Sugam Sarita

Revival of the Indian Rivers

A Research Led Study

Authors :
Dr. Shilpa Kulkarni, Prof. Gopa Das, Prof. Pritha Ubgade

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Deccan Education Society

The Deccan Education Society (DES) was established in 1884, registered on 13th August 1885 by the five towering personalities of the Indian freedom struggle, Lokmanya Bal Gangadhar Tilak, Shri. Gopal Ganesh Agarkar, Shri. Vishnu Shastri Chiplunkar, Shir. Mahadeo Ballal Namjoshi, and Shri. Vamanrao Apte & was ably supported by Shahu Maharaj of Kolhapur. In the pre-independence era these visionaries realised that the education which prevailed in India under the rule of the Britishers was to create products only to serve the Britishers. The system did not teach the people to question, criticise, create, and reflect their thoughts. It was simply a system that perpetrated the slave mentality. Hence the common mission for establishing DES was to reverse the then existing scenario and give rise to a progressive mindset.

In the view of the founders, 'Education was the means of rousing the intellect, the drooping will, and the slumbering conscience of their fallen countrymen'. At a time when the concept of democratic practice was just being conceived in India, DES decided to adopt a democratic structure for its own governance. Thus, it became a model for teacher-managed institutes in Maharashtra and symbolized the 'People's Own Initiative' in evolving education as a means of national regeneration.

DES's Institute of Management Development and Research
(IMDR®)

DES's Institute of Management Development and Research (IMDR®), Pune was founded by late Padmashree Dr. Ramesh T Doshi and Late Shri. Sumatilal Shah and was established as a constituent unit of Deccan Education Society in May, 1974. IMDR is the first management institute started in the Pune. IMDR offers two years fulltime Post Graduate Diploma in Management approved by All India Council of Technical Education (AICTE), New Delhi and recognized by Director of Technical Education (DTE) Maharashtra.

IMDR is a community of students, staff and faculty striving to be vibrant with learning processes in which individuals discover themselves while being productive with their capabilities and creative with their energy.We also nurture relatedness with the world outside so that we grow by sharing the wealth of knowledge and experience

IMDR is committed to the kind of Management Education which contributes to enlightened management practice and sustained growth of work organisation. Our students should be helped to become thoughtful and sensitive professionals,with a commitment to simultaneously contributing to the environment and the self.

PREFACE

Since ancient times, rivers have been a vital part of human life. Civilizations have been built with rivers as their backbone and have flourished only due to their proximity to water. In today's world, with advancements in technology and improved water transportation and provisioning systems, many big cities have spread away from their roots of river banks.

However, with the rapid development, a noticeable deterioration of rivers can be seen. The Central Pollution Control Board (CPCB) in 2018 identified 351 polluted river stretches in India. The assessment of water quality for identification of polluted river stretches found that 31 states and Union territories (UT) had rivers and streams that did not meet the water quality criteria. These states / UTs have to submit their action plans for the same. But there are other initiatives undertaken by various NGOs and institutions to save the rivers.

The purpose of this study was to sensitize students about the deteriorating conditions of the rivers by making them visit the riverbanks. For this study, each student must visit 6 points near the river of their choice and fill up the questionnaire, which is asking them about the condition of the river. 260 students have collected the data from which 1273 responses were collected by the students of IMDR for PGDM- I and PGDM - II.

The results have found that not only students visited and studied multiple rivers across the nation but were able to identify the river restoration projects. This book has analysed all the data collected by the students and they have even made suggestions on how to restore the river. This study is able to contribute in fulfilling IMDR's Mission, which is to make thoughtful and sensitive professionals.

FOREWORD

Mr. Atul Kirloskar
Executive Chairman,
Kirloskar Oil Engines Ltd.

पृथिव्याम् त्रीणि रत्नानि जलमन्नम् सुभाषितम् |
मूढैः पाषाणखण्डेषु रत्नसञ्ज्ञा प्रदीयते ||

There are three jewels on earth: water, food, and adages. Fools, however, regard pieces of rocks as jewels.

Mother Earth looks absolutely stunning with its radiant blue color from the surface of the Moon. About 71 percent of the Earth's surface is water-covered and Oceans hold about 95.5% percent of all Earth's water. Only 4.5% of water is potable and just 3% of water is fresh water. Rivers are part of the freshwater sources which are closest to human establishments. Rivers have been the base of civilization since ancient times. For many years' river water was the source of life and livelihood. Agriculture-oriented civilizations worshipped rivers and created towns around them. The civilizations depend on rivers and had many rituals planned around water. Daily connection with rivers was essential activity and hence the rivers were worshipped and taken care of. As time has advanced humans now do not need to visit rivers on daily basis thus bringing negligence and apathy IMDR being a socially inclined management institute decided to reconnect the youth with rivers and the research project "Sugam Sarita" was undertaken. Su-gam means easy to understand. The research project has initiated students to visit and understand the importance of rivers for human existence. It brings immense pleasure to assimilate the research-

based book Sugam Sarita led by students and faculty teams at IMDR. The book throws light on the various connection between rivers and livelihood, economics, and ecology. The meticulous research by the majority of the students on the Mula and Mutha rivers and a few more rivers around Pune city shows the importance of connecting with the rivers.

The initial chapters describe the rivers in research more in detail and add the required background for the book. These chapters outline the current status of rivers. Students collected empirical data which was analyzed and later presented in the chapters. Rivers have a deep impact on society. The book further outlines rituals and traditions which are still associated with rivers and the section of society which still has livelihoods dependent on rivers. Recreational activities, fishing, and agriculture were few directly river-dependent activities and the industrial ecosystems which were also dependent on rivers for water as resources were also considered for the studies.

The study also helped to understand the water pollution aspect. Water Pollution is now a harsh reality. The research analysis depicated alarming results. If the current state continues then we may not have potable water and soon water will turn into currency. The book has about three dedicated chapters which talk about biodiversity around the rivers, waste management of rivers, and pollution as they are interconnected. Industries are always the backbone of the growth engine. The research analysis of the industries around rivers has shown that leather, textile, and pharma are the major water-centric industries. The Waste Management chapter outlines the various efforts taken by the respective governments and also addresses the issues of waste management in rivers.

Transport is life line of growth National waterways project –Jal Vikas Marg Project has been initiated to bring trade benefits, the local community's enhancement and passenger facilitation will also ensure large-scale skills development and boost public/private

sector capability. In line with the Indian Government vision the research has undertaken waterwyas as of the aspect. The research carried out shows the current waterways systems in India and later talks about the possibility of inland water transport in Pune city. The river transports show the current waterway in India and also throw light on the possibilities of waterways and the need in and around Pune city.

The analysis shows the levels of potable water have gone down as we move from rural to urban geographies. Thus the revival of the rivers becomes inevitable. The book ends with a chapter dedicated to river revival strategies and implications. The research hence covers major aspects of rivers. Ecology, economies, transport, and biodiversity. As they say, each step that goes near nature is a step towards a better future. IMDR team has just done that to make this book a page-turner.

ACKNOWLEDGEMENT

First and foremost, praises and thanks to the God, the Almighty, for His showers of blessings throughout the research work to complete this book successfully.

We would like to express our deep and sincere gratitude to Dr. Sharad Kunte - Chairman, Governing body and council, Deccan Education Society for giving us the opportunity to do research and providing his invaluable guidance throughout this book.

We are extremely grateful to Shri. Mahesh Athavale - Vice Chairman, Governing body and council, Deccan Education Society and Chairman, Local Management Committee, Deccan Education Society's IMDR, for his constant support and encouragement.

We extend our heartfelt thanks to our IMDR family, our faculty colleagues, and the non-teaching staff for their genuine support throughout this journey.

We acknowledge and appreciate the efforts of our students in conducting the survey, gathering information and making the research work more perfecting by capturing the real time photographs. A special thanks to all our respondents for sparing their valuable time in sharing their responses and experiences which made the book more enriching.

And like they say, "a book without a reader is like a heart without beats." So, here's a big shout out to all the readers- Thank you for taking the time to read our book on SUGAM SARITA, penned in our words.

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CHAPTER 1
Rivers and the Indian Society

Some of the most dynamic and complicated landscapes are those that are formed by rivers and their basins. Perhaps the most important element for life on Earth is freshwater, which supports global human population, economies and ways of life while also being crucial for ecological health. Naming the rivers that originate on the snow-capped Himalayan peaks and flow onto the Indian subcontinent is equivalent to reciting a spiritual chant. The names Ganga, Yamuna, Saraswati, Alaknanda, and Bhagirathi are ingrained in the collective mind of the people in India. Indians venerate their rivers as goddesses and see them as holy. They serve as a lifeline for the villages, towns, and cities along their route and are intricately connected to the history and culture of the region. They are also a part of rituals and celebrations.

Since water is ultimately the source of all life, many great civilizations have developed alongside rivers and in their surrounding lush valleys. The thought of the Himalayas' perpetual melting of snow and supplying the world's great rivers throughout time is truly amazing. The great prehistoric culture and civilisation along the river Indus developed around the same time, i.e. 2500 BC, just as the Nile watered the valleys of Egypt and made them fertile, the Euphrates and Tigris encouraged the growth of Babylon, Mesopotamia, and Sumeria, and the great civilization of China arose along the two rivers Hwang Ho

and the Yangtse.

With five tributaries that were split between India and Pakistan after Partition, the Indus or Sindhu begins its journey in what is now Pakistan. The subcontinent's most imposing feature is the huge river Indus, which also served as the birthplace of its first known civilization. This civilization thrived in the Indus Valley and spanned a wide span of the surrounding areas. The Ganga and Yamuna are the other two main northern rivers, and their significance has expanded from being purely utilitarian—fertilizing valleys—to becoming metaphors for Indian culture on the cultural and religious levels. The Saraswathi, which was once thought to be another huge northern river, is believed to have submerged.

In South India, the Krishna, Godavari and Kaveri are represented as something that transcends the simple reality of flowing water and becomes a part of the enduring philosophy that permeates their existence. The river itself becomes a metaphor for life itself because of its various moods, changeability, mutability, and permanence. The wide expanse of the river is compared to the calming flow of a mother's love, which is all-accepting and forgiving in its nature. The river also symbolises the flowing path of human life, with its eventual conclusion in the wide seas of the sea, in both folk poetry and religious tradition. The tradition of dispersing cremated remains in the Ganga or any other sacred river, which dates back thousands of years, reflects the Indian people's unwavering faith in these bodies of water and their ability to carry souls from one life to the next through Karma and the river's all-encompassing embrace.

For many years, freshwater has been viewed as a natural, asocial substance that can be objectively known and, to maximise its

potential as a resource, controlled and regulated for human welfare. This is how water resource management has been conceptualised and applied in more industrialised parts of the world.

The modern idea of water as a substance removed from social, cultural, and religious context has come under increased scrutiny for a variety of reasons. As a result, there is more attention being paid to the historical, political, and cultural aspects of water in addition to its environmental aspects.

The fundamental idea is that water systems, like rivers, and society coevolve and emerge through ongoing engagement over space and time. This idea is at the heart of the viewpoints emerging from socio-hydrology and the hydro-social cycle, even though they are based on different knowledge paradigms. Rivers have supported human populations for millennia, and human societies have used and changed river flows in many ways. However, during the past century or two, the degree of human impact on rivers and watershed habitats has increased significantly.

The Sustainable Development Goals are one worldwide framework that aims to address complex, interrelated social concerns as a result of the growing scientific recognition of the mutual structure of society and water (SDGs). Along with other SDGs focusing on peace, justice, climate, conservation, and well-being, SDGs also ensures the availability and sustainable administration of water and sanitation for everyone specifically aiming to integrate water and social ties.

The UN Sustainable Development Goals now include a specific water goal, and the UN Secretary-General established a High-Level Panel on Water in 2015, reinforcing the idea that the research and policy

communities face a significant cross-disciplinary challenge when it comes to ensuring water security. The economic (World Bank, 2016; World Economic Forum, 2016), security (US Intelligence Community, 2012), social (Zeitoun et al., 2016), engineering (Royal Academy of Engineering, 2010), and environmental components of this dilemma have all been previously examined by commentators.

Rivers, lakes, wetlands, and aquifers are the main sources of water for human use, along with direct rainfall. In addition to providing numerous other environmental functions, rivers and related wetlands have intrinsic value for many civilizations.

Source: www.mapsofindia.com

River flows unite and support a variety of cultural beliefs, values, and ways of life by linking people, places, and other forms of life. The idea of environmental flows offers a framework for better understanding the interactions between river flows and humans and for fostering

those that are mutually advantageous. However, most of the methods for figuring out environmental fluxes continue to be based on the biophysical sciences. River flows are connected to livelihood, identity, sense of place, religious beliefs and rites, linguistic systems, and educational activities for many people and cultures around the world. Although these ingrained, reciprocal, and fundamental connections between people and rivers are still little understood, they can be extremely significant for the evaluation and implementation of environmental flows.

Environmental flow enthusiasts are also becoming more and more aware of the significance and complexity of interactions between people and freshwater ecosystems. The phrase "environmental flows" refers to the amount, timing, and grade of freshwater flows and levels required to sustain marine ecosystems, which support human cultures, economies, sustainable livelihoods, and well-being. A crucial first step in establishing a socially acceptable threshold between water available for off-channel allocations and water to be retained within or returned to a waterbody to sustain ecosystems is environmental flow assessment, also known as environmental water allocation or environmental water management. Although all aquatic ecosystems are included in the study of environmental flows, the focus of this research is on rivers and their social interactions.

The rivers in India are revered by countless individuals. According to sacred Hindu writings, they are "turbulent, sportive, flowing, quick, leaping, and booming,". People in India have created traditions, beliefs, and practices throughout the millennia that reflect and complement the natural rhythms of the river. They rely on the rivers for their daily needs of drinking and washing water. Cultural identities must be

maintained through rituals like ceremonial bathing and meditation as well as traditional techniques like flood recession farming.

Civilization use to worship rivers as there livelihood was dependent on rivers. Fishing, agriculture, domestic usage is still dependent on rivers.

Later, people discovered that crops do well in the fertile soil near rivers. The rich river plains of the Nile in Egypt, the Indus in southern Asia, the Tigris and Euphrates in the Middle East, and the Huang (Yellow) in China are where the world's first great civilizations emerged.

Source: www.indiamart.com

When communities and industry grew, the rushing water of rivers

provided the energy needed to run equipment.

The primary sources of fresh water for both humans and a variety of all living species are rivers. The river system is changing from a healthy, sustainable unit to an unsustainable one because of extensive human involvement. Therefore, it's critical to understand the dynamics of the river system and the variables that affect them completely.

Source: Britannica

We are unable to imagine life on Earth without water. Water is essential for human survival as well as that of animals and plants. When humans first learned to talk and understand language, they created several writing scripts to describe their feelings regarding rivers. Because of this, rivers were a key theme in every culture, civilization, folktale, and work of literature. In Indian culture, rivers are referred to as the mothers of people. Indian culture, civilisation, religion, and literature are all influenced by rivers. Hindi literature describes how important rivers are to daily life. For food, hygiene, cereals, and other daily necessities throughout the ancient era, the man was fully dependent on rivers. Because, these rivers came to represent spiritual

authority and conviction. Rivers served as a method of maintaining the heavenly existence as well as a means of enhancing it (Parlok). Even today, during the month of Maagh (January–February), millions of people, including both Indians and foreigners, congregate at Prayagraj (Allahabad) for the "Kumbha," the world's largest religious assembly, to atone for their sins and receive divine blessings. Throughout all the Vedic literature, this coexistence and bonding have been conveyed in a very emotional, realistic, compelling, and aesthetic way.

Rivers provide several advantages for humans, and there has long been knowledge of the relationship between river systems and human civilizations. Their basins are impacted by large-scale anthropogenic and natural disturbances, which frequently have detrimental effects on people. The rivers' potential to be a source of livelihood and to spur economic activity surrounding them was the main driver behind these improvements. The size of rivers as a source of the economy rose throughout this time as human civilizations across the country started to advance.

River valleys provided the ideal environment for the development of human civilizations. Even in current times, mostly major cities are located near rivers. Because a river satisfies many daily necessities of modern human life, places near rivers are more effective at luring people to settle there. As a result, it aids in the growth of a city where there are countless prospects for economic growth. Cities like Agra (R. Yamuna), Varanasi (R. Ganga), Guwahati (R. Brahmaputra), Prayagraj (confluence of R. Ganga and R. Yamuna), Delhi (R. Yamuna), and Kolkata (R. Hooghly) were built and developed mostly because of their proximity to rivers.

Source: India Today

The Sabarmati Riverfront Development project in Ahmedabad is one of the most important initiatives. These changes have aided the region's socioeconomic climate improvement and eventual urban development.

Water is associated with every social facet of life in Indian culture. After the puja rites of devotion, divine water is drunk in the temple. Idols of worship are also sprinkled with water (abhishekam). The plantain leaf which is used for food is washed with holy water and in many religions prayer is performed with water in hands. The significance of water in Indian culture is further highlighted through several additional rites. The Holy River Ganges is described in mythology as the spring that flows over the Himalayan landscape, first reaching Haridwar and subsequently Benares. It is associated with Lord Shiva. Since the Holy River Ganges is the Hindu symbol for soul purification and mental renewal, people from all over India gather to take a dip in it to wash away their sins. Other rivers with rich agriculture and plantations on their sides, such as the Brahamaputra,

Indus, Godavari, Krishna, Narmada, Cauvery, and Mahanadi, are also significant locations in Indian culture. The culture, tradition, and history of the state of Tamilnadu are deeply entwined with the Cauvery River. The Mettur Dam is built across the river, holding water that would later be released for the agriculture of wet fields. The Aadi Perukku festival (Adi means a Tamil month, Perukku means swelling) is held in the middle of July when the river is at its full flow.

The water level reaches the dam's highest point during the Aadi Perukku (nearly 120 feet). After that, the water is released to help farmers with irrigation and crop cultivation. People congregate around the dam and its surrounds during the festival to perform pujas (prayers) for Cauvery, the mother. On the eighteenth day of the month Aadi, the gods' weapons are cleansed in remembrance of the Mahabharata epic figures, the Pandavas and Kaurava, who fought for eighteen protracted days. A ruler of the Chola dynasty named Karikalan used stones to construct the Kallanai dam close to Tiruchirappalli during the second century AD.

Source: www.theconversation.com

How closely the people's lives are centered around this river is demonstrated by a recent dispute over the sharing of Cauvery water between the states of Kerala, Tamil Nadu, and Karnataka, where the river originates. Due to the ongoing depletion of river water brought on by climate change, water conservation has taken precedence over all other agricultural objectives. The dams that once aided in conservation no longer get enough water, and even during the month of Aadi, the Mettur Dam does not fill to capacity.

Very often referred to as tank management, is one of Tamil Nadu's oldest water management techniques. There are two varieties: system eri, which aids in the storage of both river and rainwater, and non-system eri, which exclusively stores rainwater. This technique aids with flood control, rainwater storage for paddy farming, ground water recharging, and the reduction of soil erosion.

Buildings are now being built right into historic water reservoirs like lakes and ponds because of urbanisation, as is the case in Chennai and the area around it. Such encroachments hinder water movement during rainy seasons, which can result in severe flooding, property loss, devastation, and destruction, as was the case in Chennai city in 2015.

Every state in India contains ancient water storage facilities, like those in Tamil Nadu. Jhalaras, which are rectangular step wells that catch water seepage from a lake or reservoir upstream, are common in Rajasthan. To furnish water for ceremonial purposes, religious rituals, and communal use, Jhalaras established a supply route. Another sort of step well is a bawari, which is used to store water that can seep into the earth and increase the level of the water table. A system of stacked steps was constructed around the reservoirs to constrict and deepen the wells to reduce water loss through evaporation.

In Udaipur, talabs are another type of reservoir that stores water for drinking and domestic usage. Such reservoirs may go by the names talai, bandhi, sagar, or samand, depending on the region. Ahar-Pynes are a type of traditional floodwater harvesting method that is unique to South Bihar.

One of the earliest methods of ground water recharge and conservation are johads. These tiny earthen check dams, known as pemghara in Odisha and madaka in Karnataka, are used to store rainwater. In Waynad, Kerala State, water is kept in wooden cylinders that are four feet in diameter and depth and constructed from natural palm stems.

A kund is a circular subterranean well in the centre of a saucer-shaped catchment area that gently descends in that direction. The primary function of it is to collect rainwater for drinking. The sandier regions of western Rajasthan and Gujarat are dotted with kunds, which are blanketed in lime and ash as a disinfectant.

Baolis are step wells for storage and distribution, with their lovely arches, carved decorations, and additional rooms. Village ponds called nadis are used to store water from irregular rains.

Source: Wikiwand

People near Tuticorin and Kanyakumari collect rainwater in large brass pots and store them in their homes before boiling it for drinking. This method is used by the Mewar Krishak Vikas Samiti (MKVS), an organisation that works to reduce sand deposits by building spillways and silt traps. Rainwater is also collected by Keralites, who then boil it before adding siragam (cumin seeds) and consuming it.

Our predecessors' combined goal was for future generations to profit from the ancient wisdom of water conservation. For the present day, we need to examine and create an eco-friendly way of water storage, purification, and conservation that may draw on the knowledge of our forefathers.

The Indian peninsula has been blessed with sizable perennial and seasonal rivers that decorate its wide topography and support a variety of social strata. Indian Peninsular Rivers, such as the Krishna, Kaveri, and Godavari, have importance on both a regional and international scale. People live in the communities around these rivers because they can get clean water, food, housing, transportation, and recreational opportunities. Resonating with the notion that river systems are designed by nature to support life. However, over the past few decades, Indian rivers natural radiance and force have gradually decreased, creating an unfavourable situation. These rivers may soon reach their limits at their very core!

India's culture and civilization place a high value on the water. The Ganga, Yamuna, Narmada, Mahanadi, Kaveri, Krishna, Brahmaputra, Ravi, Beas, and Sutlej are just a few of India's major river systems. White water rafting and canoeing are popular water sports on Himalayan rivers like the Jhelum and Chenab.

In addition to supporting life and offering rest, rivers are revered by many religions, particularly Hinduism, as holy and pious places. Indians believe that taking a holy bath in one of the holy rivers will remove one's sins and fear of dying. Of the seven holy rivers—Yamuna, Sarasvati, Godavari, Kaveri, Narmada, and Kshipra—Ganga is regarded as the holiest. The majority of rivers are personified as goddesses since they are seen as feminine.

Source: www.Sandrp.in

Bhima River

The Ganga River is a symbol of spirituality in India. It's been portrayed as a holy icon forever. Hinduism is centred on this river, and the Vedas, Puranas, and the two Indian epics Ramayana and Mahabharata all contain writings that speak of its holiness and glory. Hindus who pass away are burnt, and their remains are then dumped into this river. It is thought to cleanse their soul.

Yamuna is revered as an ancient river that once flowed through north India during the Vedic era and is thought to be the consort of Lord Krishna and Sarasvati. Since Nashik is located on banks of the holy river Godavari it is the location of the Kumbh Mela, a significant pilgrimage event. Tamil literature mentions the sacred Kaveri or Cauvery, which originates in the Western Ghats' Brahmagiri Hills.

Hindu mythology holds that the Narmada River purifies human souls by her divine gaze and cleanses them of all sin. From the Vindhya mountains, Kshipra lowers and flows across the Malwa Plateau to meet the Chambal River.

Source: theweatherchannel.com


UASC

CHAPTER 2
Economical Avenues at the River Banks

The rivers of India are of great economic importance in the lives of the Indian people. One of the earliest settlements in India, the Indus valley civilization, started on the river banks as the rivers have the potential to become the source of livelihood and generate the economic activities around them. The purpose of this chapter is to understand the economic avenues around rivers and how rivers have contributed to India's economic development.

From the ancient times, rivers have provided space for human civilizations to grow. Since several daily needs are fulfilled by the rivers, it has attracted people to settle around it, thus offering umpteen economic opportunities for the people. This is one the key reasons why cities like Agra and Delhi, situated at the banks of river Yamuna, Varanasi situated at the banks of river Ganga, Guwahati situated at the banks of Brahmaputra, and Kolkata situated at the banks of river Hooghly developed at the exponential rates According to a World Bank report titled 'Issues and Priorities for Agriculture India has about 195 million hectares of land under cultivation. Of this, about 63% or nearly 125 million hectares is rain-fed, while 37% or 70 million hectares of agricultural land depends on irrigation. Generally, rivers around agricultural zones provide much-needed water for irrigation.

Apart from agriculture, the river systems have always been the source of potable water, cheap transportation, and electricity, and it provides the livelihood of the country's large population. Other key uses of rivers include agriculture, Industrial Development Inland Navigation, Fishing, and Boosting Tourism.

The national parks are home to several endangered species that feature in the International Union for Conservation of Nature (IUCN). Hence rivers in India are critical to their survival. Further, the rivers of India also provide a livelihood to millions of people including fishermen, sand dredgers, and various other professions.

In order to understand the economic avenues around rivers a survey of the following rivers has been conducted:

1. Mula – Mutha River, Located in Pune Region
2. Ganges River
3. Indrayani River
4. Yamuna River
5. Tapi River
6. Hooghly
7. Other rivers. (like the Amba River, Bhima River, Dhomani River, Ghod Nadi etc.)

According to human geography, a catchment area can be defined as a location, such as cities, services, or an institution that attracts the population and uses its services for economic opportunities.

In the below section, a detailed analysis of the catchment area of each river is explained.

Catchment area analysis

Catchment areas can be defined as places where people are naturally drawn or as established by governments or organizations for the provision of services. Since the catchment area analysis is dependent on multiple factors such as distance, geographic boundaries, travel time, or population, hence it suggests the number of dependents on a river.

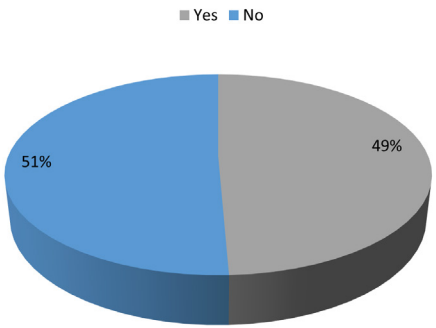


Fig 2.1: Catchment Area of the River

As per the survey, 51% of the rivers have a catchment area, which means that the surveyed rivers have lots of populations and are currently having densely polluted regions and dependents employment dependents on them.

The survey even suggests that 49% of the catchment area of the rivers is yet unexplored and, in the future, there is a scope for development in these areas.

It has been further observed that there are multiple economically dependent stalls near the area as 49% of the income is generated through the stall. Other sources of income include water sports which

contribute to 12% of the total income generated, 23% through the ticket selling of the residing small gardens, and 10% through Melas.

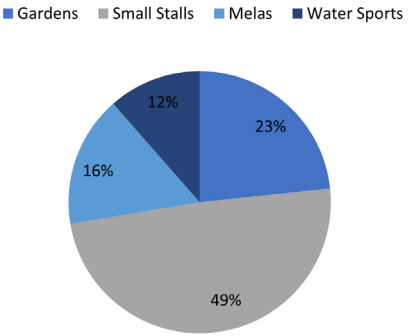


Fig 2.2: Popular activities near rivers

Fresh water has become a scarcity in today's world, and the natural and human activities in and around the river and other water bodies has polluted the water to the level that it cannot be used for non-drinking purpose also. The absence of a water treatment plant and unrestricted discharge of sewage water has tendered our river into a drainage system for cities. This had led to human diseases and also low oxygen content in water which is a threat to aquatic animals.

It has been further observed that out of the surveyed rivers, many rivers have industries located at their banks. It can be seen from the below data that many rivers have below 50 industries located at their banks. Very few areas have industries between 50 -100.

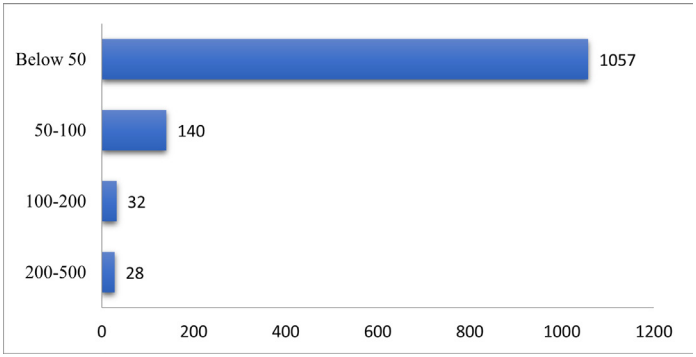


Fig No: 2.3 : Number of Industries

The river is polluted with untreated domestic sewage and industrial effluents from more than 3,500 industrial units. As per research conducted by various institutes, 40 million liters a day (MLD) of untreated effluents are being discharged into the rivers. While the city generates 277 MLD of effluents, the corporation at present can treat only 210 MLD. The level of dissolved oxygen at various places near the river is virtually negligible, threatening aquatic life. The situation been has worsened by the unchecked growth of water hyacinth, which blocks out sunlight from penetrating the water.

CHAPTER 3
Indian Rivers and it's status quo

THE KRISHNA AND BHIMA RIVER BASIN AND ITS CURRENT CONDITION

Concern over the Krishna River Basin's impending closure has raised the problem of water distribution among the user states. Thus, one must thoroughly understand the geology, climate, rainfall, water resources, geomorphology, soil types, and structure of the Krishna river basin. Krishna has a catchment area of 2,58,948 sq.km, making it the fifth-largest river basin in India. Before coursing into the Bay of Bengal, the river travels 1400 kilometres through the states of Maharashtra, Karnataka, and Andhra Pradesh. Basalts and crystalline rocks make up most of the basin's geology, with alluvium and lateritic soils making up the remainder. The Bhima and the Tungabhadra are its two greatest tributaries, and it has various small to large-scale reservoirs for irrigation and/or hydropower generation plans (e.g. Nagarjuna Sagar and Srisailam).

Source: Kachla Ghat: a gathering of pilgrims for the Kumbh festival. Photo credit: Chicu Lokgariwar

Apart from the humid areas around the Western Ghats, the region has a mostly semi-arid and dry climate. Most of the basin's soils are shallow in depth and of the Entisols, Alfisols, and Vertisols types (black soils for cotton and sugarcane). Rice, sugarcane, and oil seeds are the three main crops grown in the basin. There are worries about the basin getting smaller, how often extreme events like floods appear, and how the water quality of the Krishna and its tributaries is declining. Although there is no significant change in annual rainfall, the observation of a large-scale decline in water flows in the upper and lower levels of the basin has highlighted the need of managing and allocating the basin's water resources.

The floods in 2006 and 2009 emphasise the potential involvement of numerous human activities in the causes of flooding. To lessen the socio-economic damages that such major disasters bring into the Krishna River Basin, significant efforts must be made. Several employees have also complained about water quality difficulties, which are primarily the result of outflows from industrial towns like Pune, Satara, Kurnool, and Vijayawada. The recommendation to reduce the impact brought on by human disturbances (engineers, management specialists, geologists, economists, agricultural scientists, water quality chemists, government experts, etc.) must be followed. A river (basin) must be used by humans for socioeconomic gain, but this should be accompanied with more responsibility for basin preservation.

The Waters of Krishna Basin in the states of Andhra Pradesh and Telangana are managed and regulated by the Krishna River Management Board (KRMB), an independent organisation constituted in accordance with the Andhra Pradesh Reorganisation Act, 2014, and under the administrative supervision of Ministry of Water Resources. The Government of the successor states shall always provide to the Board the necessary funds to meet all expenses required for the discharge of its functions, as stated in Section 86, Paragraph 2, of the AP Reorganization Act, 2014. One of the 13 projects recently approved by the Centre under the "Save Rivers" programme was the conservation of the two perennial rivers, the Krishna and Godavari, which run through the two Telugu states and upper riparian States like Karnataka and Maharashtra. The official stated that the key initiatives under the action plan will be to maintain ecological balance, preserve the flora and wildlife along the riverbanks, take strict action against sand mining in the two rivers, and implement a plantation

programme on the river beds. The "Clean Waterways" project will also address the preservation of forest along rivers.

South India's Bhima River is a significant river. Before entering the Krishna River, it travels 861 kilometres southeast through Maharashtra, Karnataka, and Telangana. After 65 kilometres through a narrow valley and rocky terrain, the banks widen up and create a fertile area. It is an agricultural region with high population density. The Bhima River rises at Bhimashankar Temple in the Bhimashankar hills in the Pune District's Sahyadri Taluka, which is on the western side of the Western Ghats (19°04′03″N 073°33′00″E). Bhima has numerous smaller rivers join it as tributaries as it travels 861 kilometres (535 mi) in the southeast.

It passes through the Bhimashankar Wildlife Sanctuary before entering Khed Taluka, where it is shortly joined by a tributary, the Aria River, which drains into the Chas Kaman Reservoir from the right (west). The Chas Kaman Dam, the Bhima River's most upstream dam, impounds the Chas Kaman Reservoir. The Kumandala River enters from the right along the river for about 5 km below the Bhima bridge at Chas. The distance down the river from there to Rajgurunagar, a town on the left bank, is 8 kilometres. The Bhima River enters from the right immediately above the settlement of Pimpalgaon on the left bank 18 kilometres farther down the river. There are 10 miles along the river and from there to Siddhe Gavhan. The Bhima creates the border between Haveli Taluka on the right (south) and Shirur Taluka on the left after leaving Khed Taluka (north). It is 14 km along the river from the Bhima junction to the Indrayani River, which likewise enters from the right. The town of Tulapur in the Havali Taluka is located at the confluence on the right bank.

The principal tributaries of the Bhima River that drain western Pune are the Bhima River, the Indrayani River, and the Mula-Mutha River. Following the Indrayani, the Dhomal River enters from the right near the Wadhu Budruk settlement in about 4 km of downstream distance. The Bhima travels 3.5 kilometres before passing beneath the SH 60 bridge in Koregaon Bhima.

Source: Maharashtra Pollution Control Board

The Bhima meanders northwest from Vittalwadi, and 14 kilometres after the Vel River enters from the left, at the Parodi hamlet, the Kamania River enters from the left. Following the Kamania River's entry, the river meanders 23 km back southeast before meeting the Mula-Mutha River in the settlement of Ranjangaon Sandas, which is where the two rivers meet from the right. The river is known as the Bhima river as of this point.

With an abundant supply of water but poor sewage collection and control, has contaminated all the Bhima's tributaries Mula, Mutha, Indrayani, and Pawana.

The following contaminated river segments are listed:

a. Indrayani River is facing contamination from location of Dehu stretch to its confluence with Bhima at Tulapur (near Pune).

b. The Pawana River is facing contamination from location from Kadadhe to the Sangvi Gaon near Pune, where it meets the Mula River.

c. The Bhima River (with its tributaries, the Mula and Mutha) from Vithhalwadi to Takli, which is located downstream of Pune.

In the research region, there are two Vithalwadis. The Vithalwadi that the Central Pollution Control Board is referring to is on the Mutha River, not the Bhima River.

1. Vithhalwadi on the banks of the Mutha River

2. The Mula-Mutha River and Sangameshwar, where it meets Bhima (near Pargaon)

3. The source of the Bhima River and its course up to Sangameshwar (including additional Vithhalwadi, Takli-Bhima, etc.) are close to Pargaon, where the Bhima River meets the Mula-Mutha River.

The Bhima River rises in Bhimashankar, 945 metres above sea level, close to Karjat on the western side of the Western Ghats. The Bhima River spans the states of Maharashtra, Karnataka, and Telangana for 745 kilometres to the southeast. Bhima River in Maharashtra has a length of 451 km and a drainage area of 48,853 km2. It combines

with Krishna close to Kudlu in the Raichur District of Karnataka. Around Pune, the Bhima River receives significant tributaries from the Kundali, Ghod, Bhama, Indrayani, Mula, Mutha, and Pawana rivers.

The Bhima River and its tributaries have been proven to be contaminated based on sampling at numerous sites. Indrayani, Pawana, Mula, Mula-Mutha, and Bhima at Mula-confluence Mutha's are some of them.

Due to several factors, some of which include the following, Bhima and its major tributaries, including Indrayani, Pawana, Mula, and Mula-Mutha, are polluted despite having fertile land, access to water, and power.

1. Densely populated areas, such as Lonavala, Khandala, and Talegaon.

2. Devotees travel to the holy cities of Dehu and Alandi both year-round and during biannual yatras. A sparse sanitation system intended for a few thousand people becomes overloaded by thousands of believers. Additionally, the Pawana River is polluted by flowers, garlands, and trash.

3. The Pawana, Mula, and Mutha rivers are contaminated by the industrial and inhabited areas of Pune and Pimpri Chinchwad. The insufficient infrastructure in these cities is a result of their abrupt rise. Despite having an adequate water supply, untreated sewage still makes its way into surrounding nallas/gutters, which discharge into these rivers, because there is no suitable sewage collection and treatment system in place.

4. Automobile centres in Chakan, Talegaon, and IT parks at Talawade, Hinjewadi draw big populations across India. Chakan has numerous industrial facilities that draw a sizable population.

5. River water is widely used for irrigation since the terrain is fertile. Eutrophication of rivers downstream of Pune cities is a result of the extensive usage of chemical fertilisers.

THE MULA RIVER:

The Mulshi Dam, which creates the Mulshi Lake, dams the Mula river close to the Western Ghats. It unites with the Mutha River on the right bank and the Pawana River on the left bank farther downstream in Pune city to form the Mula-Mutha river, which later meets the Bhima River. Along the Old Pune-Mumbai Highway, the river divides the boundaries of the Pimpri-Chinchwad Municipal Corporation and the Pune Municipal Corporation. Due to heavy pollution and trash deposited into the river, there were flash floods in the river's surroundings in 2010. Due to the high levels of pollution, particularly the Pune Municipal Corporation's discharge of 125 MLD of untreated sewage into the river.

Source: India Water Portal

The Mula river goes roughly 52 km from its source at Mulshi dam to where it converges with the Mutha river. About 40 km of this run through a hilly environment, with surrounding towns like Paud, Nande, Chande, etc. having a population under 10,000. It enters Pune city behind the Balewadi sports stadium, then travels through populous areas including Pimple Saudagar, Baner Gaon, Sangvi (where Pawana and Mula meet), Bopodi, Khadki, Vishrantwadi, Wakadewadi, and behind the RTO office, where Mula and Mutha rivers converge.

Mula is regarded as the city of Pune's lifeblood. The Mula River's water is used for farming, drinking, bathing, and other industrial uses. The quality of the water in the Mula River is impacted by rising urban and industrial development. Rivers Mula and Mutha flow through practically the entire city. Therefore, it is used for the disposal of solid

trash, household garbage, hospital and industrial effluents, as well as some agricultural runoff.

THE MUTHA RIVER

The Western Ghats are the source of the Mutha River, which travels for around 21 KM before joining the Mula River in Pune. The Mutha River has been dammed twice, the first time at the Panshet Dam (on the Ambi River), which supplies irrigation and drinking water to Pune. Pune relies heavily on this water, which is dammed up again at Khadakwasla, as a supply of drinking water. Later, a second dam was constructed at Temghar on the Mutha River. It continues as the Mula-Mutha River after combining with the Mula River in Pune and flows on to join the Bhima River in Sangameshwar.

Source: Maharashtra Pollution Control Board

Traveling around Pune, an ancient and populated city. The significant area of Pune along the Mutha River is Karve Nagar, where Dr. D. K. Karve pioneered women's education and built a women's university (SNDT). Before meeting Mula under the Sangam Bridge, Mutha first encounters Mula in the peaceful neighbourhood of Deccan Gymkhana. Following its confluence, it continues as the Mula-Mutha River. One of the most filthy rivers, it gets raw sewage and trash over its whole course in Pune City.

Through closed pipelines, Pune draws roughly 1000 MLD of water for consumption from the Mutha River and dumps about 750 MLD of its sewage into the Mula River.

THE MULA-MUTHA RIVER

After converging under the Sangam Bridge, the Mula and Mutha rivers continue through Pune. The Bund Garden, constructed by Phiroze Jamshedji Jeejeebhoy, one of the longest-serving members of the Bombay Stock Exchange, functioned as a source of irrigation water for the underprivileged along the Mula-Mula river stretch in Pune.

Offering something for everyone, Bund Garden is a go-to destination for people seeking a serene, picturesque setting near Mother Nature that promotes relaxation, renewal, and re-energization. One of Pune's more renowned addresses is Koregaon Park, which is a neighbourhood south of the Mula-Mutha River.

A foundry and a factory for handmade paper may be found in Mundhwa, a historic industrial district. The upcoming residential towns are Ghorpadi and Kharadi.

Source: Maharashtra Pollution Control Board

Four kilometers separate Manjari from Pune. Here is where Vasantdada Sugar Institute (VSI), originally Deccan Sugar Institute, is situated. It is the only organisation of its sort in the world and was founded in 1975 by sugarcane farmer members of cooperative sugar plants in the State of Maharashtra. All scientific, technical, and educational tasks about the sugar business are carried out by the Institute under one roof. The Institute works to advance the sugar sector on all fronts, and to do so, it uses three main operating axes: academic, extension, and research and development.

A village called Loni Kalbhor is located on the Pune-Sholapur route not far from Pune. Here is where the Rama Krishi Rasayan fertiliser factory and an electronics component manufacturer are situated.

Theur: One of the Ashta Vinayak temples is in this historically significant area. This town has a distillery and a sugar factory, both

of which are supposedly closed. Sangameshwar (Confluence with Bhima): This is where Mula Mutha and Bhima meet.

The condition of Pune's rivers has gotten worse during the previous 20 to 25 years. Pune's population has grown exponentially, resulting in massive sewage production that is only partially treated due to the extremely inadequate capacity and dubious efficacy of PMC's sewage treatment plants. Since all STPs discharge partially treated sewage into the rivers throughout most of the year, all these rivers essentially carry only sewage rather than fresh water. Large amounts of industrial effluents are dumped into the rivers on top of all of this. The number of industrial effluents is so great that the Pollution Control Boards' monitoring is now in doubt. Pune, like many cities, faces a significant problem with solid waste management. Despite trash separation and processing, we continue to struggle with the issue of 100% rubbish collection. The trash that is scattered all over the place is evidence of the negligence of the people, which comprises of plastic, eventually mixes with surface runoffs and becomes clogged in the storm water drainage system, causing water to pool in numerous places and causing what are known as "pluvial floods." The ability of all rivers and streams in and around Pune to convey water has significantly decreased during the past several years. To do this, one must first comprehend the idea of "Flood Lines," which are determined by the Water Resources Department. The flood lines come in red and blue varieties. While red flood lines indicate the level of the flood that occurs every 100 years, blue flood lines indicate the level of the flood that occurs every 25 years. The area of property between the two Blue Flood Lines is referred to as the "Prohibitive Zone," and no building is allowed there. Additionally, there are restrictions on construction in the "Restrictive Zone," which is the area of land

between the Blue and Red Flood Lines. The conclusion drawn from this is that, while the frequency and intensity of cloudbursts are increasing, as well as the severity of rainfall, riverbeds are being severely choked by encroachments. We can contrast this circumstance with the artery delivering blood to our heart as a simple comparison. Gradually less blood is getting to the heart due to cholesterol build-up, which eventually causes cardiac arrest. Similar to how we would be anticipating a heart arrest, the encroachments on riverbeds are diminishing their water carrying capacities.

Analysis Based on the research conducted by students.

The following analysis was done in the form of a questionnaire. A Survey focussing on the issue of society and our rivers was conducted by the students at Institute of Management Development and Research, Pune on the following parameters:

Students gathered responses from all geographical areas pertaining to rural and urban vicinities from which river encompassed. The survey questions covered various aspects like waste management in rivers, economical avenues at riverbanks, waterways – possibilities and challenges, societal importance of rivers, comparative analysis

of rivers: urban v/s rural aspects, water management through rivers and river revivals. Based on their analysis, following responses were recorded and analysed.

Availability of Rivers

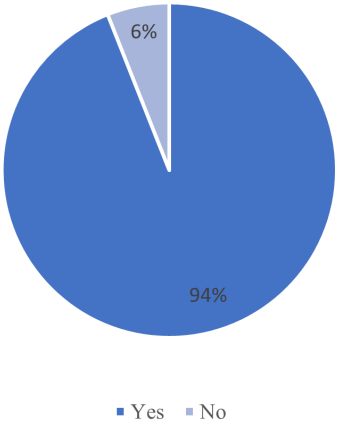


Fig 3.1: Availability of Rivers

As shown in the pie chart above there were 94% of students who have rivers near their village and city. These 94% of the students were mostly from cities like Ahmedabad, Burhanpur Bhopal, Kolhapur Karad as well as Pune City . It was observed that majority of the students were from Pune City. The remaining 6% of the students were from cities like Pune, Nagpur, etc.

Cities located on river banks.

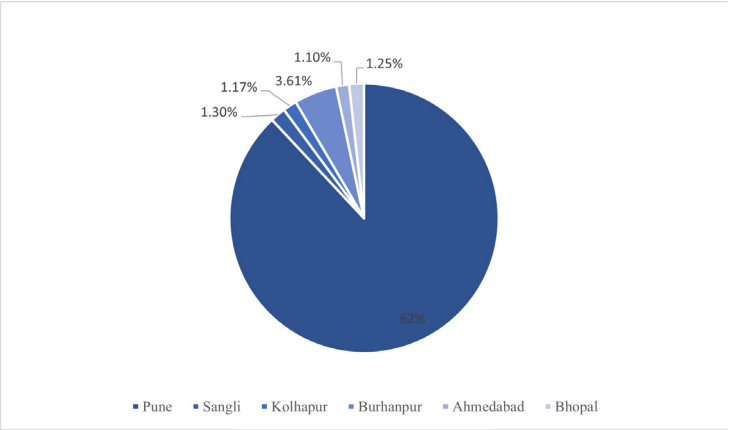


Fig No 3.2: Cities located on the river banks

As previously mentioned, most students studying at IMDR are from Pune, and so the majority of students choose Pune as the city located on the banks of the river.

The rivers Mula and Mutha flow through the Pune district hamlet of Kavadi. The Mula-Mutha is an Indian river created by the intersection of the Mula and Mutha rivers near Pune, which then joins the Bhima River, which then meets the Krishna River before draining into the Bay of Bengal. Sangli, which is located on the banks of the Krishna River, is home to 1.30% of the students. The Krishna River originates at Mahabaleshwar in the Western Ghats. It runs eastward from Mahabaleshwar to the town of Wai before emptying into the Bay of Bengal.

Kolhapur and Ichalkaranji account for 1.17% of the student body. These pupils went to the Panchaganga river banks.

Kolhapur and Ichalkaranji are on the banks of the Panchganga River, which serves as the primary supply of water for various uses. The Maharashtra Panchganga River passes through Kolhapur's borders. It begins at Prayag Sangam. The Panchganga is made up of four streams: Kasari, Kumbhi, Tulsi, and Bhogawati.

Students from Burhanpur, or 3.61% of them, conducted research on the Tapti River.

The Tapti River (or Tapi) is a river in central India that runs westward before discharging into the Arabian Sea. It is situated to the south of the Narmada River. The river flows across Maharashtra, Gujarat, and Madhya Pradesh. The Sabarmati River was visited by 1.10% of the students from Ahmedabad. It rises in the Aravalli Range of Rajasthan's Udaipur District and flows south-west across Rajasthan and Gujarat to reach the Gulf of Khambhat of the Arabian Sea. Bhopal accounted for the remaining 1.25% of students. The Betwa River was visited by these students. The Betwa River, along with the Charmanwati River, is mentioned in the epic Mahabharata. It springs in the Vindhya Range slightly north of Narmadapuram in Madhya Pradesh and runs northeast through Madhya Pradesh, Orchha, and Uttar Pradesh to the sea.

Ghats or Ports on the riverbanks.

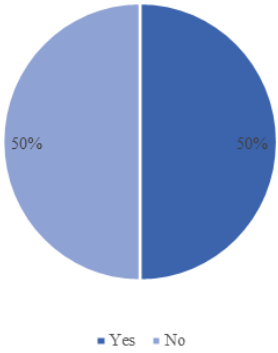


Fig. no 3.3: Ghats/ports located on the river banks

Ghat, a phrase used in the Indian subcontinent, can refer to either a range of stepped hills with valleys, such as the Eastern and Western Ghats, or a set of steps going down to a body of water or dock, such as a bathing or cremation spot along the banks of a river or pond.

The five ghats in India are the Ghats of Varanasi, Har Ki Pauri Ghat in Haridwar, the James Prinsep Ghat in Kolkata, the Ghats of Wai in Maharashtra, and the Triveni Ghat in Rishikesh.

50% of the students, especially from Kolkata, Wai, and Burhanpur, stated that ghats were located on the riverbanks of rivers that ran through their cities. The remaining 50% of Pune residents said that there were no Ghats on the banks of the rivers Mula and Mutha.

It was the same answer when it came to ports.

Mumbai Port on the Ulhas River, Kolkata Port on the Hugli River, and Paradip, town and significant port in east-central Odisha (Orissa) state, eastern India. It is located on the Bay of Bengal, on the Mahanadi River's delta, and near the mouth of one of its branches.

The festivals associated on the site of the river.

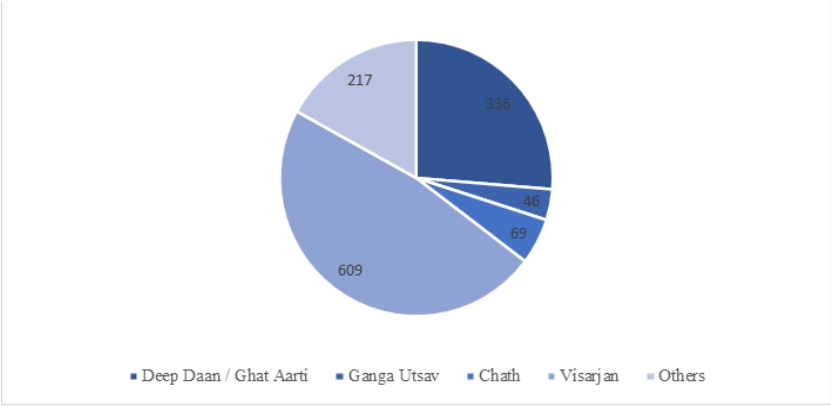


Fig. No. 3.4: The festivals associated on the site of the river

It was observed that 336 students noticed that religious activities of Deep daan and Ghat Aarti were carried out on the banks of the river. Neo-Buddhists observe Deep Daan Utsav on Kartik Amavasya, according to the Hindu calendar. While it is known as 'Diwali' or 'the festival of lights' throughout India, its past is fraught with myth and appropriation. The activities surrounding the festival of lights may appear pan-Indian, however there are several historical perspectives on Diwali.

Ganga Aarti is a large-scale ceremony performed every morning and evening on the banks of the sacred Ganges. Aarti is performed by priests at Dashashwamedh Ghat. The entire Ghat is bathed in heavenly light, which may be sensed profoundly. Huge brass lights are lighted with oil for the majestic ritual, and priests sing sacred chants that resound over the whole region.

According to 46 students, the Ganga Utsav is one of the most well-known events on the Ganga's banks. The Utsav honours the mystical

and cultural river Ganga via storytelling, folklore, talks with famous persons, quizzes, traditional artforms on display, dance and music performances by renowned artists, picture galleries and exhibitions, and much more. The Utsav celebrates the majesty of the holy river Ganga while also appreciating and practising cultural richness along the Ganga. The celebration held on its Ghats has significant spiritual significance.

Chhath is a traditional Hindu celebration that originated in the Indian subcontinent, notably Bihar, Uttar Pradesh, and Jharkhand, as well as the southern sections of Nepal. During Chhath puja, prayers are offered to Surya, the sun deity, to express thanks and thankfulness for imparting the riches of life on earth and to pray that particular requests be realised. 69 students mostly from Madhya Pradesh and Uttar Pradesh said that Chhath was one of the most renowned festivals in these states that was celebrated on the banks of the rivers passing through their cities.

The Visarjan, which is well-known in Maharashtra, is one of the primary festivals held on the banks of rivers. On the final day of the Ganesh Chaturthi Festival and the Navaratri Festival, the idols of gods and goddesses, typically Lord Ganesh and Goddess Durga, are submerged. 609 students noticed that the visarjan was well-known in their respective cities. In Kolkata, these processions are equally well-known. 217 students voted for festivals and rituals like the last rights, Mahashivratri, the Bali pooja, etc.

Importance of rivers to communities.

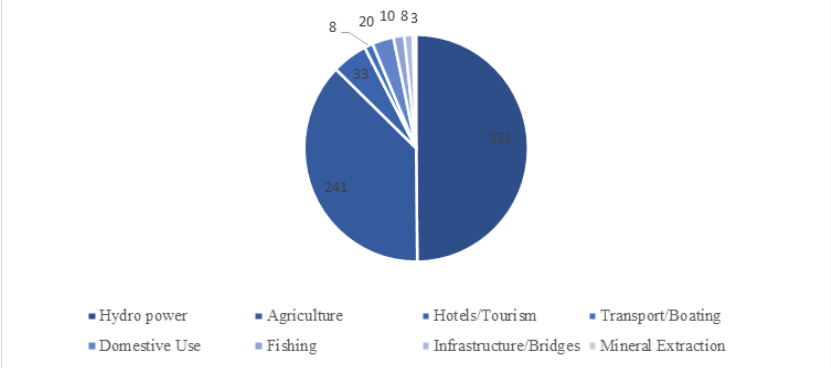


Fig. No. 3.5: Importance of rivers to the community

According to the chart above, 321 students said that hydro-power is one of the reasons why the rivers are important to communities. Hydropower, often known as hydroelectric power, is a renewable energy source that creates electricity by altering the flow of a river or other body of water using a dam or diversion construction. The Koyna Hydropower Project is India's largest hydroelectric project. It is a complicated project with four dams, the largest of which is on the Koyna River in Maharashtra, thus the name Koyna Hydroelectric Project. 241 students said that agriculture is very important to the communities and this activity is dependent on rivers around the farms.

India's agriculture industry has the world's second-largest agricultural land, employing about half of the country's population. As a result, farmers become an essential component of the industry in order to provide us with food. 33 students thought that rivers are also important for the functioning of the hotel and tourism industry. The tourist business in India is a substantial economic multiplier, which is

crucial given India's need to expand quickly and create employment. India has a diverse geographical landscape, global heritage sites, and specialist tourist goods such as cruises, adventure, medical, and eco-tourism. 20 students thought that river water is potable and can be used for domestic purposes. Due to pollution, this water can be recycled and filtered into potable water.

The nature of the rivers, whether they are perennial or ephemeral.

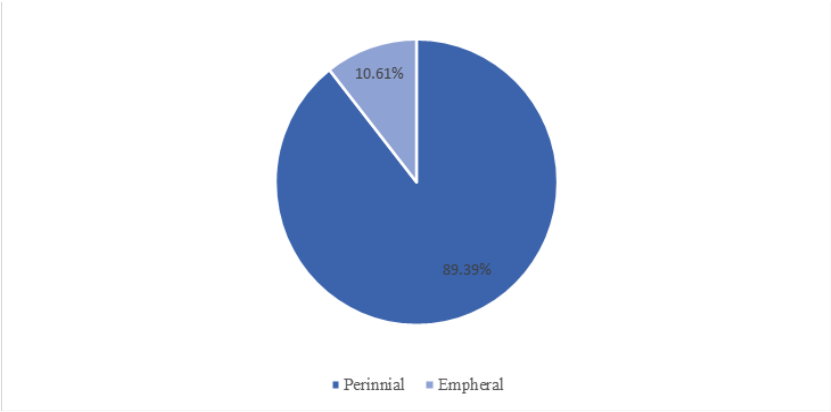


Fig. No. 3.6: Nature of the river, whether they are perennial or ephemeral

In a normal year, an ephemeral stream has running water only during and for a short time after precipitation episodes. Year-round, ephemeral stream beds are found above the water table. e.g. Luni River. Perennial rivers are rivers that have water throughout the year. Himalayan rivers such as the Ganga and Bramhaputra are perennial rivers in India. These are both rain-fed and created by glacier melting. As shown in the chart above, 89.39% of the students said that the

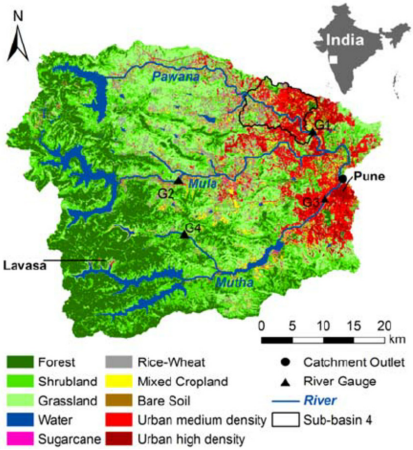
rivers located in their cities were perennial, which meant that they had water throughout the year. The remaining 10.61% of the students said that the rivers in their cities were ephemeral which means that the water drains in the rainy season.

CHAPTER 4
River Wise Analysis

A river flowing through the city has always been of great importance as it not only provides great resources but also the civilizations have been developed around rivers. Apart from contributing towards cultural and economic aspects of a city each rivers contributes uniquely towards that cities development. The below chapter is highlighting the city wise contribution of the mentioned rivers.

Mutha – Mula River

The rivers of Mutha and Mula rivers flow across Pune city, which is one of the key tributaries to the Bhima River. The Bhima river then merges with the Krishna river, near Raichur, Karnataka, India. The figure below mentions the Mutha and Mula River.



Source: Research Gate

The rivers of Mula and Mutha have been an integral part of the city of Pune. The river supports lakhs of people who reside on the banks of these rivers. Both rivers are tributary to Bhima river.

Subsequently, the Bhima river flows through the village of Kavadi in the Solapur district which is a habitat for many migratory birds. However, the increase in pollution in recent years has resulted in a reduction in the number of birds. Pollution from effluents released into the river at Pune has been found to cause high levels of pollution in the Bhima River, the reservoir of the Ujani dam, and the Krishna River too, resulting in many water-borne ailments.

Source: Research Gate

It has been further observed that untreated sewage water is discharged into the river by the Pune Municipal Corporation, the Maharashtra Pollution Control Board has classified the water quality to be of Class IV. The Pune Municipal Corporation announced plans to clean up and restore the river by pumping in oxygen ,falling in lines with the restoration efforts undertaken in Mumbai for the Mithi River.

Image: Depleting condition of Mula Mutha river
Source: hindustantimes.com

From the collected data, 700 responses were collected from the Mula and Mutha rivers and it has been observed that 43% area has industries located on its banks and 57% do not have industries. Hence, it can be concluded that only industrial waste is not responsible for the depleting conditions of the Mula and Mutha rivers.

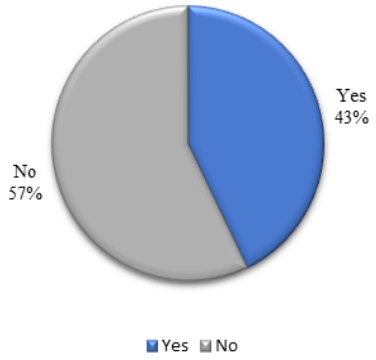


Fig. No. 4.1 : Industries located near Mula Mutha Rivers

According to Human Geography, a catchment area is an area from which a location, such as a city, service or institution, attracts a population that uses its services and economic opportunities. Catchment areas may be based on places where people are naturally drawn to a location (for example, labor catchment area) or as established by governments or organizations for the provision of services. It has been observed that 50% of Mula Mutha catchment area is urban localities.

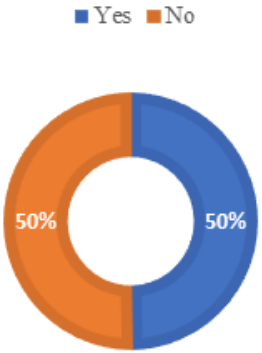


Fig. No 4.2 : Catchment Area

The study, suggests the income generated out of the catchment area of the Mula and Mutha rivers. It has been observed that most areas have small, stalls and Melas around them and the average income generated is below INR 10,000. Also, in various areas it has been observed that the income is generated between INR 10,000 to INR 20,000 per month.

Fig. SKF Eco Park
Photo Credit: Mihir Ingle

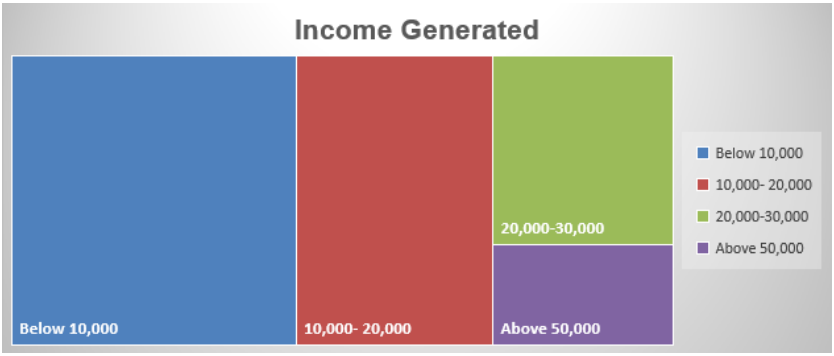


Fig. No. 4.3 Income Generated

Only 27.32% of the areas around the rivers have income above 20,000 and above. This signifies that there are very less number of industries in the catchment area of the rivers dependent on river water and the income is generated mostly from the small stalls and water sports. Many small stalls, gardens and restaurants are located near the river which are generating income for the people living in the catchment area.

While the areas near the river banks were studied, it was observed that there were water pumps on the banks of the river, which farmers were using for the irrigation purpose for agricultural land.

Water Pumps carrying water to agricultural Lands
Photo Credit: Mihir Ingle

Fig. Garden area near Krishna River.
Photo Credit: Mihir Ingle

Pavana –

Pavana Lake, also known as Pavana Dam Reservoir, is a reservoir turned artificial lake, formed by the Pavana Dam across the Pavana River in Pune district. The reservoir is 25 km from Lonavala and is also a popular as a picnic and camping site for visitors from Pune and Mumbai. The reservoir was formed as a consequence of the Pavana Dam project in Maval taluka in 1973. In recent years, areas surrounding Pavana Dam and Pavana Dam Reservoir have seen a rapid rise in tourism due to the waterbody's proximity to Lonavala hill station and forts such as Lohagad, Tikona, and Tung.

With the growth in Pavana Lake, agro-tourism has also flourished. Around 4,000 people from these two cities visit the lake every

weekend. It has been found out the average income of people around the riverside area ranges from 7,000 – to 40,000. The water color of the river has turned dark black due to excessive inlet of sewage and wastewater. In some places, there is a malodour. The water in this river in certain areas contains chemicals which extremely dangerous for human health and its nearby fauna.

List of Recreational Activities	
2 to 4	964
4 to 6	216
6 to 8	57
More then 10	33

Table No.4.1 : List of Recreational Activities

Ganga and Hooghly River

The Ganges is a trans-boundary river of Asia that flows through India and Bangladesh. The 2,525 km river rises in the western Himalayas in the Indian state of Uttarakhand. It flows south -east through the Gangetic plain of North India, receiving Yamuna ,the right-bank tributary, which also rises in the western Indian Himalayas, and several left-bank tributaries from Nepal that account for the bulk of its flow, modifying the majority mechanisms.

The majority of the cities rely upon semi-confined or confined aquifers that depend upon river water and underground water for most of their water supply. Disposal of most of their liquid effluents and solid residues to the rivers and ground. There has also been an inevitable rise in waste production. Drainage of surface water has been disrupted as the small low-lying channels and streams have been filled with municipal waste. The total water potential of the Ganga basin

including surface water and groundwater potential , is around 525.02 km and 170.00 km respectively. The basin supports approximately 42% of the total population in India. Water tables are declining at approximately an average of 0.20m per year in many parts of the basin and there is a trend of deteriorating ground water because of increase in utility.

The usage of water has increased exponentially and most of the areas are highly reliant upon groundwater. Unfortunately, degradation of groundwater both in terms of quantity and quality has deteriorated the situation.

Ganges River on Indian Map

Source: Maps of India

In state of West Bengal ,India, a feeder canal taking off from its right bank diverts 50% of its flow southwards, artificially connecting it to the Hooghly River. The Ganges continues into Bangladesh, its name changing to the Padma. It is then joined by the Jamuna, the lower stream of the Brahmaputra, and eventually the Meghna, forming the major estuary of the Ganges Delta, and emptying into the Bay of Bengal. The Ganges-Brahmaputra-Meghna system is the third largest river on earth by discharge.

The main stem of the Ganges begins at the town of Devprayag, at the confluence of the Alaknanda, which is the main source stream because of its greater length. The Ganges is threatened by severe pollution. This poses a danger not only to humans but also to animals. The levels of fecal coliform bacteria from human waste in the river near Varanasi are more than a hundred times the Indian government's official limit. The Ganga Action Plan, an environmental initiative to clean up the river, has been considered a failure which is variously attributed to corruption, a lack of will in the government, poor technical expertise, environmental planning, and a lack of support from religious authorities.

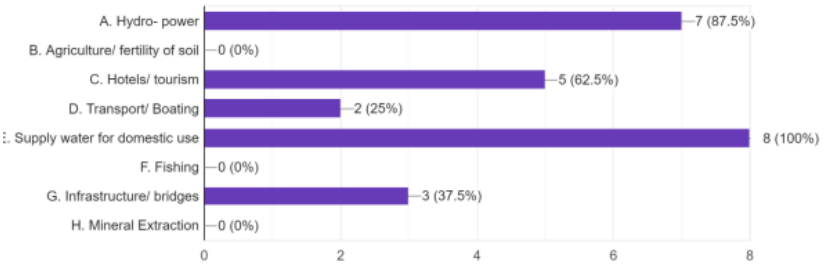
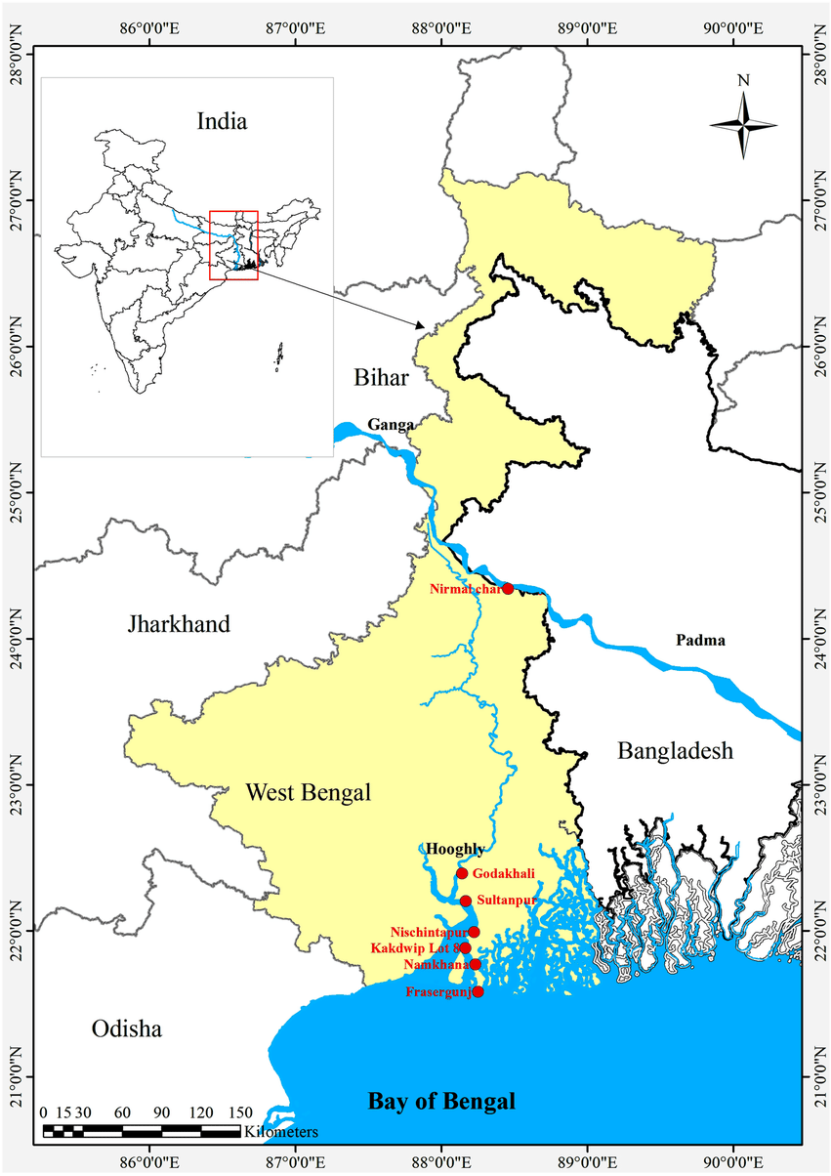


Fig. No. 4.4 – Industries Dependent on River

The river is very important from the point of view of several economic activities and these activities are completely dependent on the river. Various non-agriculture activities such as fishing and Mineral extraction is done on the banks of river. There are several recent units and resorts set up near the river and even on the banks of the river. 62.5% of hotels and tourism is dependent on the river. 25% of transport and boating is also dependent on the river. Whereas all of the river water is important for the domestic household that is dependent on rivers.

Hooghly River

Until the seventeenth century, when the main course of the Ganges shifted eastward decisively, the Hooghly was the major channel through which the Ganges entered the Bay of Bengal. From its source in the high Himalayas, the Ganges flowed in a broadly southeasterly direction across the Indian plains before descending to the loose alluvial soil of Bengal and charting a southward course through what would later be known as the Hooghly basin.



Hooghly River

Source: Research Gate

At just 460 kilometers (approximately 286 miles), its length is modest in comparison with great Asian rivers like the Yangtze in China or the Ganges itself. Nevertheless, through history, the Hooghly has been a waterway of tremendous sacred and secular significance. Europeans arriving on the Hooghly in the late 17th century were fascinated by the position that the river occupied in local life, and in particular its significance in Hindu religious practices and beliefs. In many contemporary accounts, sacred rituals conducted using river water are described. The water was considered so valuable that it was bottled, transported, and sold to devotees across India who could not visit and bathe in the river.

The river ghat is mostly used for household purposes like washing and bathing and also for religious purposes like idol immersion in Durga Puja. There were few catchment areas around most of the river, where mostly fishing was the main activity. Katla, rohu, and tilapia are the most popular fish found in Hooghly.

The water was malodourous, with water remaining stagnant most of the time except during times of tides, since Hooghly is tributary near the end of Ganga river the before merging in Bay of Bengal.

While agriculture is impacted adversely by the rising pollution of rivers, it is also one of the reasons for contaminating waters. The use of modern pesticides, herbicides, and fertilizers is polluting our rivers. Interestingly, this impacts the overall productivity of agricultural land as river water contaminated by industrial effluents cannot be used for irrigating crops.

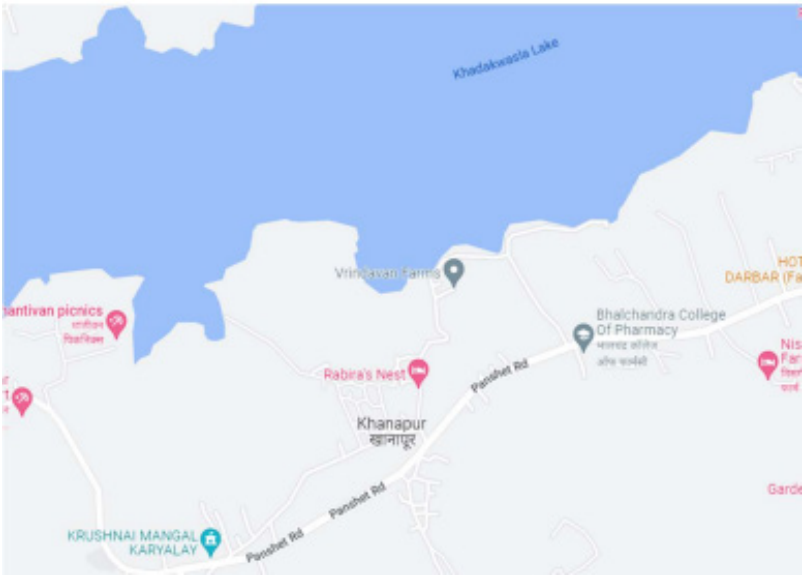
No of Industries	
Below 50	19
50-100	2

Table No 4.2 : Number of Industries

Polluted water does not allow seeds to germinate and cause stunted growth, denying farmers of a bumper harvest. Indigenous agriculture is vital to India for maintaining self-sufficiency in food.

Source: Banks of Krishna River, West Bengal, (Murlidhar Ratanlal Exports Ltd.)

Photo Credit: Diganta Chakraborty



Location on Map

Hotels Situated near river Banks

Photo Credit: Diganta Chakraborty

Yamuna River

Yamuna River, also called Jamuna, major river of northern India. Yamuna primarily flows through Uttarakhand and Uttar Pradesh states. It is one of the country's most sacred rivers. The Yamuna rises on the slopes of the Bandar punch massif in the Great Himalayas near Yamnotri (Jamnotri) in western Uttarakhand. The Eastern and Western Yamuna canals are fed from the river at that point.

Salient features of Yamuna Basin in India	
Basin Extent	
Longitude	28° 42' 3.3804" N
Latitude	77° 16' 19.5672" E
Length of Yamuna River (Km)	1376
Catchment Area (Sq. Km)	219668
Average Water Resource Potential (MCM)	85021
Utilizable Surface Water Resource (MCM)	11983
Live Storage Capacity of Completed Projects (MCM)	330

Table No. 4.3 : Salient features of Yamuna Basin in India

The Yamuna River is one of India's longest rivers, flowing for 1376 kilometers, The Yamuna River originates from the Yamunotri Glacier near Bandarpunch peaks (38°59' N 78°27' E) in the Mussoorie range of the lower Himalayas at an elevation of about 6,387 meters above the mean sea level in district Uttarkashi (Uttarakhand).

The river not only provides a livelihood for the population living in the basin but also offers life support to agricultural, industrial, and

urban sectors and is the main source of drinking water for most of the towns along its course. More than 70% of the drinking water supply of Delhi is abstracted from the river Yamuna (CPCB, 1996., Upadhyay et al., 2010). An estimated 57 million people are dependent on the water of the Yamuna River.

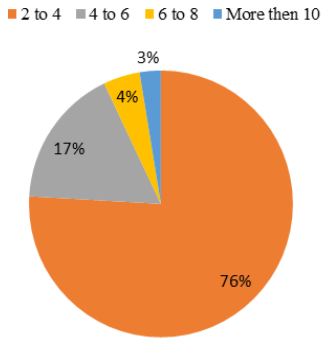


Fig. 4.5: List of recreational Activities

Because of the rapid development of urban population, industrialization, and inadequate infrastructure, the river water quality across the country is deteriorating alarmingly. The industrial towns all along the river discharge significant amounts of waste into the river. In the lower stretch, the Yamuna becomes a drain, receiving mainly agriculture, industrial and domestic effluents (Ali et al., 2001) According to CPCB (2000) there were approximately 359 industrial units out of which 22 industrial units in Haryana, 42 units in Delhi, and 17 units in Uttar Pradesh were found to be directly discharging and polluting the river. These industries include paper, sugar, chemical, leather, distillery, pharmaceuticals, power, etc. It has several large and industrial cities on its banks like Yamunanagar, Sonipat, Panipat, Delhi, Agra, and Mathura.

The categories of industries discharging wastewater into Yamuna river include Pulp & paper, Sugar, tannery, steel plants, distilleries, Textiles, Leather, Chemical, Pharmaceuticals, rubber, glass, Oil Refineries, Thermal Power Plants, food, etc. (CPCB, 2006). Due to extensive anthropogenic pressure, the river Yamuna is rapidly deteriorating into a sewage drain. Delhi discharges its treated and untreated domestic and industrial wastes through small or large drains. 95% of the Yamuna pollution in Delhi is a result of discharge of wastewater through seven major drains like; Najafgarh, Yamunapur, Sen Nursing Home, Barathpula, Maharani Bagh, Kalkaji, and Tuglakabad. In Delhi, the Yamuna River is so polluted that beyond Okhala, it hardly supports any form of life. Not only the organic matter and nutrients but several pesticides and heavy metals have also been found at an alarming level in the river.

No.	Segment	Reach	Length (Km)	water quality levels
1	The Himalayan Segment	From origin to Tajewala Barrage	172km	BOD (03 mg/L), COD, TDS and DO (6-10 mg/L)& more or less no pollutants.
2	The Upper Segment	From Tajewala Barragae to Wazirabad Barrage	224Km	BOD (1-3 mg/L) , COD and DO(10-7 mg/L).
3	The Delhi Segment	Wazirabad Barragae to Okhla Barrage	22Km	BOD(3-25 mg/L), COD and DO(7-1 mg/L) values of the river water are seriously bad.
4	The Eutrophicated Segment	Okhla Barrage to Chambal Confluence	490km	BOD: 18-6 mg/L , DO: 1-12 mg/L.
5	The Diluted Segment	Chambal Confluence to The Ganga Confluence	468Km	BOD: 13-1 mg/L, DO: 11-7 mg/L.

Table No. 4.4 : Quality levels of Yamuna River

India is a blessed country when with 14 major, 55 minor and numerous small rivers. India is often referred as the “Land of Rivers”. In fact riverbanks first hosted human civilizations in India as elsewhere in the world. Rivers in India play important social and economic roles. This is the reason why Indians worship rivers as goddesses. Our mythological stories are full of stories glorifying the rivers.

However, there are several sources of water pollution, which work together to reduce overall river water quality. Industries discharge their liquid waste products into rivers and agricultural practices that use chemical fertilizers and pesticides also contribute to river pollution as rainwater drains these chemicals into the rivers. Domestic wastes that we throw into rivers adds to pollution levels. As population grows, the size of towns and cities also grows. The river wise analysis confirms the claim. Further chapters discuss the river pollution in depth.

CHAPTER 5
River Pollution

The population explosion and rapid economic development have led to severe environmental degradation that neglects the sparing of environmental resources on which sustainable development relies. All over the world, the economic aspect of growth and development becomes primary with an increase in profits, whereas the issue of environmental pollution, depletion, and degradation of resources take a backseat. The Indian scenario is a superlative version of this worldwide phenomenon, prominently due to its heavy population.

The force of industrial development has resulted in tons of residuals, having disastrous effects on the air, water, and land resources, which is ironically lopsided to the contribution to all-around economic growth. While the percentage of the iron and steel industry is 55% and 16% respectively, food and chemical processing calculate a whopping total of 86% waste and 25% industrial output.

These trends of unsustainable growth greatly imperil the economically backward sections to ecological degradation as well as pollution, on account of their direct dependence on natural resources like soil, and forests for necessities like fuel, wood, fodder, and water. In the absence of alternatives, the vicious circle of weakening the base support of the poor leading to perpetual poverty and a poor quality of life continuing. Hence for a country like India, a key to lowering the poverty percentage is the country's ability to renew its natural

resources and aid its citizens to regain control over their quality of life.

Water bodies like rivers are often treated as dumpsters by industries. However, wastewater disposal into the river adversely affects the health of human and aquatic life. Wastewater disposal from the domestic as well as industrial sectors is a global challenge nowadays. Though every water body can naturally remove pollutants from the wastewater with the help of naturally occurring aquatic animals and plants, but it has its limits. Chemical, physical, and biological reactions can be used to further purify and degrade pollutants. However, unlimited waste carelessly disposed of in rivers as a cheap and easy way cannot be naturally neutralized. Industrial growth and development as well as man-made interferences like deforestation, global warming as well as the population boom, are creating fluctuations in the water cycle and the environmental balance. In Indian states, clean and hygienic water for drinking and cooking is very scarce, especially in Rajasthan and Maharashtra. Moreover, all over India, this hygienic potable water is available to only a small portion of the population. The remaining masses are using polluted or even chlorinated water for drinking causing several chronic health issues.

Major sources and effects of water pollution

There are various sources of water pollution. Based on the sources, water pollution is classified into point and non-point sources. Point sources/known sources are sources where the point of production is known. For example, industrial and domestic sewage plants are known sources which discharge waste directly into the water bodies. While nonpoint sources refer to those sources which indirectly discharge their pollutant into the water bodies such as agricultural

runoff, air pollutant discharge through rain or air impurities settling process, etc. Identifying and remediating the non-point sources of pollution is very difficult and costly. Industrial growth over the years has caused a growth in various chemical productions. This has also caused an upsurge in waste generation from chemical industries. The research suggests that in most places the waste management facility is not present and the waste is directly disposed of in the river.

Fig 5.1: Waste Management Facility Presence

Photo Credit: Sanjana Kashtey

The rapidly increasing population and development of industries create huge pressure on various water bodies and also increase pollutant levels in the water ecosystems. Human activity either at the domestic level or industrial level is responsible for the deterioration of water quality. These human activities include direct disposal of solid waste and discharge of industrial and domestic wastes, sewage and garbage disposal, agricultural runoff, disposal of dead bodies of plants and animals, etc. The industrial dumping of water also includes a large number of heavy metals. These heavy metals like Lead (Pb), Cadmium (Cd), Copper (Cu), Chromium (Cr), Nickel (Ni), Zinc (Zn), and Arsenic (As) have various adverse effects on aquatic life as well as on human health. These heavy metals interfere with normal metabolic processes. Continuous exposure to these metals may result in their bioaccumulation, and the function of the central nervous system, lungs, liver, kidneys, endocrine glands, and bones may be

impaired. Heavy metal pollution of water bodies possesses serious concern to human health.

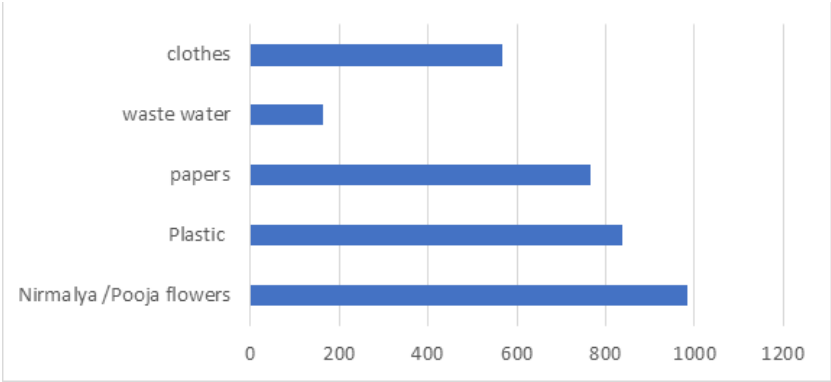


Fig 5.2: Types of waste in river

Photo Credit : Aditya Nimak

It has been observed that there is a direct correlation between waste and industrialization. Due to higher number of industries, more types of waste were generated. The smell of the river water also indicates the level of pollution suffered by the river. It was observed that most of the rivers were polluted and the water was malodorous.

Fig 5.3: Odour Analysis

The colour of the water is one of the best reflections of the health of the surrounding environment. Blue glacial ice is often thought of as the purest form of water. A mountain stream is usually clean and clear without colour at its headwaters but soon starts to get contaminated as it follows its course. Pollution and some of the by-products of poorly planned development can then spread all sorts of pollutants in the water

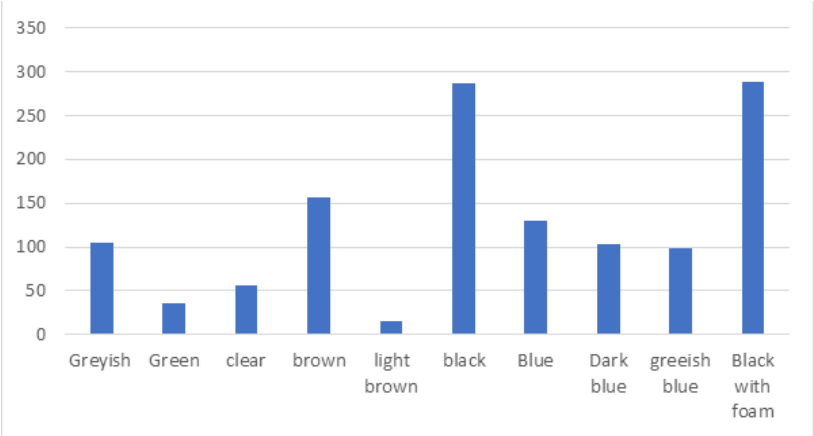


Fig 5.4: Colour analysis of river water

Mula river before Khadakwasla dam: rural site

Photo Credit: Aditya Nimak

Mula river in rains

Photo Credit: Guarav Bharmbe

Natural light is made up of several different colours associated with different wavelengths within the light spectrum. The colour we associate with anything is the range of light waves that are reflected in our eyes by the molecules that comprise the entity. We don't see the colours of light that are absorbed. When it comes to pure water, blue light is reflected while other colours of light, especially reds, are absorbed. When looking at the colour of water, it is important to note the difference between the apparent colour and the true colour of a body of water. The apparent colour is the colour of the water when looking at it without removing any suspended and dissolved particles. The true colour is the colour of the water after the suspended particles have been removed. Suspended particles are things such as algae, sediments, or small particles of a mineral. Dissolved particles are things such as tannins (a yellowish-brown organic acid that is

found in plant tissues) or particles of iron and manganese from rocks or soil. Bluewater has a very low amount of dissolved particles in it. Factors such as minerals, soil runoff and sediment, and even algae can cause water to varying from its natural colour of blue. The most common cause for water to change colour is minerals. When a rock is weathered down over time, the minerals from the rock are dissolved and small pieces are released into the water causing different colours. Iron, manganese and calcium carbonate from limestone are all common minerals that can cause water to change in colour from the range of green-blue to the range of red-orange.

Most of the natural river water is clear, but if there is an increase in the growth of algae in the water, the river appears green. The water appears blue when containing more calcium carbonate, appears red with more sulphur, and appears black with more mud. Industrial pollution also changes the river colours. For example, an effluent containing a high amount of copper shows blue, and the wastewater from the paper factory looks black.

Pune has an abundance of water from the Khadakwasla dam, but its intra-city distribution is extremely uneven. Some areas get as much as 600 liters per capita per day (lpcd) while others get barely 100. This results in enormous quantities of wastewater sewage, despite the capacity of sewage plants being 600 million liters per day, drained in its two main rivers, the Mula and Mutha, hence both rivers remain severely polluted. The Mula-Mutha River water in Pune had deteriorated in quality. Its biological oxygen demand, an indicator of organic pollution, has risen to over 30 mg/l, more than ten times the permissible limits for bathing. Pune is a classic case of overconsumption; the Municipal Corporation is currently supplying water sufficient for the projected population in the year 2050. More water means

more sewage, resulting in the overloading of sewage treatment plants. As a result, there are greater pollution loads discharged into the Mula-Mutha, two rivers that confluence within city limits and serve to flush away Pune's excreta. The Pune Municipal Corporation has a waterworks capacity to treat and distribute 1292 MLD. It is however currently supplying 1222 MLD of water at a staggering average supply rate of 321 LPCD, more than double the standards set by the Central Public Health and Environmental Engineering Organization, a technical wing of the Ministry of Urban Development. The actual statistics suggest that , after leakages in the piped network, work out to 866 MLD, or 228 LPCD.

Earth5R , a worldwide NGO working on climate change initiatives took initiative by cleaning up the banks of the Mula-Mutha River. The project involved cleaning up the plastic that was thrown on the banks of the river which would otherwise form a layer on the river eventually. It took two hours to do a thorough cleanup of the banks of the river. Several huge garbage bags were filled with the trash collected by the team.

Mula and Mutha rivers are part of five rivers in Maharashtra covered under the pollution abatement scheme of Jalshakti Mantralaya in the last five years. Funds released under the central scheme are Rs1183 crore. In 2017, union minister of state for Jal Shakti department, Mr. Bishweswar Tudu announced that five rivers in Maharashtra — Krishna, Panchganga, Mula Mutha, Tapi, and Mula-Mutha are part of pollution abatement scheme. Maharashtra government has taken up projects for setting up 76 sewage treatment plants of total capacity 1279.70 MLD.

CHAPTER 6
Biodiversity Encompassing River

As seen from an earlier chapter, pollution has marred the entire river ecosystem and yet we find some oasis in the ecosystem of the rivers. This chapter depicts the biodiversity around the river captured through the student projects.

Indian streams are some of the recently adopted horizons of wealthy freshwater diversity which is now jeopardized species. According to India's National Biodiversity Action Plan, "Nearly 50% of the aquatic plants of the world are recorded from the Indian subcontinent but only a few have been studied in detail." India is a globally leading country when it comes to freshwater fish species i.e (650+ species). In freshwater fish diversity, India is ranked eighth in the world and third in Asia. At the same time, these rivers support millions of local people, securing means of life. Rivers flowing through the Eastern and North Eastern Himalayas and the Western Ghats have been designated as worldwide hotspots of freshwater ecosystems.

The Western Ghats are a hotspot when it comes to native freshwater biodiversity. It has 16% of the 1,146 freshwater species present nationally. Although, a further 2% is threatened with extinction. While in the Eastern Himalayan Hotspot, approximately 31% of the species were studied . There is clear need of detailed studies, as there is insufficient data which can lead to mismanagement.

Thousands of indigenous, forest-dwelling tribes in the North East, Himalayas, and Western Ghats rely completely on these streams for sustenance. Many creeks and marginal stretches are revered and are protected vigorously by local organizations. Today, in Rivers of India, aquatic biodiversity and river-dependent communities are facing major problems such as breakwaters, toxins, intrusion on a person's territory, extraction of sand, desertification, and substandard treatment. Hence, these factors are affecting facets of rivers namely in the following ways:

- Ecological factors
- Socio-cultural factors
- Spiritual factors
- tourism-related factors
- commercial factors

More than 10.8 million people are relying on riverine fisheries which are impairing and declining at an appalling rate. Large embankments are planned in and around, environment-friendly perceptive sites to safeguard areas. Examples like Ramsar, World Heritage Sites, artificial structures enclosing a self-contained ecosystem, sacred regions, community preserved areas. Native people are mostly affected by these and many have been opposing and sending indications to The Ministry of Environment and Forest (MoEF) to cancel these detrimental projects. Particularly, in the North Eastern State of Sikkim, a waterfall of dams is eradicating brooks and areas which are regarded sacred by many tribes and religions. Nevertheless, dams are getting consent, violating communal and ecological

problems. Keeping these problems in mind, specialist reports are being prepared against these government appointed committees. Dams are negatively affecting the Ramsar swamp locations in India. However, there is no reporting of this to the Convention on Biological Diversity (CBD), nor is there any alleviation. Freshwater ecosystems such as rivers which are unpolluted are being overgrown with life and provide a home to a variety of marine as well as terrestrial plants and animals that count on each other's surroundings for diet and survival to sustain the ecological balance of the river.

Rivers donate significant natural services to humans. Creek terrains have served as areas for accommodations and the growth of civilizations for ages. The requirement of the potable water is increasing which has created imbalance in the natural waste management cycle in the water.

Rivers in metropolitan India: -

Rivers in urban areas are facing numerous difficulties. It is in the form of sewage combustion, garbage dumping, invasion, channelization, etc. All these concerned aspects harshly affect the quality of spring as well as the innate functioning of a river directing to losing the habitat for the number of plants and varmints species. The loss of habitat affects both ,flora and fauna. Right from animal species that are visible to the naked eye and the tiny or microscopic ones that live in the rivers are suffering due to lack of habitat The consequences are evident and can be investigated through visual compliance.

However, small-sized animals like snails, oceanic vermins, and even microscopic ones such as 'rotifers' are understood to be equally or moderately affected by small changes in water quality such as

temperature, oxygen available to living aquatic organisms, and restorative concentrations. However, studies on these animals continue to be limited due to the ordinances of specific experimental procedures, laboratory infrastructure, and classifying organism techniques.

There is a terrible crisis in relation to the Mula-Mutha river. What was once a means of survival for the city has been reduced to a home for all kinds of waste. The logistic support functions of the river are crucially reduced as it passes through Pune. Pune Municipal Corporation has devised a plan to revive the river, the plan is in consultation with environmentalists and citizen partnership is in execution today.

The Mutha river is burdened with so much waste that with the exception of flooding, the water is almost entirely raw waste. The area of the intersection of the two rivers is practically choked with decaying organic matter, with bubbles of methane (CH^4) and other gases becoming active at the surface The Mutha river, when flowing downstream from Vitthalwadi is akin to an open canal. This then pollutes the Mula river at confluence. In many places, there are thick bodies of Tubificid Worms which cause intestinal disorders in fish or sometimes food poisoning in cattle and humans ."Blood Worms" (Chironomidae Larvae) is also observed which causes severe stomach related diseases . Tremendous populations of these animals are pointers of sewage pollution. At many places near Khadakwasla Dam, however, both above and below the actual dam areas, the water is clear and supposedly uncontaminated.

Water Hyacinth is a type of free-floating tropical American plant now found in water bodies across the globe. These intrusive species prevent the sunlight reaching at the level of oxygen in water systems,

which results in decreasing the quality of water and severe entailing various lifeforms in the ecosystem.

Photo Credit : Vendati Pandav

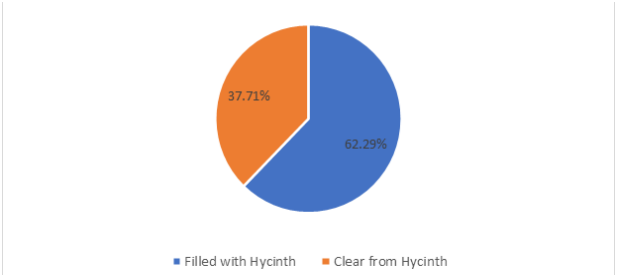


Fig 6.1: Hyacinth Coverage

The research undertaken also illustrates the vast growth and residue of river surface by Hyacinth. Hyacinth indicates that the water body is polluted. Growth on hyacinths affects fish as well birds.

India's substantial geographical spectrum is now home to a wide category of inhabitant birds with the abundance of boosting various arrivals of migratory birds in winter. Furthermore, in India, there

are numerous places like national parks and sanctuaries that have bird watching. The bird habitats of the Indian Subcontinent can be divided into forests, scrublands, swampland, marine, meadows, deserts, and farmlands. Birds in the region are presently facing many threats; the most important of which are loss of habitat and breakdown of food chain. Urban development has significant impact on the diversity of wetlands and communities of many species of birds. Major risks include overexploitation of swampland reserves, increasing hydroelectric developments, pollution caused due to sewage, industrial effluents, agricultural fertilizers, and pesticides. Even in all these unfavourable conditions biodiversity has made its way and strengthened itself. Mula-Mutha River streaming through Pune city is a fair example of the same. This dilapidated river, which flows through the heart of the city has a profusion of birdlife which can be glimpsed along the banks.

The following graph represents the animals found all over the rivers -Mula and Mutha. Many species of birds are discovered encircling Mula and Mutha river.

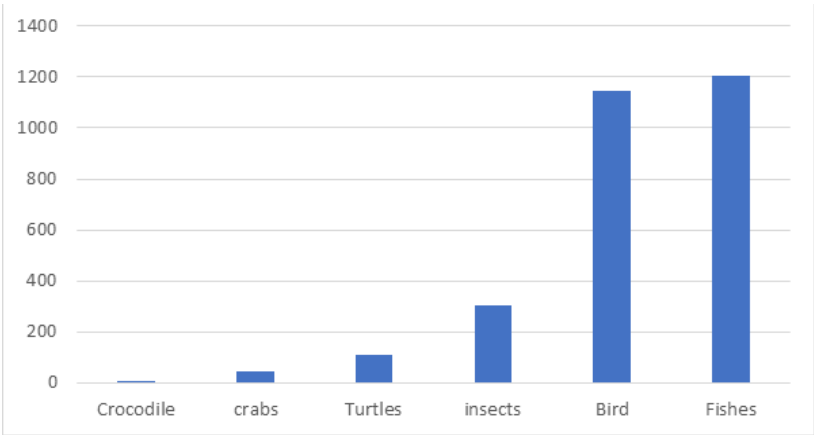
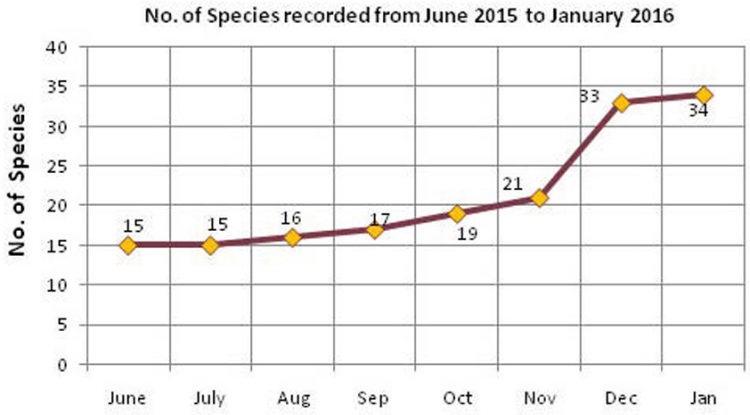


Fig 6.2: Animals in and around river

Birds on every side Mula- Mutha River



Graph -1: Diversity trend at Mula Mutha bird site

Source: Bird diversity report on Mula and Mutha

The birds signify biodiversity wellness. Rivers are used by birds in many ways: wetlands provide them with breeding grounds, rivers are sources of food and water, and rivers are a useful system that helps certain birds navigate. Some main factors that are directly affecting river ecosystems include human activities such as damming, recreational activities, and pollution from urban areas. These will then lead to a direct effect on birds. For example, damming causes a huge shift in rivers by changing the way that river's function and flow. This can cause water systems to fluctuate in temperature which in turn affects sensitive species

Oxygen (02) levels can also decrease, causing harm to fish or any other organisms that birds may depend on for food. Without fish and insects, a bird's food sources will become scarce and decrease over time. Pollution is another factor that causes harm to not only food sources but also water quality. This will again be passed up the food

chain to birds and other animals that consume these food sources.

Photo Credit: Sandesh Kashtey

Photo Credit: Mihir Ingale

Fish contributing to River

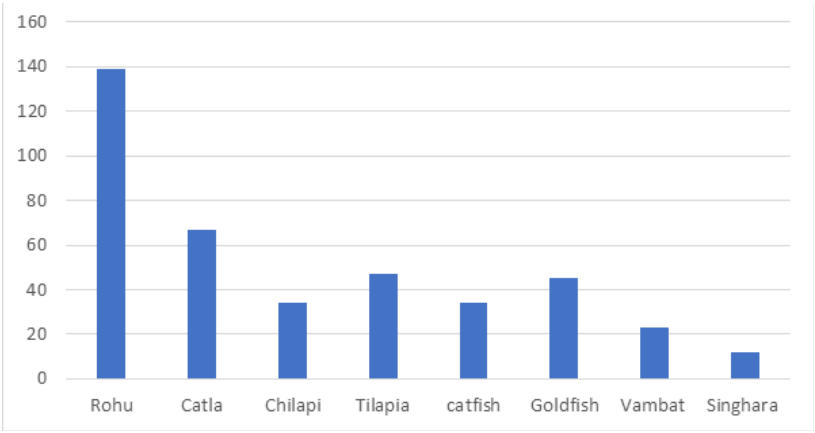


Fig 6.3: Fish in Mutha Mula River

River Mula endorses itself through industrial and crawling ambient environment which resulted in poisoned with emissions of industrial gases in addition to civic wastes. Yet, not repeatedly, the killing of fish was discerned at many locations. Shortly, after monsoon, half of the year, River Mula is gulped with water Hyacinth. Control measures comprising of bio-tech have been inadequate in battling this. Fortunately, it has not entered the river Mutha, as only a few patches of water hyacinth are detected.

Fishing on the Mula river at Chande -Nanade bridge near Hinjewadi
Photo Credit: Poonam Digwani

Pathway ahead

Rivers are alleviations of existence. So, not only humans but any life forms are dependent on them. Despite of the fact , humans are not contemplating any other life forms and making the river a place filled with profanity.

The chapter has summarized many species that are still dependent on the river. Therefore, it is now fundamental to retain the minimum flow of water throughout the year to nourish life in riverine drive habitats. Streams such as Ambil Odha and Nagzari, and rustic springs that forage the river must be renovated along with the major river bod Around 50 years ago, there was so much water in the river that it was feasible to jump off a bridge in the river and swim towards the ghats . Now, channelization has diminished its flow and no action is being taken to make sure the river has even a fraction of the water it used to possess even a minimum amount of water. This has taken away from

the river water which was able to meet some of the city's water necessities. Social activist Dr. Narendra Dabholkar started initiatives to impede the river from muffling further by trying to stop Ganesh Visarjan in the river. The movement has spread like wildfire and for the first time this year, the five main Ganesh idols--the pride of Pune city--were inundated in the tanks rather than in the rivers.

Here are some steps we can take to control pollution in rivers.

• Always avoid releasing untraversed sewage into lakes and rivers as it gets to mix with water and contaminates it.

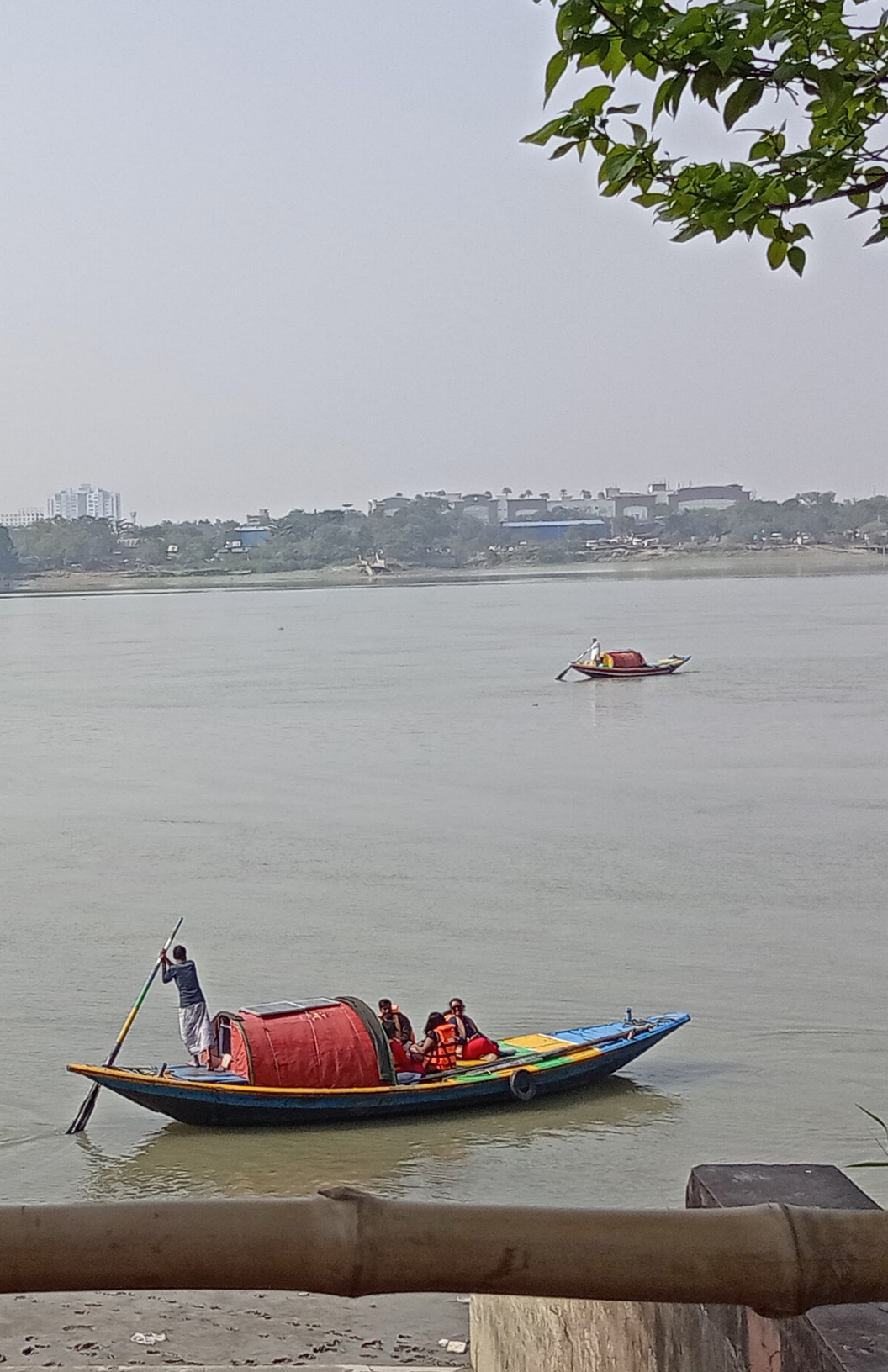
• Do not throw any solid waste into the water streams as it obstructs the flow of water thereby leading again to contamination.

• Avoid dumping construction waste into the river. Use organic gardening techniques and avoid using pesticides and other herbicides.

• Avoid releasing lethal chemicals and grease into storm drains.

• Always check that your car engine is not dribbling oil that finds its way into drains and then into rivers.

Once the rivers are clean and flowing around the year without any problem then such rivers can be used for transport. The possibility of such rivers is discussed in the next chapter



CHAPTER 7
Waterways - The new transport of the era

Introduction

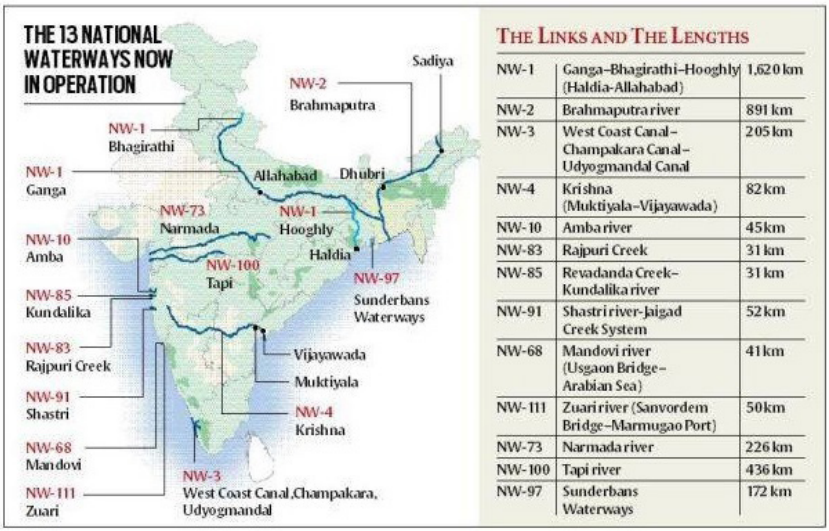
Unpolluted, flowing water is also considered a soothing effect for sore eyesight. Rivers are the backbone of human civilization as they have offered much more impact than just drinking. The current chapter looks at river water transport options in India.

Inland waterways university is a network in the form of rivers, canals, backwaters, and creeks that can be used for transportation in place of or in addition to roads and rails. Through the ages, rivers have served as effective waterways, carrying people and goods over long distances. Even today, many countries depend heavily on inland water transport, especially for large and bulky cargo, as it is cheaper, more reliable, and less polluting than transporting goods by road or rail. A vast country like India could use such a huge mode of transportation. But with passenger and cargo transportation, the river would be over stressed.

India has a total coastline of 7551 km with 13 major ports trust, approximately 200 minor ports. The country has an extensive network of inland waterways in the form of rivers, canals, backwaters, and creeks. The total Navigable length is 14,500 km, of which about 5200 km of rivers and 4000 km of canals can be used by mechanized craft and cargo moved in the financial year 2013-14 and 2014-15

respectively 322.63 and 365.37lakh tonnes in India. The country has been divided into 20 river units that include 14 major river basins. The remaining 99 river basins have been grouped into six river units. The poor planning and neglect of this sector over the decades is reflected by the fact that the Ganga-Brahmaputra-Meghna basin which covers 34 percent of the country's area contributes about 59 percent of the water resources. The west flowing rivers flowing towards the Indus that covers 10 percent of the area account for a mere 4 percent of the resources while the remaining 56 percent of the area contributes 37 percent of the runoff. Clubbed with this geographical picture is also the fact that India has 7,551 kilometer of coastline and about 14,500 kilometers of navigable inland waterways. This huge potential has by and large remained unexploited despite the universal acceptance of the fact that waterways transportation is fuel efficient, environment-friendly, and more economical as compared to rail and road. As the current scenario stands, Inland water transport (IWT) has only less than a 5 per cent share of the total goods transported within the country through various modes such as rail, road, and water. This is much less in comparison to other nations which are similarly blessed with such a vast river network. Let us compare ourselves with our immediate neighbour China with which we tend to compete for both on economic and industrial fronts. As against our 14,500 kilometers of navigable inland waterways, China has over one lakh kilometers of well-honed waterways. This scenario is significant both from the public and planner's point of view, when fresh efforts are afoot to develop inland waterways. The idea behind this endeavour is to provide relief from the choked road and railways network with a cheaper option that has the potential to help the economy, particularly in the rural sector. For instance, in China, 47 percent of

goods and passenger traffic is on the water while in Korea and Japan, 43 and 44 percent of goods and passenger traffic respectively is on water. In European countries, 40 percent of goods and passenger traffic is on water. India accounts for just 3.5 percent of goods and passenger traffic through inland waterways.



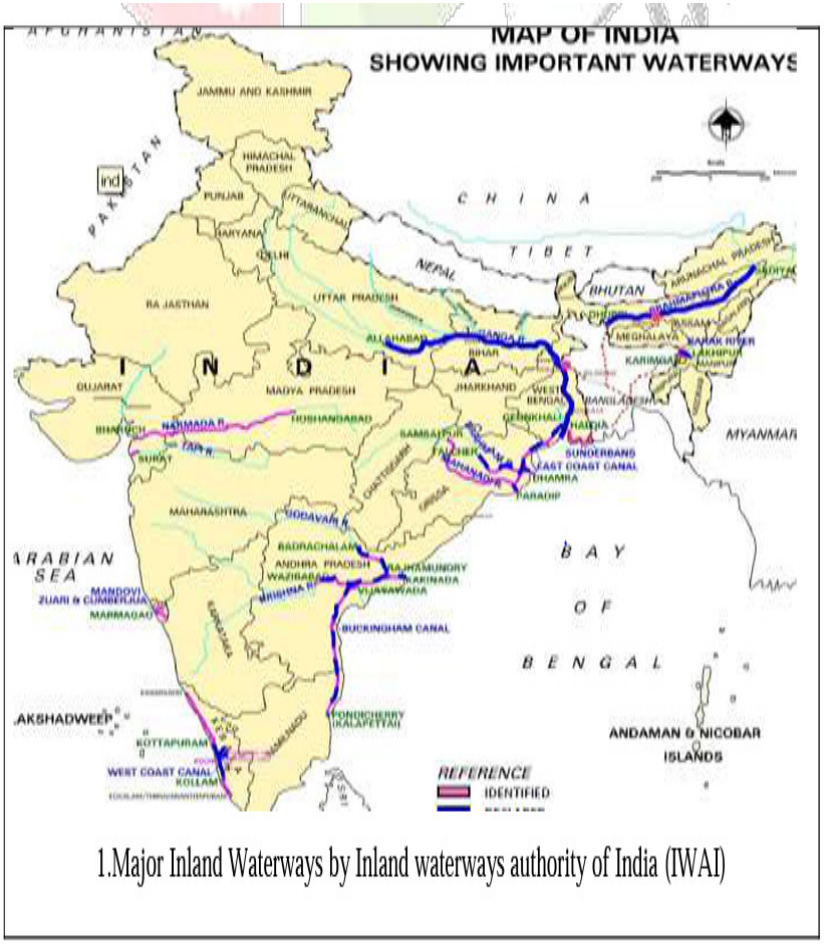
THE LINKS AND THE LENGTHS

NW-1	Ganga–Bhagirathi–Hooghly (Haldia-Allahabad)	1,620 km
NW-2	Brahmaputra river	891 km
NW-3	West Coast Canal–Champakara Canal–Udyogmandal Canal	205 km
NW-4	Krishna (Muktiyala–Vijayawada)	82 km
NW-10	Amba river	45 km
NW-83	Rajpuri Creek	31 km
NW-85	Revadanda Creek–Kundalika river	31 km
NW-91	Shastri river-Jaigad Creek System	52 km
NW-68	Mandovi river (Usgaon Bridge–Arabian Sea)	41 km
NW-111	Zuari river (Sanvordem Bridge–Marmugao Port)	50 km
NW-73	Narmada river	226 km
NW-100	Tapi river	436 km
NW-97	Sunderbans Waterways	172 km

Source: Inland Waterway Authority of India

List of water Ways-

These waterways include Ganga -Bhagirathi-Hooghly river system (Allahabad-Haldia- 1620 kilometers) as NW-1, River Brahmaputra (Dhubri-Sadiya- 891 kilometers) as NW-2, West Coast Canal (KottapuramKollam) along with Udyogmandal and Champakara Canals- 250 kilometers as NW-3, Kakinada-Puducherry canals along with Godavari and Krishna rivers (1078 kilometers) as NW-4. The NW-5 consists of East Coast Canal integrated with the Brahmani River and Mahanadi delta Rivers (588 km).



1.Major Inland Waterways by Inland waterways authority of India (IWAI)

Source: Inland Waterway Authority of India

The waterways are an essential part of the transport. Indian Government also emphasizes on waterways and hence the study undertaken suggests the waterways condition of the rivers in consideration.

Importance of rivers as Transport

The following diagram depicts the importance of transport activity on the rivers

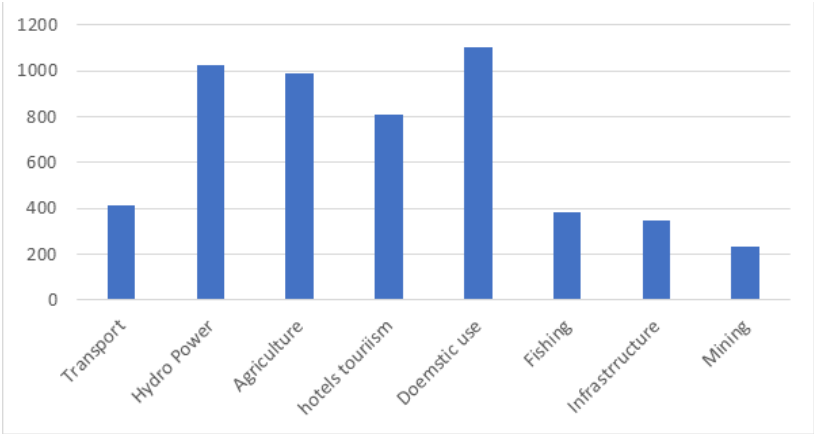


Fig 7.1: Importance of river as transport

The research shows the cities which are located on the river banks.

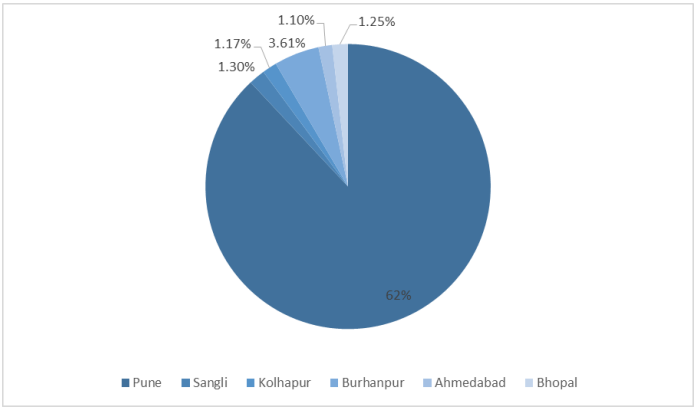


Fig 7.2: Cities on riverbanks as per survey

THE KRISHNA AND BHIMA RIVER BASIN AND WATERWAYS

Source: Inland Waterway Authority of India

Bhima river is a major river in the state of Maharashtra, India. It is one of the main tributaries of the Krishna river and flows through the districts of Pune, Solapur, Satara, Sangli, and Osmanabad. The river originates near Bhimashankar in the Western Ghats and flows for a total length of about 725 kilometers before joining the Krishna River near Raichur in Karnataka.

The Bhima River is an important source of water for irrigation, drinking, and industrial purposes in the region. It is also a major source of hydropower, with several dams and hydroelectric power stations built on the river. The river basin is known for its fertile agricultural land, with sugarcane being a major crop grown in the region. The river also plays an important role in the cultural and

religious life of the people living along its banks, with several temples and pilgrimage sites located in the region

The basin is trapezoidal in shape with its axis aligning Northwest to Southeast. Bhima basin is located on the northern border of Krishna basin separated from Godavari Basin by Harishchandra and Balaghat ranges. Bounded by Western Ghats on West, it is separated from Upper Krishna sub basin (catchment of Krishna mainstream) by Mahadeo ranges. Total area of the basin is 48,899 Sqkm which is 70.43% of Krishna Basin. The basin is divided into Upper Bhima & Lower Bhima sub-basins. While Upper Bhima basin falls entirely in Maharashtra about 5% area of Lower Bhima basin falls in the state.

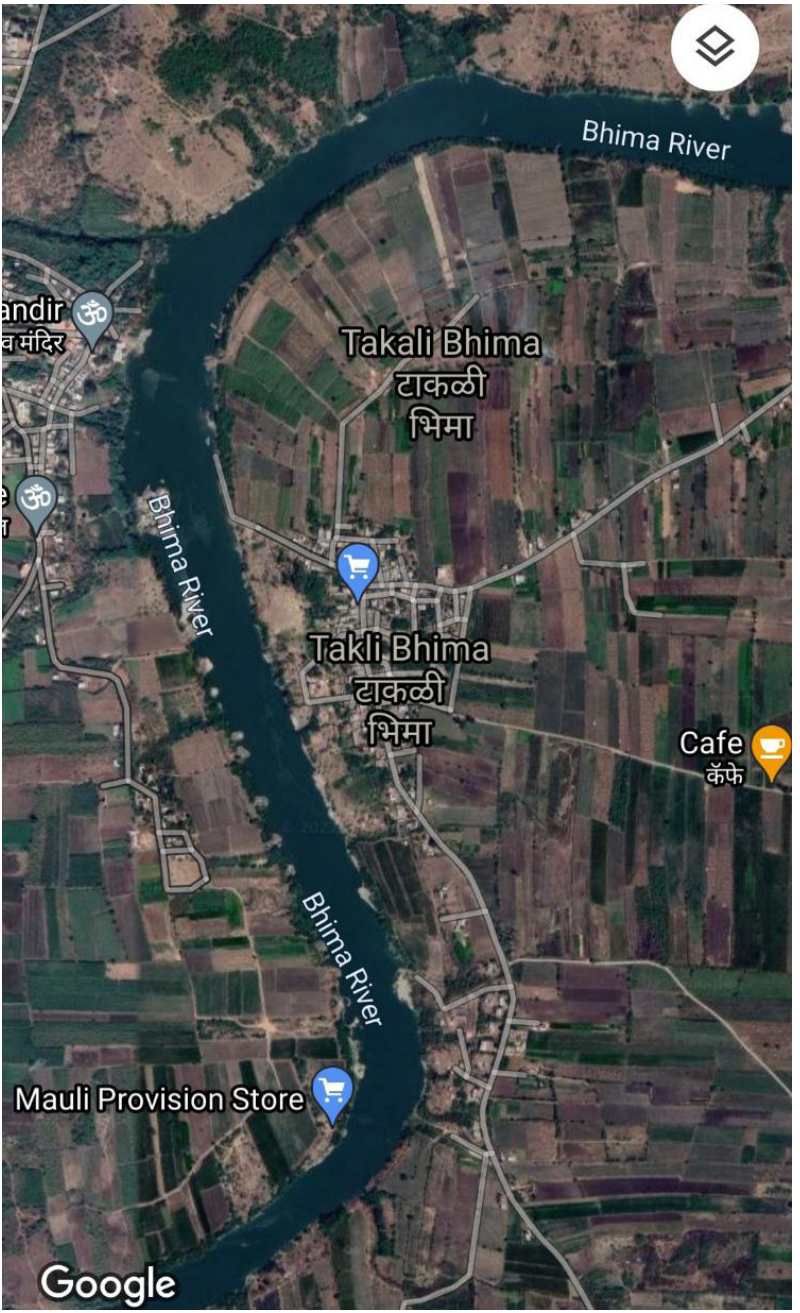


Photo :Kunal Madot

Proposed Waterways on Bhima River

Waterways can be at Pandharpur, Ujaani dam, and the confluence of Indrayani and Bhima .Very less waterways were observed on this stretch. The feasibility study conducted by CWPRs in 2018 shows a promising future for water transport.

THE MULA RIVER:

The Mula River is a river that flows through the Indian state of Maharashtra. It is a tributary of the Bhima River, which in turn is a tributary of the Krishna River. The Mula River originates in the Sahyadri mountain range near Lonavala, and flows through the districts of Pune and Solapur before joining the Bhima River near the town of Tuljapur. The river is approximately 146 km long and is an important source of water for irrigation, drinking, and industrial use in the region.

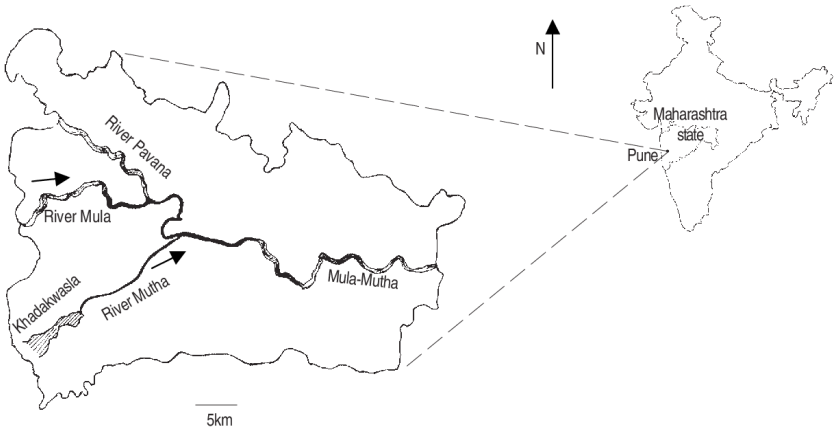
The Government of India has proposed waterways in Pune district and one of the waterway under construction is at Mulshi dam, Rahatani and Pimple Gurav. The decision will benefit those living near the rivers in Chinchwad, Kiwale, Ravet, Dudulgaon, Moshi, Thergaon, Sangvi, Poonawale, Rahatni, Borhadewadi, Pimple-Gurav, Wakad, Charholi, Thergaon, Pimple-Nilakh, Chikhli.The plan is passed under Mula –mutha Riverfront Development plan.

Mula-Mutha Riverfront Development: The Mula-Mutha river is the lifeline of Pune, and the riverfront development project aims to beautify the riverbanks and create a sustainable ecosystem. The project includes several components like developing walkways, cycle tracks, green spaces, and recreational areas along the riverfront.

The Mutha river

The Western Ghats are the source of the Mutha River, which travels for around 21 kilometres before joining the Mula River in Pune. The Mutha River has been dammed twice, the first time at the Panshet Dam (on the Ambi River), which supplies irrigation and drinking water to Pune. Pune relies heavily on this water, which is dammed up again at Khadakwasla, as a supply of drinking water. Later, a second dam was constructed at Temghar on the Mutha River. It continues as the Mula-Mutha River after combining with the Mula River in Pune and flows on to join the Bhima River in Sangameshwar.

Pawana -Mula- Mutha River Map



Source : Pune Municipal Corporation

The Rivers Mula -Mutha have found a place on the National waterways Pune city has been selected as one of the beneficiaries of the National Waterways project. The Mula-Mutha will be added to the list of rivers that are going to be part of this project.

Mula River

Source : Mihir Ingale

Mutha River

Source : Mihir Ingale

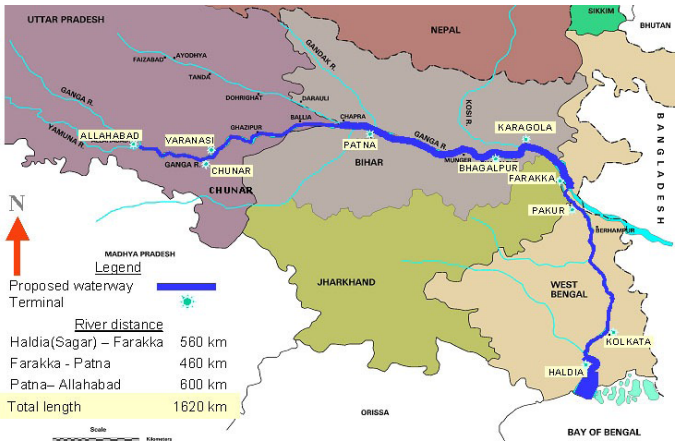
Ganga River Basin

Ganges River, Hindi Ganga, great river of the plains of the northern Indian subcontinent. Although officially as well as popularly called the Ganga in Hindi and in other Indian languages, internationally it is known by its conventional name, the Ganges. From the time of its immemorial it has been the holy river of Hinduism. For most of its course, it is a wide and sluggish stream, flowing through one of the most fertile and densely populated regions in the world. Despite its importance, its length of 1,560 miles (2,510 km) is relatively short compared with the other great rivers of Asia or the world.

Out of 1124 responses, 26 responses covered the Ganga river. The Responses were from Kolkata, Varanasi, and Kanpur**.**

Waterways on River Ganga

Ganga-Bhagirathi-Hooghly river system from Allahabad to Haldia was declared as National Waterway No. 1 vide National Waterway (Allahabad-Haldia stretch of the Ganga Bhagirathi- Hooghly river) Act 1982 (49 of 1982).



Source: Inland Waterway Authority of India

Godavari River

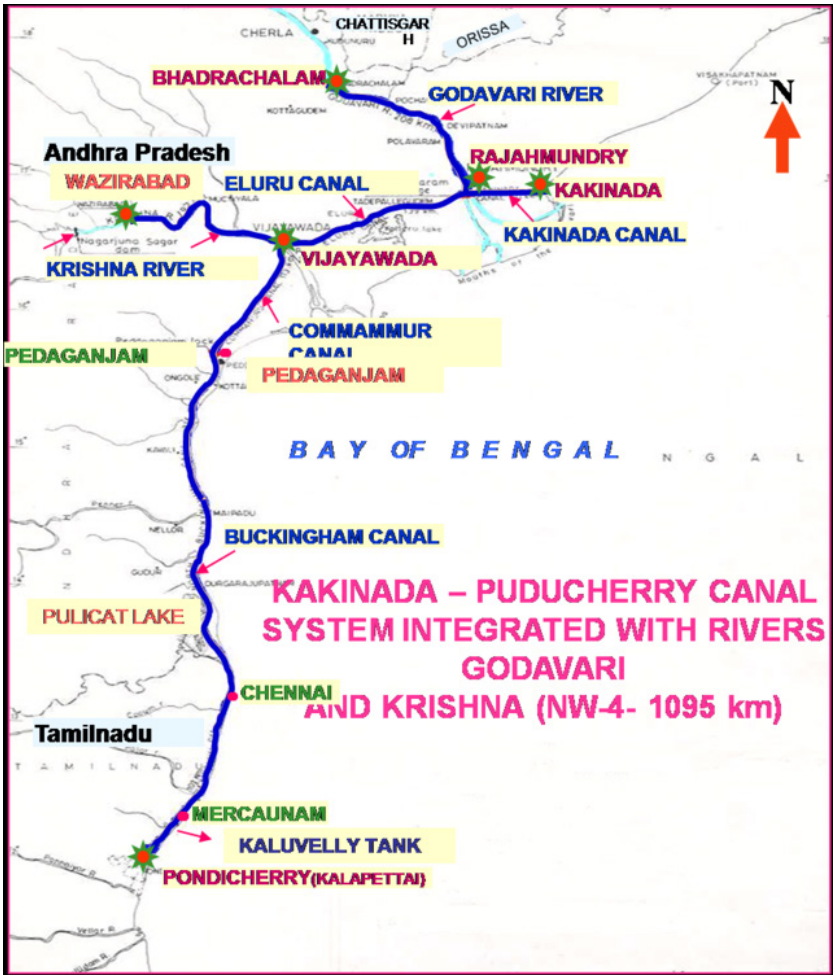
The Godavari River is important in India and it flows from western to southern India. The catchment area of the river is regarded as one of the biggest in the country. The river is 1,465 km long and ranks as the second longest river in the country (after the Ganges). The drainage basin of the river is present in six states of India: Chhattisgarh, Maharashtra, Andhra Pradesh, Madhya Pradesh, Karnataka, and Orissa.

About Godavari River

The source of the Godavari River is situated near Trimbak in the Nashik District of Maharashtra. After setting off, the river runs towards the east, traversing the Deccan Plateau. In the end, the river empties into the Bay of Bengal at Narasapuram in West Godavari district, Andhra Pradesh.

National waterway 4

The Kakinad canal and Eluru canal and Commamur canal which are irrigation cum navigation canal also interlink the two major river systems of Godavari and Krishna.



Source: Inland Waterway Authority of India

The Research suggested that the river at Nashik is currently being sued for water transport between various ghats of Nashik.

Source : Mihir Ingale

Conclusion

Inland water transport is a dream in such places and a reality in others. To make use of this transport a revival plan is a must. The next chapter suggests the strategies for revival and finally to reach the goal.

CHAPTER 8
The Indian River Revival Plan: Approaches and Strategies

Rivers as we have seen through earlier chapters need to be revived. Pollutions, dams, construction in bay areas and encroachments have really made the rivers non-existent in certain parts. This chapter makes an attempt to revive the rivers. Large river systems make up one of the most fundamental life-support systems that have kept civilizations alive. It is predicted that rivers will play a crucial role in determining how long human civilizations will survive. One of the main sustainability agendas will be the development of dynamic strategies for the management of natural freshwater systems on a planet where the human population is predicted to nearly double by the middle of the century and which is also likely to be affected by an unprecedented rate of global change. Civilizations have thrived in the South Asian region for more than 5,000 years, creating a population hotspot that is abode to nearly a sixth of the earth's population. As a result, there have been numerous human interventions and effects on the local freshwater systems. Therefore, a holistic perspective that emphasises the interdependence of the land, water, and humanity is required for understanding water issues and water security in this region. Understanding big river systems is crucial for ensuring their futures and, by extension, our own futures, as they are a lifeline

for human populations. Surface runoff, stream flow, and discharge patterns of the peninsular rivers in India need to be thoroughly studied through rigorous science, among other things.

The sale and disposal of plastic materials near sacred sites, the flushing of sewage, the washing of garments, and the bathing of animals are all practices that have brought the Ganga to the brink of extinction. The Yamuna and other sacred rivers are the same way. More than 3 billion litres of untreated sewage is reportedly being poured into the Ganges, according to experts. When it gets to Varanasi, Ganga transforms into a sewer. As a result, it is ranked sixth among the world's most contaminated rivers. The discharge from 15 drains flows into the Yamuna after it passes through the Wazirabad and Okhla barrages, making it notorious for being extremely dirty.

Although it was frequently argued that South Indian rivers were significantly less polluted than rivers in North India, particularly those from Uttar Pradesh, the CPCB (2015) study hushed everyone. According to the report, around 37,000 MLD of untreated sewage water enters waterways daily across the nation. No area is exempted from river pollution, not in the north or south, not in the east or west. According to the survey, both urban and industrial wastewater discharge have contributed to the pollution of as many as 302 river segments on 275 rivers across the nation over time.

Source: thehansindia.in

Approach to be adopted for Indian River Revivals –

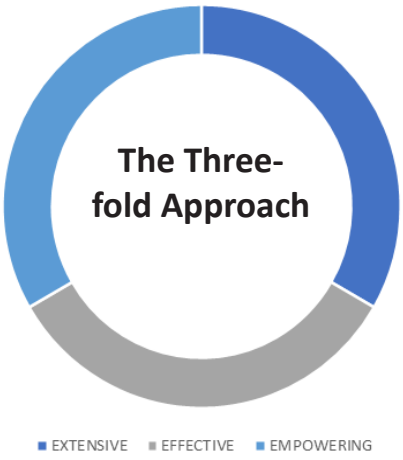


Fig 8.1: Three-fold Approach

A three-fold approach can be adopted for the revival of Indian rivers. It can be explained as follows:

1. Extensive

Give scientifically supported solutions that display how natural systems restore water. Working with nature enhances water resource management, contributes to universal water security, and promotes the fundamental tenets of sustainable development. The immense potential for nature-based solutions is still not fully realised, and traditional, human-built (also known as "grey") infrastructure continues to dominate water management. Green infrastructure is a component of nature-based solutions and can effectively replace, supplement, or operate alongside grey infrastructure. To optimise benefits and system efficiency while reducing costs and trade-offs, the best mix of green and grey investments must be found. Because they also produce social, economic, and environmental co-benefits like improved human health and livelihoods, food and energy security, sustainable economic growth, decent jobs, ecosystem restoration and maintenance, biodiversity, and nature-based water solutions are essential achieving the 2030 agenda for Sustainable Development. Nature based solutions will be crucial in advancing the revival of rivers and creating a fairer future for everybody, even though they are not a cure-all.

2. Effective

Create methods that will ensure dependable supply in the future while simultaneously addressing the present need to provide people with access to safe water. Panellists for World Water Day in March 2020 recommended a shift in perspective about wastewater treatment. Recyclers are working to reduce water imports and increase water security in some nations, including Singapore. The wealthy East Asian nation is a pioneer in the creation of cutting-edge

technology that purifies wastewater for use in other applications, such as drinking. Agriculture uses over 70% of the freshwater in the world. Irrigation improvements can aid in reducing supply and demand imbalances. In certain cases, wasteful irrigation techniques from a bygone era have made it more difficult for farmers to feed and clothe a population that is expanding. Systems for collecting water are crucial in places without alternative reliable water sources. India is upgrading its rainwater collection infrastructure even though it is experiencing few of the worst effects of climate change. These initiatives give water resources independent control. In essence, each component is connected to and has an impact on the others, and the entirety is larger than the sum of its parts. Communities that run sewage treatment facilities and pursue alliances with renewable energy providers to use wastewater as fertilizer for algae and other biofuel crops are excellent examples of holistic management. In turn, the crops clean the effluent and absorb nutrients, greatly lowering pumping and treatment expenses.

3. Empowering

By using frameworks for capacity building, empower local communities. In order to achieve our goal of eliminating intense poverty within our generation, supporting safe and sustainable drinking water for rural populations is crucial. Given that 70% of the world extremely poor live in rural areas and that close to 768 million people still lack improved water access globally. Rural water delivery presents a different set of difficulties from urban water provision. Due to a smaller population that is dispersed across a larger region, rural locations frequently have greater per capita construction costs for water systems than metropolitan ones. This results in

significant running costs that must be borne by fewer consumers. Most significantly, there might not always be a clear organisation willing to assume the duty of running the system after it is built. This institutional void causes inadequate water charge collection, which in turn results in subpar operation and upkeep of the rural water systems. Even more crucial than developing rural water infrastructure is maintaining them. The institutional difficulty of operating and maintaining complicated rural water systems has frequently been addressed by handing management of those systems over to the community, but with limited success.

Strategies to be adopted for Indian River Revivals -

1. Preventing River Pollution from Agricultural Runoff:

Agricultural runoff can be reduced if farmers are encouraged to switch to organic farming. Our farmers require organic content in their soil if they want to produce decent yields and make a living from agriculture. Only by reintroducing tree leaves and animal faeces can soil become healthy. This is beneficial not just to the river, but also to the land, farmer revenue, and public health. Incentivizing farmers to switch to organic farming is therefore not just necessary for our waterways, but also for the nation's food security and the well-being of hundreds of millions of farmers.

2. Treating Industrial & Chemical Waste:

Chemical and industrial waste are now managed in India in such a way that the polluting company is expected to clean its effluent before discharging it into the river. In practise, this means that many firms will only treat their effluent when inspectors are present. Many enterprises discharge untreated sewage into rivers while no one is

watching. If we want this treatment procedure to be effective, we must make wastewater treatment a profitable commercial proposition.

3. PPP Model to Tackle River Pollution in India:

This problem can be solved quickly, as the necessary technologies are already available. What is required are strict laws and the commitment to put them into effect. We are not required to clean the waterways. If we cease contaminating them, they will be clean after just one flood season.

The World Bank is involved in several sectors of water resource management, as well as the provision of drinking water and sanitation services throughout the country. Here are some examples of how. Groundwater is a critical source of irrigation as well as rural and urban residential water supplies. However, overuse of this important resource has resulted in its depletion.

Source: www.theprint.com

1. Initiatives taken by the World Bank to provide potable water:

The World Bank is assisting the government's national groundwater programme, the Atal Bhujal Yojana, in its efforts to enhance groundwater management. This is the world's biggest community-led groundwater management initiative, with 9000 panchayats in seven Indian states participating.

In the agricultural province of Punjab, where excessive tubewell irrigation is driving the water table to plummet, the Bank assisted the state government in piloting an innovative groundwater conservation project. The "Paani Bachao, Paisa Kamao" (Save Water, Earn Money) initiative encourages farmers to decrease their use of groundwater. Around 300 engaged farmers were offered economic incentives to conserve power used for irrigation, resulting in water savings ranging from 6 to 25% without a negative impact on productivity.

The World Bank has backed the government's efforts to supply safe drinking water to rural populations during the previous decade. Over 20 million individuals have benefited from a variety of programmes totaling $1.2 billion in funding.

Villages in the alpine state of Uttarakhand were without water because the high Himalayan topography made it difficult to install and maintain the necessary infrastructure. Many residents, particularly women, had to trek more than 1.6 kilometres to get pure water for household purposes.

The World Bank-financed Uttarakhand Rural Water Supply and Sanitation Project assisted around 1.57 million people in the state between 2006 and 2015 by developing sustainable rural supply of

water and sanitation services in underserved regions. The initiative aimed to strengthen infrastructural and institutional capacity, particularly that of village communities, to make them more resilient to natural catastrophes in the mountain state, which is prone to flash floods, earthquakes, and landslides.

The southern state of Kerala has one of the greatest levels of rainfall in the country, yet its undulating landscape drains most of the rainwater into the sea. Rapid urbanisation across the state has resulted in depleted water resources.

Since the early 2000s, the World Bank has worked with the state government to ensure that rural residents have a consistent supply of piped water in their homes at a cost that even low-income families can pay. For the first time in their lives, Jalanidhi I (2000-2008) and Jalanidhi II (2012-2017) helped deliver water into village homes by placing local communities in charge of operating their own water supply networks.

Continuous piped water delivery has been a pipe dream for India's rapidly urbanising towns. Most urban homes have access to water for only a few hours per day, and typically for a few days per week. This is especially detrimental to the poor, women, and children, who spend time and money obtaining water for their daily requirements.

2. Karnataka Water Supply Improvement Project and Karnataka Urban Water Supply Modernization Project:

The southern state of Karnataka has now demonstrated that 24/7 water delivery in metropolitan areas is feasible, economical, and sustainable. The World Bank-backed Karnataka Water Supply Improvement Project assisted in piloting this approach in the three

water-stressed cities of Hubbali-Dharwad, Belagavi, and Kalaburgi; a follow-up project, the Karnataka Urban Water Supply Modernization Project, is now scaling up to cover the entire population of the three cities.

Even though residents must pay for the water they consume, the cost for "lifeline usage" (up to 8-kilo litres) is set at levels that poorer households can afford. Water connections at the household level are subsidised so that poorer families can benefit from the increased services.

3. The Shimla Water Supply & Sewerage Service Delivery Reform Project:

Shimla, the capital of Himachal Pradesh's mountainous state, has a similar narrative. Due to dwindling water supplies, fast population expansion, and an increase in the number of visitors visiting the resort town, the city only received water for a few hours every three days. Shimla Water Supply & Sewerage Service Delivery Reform Project improvements have guaranteed that the city now receives at least 3-4 hours of water service per day, with attempts underway to convert to 24x7 supply. All of this has been accomplished not just by repairing the pipes, but also by repairing the institutions that repair the pipes. The World Bank initiative helped to fund the creation of a professionally managed water service that is directly accountable to residents.

To conclude, river revival is a long term but a possible measure. It a s sustainable solution and requires a strong will power. It is each citizen's duty and participation which will make the revival possible.

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As time has advanced humans do not need to visit rivers on daily basis thus bringing negligence and apathy DES's IMDR being a socially inclined management institute decided to reconnect the youth with rivers and the research project "Sugam Sarita" was undertaken. Su-gam means easy to understand. The research project has initiated students to visit and understand the importance of rivers for human existence. This research-based book Sugam Sarita is led by students and faculty teams at DES's IMDR. The book throws light on the various connection between rivers and livelihood, economics, and ecology. Through this book, the authors believe to sensitize students- our youth towards importance of rivers in our lives.

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