International Journal of Advance Research and Innovation
Vol. 10(1), Jan-Mar 2022, pp. 1-9
Doi: 10.51976/ijari.1012201
www.gla.ac.in/journals/ijari

Article Info

Received: 31 Jan 2022 | Revised Submission: 21 Feb 2022 | Accepted: 04 Mar 2022 | Available Online: 15 Mar 2022

River as "Lifeline of Urbanisation" - An Environmental Case Analysis

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ABSTRACT

Rivers and water are essential resources for human life, the environment and development of any nation. In India, the significance of rivers as the focal point of human settlement was established from the early times of civilisation and will remain so. Ancient India is always referred as land of seven rivers. Rivers here have religious significance but India's rivers are depleting at an alarming rate. Riverfronts are not merely unique spaces in a city, but also the most representative region which reflect the local character. Since the industrial revolution, urban population and the need for land have increased rapidly; a good many riverfront spaces have been occupied, resulting in the deterioration of water quality of the rivers. A case study on the degradation of river and their restoration is been explained in this paper using example of Hindon river and Yamuna River. The region of Ghaziabad is plain and lacks topographic prominence. River channels break the monotony of physical landscape. The major sources of waste generation within Ghaziabad largely comprise of residential areas, poor yojna area, vegetable markets industrial and slaughter waste open dumping of municipal solid waste quiet often in scattered heaps has occupies a larger space near the river. The land around the river Hindon is a breeding ground for pathogens, flies, malodours and generation of which leads to water pollution. The land can be completely bioremedised followed by development of beautiful garden "Eco-Energy Park - Hindon Eco Park" adjacent to Sai Upvan. The research aims at providing landscape solutions to eliminate the further degradation and pollution of nearby soil, air and Hindon river. Today, with the abysmal state of drainage and solid-waste management of the city Delhi, the Yamuna has become a huge drain carrying the waste of this mega city. Millions of rupees have been spent by successive governments in order to clean the river, but to no significant change in the situation. The spaces around the river are also rather 'lost spaces' with either agricultural field, derelict power stations, stadiums and memorials. With very high densities in the residential areas, it has to be realized that Delhi is in dire need of a large public open space. The study aims at reconnecting the city to the river not only metaphorically, but to establish physical linkages and improve the quality of the environment and create opportunities to activate the riverfront. The paper will focus on the causes, impact and measures of pollution of rivers in case of Yamuna and Hindon in NCR region.

Keywords: *Pollution; Urban spaces; Degradation; Riverfront; Landscape.*

1.0 Introduction

Rivers are the source of all civilizations and their growth. Ancient civilizations thrived along the rivers' paths and perished as the rivers changed direction. The Indus Valley Civilization, which grew along the plains of the Indus River ranges from the Arabian Sea to the Ganges, disintegrated due to climate change, which caused the river Saraswati, which was the source of monsoon water to the Hakra Valley in the Harappa civilization's desert region, to change course or dry up.Similarly Hindon with a huge catchment area and completely rainfed originates in Sahranpur District crossing many cities and lastly merging in Yamuna.The rivers reflect a strong sense of cultural and social value.The popularity has somewhere been one of the reason of pollution along with number of inhuman activities.The case study further details out various measures taken in bringing back the quality and real

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essence of the river and its water quality without disturbing and compromising on the social and cultural values.Holding the strategic locations and considering various factors, the proposal even reflect the recent sustainable solutions for eg adopting landscape values,planning of buffer spaces,providing alternatives to the sources of pollutant producing factories and various human activities such as religious and some time social events.

2.0 Case Analysis 1 – Yamuna River, Delhi

2.1 River Yamuna and its significance

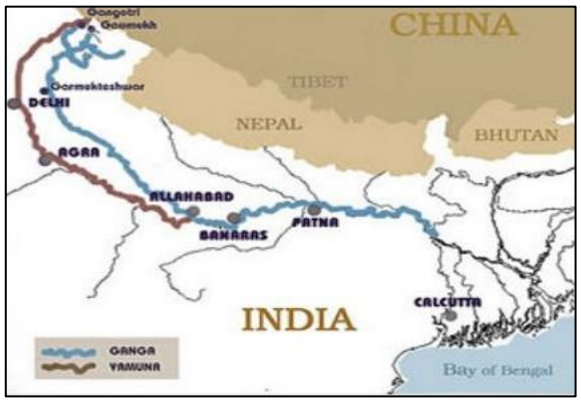
The Yamuna is the twin sister of Yama and the daughter of Surya (the Sun God) and his wife Saranya, according to tradition. A plunge in the Yamuna is thought to cleanse a person of all previous misdeeds and material contaminations. The River Yamuna is a cultural symbol and is regarded as a Goddess in Indian culture, in addition to being a traditional water supply. Many temple towns dot its banks, and their characters are shaped by the river.

The Yamuna and other water bodies served as the backdrop for monuments built along the river's banks, from Delhi's oldest city, Indraprastha, dating from the Mahabharata era (about 1450 BC), to the grand Mughal metropolis of Shahjahanabad (1638–1649). The city's significant monuments provide compelling evidence of prior cities' connections to the river.

However, with the 20th century and modernist city design paradigms, the river was viewed as more of an utilitarian component than a recreational one, with which the general public had no daily interaction. The city was facing the river with its back to it.

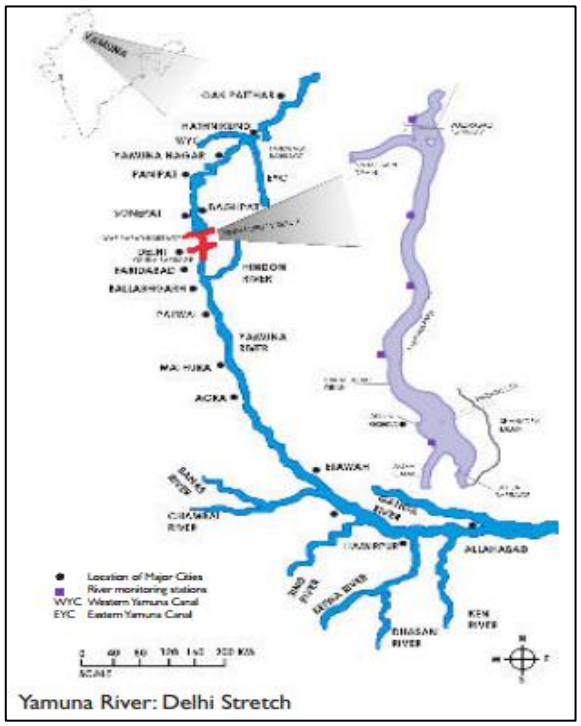
The Yamuna has now become a massive sewer conveying the garbage of this megacity due to the city's poor drainage and solid-waste management. Several administrations have spent millions of rupees to clean the river, but there has been no major improvement in the situation. The areas around the river are likewise a bit of a 'lost space,' with agricultural fields, abandoned power plants, stadiums, and memorials. With such high concentrations in residential areas, it is clear that Delhi need a significant amount of public open space. The research intends to not only figuratively connect the city to the river, but also to construct physical links, improve the environment, and generate chances to utilise the riverside.

Figure 1: Map of Yamuna River, India



Source: http://www.envis.nic.in/

Figure 2: Map of Yamuna River, Delhi Stretch



Source: Action plan for cleaning of river Yamuna, Delhi Jal Board

2.2 Origin and mythological history

The Yamuna starts in the Himalayas near Yamunotri, north of Haridwar. Saptrishi Kund, a glacial lake, is the Yamuna's official source. There is a barrage at Tajewala, 75 kilometres upstream of Wazirabad, that allows the river's waters to flow into the Western and Eastern Yamuna Canals. At a height of 211 metres above sea level, the Yamuna reaches Delhi from Palla Village. It departs the city at a height of 197 metresabove sea level, resulting in a 1 in 3000 gradient.

Figure 3: Yamuna at its Source at Yamnotri and Down the Himalayas

Figure 4: Yamuna: in Mathura. Ghats Located on the River. There are Total 25 Ghats Mathura

The River Yamuna is a cultural symbol and is regarded as a Goddess in Indian culture, in addition to being a traditional water supply. Many temple towns dot their banks, and their characters are shaped by the river.Yamuna is also mentioned in the Mahabharata as one of the Ganges' seven tributaries. Since time immemorial, bathing in and drinking Yamuna's waters has been thought to cleansesin.

Figure 5: Yamuna in Agra, The Yamuna Forms the Backdrop to in Taj Mahal

2.3 River Yamuna in Delhi

The River Yamuna's Delhi length is just 22 kilometres long, compared to its 1,370-kilometer trek from Yamunotri (its birthplace) to the ocean. Despite covering just 2% of the river basin's length, it accounts for almost 80% of the pollutant load in the whole span of the river. For over nine months of the year, there is no water in the river. The barrage built at Wazirabad, where the river enters the city, impounds water.

Sewage and garbage from Delhi's 22 sewers are the only things that end up in the river. In other words, in Wazirabad, the river vanishes. The river in the Delhi Zone was destroyed by low levels of dissolved oxygen (DO) and a high amount of pollution. The chapter will focus on the different elements that cause pollution in the Yamuna River, as well as the government's efforts to safeguard the river.

The water quality of the Yamuna River is degrading as pollution levels rise. Domestic wastewater, agricultural runoffs, mass bathing, religious offerings, clay idols, and other sources of contamination all contribute to pollution. The existence of several towns and cities along the Yamuna's banks, which use the river to dump trash, exacerbates the river's deterioration. As a result, it's now more important than ever to figure out how to clean up the river.

Figure 7: Wazirabad Barrage

Figure 8: ITO Barrage

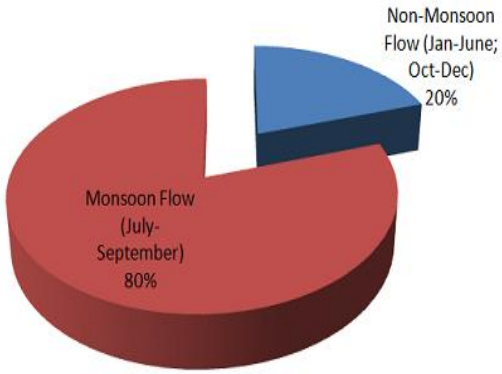
2.4 Flow of Yamuna river

Throughout the year, the river experiences both dry and flood conditions. The river is nearly dry in many portions of its run from January to June due to the high population density in the watershed, then floods from July to September.

The yearly flow of the river Yamuna is seen in Figure 9. The river flow decreased dramatically during the non-monsoon season (October to June), and some river portions became completely dry; nevertheless, during the monsoon season (July-September), the rivers receive huge amounts of water that exceed their conveyance capacity, resulting in floods (CPCB, 2006).

During its course, the river is dissected at five barrages: Dak Patthar (about 160 km from its source in Uttaranchal); Hathnikund (172 km from its source, just at the foothills in Haryana); Wazirabad (in NCT Delhi, 396 km from its source); Okhla (in NCT Delhi, 418 km from its source); and Mathura (in NCT Delhi, 418 km from its source) (Near Gokul village in U.P. about 570 km distance from origin). These barrages are the river's primary water abstraction points. The Yamuna River receives water from a variety of sources, including tributaries, canals, and drains from various metropolitan areas. Figure 10 depicts the flow in Delhi.

Figure 9: Water Flow Estimation in Yamuna River



2.5 Pollution sources of river Yamuna

The Central Pollution Control Board (CPCB), the Central Water Commission (CWC), the Delhi Pollution Control Committee (DPCC), and the State Pollution Control Board (SPCB) in India periodically monitor the Yamuna River at 19 places, as well as its primary tributary, the Chambal River near Udi. In addition, the Yamuna's twenty-eight major drain outfalls are being monitored. Until the confluence of the river Chambal, the organic pollution level in Delhi has increased dramatically, and the biochemical oxygen demand (BOD) level does not meet the mandated criteria for Class C category. The dissolved oxygen (DO) level in the same section of the river fluctuates from zero to well above saturation.

The existence of organic pollutants and the predominance of eutrophic conditions are reflected in this. The whole Yamuna River section has a high level of bacterial pollution. Figures 7 and 8 show the annual average DO and BOD values for the months of March through June. Cadmium, Nickel, and Lead are the heavy metals that are seldom found in the river, although zinc and iron are abundant. BHC is found in various areas of the country, although other pesticides including Aldrin, Dieldrin, Endosulfan, and DDT are uncommon. Micropollutants are most commonly seen during dry seasons, and they have been dropping in recent years. The whole Yamuna river stretches have been divided into five sections based on water quality: Himalayan stretch, upper stretch, Delhi stretch, mixed stretch, and mixed stretch.and diluted stretch (Table 1).

Table 1: Distinguished segments of River Yamuna

Section	*Origin-End*	*Length (km)*
Himalayan Segment	From origin to Tajewala Barrage	172
Upper Segment	Tajewala Barrage to Wazirabad Barrage	224
Delhi Segment	Wazirabad Barrage to Okhla Barrage	22
Eutrophicated Segment	Okhla Barrage to Chambal Confluence	490
Diluted Segment	Chambal Confluence to Ganga Confluence	468

Source: CPCB, 2006

Figure 10: Sources of Pollution in Delhi

2.6 Pollution of river Yamuna, NCT

Although the river is contaminated practically the whole way across the plains, it is most polluted during its voyage through the NCT. The following are the primary sources of pollution in NCT:

- Increasing human population density along riverbanks and people' inadequate sanitation habits.
- Domestic wastewater that hasn't been treated.
- Pollution from untreated industrial effluents; (agricultural runoffs; dead body dumping and cattle washing).
- Pesticide residues that go undetected and untreated produce a hazardous trail across the river.
- Religious activity and idol immersion.

Pollution assessed in terms of BOD load has grown 2.5 times between 1980 and 2005, according to monitoring data. The BOD load grew from 117 tonnes per day (tpd) in 1980 to 276 tpd in 2005. For over nine months, there has been no fresh water flow in the river. Water is held in reserve at the Wazirabad barrage, which was built by Delhi. The only water that flows after that is sewage and garbage (Table 2).

Water quality trend indicated increase in the number of coliform bacteria, TKN, ammonia concentration upstream of Delhi. After Delhi, the organic pollution and microbial contamination reflect increasing trend upto Allahabad.

Table 2: Water Quality of River Yamuna at Nizzamuddin, Delhi

1988			1996			2009		
DO	BOD	Total coliforms	DO	BOD	Total coliforms	DO	BOD	Total coliforms
1.9	18	1600000	0.30	25.00	147818	0.0	23.00	22516660

Source: CPCB (2006) and personal communication

Table 3: BOD in the River during 2007-2008, Delhi

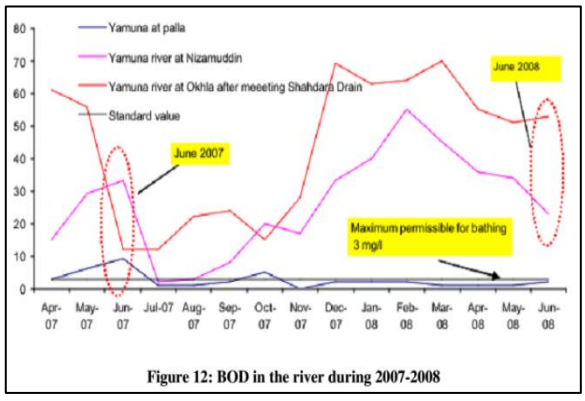


Figure 12: BOD in the river during 2007-2008

Source: Compiled from the water quality monitoring reports of CPCB during 2002-2008; CSE, May 2009

2.7 Restoration & conservation of river Yamuna (recommendations by NGT)

A river's restoration necessitates interventions that restore channel morphology (such as depth, bed features, and meandering), flow regime, water quality, biological diversity, and riparian and floodplain habitats in a way that assures their interconnections. The river's flow regime is the

master variable that governs all other elements and, as a result, the river's characteristics. The restoration of a river's flow regime and water quality is crucial, and it necessitates a catchment-wide response. All attempts to restore the channel, biodiversity, and floodplain habitats would be thwarted if wastewater is discharged without proper treatment and flows are not provided. Wastewater discharges must be efficiently managed, and the quality of treated effluent entering the river must be strictly controlled.

In an alluvial river like the Yamuna, channel habitat restoration necessitates dredging out of accumulated sediments and sludge, as well as some re-meandering. Riparian habitats require protection from erosion and periodic channel movement. Non-structural alternatives should be favoured, such as the planting of suitable plants. Riparian / floodplain zones connect a stream to its terrestrial catchment, and they can change, integrate, dilute, or concentrate pollutants before they reach a river. Floodplain habitats with adequate wetland vegetation assist to enhance water quality even further, and river water quality may be recovered to a pretty high level depending on the breadth of floodplain regions and the volume and quality of wastewaters. Floodplain restoration entails reconfiguring low-lying terrain to create ecosystems that encourage and increase flood protection.interaction between river and adjacent area through hydrological linkages. In light of the following:

- Because of near-stagnant circumstances and the discharge of solid wastes, the river channel has silted up in several places.
- Due to a lack of river flows, most portions of the floodplain have silted up, and significant areas have been elevated by dumping soil, debris, and solid building wastes.
- The floodplain biodiversity has been drastically changed and diminished as a result of excessive development of weeds such as water hyacinth and untreated sewage discharge, or as a result of farmers filling up water bodies for farming. Floodplains have lost their natural roles.
- Over time, groundwater recharge has decreased.

The following measures are being taken to restore and re-naturalize the current river channel and remnant floodplains in order to restore natural river functions, improve water quality, and increase groundwater recharge:

- On the floodplain, all garbage dumps and solid wastes must be removed.
- All encroachments and structures, such as bunds, walkways, nurseries, and dwellings, must be removed from the floodplains indicated below for each subzone.
- All silted up portions of the river channel should be dredged to remove organic muck/sludge, and the natural levees (river banks) must be protected by appropriate trees, shrubs, and grasses that naturally occurred in the area in the past.
- Dredge and extend any water bodies/shallow marshes on the floodplain so that they can retain enough freshwater during the rainy season, help recharge groundwater, and be utilised to grow fisheries (or act as natural breeding/feeding grounds for riverine fishes).
- Treatment wetlands should be built in the higher elevation regions of the floodplain (about 100-150 m belt along the two main embankments) to improve the water quality of the wastewater that will be permitted to pass through them after treatment in the STPs (or in situ treatment on storm water drains).
- Access to the river channel for social, cultural, and religious purposes should be permitted at pre-determined places to prevent the development of pucca paths/roads and lined Ghats. Because the river's flow is heavily limited and regulated, many of the spurs have lost their original role. Their length can be limited in order to give the river channel more room to meander and transport more water.
- Several large culverts must be installed in the guide bunds of various road bridges/flyovers to allow free flow of water, connectivity for wildlife movement (such as fish and reptiles), and to prevent road/bund damage during severe floods.

The supply of Environmental Flows across the whole 52 km course will be critical to the river's successful restoration for its biological services and future viability. Despite a previous Supreme Court order to provide 10 cumecs of freshwater flow downstream of Wazirabad, the required flow has yet to be provided. The Committee advises that the Environmental Flows criteria be re-evaluated for the whole 52-kilometer span, particularly during the lean

season, and that the needed flows be ensured as soon as possible.

River policing by a specialised unit should be enforced by the individual governments to ensure the ecological integrity of the river, to prevent encroachment and dumping of solid wastes, and to prohibit unlawful structures and unregulated farming.

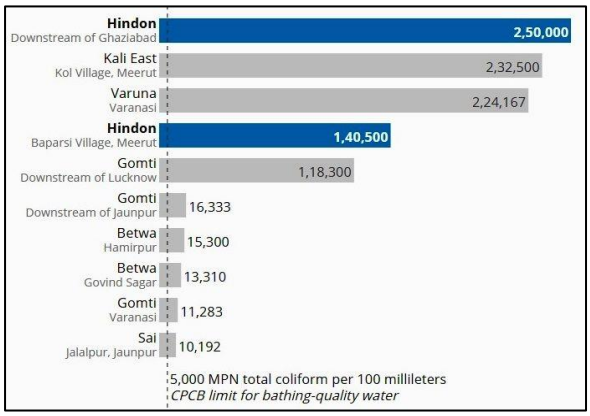
The Committee recommends the formation of an autonomous society or trust, such as the Delhi Biodiversity Foundation, to promote public awareness about river Yamuna conservation, society participation in river restoration, and long-term studies and monitoring of riparian ecosystems and their management.

3.0 Case Analysis 2 – Hindon River, Ghaziabad

Hindon River, a tributary of the Yamuna River and also known as "Hamandi," is historically and religiously significant. The river begins in the Saharanpur area and flows through different civilisations, bringing sustainability and other advantages. In the current situation, the river is on the edge of dying since the poisonous level in the river water has reached dangerously high levels. The Hindon River is intensively used as a water resource for home, agricultural, and industrial applications, while untreated groundwater is the principal supply of drinking water in this densely populated and mostly rural basin. The river receives all of its water from rain and has a catchment area of 7,083 square kilometres (2,735 sq. mi).

3.1 Contamination of Hindon

Figure 12: Contamination Level of Different Water Bodies



Source: Central pollution control board, water quality data report 2014

The Hindon River area has revealed a diverse range of highly acutely toxic organochlorine and organophosphorus pesticides and heavy metals in high levels in river water and groundwater throughout the catchment, exceeding all international and national standards that declare its water unsafe for bathing, drinking, and other household purposes. Industrial wastewater and untreated domestic sewage are the primary sources of river contamination.

The Central Pollution Control Board rated the river "unfit" for bathing in a 2015 study. Almost 400 towns relied on Hindon River water until the life-giving water began to induce chronic illnesses that led to death. According to official statistics, 151 of the 400 settlements on the river's banks have reported cancer, neurological and digestive diseases, and skin and respiratory infections as a result of the polluted water. Locals living near or in the affected areas have expressed their displeasure with the river's plight. They claim that "deterioration began when manufacturers began to arrive in the 1980s." The water is now so filthy that it causes medical problems, and people here eat more drugs than food.' They chastised governments for their inaction, claiming that "rivers don't bring votes."

3.2 Site selection and proposal of Eco park

The Ghaziabad Nagar Nigam is an Urban Local Body in charge of collecting, transporting, and disposing of solid waste in compliance with municipal waste regulations. There are 130 acres between SAI UPVAN and the railway line. The area of land is Hindon Air Force Station's "Air Funnel." Because of the vulture threat, the air force officials have prohibited further MSW disposal at this site and sought control measures. Ghaziabad Nagar Nigam has given the go-ahead to develop the whole 130-acre plot. It has been agreed that this region would be developed in two stages. The total site area is 52.60 acres. The goal is to repair and improve the site by restoring ecological diversity and reducing pollution and degradation.

The project will result in the elimination of additional degradation and contamination of the surrounding soil, air, and Hindon River. The idea is to restore wealth where there is pollution and destruction. Every part of the park must try to show a strong dedication to the environment. The park will produce its own water by collecting storm water. The Park will contain numerous aspects that will be

shown in a practical approach to sensitise people to the environment. It will be a centre of excellence and lifelong learning for the city of Ghaziabad in Ecology, Sustainability, and environmental education.

Figure 11: Old Dump Site "How it Looked" Before Work Began

3.3 Design concept - Eco park

Parks are public green spaces. In general, the places feature a profusion of trees and plants, grass, and other facilities (such as benches, playgrounds, fountains, and other equipment) that allow for leisure and relaxation. Ecological, on the other hand, is an adjective that refers to what is related to ecology. In its widest definition, this latter term (ecology) refers to the interactions that keep living creatures connected to their surroundings. Natural landscape preservation and the protection of vulnerable animal habitats go a long way toward offering an environmentally sound and cost-effective solution. Trees take a long time to mature, and mature trees or stands are extremely valuable to park visitors and animals. Furthermore, maintaining natural landscapes may increase biodiversity and aid in the conservation of critical natural resources such as water.

Working with the land's natural structure, taking cues from its terrain and vegetation, ecological harm may be avoided, lowering building costs while producing a park with its own feeling of place and distinctiveness. There is a rising desire these days to build parks with a "signature aspect" that distinguishes them. Simultaneously, we recognise the necessity of giving both children and adults with access to nature. One method to fulfil these aims, especially on a restricted budget, is to preserve the natural environment, even if it means foregoing some of the more usual planned aspects. Creating a park that makes use of and reveals natural processes.

Similarly, cultural items that are still present on the site should be included into the design to create a historical perspective. This not only serves as an educational component, but it also fosters stewardship, which is essential for any effective open space. It is also critical to provide social venues for individuals to engage and create social capital. Suburban development, like many small towns and even major cities, lacks a central gathering area or town square. Parks are increasingly becoming locations where individuals can network and establish community.

3.4 Resource conservation

Conserving resources is critical to creating an Eco Park that is as efficient as possible. Selection of existing disturbed terrain and placement of buildings to take use of natural day light, ventilation, and solar gain. Rainwater harvesting and the design and implementation of efficient irrigation systems to limit the quantity of storm water delivered to the storm sewer, celebrate and hold storm water on-site. Wetlands should be restored and created whenever possible to improve flood management and water quality. Using native species and eliminating trimming by allowing plants to develop their natural shapes and providing adequate area for development. Socially, the room may be livelier and designed in such a manner that it encourages social meeting spaces and public inclusion.

4.0 Conclusion

The potential aspects of rivers and their impact on city life and surroundings considering ecology also, is explained in the paper. Rivers in an urban fabric are an opportunity for the designer or an architect to make the lifeline stronger; by making the waters connect with the people living in the city.

Ecological landscape design is one such example where the design aspects are based on an understanding of the environment's ecology, resulting in a complete, dynamic, responsive, and intuitive approach. It is comprehensive in that it examines both the past and the present, as well as local and regional landscape patterns and processes. It is responsive because it is based on an awareness of the constraints and opportunities of context, whether natural, cultural, or a combination of the two.

Maintaining landscape integrity, supporting landscape sustainability, integrating riverfront development and improving the natural and cultural character of place are factors that guide ecological landscape design. Two avenues of inquiry led to the creation of ecological design. Ecological landscape design, on the other hand, makes use of fundamental ecological principles.

The degradation of river Yamuna and Hindon seems to be on parallel line due to external factors.River yamuna's rejuvenation is based on its integrated riverfront development and revival of river Hindon is based on the reworking and applying the ecological priciples on the surrounding areas.Input from these two lines of study serves as the foundation for ecological landscape design, which is defined here as incorporating four overlapping features.

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