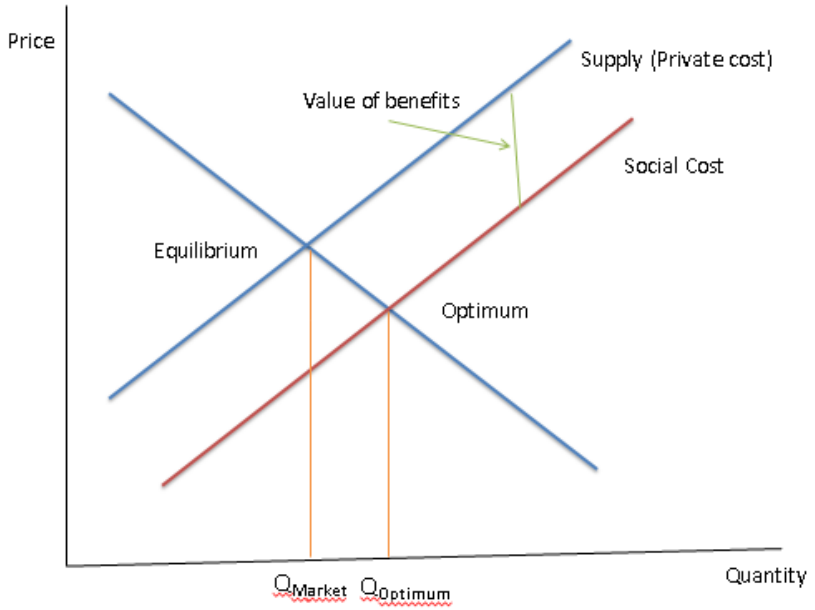


Figure 3 social vs private cost of lake

The value of benefits in the above graph is the cost that is necessary for common goods to be charged for using the goods. Hence, government can either make entry fee, taxes etc. on common goods to reduce the use of the resources or make certain rules and regulation to minimize the consumption and maximize the benefits for the society.

Both natural and artificial lakes have long been exploited and misused by humans, who have an ambivalent view toward them. On the one hand, they are praised for their tranquil natural beauty, but they have long been seen as wastelands suited for disposing of domestic garbage, sewage, and other effluents. These lakes are quite noticeable and important components of any ecological, urban, or environmental fabric. They play a crucial role in preserving and enhancing any region's biodiversity, ecology, economy, and beauty. Urban lakes are still suffering from a number of detrimental effects as a result of the pressure that urbanization and industrialization are continuously exerting on urban areas. Due to poor management and the careless throwing of rubbish into them, they are becoming dry and filthy in every corner of the planet. Due to different anthropogenic and natural forces, all the once-beautiful lakes in the globe are now cesspools. Uncontrolled dumping of waste water, solid waste, and garbage, unchecked aquatic weed growth, and significant siltation are a few of the key elements that can be held responsible for this occurrence.

3.7 Environment

The word "environment" comes from the French word "environ," which translates to "surrounding". Environment can be defined as the surrounding areas where both living and non-living beings can be found. The Environment Protection Act, 2019 (2076) define environment as

the interaction and inter-relationship among the components of natural, cultural and social systems, economic and human activities and their components. The environment is everything that surrounds us, including all living things or biotic components (such as microbes, plants, and animals) and non-living things or abiotic components (such as air, water, sunshine, etc.) that are found in the natural world. Environment includes air, water, land, living organisms, and materials surrounding us which is shown in figure below (Sadiku et al., 2020). Interactions between the biotic and abiotic components lead to a functional ecosystem and sustainable life on the planet earth. We receive all of the essential products and services, including food, clean water, medicine, raw materials for manufacturing, and tourism (Dr. Mayank Pandey, 2020).

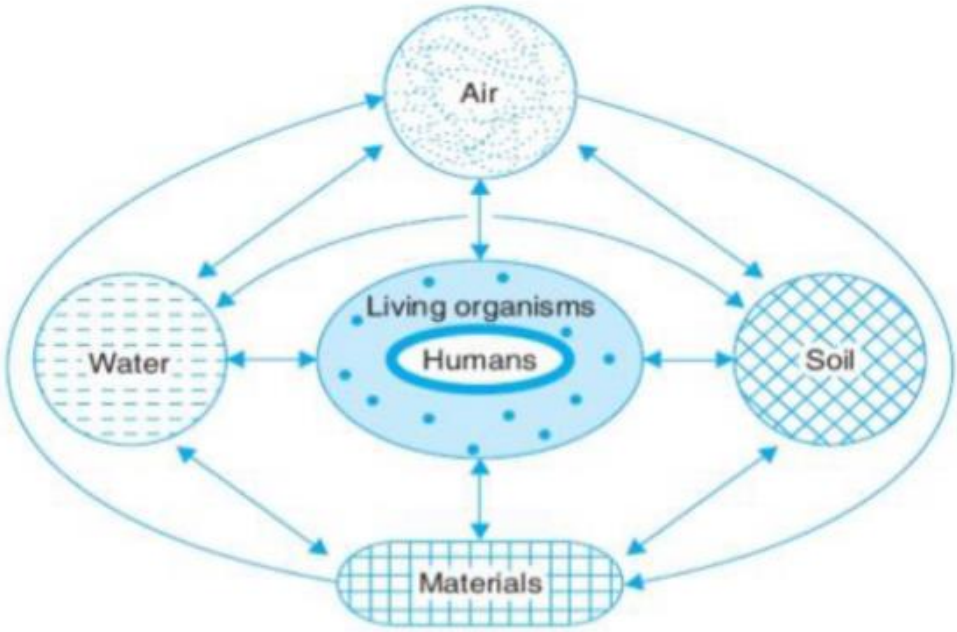


Figure 4 The concept of environment

3.7.1 Components of Environment

Earth is divided into three distinct spheres that stand in for the solid (rock/soil), liquid (water), and gaseous (air) aspects. The biosphere is the area where the three spheres overlap and where life is possible.

3.7.1.1 Lithosphere

The brittle upper part of the mantle and the crust create the solid, outer layer of the Earth called the lithosphere. The surface of the lithosphere is uneven due to various geological features such towering mountains, plateaus, deep valleys, and sea bottoms. It is the site of a number of geological processes, including weathering and erosion, volcanic eruptions, and biogeochemical cycles.

3.7.1.2 Hydrosphere

Hydrosphere comes from Greek word Hydor means water. The hydrosphere, or water component of Earth, makes about 70% of its surface in the form of liquid, vapor, or ice. Seas and oceans make up the marine ecosystem, which is home to 97 percent of the planet's total water content and remaining 3 percent persists in the form of glaciers, rivers, lake, ponds etc. The hydrosphere is an essential component of the water cycle and is essential for maintaining the planet's regular climatic, meteorological, physical, chemical, and biological processes.

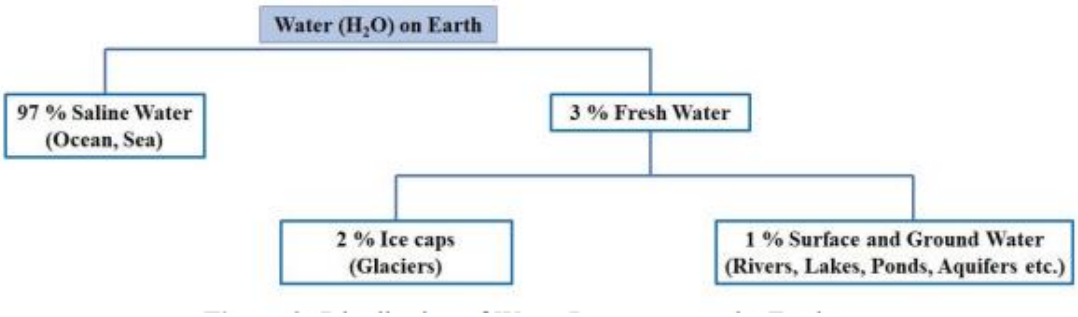


Figure 5 Distribution of water resource on earth

3.7.1.3 Atmosphere

Atmosphere comes from Greek word Atmos which means vapor. The term "atmosphere" refers to the gas and aerosol envelope that surrounds a planet's ocean, land, and ice-covered surface and extends into space. The composition of gases in the atmosphere is shown below:-

Table 2 composition of gases in atmosphere

Component	Volume (%)
Nitrogen	78.084
Oxygen	20.946
Argon	0.934
Carbon di oxide	0.04
Gases in traces	Remaining

The atmosphere can be divided into four different layer and they are:-

Troposphere

The troposphere is the lowest layer of the atmosphere where most clouds on Earth are found and where most meteorological events take place. This layer's altitude ranges from 16 km at the equator to 8 km at the poles.

Stratosphere

The stratosphere is second layer of atmosphere which lies above the troposphere and rises to a height of roughly 50 km (30 miles). As the upper stratosphere's ozone (O3) layer absorbs solar energy and temperature rises, the temperature in this layer climbs from the tropopause (-56 0 C) to the stratopause (-2 0 C).

Mesosphere

The mesosphere is the third layer in the atmosphere below thermosphere and above the stratosphere. The temperature starts to drop again and reaches -96 0 C at the mesopause, the highest boundary of the layer.

Thermosphere

The layer of the Earth's atmosphere known as the thermosphere is situated above the mesosphere and under the exosphere. The temperature in this layer quickly rises from -96 0 C (lower boundary) to 1200 0 C (upper layer) due to the ionic oxygen atoms and other ions that are present.

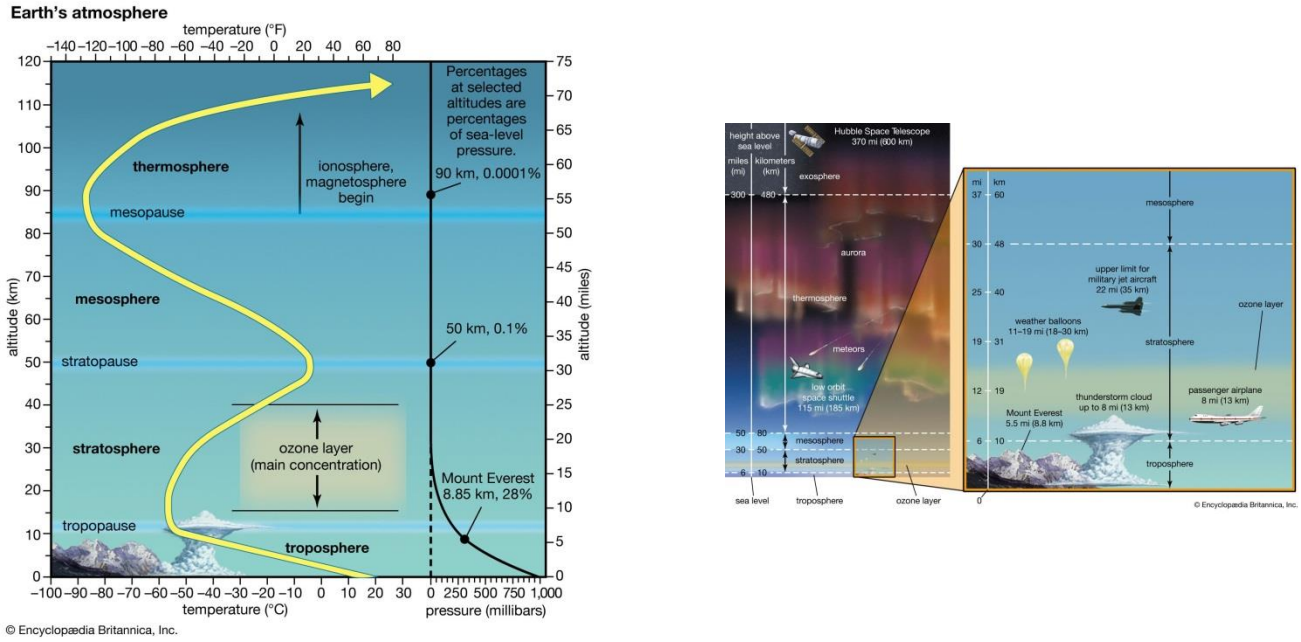


Figure 6 Earh's atmosphere

3.7.1.4 Biosphere

Biosphere comes from Greek word Bios which means life. This is the thin layer of Earth where life can be found, from deep-sea vents to mountaintops. It is made up of both living and nonliving elements.

3.8 Lake and Environment

Lake has an ability to modify the environment around the lake surrounding. Small bodies of water that are few hectares in size such as ponds, does not cause considerable amount of environmental modification while a large body of water such as lake, would cause considerable change in locality climate ranging from microscale to the synoptic scale. The effect of large water bodies on environment depends on various factors of lake such as depth, areal extent, configuration of lake, location of lake, direction and velocity of wind flowing around lake.

Through modifications to the atmospheric boundary layer, lakes have an impact on the climate because of:-

- The thermal lag of Lake Surface temperatures compared to the adjacent land areas
- The availability of open water over lakes for evaporation, and
- Alterations of winds by lakes as a result of contrasts in surface roughness between the lake and the land surfaces.

3.8.1 Lake on Air Temperature

Lake changes the air temperature around the vicinity significantly making lake area a suitable place to reside. The air temperature is affected primarily due to the thermal lag of the lake. Thermal lag is a body's temperature over time as a function of its thermal mass. Large thermal lags are characteristic of bodies with high thermal mass (high heat capacity and low conductivity). Water have very high specific capacity of 4186 J/kg·K (1 cal/g·C) and low thermal conductivity of 0.6 W/m·K at 20 degree Celsius in comparison with nearby surrounding specially land which have specific heat capacity of 0.2 cal/g. this makes water most favorable for thermal lag. This is most noticeable for lakes in climates with significant seasonal temperature variation. Compared to land surfaces, lakes warm up more slowly in the spring and summer and cool down more slowly in the fall because water has a heat capacity that is about three times more than that of soil. The Great Lakes, which cover an area of 25 000 km2, have the biggest effects on the climate, but lakes and man-made reservoirs smaller than 200 km2 also have an impact.

Water has very high specific heat capacity as a result it can hold lot of heat energy. During summer, the air above the water has high temperature while the water has lower temperature. Hence, lake takes lots of warm water to heat the lake up. This is the reason why the air above the lake is cooler which in turn drops the surrounding temperature around the lake.

Similarly, during winter the temperature of water is higher than wind as the specific heat capacity of water is higher than that of wind. So, wind take heat from lake water and makes the surrounding area temperature slightly higher than far area.

Particularly on the predominant downwind shore, lakes modify the coastal climate along their shorelines. Wintertime temperatures are warmer than summertime temperatures over and close to

major lakes. Lakes help to moderate extremes of heat and cold. If the lake surface freezes, the moderating effects of lakes on winter air temperatures are diminished but not entirely removed. Also, the freezing effects of huge lakes postpone the beginning of the growth season in the spring, but they also postpone the first frost in the fall when they are close by. For the larger lakes, this effect on the climate extends 10–30 km inland. Fruit crops are grown around lakeshores in climates where they may not naturally thrive because of the tempered air temperatures and extended freeze-free seasons close to lakes.

3.8.2 Lake on moisture and precipitation

The temperature of lake water and air above the lake are different from each other resulting in difference in vapours pressure. The vapor pressure difference between the lake's surface and the surrounding air determines the moisture fluxes over a lake. The greatest vapor pressure differential occurs in late fall and early winter, when evaporation is at highest. When the vapor pressure differential is at its lowest in spring and early summer, evaporation is reduced. If the water temperature is lower than the dew point of the air, water vapor will condense onto a lake, the opposite of what happens when it evaporates.

Due to the thermal lag, lakes are often colder in spring and summer than the ambient air temperature. Under these circumstances, a stable marine layer forms in the lower atmosphere. As a result, convective cloud formation and afternoon rain shower and thunderstorm activity are suppressed over the lake and the nearby downwind terrain. On the other hand, lakes emit a lot of sensible heat and latent heat to the atmosphere in the fall and winter when the lake temperature is often higher than the air temperature. This leads to an unstable lower atmosphere and encourages lake-effect clouds and precipitation, which are convection, condensation, clouds, and precipitation above lakes and downstream. In the spring and summer, when the lake is colder than the air, fogs may form over and around lakes. In the winter, when steam fogs form in cold air over warmer lake waters, fogs may form over and around lakes.

Lake-effect snowfall is frequent over and downwind of lakes in areas when winter temperatures drop below freezing, resulting in two to three times as much snowfall as happens upwind of the lake. If the lake surface freezes, the amount of lake-effect snowfall is reduced. From early autumn until temperatures drop below freezing, lake-effect precipitation occurs. Large lakes' heightened snowfall increases the cost of snow removal along traffic routes and calls for stronger buildings to sustain the increased snow loads on roofs. The increased snowfall also makes skiing and other winter activities possible.

3.8.3 Lake on wind

Due to less friction on water surfaces, wind speeds across lakes are higher than those over land. Wind speeds on land surrounding lakes are highest close to a the shore and decrease further inland when friction slows the wind. On spring and summer days with weak synoptic scale flow and a

lake that is significantly cooler than the surrounding land and prevailing air temperatures, a lake breeze may form. Several hours after daybreak, a cold, moist onshore air flow from the lake across the shore toward land develops and lasts through the afternoon. Air temperatures are 5–10°C lower along the shore than inland due to the lake wind, which may stretch several kilometers inland. Convection and clouds may begin to form in the lake breeze front's zone of convergence.

The study of the effects of open water bodies on the climate of urban areas, including treatment wetlands, ponds, rivers, and water features, has become increasingly important in recent years. These observations have shown that temperatures tend to be noticeably lower around and downwind from such water bodies, with decreases of about 1-2 degrees Celsius relative to the adjoining places. Most often, during the day, the biggest temperature drop is seen. Additionally, it has been discovered that using green infrastructure components like grass swales and vegetated filter or buffer strips results in comparable outcomes. These green elements are essential for managing storm water because they slow the flow, encourage infiltration, and promote increased evapotranspiration. These elements work together to successfully adjust the urban microclimate, resulting in urban areas that are cooler and more comfortable. (Coutts, 2013)

Greening urban areas through the revival of abandoned ponds is a promising climate change adaptation strategy. Research in Janakpur, a city with over 200 ponds, found that houses near these water bodies experienced a significant 2°C temperature reduction during summer compared to those situated farther away. This cooling effect is attributed to the evaporation of water from the ponds, which acts as a temperature sink, absorbing heat from the surroundings. The presence of wind further enhances this cooling effect by carrying the released vapor and reducing humidity. Increasing wind speed extends the cooling impact, making ponds valuable assets for mitigating the escalating heat caused by climate change (Lal, 2016).

3.9 Local Development

The local scale covers the region "characterized by diverse land area, economic, social, cultural, and political homogeneity, and a common, broadly understood identity." Broadly understood identity defines not only cultural connections but also shared attitudes, interests, habits, and behaviors. Because of this, residents of local communities tend to form close friendships with one another. So, local development is the area consists of the administrative assigned boundary subject to the authority of the local government where institutions, organizations, and individuals affiliated with local authorities participate in this process in order to take use of local resources and possibilities and carry out various tasks that will benefit the residents of the area. (Sekuła, 2002) The International Association for Community Development (IACD) defines Community development as a practice-based profession and an academic discipline concerned with the organization, education and empowerment of people within their communities. Local development is an inclusive concept that includes enhancing the economic and social well-being of rural

residents. Theoretically, decentralization was strongly associated with our nation's introduction of these stages of development strategy in the 1950s, market-led development strategy in the 1960s and 1970s, and NGOs-led development strategy in the 1980s. (Bhattachan, 1997 as cited in Rawat 2010)

The goal of local development is to enhance the standard of living and future economic prospects in a specific region or municipality. Many different stakeholders, including academics, professionals, and global institutions like the World Bank, United Nations, and the Organization for Economic Development and Co-operation OECD, have acknowledged and endorsed this idea. Due to elements including rising global competition, population migration, technological advancement, and ensuing spatial inequities, local development has become more crucial. Successful local development programs can help close the gap between economically struggling and prosperous places. They accomplish this by expanding employment options and encouraging the development of neighborhood businesses. Additionally, they promote increased investment from the private sector and improve communication between financiers and developers. Local economic strategies consequently grow more confident and well-coordinated. Effective local development also enables a better comprehension and assessment of the area's economic resources, distinctive benefits, and particular capabilities. This results in a more thorough evaluation of strategies and their likelihood of success. (Kisman & Tasar, 2014)

Some of the key significances of local development are:-

Balanced Regional Growth: By encouraging balanced growth across the many regions of a nation, local development efforts aim to resolve spatial imbalances and disparities. Local development contributes to the reduction of regional inequalities and provides a more equitable distribution of resources and opportunities by promoting economic possibilities and enhancing living circumstances in particular places. Economic Diversification: Diversifying a region's economic base is a common goal of local development initiatives. These programs lessen reliance on a particular business or sector, increasing the resilience of the local economy by fostering the expansion of numerous companies and sectors. By lowering sensitivity to outside shocks and fostering sustainable development, this diversification can enhance the overall national economy.

Job Creation and Entrepreneurship: Local development initiatives place a strong emphasis on the creation of jobs and the encouragement of entrepreneurship in a certain area. These programs promote economic activity and job prospects by building a welcoming business environment, offering resources and training, and encouraging innovation. Higher income levels, lower unemployment rates, and improved population economic wellbeing are all results of more job options.

Social Cohesion and Community Participation: Local development understands the value of social cohesion and community involvement in promoting sustainable development. Local development initiatives make ensuring that development plans are responsive to the needs and ambitions of the

community by incorporating local citizens, community organizations, and stakeholders in decision-making processes. Residents are empowered and given a sense of ownership through this participatory method, resulting in more inclusive and sustainable development outcomes.

Infrastructure and Service Provision: Improvements to local infrastructure and the provision of basic services like transportation, healthcare, education, and public utilities are frequently given first priority in local development initiatives. In addition to directly benefiting the local populace, improving the area's physical and social infrastructure also draws in investments, streamlines business operations, and promotes further economic growth.

Tourism and Cultural Heritage: To promote economic development, local development can take advantage of a region's distinctive cultural heritage, natural resources, and tourism potential. Local development projects can produce income, create jobs, and promote the region's cultural identity through investing in tourism infrastructure, protecting cultural landmarks, and supporting sustainable tourism practices.

3.9.1 Dimension of Local Development

The concept of sustainable local development recognizes that three dimensions are interconnected and should be considered together to ensure long-term well-being and they are:-

- Physical Development
- Social Development
- Economic development
- Disaster Preparedness and Resilience

3.9.1.1 Physical Development

The process of upgrading and strengthening the built environment and infrastructure within a particular geographic area is referred to as local community physical development. For its people, this development seeks to build a more livable, sustainable, and affluent neighborhood.

Indicator of Physical Development

A local community's progress and the caliber of its physical development can be seen by indicators of locality physical development, which are quantifiable and observable elements. These variables assist in determining the area's infrastructural quality, amenities, and general livability. Some common indicator are as:-

- Housing quality
- Road infrastructure
- Public transportation
- Access to basic services
- Waste management

- Green space and parks
- Crime rate and safety
- Water and sanitation services

3.9.1.2 Social Development

The process of strengthening a local community's residents' wellbeing, inclusion, and overall quality of life is referred to as social development. It entails creating and fostering social bonds, advocating for equality and social justice, and presenting chances for individual development and community involvement. The following are some critical facets of social development in a neighborhood:

- Education
- Health care
- Social services
- Community engagement
- Cultural and recreational activities
- Social support networks
- Diversity ad inclusion
- Gender Equality
- Poverty alleviation
- Community safety

Indicator of Social Development

Measureable elements that reveal information about a community's social development progress and well-being are known as locality social development indicators. These metrics aid in measuring the effectiveness of social services, involvement of the local community, inclusiveness, and general social cohesion. Here are a few typical metrics for assessing a community's social development:

- Education attainment
- Literacy rate
- Health care access
- Social services utilization
- Community Participation
- Cultural and recreational activities
- Inclusivity and diversity
- Poverty and Income Inequality
- Gender equality
- Social awareness and empathy

3.9.1.3 Economic Development

The process of enhancing the region's economic health, productivity, and general prosperity is referred to as economic development. It includes programs and strategies to uplift the standard of living for its citizens by boosting income opportunities, creating jobs, and attracting investment. The goal of the multidimensional process of economic development is to create a strong and resilient local economy. Here are some crucial elements of local economic development:

- Job creation and employment opportunities
- Investment and infrastructure
- Access to finance
- Innovation and technology adoption
- Public private partnership
- Income distribution and poverty alleviation
- Quality of life improvement

Indicator of Economic Development

A local community's indicators of economic development are quantifiable elements that offer perceptions into the development and performance of the local economy. The community's economic prosperity, improvement, and sustainability are evaluated using these metrics. The following are some typical metrics for assessing a community's economic development:

- Gross Development Product (GDP)
- Employment rate
- Unemployment rate
- Income level
- Poverty rate
- Business activities and startups
- Tourism revenue

3.9.1.4 Disaster Preparedness and Resilience

The ability to respond quickly to and recover from natural or man-made disasters makes disaster preparedness and resilience crucial components of local development. Local communities can lessen the impact of catastrophes on their social, economic, and environmental systems by putting measures in place to reduce risks and increase resilience. The following are some essential components of disaster readiness and resilience for neighborhood development:

- Risk assessment and mapping
- Early warning system
- Emergency response planning
- Community Awareness and education

- Infrastructure and Building Codes
- Natural resources Management
- Social safety nets
- Capacity building
- Backup system and redundancy
- Post disaster recovery and reconstruction
- Ecosystem restoration and conservation

Indicator of Disaster Preparedness and Resilience

A local community's indicators of disaster preparedness and resilience are quantifiable aspects that shed light on the amount of readiness and effectiveness of the community's response to disasters. The community's ability to manage risks, respond to emergencies, and recover from a disaster is determined by these indicators. Here are a few typical metrics for assessing a community's readiness and resilience for disasters:

- Community Awareness and education
- Emergency response planning
- Early warning system
- Evacuation routes and shelters
- Training and capacity building
- Infrastructure and building codes compliance
- Financial preparedness

3.9.2 Relation between Social, Economic and Environmental Development

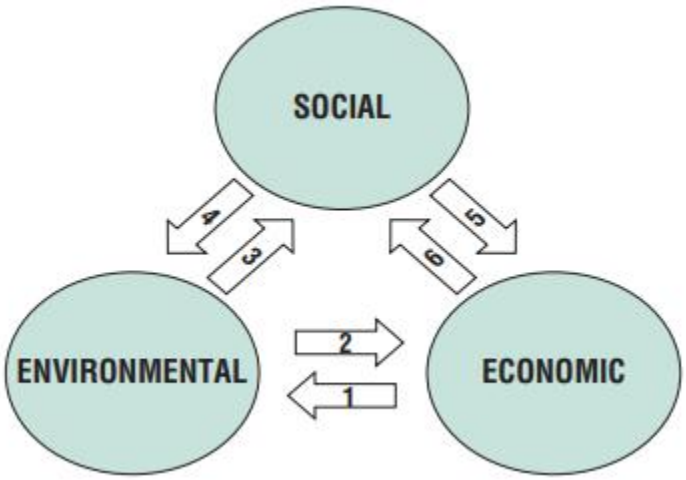


Figure 7Relation between social, economic and environmental

1. Effects of economic activity on the environment (e.g., resource use, pollutant discharges, waste).

2. Environmental services to the economy (e.g., natural resources, sink functions, contributions to economic efficiency and employment).

3. Environmental services to society (e.g., access to resources and amenities, contributions to health, living and working conditions).

4. Effects of social variables on the environment (e.g., demographic changes, consumption patterns, environmental education and information, institutional and legal frameworks).

5. Effects of social variables on the economy (e.g., labour force, population and household structure, education and training; consumption levels, institutional and legal frameworks).

6. Effects of economic activity on society (e.g., income levels, equity, employment).

3.10 Society Creating Risk

Risk is a real or potential threat of a disaster that can lead to major loss of life, livelihoods and infrastructure. It is the likelihood of something happening and consequences if it happens. A risk is a combination of three components: hazard, exposure and vulnerability -represented by three sides of a triangle which is called as **risk triangle**. Any one side of the triangle increases, the area of the triangle increases, hence the amount of risk also increases and vice-versa.

Figure 9 Risk Triangle

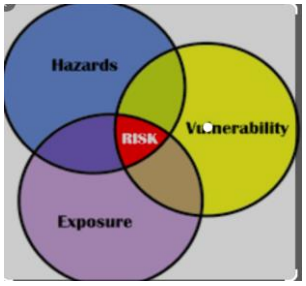


Figure 8 Relationship between risk, hazard, vulnerability and exposure

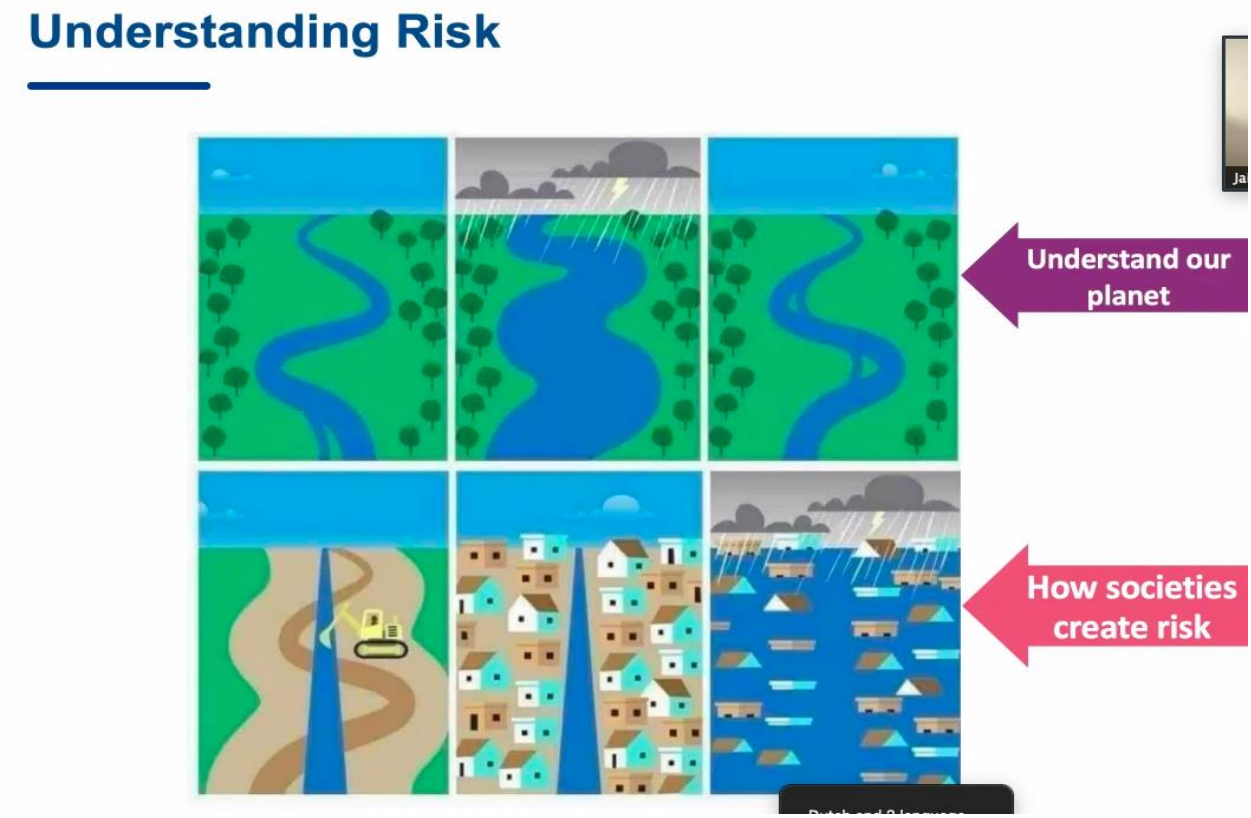


Figure 10Community creating Risks (Adopted from Theories of Risk, Inclusion and Land Use by Suman Kumar Karna)

Sometime risk is induced by societies and community itself. As shown in the above picture, there is a natural flow of water which is generally small but during certain period the flow increases. When a settlement starts growing in river bank, these settlements does not consider the return period of the biggest flood and grows with passing days. On certain time period, the river increases and return back to its original stage flooding the whole settlement. Here, people are increasing risk toward themselves.

3.11 National and International Context

3.11.1 Lake on preventing flooding

The Mekong River's dependable dry and wet season patterns, as well as the aquatic species adapted to the river pulse and the diverse habitats it creates, have allowed the floating villages on Tonle Sap Lake in Cambodia to sustain their livelihoods for centuries.

Near Phnom Penh, the Tonle Sap River connects Tonle Sap Lake to the Mekong River and is a 120 km (74 mi) long tributary of the Mekong River that is heavily impacted by the Asian monsoon. The freshwater lake is shallow during the dry season, rarely rising above 3.3 m (11 ft), but during the wet season, it can reach depths of 8 to 10 m (26 to 33 ft). The Mekong River floods during the rainy season enlarge the dry season lake, making it 250 km (155 mi) long and 100 km (62 mi)

wide. The Tonle Sap Lake enlarges by 200% to 300% as a result of this development, and its water volume rises from 10 km3 (2.4 mi3) to 80 km3 (19 m3). Homes on stilts or floating communities have been built around the lake and river to shelter people from the rising waters, which can reach depths of 10 m (33 ft) due to seasonal fluctuations in water levels. (Olson, 2018)

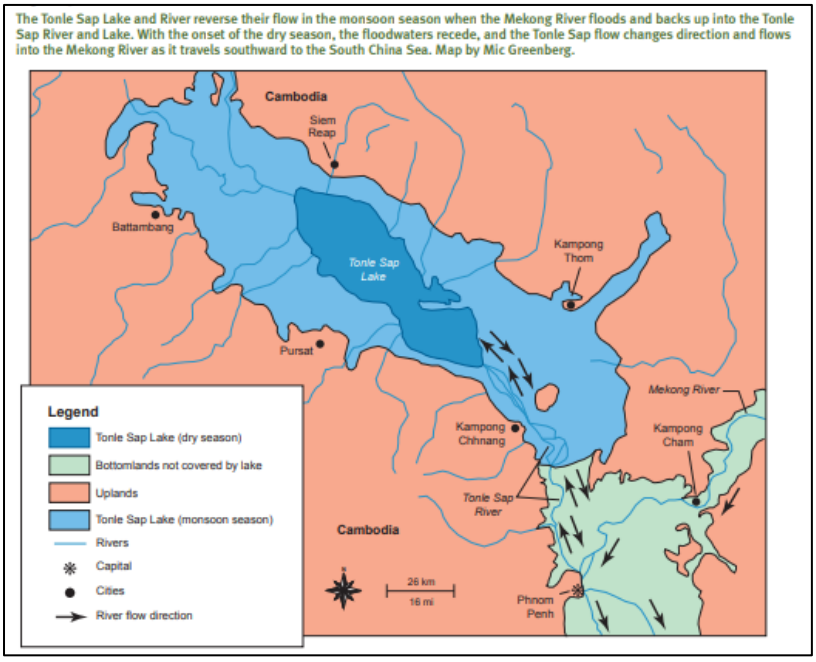


Figure 11 Tonle Sap Lake during dry and monsoon season

This lake prevents flooding by Mekong River by taking water during monsoon season and act as a retention pond. This lake can be taken as an example of how a lake can prevent flooding acting as a retention pond. In this same way, artificial lake can be created as a retention pond near river area with high probability of flooding to prevent flooding and reduce the risk of life and property.

3.11.2 Artificial:Lake in development of Bhopal

The capital of Madhya Pradesh, Bhopal, is a special example of how human creativity and natural beauty can coexist. It has stunning landscapes with man-made lakes. Among these, the well-known Upper Lake, or Bada Talab, is significant historically because King Bhoj skillfully created it at the start of the 11th century. Raja Bhoj established a large lake that stretched from Bhojpur to Sehore and Mendua village by building an earthen dam over the Kolans River, a rain-fed tributary of the Betwa River. A rich environment that sustained the livelihoods of local inhabitants, particularly the Gond and Bhil tribes, was fostered by this reservoir, which had a significant impact on the surrounding areas. These tribes, which were made up of farmers and hunters, obtained their food purely from the abundant resources of the natural world. These tribal tribes were able to establish and thrive in an ideal environment thanks to the natural diversity that the Upper Lake's presence produced.

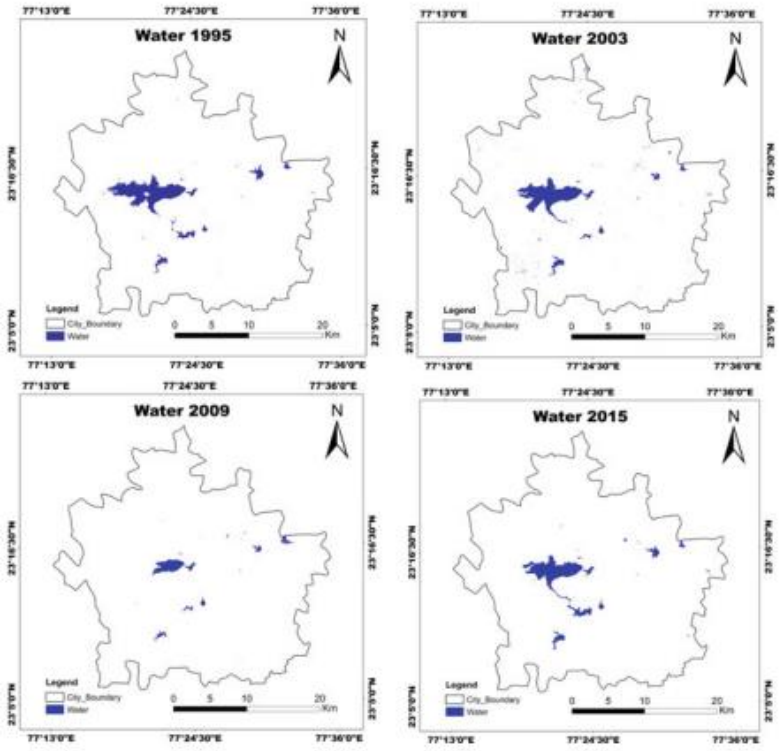


Figure 12 Water bodies of Bhopal in 1995, 2003, 2009 and 2015

Source: Tiwari, 2009

Bhopal has seen incredible population increase throughout the years, going from 600,000 people in the 1970s to a stunning 1.8 million people in 2011, indicating a rapid urbanization. The city's abundance of natural beauty, highlighted by its undulating geography and several attractive artificial and natural lakes, is what makes it so alluring. However, the city's once-pristine environment has suffered due to the persistent waves of urbanization, which are being fueled by

economic investments in urban sectors, inter-city mobilities, and regional connectivity, and have deprived it of its well-known attractiveness.

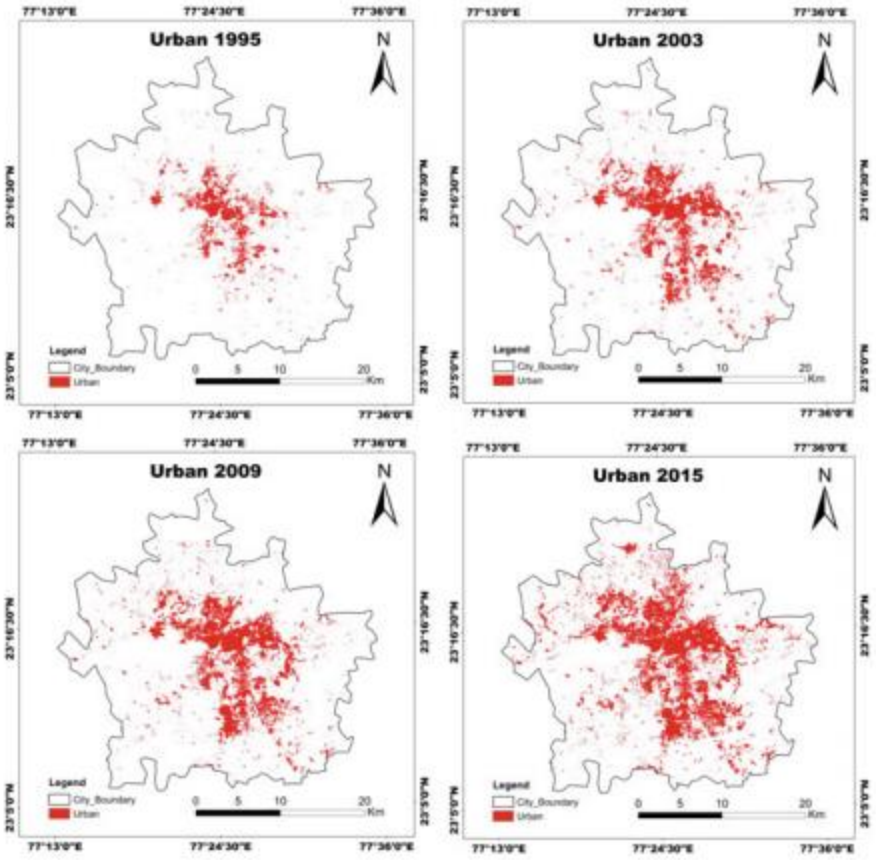


Figure 13 Urban growh of Bhopal

Bhopal once had a reputation for being one of India's greenest cities, but that honor may soon be lost. A shocking study by IISc Bangalore researchers has found a disturbing drop in the city's vegetative cover. The excellent 92% vegetative cover that Bhopal had in 1977 had severely decreased by 2014 to just 21%. The study's alarming predictions include further deterioration to just 11% by 2018 and a drastic decline to just 4% by 2030 if the local administration sticks with its current course of action. With a delicate balance needed between economic developments and maintaining the city's priceless natural legacy, this disturbing trend urgently calls for sustainable solutions.

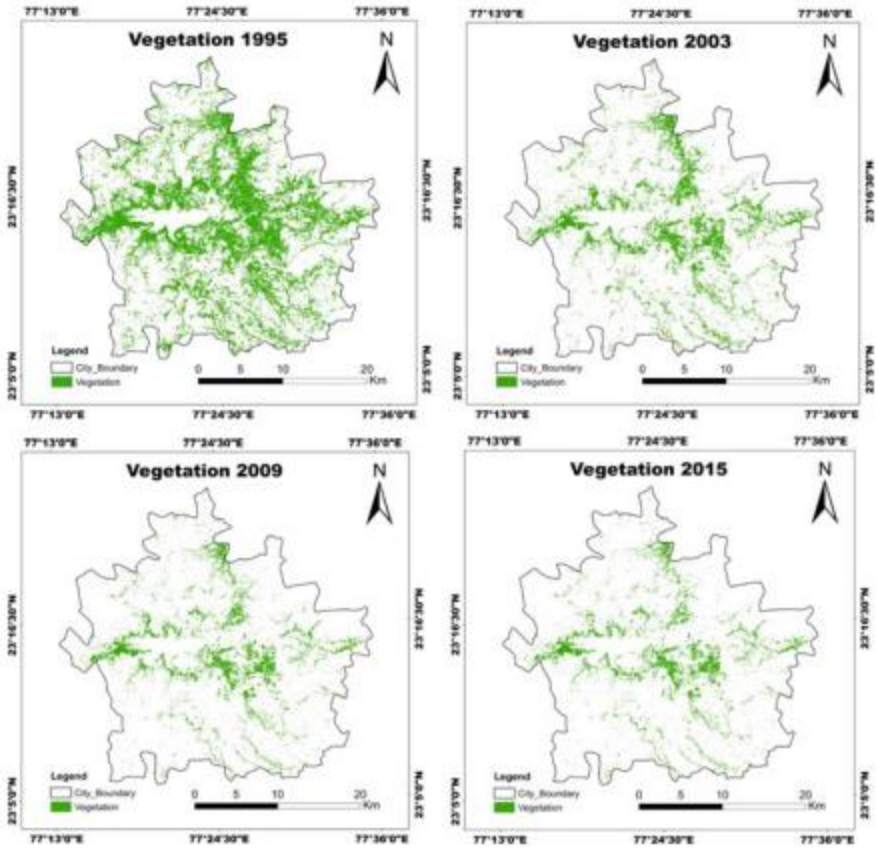


Figure 14 Vegetation of Bhopal

Bhopal has seen numerous problems with lake encroachment and water quality in recent years. Pollution has caused the once-pristine Upper Lake, which was immediately consumable, to require initial treatment before consumption. There are also problems with the water quality in a number of nearby lakes. Tragically, out of the 31 lakes that were registered, only 21 still exist, with 11 being lost forever. Since 2005, there has been no approved master plan, which has caused unplanned urban growth and the emergence of gated communities and townships lacking in adequate infrastructure and planning rules. This growth has also resulted in land speculators buying up agricultural land, driving up prices, destroying lives, and harming the environment. Groundwater levels have decreased and the surrounding flora has withered over time, showing an unsettling trend in the area's environmental quality. To solve these urgent problems and ensure sustainable development in Bhopal and its peri-urban areas, immediate and concerted effort is needed. (wadwaker, 2018)

Land use / Land cover change						
	1972	1992	2000	2011	2016	% change
Agriculture	3524.03	3234.12	2968.42	2300.81	1906.86	-45.89
Built up	594.86	678.84	1408.28	2205.86	2129.8	258.03
Barren	522.17	1198.76	661.44	456.84	1067.38	104.41
Other	1373.33	908.88	982.45	1060.76	911.81	-33.61

Figure 15 Landuse of Bhopal

Source:- Jogdand, 2017

3.11.3 Phewa Lake encroachment

Phewa Lake in Pokhara is shrinking each day due to siltation from the river and streams feeding into it, dumping of urban garbage and encroachment on the bank by real estate speculators. Phewa Lake had a size of 1,119 hectares in 1957, but a survey conducted by Gandaki Province earlier this year revealed that it had reduced to 572 hectares.if the similar trend continues for another two decade, the lake will be turned into a mere pond.

Figure 16 Phewa Lake original vs present area

3.12 Buffer Zone

Lands that are immediately next to waterbodies like lakes, reservoirs, rivers, streams, and wetlands are referred to as riparian buffer zones. Both the prevention of nonpoint source pollution and the associated water quality in neighboring waterbodies are significantly impacted by these land areas. They are therefore frequently utilized in water resource protection projects. Since the early days, different cities have had laws restricting the use of private land that is a certain distance from a river, lake, wetland, or tidal shoreline. These "setbacks" or "buffer strips" are used

for a variety of reasons, including the preservation of riparian habitat and waterfront amenities as well as the protection of surface waterways from pollution and erosion.

Setting up suitable landscaping near lakes and ponds can have long-term advantages in addition to improving your course's aesthetic appeal. Buffer zones, for instance, help to lessen the amount of nutrients and sediment that are transported through the system and out to the watershed. There will be indirect benefits to the health of your pond when buffer plants are actively filtering nutrients and the plants are adding little nutrient input to the water. The filtering of nutrients from runoff as well as direct filtration of the water from any plants that are "feet wet" will prevent the growth of unwanted plants and algae in the water.

Without a barrier separating the grass area from the lake or pond, erosion along the shoreline may happen, leading to high sedimentation rates into the water body, poor water quality, and the destruction of the original environment. A suitable buffer zone will stabilize the beach and greatly lower the likelihood of erosion-related problems.

Additionally, a well-maintained buffer can serve as a useful habitat for "good" species and a deterrent to opportunistic wildlife. While allowing for an increase in the species richness around the lake, buffers can offer safe habitat for many desirable species, such as birds, frogs, and rabbits. In contrast, where there is a well-established buffer, nuisance animals is often kept away from aquatic settings. Due to their inability to observe possible predators when access to the water is restricted, geese frequently select alternate areas for breeding. In the absence of sufficient breeding places, geese frequently select other feeding grounds.

The buffer also serves as a secondary benefit by preventing water access and potential harm to people. Buffer vegetation may frequently catch trash before it enters the water as well, making maintenance jobs like waste cleanup much simpler.

3.12.1. Buffer maintenance

A buffer zone often needs regular upkeep to keep healthy buffer plants in place and control tree development. It is often advised to reduce the buffer area to no less than 18″ in the cooler months to reduce the inflow of nutrients from clippings and dead plant matter. According to certain studies, trimming the tops of beneficial grasses on occasion will result in a greater uptake of phosphorus and nitrogen. Removing clippings and other cut material will help to reduce the amount of nutrients entering the watershed. Throughout the growth season, selective aquatic herbicide applications can be used to control the buffer and keep undesired species from colonizing while enabling the beneficial species to flourish.

They have been severely deteriorated across the majority of lake basins in the world as a result of human activity and nearby land-use changes.

The state of many streams, lakes, reservoirs, and coastal areas' water has gotten worse as a result of the growth of agriculture, industrialization, and urbanization. The problem of water contamination has gotten worse, and NPS pollution, a major source of nitrogen and phosphorus in freshwater, has emerged as the main factor contributing to the decline in freshwater quality.

The development of agriculture, industrialization, and urbanization has led to a worsening of the water quality in many streams, lakes, reservoirs, and coastal areas. The issue of water contamination has gotten worse, and NPS pollution—a significant source of nitrogen and phosphorus in freshwater—has emerged as the primary cause of the deterioration in freshwater quality.

The width is an important factor to considers while building a lake riparian buffer zone. The riparian buffer zone is not as wide as it may be. Natural resources and financial investment will be wasted if the width is too large. It won't be enough to safeguard the lake if the breadth is too small.

The phrase "minimum acceptable width" refers to the ideal width at which we may receive the best ecological benefits while spending the least amount of money, and it must be taken into account when building a lake riparian zone. If the lake riparian buffer zone is built in a hasty manner without defining the goals beforehand, it will result in a waste of resources.

Numerous studies have found a substantial relationship between the riparian zone's land use and land cover (LULC) composition and structure and the environmental quality of the water. The riparian buffer zone should be wide enough to accomplish the goal of preserving the lake's aquatic ecosystem and enhancing water quality.

Problem observed after Expanding Buffer Zones

Bangalora once known as city of lake suffered from urbanization. In 1960, there were 280 lakes and tanks altogether. And thirty years later, the total number of water bodies was less than eighty. There are currently just 17 lakes in the city, and more NGO workers and activists care for them than government workers do. So, to protect this, a buffer zone of 30m was initially started. Though buffer zone was created, due to lack of awareness and proper implementation of rules and regulation, the buffer zone was encroached slowly at several spots around number of lakes. Realization of importance of buffer zone, National Greens Tribunal (NGT) made a new rule of 75m green buffer zone around lakes and storm water drains, directing that no construction be allowed there.
The problem with new buffer zone is that there are existing 31,500 buildings in the increased buffer zone of lake. Also, number of apartments units are being constructed by builders in the area as plan of the building have been passed as there was no 75m buffer zone rule before that but after the law have been passed, the palikas cannot allow those apartments units occupancy certificate making those houses unable to use by residents.
So, a lesson that can be learned from this example of Bengalure is that a buffer zone is necessary

to protect lake from human activities and if proper buffer zone with study during initiation of lake is not created and new one is created after certain time number of buildings will be constructed in the area making new implementation rather very hard. (*Watershed Management for Potable Water Supply*, 2000)

Chapter 4: Case area

4.1 Introduction

4.1.1 District

Bharat Lake is located in Sarlahi district which is one of the eight districts of provience number 2 (Madesh Pradesh) and is located at around middle of the provience. This district is surrounded by Mahottari in the east, Rauthad in the west, Sindhuli in the north and Bihar state of India in the south. This district covers an area of 1259 km^2 with average length of 32km in the north south direction and average length of 40km in east west direction. This district is surrounded by Bagmati River in the west, Mahabharat himilayan range, chure range, forest etc. around north and plain terai in the south. The lowest altitude in the district lies 60m above the sea level while the highest altitude lies 659m above sea level. This district has around 67.26% agricultural lands, around 24.29% forests and 1.28% urban area.

Figure 17 Location of district

The residents of Sarlahi think that the temple's name, Sarla Devi, is where the town gets its name. The Sarlahi district's Hempur village is home to the Sarla Devi shrine. There is a myth that claims anyone who brings a light to the temple at night will perish. Due to this, nobody still visits that shrine at night while carrying a light. There are 81 lakes recorded in Madhesh Province, all in the Terai region with the most lakes in in Dhanusha (23) and least in Parsa (3). Out of 136 Palikas in the province, Janakpurdham Sub-Metropolitan City in Dhanusha district has the biggest number

of lakes (21) compared to other Palikas**.** In sarlahi district, there are 10 lakes which are given below.

Sarlahi	Betini Daha	Freshwater, Lacustrine	4	Degraded
	Chandragunj Pokhari	Freshwater, Lacustrine	0.95	Degrading
	Hatmare Pokhari	Man-made	5	Degrading
	Kerwa Pokhari	Man-made	4	Degrading
	Lekhandehi Taal	Freshwater, Lacustrine	2	Degrading
	Math Pokhari	Freshwater, Lacustrine	3	Degrading
	Nadhi Taal	Freshwater, Lacustrine	1.54	Degrading
	Nagarpalika Pokhari	Man-made	2	Degraded
	Nassi Pokhari	Man-made	0.6	Degraded
	Panpiya Taal	Freshwater, Lacustrine	0.53	Degrading
	Purano Pokhari (Musailiko Pokhari)	Lacustrine, permanent	3	Degrading
	Total		**26.6**	

Figure 18 Lakes in sarlahi

Source:National Lake Conservation Development Committee (NLCDC)

The study done by National Lake Conservation Development Committee suggests that each of the 10 lakes in Sarlahi district is degrading or degraded. So, all these lakes require upgrade through conservation, protection and revitalization.

4.1.1.1 Weather data

Simulated historical climate and weather data for Sarlahi for 30 years

The graph displays the number of days each month that are sunny, partly cloudy, overcast, or rainy for Sarlahi based on 30 years of hourly weather model simulations. Days with 20% or less clouds are categorized as sunny, 20% to 80% as partly cloudy, and more than 80% as overcast. Most of the months in Sarlahi are generally sunny, while july and august are generally cloudy and overcast.

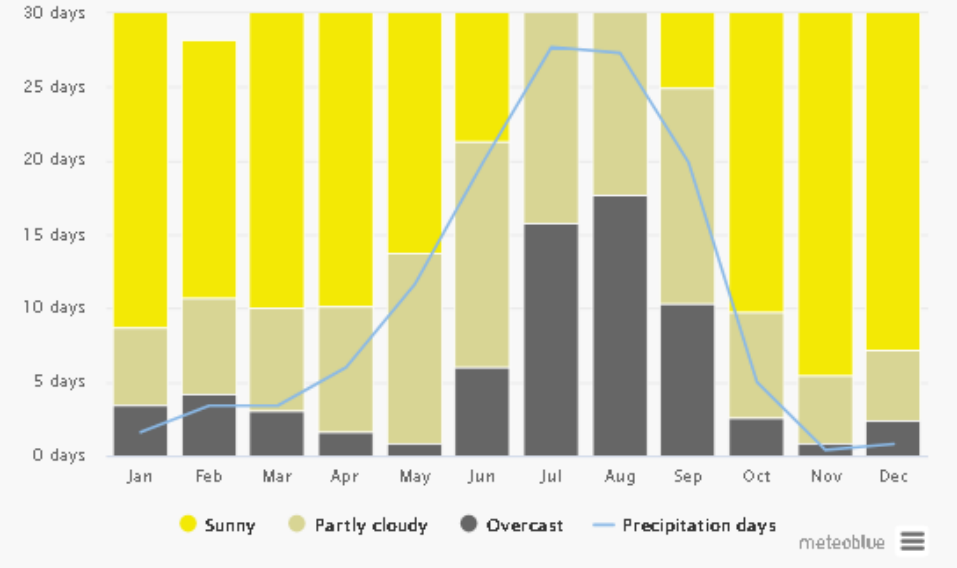


Figure 19 Cloudy, sunny and Precipitation days

The maximum temperature greater than 35 degree Celsius can be observed in April, May and June when it is mostly sunny. Apart from these, most of the months are have temperature above 25 degree. Months like November, December, January and February are winter months with temperature below degree.

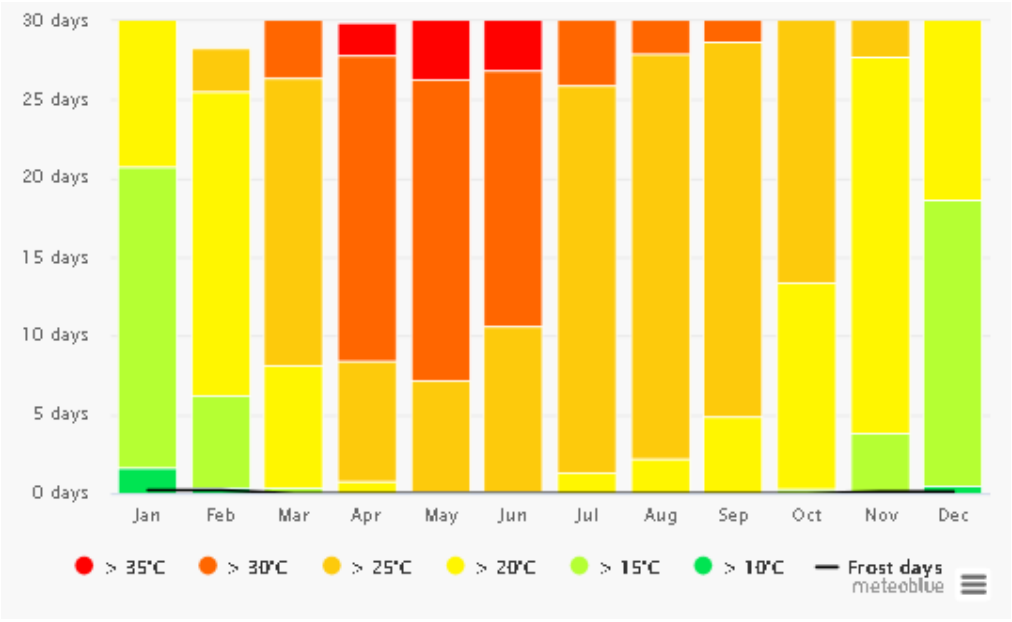


Figure 20 Maximum temperature

Months like November, December, January have very less rainfall with December having no rainfall at all. Maximum rainfall can be observed in months like June, July, August and September.

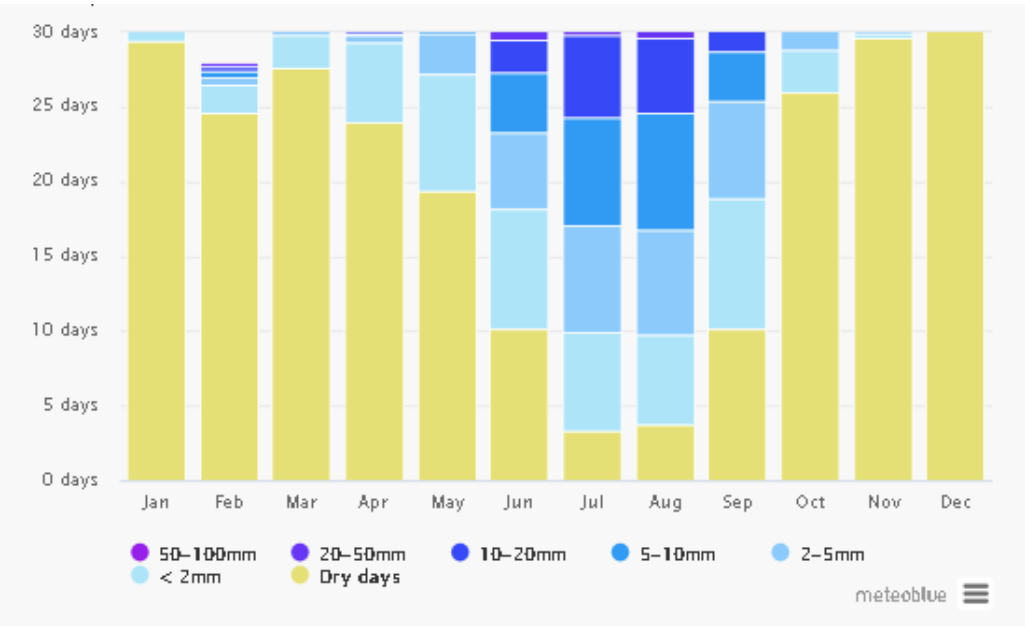


Figure 21 Precipitation amount

The maximum daily temperature slowly increases from January with 22 degree and reaches 35 degree during May. The temperature then slowly decreases and reaches 22 degree at December. Precipitation also increases slowly from January till May then suddenly increases with highest precipitation during august. The rainfall then again decreases after august.

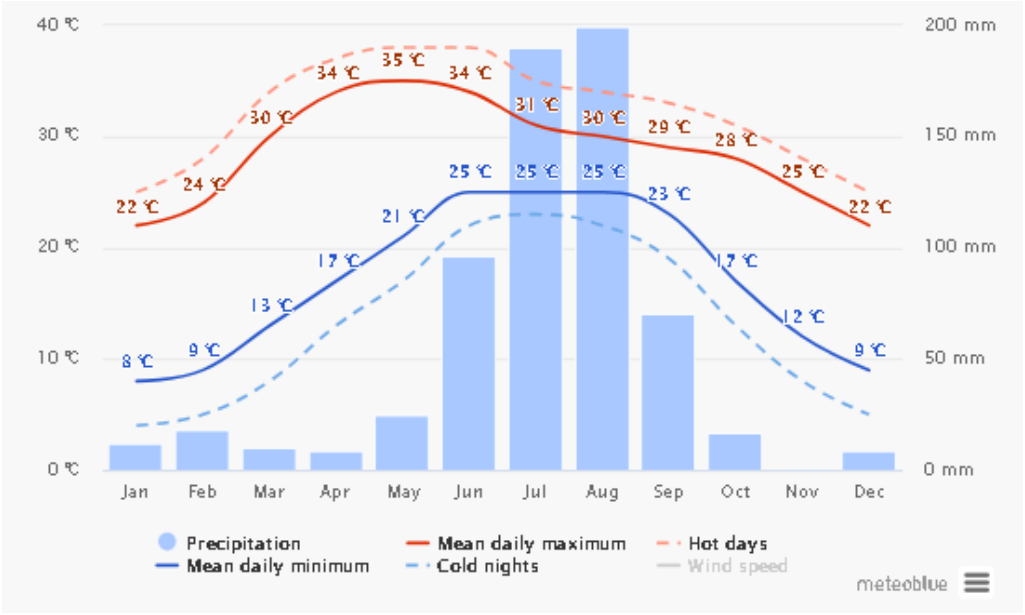


Figure 22 Average temperature and precipitation

Maximum wind in Sarlahi can be observed during months of December, January, February and March. However, minimum wind can be observed in months of June, July, August and September. From the study of wind rose diagram of Sarlahi, it can be observed that wind blow in North direction.

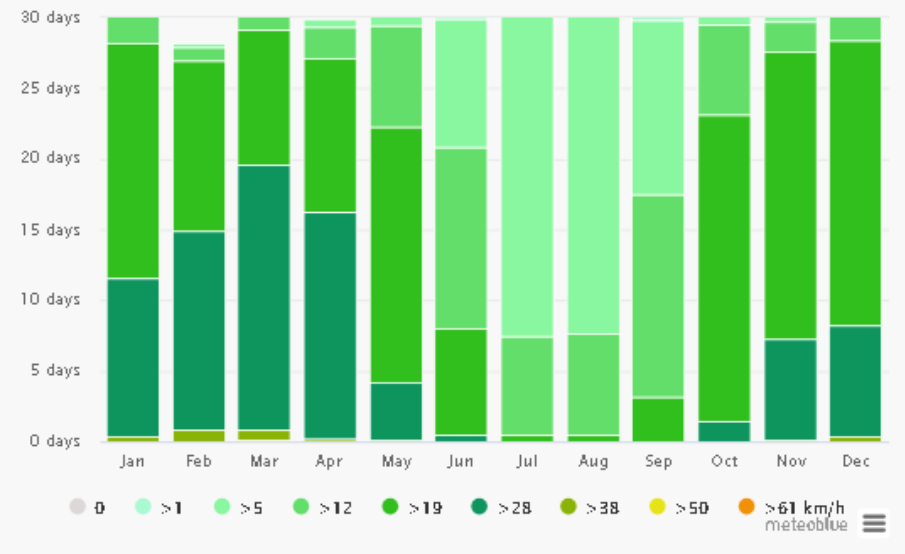


Figure 23 Wind speeed

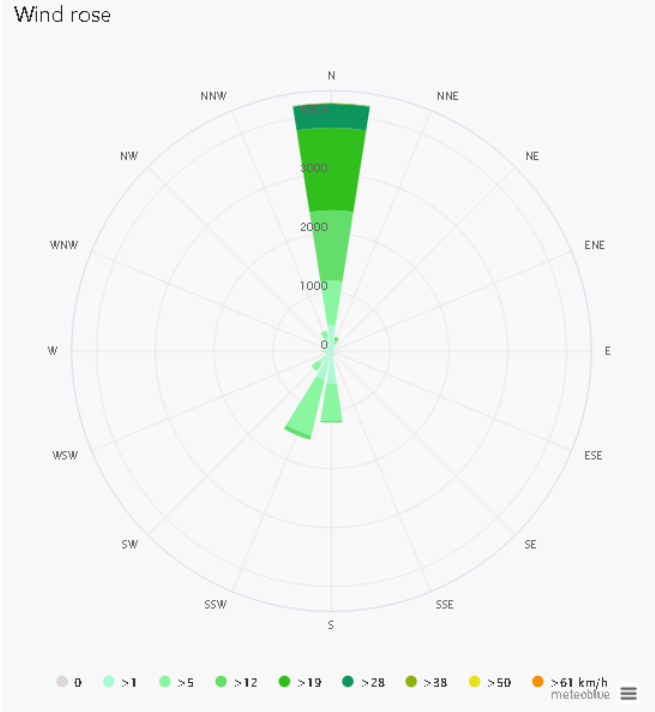


Figure 24 Wind Rose diagram

Source: Simulated historical climate & weather data for Sarlahi - meteoblue

The district consists of twenty municipalities, out of which eleven are urban municipalities and nine are rural municipalities. Bagmati municipality is one of the urban municipalities of Sarlahi district.

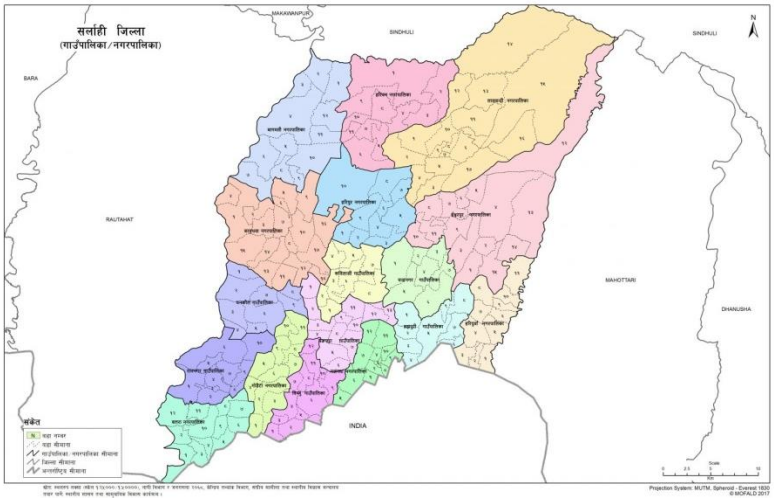


Figure 25 Municipality of sarlahi

4.2 Municipality

Bharat Lake is located in Bagmati municipality of Sarlahi district. It was formed in 2016 occupying current 12 sections (wards) from previous 12 former VDCs. Bagmati Municipality got its name from the Bagmati River in western part of Sarlahi District and District Border of Sarlahi and Rautahat. Bagmati municipality covers an area of101.18 km^2.

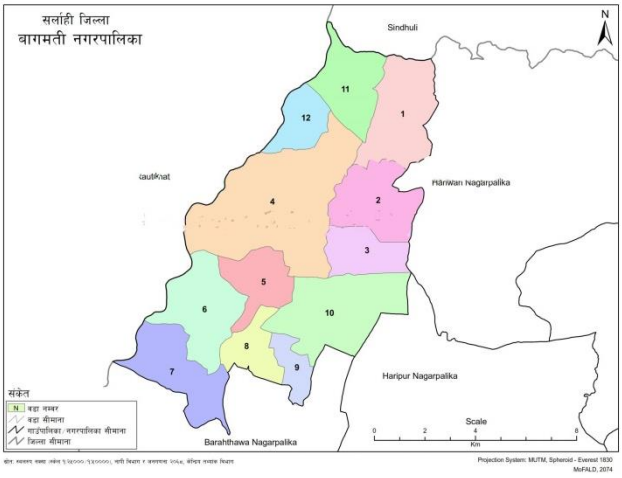


Figure 26 Bagmati municipality

4.2.1 Relative Location

East: Harion Municipality

North: Sindhuli District

West: Rautahat District

South: Barahathwa Municipality

4.2.2 Administrative and Political Division

The old four VDCs were combined into one municipality at 2073 BS, which was then divided into 12 wards, under the new system.

New Ward Number	Former VDC/s	Wards of former VDC/s
1	Dhungrekhola	1, 2, 4
2	Dhungrekhola	5, 6, 7
3	Dhungrekhola	8, 9
4	Karmaiya	7, 8, 9
5	Rajghat	6, 7, 8
6	Rajghat	4, 5, 9
7	Rajghat	1, 2, 3
8	Shankarpur	3, 4, 5
9	Shankarpur	1, 2, 6, 8
10	Shankarpur	7, 9
11	Karmaiya	4, 5, 6
12	Karmaiya	1, 2, 3

Figure 27 Administrative division

4.2.3 Physiographic

Particulars	Description
Total Area	101.2 SQ. km
Altitude from sea level	60m to 600m
Average annual rainfall	1899.6 mm
Average Annual temperature	Hi 31+° Low 20°
Climate	Lower Tropical and Upper Tropical
Main Rivers/Khola	Bagmati River, Dhungrekhola, Godari Khola, Sukekhola
Irrigation	Bagmati Irrigation Project

Figure 28 Physiographic situation

4.2.4 Geomorphology

The majority of the Bagmati Municipality is located in the Terai region, while some of it is located in the Bhawar region, also called "Char Kose Jhadi." Topographically, ward no. 1 and ward no. 11's some parts are laid in the height of hills whereas other wards lie in the plain part. Ward no. 11, 12 4, 5, 6, and 7's western parts is situated in the banks of Bagmati river.

4.2.5 Population and Density

According to the CBS 2011 data, Bagmati Municipality has a total population of 40,399. A recent census of 2021 reveals that this municipality has a total population of 45,459 people. According to CBS 2011, the municipality's population density is 399.20 people per square kilometer, and a

more recent data of CBS 2021estimates the population density to be 449.20 people per square kilometer.

4.2.6 Caste and Ethnicity

This municipality has over 50 different ethnic groups living there. The majority of the Tamang community, followed by the Magar, Brahmin/Chhetri, and Kushwaha ethnic groups, make up this area's population. This municipality also has ethnic group like Thami, Therai Bhramin, Dhobi, Dom etc. with very minimum population.

4.2.7 Economic Condition

4.2.7.1 Professions

In this municipality, more than half of the population that is working is engaged in the agricultural industry, while one-fourth of the population is a general worker in the non-agricultural sector.

subject	total	Percentage
नोकरी जागिर (सरकारी तथा अर्धसरकारी संस्था)	345	3.55%
नोकरी जागिर (गैर सरकारी निकाय)	701	7.21%
नोकरी जागिर (निजी संस्था	457	4.70%
ज्याला मजदुरी (कृषि क्षेत्र)	4943	50.81%
ज्याला मजदुरी (गैर कृषि क्षेत्र)	1890	19.43%
पेशागत काम	589	6.05%
व्यापार व्यवसाय	521	5.36%
स्वरोजगार	171	1.76%
घरेलु तथा साना उद्योग	15	0.15%
आफ्नै उद्योगधन्दा	37	0.38%
ठेक्कापट्टा	59	0.61%
total	**9728**	100.00%

Figure 29 Profession of citizen

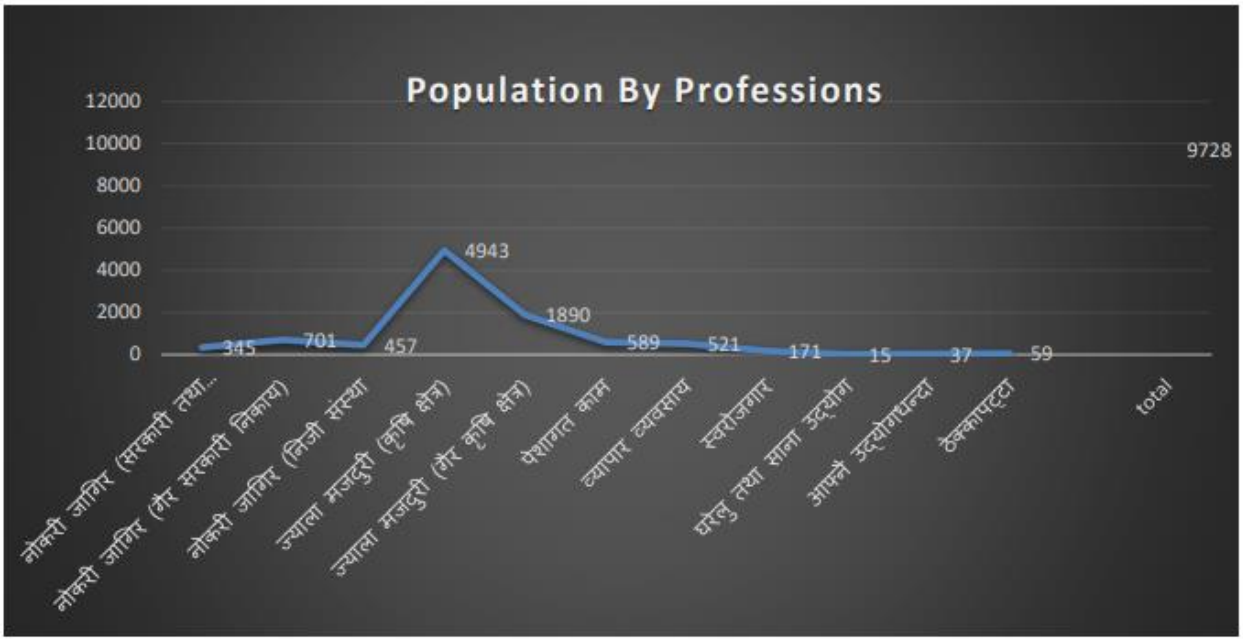


Figure 30 Graphical representation of professions

4.2.7.2 Income

The majority of the income frequency in the municipality is below NRs. 10,000.00 and below NRs. 30,000.00 annually. It appears that two thirds of the people earn very little money each year.

Figure 31 Income chart

4.2.8 Household facilities

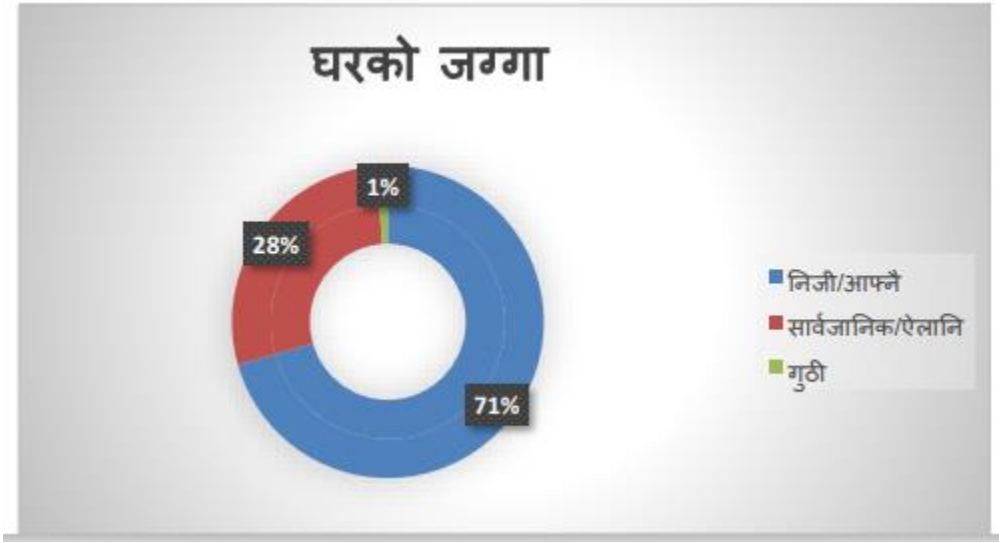


Figure 32Household facilities

4.2.9 Types of House

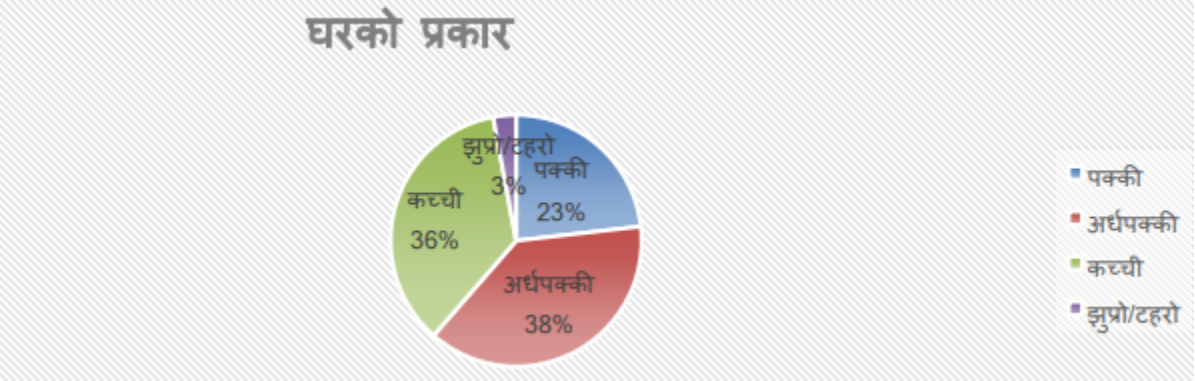


Figure 33 Type of houses

4.2.10 Social Development

4.2.10.1 Education

The percentage for literacy is 66.93. 2.65 percent of people can only read, while 30.42 percent of people are illiterate.

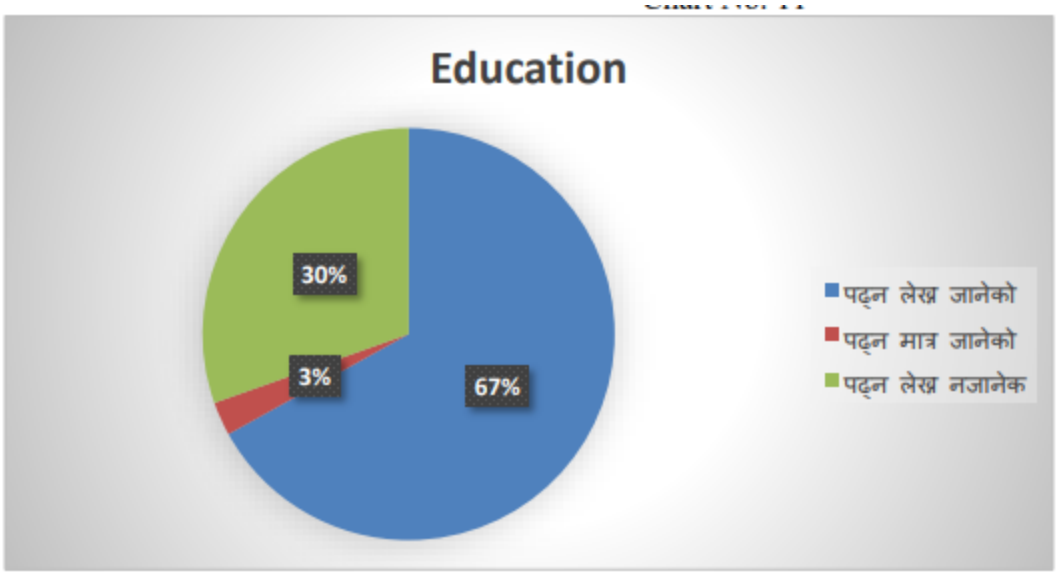


Figure 34 Education of municipality

4.2.10.2 Education Degree

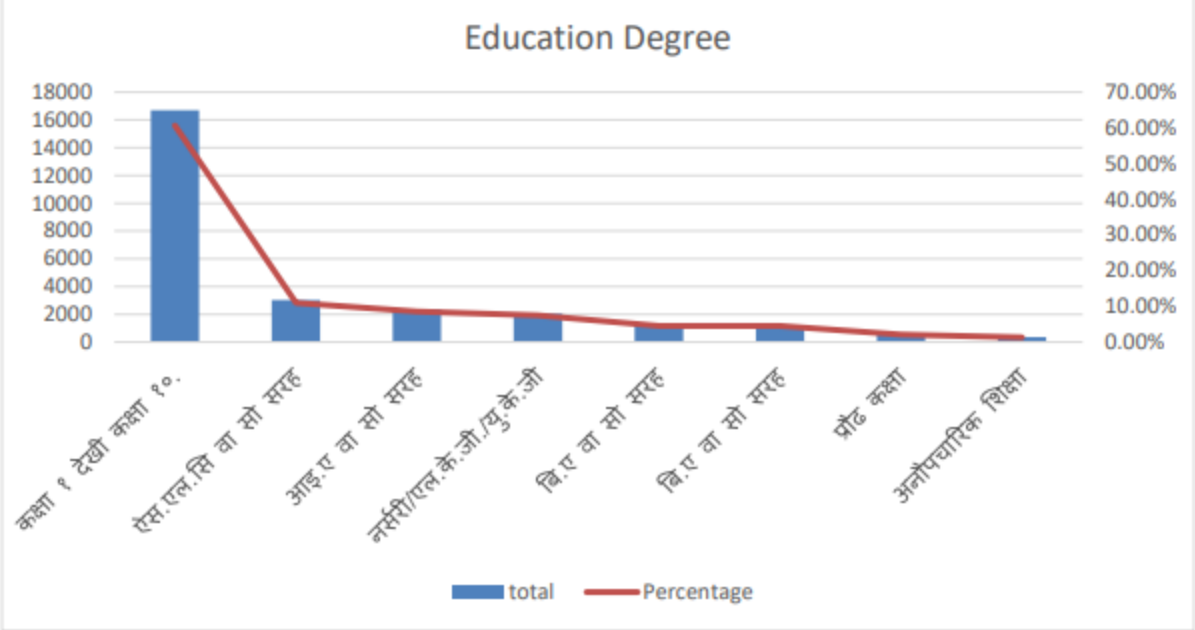


Figure 35 Education degree

4.3 Bharat Lake

The second-largest artificial lake in the nation is called Bharat Lake, and it is located in the Bagmati municipality of the Sarlahi district in Nepal's Mahendra Pradesh. The lake's advantageous location under the East West Highway at Karmaiya in Sarlahi, just 1 km east of the Bagmati Bridge and 3 km south of the Bagmati Bridge, has aided in its growth as a well-known tourist destination. The lake, which has a depth of 14 meters (45 feet) and a vast area of more than 150 bighas, is a tribute to the foresight and work of Mayor Bharat Kumar Thapa. The lake, which bears the former mayor's name, is the result of his idea and perseverance during that time. Bharat Lake has developed into a major tourist destination, luring travelers from all over the Madesh Province to its green belt-lined road encircling the waters' glistening surface. In addition to its recreational value, the lake supports fish farming, is important for preserving the formerly naked land, aids in groundwater retention, and improves urban quality.

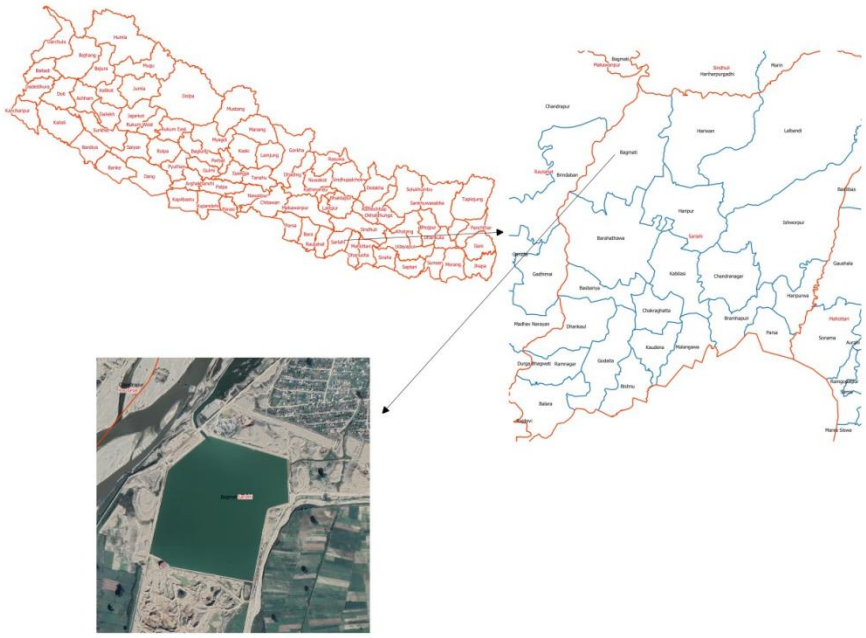


Figure 36 Location of Bharat Lake

Figure 37 Bharat Lake

Source:- Bharat Lake - Tourist destination in Nepal - Bharat Taal (jankarinepal.com)Nepal - Bharat Taal (jankarinepal.com)

The construction of Bharat Lake has been a revolutionary undertaking for the area, providing both the local population and the government with a number of advantages. The formerly barren site has been transformed into a bustling recreational area, promoting tourism and local government and resident economic growth. Fish aquaculture at the lake contributes to its relevance by bolstering the local economy and meeting regional requirements. Additionally, the lake's presence has helped to retain groundwater, resolving local concerns about water scarcity. A popular travel destination within Madesh Province, the area has a distinct identity thanks to the attractive green belt and the growing tourism industry. As long as Bharat Lake thrives and draws tourists, it will serve as proof that interdisciplinary efforts to change the region's scenery and improve the lives of its inhabitants were successful.

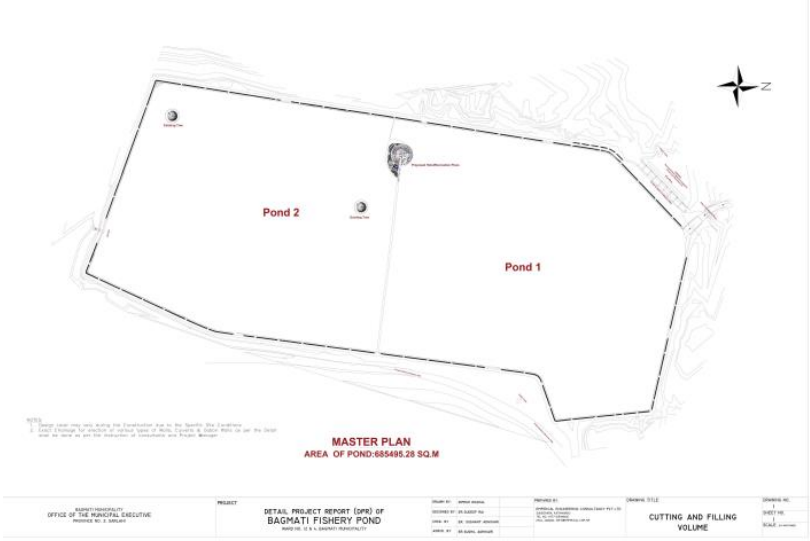
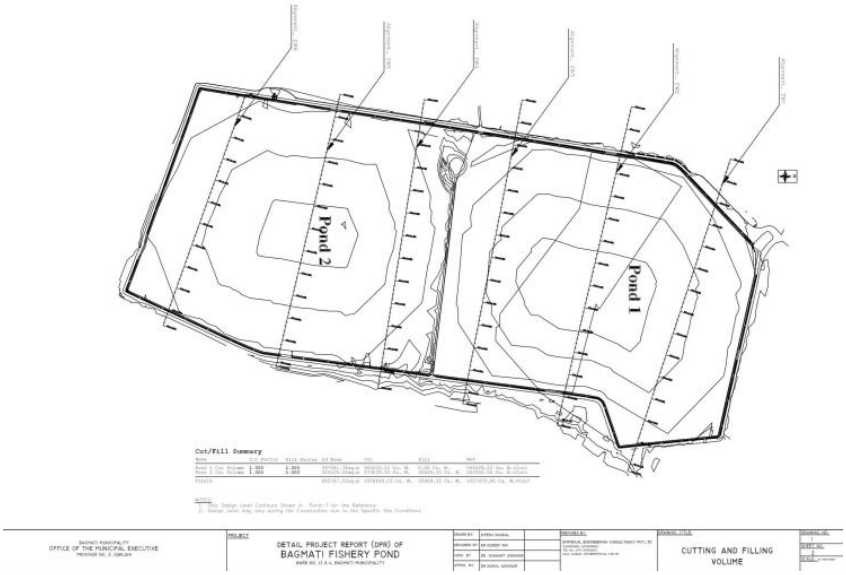


Figure 38 Design drawing of Bharat Lake



Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
Pond 1 Cut Volume	1.000	1.000	357081.78sq.m	505029.22 Cu. M.	0.00 Cu. M.	505029.22 Cu. M.<Cut>
Pond 2 Cut Volume	1.000	1.000	325105.56sq.m	573639.93 Cu. M.	20689.35 Cu. M.	552950.58 Cu. M.<Cut>
Totals			682187.33sq.m	1078669.15 Cu. M.	20689.35 Cu. M.	1057979.80 Cu. M.<Cut>

Figure 39 Estimation of cut and fill

In order to build a fish pond and bring in money for the Bagmati municipality, a basic pond excavation project, also known as "Bharat taal," was the origin of Bharat Lake. However, as work on the project continued, it evolved into a magnificent tourist destination and started to generate a

sizable amount of income for the local government. The lake's beautiful ocean view has captured the attention of tourists, luring both local and foreign visitors, mainly from the nearby country of India. Its advantageous location, only a short distance from the border between India and Nepal, enables people from India to travel to the lake and return home on the same day. Beyond its appeal to tourists, the lake is essential for the southern region's water recharge system during the dry season. Although the municipality initially referred to it as "Bagmati Fish Pond," the people lovingly refer to it as "Bharat taal," a monument to the lake's transformation from a humble pond to a beloved and lively tourist destination.

4.3.1 Project Hightlights

Table 3 Project Hightlights

Name of the Proiect	Bagmati Fisherv Pond
location Wards	4 & 12
Total Estimated Cost of Proiect	NRs. 882,753,106.16
Project Completion Period	3 Years
Total Area Covered	150 Bighas
Total Areas of Ponds	685495.28 SQ.M (101.21 Bighas)

Before the construction of the lake, the land was barren and agriculture was done in this area. Only one settlement north of the present Bharat Taal was situated whose major source of income was agriculture and animal husbandry. Another settlement was also due north along east west highway and depends on highway activities for economic activities. Few houses were along the minor road.

Figure 40 Location Before Bharat Lake Construction

After the construction of Bharat Lake in 2076 B.S, major changes occurred in the area. The shifts have been observed in land price to change in economic activities of people to change in physical attribute of the area.

Figure 41 Location After Bharat Lake Construction

The wall constructed in around the lake to store water has a bottom width of 3.80m, while the top width is 0.50m. Stone masonry wall of 1:6 have been used with 3m below ground level and 2.80m above the ground level.

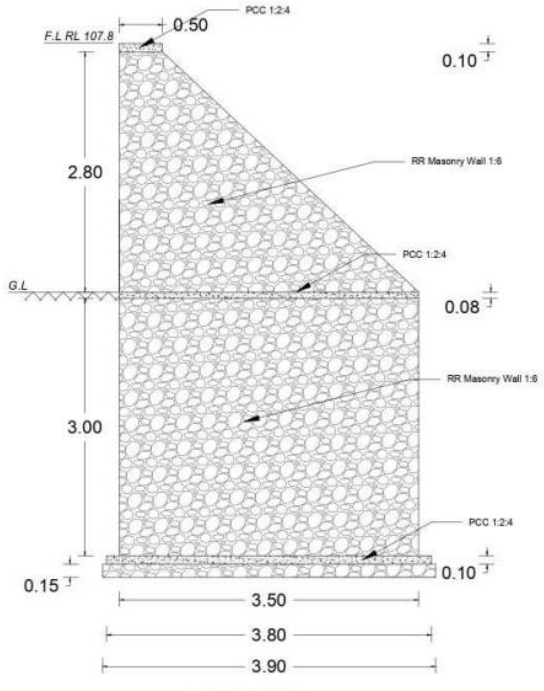


Figure 42 Section of wall surrounding the lake

The road constructed around the lake consists of concrete block pavement for movement of pedestrian near the lake. The boundary between lake and block pavement is seperated by cylinderical pipe railing. On side of the block pavement, flower bed is made where flower are grown to enhance the beauty of lake. Next to flower bed is a blaced top asphalt pavement which can be used for walking as well as movement of vehicle.

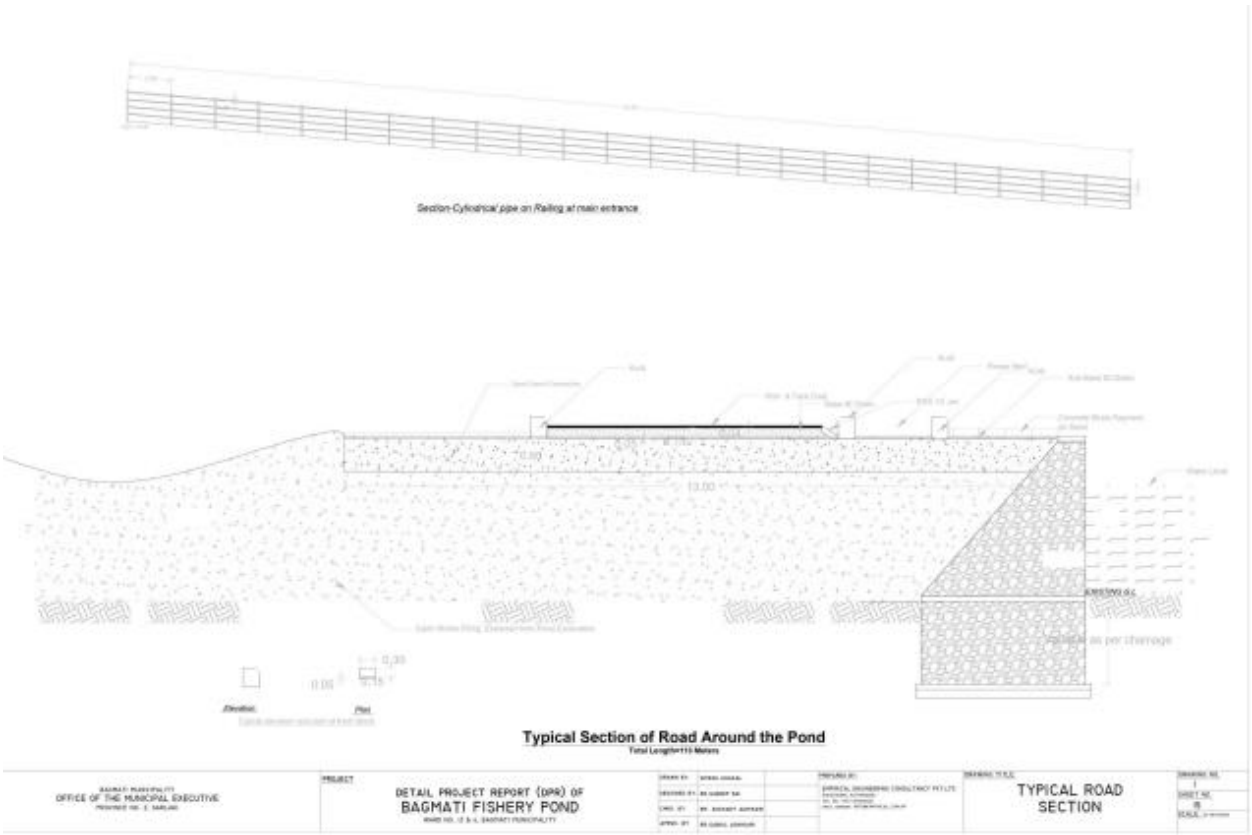


Figure 43 section of road

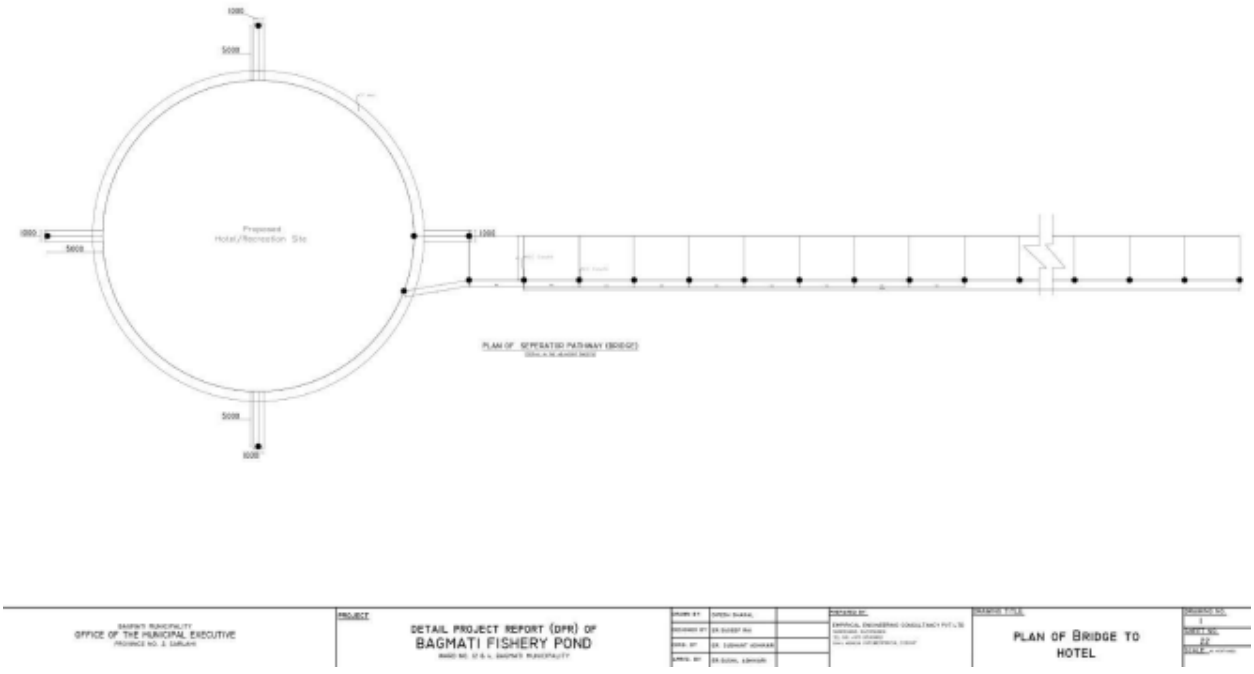


Figure 44 Plan of Central recreational area of lake

On center of lake, a hotel is under construction where visitor can stay and rest during the visit to the pond. This hotel separates two ponds from one another.

Chapter 5: Data and Analysis

5.1 Chronological Development

Bagmati municipality, located in Sarlahi district, is one of the urban municipalities formed on 2073 B.S by merging 4 previous VDC. The major source of income in the municipality was agriculture as most of the families owned certain land and were working on those lands. The income generated from agriculture was not sufficient to sustain a whole family. Few percent of people of this municipality were working on other sector apart from agriculture. So, majority of people were poor and were forced to move abroad for job opportunities. The youth that were still present in the municipality, majority were still unemployed. They had no idea about what to do to earn their living.

Observing these situations, the elected official as well as local and municipal government officer had a meeting to determine some innovative idea to increase employment opportunities in the municipality and enhance the economic condition of the municipality. The meeting headed by Mayor of the municipality presented an idea to develop a fish pond. To develop this pond, this was initially proposed to be around 40 to 50 bighas in area, required large open area. So, the search for open land where fish pond can be possibly developed was searched.

Before the flood of 2050, Bagmati River used to flow along left of where it is present now. After the flooding, the river flowed through two routes that are one as it is present and other at the left of the present river. The river on the left, also called as “Shuke Bagmati” at present, slowly dried and whole Bagmati started flowing through one path. The path left by the Shuke Bagmati was a sandy area and neither vegetation nor any activities were conducted in the area. This land belonged to “Sagarnath Jungle Pariyojana”. Observing the area and with the intention to use the barren unsed land, the idea to develop lake in the area was developed. This idea was conveyed to the Sagarnath Forest Pariyojana and thepariyojana was also ready to provideland for betterment of municipality. Finally, the name of the project was given “Bagmati Fishery Pond” and the legal process of development started.

Figure 45 Initial concept and final design

After the formal beginning of the project, the idea that a fishery pond will not attract huge number of tourists was determined and clear water pond for recreational activities was initiated and tender was issued. Though the name of the lake is Bagmati Fishay Pond, but the activity of fishing is

completely prohibited in the area. At first, the design of lake was made in such a way that a whole pond was divided into three sections. The problem with this was that the lake will not look as one rater will look as three different lakes. So, the lake was divided into two sections with a recreational hotel at the center of the lake.

At present, one section of the lake has been completed and next section is under construction. The material obtained from digging of the pond is either being used in municipality for construction work or is being sold issuing the tender. After digging the pond, the base of the pond was not made impervious using any impervious material rather the water from Bagmati was diverted into the lake. It took around 16 to 17 days to fill the pond and as the base was pervious, the water was completely soaked in 3 days. This process was repeated for 5 times. Now, the lake is able to hold water for longer period of time. The water from Bagmati Irrigation Project cannel have been used to constantly supply water to make for the water evaporated and seepage. s

5.2 Observation from the study area

The lake, Bagmati Fishery Pond or commonly known as Bharat Lake, is located around 2 Km from the east west highway and around 500m east of the Bagmati River. The road from highway to the lake is called as dam side road as it is made along the embankment dam made along the river. The road has been recently black toped. Public vehicle only can bring people to the highway and should take another vehicle used only for the purpose of going to the lake and coming from the lake. The vehicle can take four persons at once. So until there are four persons on the vehicle, people need to wait for some time. The trip from the main highway to the lake takes about 10-15 minutes via those vehicles. People can also walk from main highway to the lake which tales around 30-40 minutes in average. Similarly, those with their own vehicle can directly go using their vehicle. After reaching the Lake these vehicles need to park. There is parking cost allocated for different vehicle. The income generated from the parking goes directly to the municipality.

Generally, the flow of the people is very less in the lake during morning. Few construction workers and people from nearby community arrive there for working and walking. People start arriving in the lake after around 9 10 am, majority of them being shopkeeper. They open their shop at that period of time. Few visitors were also observed during that period of time. The number of visitors slowly increases from 10 am to around 2 pm. After around 2 pm, the number of visitor increases and the lake becomes vibrant.

The lake provides various recreational activities for the people arriving in the area. Initially, people can buy different gifts items specially belonging to Mithila community in the shop around the area. There are lots of restaurants and food stalls around the area where people can buy food and enjoy food watching the beautiful view of lake. There are people with camera who will capture photo in high quality. There is the facility of boat riding with two types of boats. One boat is large boat while other boats are small. People can ride in the boat and observe the lake. The payment for the boat ride goes to the owner of boat and municipality. Further, there are horses in the area. People

can ride horse along the road made around the boundary of lake. Similarly, there is camel in the lake which attracts lots of visitors. Additionally, sky bike is present in the lake to observe lake from elevated point of view.

The road along the boundary of the lake is a blacked topped road with flower bed on its right toward lake. The space next to flower bed is stone pavement pathway for movement of people around the lake. Since, the flower bed has not been maintained properly, some part of the flower bed have been infected with insects and pest degrading the bed. The roads which have been constructed have been intact. On space next to road on left, all the shops, food stall, ticket counter etc. are located.

The study area Bagmati Fishery Project or commonly known as Bharat Lake is still under construction. One lake has been completed while the excavation work of the next lake is still under process. Excavating machines are used in huge number for construction which is causing noise in the surrounding. The water level on the lake has been reduced at present as the wall was unable to hold the pressure while water from the lake was drained out. Now, a new wall has been constructed in the same area for holding water. After accumulating water for long period of time, the water become dirty and need removal. Municipality has suggested that they remove water in every 2 to 3 years.

5.2.1. Boating in Bharat Lake

Boating is one of the major sources of attraction in the lake and contributes maximum economic benefit to the municipality. There are 32 medium size boats and 1 large boat for boating around the lake. For the purpose of riding the boat, one should first buy ticket from the ticket counter. The cost for riding medium boat is Rs.300 per adult above five years old and is free for children below five. Similarly, riding large boat cost Rs.300 if you want staying inside the boat and Rs.500 if you want to stay at top of the boat which is open top. The children below the age of five years are given free ride if they tag along with their parents. The large boat is a 63 seated boat and only goes for trip after minimum of 25 people have bought ticket while medium boat have a capacity of 10 people. The medium boat provides three round trips round the lake while the large boat provides two round trips. Before stepping inside the boat, each individual should wear life jacket for protection in case of emergency compulsory.

The boating facility has provided employment opportunity to 6 people in two different counters and around 40 captains for riding boats. All these boats in the lake are private boats and are not owned by municipality. The captain riding boat are first given training to ride the boat and are certified by Boat Samiti under observation and guide of the municipality. The municipality has been directly benefited by the boating as 20% of every ticket price goes to municipality directly and remaining is divided among owner of the boat and captain riding the boat.

Boating and its effects

Though boating has been one of the most important economic contributor, there are few negative effect of boating on lake such as:

Water clarity

Water clarity is caused by propellers have the potential to directly or indirectly damage the lake or river bottom by increasing the amount of sediment particles in the water or by causing nutrients that are stored in the sediments, like phosphorus, to leach out making accessibility for the growth of algae. Shoreline erosion may be exacerbated by waves produced by watercraft, which can make water hazy.

Water Quality (Metals, hydrocarbons, and other pollutants)

Boat engines need to produce huge power to run the boat. During this, some gasoline that is injected into the motor gets ejected unburned resulting in degradation of water quality.

Damage Shoreline

While boat moves in lake, it causes waves which moves toward shore and end impacting along the shore. The wave may not be large but continuous wave creation in long term damages the wall surrounding the lake and shoreline.

Aquatic plants, fishes and wildlife

Boats impact aquatic plants, fishes and wildlife living along shore directly through contact of propeller and indirectly through turbidity and wave action. Fishes and wildlife normal activities such as nesting, spawning and feeding may be affected by boats.

Human environment

Boats disturb human environment through increase in air pollution, noise and safety as well as also increases crowding around the area. So, people may not receive peace and quiet around the area making it difficult to stay.

5.2.2. Pollution

Pollution was another major problem observed in the lake area despite few dustbins placed for throwing garbage. There is no separate waste dustbin for organic and inorganic waste material. Further there are only few dustbins around the area making it difficult for people to find the dustbin at their convenience. The major cause of pollution in the area was due to increased number of visitors in around the lake. Also, the food stall provide food in polythene bag or paper which after eating is generally thrown in around lake area or into lake water making both surrounding area as well as lake water pollution.

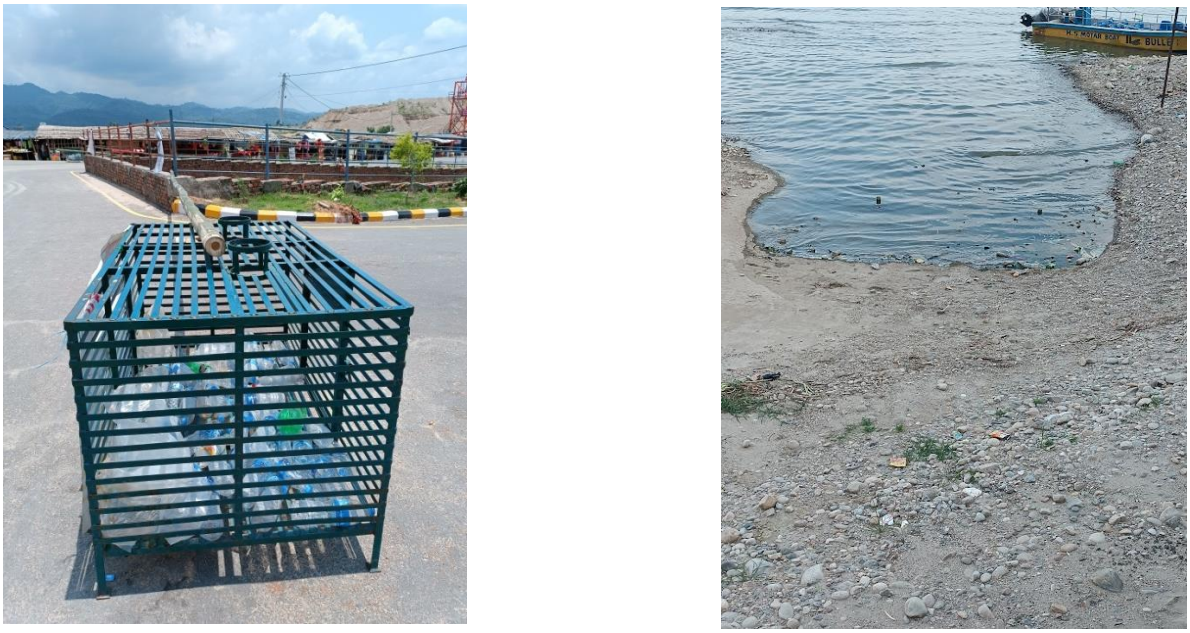


Figure 46 Dustbins placed around the lake but pollution on lake water

Landscape pollution

The natural beauty and water quality of lakes are being harmed by landscape pollution brought on by tourists, as we have seen during our research. High levels of landscape pollution both inside and outside of parks are caused by tourism. It covers all paper, plastic bags, and sewage. Tourists toss trash and waste materials into lakes and on open terrain. The major harmful effects of tourism at Bharat Lake are to blame for the lake's degradation. Disease-causing organisms and their vectors have habitats due to pollution.

5.2.3. Intake to the lake

There are two inlets or intakes and one outlet in the lake. The two inlets are on two side of the lake: north and north west side. The first inlet is for drawing large amount of water mostly during rainy season and while cleaning and completely filling the lake. The water is drawn through this inlet through making dam along the cross section of river. At the first filling of the lake, water was provided through this inlet. The other inlet is used for continuously supplying water. This inlet is an irrigation canal of Bagmati Irrigation Project which supply water to be maintained at same level which is decreased due to infiltration, seepage, evaporation, transpiration etc. The outlet of the lake lies in south side of the lake and is used to remove water from the lake. The outlet is then connected to the same Bagmati river downstream of the river.

Figure 47 Inlets of the Lake

5.2.4. Location Attribute Analysis

Bharat lake is located along the edge of Bagmati river. The lake is about 160m from the bank of the river. The river Bagmati has a possibility of flooding making the surrounding area vulnerable to flooding. This lake can act as a retention pond during small flooding protecting nearby surrounding. But during large flooding, this lake act as source of disaster. Bharat lake have attracted huge population around the lake surrounding which is a flood plain area. The population around the lake are vulnerable toward flood.

Figure 48 Location of Bharat Lake

5.3 Finding of the questionnaire survey

In this chapter, the result of the survey conducted are analyzed and set in different graphs to understand the influence of lake on environment enhancement and local development from point of view of nearby residents, visitors and shop-owner residing near lake area.

In near lake area, total of 149 sample of data were collected among which 120 of them were visitors visiting the lake, 20 were shopkeeper residing shop near lake vicinity, 7 cameraman's roaming around lake, 1 owner of horse and 1 owner of camel.

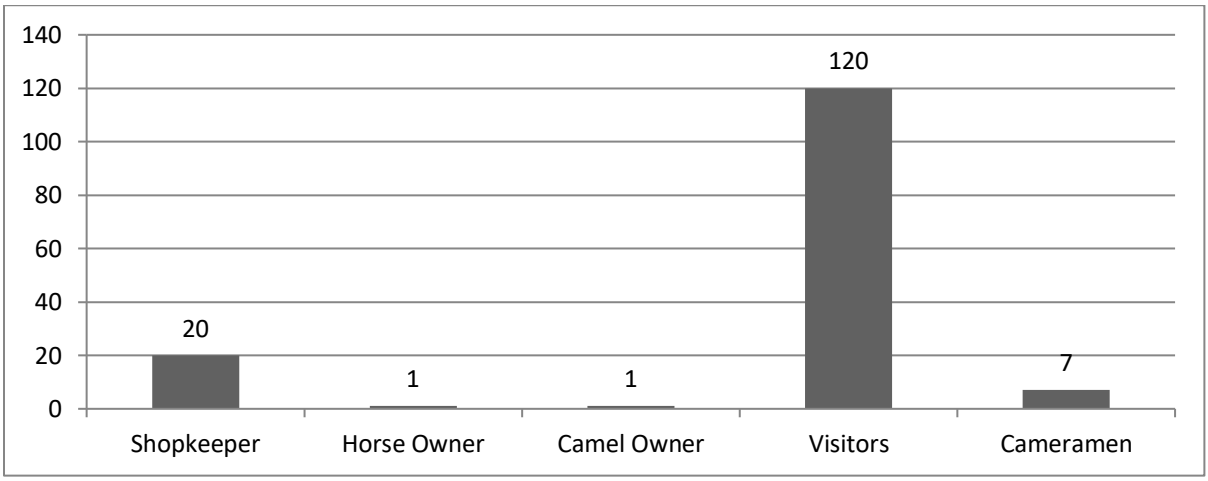


Figure 49 Bar chart showing number of survey conducted

In a community next to the lake, a total of 70 household surveys were conducted consisting of shop, old houses and new houses.

5.3.1 User Profile

5.3.1.1 Visitors

Among 120 survey conducted among the visitors of the lake, it was observed that 69 of them were male which is 57% while 51 of them were female which is 43%.

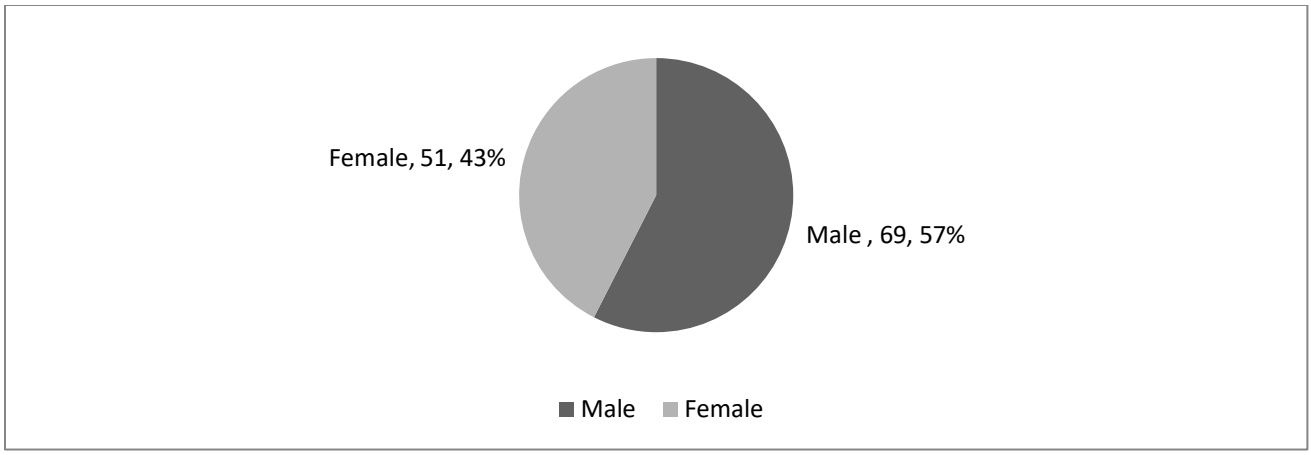


Figure 50 Pie chart showing gender group of visitors

To understand the active age group to visit the lake, age of the visitors were also recorded. Age group was divided into four groups <20, 20-40, 40-60 and >60 age. It was observed that among 120 people, majority of them were age group of 20-40 with 69 which is 58%. Similarly, 21 (17%) were below 20 and 30 (25%) of them were of age 40-60. The number of people with age greater than 60 was found to be null. During the survey, the minimum age of the visitor was 15 years old while maximum age of the visitor was 55 years old.

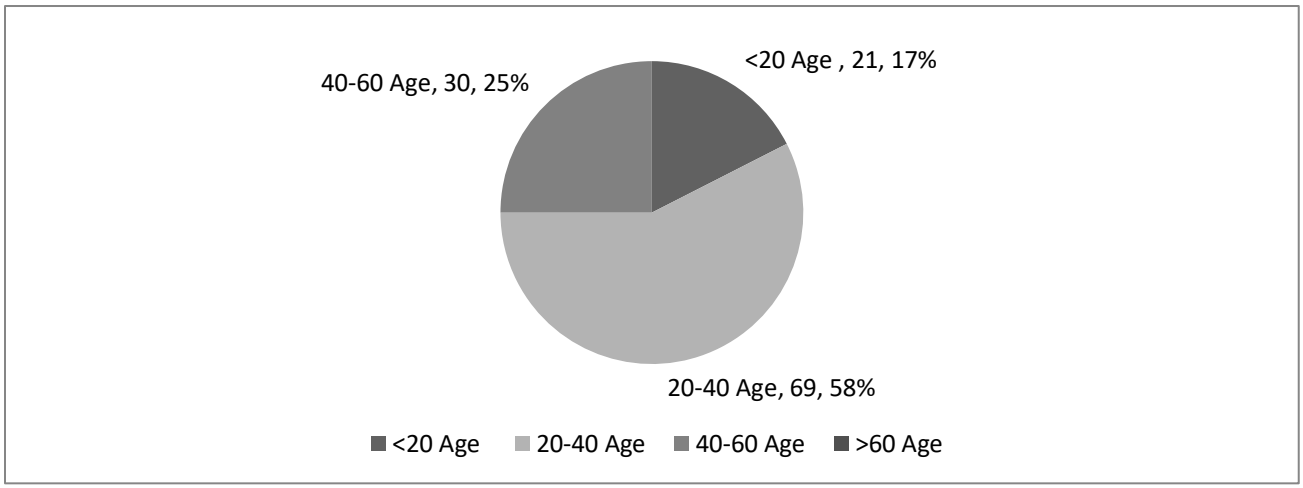


Figure 51 Pie chart showing age group of Visitors

5.3.1.2 Shopkeeper

Among total of 20 survey conducted among the shopkeeper residing around lake area, majority of them were female with 70% (14) and 30% (6) of them were male.

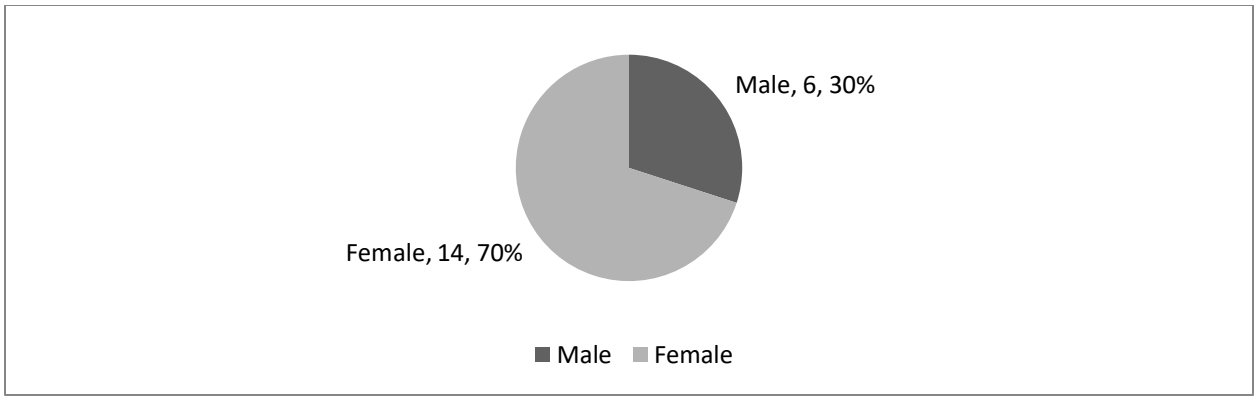


Figure 52 Pie chart showing gender of shopkeeper

Majority of the shopkeeper living around lake area were between 20-40 years old i.e 9 of them was of this range. Additionally, 6 of them were below age of 20 and 5 of them were between 40-60 years old. No one of the 20 shopkeeper was above the age of 60. The minimum age of the shopkeeper during survey was found to be 10 and maximum age was determined as 58 years old. The 10 years old child was working as a substitute to their family member as they were unavailable that day.

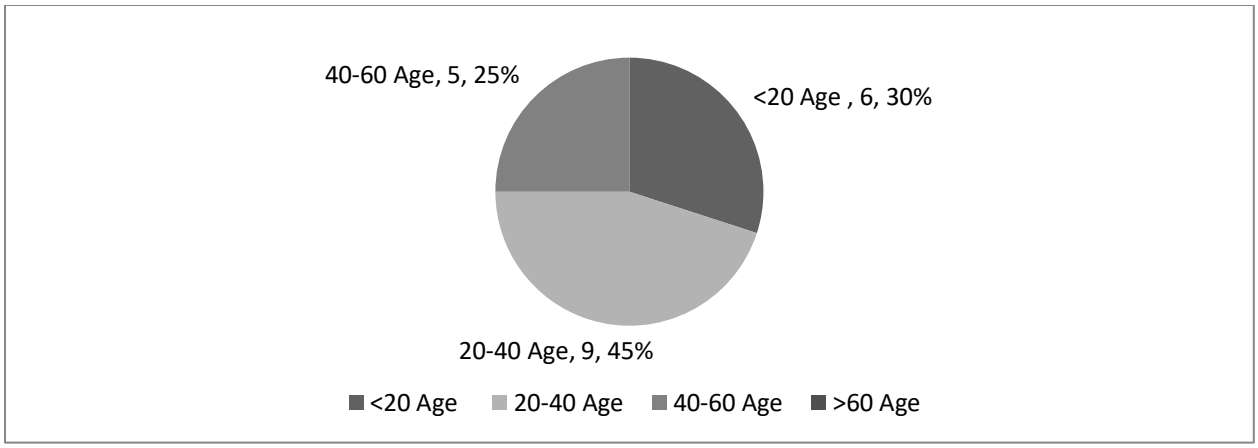


Figure 53 Pie chart showing age group of shopkeeper

Among 7 cameramen all of them were male and with further questioning it was found that all the worker working as cameramen were male. Similarly, the camel person was also male of age 55 years old. Additionally, the horse person was also male of age 40. Same like cameramen, all the horse person were male.

5.3.2 Preference time of visit in a day

The time in a day this survey is categorized is morning (5am to 12pm), afternoon (12pm to 4 pm) and evening (4pm to 8pm). When talking about the preference about visit time, 77% (93) visitors

want to visit the lake at around evening time. 16% (19) preferred to visit lake during afternoon whole 8 (7%) want to visit during morning.

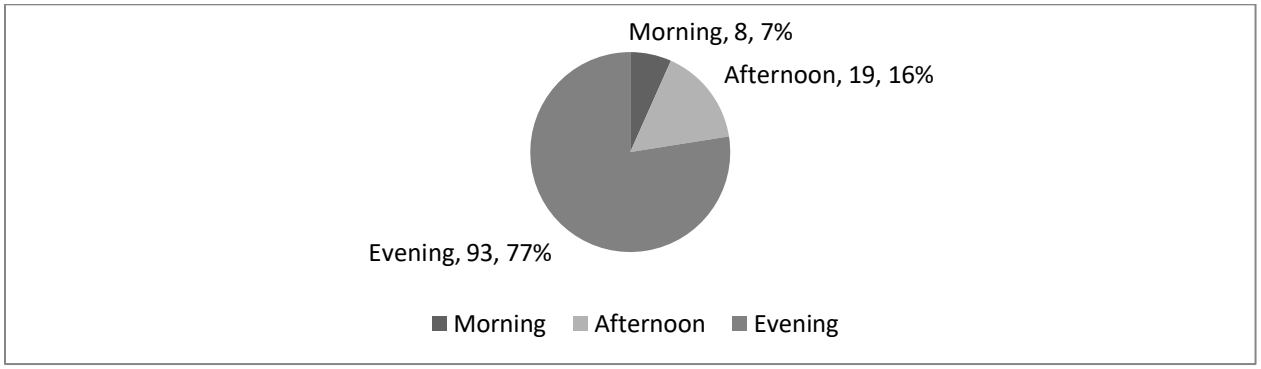


Figure 54 Pie chart showing preference time

5.3.3 Time spent around the lake

Time spent around lake is categorized as less than 2 hours, 2-4 hours and greater than 4 hours. Majorly, people spent around 2-4 hours in lake which is 63 (52%). 26% (31) people spent greater than 4 hours in lake while 22% spent less than 2 hours in lake.

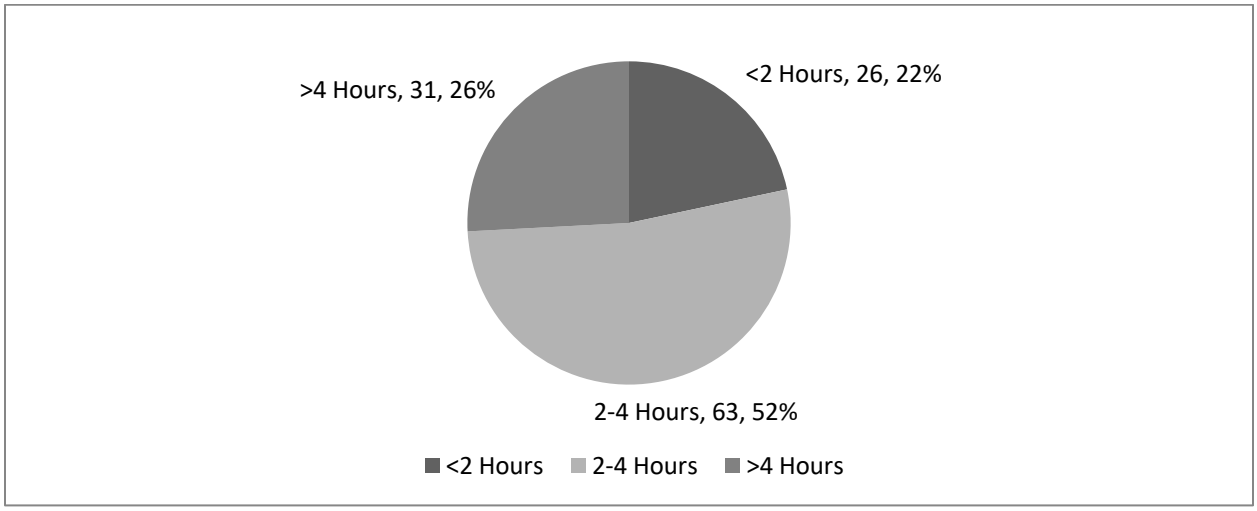


Figure 55 Pie chart showing time spent around lake

5.3.4 Visitor's residence

Only 13% which is 16 people are from the same ward as the lake that is ward 12. 20% (24) are from the same municipality except ward 12. 42% (50) people are from Sarlahi district except Bagmati municipality. 22% (27) people are from other district than Sarlahi and 3% which is 3 people are from other country.

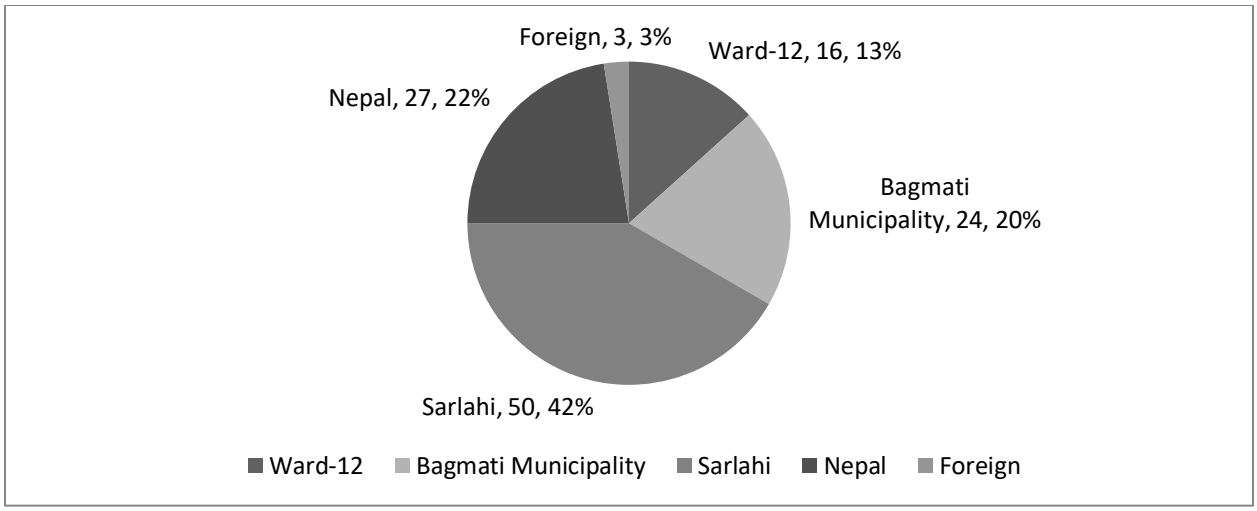


Figure 56 Pie chart showing place from where they arrived

5.3.5 Means of transportation to visit lake

Since the distance between lake and main highway is few kilometers, so people use public vehicle to reach the lake. 71 (59%) people use public vehicle to reach the destination. Similarly, 31 (26%) travel using their own vehicle majorly bike. 10% (12) of them visit the lake area walking and 5% (6) use bicycle to reach the lake area.

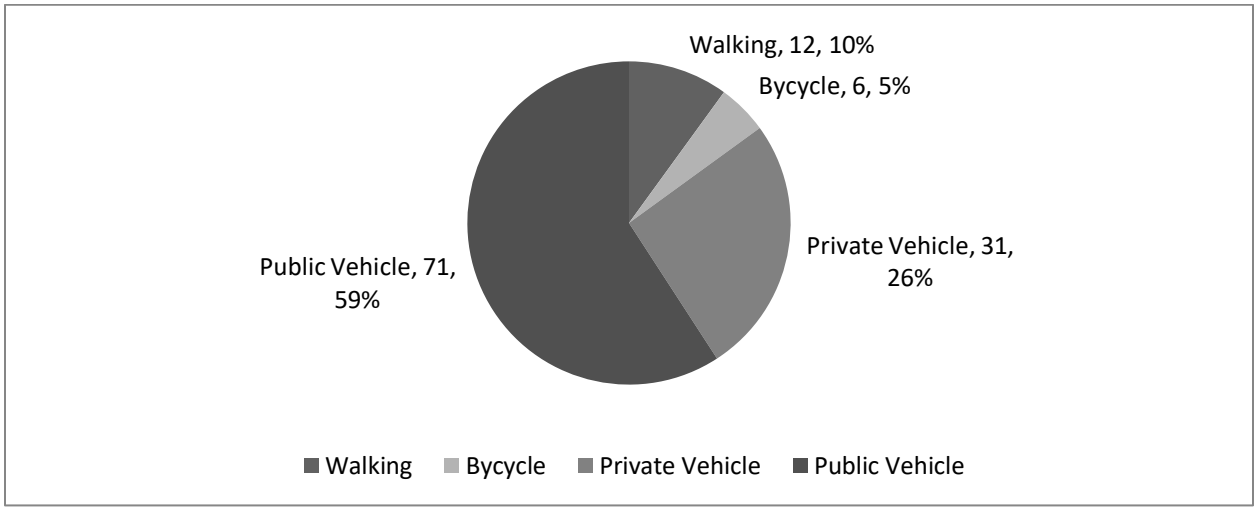


Figure 57 Pie chart showing means oftransportation

5.3.6 Frequency of visit

Since the frequency of visit of people is very random in our survey so, it is divided into two group namely first visit and more than once visit. 27% (33) people have visited the lake for the first time while 73% (87) people have visited the lake more than once. People visiting lake more than once

have visited lake only twice since construction to regular daily visit making dispersity very high. This makes classification of these people very difficult.

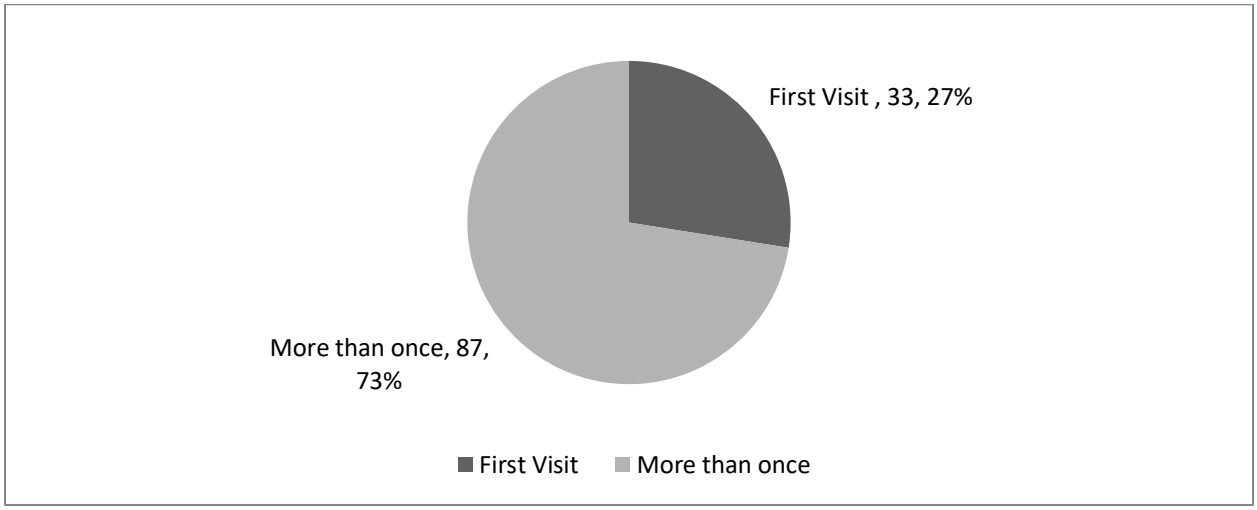


Figure 58 Pie chart showing frequency of visit

5.4 Questionnaire on people residing and visiting near lake area on weather

Lake can reduce the temperature of nearby area by few degrees Celsius. This reduce in temperature have been observed through different experiment performed by various researcher. People can also observe the difference in temperature. The observation of people about difference in temperature during summer and winter is obtained through the survey and analyzed.

5.4.1 Summer temperature difference

Shopkeeper

During summer, half of the shopkeeper, 10 (50%), stated that they feel cooler near lake area than other area. while 6 (30%) of them believed that the temperature difference near lake area and further distance is same, 4 (20%) believed that the area surrounding lake is warmer than other place.

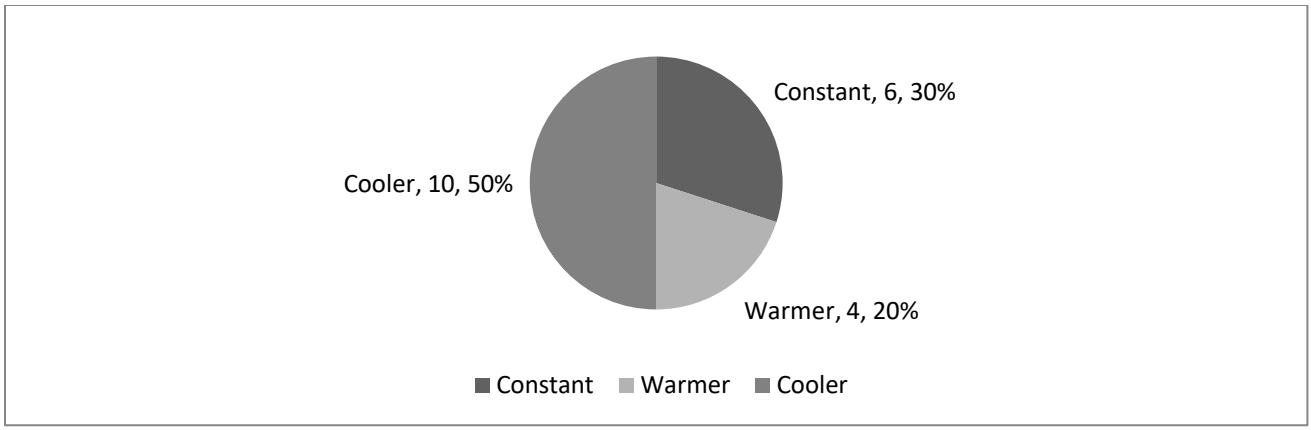


Figure 59 Pie chart showing summer temperature difference feeling by shopkeeper

Among 10 people who observed that lake area is cooler than other nearby area, 6 (60%) think that the change is little, 1 (10%) believe that the change is moderate and 3 (30%) believe that the change is very little.

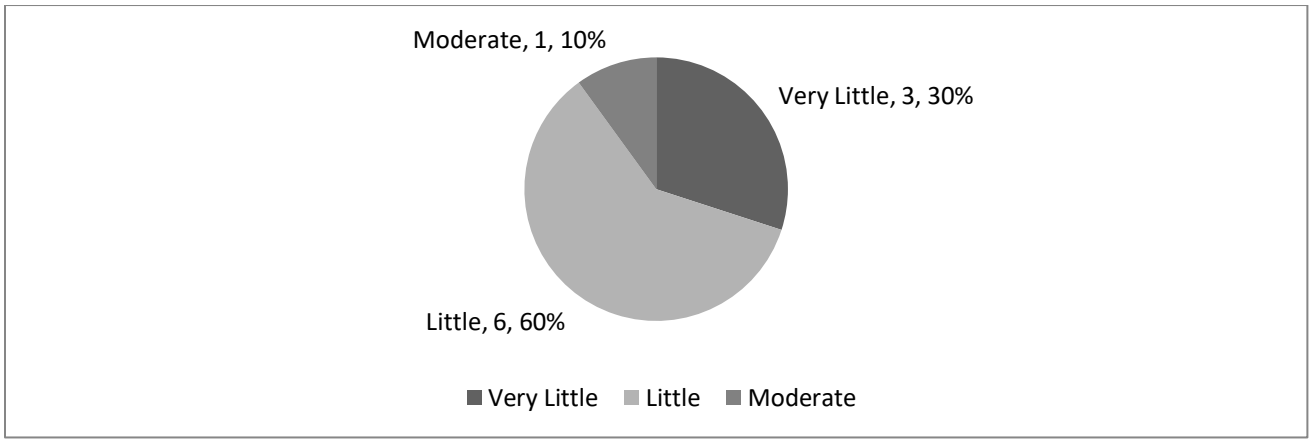


Figure 60 Pie chart showing intensity of coolness in summer

Visitors

Since the survey was conducted in summer season, visitors of the lake can be asked the same question on how they feel near lake area. Majority 106 (88%) felt that the lake area feels more cooler than other area. 11 (9%) believe that the temperature difference is constant between other area and lake area. 3 (3%) thought that the lake area is warm than other nearby residing area.

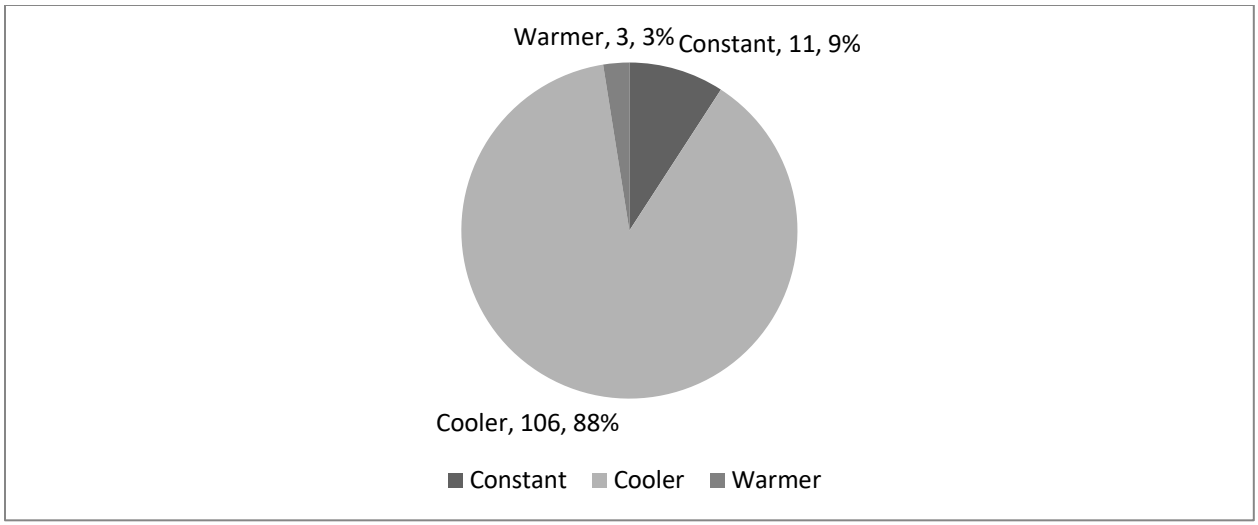


Figure 61 Pie chart showing summer temperature difference feeling by visitors

5.4.2 Winter temperature difference

Since, shopkeepers have only been there for more than year so the change in temperature for winter was surveyed with shopkeeper. 45% which is 9 out of 20 believed that the winter is warm near lake. The same percentage believed that the lake area is colder in winter. 10% which is 2 of 20 believed that there is no change in temperature difference in winter near lake area and other area.

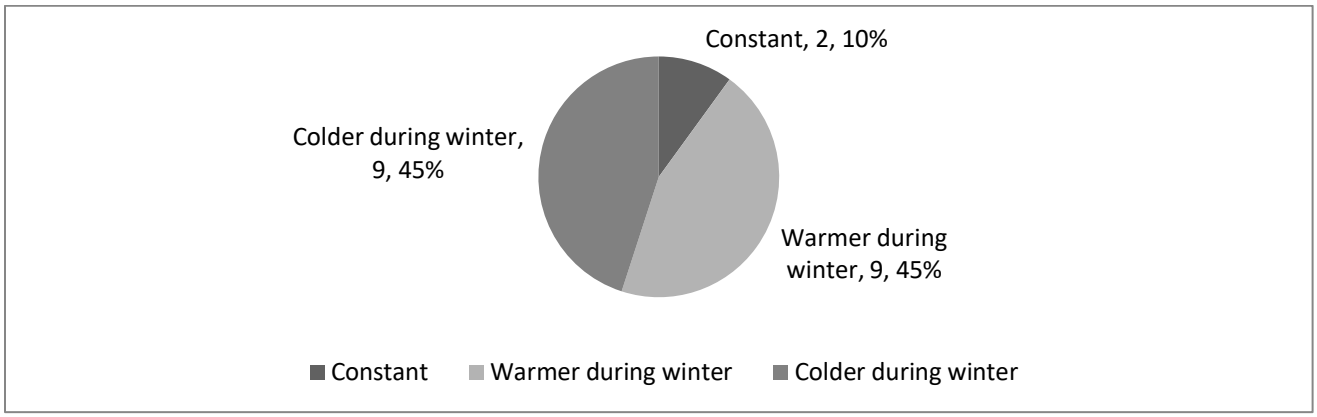


Figure 62 Pie chart showing winter temperature change feeling

Out of 9 people who believe that area near lake is warmer than other area, 5 (56%) believe that the change is little while 4 (44%) believe that the change is very little.

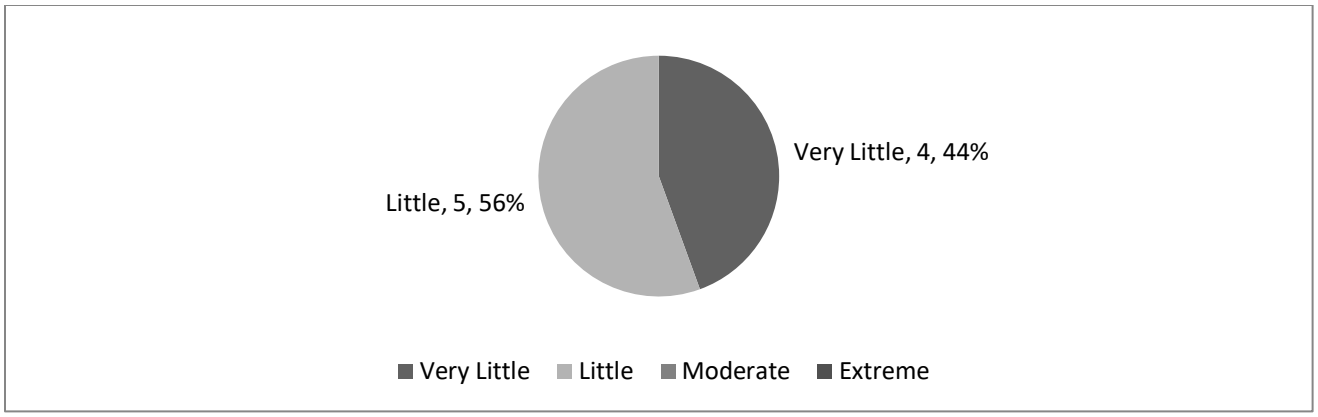


Figure 63 Pie chart showing intensity of warmness

5.4.3. Change in Wind

Lake has the ability to make the near surrounding area windier as compare to far area. This is because the friction between water and air is less then the friction between land and air. Thus, when air first strike land from water, is velocity is much greater. So, to understand whether people have been observing the same phenomenon or not, this survey on wind was conducted.

Shopkeeper

Since, shopkeepers and vendors have been staying in around the lake for longer period of time: this survey was done on them. While asking this question, 80%responded that the area have been windier than before when there was no lake. 10% believed that it was constant or less windy then earlier.

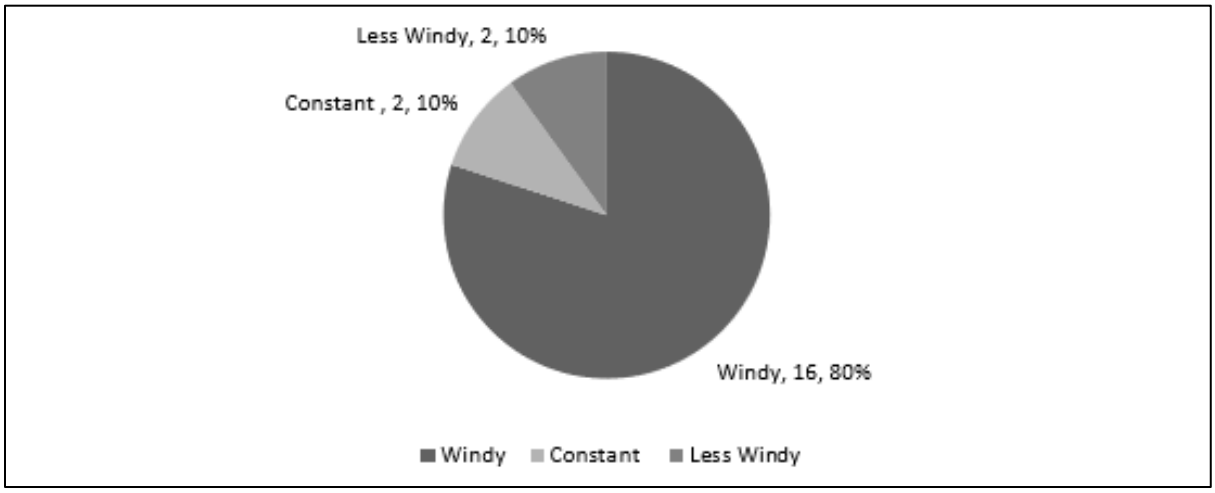


Figure 64 Pie Chart showing wind nature

On among those 80% believing it to be windy, when further asked about the intensity of wind, 38% thought that it was little windy while 31% believed that it was extreme windy as compared to past.

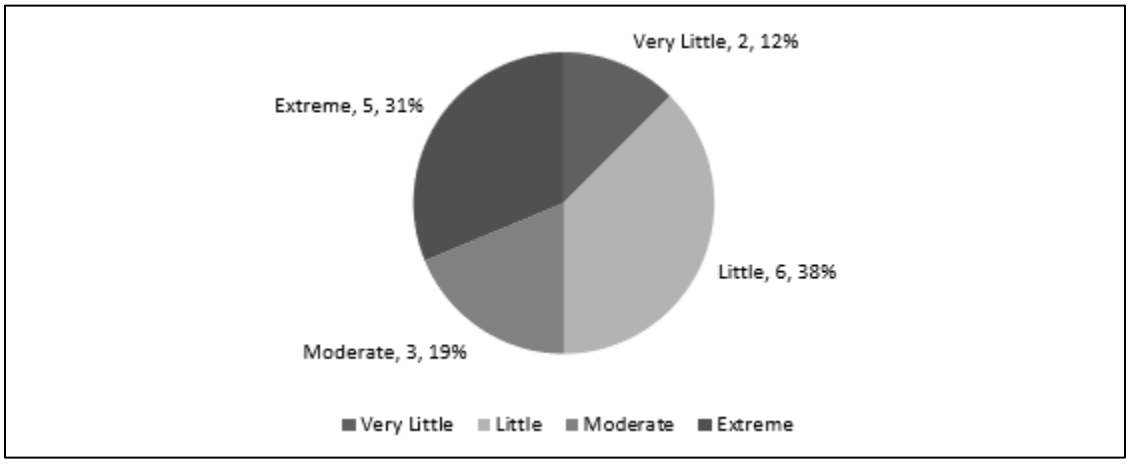


Figure 65 Pie Chart showing intensity of wind

Visitors

Since, visitors were also observed in around the lake: question about their perception on wind was asked to better verify the nature of lake. It was found that 97% believed that the area around lake is windy then other area from where they belong.

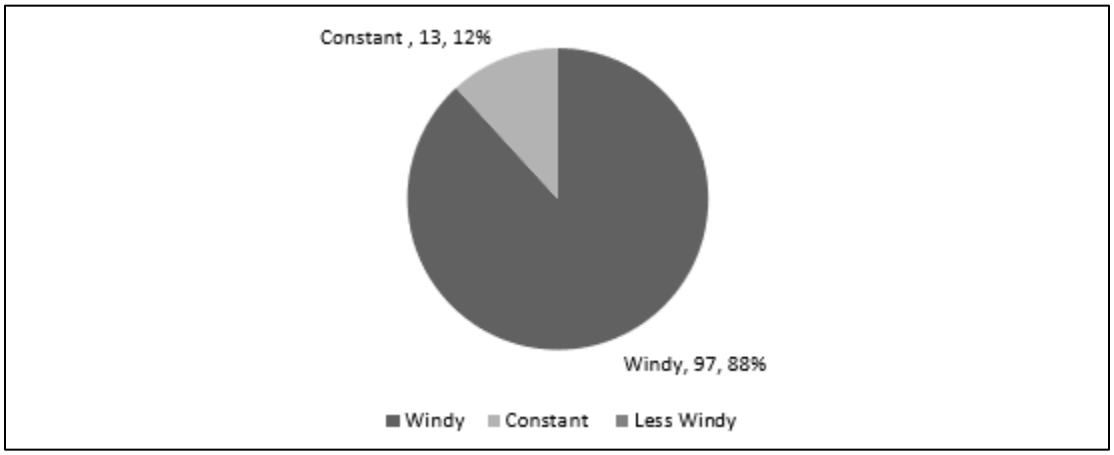


Figure 66 Pie chart showing nature of wind

On further asking those 97% about the intensity of wind, it was found that 43% perceived that the wind was little windy then other area, 23% found it to be extreme windy, 22% moderate and 16% very little.

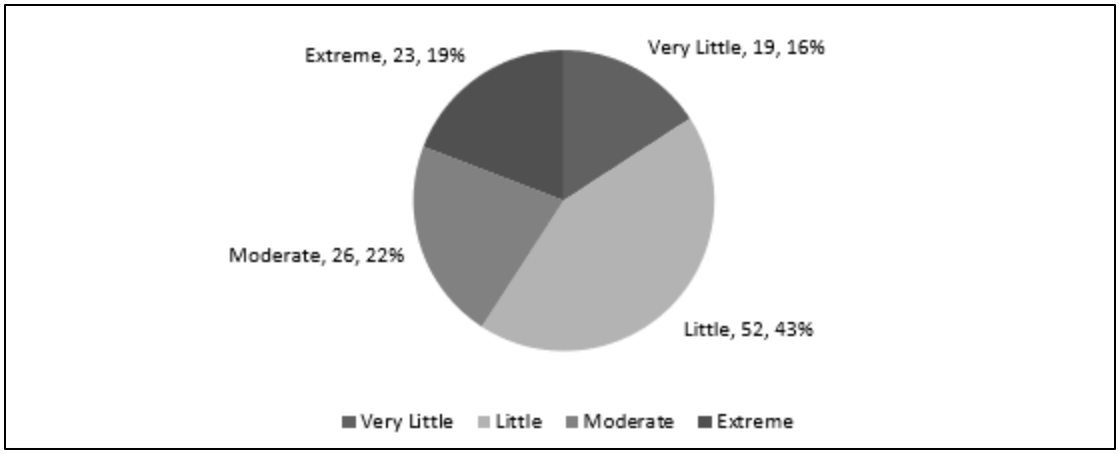


Figure 67 Pie chart showing intensity of wind

5.5 Economic activities

Money spent by visitors during visit to the lake area and money earned by shopkeeper are crucial to determine the economic generated by the lake.

5.5.1 Money spent by visitors

During visit to the lake, visitors mostly tend to use 500-1000. 30 (25%) visitors spend around 500-1000. 22% (27) spent less than 500, 20% (24) spent 1000-1500, 18% (21) spent greater than 2000 and 15% (18) spent 1500-2000.

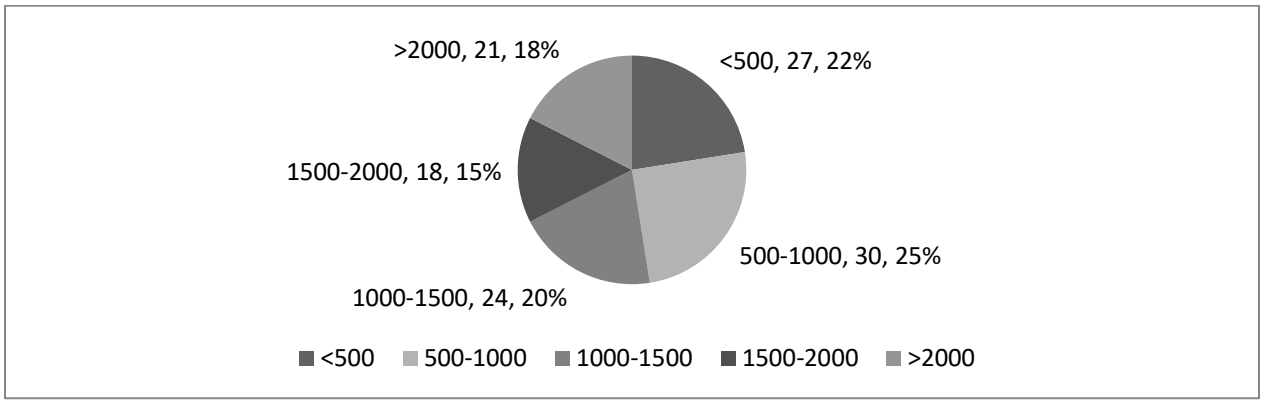


Figure 68 Pie chart showing money spent by visitors

5.5.2 Money earned by shopkeeper

On a daily basis, shopkeepers around the lake earn 1000-1500 which is 35% (7) of total number of surveyors. 20% (4) earn 1500-200 and same percentage earn below 1000. 5 (25%) earn more than 2000 in a day.

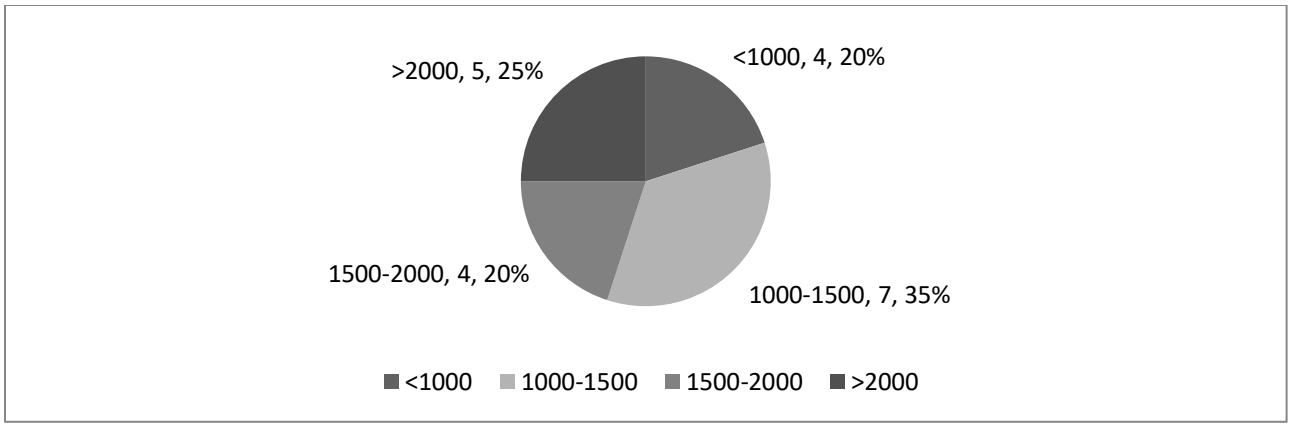


Figure 69 Pie chart showing money earned by shopkeeper

5.6 Analysis of Buffer zone

As per the building code of our country Nepal, the setback for construction of structure shall be 50m from boundary of lake and 10m from boundary of canal. A canal is used to provide water to lake continuously. Therefore, a 50m buffer around the lake and 10m buffer from canal edge was constructed using QGIS. Buffer is a component of geoprocessing tool for vector data analysis which help to create a layer of polygon around a feature at fixed given distance.

Figure 70 Buffer zone of 50m around the lake

This setback around lake is constructed to ensure protection of lake from unhealthy human activities as pollution. Similarly, setback along canal is made to ensure that the water of canal remains unpolluted which further make water of lake less polluted. But the rule is being violated along the canal as well as around the lake. Numbers of houses are constructed along the buffer or setback area. In around lake shops have been constructed to enhance economic activities but these shops shall be kept away from setback to promote lake health. Not only person but also government is not properly observing where constructions are being done. Government is allowing people to construct along and inside the buffer zone. These problems may seem small now but they may lead to serious problem future such as pollution and destruction of lake habitats.

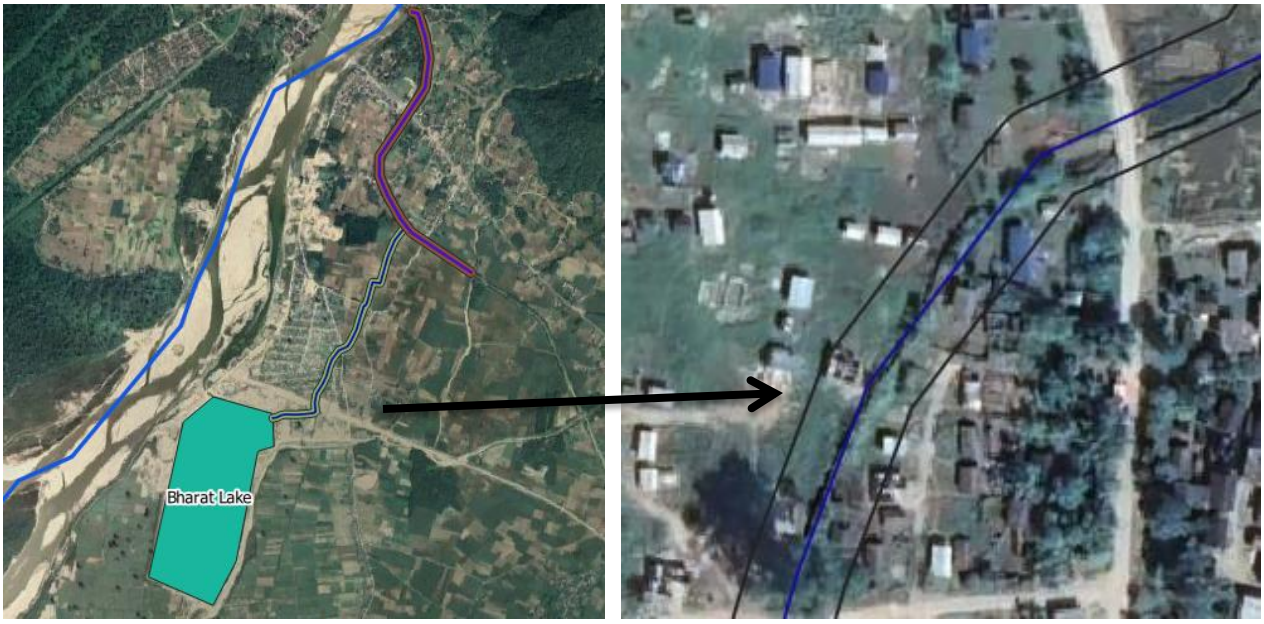


Figure 71 Buffer zone of 10m along the canal

5.7. New Development Work

5.7.1 Construction and Maintenance of road

After the construction of the lake, 3 road have been upgraded by widening and black topping. The road along the river, called as Dam side road, was a gravel road which have been reconstructed and black topped. The road passing through the edge of settlement was a pedestrian road which is widened and black topped. The road east of the settlement have been widen and under construction for black topping. These all roads have been developed as a result of this new lake construction. On questioning the authority about further development of lake roads, they suggested that as the development of lake takes place, new roads to connect lake to highway and settlement will be constructed.

Figure 72 Road network widen and maintained

5.7.2. Future new development Projects

After the construction of lake, a new wave of development has been started. A new mini open zoo construction project has been started at the Nursery (90 bigha) where at present mango and tree to provide food for zoo animals like Churi, Amala, Lapsi, Tooth, 1Kimbu have bben planted. This lies just south of lake which will promote tourism and increase their stay at the municipality. A small wetland project due south of lake has been initiated and will use lake water. An open picnic spot and closed seminar hall is also under construction. Similarly, while coming to the lake on the bank of river, a project to make Ghat is being started. This will help visitor to walk from main highway to the lake and understand the culture of Nepalese community.

Figure 73 Bhagmati Ghat purposed plan

On ward 11, a funpark called Buddha Park along with a hiking route is under construction. The vision of the ward is that a tourist will visit Bharat Lake, observe zoo and wetland, go to funpark where there are hotels fornight stay and during morning they can hike on the hiking route and complete their journey. All these project concept have been started after the formal construction of lake.

Figure 74 Bagmati Fun Park

Apart from these, new hotels and restaurants are expected to be constructed soon along the road connecting lake. All these development works are a outcome of one artificial lake project.

5.7.3. Land Price Speculation

As per the KII and interview conducted among local people, it was found that people are more interested in buying land around the lake area. As a result of this, the price of land has been increasing around lake area at present. KII informant suggested that the land price have been around double after construction of lake and is still rising and the land around the lake a valuable asset. At present, people are not interested in selling their land because they believe that the price of land will further increase. So, because of this reason, the number of land transaction has been very few in these year around the surrounding. This is another reason why there have been less houses constructed around the lake.

5.8. Enhancement of Ground Water Table

Depending upon the position of lake, lake can either take water from groundwater along with surface runoff and precipitation or can provide water for groundwater downstream. The construction of the Bharat Lake has helped in enhancement of ground water table. Ranjit Misra and Sugan Badal, Sub-Engineers, KII suggested that the Bharat Lake have increased the ground water table downstream of lake to area such as Rajghat, Soltee to up to Bharatwa (which is around 10km south of lake). Bhagwat Mahato, Ward-4 Secretary, also suggested that the groundwater table have increased after the construction of lake which further strengthen their remarks.

Figure 75 Picture showing Groundwater table increased area

Chapter 6: Conclusion and Discussion

The research found out that the development of artificial lake i.e Bharat Lake have helped in development of the municipality as well as for enhancing the environment around the area. The survey showed that 88% visitors and 50% shopkeeper believe that lake construction has made the area cooler during summer than previous. Similarly, 45% shopkeeper suggested that winter is warmer near the area after construction of lake. Also, the wind intensity is high around the lake as suggested by surveyors. All these change in climate have helped in enhancement of environment. The populations of municipality have been economically benefited from lake as they have been able to work around the lake and earn their living. But as the numbers of visitors have been increasing, there have been increase in pollution around the area. So, proper plans and management shall be effectively implemented for preserving lake for future. Similarly, as the lake is located near river flood plain, proper flood management plan shall be prepared in case of flooding. In our country, new towns are being developed. These places need to attract new population for further development. For attracting new population, the town requires economic activities and development of locality. Economic activities and development around the locality can be generated with construction of artificial lake similar to Bharat Lake. Hence, if any place needs to attract new settlement, then Bharat Lake can be used as reference to these upcoming new town to attract new population.

Chapter 7: Recommendation

7.1. Recommendation for lake improvement

7.1.1. Site Specific

- Encouraging and facilitating a variety of recreational and physical uses, such as jogging trails, fitness centers, cycling routes, fishing, paddle boating, restaurants that serve prepared food, gift shops, pottery shops, etc., in order to boost user activity.
- Create a more gracefully curved lakeshore by keeping the scene at a small scale
- Construct a continuous path for bicyclists and pedestrians. To improve the walking track, the necessary infrastructure facilities should be included, such as benches, drinking water fountains, public restrooms, small exercise areas, trash cans, light posts, and restrooms at each alternate location.
- The water channel supplying water to the lake and outlet taking water away should be maintained and enhanced via a variety of channels, and no construction plan should obstruct this continuity.
- Fixing the lake boundary requires defining and demarcating the lake area. It is imperative that developments do not jeopardize the privacy, safety, or security of the local people by extending public activity facilities into the most distant and intimate areas of the neighborhood.
- The lakeshore landscaping should incorporate greenery to create a suitable setback from the road and the residential plot boundary. Planting the right kind of trees can provide noise and pollution screening. An appropriate drainage system for surface runoffs should be a top priority when designing landscape items. Upkeep and Administration
- Adhere strictly to the rules and legislation to stop the encroachment of the lake.
- Excavate sludge from the waterbed to increase the capacity to hold water.
- Prevent the direct disposal of trash into the lake to enhance the quality of the water. It is necessary to raise the amount of dissolved oxygen in the water by mechanical, chemical, and biological methods.
- Several government departments must be involved in lake management, and since there is frequently a lack of coordination between these organizations, an integrated high power management system is required.

7.1.2. National wise

Restoration of the Ecosystem:

Create and preserve vegetative buffer zones around lakes to lessen pollution, fertilizer runoff, and sedimentation. Planting native plants may be one way to do this.

Wetland Protection:

Preserve and replenish wetlands, as they are essential to preserving water quality and fostering biodiversity.

Management of Water Quality:

Monitoring Systems: To locate and eliminate sources of pollution, conduct routine monitoring procedures for water quality.

Wastewater Treatment: To avoid contaminating lake water, develop and deploy efficient wastewater treatment systems for businesses and urban areas.

Participation in the Community:

Public Awareness: Encourage sustainable practices and educate the local community on the value of lake ecosystems.

Community-based Management: To guarantee long-term sustainability, include nearby communities in lake management choices and operations.

Conservation of Biodiversity:

Restoration of Habitat: To support a variety of plants and animals, restore and safeguard the natural ecosystems in and around the lakes.

Control of Invasive Species: Take action to manage and control invasive species that could endanger the ecosystem's biodiversity in lakes.

Development of Infrastructure:

Boat limits: To reduce disruption to the lake habitat, establish and enforce boat usage limits.

Infrastructure along the shore: To lessen the effects of human activity, develop infrastructure such as trash disposal sites, environmentally friendly tourist destinations, and recreational spaces.

Governance and Policy:

Integrated Management Plans: Create thorough plans for the ecological, social, and economic elements of lake management.

Enforcement of Regulations: Make sure that the laws currently in place pertaining to lake management and environmental preservation are strictly enforced.

Resilience to Climate Change:

Adaptation to Climate Change: Take into account how climate change can affect lakes and put resilience-boosting measures in place, like watershed management and adaptation plans.

Research, Studies and Information:

Encourage research projects in order to gain a deeper understanding of the ecosystems, dynamics, and variables influencing the health of lakes.

Establish procedures for disseminating study findings and data to pertinent parties.

Global Cooperation:

Cooperation with NGOs and International Organizations: To obtain knowledge, resources, and backing for programs aimed at improving lakes, pursue cooperation with non-governmental organizations (NGOs) and international organizations.

7.2. Recommendation for planning and establishment of buffer zones

During preparation of buffer zone, following points should be considered:

Hydrology and soils

During planning of buffer zone, the first and foremost concern should be to understand the hydrology and soils of the site. If the location is a first- or second-order (small) stream, one must deal with groundwater and overland storm flow lateral flows. The stream bank and locations where the water table is close to the surface must be included in the buffer's location. For larger stream, one must also prepare for interactions with waters that overflow out of the channel during storms. Similarly, people consider that if plant is planted in soil, the soil take care of the plant and grows on its own which may be true to some extent. But for proper growth of plant in riparian area, attention for soil is a must.

Placement and zoning of vegetation in buffer zones

For a lake or river, a buffer should be constructed one along its boundary and the other along the boundary of the tributary contributing to the lake or river. Further, if possible, the buffer shall be divided into three zones. The first zone consists of native trees in narrow area and these trees shall never be logged. The second zone shall lie just next to the first zone with wider area and native trees planted with possibility of cutting tree if necessary for income generation. The third zone shall be next to the first zones and shall contain grass or similar status and property plant. Each zone has different purpose. The first zone protect bank and provide stability. The second zone helps to treat groundwater by removing nitrates and acidity while the last zone helps to trap suspended material, sediment and dissolved nutrients.

Exotic plants

Riparian buffers are occasionally invaded by foreign species, even in the absence of human activity, which compromises the buffer's ability to function properly. So in such cases, these plants shall be removed during their early stage of growth.

Problems with herbivores

There are two types of herbivores, domestic and wild animals, destroying the buffer zone. Hence, for this management, fencing shall be done as well as awareness to farmer grazing their domestic animals on importance of buffer shall be provided. (Correll, 2005)

Also, another way of providing buffer is by surrounding the settlement near the lake by buffer zone. This method is also effective. If we are able to provide this kind of buffer in settlement and other buffer in around the lake then the lake may be protected even more. A example of such buffer is shown below which is extracted from riparianresources, is a buffer between lake and settlement of Boreal Forest Region. The settlement near the Bharat Lake is similar to this forest region. Hence, the same method can be used to protect the lake.

Figure 76 Example of one method of buffer zone

7.3 Recommendation for Construction Procedure of an Artificial Lake

These few steps shall be taken while preparing an artificial lake.

Feasibility study

Site Selection

Design and Engineering

Obtain permits and approvals

Excavation and earthworks

Lining and Sealing

Water Sources and Filling

Infrastructure and safety measures

Monitoring and Maintenance

Recreational and Landscaping

7.4. Recommendation for choosing Location of an Artificial Lake

Similarly, Location of lake depends on various factors. Some important points that would help to determine an ideal location for new artificial lake construction area as:

Geography and Topography

Hydrology

Environmental Impact

Climate

Land use and Ownership

Infrastructure and Accessibility

Safety and Risk Assessment

Water Quality

Regulatory and Legal Compliance

Community and Stakeholder Investment

In the end, a thorough feasibility study and careful evaluation of these variables will determine the ideal location for an artificial lake. To make well-informed decisions, it is advisable to confer with specialists in environmental science, engineering, hydrology, and geology.

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- What is Freshwater and Where is it Found? (worldwildlife.org)

ANNEX

ANNEX-I: - Survey Interview

Personal Information

Name of Informant				
Age				
Sex				
Household Number				
Household type	Rent		Owned	
Ethnicity/Religion				
Number of family member				
Date of house constructed				
Origin/Ancestors				
Place from where they migrated				
Marital Status	Married		Unmarried	
House use	Residential		Commercial	Other
Number of rooms rented	1-2	2-4	4-6	6-8

Section 1: Environmental Changes

Have you noticed any change in the temperature difference since the construction of the lake? (Yes/No)

In your opinion, is the winter temperature warmer than before due to the lake construction? (Yes/No)

How would you describe the magnitude of the temperature difference you have observed? (Very little/Little/Moderate/Extreme)

Do you feel that the summer temperature is cooler than before because of the lake? (Yes/No)

How much of a difference in summer temperature have you noticed? (Very little/Little/Moderate/Extreme)

Have you experienced an increase in wind blowing in the area after the lake construction? (Yes/No)

How significant is the increase in wind, in your opinion? (Very little/Little/Moderate/Extreme)

Do you feel that there has been a change in the rainfall pattern since the lake was constructed? (Yes/No)

During summer, do you think there has been more or less rainfall due to the lake construction? (More/Less)

If there has been less rainfall, how much less have you observed? (Very little/Little/Moderate/Extreme)

Conversely, during winter, do you believe there has been more or less rainfall due to the lake construction? (More/Less)

If there has been more rainfall, how much more have you observed? (Very little/Little/Moderate/Extreme)

Section 2: Perception of the Lake's Impact

Do you feel that the lake has improved the overall environment of the area? (Yes/No)

How would you rate the environment around the lake? (Bad/Moderate/Good/Very Good)

Do you prefer residing in your present location with the lake or in your previous location? (Present Location/Previous Location)

If you prefer your present location, what is the primary reason for your preference? (Because of the lake environment/Because of other factors: please specify)

What do you believe the lake can do? Can it cause disasters or help prevent them? (Cause/Prevent)

If the lake helps prevent disasters, what type of disaster(s) do you think it prevents? (Please specify)

Section 3: Disaster Preparedness and Pollution

19. Have you received any training for disaster preparedness? (Yes/No)

20. If no, are you interested in taking training for disaster preparedness? (Yes/No)

21. Do you know about the evacuation route in case of any disaster? (Yes/No)

22. Do you feel that pollution has increased around the lake compared to the past? (Yes/No)

23. If yes, what do you believe are the primary causes of pollution around the lake? (Increased tourists/Lack of management/Community people throwing waste/All of the above)

24. Do you feel that pollution has also increased around the surrounding community? (Yes/No)

25. If yes, what do you think are the primary causes of pollution in the surrounding community? (Please specify)

Section 4: Socio-Economic Impact

26. Does any member of your family work in a job related to the lake? (Yes/No)

27. If yes, please describe the job that various members of your family do in relation to the lake: _____

28. What is your overall family income? (Below 50000/50k-100k/>100k)

29. Do you feel that the lake has improved the economic condition of the community? (Yes/No)

30. Has the presence of the lake deprived or reduced the chance of business for those who used to operate near the lake area? (Yes/No)

31. In your opinion, has the area become more expensive than before due to the lake's presence? (Yes/No)

32. If yes, how would you describe the level of expense in the area now? (Very little/Little/Moderate/Extreme)

33. Have you noticed an increase in the employment rate in the community since the lake was constructed? (Yes/No)

34. Do you feel that the lake has created new job opportunities for the local residents? (Yes/No)

35. How do you perceive the overall impact of the lake on the community's financial situation? (Positive/Negative/No significant impact)

36. Are there any concerns you have regarding the lake's impact on the local economy? (Please specify) _____

37. In your opinion, has the ecological condition of the lake influenced tourism and recreation in the area positively? (Yes/No)

38. If yes, how has tourism and recreation improved in the area due to the lake's presence? (Please specify) _____

Public Perception and Involvement in Lake

Do you visit the lake frequently? (Yes/No)

If yes, at what time of day do you usually visit the lake? (Morning/Afternoon/Evening)

Do you believe that the lake should be visited regularly? (Yes/No)

How often do you visit the lake in a month? (Once a week/Multiple times a week/Once a month/Less than once a month)

How much do you typically spend while visiting the lake? (Below 500/500-1000/>1000)

What activities do you usually engage in when visiting the lake? (Boating, fishing, picnicking, walking, etc.)

Considering the presence of the lake, do you prefer this area with the lake or without the lake? (With lake/Without lake)

How has the lake influenced your perception of this area as a recreational spot or living location? (Positive impact/No impact/Negative impact)

How willing are you to actively participate in conserving the lake? (Not at all/Willing to participate in a conservation program/Willing to donate money instead of time)

Are you currently involved in any lake conservation initiatives or programs? (Yes/No)

If yes, please specify your involvement or the organization you are associated with.

Would you be willing to pay a certain amount of money for lake protection and preservation? (Yes/No)

If no, what are your reasons for not paying money for lake conservation? (Please select all that apply or specify your reason)

Are you aware of any existing lake conservation projects in the area? (Yes/No)

If yes, how effective do you think these projects are in preserving and protecting the lake? (Highly effective/Moderately effective/Not effective)

How do you believe the community and local authorities can work together to ensure the lake's long-term conservation and environmental sustainability?

Do you think the government or local authorities are doing enough to protect the lake and its surroundings? (Yes/No)

Would you support the implementation of stricter regulations for activities around the lake to preserve its ecological balance? (Yes/No)

What specific measures would you like to see implemented to enhance lake conservation and sustainable use?

Extra Questions for Shopkeeper

How much do you earn per day on average?

How much have you earned maximum on a day?

How much should you pay municipality for staying in the stall?

Is this income enough for your survival?

ANNEX-II: - Key Informant interview

KII No.1

Name:- Ranjit Misra

Position:-Sub-Engineer, Bagmati Municipality

Can you please describe the about the land used for the construction of this Artificial Lake?

Well, during that time, the land was completely barren and no one used to live around there. Few wild animals used to roam sometime near the area. Old Bagmati used to flow through this land at past. But eventually, the river dried and was completely barren.

Was the land government land?

No, the land belonged to Sagarnath Jungle Pariyojana. With consultation and meeting with Forest Pariyojana by municipality, this land was used for construction.

Can you please describe about the chronological development of lake?

Initially, this project was purposed during first tenure of Mayor Bharat Thapa. First, this project was designed to make a fish pond to promote fishery in the municipality. But, after further discussion with different member of municipality, it was suggested that instead of fishery pond, his pond should be recreational pond to attract tourist and enhance economy of the area. So, still the official name of this pond is Bagmati Fishery Pond. The pond was started to be constructed in an area of about 50 bigghas but was increased to around 100 bigghas. There are two lakes with around 50 bigghas each and one lake ahs been completed and the other is still under construction.

What are the facilities, recreational activities available in around lake?

Well, there are shop stall for buying gifts and fast food as well as restaurants stalls. The most popular activities in around lake are Boat riding. The boats were non motor boat at past but with increase in popularity, small motor boats were introduced. Further, a big boat “Streamer” was introduced lately. There are activities like Horse riding, Camel riding, Photographer to take photo etc. Also, in the center of lake there is a hotel under construction which can further attract tourist.

How is water provided in the lake?

During the first supply of water to the lake, water has been provided by creating dam on Bagmati river on north-east side. After that water have been continuously supplied though irrigation canal of Bagmati Irrigation Project.

Is there outlet for water around the lake?

Yes, there is outlet on south side of lake and is connected to downstream of river.

Who and how was the soil obtained during construction of lake used?

The soil obtained was used by municipality for some construction around the municipality and remaining was sold by conducting tender.

How much benefit has the lake provided to municipality? Can you please explain economic as well as development influenced by lake?

Well first and foremost, the lake has been able to provide employment opportunity to number of people of the municipality. They have been able to earn money and make their living. Similarly, the municipality have been benefited by earning tax from the earning making lake as the source of income for the municipality. Furthermore, numerous roads have been constructed connecting highway to the lake. Similarly, the cost of the land around the lake area have been rising. So, people have been avoiding selling land at these days. Few constructions of houses have been constructed along the road surrounding the lake. These development on economics as well as development of houses will be more rapid after complete completion of lake.

Are there any other benefits brought on by the lake?

Well, apart from these development dynamics, there have been increase in water table on downstream or south side of the lake. The water level has found to be increased in around area such as Rajghat, Soltee to up to Bharatwa (which is around 10km south of lake).

KII No.2

Name:- Bhagwan Mahatho

Position:-Ward Secretary, ward no-4

Do you feel that the development of Bharat Lake has helped in development of ward 4?

Yes, obviously the development of lake has helped in the development of the ward. But the development has not been as par ward 12, which has been more benefitted.

What are the developments that you have observed after the development of the lake for your ward?

Well, firstly few of our citizen have been working in different occupation generated by development of the lake. Secondly, the price of lands has been increasing. Finally, few roads have been constructed connecting toward the lake area. Also, I believe that after complete completion of the lake, the advantage obtained from lake may increase.

Has there been increase in ground water table in this ward after construction of the lake?

Yes, there has increase in ground water table in well after construction of lake.

KII No.3

Name:- Aaitye Bott

Position:-Ward Member, ward no-11

Can you please describe about the new lake that have been under construction in this municipality?

The lake that has been under construction in this municipality is Bagmati Machha Pokhari (Bagmati Fishery Pond). This lake is commonly known as Bharat Lake, which is named after the mayor of Bagmati Municipality, Bharat Thapa, during whose tenure this lake project was initiated. This lake is constructed in the land once used by Shuke Khola. Initially started with the purpose of constructing fishery pond, this lake was converted to touristic destination to enhance the income generation and produce employment opportunity.

Has the development of the lake has helped your ward?

Well, after the development of this lake, a new fun park is started in this ward 11. This construction is directly related with lake as the aim of this park is to increase the stay of tourist in this municipality after they come to visit lake. They can visit the park and stay for the night in the hotel constructed in the park.

Do you believe that this lake has helped in the development of this municipality?

Obviously, this lake has helped in the development of the municipality. This lake has helped in economic development of the municipality as well as provide employment opportunity to number of citizens of the municipality. Also the ground water table have increased in around the area downstream such as Rajghat, Shankarpur etc.

KII No.4

Name:- Bimaya Bk

Position:-Ward Member, ward no-12

Can you please describe about the new lake under construction in Bagmati municipality?

The name of the lake is called Bagmati Fishary pond and it is in the process of construction. The first phase of the project is completed and the next phase is under progress. Under first phase, there has been construction of first lake and in second phase there is construction of next lake. This lake has provided the municipality with lots of advantages such as improving economy of the municipality, providing employment opportunity, development of physical infrastructure etc. Further, the development of this lake has enabled the construction of this community, Naya Basti, as people will be able to get employment opportunity and the settlement can self-sustain.

Can you further describe about this community?

This community was developed by municipality for providing shelter to landless people living scattered around the Sagarnath Forest and the development of lake has a huge influence on forming this settlement. Different trainings have been provided to the people of the community such as doll making, cloths sewing etc. These objects have been used for selling in shops around the lake. There was only one road joining this community to the main highway but after construction of the lake number of roads have been widen and maintenance and black topping are also in progress.

KII No.5

Name:- Sugal Badal

Position:-Sub-Engineer, Bagmati Municipality

Can you please describe about the new lake under construction and its chorologic development in Bagmati municipality?

The Bagmati river used to flow in this land once. But after the flooding of 2050, the Bagmati river changed its path leaving a small river flowing through the same area. The river dried and the land remain vacant. This vacant land belonged to Sagarnath Forest Conservation and after observing this vacant land an idea of creating a pond was introduced.

Initially, it was proposed for the development of Fishary pond but after realizing that a fishery pond cannot generate enough revenue and tourist attraction, a purpose to construct recreational pond was planned. The lake was supposed to be in 3 sections but after discussion it was recommended that the lake will be constructed in 2 sections as making 3 sections will make the lake look divided.

After concept was developed, construction started. In first phase, one lake is constructed. The lake was filled with water after creating dam. It took around 16-17 days for filling water and the water was seeped in 3 days. The process was repeated for 4 times and slowly the water started retaining in the pond. After 5^{th} time the water have been in hold for longer time period. Although large amount water is provided through the river creating dam, for daily use water is provided from canal. The construction of this whole project is supposed to be completed in coming 2 years.

With the construction of lake, there will be few other developments like open and closed picnic spots, a mini zoo, conference hall, fun parkin ward 11 etc. these all developments are connected with the development of lake.

Can you please describe about the economic and other benefits obtained after the development of lake to the municipality?

Well first and foremost, this lake has been able to provide employment opportunity to number of people of the municipality. The municipality has been able to collect revenue of around 15 lakhs per months which is also been utilized in making the lake more decorative. The revenue generated

from lake have to be distributed among province and municipality with province taking 40% of the revenue and municipality 60%. The number of visitors in lake have been increasing resulting in increase in shops and opening of other recreational activities. Similarly, with the development of lake, number of infrastructures have been developed such as roads, water supply, electricity etc. Similarly, the price of lands around the lake have been increasing.

KII No.6

Name:- Om Bahadur Shrestha

Position:-Ward Chairman ,Ward-12

Can you please describe about the development of the lake being constructed in this Bagmati Municipality?

As our municipality still is an agricultural supported municipality as many people are engaged in agriculture for supporting their family. But the income generated from agriculture is not enough to support a family. Also, number of youths in our municipality were unemployed. This all resulted in foreign employment making the municipality lacking youth. So, in order to create employment opportunity in the municipality and reduce foreign employment, a plan was necessary. Hence, the municipality with all ward chairman and other elected members stayed at a meeting and though number of plans. Among such plans, construction of fishery pond was one of them. But after further discussion, it was advised that the pond shall be created as a recreational pond.

What are developments taking place around the lake after construction of the lake?

Well, the roads have been developed after the construction of the lake. Also, people as well as municipality have been economically benefited from lake. The lake has made the whole municipality popular in the country as well as in foreign land. Numerous projects have been initiated after this lake was constructed such as fun park, picnic spots, hotels etc.

ANNEX-III: - Important Drawings and Figures of the Lake

Figure 77 Purposed site for lake

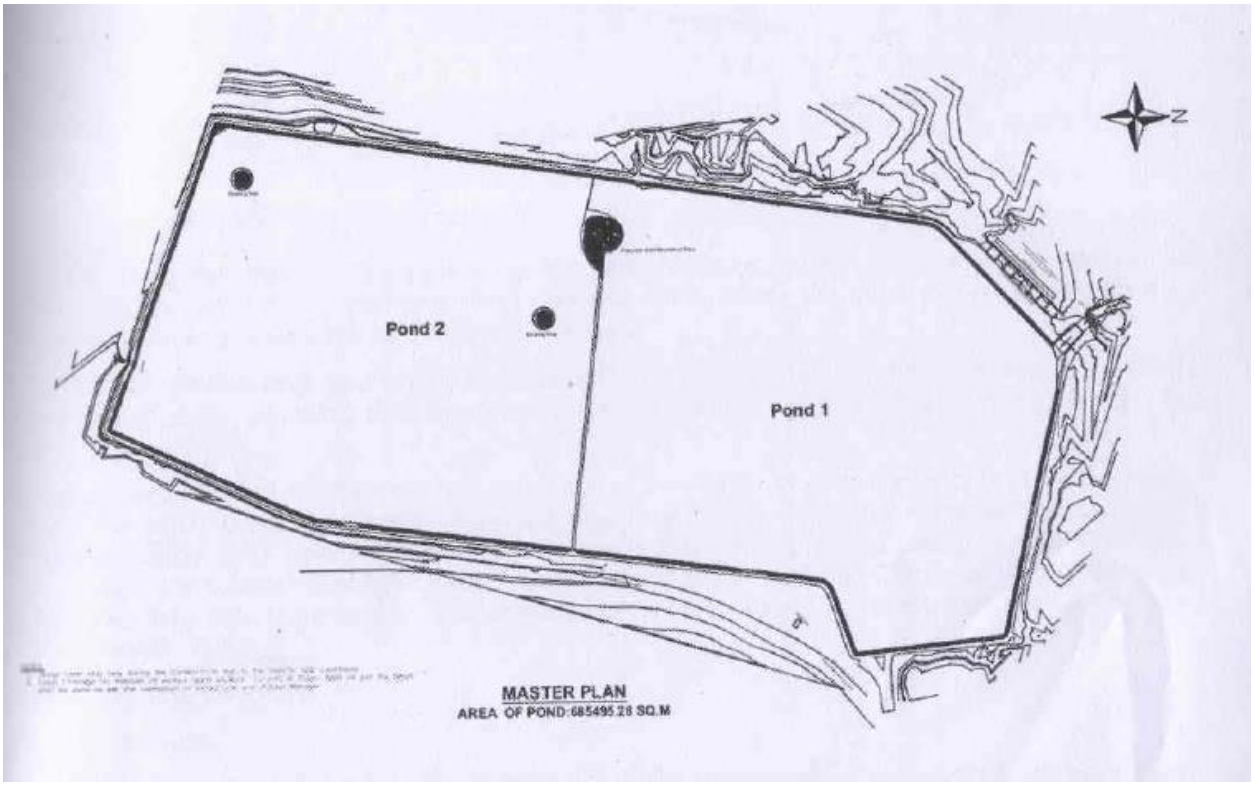

Figure 78 Master Plan

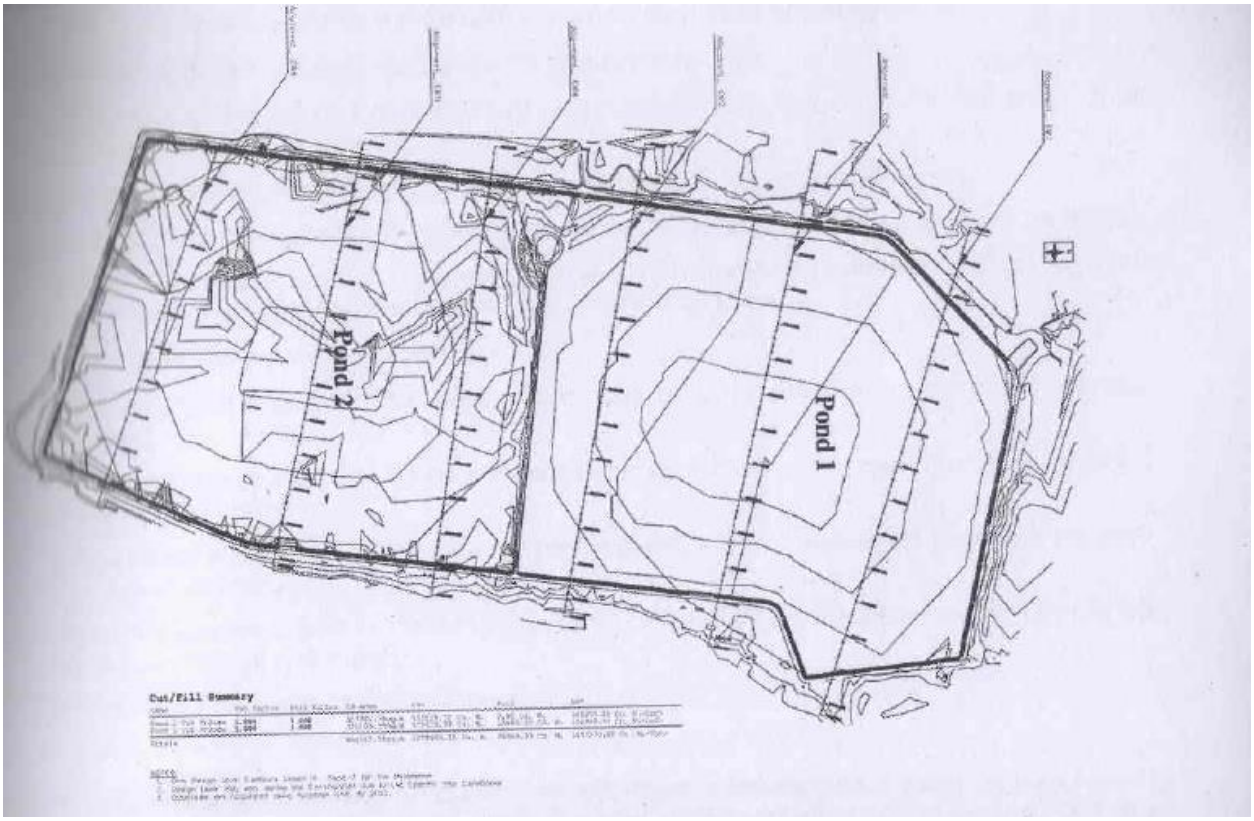

Figure 79 Contour and cut/fill summary

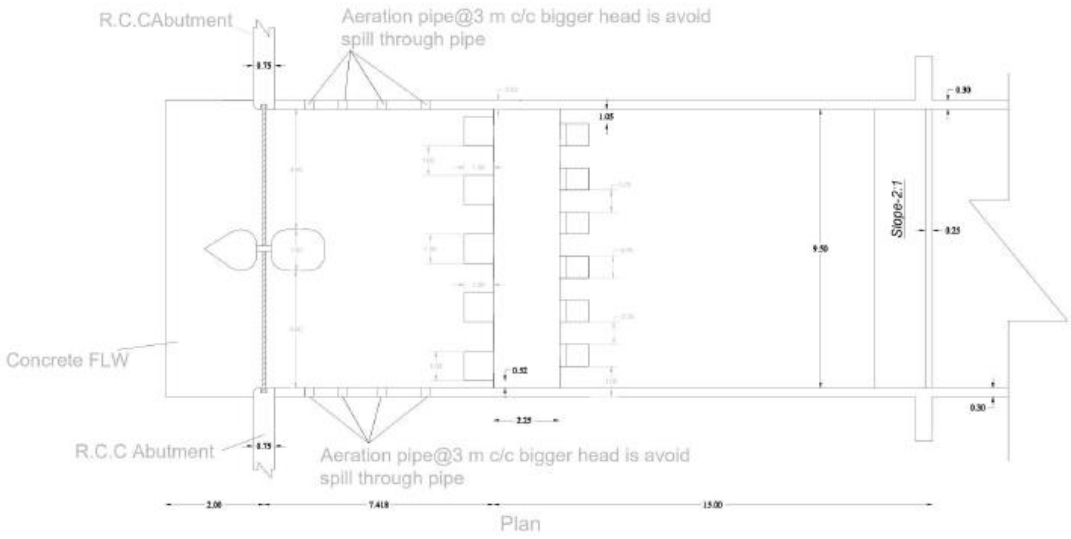

Figure 80 Plan of Inlet

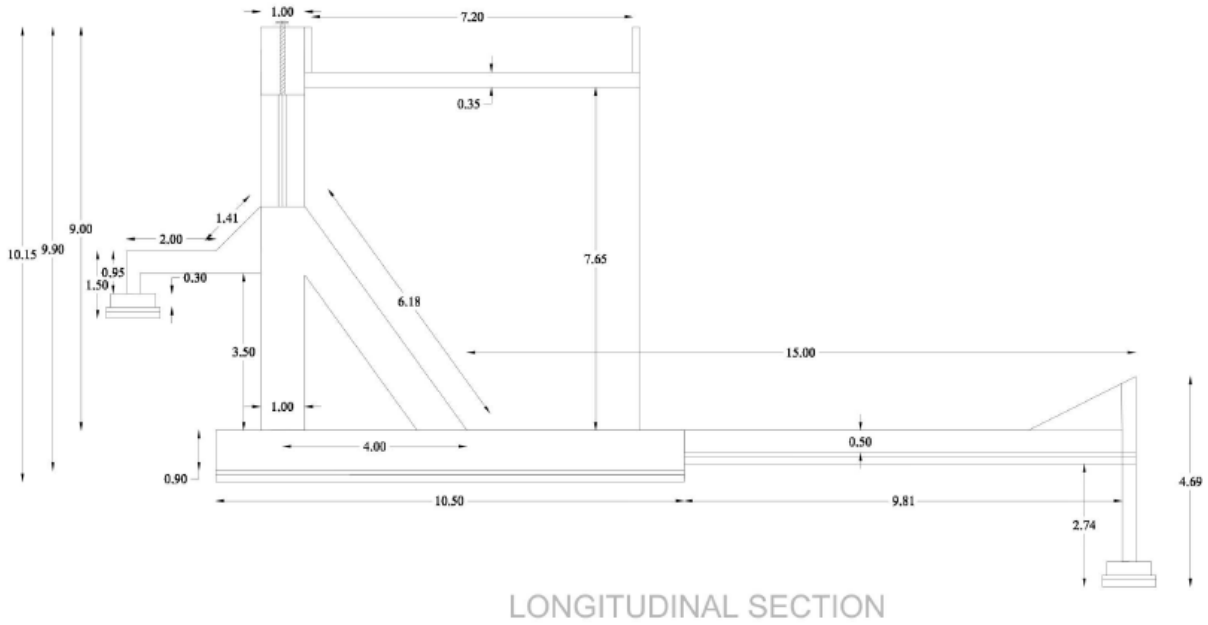

Figure 81 Section Of Inlet

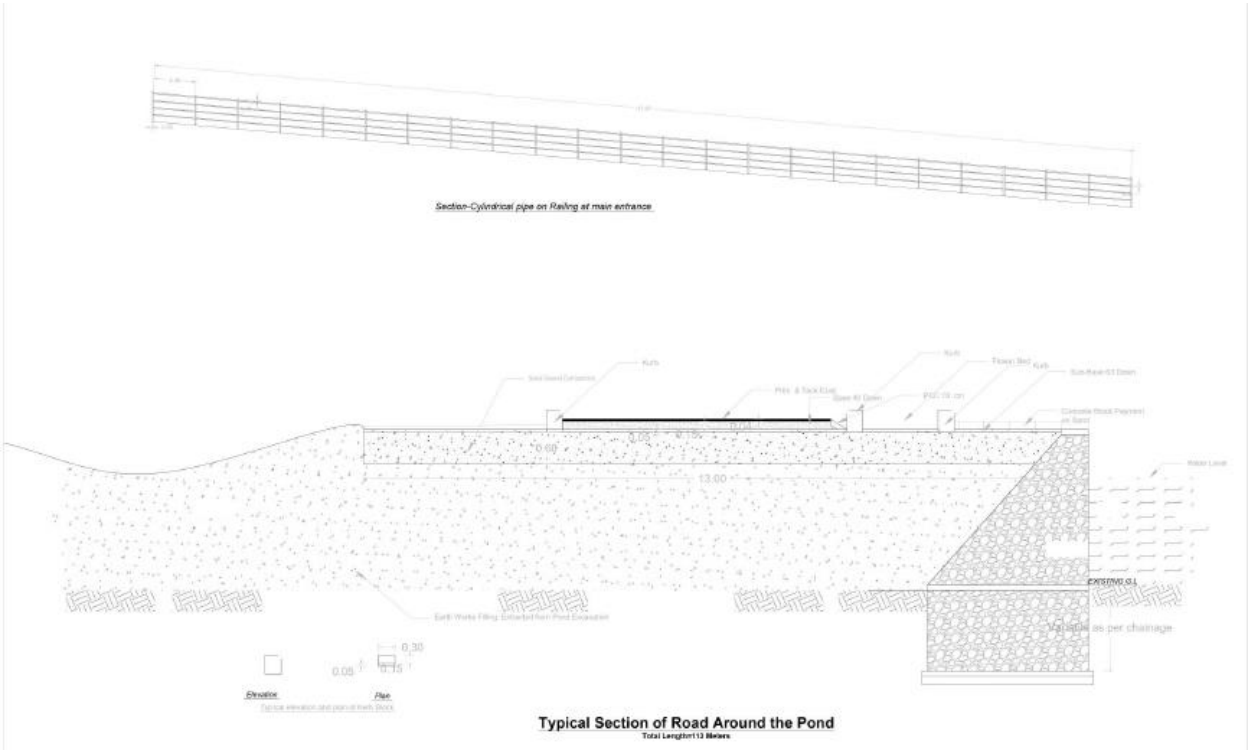

Figure 82 Typical Section of Road

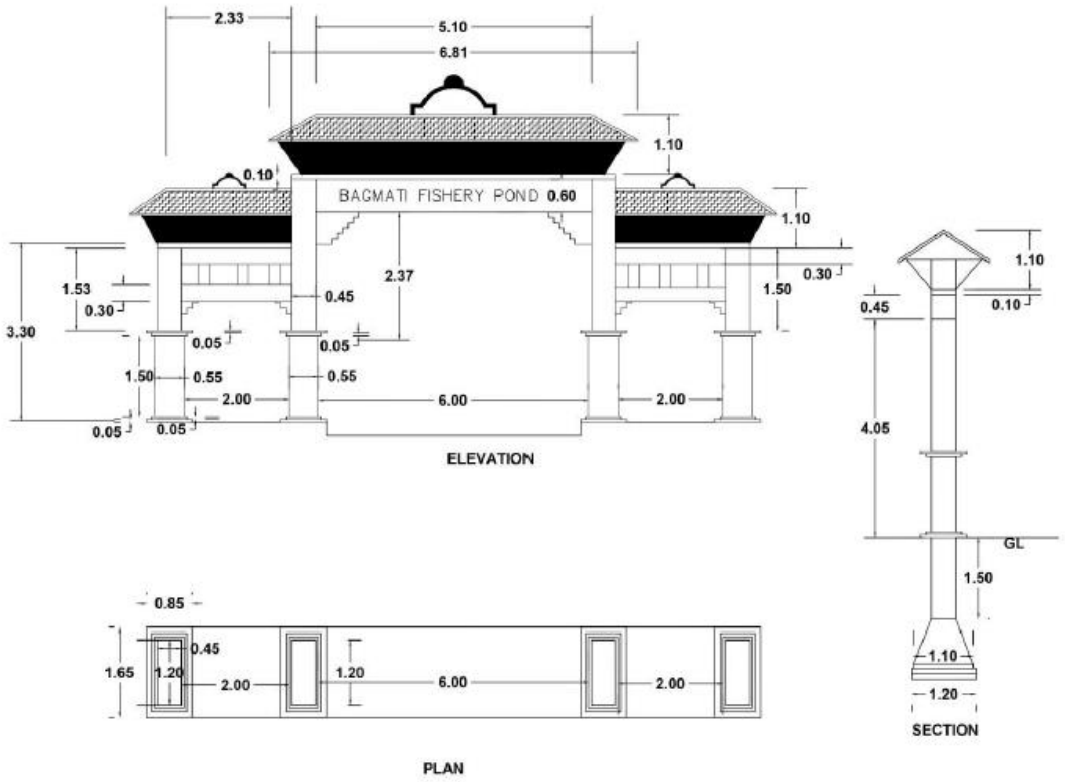

Figure 83 Plan of Gate

ANNEX-IV Final Jury Comments and Resolution

FINAL JURY COMMENTS AND RESOLUTION			
N.	**Jury**	**Comment**	**Resolution**
1	Nava Raj Pyakurel	The recommendation should be for site specific as well as national wise specific.	Mentioned in 7.1.2 National wise recommendation
2		The theoretical aspect on how a lake increase surrounding temperature during summer should be mentioned.	Reflected in 3.8.1 lake on air temperature
3		The site selection for new lake development should be mentioned.	Reflected in 7.4 Recommendation for choosing location
4		Location of Bharat Lake shall be properly shown.	Reflected in 5.2.4 Location Attribute
5	Kishore Kumar Jha	The land acquisition is an important aspect. Who was the owner of the land and how the land was obtained by municipality?	Reflected in 5.1 Chronological development
6		Change in Abstract is necessary.	Abstract revised
7		Recharge of water is another important aspect. How is water suppled in the lake?	Reflected in 5.2.3 Intake to lake
8		Why is the name of lake Bagmati Fishery Pond and how the name	Mentioned in 5.1 Chronological development

	Dr. Ajay Chandra Lal	Bharat Lake came to be more popular?	
9		What is the condition of Fishing in the lake?	Mentioned in 5.1 Chronological development

ANNEX- V: - IOEGC Acceptance Letter and Paper

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Date: November 26, 2023

To Whom It May Concern:

This is to certify that the paper titled "***The role of water bodies in environmental enhancement and local development: A case study of Bagmati Fishery Pond***" (Submission# **569**) submitted by **Yuvaraj Timalsina** as the first author has been accepted after the peer-review process for presentation in the 14th IOE Graduate Conference being held during Nov 29 to Dec 1, 2023. Kindly note that the publication of the conference proceedings is still underway and hence inclusion of the accepted manuscript in the conference proceedings is contingent upon the author's presence for presentation during the conference and timely response to further edits during the publication process.

Bhim Kumar Dahal, PhD
Convener,
14th IOE Graduate Conference

The role of water bodies in environmental enhancement and local development: A case study of Bagmati Fishery Pond

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Abstract
The increases in urbanization have kept tremendous pressure on environment resulting in need of proper plan to protect the environment. Similarly, with urbanization there is need for potential economic generating sectors and sustainable development of such area. During such instances, Lake ecosystems can be used as one of the incentives to foster environment balance as well as promote economic and physical development surrounding the area. This paper is conducted not only to understand but also to validate that an artificial lake can enhance environment and local development around the vicinity of lake. For this, an artificial lake located in Bagmati municipality of Sarlahi district, Bagmati Fishery Pond, also commonly known as Bharat Lake, is considered as the study area. This research used various techniques such as survey, interview, through observation, municipality data etc. in order to analyze environment, economical development, physical development as well as understand people's perspective of lake enhancing environment and developing urban areas. Therefore, both qualitative as well as quantitative method of data and information collection were used. The development of locality before and after construction of lake was also studied to observe the change brought by lake. The study showed that although the lake is still in construction phase, it has been able to provide employment opportunity, enhance economy of overall municipality, increase development around the area as well as make the surrounding climate and environment much more livable. Hence, this Lake have been able to enhance the environment as well as promote development round the area where there was barren land with no infrastructure at past.

Keywords
Urbanization, Environment, Development, Artificial, Infrastructure

1. Introduction

The balance of the environment and the well-being of communities are at risk due to the tremendous ecological challenges brought on by rising urbanization and human activity. Water bodies including lakes, rivers, and ponds are crucial in this context for regulating local habitats and promoting sustainable development. Lake, which is a large depression of freshwaters on Earth that is bordered by land and may be standing still or moving slowly, is one of the most essential parts of an ecosystem which contributes in enhancing the environment by changing the atmospheric condition near the vicinity. Small bodies of water causes local modification to the environment which are generally insignificant while large bodies of water such as lakes, cause major significant effect on climate and environment ranging from the microscale to the synoptic scale. [1]

Generally, for people residing on developing countries, their major source of social well beings, economic dependencies and livelihood depends upon the goods and services available from different ecosystem including Lake Ecosystem . [2] Further, this ecosystem contribute to the development of local as well as national development through economic generation, enhancing in-migration, increasing social cohesion, adding toward tourism etc. Following the identification of importance of Lake Ecosystem to local and national development, there have been increased interests in development of new artificial ecosystem like lake and wetlands for supporting livelihood surrounding the water ecosystem. [3]

Lake constructed by human to fulfill their needs and demands are artificial lakes, also known as man-made lakes or reservoirs. These lakes are constructed for a variety of reasons such as for hydropower generation purpose, water storage, agriculture, irrigation, naturalistic purposes, recreational activities, hobbies like fishing, boating, and other outdoor pursuits including natural history, bird watching, painting and walking etc. [4]

The maximum temperature has been increasing at rate of 0.05 degree Celsius per year for summer in our country making life difficult. Similarly, the maximum temperature during winter have been decreasing while mean annual maximum temperature have already reached above 30 degree Celsius in terai region. The coolness provided around the water bodies with tranquility makes people feel a profound emotional connection to water.[5] As a result, the majority of bodies of water within developments can be utilized as marketing tools to establish the new emerging center. Furthermore, artificial lake helps in changing physical state of the locality through improvement and transformation of the built environment via construction of new structures such as roads, bridges, buildings, parks etc. Similarly, these lakes attract new population which results in accumulation of different culture enhancing diversity.

Bagmati Fishery Pond also commonly known as Bharat Lake is the second-largest artificial lake in the nation and is located in the Bagmati municipality of the Sarlahi district in Nepal's Mahendra Pradesh. After the construction of this lake, there have been waves of new development work around the lake surrounding. New markets have arises revolving around the

benefits obtained through Lake Ecosystem. Further, the environments have been positively influenced by lake but the lake has been polluted as a result of throwing garbage in lake, improper management, boating etc. This is so as lakes are common resources (positive externalities): people tend to use these resources collectively but are not willing to pay for these resources either collectively or individually making it undervalued and overused. Hence, a comprehensive study to understand the influence of the lake on environment enhancement and local development along with people's perspective of lake was necessary for sustainable management and development of the lake: the research was conducted.

2. Objective

The objective of this paper is to analyze the role of water bodies in environmental enhancement and local development taking case of Bagmati fishery pond.

3. Literature review

Lake Defination

Lake is a natural depression that is surrounded by land from most sides and contains freshwater. Generally, in mountain region, at some place natural basin are formed with impervious beds. Water from springs and streams generally flows toward the basin ad lake are formed. Lakes in Nepal are commonly called Pokhari, Tal, Rah, Dah, Kund etc. Additionally, a lake may be isolated, with no apparent direct water input and, occasionally, no apparent direct discharge. These remote lakes are frequently salty as a result of groundwater intrusions or evaporation. Anywhere in a river basin, may have a lake depending on its source. A headwater lake is fed by numerous tiny tributary streams, direct surface precipitation, and groundwater influx rather than a single river. These lakes usually always have just one river outlet. Lakes in river basins further downstream have one major output and one major input, with the water balance from input to output fluctuating depending on other water sources.

Importance of Lake

Lakes provide necessary resources including food, water, and recreational advantages, promoting the health of both people and wildlife. Lakes regulate river flow and maintain ecosystem stability by retaining water, reducing the effects of floods and droughts. As rainwater flow is slowed by their presence, fast landslides are also prevented. Regularly spaced lakes can help to reduce temperatures and raise humidity, which helps to reduce the likelihood of wildfires. Additionally, availability of food and water in their native land (Forest), wild animals does not need to move toward community, reducing the attack of wild animals. Lakes also divert lightning strikes away from dry communities, reducing the possibility of wildfires and potential harm to populated areas. By storing water, they can control river flow, recharge groundwater, increase natural beauty, moderate local climates, maintain biodiversity, and enhance local beauty. By providing home to aquatic and semi-aquatic plants and animals, which in turn provide food for many terrestrial creatures, they also add to the environmental richness. [6]

Economic Value of Lakes

Lakes are important resources for both communities and enterprises because they have a wide variety of economic value. These water bodies produce a cascade of economic advantages, from tourism and recreation that boost local economies through pursuits like boating, fishing, and camping, to the enhanced property prices of lakeside real estate. Additionally, lakes offer vital water resources for drinking, manufacturing, and agriculture, supporting a variety of sectors and maintaining livelihoods. Their ecosystem services, including as water filtration and flood control, and biodiversity contribute not just to environmental health but also to infrastructural cost savings.
Relation between Lake and Environment Lake has an ability to modify the environment around the lake surrounding. The effect of large water bodies on environment depends on various factors of lake such as depth, areal extent, configuration of lake, location of lake, direction and velocity of wind flowing around lake. Through modifications to the atmospheric boundary layer, lakes have an impact on the climate because of:-

- The thermal lag of Lake Surface temperatures compared to the adjacent land areas.
- The availability of open water over lakes for evaporation, and
- Alterations of winds by lakes as a result of contrasts in surface roughness between the lake and the land surfaces. [6]

Lake on Air Temperature

On summer, the air temperature around lake area is slightly cooler then nearby area. A research done by [7] in Janakpur, a city with over 200 ponds, found that houses near these water bodies experienced a significant 2°C temperature reduction during summer compared to those situated farther away. But during winter, the vicinity around lake is slightly warmer then surrounding area.

Lake on wind

Due to less friction on water surfaces, wind speeds across lakes are higher than those over land. Wind speeds on land surrounding lakes are highest close to the shore and decrease further inland when friction slows the wind. [1]

Lake as common resources

Any resource that offers people tangible benefits but that nobody in particular owns or has exclusive claim to is considered a common resource. It is free products, such as those that are commonly held by no one. Lakes are also common resources as they are used by all but are not given enough attention to promote and preserve it. These resources can be consumed by anyone without any discrimination makes these resources vulnerable toward over consumption resulting toward depletion.

Society Creating Risk

Sometime risk is induced by societies and community itself. As shown in the picture, there is a natural flow of water which is generally small but during certain period the flow increases. When a settlement starts growing in river bank, these settlements does not consider the return period of the biggest flood and grows with passing days. On certain time period, the river increases and return back to its original stage, flooding the whole settlement. Here, people are increasing risk toward themselves.

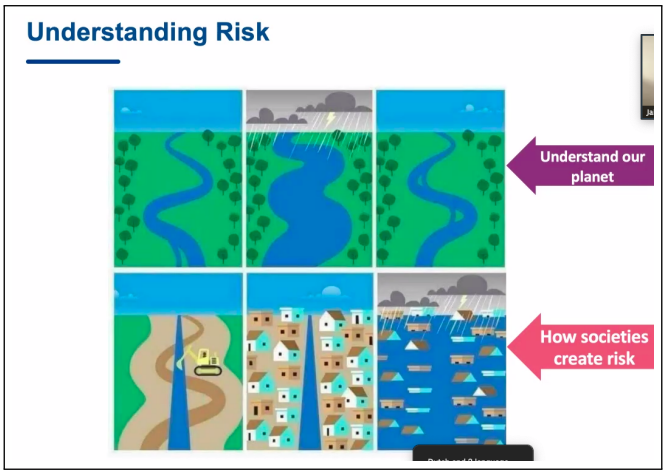

Figure 1: Risk created by society [8]

Buffer zone

Lands that are immediately next to waterbodies like lakes, reservoirs, rivers, streams, and wetlands are referred to as riparian buffer zones. Both the prevention of nonpoint source pollution and the associated water quality in neighboring waterbodies are significantly impacted by these land areas. They are therefore frequently utilized in water resource protection projects. Since the early days, different cities have had laws restricting the use of private land that is a certain distance from a river, lake, wetland, or tidal shoreline. These ”setbacks” or ”buffer strips” are used for a variety of reasons, including the preservation of riparian habitat and waterfront amenities as well as the protection of surface waterways from pollution and erosion. The use of setbacks has been more prominent in present days as water bodies have been constantly encroached and polluted. For instances, National Green Tribunal's (NGT), an environment protecting body of India, has increased buffer zone from 30m to 75m in Bengaluru city.

Setting up suitable landscaping near lakes and ponds can have long-term advantages in addition to improving course's aesthetic appeal. Buffer zones, for instance, help to lessen the amount of nutrients and sediment that are transported through the system and out to the watershed. There will be indirect benefits to the health of pond when buffer plants are actively filtering nutrients and the plants are adding little nutrient input to the water. The filtering of nutrients from runoff as well as direct filtration of the water from any plants that are ”feet wet” will prevent the growth of unwanted plants and algae in the water.

Without a barrier separating the grass area from the lake or pond, erosion along the shoreline may happen, leading to high sedimentation rates into the water body, poor water quality, and the destruction of the original environment. A suitable buffer zone will stabilize the beach and greatly lower the likelihood of erosion-related problems. Additionally, a well-maintained buffer can serve as a useful habitat for ”good” species and a deterrent to opportunistic wildlife. While allowing for an increase in the species richness around the lake, buffers can offer safe habitat for many desirable species, such as birds, frogs, and rabbits. In contrast, where there is a well-established buffer, nuisance animals is often kept away from aquatic settings. Due to their inability to observe possible predators when access to the water is restricted, geese frequently select alternate areas for breeding. In the absence of sufficient breeding places, geese frequently select other feeding grounds.

International Context

Lake on preventing flooding

Tonle Sap Lake prevents and control flooding due to Mekong River by taking water during monsoon season when rainfall is very high and act as a retention pond. This lake can be taken as an example of how a lake can prevent flooding acting as a retention pond. [9] In this same way, artificial lake can be created to be used as a retention pond near river area with high probability of flooding to prevent flooding and reduce the risk of life and property.

Bhopal Development

The capital of Madhya Pradesh, Bhopal, is a special example of how human creativity and natural beauty can coexist. The city's abundance of natural beauty, highlighted by its undulating geography and several attractive artificial and natural lakes, is what makes it so alluring attracting huge number of population. The populations of the area have been utilizing the resources from artificial lake and making their living. At present, the increase in number of population is affecting artificial lake environment creating need of proper management. [10]

4. Methodology

This research method uses pragmatic paradigm which believes that there are various methods to understand and interpret the world and performing research. During the study, the problem is constantly debated, renegotiated, interpreted and finally best output is taken as the one that solves the problem. In our study, to analyze the local development and environmental state surrounding around the new constructed lake area, both qualitative as well as quantitative data were analyzed. Qualitative data include the interview, key informant interview etc. and quantitative data were obtained through survey, observations etc. Additionally, QGIS, an open source Geographical Information System (GIS) program, helps in creating, managing integrating, mapping and analyzing data to a map. QGIS is used to create buffer around the study area and further understand the lake surrounding. Both these qualitative and quantitative data are also used to understand people view toward the growing economy and development around lake.

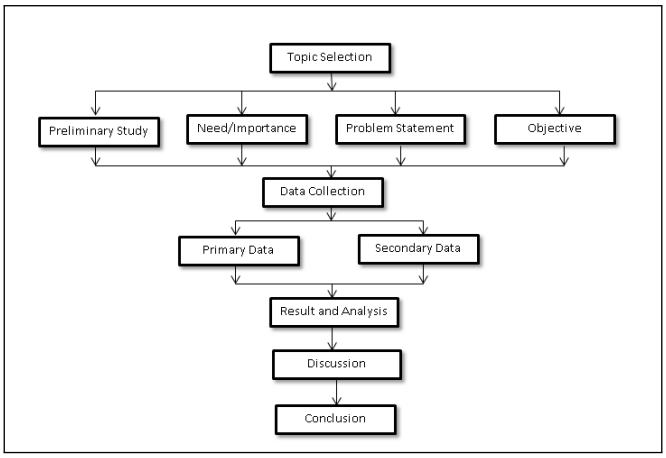

Figure 2: Conceptual framework of the research

Ontology

The ontological position of the research is that the development of artificial lake in a community will improve the environment around the area making the surrounding more livable and boost the development of locality.

Epistemology

The epistemology position of the research is that the study is a social science study about understanding influence of artificial lake on environment enhancement and local development which can be obtained through direct interaction with people as in interview, obtaining knowledge through survey, observation etc. and through secondary data sources.

5. Site Context

Bagmati Fishery Pond, second-largest artificial lake in the nation, is located in the Bagmati municipality of the Sarlahi district in Nepal's Mahendra Pradesh. This lake, which has a depth of 14 meters (45 feet) and a vast area of more than 150 bighas, is a tribute to the foresight and work of Mayor Bharat Kumar Thapa hence is also commonly known as Bharat Lake.

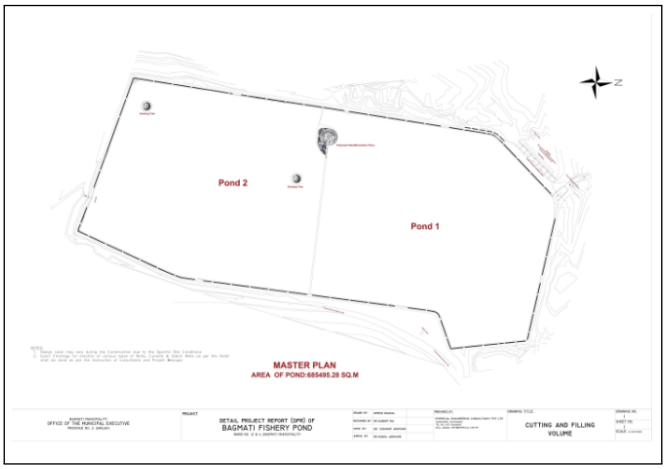

Figure 3: Plan of Bharat Lake

The lake's advantageous location from the East West Highway at Karmaiya in Sarlahi, just 1 km east of the Bagmati Bridge and 3 km south of the Bagmati Bridge, has aided in its growth as a well-known tourist destination. The construction of Bharat Lake has been a revolutionary undertaking for the area, providing both the local population and the government with a number of advantages through income generation, recreational center, improvement of environment etc. The formerly barren site has been transformed into a bustling recreational area, promoting tourism and local government and resident economic growth.

6. Finding, data analysis and discussion

Sample Size The population visiting lake is unknown as there are no data taken about number of people visiting the lake; however, people working around lake as well as official personal of lake suggested that the number of visitors ranges from few hundreds during normal days to few thousand during festive days. Hence, for the research the population is considered unlimited, confidence level taken as 95%, margin of error 10%, population proportion 505 to determine survey sample. The formula used is n=z2*p*(1-p)/e2 where, e=margin of error n=sample population z=z-score (for 95% confidence z=1.96) p=population proportion With calculation, the population to be surveyed was found to be 96 and so 120 visitors were surveyed.

Hence, around lake area, total of 149 sample of data were collected among which 120 of them were visitors visiting the lake, 20 were shopkeeper residing shop near lake vicinity, 7 cameraman roaming around lake, 1 owner of horse and 1 owner of camel. These surveys were conducted to understand the influence of lake on economy of people, change in climate around area as observed by people and to validate the new development waves brought after construction of lake.

Study on atmosphere

Questionnaire on temperature variation during summer among visitor suggested that around 88% believe that lake area is relatively cooler then surrounding area while 50% shopkeeper believes that lake area is cooler. This showed that area around lake is generally cooler than other area. Furthermore, 45% shopkeeper thinks that winter temperature is slightly warmer around lake then far area from lake suggesting lake makes winter climate warmer. Similarly, around 88% visitors and 80% shopkeeper found that the intensity of wind to be greater in around lake area.

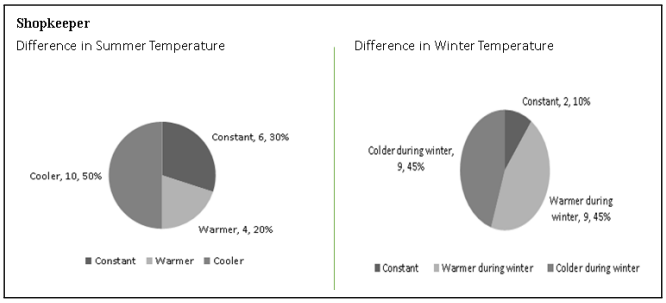

Figure 4: Pie chart showing shopkeeper perception on temperature change

Study on economy

Questionnaire on money spent by visitors suggested on average

people spent around Rs.1043 per one visit while shopkeeper earned around Rs.1300 per day during normal days while this can increase during festive days. The lake has been attracting large number of tourist from all around the country along with few from foreign country mostly from India. Similarly, the lake has been able to provide employment opportunities to more than 500 people directly and numerous people indirectly. The lake is still under construction indicating after complete construction more tourists will be attracted and more people of municipality will be benefitted.

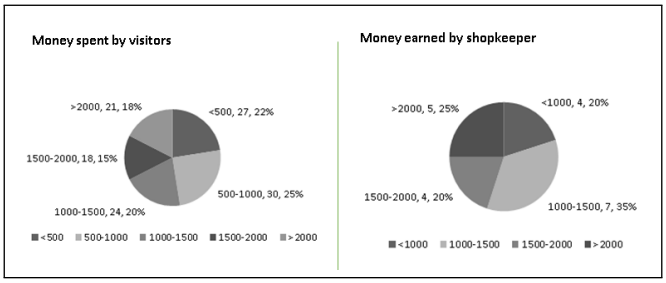

Figure 5: Pie chart showing money spent by visitors and earned by shopkeeper

The lake has been a source of economic generation for the municipality as well. The municipality collects Rs.1200 to Rs.2500 per months from shopkeeper depending on the size of shop around the vicinity of lake. Additionally, cameramen, camel owner, horse owner and other recreational activities owner also shall pay Rs.2500 per months to the municipality. Furthermore, municipality collects 20% tax from each individual riding on boat as well as sky cycle. The money collected from this taxation is further used for the welfare and betterment of lake.

Study on environment

Bharat Lake have also increased the ground water table downstream of lake to area such as Rajghat, Soltee to up to Bharatwa (which is around 10km south of lake) as suggested by Ranjit Misra and Sugan Badal, Sub-Engineers of the municipality.

Bharat lake is located along the edge of Bagmati river. This lake can act as a retention pond during small flooding protecting nearby surrounding. But during large flooding, this lake act as source of disaster. Bharat lake have attracted huge population around the lake surrounding which is a flood plane area. The populations around the lake are vulnerable toward flood.

Study on physical development

After the construction of the lake, 3 roads have been upgraded by widening and black topping. The road along the river, called as Dam side road, was a gravel road which has been reconstructed and black topped. The road passing through the edge of settlement was a pedestrian road which is widened and black topped. The road east of the settlement have been widen and under construction for black topping. Also, the prices of lands have been increased around the area. KII informant suggested that the land price have been around double after construction of lake and is still rising. People are not interested in selling their as the land price is increasing at present, so land transaction have been very less.

After the construction of lake, new waves of development have been started. A new mini open zoo construction project have been started at the Nursery (90 bigha) where at present mango and tree to provide food for zoo animals like Churi, Amala, Lapsi, Tooth, 1Kimbu have bben planted. This lies just south of lake which will promote tourism and increase their stay at the municipality. A small wetland project due south of lake have been initiated and will use lake water. A open picnic spot and closed seminar hall is also under construction. On ward 11, a funpark called Buddha Park along with a hiking route is under construction. The vision of the municipality is that a tourist will visit Bharat Lake, observe zoo and wetland, go to funpark where there are hotels for night stay and during morning they can hike on the hiking route and complete their journey.

Pollution around the lake

Pollution is another major problem observed in the lake area despite few dustbin placed for throwing garbage. There is no separate waste dustbin for organic and inorganic waste material. Further there are only few dustbins around the area making it difficult for people to find the dustbin at their convenience. The major cause of pollution in the area was due to increased number of visitors in around the lake. Also, the food stall provide food in polythene bag or paper which after eating is generally thrown in around lake area or into lake water making both surrounding area as well as lake water pollution.

Buffer zone As per the building code of our country Nepal, the setback for construction of structure shall be 50m from boundary of lake and 10m from boundary of canal. A canal is used to provide water to lake continuously. Therefore, a 50m buffer around the lake and 10m buffer from canal edge was constructed using QGIS. Buffer is a component of geoprocessing tool for vector data analysis which help to create a layer of polygon around a feature at fixed given distance.

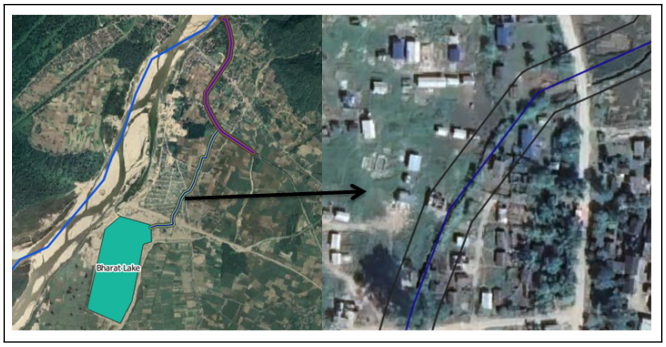

Figure 6: Buffer of 10m along the canal

This setback around lake is constructed to ensure protection of lake from unhealthy human activities as pollution. Similarly, setback along canal is made to ensure that the water of canal remains unpolluted which further make water of lake less polluted. But the rule is being violated along the canal as well as around the lake. Numbers of houses are constructed along the buffer or setback area. In around lake shops have been constructed to enhance economic activities but these shops shall be away from setback to promote lake health.

Figure 7: Buffer of 50m around the lakel

7. Conclusion and Recommendation

The research found out that the development of artificial lake i.e Bharat Lake have helped in development of the municipality as well as for enhancing the environment around the area. The survey showed that 88% visitors and 50% shopkeeper believe that lake construction has made the area cooler during summer than previous. Similarly, 45% shopkeeper suggested that winter is warmer near the area after construction of lake. Also, the wind intensity is high around the lake as suggested by surveyors. All these change in climate have helped in enhancement of environment. The populations of municipality have been economically benefited from lake as they have been able to work around the lake and earn their living. But as the numbers of visitors have been increasing, there have been increase in pollution around the area. So, proper plans and management shall be effectively implemented for preserving lake for future. Similarly, as the lake is located near river flood plain, proper flood management plan shall be prepared in case of flooding. In our country, new towns are being developed. These place need to attract new population for further development. For attracting new population, the town requires economic activities and development of locality. Economic activities and development around the locality can be generated with construction of artificial lake similar to Bharat Lake. Hence, if any place need to attract new settlement, then Bharat Lake can be used as reference to these upcoming new town to attract new population.

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ANNEX-VI: - Plagiarism Check Report

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ANNEX-VII: - Final Presentation Slides

A
Thesis
On

The Role Of Water Bodies In Environmental Enhancement And Local Development: A Case Study Of Bagmati Fishery Pond

MAY, 2023

Submitted To:-
Department Of Architecture
Lalitpur, Nepal

Submitted By:-
Yuvaraj Timalsina
078MsUrP020

Introduction

- Background
- Need
- Importance
- Problem Statement
- Objectives
- Limitation of Research

Background / Introduction

Water Bodies

Water bodies are place with accumulation of water.

Water bodies can be both salt water and fresh water as well as large and small.

Types of Water Bodies

Large water bodies like Ocean

Small water bodies like:-
Stream
Lake
River
Pond etc.

Figure:- Water bodies

Source:-EU Neighbours

Background / Introduction

Lake

Lake is a depressed area filed with freshwater and surrounded by land.

Lake ecosystem plays functional, regulatory and social role as well as are important in managing microclimate of a region. (Birawat et al., 2021)

Lake are also important hydrological and ecological entity. (Birawat et al., 2021)

Importance of Lake

For people residing on developing countries, their major source of social well beings, economic dependencies and livelihood depends upon the goods and services available from ecosystem like wetland or lake ecosystem. (Gebremedhin & Belliethathan, 2019)

Figure :- Lake

Source:- Bharat Lake - Tourist destination in Nepal - Bharat Taal (jankarinepal.com)Nepal - Bharat Taal (jankarinepal.com)

Background / Introduction

Importance of Lake Cont.

Lake Ecosystem is considered to be one of the most important ecosystems which contribute to the development of local as well as national economy by producing wide range of goods and services like food, water, recreational benefit, aesthetic benefit etc. (George Halkos & Steriani Matsiori, 2012)

Artificial Lake

Determining the importance of lake ecosystem, there has been increased interest in developing artificial lake to support livelihood around the lake. (George Halkos & Steriani Matsiori, 2012)

Artificial lake are lake constructed by human kind for different use like water storage, hydroelectric power generating, recreational activities, agricultural purpose, habitat for birds and animals, aesthetic purpose etc.

Background / Introduction

Lake and Environment

Environment can be defined as a sum total of all the living and non-living elements and their effects that influence human life.

Bodies of water modify the atmospheric environment in their vicinity.

Larger bodies of water, such as lakes, cause more significant effects on climate at scales ranging from the microscale to the synoptic scale.

After the construction of artificial lake, change in environment can be observed in the area.

Background / Introduction

Lake and Local Development

Local development is the process of utilizing local resources and opportunities while remaining within the jurisdiction of the local government and carrying out tasks in a variety of areas that benefit the local community's residents

Lake helps in changing physical state of the locality through improvement and transformation of the built environment via construction of new structures such as roads, bridges, buildings, parks etc.

Similarly, lake attracts new population which results in accumulation of different culture as a result of which the local culture may get changed.

Also, lake helps in improving social well-being and quality of life of people residing in the local community through inclusivity and improving lifestyle.

Finally, lake also helps in improving the economy of local people.

Background / Introduction

Lake and Economic Development

Lake ecosystem have direct (visible) and indirect (invisible) benefits.

There are at least four different ways to value wetlands, resulting in four different sorts of values:-

- **Owner values** are derived from marketable wetland goods and services, like food, water, and aquatic plants (environmental benefits).
- **User values** are the benefits from consuming or using wetland-related outputs (such as recreation or improved water quality).
- **Regional values** are derived from wetland-related business activity (e.g., gross business volumes, employment).
- **Social value** can be measured by aggregating user values and owner values. (Lisa A. Roberts & Jay A. Leitch, 1997)

Need / Introduction

Tranquility, coolness, and beauty of water connect human with water which can be used as marketing tools to establish the new emerging market for enhancing local development. ("Constructed Wetlands: The Economic Benefits of Runoff Controls," n.d.)

The maximum temperature of Nepal have been rising at a quicker rate (0.05°C/year) with mean annual maximum temperature of terai belt exceeding 30°C making living very difficult. (Marahatta at all, 2009)

The coolness during summer and warm during winter enhances the environment around lake making the land a valuable entity resulting in change in land use ("Constructed Wetlands: The Economic Benefits of Runoff Controls," n.d.)

After the construction of Bharat lake, there have been subsequent change in local development (new development arises revolving around benefits of lake ecosystem) and local environment.

Further, SDG's goal 6 related to water and sanitation sub goal 6.6 states to protect water related ecosystem including mountain, forests, wetlands, rivers, aquifers and lakes.

Hence, a study is necessary to understand how the local development and environment have been shifting from when there was no lake to now after construction of artificial lake.

Importance / Introduction

Artificial Lake constructed plays a major role in development and environment of local area and economy of whole regional area.

But there still exist gap in study about understanding the influence of such artificial lake in change in local development and environment of the area.

Hence, this study is important for all those new upcoming artificial lake projects designed to improve local development and environment through Lake Ecosystem.

Similarly, policy makers can use this research as a guideline to make new policies to enhance the emerging market and further improve the economy of the sector.

Also, people residing surrounding lake can benefit from this research as they can observe the shift in economy and make economic decision as per the market change and growth.

Problem Statement / Introduction

The balance of the environment and the well-being of communities are at risk due to the tremendous ecological challenges brought on by rising urbanization and human activity.

Water bodies including lakes, rivers, and ponds are crucial in this context for regulating local habitats and promoting sustainable development.

Despite these potential benefits, there is an urgent necessity to understand and assess the different functions that water bodies play in preserving the environment and driving local development.

Hence, a study into the complex relationships that exist between water bodies, ecosystem health, and community well-being in an effort to determine how these aquatic resources might be used as promoters of both environmental and socioeconomic development is needed.

This study attempts to offer practical insights and recommendations that can guide policy decisions, urban planning strategies, and conservation efforts for maximizing the benefits derived from water bodies while preserving their long-term integrity by addressing gaps in current research.

Objective / Introduction

The major objective of this paper is to analyze the role of water bodies in environmental enhancement and local development taking case of Bagmati fishery pond.

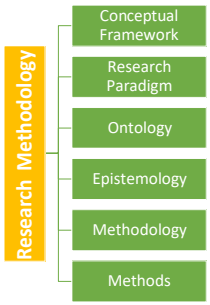
Other minor objectives are:-

- To investigate people's perspective about effect of lake.
- To understand the linkage of market economy with lake site activities.
- To analyze the change in environmental situation around the lake.

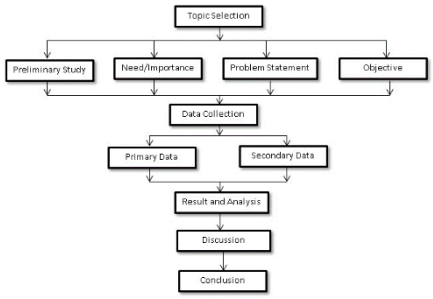
Limitation / Introduction

This research is limited to only one artificial lake which is Bharat lake. As a result, the findings of the research may be site specific and may not be completely applicable to other artificial lake.

The negative impact of artificial lake is not fully considered in the research as it could deviate the output of the research but can be used as opportunity for further research.



Conceptual Framework



Research Methodology

Research Paradigm

In this research, researcher uses interpretivism technique to people opinions. So, positivist method cannot be used in this research.

In interpretivism, realities cannot be measured not quantified but can be interpreted only which is qualitative in nature. But, during the research, researcher uses quantitative method to obtain data such as in from of survey and observation. Therefore, interpretivism method cannot only used to justify the research.

Hence, this research method uses pragmatic paradigm which as described by Uprety believes that the reality is constantly debated, renegotiated, interpreted and therefore the best method to use is the one that solves the problem. Pragmatic way of solving a research is not a single philosophical paradigm but uses a mixture of both qualitative and quantitative methods.

Research Methodology

Ontology

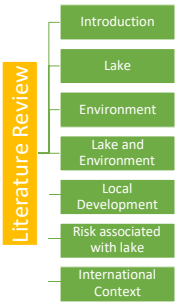
The ontological position of the research is that the lake changes the environment of the surrounding area as well as local climate which attract new population around the area resulting in development of locality.

Epistemology

The epistemology position of the research is that the study is a social science study about understanding influence of artificial lake on environment enhancement and local development which can be obtained through direct interaction with people as in interview , obtaining knowledge through survey, observation etc. and through secondary data sources.

Methods

Research Method	Primary or Secondary	Qualitative or Quantitative	Use
Household Survey	Primary	Quantitative	To understand general characteristics of population
Key Informant and Users Interview	Primary	Quantitative	To gain more in depth understanding of topic
Observation	Primary	Either	To understand how something occurs in its natural settings.
Literature Review	Secondary	Either	To situate research in an existing body of work or to evaluate trends within a research topic



Introduction

Water is basic need for human being and is essential to survive. UN described water as the core of sustainable development and is necessary for energy, socio-economic development, food production, healthy ecosystem and for human as well.

So, Sustainable Development Goal (SDG) goal number 6, Clean Water and Sanitation is oriented toward water.

Lake is one of the major sources of surface water.

Lake

Lake is a natural depression that is surrounded by land from most sides and contains freshwater.

Types of Lake

The simplest classification is based on the dimension of a lake.
- Small
- Big
- Very large.

Lakes are classified on the basis of:-
- Origin
- Trophic levels
- Mixing of water.
- Nature of Inflow-outflow

Hutchinson (1957) classified major types of lakes on Earth into 11 major groups with sub division of 76 types.

Nepal's permanent lakes are broadly categorized into three main categories based on their geological origin and they are:-

- Glacial or Himalayan lakes e.g. Rara, Gosainkunda, Shey Phoksundo
- Tectonic or sub Himalayan lakes e.g. Phewa, Begnas, Rupa
- Ox-bow or Terai lakes e.g. Ghodaghodi tal, Bishazaree tal, Rani tal (Sharma, 1977 as cited in kunwar,2008).

Importance of Lake

Lakes are important ecosystems that contribute significantly to regional and societal progress by offering a wide variety of products and services

These ecosystems provides:
- Food
- Recreational advantages
- Promoting the health of both people and wildlife.
- Water for drinking, industrial, and agricultural needs
- Regulate river flow and maintain ecosystem stability by retaining water
- Reducing the effects of floods and droughts efficiently absorb rainwater
- Regulatory function by controlling regional weather patterns and microclimates.
- As rainwater flow is slowed by their presence, fast landslides are also prevented.
- Keep wild animals away from community since they have access to enough food and water
- Economic engines for neighboring communities through irrigation, transportation, and fishing.
- Critical hydrological and biological role in flood control, groundwater recharge, and biodiversity preservation.
- Regularly spaced ponds can help to reduce temperatures and raise humidity which helps to reduce the likelihood of wildfires
- Ponds also divert lightning strikes away from dry communities, reducing the possibility of wildfires and potential harm to populated areas.
- Significantly improve the surroundings' natural beauty

Lake and Environment

Environment can be defined as the surrounding areas where both living and non-living beings can be found.

The Environment Protection Act, 2019 (2076) define environment as the interaction and inter-relationship among the components of natural, cultural and social systems, economic and human activities and their components.

Lake has an ability to modify the environment around the lake surrounding. Small bodies of water that are few hectares in size such as ponds, does not cause considerable amount of environmental modification while a large body of water such as lake, would cause considerable change in locality climate ranging from microscale to the synoptic scale.

Through modifications to the atmospheric boundary layer, lakes have an impact on the climate because of:-
- The thermal lag of Lake Surface temperatures compared to the adjacent land areas
- The availability of open water over lakes for evaporation, and
- Alterations of winds by lakes as a result of contrasts in surface roughness between the lake and the land surfaces.

Lake on Air Temperature

Lake changes the air temperature around the vicinity significantly making lake area a suitable place to reside.

This is most noticeable for lakes in climates with significant seasonal temperature variation.

Compared to land surfaces, lakes warm up more slowly in the spring and summer and cool down more slowly in the fall because water has a heat capacity that is about three times more than that of soil.

Lakes are often colder in spring and summer than the ambient air temperature.

Close to major lakes wintertime temperatures are warmer than other area.

Lakes help to moderate extremes of heat and cold. (Schmidlin, n.d)

Lake on moisture and precipitation

The temperature of lake water and air above the lake are different from each other resulting in difference in vapours pressure.

The vapor pressure difference between the lake's surface and the surrounding air determines the moisture fluxes over a lake.

The greatest vapor pressure differential occurs in late fall and early winter, when evaporation is at highest.

When the vapor pressure differential is at its lowest in spring and early summer, evaporation is reduced. (Schmidlin, n.d)

Lake on wind

Due to less friction on water surfaces, wind speeds across lakes are higher than those over land.

Wind speeds on land surrounding lakes are highest close to a the shore and decrease further inland when friction slows the wind. (Schmidlin, n.d)

The study of the effects of open water bodies on the climate of urban areas, including treatment wetlands, ponds, rivers, and water features, has become increasingly important in recent years. These observations have shown that temperatures tend to be noticeably lower around and downwind from such water bodies, with decreases of about 1-2 degrees Celsius relative to the adjoining places. (Coutts et al., 2013) .

Research in Janakpur, a city with over 200 ponds, found that houses near these water bodies experienced a significant 2°C temperature reduction during summer compared to those situated farther away. This cooling effect is attributed to the evaporation of water from the ponds, which acts as a temperature sink, absorbing heat from the surroundings(Lal, 2016)

Local Development

Local development is the area consists of the administrative assigned boundary subject to the authority of the local government where institutions, organizations, and individuals affiliated with local authorities participate in this process in order to take use of local resources and possibilities and carry out various tasks that will benefit the residents of the area. (Sekula, 2002)

The goal of local development is to enhance the standard of living and future economic prospects in a specific region or municipality.

Dimension of Local Development

- Physical Development
- Social Development
- Economic development
- Disaster Preparedness and Resilience

Physical Development

The process of upgrading and strengthening the built environment and infrastructure within a particular geographic area is referred to as local community physical development.

For its people, this development seeks to build a more livable, sustainable, and affluent neighborhood.

Indicator of Physical Development

- Housing quality
- Road infrastructure
- Public transportation
- Access to basic services
- Waste management
- Green space and parks
- Crime rate and safety
- Water and sanitation services

Social Development

The process of strengthening a local community's residents' wellbeing, inclusion, and overall quality of life is referred to as social development.

It entails creating and fostering social bonds, advocating for equality and social justice, and presenting chances for individual development and community involvement.

Indicator of Social Development

- Education attainment
- Literacy rate
- Health care access
- Social services utilization
- Community Participation
- Cultural and recreational activities
- Inclusivity and diversity
- Poverty and Income Inequality
- Gender equality

Economic Development

The process of enhancing the region's economic health, productivity, and general prosperity is referred to as economic development.

It includes programs and strategies to uplift the standard of living for its citizens by boosting income opportunities, creating jobs, and attracting investment

Indicator of Economic Development

Gross Development Product (GDP)
Employment rate
Unemployment rate
Income level
Poverty rate
Business activities and startups
Tourism revenue

Disaster Preparedness and Resilience

The ability to respond quickly to and recover from natural or man-made disasters makes disaster preparedness and resilience crucial components of local development.

Local communities can lessen the impact of catastrophes on their social, economic, and environmental systems by putting measures in place to reduce risks and increase resilience.

Indicator of Disaster Preparedness and Resilience

Community Awareness and education
Emergency response planning
Early warning system
Evacuation routes and shelters
Training and capacity building
Infrastructure and building codes compliance
Financial preparedness

Lake as common resources

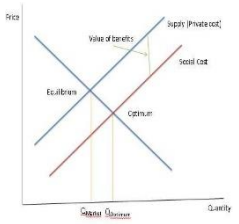
Any resource that offers people tangible benefits but that nobody in particular owns or has exclusive claim to is considered a common resource.

It is free products, such as those that are commonly held by no one.

Lake are also common resources used by all but are not given enough attention to promote and preserve it.

These resources can be consumed by anyone without any discrimination makes these resources vulnerable toward over consumption resulting toward depletion.

The value of benefits in the above graph is the cost that is necessary for common goods to be charged for using the goods. (Joshi, Presentation)



Risk and Society

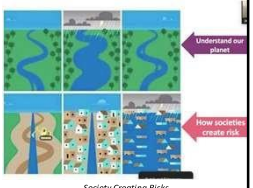
Risk is a real or potential threat of a disaster that can lead to major loss of life, livelihoods and infrastructure. It is the likelihood of something happening and consequences if it happens.

Sometime risk is induced by societies and community itself. As shown in the above picture, there is a natural flow of water which is generally small but during certain period the flow increases.

When a settlement starts growing in river bank, these settlements does not consider the return period of the biggest flood and grows with passing days.

On certain time period, the river increases and return back to its original stage flooding the whole settlement. Here, people are increasing risk toward themselves.

Risk Triangle



Society Creating Risks

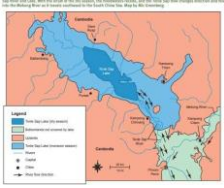
International Context

Lake on preventing flooding

The freshwater lake, Tonle Sap Lake, is shallow during the dry season, rarely rising above 3.3 m (11 ft), but during the wet season, it can reach depths of 8 to 10 m (26 to 33 ft).

The Tonle Sap Lake enlarges by 200% to 300% as a result of this flood water entering the lake, and its water volume rises from 10 km3 (2.4 mi3) to 80 km3 (19 m3).

This lake prevents flooding by Mekong River by taking water during monsoon season and act as a retention pond. (Olson & Morton, 2018)



Tonle Sap Lake

This lake can be taken as an example of how a lake can prevent flooding acting as a retention pond.

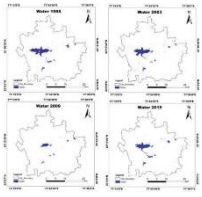
In this same way, artificial lake can be created as a retention pond near river area with high probability of flooding to prevent flooding and reduce the risk of life and property.

Artificial Lake in development of Bhopal

The capital of Madhya Pradesh, Bhopal, is a special example of how human creativity and natural beauty can coexist. It has stunning landscapes with man-made lakes.

The well-known Upper Lake, or Bada Talab, is significant historically because King Bhoj skillfully created it at the start of the 11th century.

Raja Bhoj established a large lake that stretched from Bhojpur to Sehore and Mendua village by building an earthen dam over the Kolans River, a rain-fed tributary of the Betwa River.



Lakes of Bhopal

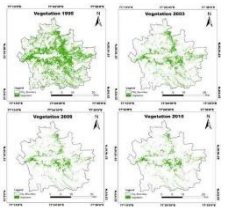
A rich environment that sustained the livelihoods of local inhabitants, particularly the Gond and Bhil tribes, was fostered by this reservoir, which had a significant impact on the surrounding areas.

These tribes, which were made up of farmers and hunters, obtained their food purely from the abundant resources of the natural world. These tribal tribes were able to establish and thrive in an ideal environment thanks to the natural diversity that the Upper Lake's presence produced.

Bhopal has seen incredible population increase throughout the years indicating a rapid urbanization.

The city's abundance of natural beauty, highlighted by its undulating geography and several attractive artificial and natural lakes, is what makes it so alluring.

However, the city's once-pristine environment has suffered due to the persistent waves of urbanization, which are being fueled by economic investments in urban sectors, inter-city mobilities, and regional connectivity, and have deprived it of its well-known attractiveness



Change in Vegetation cover of Bhopal

A shocking study by IISc Bangalore researchers has found a disturbing drop in the city's vegetative cover. The excellent 92% vegetative cover that Bhopal had in 1977 had severely decreased by 2014 to just 21%.

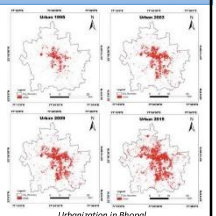
The study's alarming predictions include further deterioration to just 11% by 2018 and a drastic decline to just 4% by 2030 if the local administration sticks with its current course of action

Bhopal has seen numerous problems with lake encroachment and water quality in recent years.

Pollution has caused the once-pristine Upper Lake, which was immediately consumable, to require initial treatment before consumption.

There are also problems with the water quality in a number of nearby lakes. Tragically, out of the 31 lakes that were registered, only 21 still exist, with 11 being lost forever.

unplanned urban growth and the emergence of gated communities and townships lacking in adequate infrastructure and planning rules.



Urbanization in Bhopal

This growth has also resulted in land speculators buying up agricultural land, driving up prices, destroying lives, and harming the environment. Groundwater levels have decreased and the surrounding flora has withered over time, showing an unsettling trend in the area's environmental quality.

To solve these urgent problems and ensure sustainable development in Bhopal and its peri-urban areas, immediate and concerted effort is needed. (Wadwekar & Wadwekar, 2018, Tiwari, 2009)

Case Area

- District
- Weather Data
- Municipality
- Bharat Lake

Introduction to District

Bharat Lake is located in Sarlahi district which isone of the eight districts of provience number 2 (Madesh Pradesh) and is located at around middle of the provience.

This district is surrounded by Mahottari in the east, Rauthad in the west, Sindhuli in the north and Bihar state of India in the south.

There are 81 lakes recorded in Madhesh Province while in sarlahi district, there are 10 lakes

The study done by National Lake Conservation Development Committee suggests that each of the 10 lakes in Sarlahi district is degrading or degraded. So, all these lakes require upgrade through conservation, protection and revitalization.

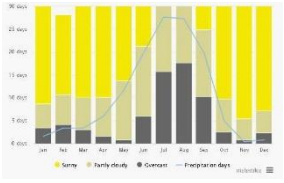
Sarlahi	Betlai Duha	Freshwater, Lacustrine	4	Degraded
	Chandraguni Pokhari	Freshwater, Lacustrine	0.95	Degrading
	Hatmare Pokhari	Man-made	5	Degrading
	Kerwa Pokhari	Man-made	4	Degrading
	Lekhandehi Taal	Freshwater, Lacustrine	2	Degrading
	Math Pokhari	Freshwater, Lacustrine	3	Degrading
	Nadhi Taal	Freshwater, Lacustrine	1.54	Degrading
	Nagarpalika Pokhari	Man-made	2	Degraded
	Nasi Pokhari	Man-made	0.6	Degraded
	Panjiya Taal	Freshwater, Lacustrine	0.53	Degrading
	Purano Pokhari (Munalika Pokhari)	Lacustrine, permanent	3	Degrading
	Total		26.6	

Lakes in sarlahi

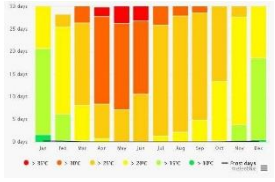
Source:National Lake Conservation Development Committee (NLCDC)

Weather data

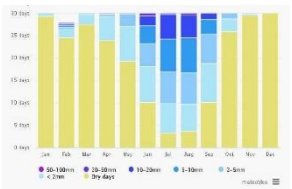
Simulated historical climate and weather data for Sarlahi for 30 years



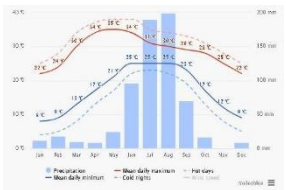
Cloudy, sunny and Precipitation days



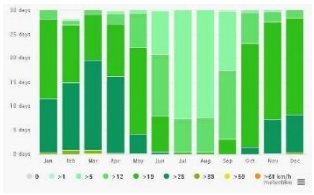
Maximum temperature



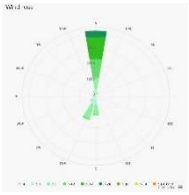
Precipitation amount



Average temperature and precipitation



Wind speeed



Wind Rose diagram

The district consists of twenty municipalities, out of which eleven are urban municipalities and nine are rural municipalities.

Bagmati municipality is one of the urban municipalities of Sarlahi district.

Municipality

Bharat Lake is located in Bagmati municipality of Sarlahi district. It was formed in 2016 occupying current 12 sections (wards) from previous 12 former VDCs.

Bagmati Municipality got its name from the Bagmati River in western part of Sarlahi District and District Border of Sarlahi and Rautahat.

Bagmati municipality covers an area of101.18 km^2

Relative Location

East: Harion Municipality
North: Sindhuli District
West: Rautahat District
South: Barahathwa Municipality

Administrative and Political Division

Particulars	Description
Total Area	101.2 SQ. km
Altitude from sea level	60m to 600m
Average annual rainfall	1899.6 mm
Average Annual temperature	Hi 31°, Low 20°
Climate	Lower Tropical and Upper Tropical
Main Rivers/Khola	Bagmati River, Dhungrekhola, Godari Khola, Sukekhola
Irrigation	Bagmati Irrigation Project

Geomorphology

The majority of the Bagmati Municipality is located in the Terai region, while some of it is located in the Bhawar region, also called "Char Kose Jhadi." (ward no. 1 and ward no. 11's)

Physiographic

New Ward Number	Former VDC/s	Wards of former VDC/s
1	Dhungrekhola	1, 2, 4
2	Dhungrekhola	5, 6, 7
3	Dhungrekhola	8, 9
4	Karmaiya	7, 8, 9
5	Rajjhat	6, 7, 8
6	Rajjhat	4, 5, 9
7	Rajjhat	1, 2, 3
8	Shankarpur	3, 4, 5
9	Shankarpur	1, 2, 6, 8
10	Shankarpur	7, 9
11	Karmaiya	4, 5, 6
12	Karmaiya	1, 2, 3

Population and Density

CBS 2011 40,399 399.20 people per square kilometer
CBS 2021 45,459 449.20 people per square kilometer.

Caste and Ethnicity

This municipality has over 50 different ethnic groups living there.

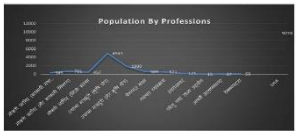
The majority of the Tamang community, followed by the Magar, Brahmin/Chhetri, and Kushwaha ethnic groups, make up this area's population.

This municipality also has ethnic group like Thami, Therai Bhramin, Dhobi, Dom etc. with very minimum population.

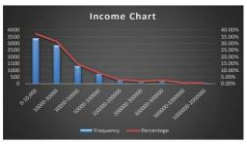
Economic Condition

Professions

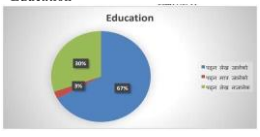
subject	total	Percentage
total	9728	100.00%



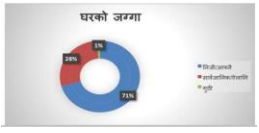
Income

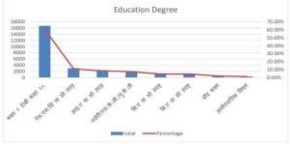


Education



Household facilities





Bagmati Fishery Pond

The second-largest artificial lake in the nation is called Bharat Lake, and it is located in the Bagmati municipality of the Sarlahi district in Nepal's Mahendra Pradesh.

The lake, which has a depth of 14 meters (45 feet) and a vast area of more than 150 bighas, is a tribute to the foresight and work of Mayor Bharat Kumar Thapa.

Bharat Lake

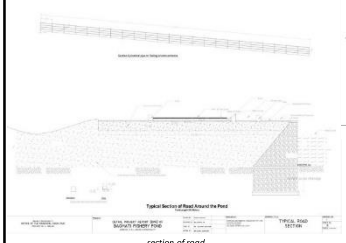
Location of Bharat Lake

Project Hightlights

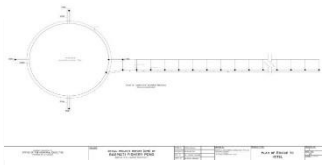
Name of the Proiect	Bagmati Fisherv Pond
location Wards	4 & 12
Total Estimated Cost of Proiect	NRs. 882,753,106.16
Project Completion Period	3 Years
Total Area Covered	150 Bighas
Total Areas of Ponds	685495.28SQ.M (101.21 Bighas)

Before the construction of the lake, the land was barren and agriculture was done in this area. Only one settlement north of the present Bharat Taal was situated whose major source of income was agriculture and animal husbandry. Another settlement was also due north along east west highway and depends on highway activities for economic activities. Few houses were alongthe minor road.

After the construction of Bharat Lake in 2076 B.S, major changes occurred in the area. The shifts have been observed in land price to change in economic activities of people to change in physical attribute of the area.



section of road



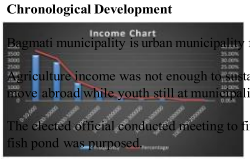
Plan of Central recreational area of lake

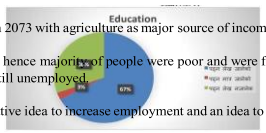
Section of wall surrounding the lake

Data and Analysis

- Chronological Development
- Observation
- General Finding
- Questionnaire on Climate Change
- Questionnaire on Economic activities

Chronological Development



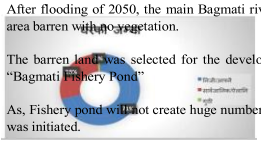


Bagmati municipality is urban municipality formed on 2073 with agriculture as major source of income.

Agriculture income was not enough to sustain family hence majority of people were poor and were forced to move abroad while youth still at municipality were still unemployed.

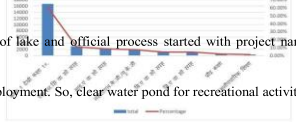
The elected official conducted meeting to find innovative idea to increase employment and an idea to develop fish pond was purposed.

After flooding of 2050, the main Bagmati river flowed in two path. The one on the left dried making river area barren with no vegetation.



The barren land was selected for the development of lake and official process started with project name "Bagmati Fishery Pond"

As, Fishery pond will not create huge number of employment. So, clear water pond for recreational activities was initiated.



The lake is divided into 2 section while the work on one section is nearly complete and tested with water for retention while the other lake is still under construction

It took around 16 to 17 days to fill the pond and as the base was pervious, the water was completely soaked in 3 days at first.

This process was repeated for 5 times and finaly the lake is able to hold water for longer period of time.

The water from Bagmati Irrigation Project cannel have been used to constantly supply water to make for the water loss from evaporation and seepage.

Ongoing construction of next lake

Activities available at around the lake

1.Gift Shops
2.Food Stalls
(Registered=150 including 30 chatpate stall)
3.Horse Riding(Horse =3)
4.Camal Riding(Camel=1)
5.High Resolution Photography
(Photographer=75Registered)
6.Sky Cycling
(Rs 500 per ride)
7.Boating
(32 medium and 1 large size boat)
(Rs300 for medium boat)
(Rs300 to stay inside and 500 for outside for large boat)
8.Cycle riding on ground

Intake to the lake

There are two inlets or intakes and one outlet in the lake.

The first inlet is for drawing large amount of water mostly during rainy season and while cleaning and completely filling the lake.

The other inlet is used for continuously supplying water. This inlet is an irrigation canal of Bagmati Irrigation Project which supply water to be maintained at same level which is decreased due to infiltration, seepage, evaporation, transpiration etc.

Fig:- Intake of the Lake

Observation

The lake, Bagmati Fishery Pond or commonly known as Bharat Lake, is located around 2 Km from the east west highway and around 500m east of the Bagmati River

Public vehicle only can bring people to the highway and should take another vehicle used only for the purpose of going to the lake and coming from the lake.

The vehicle can take four persons at once. So until there are four persons on the vehicle, people need to wait for some time.

The trip from the main highway to the lake takes about 10-15 minutes via those vehicles..People can also walk from main highway to the lake which tales around 30-40 minutes in average.

Similarly, those with their own vehicle can directly go using their vehicle. After reaching the Lake these vehicles need to park. There is parking cost allocated for different vehicle. The income generated from the parking goes directly to the municipality.

Generally, the flow of the people is very less in the lake during morning. People start arriving in the lake after around 9 10 am, majority of them being shopkeeper.

The number of visitors slowly increases from 10 am to around 2 pm. After around 2 pm, the number of visitor increases and the lake becomes vibrant.

Initially, people can buy different gifts items specially belonging to Mithila community in the shop around the area.

There are lots of restaurants and food stalls around the area where people can buy food and enjoy food watching the beautiful view of lake.

There are people with camera who will capture photo in high quality. There is the facility of boat riding with two types of boats. One boat is large boat while other boats are small. People can ride in the boat and observe the lake. The payment for the boat ride goes to the owner of boat and municipality.

Further, there are 3 horses in the area. People can ride horse along the road made around the boundary of lake.

Similarly, there is a camel in the lake which attracts lots of visitors.

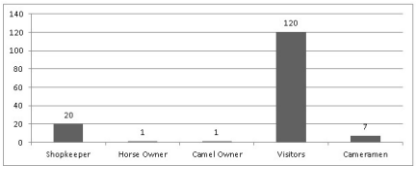
Additionally, sky bike is present in the lake to observe lake from elevated point of view

The road along the boundary of the lake is a blacked topped road with flower bed on its right toward lake.

The space next to flower bed is stone pavement pathway for movement of people around the lake.

General finding of the questionnaire survey

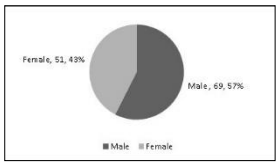
In near lake area, total of 149 sample of data were collected among which 120 of them were visitors visiting the lake, 20 were shopkeeper residing shop near lake vicinity, 7 cameraman roaming around lake, 1 owner of horse and 1 owner of camel.



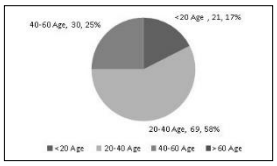
User Profile

Visitors

Gender



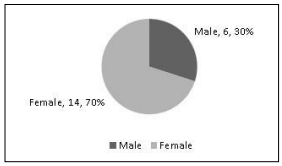
Age



User Profile

Shopkeeper

Gender



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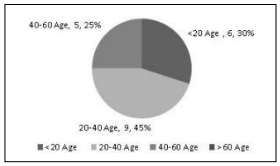
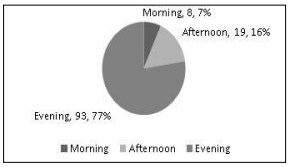


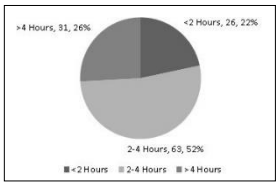
User Profile

Visitors

Preference time of visit in a day



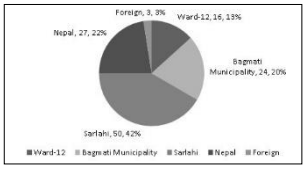
Time spent around the lake



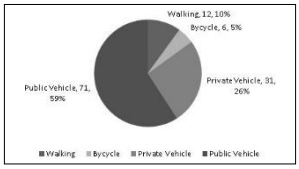
User Profile

Visitors

Visitor's residence



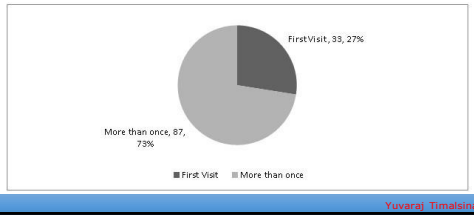
Means of transportation to visit lake



Frequency of visit

27% (33) people have visited the lake for the first time while 73% (87) people have visited the lake more than once.

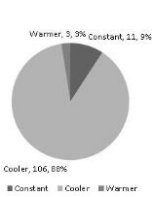
People visiting lake more than once have visited lake only twice since construction to regular daily visit making dispersity very high. This makes classification of these people very difficult.



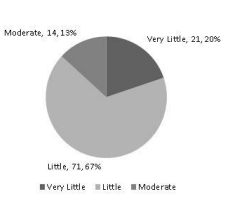
Questionnaire on Climate Change

Visitors

Difference in Summer Temperature



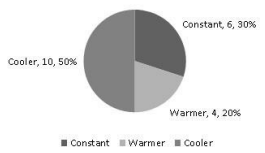
Intensity of Coolness



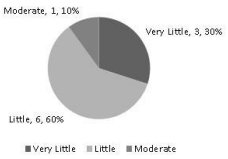
Questionnaire on Climate Change

Shopkeeper

Difference in Summer Temperature



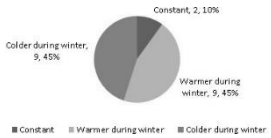
Intensity of Coolness



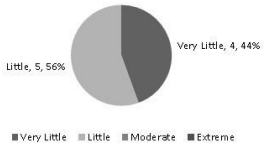
Questionnaire on Climate Change

Shopkeeper

Difference in Winter Temperature



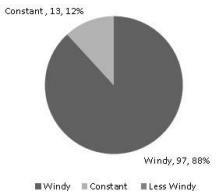
Intensity of Warmness



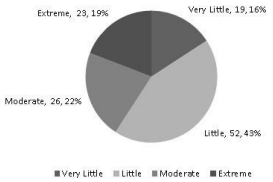
Questionnaire on Climate Change

Visitors

Difference in Wind



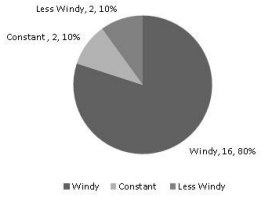
Intensity of Wind



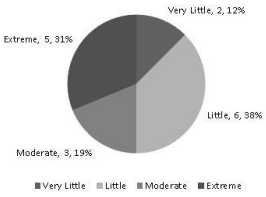
Questionnaire on Climate Change

Shopkeeper

Difference in Wind

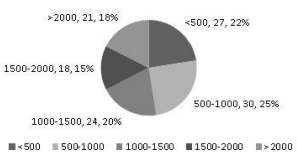


Intensity of Wind

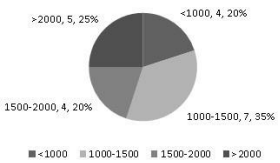


Questionnaire on Economy

Money spent by visitors



Money earned by shopkeeper



Economic Benefit to Municipality

Service charge from activities around the lake

Shopkeeper=Rs 700-Rs 1500 per month
Small Food Stall= Rs700 per month
Large food stall=Rs1500 per month
Photographer=Rs1500 per months
Horse Owner=Rs1500 per months
Camal Owner=Rs1500 per month
Boating=20% from each ticket

The revenue collected from the lake goes to Pradesh and the municipality.
40% of the revenue goes to Pradesh
Remaining 60% goes to the municipality

Analysis of Buffer Zone

As per the building code of our country Nepal, the setback for construction of structure shall be 50m from boundary of lake and 10m from boundary of canal. A canal is used to provide water to lake continuously.

Therefore, a 50m buffer around the lake and 10m buffer from canal edge was constructed using QGIS.

Buffer is a component of geoprocessing tool for vector data analysis which help to create a layer of polygon around a feature at fixed given distance.

This setback around lake is constructed to ensure protection of lake from unhealthy human activities as pollution.

Fig:- Buffer of 50m around lake and shop around the Buffer Area

Contd.

Similarly, setback along canal is made to ensure that the water of canal remains unpolluted which further make water of lake less polluted.

But the rule is being violated along the canal as well as around the lake. Numbers of houses are constructed along the buffer or setback area.

In around lake shops have been constructed to enhance economic activities but these shops shall be kept away from setback to promote lake health.

Not only person but also government is not properly observing where constructions are being done. Government is allowing people to construct along and inside the buffer zone. These problems may seem small now but they may lead to serious problem future such as pollution and destruction of lake habitats.

Fig:- Buffer of 10m around canal and houses around the Buffer Area

Change in Ground water table

Depending upon the position of lake, lake can either take water from groundwater along with surface runoff and precipitation or can provide water for groundwater downstream.

Ranjit Misra and Sugan Badal, Sub-Engineers, KII suggested that the Bharat Lake have increased the ground water table downstream of lake to area such as Rajghat, Soltee to up to Bharatwa (which is around 10km south of lake).

Bhagwat Mahato, Ward-4 Secretary, also suggested that the groundwater table have increased after the construction of lake.

Roads after construction of lake

After the construction of the lake, 3 road have been upgraded by widening and black topping.

The road along the river, called as Dam side road, was a gravel road which have been reconstructed and black topped.

The road passing through the edge of settlement was a pedestrian road which is widened and black topped.

The road east of the settlement have been widen and under construction for black topping.

Land Aspect

The price of land have been increased around the area.

KII informant suggested that the land price have been around double after construction of lake and is still rising.

People are not interested in selling their land at present so land transaction have been very less.

Future development Projects

After the construction of lake, a new wave of development have been started.

Bagmati Ghat and Park has been constructed along the river side of Bagmati River around the middle way to Bagmati Fishery Lake to promote walking from main highway to the lake.

A new mini open zoo construction project have been started at the Nursery (90 bigha) where at present mango and tree to provide food for zoo animals like Churi, Amala, Lapsi, Tooth, 1Kimbu have been planted. This lies just south of lake which will promote tourism and increase their stay at the municipality.

Fig:- Bagmati Ghat Purposed Plan and Approximate Location

Future development Projects

A small wetland project due south of lake have been initiated and will use lake water.

A open picnic spot and closed seminar hall is also under construction.

On ward 11, a funpark called Buddha Park along with a hiking route is under construction.

The vision of the ward is that a tourist will visit Bharat lake, observe zoo and wetland, go to funpark where there are hotels for night stay and during morning they can hike on the hiking route and complete their journey.

All these project concept have been started after the formal construction of lake.

Fig:- Bagmati Fun Park Purposed Plan

Problems

Due to increase in visitors, the lake area have been polluted.

The high increase in competition among shopkeeper have made few shopkeeper to leave the area.

Location Attribute Analysis

Bharat lake is located along the edge of Bagmati river.

The lake is about 160m from the bank of the river.

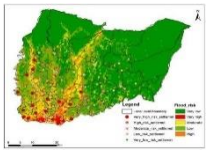
This lake can act as a retention pond during small flooding protecting nearby surrounding.

But during large flooding, this lake act as source of disaster.

Bharat lake have attracted huge population around the lake surrounding which is a flood plane area.

The population around the lake are vulnerable toward flood.

Fig:Bharat Lake and Bagmati River



Source:- "Flood risk modelling in southern Bagmati corridor, Nepal" (a study from Sarlahi and Rautahat, Nepal)

Implication

New town are being developed in our country.

These place need to attract new population for further development.

For attracting new population, the town requires economic activities.

Economic activities can be generated with construction of artificial lake similar to Bharat Lake.

Hence, if any place need to attract new settlement, then Bharat lake can be used as reference to these up coming new town to attract new population.

Similarly, this research can be used as a reference to observe how an artificial lake helps in changing the environment of the area.

Recommendation

- Encouraging and facilitating a variety of recreational and physical uses, such as jogging trails, fitness centers, cycling routes, fishing, paddle boating, restaurants that serve prepared food, gift shops, pottery shops, etc., in order to boost user activity.
- Create a more gracefully curved lakeshore by keeping the scene at a small scale
- Construct a continuous path for bicyclists and pedestrians. To improve the walking track, the necessary infrastructure facilities should be included, such as benches, drinking water fountains, public restrooms, small exercise areas, trash cans, light posts, and restrooms at each alternate location.
- The water channel supplying water to the lake and outlet taking water away should be maintained and enhanced via a variety of channels, and no construction plan should obstruct this continuity.

Contd.

- Fixing the lake boundary requires defining and demarcating the lake area..
- The lakeshore landscaping should incorporate greenery to create a suitable setback from the road and the residential plot boundary.
- Adhere strictly to the rules and legislation to stop the encroachment of the lake.
- Excavate sludge from the waterbed to increase the capacity to hold water.
- Prevent the direct disposal of trash into the lake to enhance the quality of the water. It is necessary to raise the amount of dissolved oxygen in the water by mechanical, chemical, and biological methods.
- Several government departments must be involved in lake management, and since there is frequently a lack of coordination between these organizations, an integrated high power management system is required.

Contd.

A buffer zone of 50m should be created.

Shop and restaurants around the lake shall be kept away from the buffer zone.

The path just next to the lake shall be made restricted area so that people will not go at the edge of the lake: this will help to prevent pollution on lake water.

Few viewpoint should be constructed for observing lake from near distance.

To prevent pollution from settlement, buffering of the community can be one of the method.

Fig:- Example of using Buffer zone

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Thank You !!