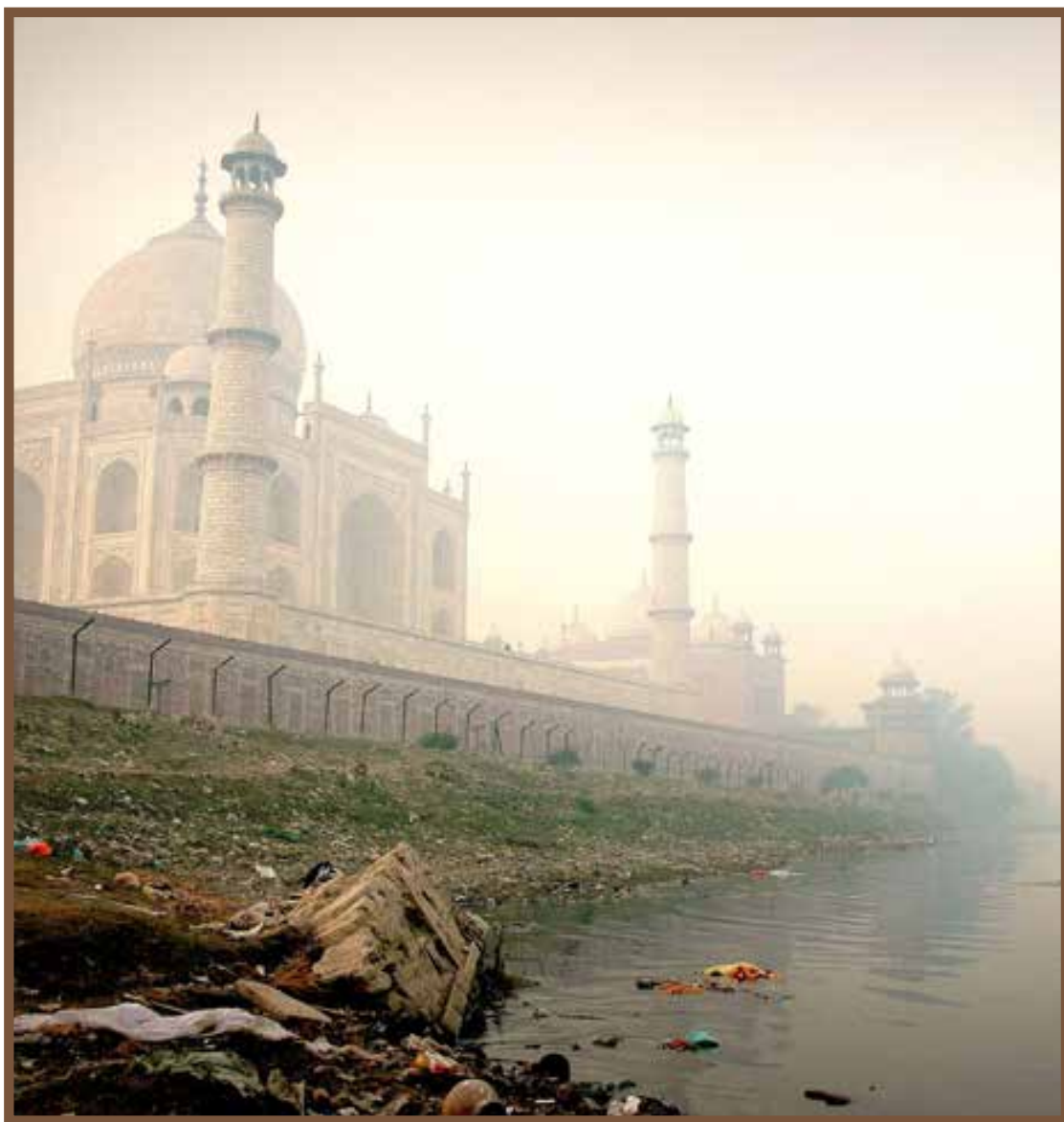


THE YAMUNA RIVER: Life and Death of a Principal Waterway



With a Special Focus on Delhi

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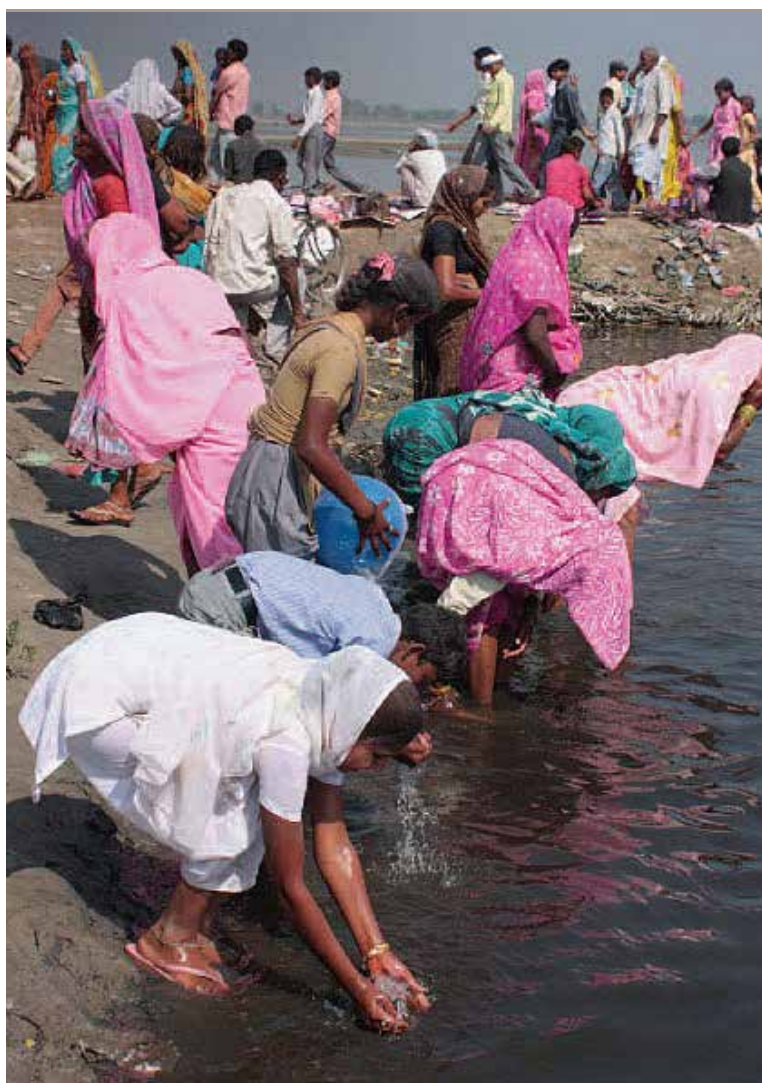
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ACRONYMS

AIIMS	All India Institute of Medical Science
BOD	Biochemical Oxygen Demand
CSE	Center for Science and Environment
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board (India)
CTC	Community Toilet Complex
DJB	Delhi Jal Board
DO	Dissolved Oxygen
EC	Electric Conductivity
FC	Fecal Coliform
GAP	Ganga Action Plan (Indian Government)
GOI	Government of India
HEV	Hepatitis E Virus
JBID	Japan Bank for International Development
MCD	Municipal Corporation of Delhi
MIT	Massachusetts Institute of Technology
MLD	Million Liters Per Day
NCTD/	
NCT	National Capital Territory of Delhi
NDM	New Delhi Metallobetallactamase
NGO	Non-Governmental Organization
PE	Population Equivalent
TC	Total Coliform
TDS	Total Dissolved Solids
TERI	The Energy and Resources Institute
TKN	Total Kjeldahl Nitrogen
ULB	Urban Local Bodies
YAP	Yamuna Action Plan (Indian Government)



Worshipping the Yamuna River

Introduction

The Yamuna River is considered one of India's most sacred rivers. It is said to wash away the fear of death for anyone who takes a dip. Yet, the river itself, in key regions, is either dying or dead itself.

The river courses through the Indian states of Uttarakhand, Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh and Delhi, providing water to an estimated 57 million people a day. Its basin encompasses nearly 11% of India's landmass. As the largest tributary of the River Ganga, it also amounts to 40.2% of the Ganga Basin.¹

Yet, while the river is depended on by a population larger than the populations of Canada, Greece, and Ireland combined, it is heavily polluted with domestic waste, including sewage and dead bodies, as well as carcinogenic industrial and agricultural effluents.

Delhi is the largest contributor to the Yamuna's pollution load. By the time the river reaches the metropolis, every drop of its fresh water has been siphoned off to serve households, businesses, industries and farms. The parched riverbed, in turn, becomes an open sewer that, according to the Supreme Court, has reduced the river's life-supporting oxygen levels to 0 %.²

SITUATION OVERVIEW

- Just few miles from the Yamuna's birthplace, a majority of its waters are siphoned off.
- An estimated 92% of the river's waters are used for irrigation.
- As the river courses through Northern India, it becomes overwhelmed with pollution, including carcinogenic chemicals and human waste.
- About 70% of the total cattle population in the Yamuna basin use the river and its canals for bathing and drinking purposes directly, impacting water quality substantially.
- While Delhi only constitutes 2% of the Yamuna's catchment, the river unevenly accounts for more than 70% of Delhi's water supplies. Available water treatment facilities are not capable of removing pesticide traces. Waterworks laboratories cannot even detect them.³
- By the time the river leaves Delhi, the Yamuna has been entirely drained, mostly in order to feed thirsty cities and farms.
- Once emptied of its waters, the Yamuna's riverbed becomes an open sewer.



A Holy Man Meditates on the Dry Yamuna



SOURCES OF POLLUTION IN THE YAMUNA RIVER

Yamuna is the most-polluted river in the country. The current state of the river is of serious concern, and in order to address the pollution crisis effectively, it is important to first understand the causes of pollution. Approximately, 85% of the river's pollution comes from domestic sources.⁴ The major sources contributing to the pollution of Yamuna are: untreated sewage, industrial effluents, the dumping of garbage and dead bodies, immersion of idols and pollution due to in-stream uses of water.⁵ Further, the dilution capacity of the river is reduced due to significant water abstraction, leading to greater deterioration of the river. National Capital Delhi is the major contributor of pollution in the Yamuna River, followed by Agra and Mathura. For a focus on the sources of pollution in Delhi, please see page 11.

DOMESTIC POLLUTION

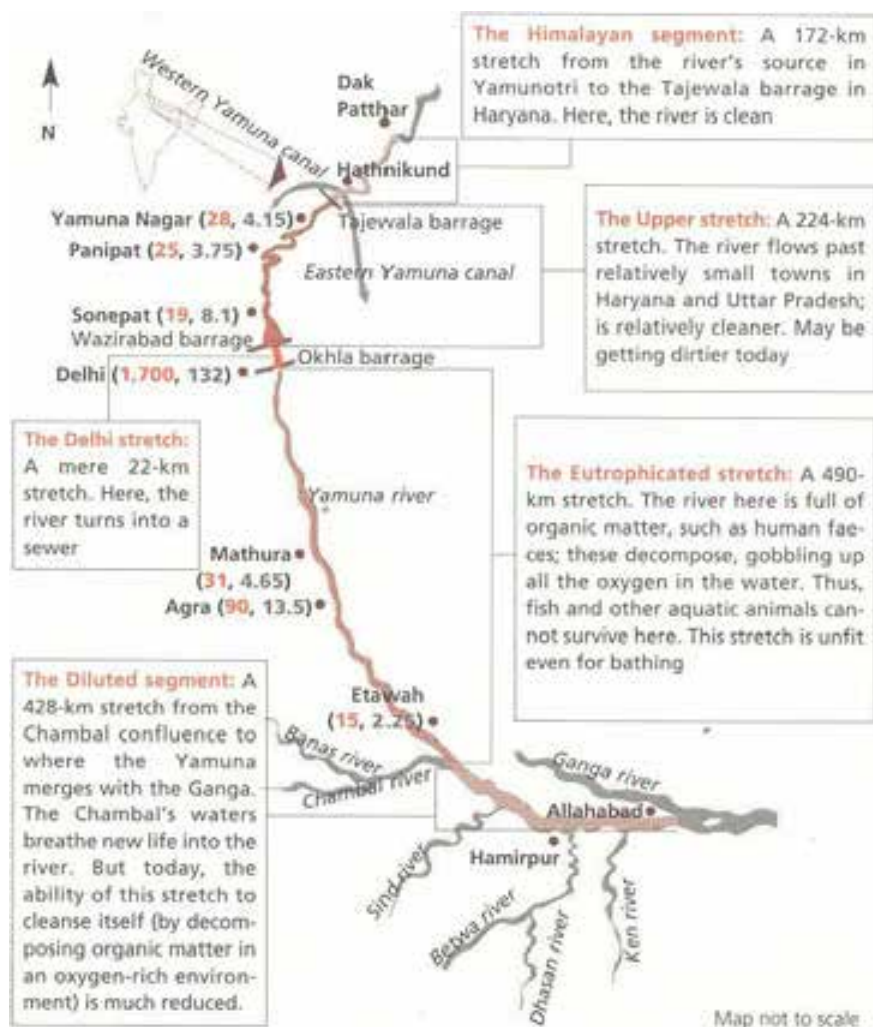
Domestic pollution is the major source of pollution in the Yamuna River and is mainly caused by India's metropolises. Major urban centres contributing to the improper disposal of domestic waste into Yamuna River are: Panipat, Sonapat, Delhi, Ghaziabad, Mathura-Vrindavan, Agra, Etawah and Allahabad.⁶ The sources of domestic pollution will be examined in detail within this report.

DISCHARGES FROM SEWAGE TREATMENT PLANTS INTO THE RIVER

Sewage treatment plants (STP's) have been constructed at various urban centres in order to conserve the water quality of the river. The treated, untreated or partially treated sewage from these STP's is discharged directly or through a carrier drain into the river.⁷ Due to unavoidable reasons such as power failures, mechanical problems or maintenance issues, there are times that STPs do not operate. These times pose a major threat to water quality, as the collected sewage is discharged into the river at a few locations without any treatment.⁸ This is a significant problem in stretches of the river where

- The bubbling black waters only become partially diluted as they make their way to cities such as Agra, the home of the Taj Mahal, and Vrindavan, a location holy to India's Hindus. Such municipalities are yet reliant on the river for their drinking water.
- The Yamuna, as with any river, desperately needs to maintain a minimum ecological flow in order to meet a dilution capacity. Yet, despite India's Supreme Court's High Powered Committee's directives, not even the minimum flow of fresh water is being allowed into to the Yamuna.

SEGMENTS OF THE YAMUNA RIVER



BARRAGES IN THE YAMUNA RIVER

Site	Structure	State	Purpose	State of river
Dak Patthar	Barrage	UA	Power generation	Water diverted into canal
Asan	Barrage	UA	Power generation	Water diverted into canal
Hathnikund	Barrage	UP / Haryana	Irrigation and drinking water	Water diverted into WYC and EYC (No water flow downstream in dry season)
Wazirabad	Barrage	Delhi	Drinking water	Generally no water flow downstream in dry season
ITO bridge	Barrage	Delhi	Water supply to power plant	Water available mainly from drains
Okhla	Barrage	Delhi / UP	Water supply into Agra Canal	Generally no water flow downstream in dry season

Source: CPCB, 2000. WYC – Western Yamuna Canal; EYC – Eastern Yamuna Canal

STP's are located upstream, e.g. Mathura-Vrindavan and Agra, as the water abstracted for people living downstream becomes unsuitable for use.⁹

DOMESTIC POLLUTION DUE TO IN-STREAM USES OF WATER

Bathing

The Yamuna is revered as one of the most sacred rivers, and bathing in the river is seen as highly auspicious. Yet such activities, especially mass bathing, contributes significantly to an increase in disease-producing pathogens in the aquifer. Associated religious activities, such as offering flowers, milk, and sweets into the river water, further increase pollution levels.¹⁰

Domestic Laundry

The washing of clothes alongside the Yamuna's banks also contributes to river pollution.¹¹ As garments are laundered, detergents, inorganic, organic and biological contaminants are released into the river. In-stream foaming results, thus hampering oxygen diffusion rate in the river water¹². As oxygen diffusion is essential for self-purification, its reduction can prove deadly to flora and fauna dependent on the aquifer.¹³

Open Defecation

The Yamuna basin is one of the most densely populated river basins in the country. Due to the non-existence of sanitary facilities in rural areas and urban areas, especially in slum clusters, a large section of the population directly uses the river for open defecation.¹⁴ This contributes significantly to the release of pathogens into the aquifer.¹⁵

Dumping of Garbage, Animal By-Products and Dead Bodies

A large portion of solid waste generated by individuals living along the bank of Yamuna River

"The dry weather flow in the river Yamuna along Delhi is nearly zero. This has resulted in almost total depletion of the self-cleansing capacity of the river..."

- Government of India MoEF

finds its way into the river. Materials include domestic garbage, dairy by-products, remnants from slaughterhouses, and items, such as flowers and plastic bags, that had been discarded in the process of worship.¹⁶

The disposal of the dead bodies of infants in the river is practiced throughout the entire stretch of

Yamuna. Floating human bodies and animal carcasses, some of which have been partially eaten or are rotten, are generally observed in the lower part of the river.¹⁷ This drastically increases the risk of pathogenic contamination.¹⁸

Immersion of Idols

The immersion of idols, especially during the Hindu festivals of Durga Puja and Ganesh Puja, takes place all along the Yamuna riverfront.¹⁹ Flowers, straw, bamboo, clay/ plaster of Paris and harmful chemicals used in the manufacturing of idols especially proliferate as river waste at such times.²⁰

Cattle wading

It is estimated that about 70% of the total cattle population in the Yamuna basin are taken to the river for bathing and drinking purposes.²¹ The discharge of urine, dung and washed-off organic and inorganic materials add to pollution load. In addition, as the large animals wade, sediments at the bottom of the river are churned, further adding to the aquifer's problems.²²

INDUSTRIAL POLLUTION

After independence, industrialization took place rapidly in the Yamuna Basin. Today, large clusters of manufacturers and plants line the riverbanks in locations including Kota, Gwalior, Indore, Nagda, Khetri, Yamuna Nagar, Panipat, Sonapat, Delhi, Baghpat, Ghaziabad, Gautam Budha Nagar, Faridabad and Mathura.²³ Primarily, such facilities are responsible for the manufacturing of pulp & paper, sugar, alcohol, textiles, leather,

chemicals, pharmaceuticals, and food products. Oil Refineries and Thermal Power Plants also proliferate.²⁴

In order to comply with environmental laws, industries are required to treat their effluents to a prescribed standard.²⁵ Yet many industries have been found out of compliance, releasing often quite toxic waste directly into the Yamuna.²⁶

The Yamuna:

Dry by the Hands of Mankind

Due to extensive public works, the Yamuna River's waterflow is significantly depleted, except in times of monsoon. Within a handful of kilometers of its source, the river is drained of the majority of its water, mostly for agricultural use. By the time the river reaches Delhi, the waters are fully drained, and the riverbed becomes a depository for the city's human waste.

ACCORDING TO INDIA'S CENTRAL POLLUTION CONTROL BOARD (CPCB), THE BARRAGES ERECTED WITHIN THE YAMUNA:²⁷

- Block the flow of the river
- Impact water quality through the Intermittent release of water
 - Due to sudden releases of water from the barrages during monsoon season, sludge that contains toxic chemicals and organic materials is flushed downstream, where it mixes with, and deteriorates the quality of the water downstream
- The toxins that have been flushed downstream rapidly consume dissolved oxygen, causing die-offs of fish and other creatures that are dependent on the aquifer
- Yet, the barrages have one positive characteristic, in that the reservoirs created by them do somewhat help to oxidize water



Devotees about to immerse a large idol of the goddess, Sri Durga Devi, into the Yamuna. The white foam on the water's surface is from industrial run-off. The paint on the idol is likely toxic.

The River, Quite Simply, Can't Clean Itself

According to India's Ministry of Environment and Forests, "The dry weather flow [of water] in the river Yamuna along Delhi is nearly zero. This has resulted in almost total depletion of the self-cleansing capacity of the river of Wazirabad.

Pollution in the Yamuna cannot be controlled fully unless a minimum flow is maintained in the river. It is mentionable that sewage treatment plants are designed for reducing the pollution in sewage to a certain economically achievable level only. The rest of the pollution is controlled by the dilution available in a water body. To maintain the water quality of the river within the bathing class standard, nearly 10 times the discharge of the fully-treated municipal waste water is required."²⁸

All the while, more water can be safely allowed to flow in the Yamuna riverbed if better water management programs are implemented. According to a report from the School of International Studies at Jawaharlal Nehru University in New Delhi, "studies undertaken by the UNICEF and the WWF have shown that if the precipitation within the watersheds or sub-basins is harvested and conserved properly, satisfaction of domestic water needs need not remain problematic."²⁹

Water Leakages Significantly Add to the Problem

In the city of Delhi alone, an estimated 40% of water is lost through its infrastructure of leaky pipes. Significant amounts of water are also lost in the transportation of the resource from one region to another.

According to the Center for Science and Environment, because cities are now sourcing their water from further distances, not only has the cost of potable water increased, but cities across India are losing 20%-50% of their water supplies as they traverse sometimes great distances.³⁰



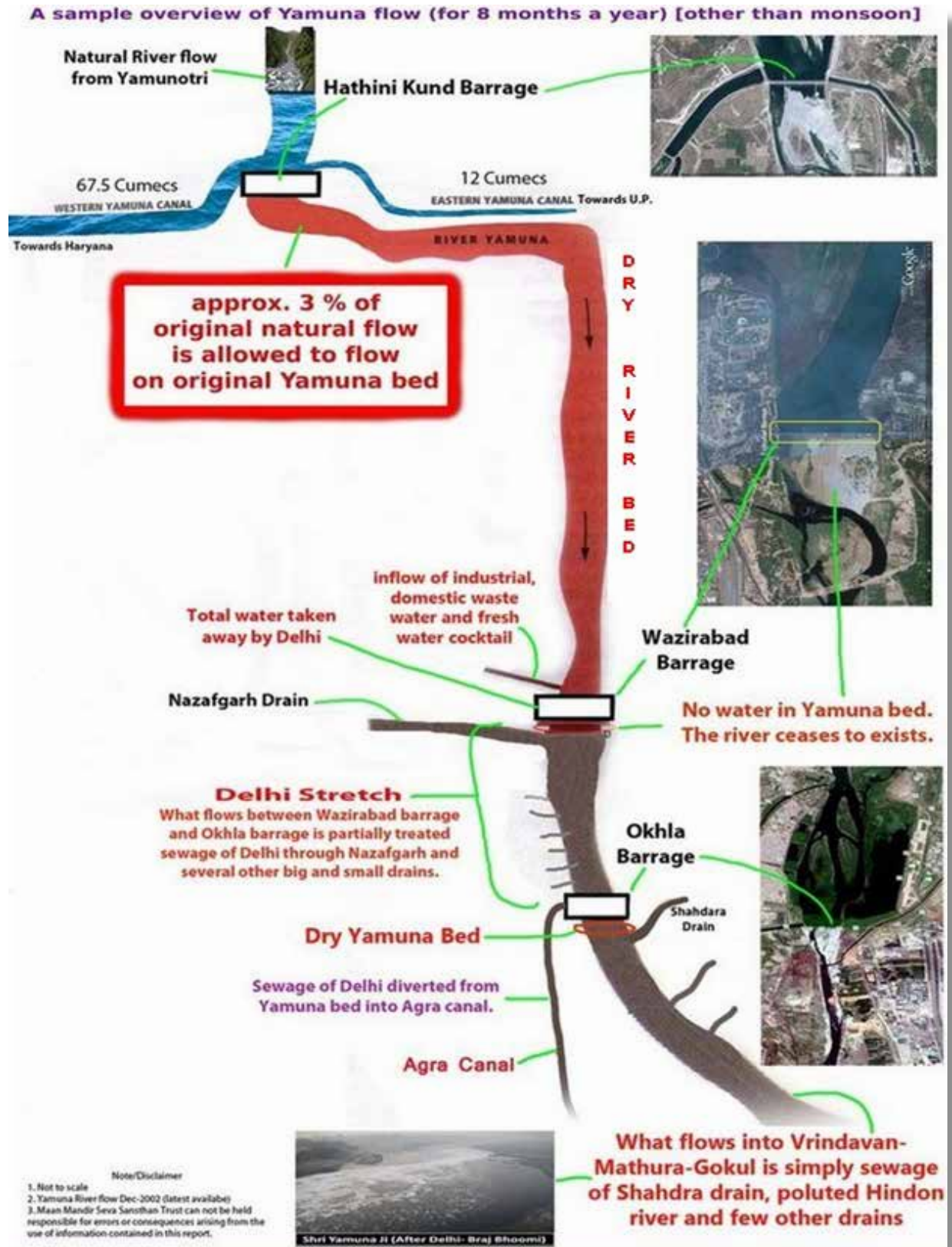
A massive die-off of fish due to pollution in the Yamuna

When reviewing such statistics, it can't help but come to mind that if the same water that is being lost to transportation and leaky pipes was again allowed to flow freely as the Yamuna, significant inroads could be created towards enabling the river to successfully wash away toxic effluents. In addition, repairing such leaks would do much to ensure that a balanced proportion of people, not just the rich or those residing near treatment plants, have access to a regular and equal supply of water. Please see page 14 for examples.

Policies are Largely Ineffective

Water policies set by the Government of India's National River Conservation plan closely resemble those set by western nations, such as the United States and those in Europe. Yet, while the policies are similar, the context for where they are set are widely different. For example, nations such as the UK are privy to uninterrupted electricity 24-hours a day. This not possible in much of India. Similarly, in the USA, one will find that common pollution sources do not include open defecation, floating bodies, cattle bathing, immersed idols, and toilets that flush directly into rivers.

As a result, according to a study by the MIT Center for Energy and Environmental policy, "water pollution regulations have been ineffective... the



Source: Maan Mandir Seva Sansthan Trust

National River Conservation Plan, which is the cornerstone of water policy in India, had no impact on the three measures of water quality we consider.

“The results suggest that bottom-up environmental policies are more likely to succeed than policies, like the water pollution regulations, that are initiated by political institutions. Thus, while the results suggest that developing countries are able to effectively curb pollution, regulations imposed by international treaties, like those contemplated as part of an effort to confront climate, may have limited success without widespread political support from within.”³¹

PART II: Focus on New Delhi

The current state of the Yamuna river is of serious concern, especially in the National Capital Territory of Delhi. Founded thousands of years ago on the banks of the Yamuna, Delhi has been the capital of at least 10 powerful empires.³²

Research shows that Delhi has been growing by approximately 1000 people per day for a number of years.³³ According to 2011 Census data, today, Delhi’s population stands at about 16.8 million. Approximately 45% of the city’s population resides in slums.³⁴ About 86% of Delhi’s water supply comes from surface water, the Yamuna being a prime source.³⁵

Dr. RC Trivedi, a senior scientist at the Central Pollution Control Board, has been monitoring Yamuna water quality for more than two decades. He says, “the Yamuna is the most polluted river in India, at least the 500km stretch from Delhi to the Chambal confluence.”

The flow of the Yamuna river within Delhi is regulated by three barrages: the Wazirabad Barrage, the ITO Barrage and the Okhla Barrage. The length of Yamuna in Delhi, from the Wazirabad barrage to the Okhla barrage, is 22km, barely 2% of the length of the river basin (see page 9). Yet, reflecting Dr. Trivedi’s statement, reports indicate that Delhi’s segment

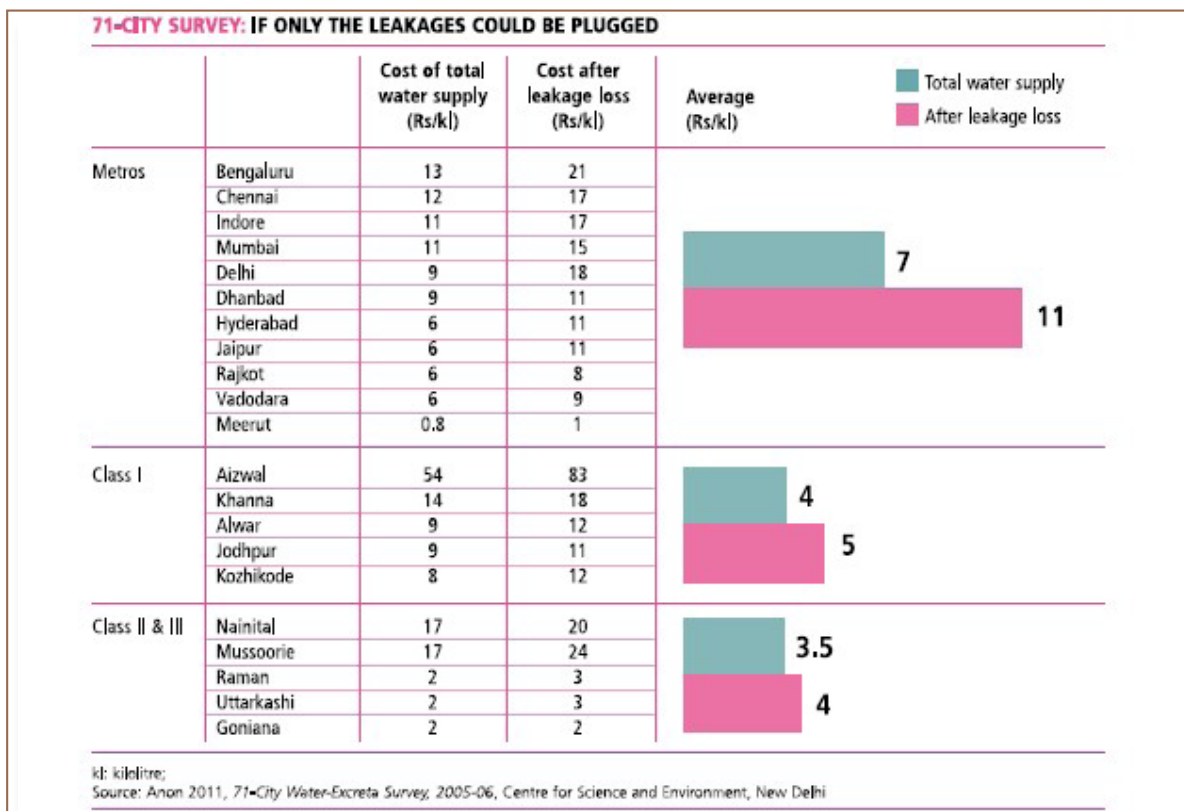


Chart: CSE³⁶



A Delhi Slum Resident Leaving Her Home In Order to Fetch Water

of the river contributes to the most significant proportion of pollution in the entire stretch of the aquifer. Percentage estimates range between 70% and 80%.³⁷ Compounding matters, as we will see below, is that there is no fresh flow of river water permitted during the dry season, which amounts to 9 months of the year.³⁸

ECOLOGICAL FLOW

The Yamuna enters Delhi at the barrage constructed at Wazirabad. Here, the city of Delhi draws out water, significantly reducing the flow of the river. Says the advocacy group, Maan Mandir Seva Sansthan Trust, “there is not one drop of Natural Fresh River Water in River Yamuna in Delhi & Beyond”.³⁹ As a result, the Yamuna becomes a thick, stagnant, malodorous waste canal composed primarily of toxic material and raw sewage.⁴⁰

Survey data reveals that not all citizens of Delhi are aware of the severe environmental crisis that they face⁸. Yet, as we will review later in this document, the polluted aquifer presents a significant threat to the health and well-being of the metropolis’ residents.

Despite the fact that the Supreme Court has ruled that all states through which the Yamuna flows must ensure that an ecologically-sound amount of water is permitted to flow in all parts of the river at all times, nothing has changed, and the Yamuna thus remains in great peril.

UNTREATED SEWAGE

As reported in 2005, 40% of India’s sewage treatment capacity belongs to Delhi, yet a massive gap remains between sewage generation and treatment.⁴¹ Specifically, Delhi generates about 3,800 million liters per day (MLD) of sewage and the installed waste treatment capacity in Delhi is 2,330 MLD. Only 70% of the treatment capacity is utilized, so that 1,575 MLD of sewage is treated. This means that only 48% of sewage generated in Delhi receives treatment.⁴² Further, it has been reported that the available water treatment facilities are not adequate to remove all the pollutants. Delhi’s Najafgarh drain (photo on following page) and the Shahadra drain are the two largest polluters of the river.⁴³

The Delhi sewage system is unable to support the city’s ever-growing population. A large portion of the metropolis does not have an official underground drainage system, resulting in the untreated sewage of millions being deposited directly into the Yamuna.

THE YAMUNA AS A PUBLIC TOILET

At least forty-five percent of the population of Delhi lives in slums.⁴⁴ Their living is in haphazard, makeshift congested settlements, characterized by physical deterioration. As a result, very few people have toilets and other conveniences and they resort to using the river banks for morning defecation, washing and bathing.⁴⁵ In other instances, their bodily waste flows into open storm water drains, which are the same drains through which treated sewage from STPs enter the river. Treated and untreated waste is mixed, resulting in unabated pollution levels (see charts/graphs, page 25).⁴⁶

GARBAGE DUMPING

The use of the Yamuna by the public for garbage disposal, especially of non-biodegradable polythene bags, is especially harmful to the river. Over time, such solid waste clogs the drainage and sewerage system, and eventually the river itself. While Delhi has introduced a law banning the use of polythene bags, it has not been successfully

implemented, to the detriment of the aquifer.⁴⁷

LAUNDRY AT THE DHOBI GHATS

The washing of clothes is handled by washermen known as dhobis. In Delhi, dhobis use the Yamuna's riverbanks to carry out their work and the wastewater, loaded with dirt, large quantities of soap, detergents and chemicals, drains into the river.⁴⁸ Such practices are increasingly contributing to pollution of the river, as the dhobi trade has gone up in urban Delhi, with increasing work coming from hospitals and railways.⁴⁹

INDUSTRIAL WASTE

Scientific data shows that the level of industrial pollution in the Yamuna river is nearly 13 times the permissible limit.⁵⁰ In Delhi, such levels are among the highest in India.

Data collected over a 10-year period by the Central Water Commission, through its 371

monitoring stations across the country, shows that Yamuna has the highest level of biochemical oxygen demand (BOD) concentration when it passes through Delhi. The BOD test is used to measure the level of industrial pollution in rivers.⁵¹ Officials have reported that most of the industrial waste is released into the river streams, because companies do not spend money on treating their by-products. Unfortunately, regulatory and enforcement bodies far too often ignore the issue.⁵²

ASH IMMERSION

It is part of religious and social tradition that after someone passes away, their cremated remains are scattered into the river. While the quantity of ash is small, it becomes a problem when it happens thousands of times, and tends to pollute the river considerably.⁵³



The Nazafgarh Drain in Delhi Emitting Untreated Sewage into the Yamuna River



The Yamuna River Flooding the City of Delhi, Making Headline News. Encroachment on Delhi's Floodplains Increases the Potential of Such Disasters.

Yamuna River Floodplains & Impact on Groundwater

GEOGRAPHICAL BACKGROUND ON FLOODPLAINS

The Yamuna floodplains in Delhi serve a critical function for the city. Yet, growing urbanization, and the unchecked use of ground wells have seriously encroached on floodplain land and resources, placing the city and its people in peril.

The floodplain owes its very formation to tectonic and seismic activities in the Himalayan region, from where it originates. "These features make the area vulnerable to geological hazards"⁵⁴

The main functions being served by the floodplains highlighted in the map on the following page are to:

- Provide safe passage to flood waters
- Recharge ground waters (aquifers) through

flood waters spreading, settling and seeping underneath⁵⁵

The Yamuna's flood plains in Delhi have about 97 square kilometers of active flood plains. Of this, about 16.5 square kilometers are under water and the remaining 80.5 square kilometers are either waterlogged or have a very shallow water table⁵⁶

CURRENT CONSTRUCTION OVER FLOOD PLAINS

Being a mega-city, Delhi's urban space comes at a premium, and is heavily-prized by construction companies and developers. Large sections of the floodplains to the west have already built over with structures ranging from power plants to bazaars. Over the last 10 – 15 years, the river bed in the east has also seen developments including the Delhi Metro, Akshardham Complex and the Commonwealth Games Village.⁵⁷ Experts say that such construction has resulted in reducing water infiltration capacity of these areas by three to four times, and warn that any more construction in the Yamuna flood plain "will adversely impact

the underground water recharge and cause more flooding and disasters.”⁵⁸

POOR QUALITY OF WATER INFRASTRUCTURE IN DELHI

As previously mentioned, the city of Delhi faces major water infrastructure issues, such as delivery losses, thefts and leakages in water supply, corrosion and degradation of pipelines. The poor quality of water infrastructure is a serious issue and results in a number of cascading problems for city residents.⁵⁹

Official reports from 2008 state that the Delhi Jal Board supplies about 30 million cubic meters of drinking water every day to the city, but due to infrastructure problems such as leaking pipes, approximately 40% leaks out.⁶⁰

In addition, there is also an unequal distribution of water across the city. The areas next to a water treatment plant tend to have a good supply of water. Prashant Vihar, for example, enjoys a water supply of 600 liters per capita per day).⁶¹ Conversely, areas further away only get modest water supplies. South Delhi, as an example, receives a water supply of just 60 liters per capita per day.⁶²

Some of the reasons for uneven supply are:

- (1) Pipelines with very high water pressure tend to develop leakages at joints.
- (2) The resultant inconsistent pressure deteriorates the water pipes, and then may lead to the bursting of the pipe.
- (3) In addition, leakage leads to water in the pipeline getting contaminated due to soil and pollution entering through the point of leakage.⁶³

At present, the Delhi Jal Board only

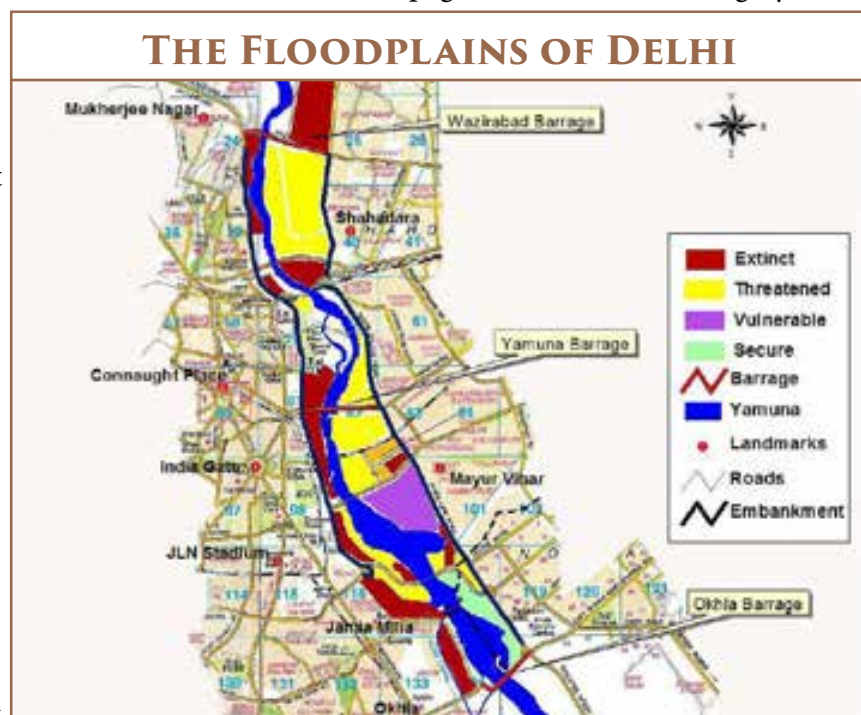
supplies water three hours in the morning and three hours in the evening to cover peak demand hours, while minimizing leakage. As a result, this has fostered a number of sub-optimal practices by the residents of Delhi to compensate:⁶⁴

(1) As water supply is time-restricted, people store excess water in the morning to cover their needs for the day. In the evening when water is supplied again, residents tend to throw away their stored water and fill up with fresh water. This results in a large volume of wasted water every day.

(2) A large number of residencies across the city have installed water pumps to cover their shortage in water supply. Many pumps are run even when there is no water, and as such they pull in soil and pollution from gaps at any leakage points. This leads to contamination of the water supply coming in through the pump at the beginning of the next supply run.⁶⁵

RECHARGING WATER AT FLOOD PLAINS

Experts have estimated the infiltration share of rainwater to be less than 5% in most parts of Delhi.⁶⁶ It was concluded that the major contribution to aquifer recharge originates from canal/river seepage and infiltration of highly



degraded agricultural and urban surface run-off. The groundwater recharge from rainfall varies widely in space and time with an average of 10% fractional recharge. Due to relatively-low permeability, the movement of groundwater is generally slow and sluggish.⁶⁷

USE OF GROUND WELLS IN DELHI

Due to the shortage of water available from the Yamuna to support the growing water needs of Delhi, ground water which is replenished by the floodplains is used extensively across the city out of necessity. According to estimates, in 2004 there were between 200,000 and 360,000 private bore wells extracting an estimated 1,300 mld of water.⁶⁸ Thus, up to 50% of water demand in Delhi was being met through groundwater abstraction in 2004.⁶⁹ These wells incur considerable additional costs due to construction, electricity and maintenance.

This heavy dependence on ground water across the city has led to over-exploitation and as such, Delhi's water table is already low and dropping. Estimates on the range of this drop in water table range from 0.1m – 0.4m per year in various parts of the city.⁷⁰ Another report issues a stark warning: "at current consumption rates, New Delhi will run out of ground water by 2015."⁷¹

Over-exploitation also supplements the vulnerability of fresh groundwater resources to increased salinity. At present, saline groundwater is considered to be main problem affecting groundwater quality in Delhi. "In large areas of northern and western Delhi, the electric conductivity (EC) of the groundwater exceeds 3,500 IS/cm, and thereby the maximum permissible limit (2,000 mg/L) for total dissolved solids (TDS) in the Indian Drinking Water Standard."⁷² Other samples of ground water across of Delhi have also shown unsafe levels in several other areas such as Iron, Fluoride, NO₃ and Coliform.⁷³

City Water Infrastructure

Delhi currently has a sewage treatment capacity of 512.4 MGD (2321 MLD). The table on the following page summarizes the various Sewage Treatment Plants (STP) in Delhi and their individual capacity.

The sewage from these STP's is generally discharged directly or through carrier drains into the Yamuna River. These plants were designed around Total Suspended Solids and Biochemical Oxygen Demand removal, whereas the removal of Faecal Coliforms and pathogens was not considered (this was to minimize construction and operational costs). However, it was later realized that these plants produced a very poor quality of effluent³¹. In addition, due to a poor sewerage network and other factors, most of STPs are underutilized. Current estimates are the plants are utilized at a rate of approximately 70%, which only leads to approximately 48% of sewage in the city being treated.⁷⁴

According to the Central Pollution Control Board, connections of STPs with the river can pose a threat of their own to water quality. Much of this happens when the plants are shut down due Delhi's regular power failures, mechanical problems or plant maintenance. In such cases, the collected sewage is generally bypassed and discharged into the river without any treatment. Such discharges keep the river downstream unsafe and unsuitable for human activities."⁷⁵

The Effect of the Health of Yamuna on the Health of the People of Delhi

Water and disease are closely related. When a river falls sick, it affects the health of the community that depends on it.

An estimated 80% of all health problems and one-third of deaths in India are attributable to water-borne disease.⁷⁶ For example, dangerously-high levels of heavy metals such as lead, cobalt, cadmium, chrome, nickel and zinc have been

detected in Yamuna.⁷⁷ The presence of these metals in the river poses a health risk to the people living there and areas downstream.

In Delhi, the health of the Yamuna is linked to the quality of drinking water, a high prevalence of diarrheal diseases, the presence of drug-resistant bacteria and the contamination of vegetables. The Delhi-based PEACE Institute Charitable Trust initiated a study¹⁴ to discover the correlation between the health of the Yamuna and the health of the community dependent on it over the last 25 years. The researchers unequivocally blame the city's increasing ill-health on the river's condition.

DRINKING WATER QUALITY IN DELHI

According to the Delhi Jal Board, there is no possibility that contaminated water is being supplied for drinking purposes. But the MCD (Municipal Corporation of Delhi) has regularly

been testing drinking water and has found a large number of samples unfit for consumption. In 2004, 16% of water from various sources was deemed unfit for drinking. In all, 95.6%, 43.9%, 24.4% of samples were found unfit from hand pumps, water trolleys and DJB-stored water respectively. It in itself is alarming that a quarter of the samples of DJB-stored water was found to be unfit.⁷⁸

The situation was equally grave in 2009. The Municipal Corporation of Delhi (MCD) found 15% of Delhi's water to be unfit for drinking. In south Delhi, the contamination is highest, with 50% of the samples declared polluted.⁷⁹

A study on the analysis of the microbiological flora of the water supplied for drinking purposes by Professor Sarman Singh (2000) of AIIMS found that Delhi water is biologically contaminated.

The study reveals that even direct tap water was found contaminated in more than 50% of samples.

DISEASES

An example of the relation between the occurrence of waterborne diseases and pollution of Yamuna drinking water is from 1955-56 in Delhi, when sewage water mixing with Yamuna raw water resulted in an outbreak of a new infection which was for the first time documented as hepatitis E virus (HEV). At the time, it infected more than 30,000 people.⁸⁰

In recent times, an article in the British medical journal, The Lancet¹, warned that bacteria in New Delhi's drinking water carries a gene, NDM-1 (New Delhi

Summary of Sewage Treatment Plants in Delhi⁸¹

Number	STP	Capacity (MGD)
1	Dr. Sen Nursing Home	2.2
2	Delhi Gate	2.2
3	Kondli	45
4	Ox dalim Pond (Nehru Vihar)	6
5	Keshapur	60
6	Mohruli	5
7	Yamuna Vihar	20
8	Rithala	80
9	Papam Kauri	20
10	Najafgarh	5
11	Nitron	40
12	Pitara	15
13	Coronation Pillar	40
14	Vasant Kunj	5.2
15	Narela	10
16	Okhla	140
17	Galena	5
18	Bakardua	3 M.D
19	Mouzanand	3 M.D
20	Hokarpet	2 M.D
21	Tikri Kund	2 M.D

Chart: CPCB Delhi

metallobetalactamase), for an enzyme that is resistant to almost all known antibiotics.⁸¹ Resistant bacteria were found in water used for drinking, washing and food preparation in Delhi. The bacteria were also found in swimming pools in heavily populated areas where children play.

An estimated 500,000 people in New Delhi now carry resistant bacteria, and medical authorities worry that the rapid spread of this form of resistance could cause problems for routine medical procedures that depend on the ability to treat infections. The situation is a serious health concern, as many cities and towns downstream of Delhi source their drinking waters from the Yamuna River.

Research suggests that temperatures and monsoon flooding make Delhi ideal for the spread of NDM-1.

Additionally, common diarrheal diseases are endemic in Delhi. In the city, the inadequacy or non-availability of sufficient quantities of piped water forces people to resort to alternatives that can be harmful. It is in this environment that waterborne diseases like cholera and gastroenteritis flourish.

Acute diarrheal diseases are directly attributable to the ingestion of contaminated water or food. Contamination is often due to faecal-oral transmission.⁸³ The question of both adequacy and quality of the water supply available to the household for drinking purposes is therefore of great importance in Delhi.⁸⁴

TAINTED VEGETABLES

The rise in typhoid cases between 1997 and 2003 in Delhi was due to eating raw vegetables.⁸⁵ During the monsoon season, the Yamuna river water floods the land and contaminates

WORKS AND ACTIVITIES CARRIED OUT UNDER YAMUNA ACTION PLAN

Components	Unit	States		
		Haryana	Delhi	UP
Sewerage/wastewater interventions				
A. Interception and diversion of open drains	km	172	-	42
B. Sewage pumping stations	Nos.	21	-	28
C. Sewage treatment plants				
Installations	Nos.	11	-	15
Capacity creation	mld	303	-	399
D. Low cost sanitation				
Community toilet complex	Nos.	75	958	561
Squatting seats	Nos.	1160	27000	2910
E. Pilot projects				
Decentralised sewage treatment				
Mini STPs (3 and 2 mld)	Nos.	-	4	-
Micro STPs (0.15 mld)	Nos.	-	10	-
Decentralised STPs on drains (10 mld)	Nos.	-	2	-
Disinfection of STP effluent (1 / 2 mld, various technologies)	Nos.	3	2	1
Non-sewerage interventions				
F. Improved wood based crematoria		24	4	70
G. River front development (Construction of bathing facilities)		2	-	7
H. Public participation workshops	Nos.	726	5382	915

Chart: Foundation for Greentech Environmental Systems⁸²



A Swimmer Wades Through Chemical Foam Into the Yamuna

developed the first Yamuna Action Plan (YAP) to restore the river. The plan's goals were to stop the dumping of untreated wastewater into the Yamuna and to divert raw sewage through the building of public toilets and the installation of interceptor systems and sewage lines. Public education was also an important component of the plan.

In 1993, YAP was launched as a project that was to last until the year 2000. It was later granted an extended phase that lasted until the year 2003.

the soil. The vegetables growing in this soil absorb the contaminants. The seriousness of the contamination was highlighted in a study undertaken by The Energy and Resources Institute (TERI). Not only do common vegetables (such as spinach, radish, brinjal, cauliflower, tomato and cabbage) contain all kinds of pathogens, including Salmonella Typhi and Typhoid bacteria, they also carry high traces of heavy metals and pesticides (TERI report).⁸⁶

PART III: India Responds

YAMUNA ACTION PLAN I

In 1977, the Central Pollution Control Board initiated a comprehensive survey of the Yamuna River's entire course. In so doing, researchers examined basin topography, population, industrial activities, base flow, agricultural usage, and estimated pollution load.

It was found, to nobody's surprise, that the aquifer was heavily polluted. Two-thirds of its pollution consisted of domestic waste. The rest was from agrarian and industrial activities.

In response to this study, the Indian government

To implement the extensive scheme, the Japan Bank for International Development (JBIC) awarded a "soft loan amounting to Yen 17.77 billion for pollution abatement works in 15 towns. Beneficiary states were Haryana (Yen 6 billion), Uttar Pradesh (U.P.) (Yen 8 billion) and Delhi (Yen 3.77 billion). However, in April 1996, on the directions of the Supreme Court (apex court in India), six additional towns of Haryana were included. Finally, YAP I covered pollution abatement works in 21 towns. The approved cost of YAP I was INR. 5.09 billion."

YAP ACTIVITIES EXPLAINED

Under the first Yamuna Action Plan, domestic pollution, specifically raw sewage, was given priority over the treatment and/or abatement of industrial, agricultural, and other forms of waste. At the plan's onset, fifteen Class-I cities (cities with populations above 100,000) fronting the Yamuna in the states of Delhi, Haryana and Uttar Pradesh, were targeted for the development of new sewage management systems and public education programs. Additional regions were later added, as mentioned in the previous section.

PROJECT COMPONENTS:⁸⁷

- New, as well as renovated sewage treatment plants (STP): 29 STPs were built in all

- Lines and drain interceptors to divert raw sewage from flowing directly into the Yamuna
- New pumping stations
- Community and portable toilet complexes: 1,216 toilet blocks were constructed
- Improved wood-based and electric crematoria- established in 98 locations to prevent unburned or partially-burned corpses from entering the Yamuna waterway
- Riverfront development- the building of bathing ghats, planting of trees, etc.
- Community education: 7023 workshops were held in all throughout the duration of YAP I.

According to researchers at TERI University, “YAP I also included construction of 5 mini-sewage treatment plants and 10 micro-sewage treatment plants for some of the community toilet complexes (CTCs) to examine viability of decentralized sewerage system and on-site treatment of sewage, respectively.... This was also supplemented by carrying out a river pollution study to estimate future pollution loads into river Yamuna from different sources in 33 major towns of the Yamuna river basin.⁸⁸ Thus, the total sewage treatment capacity created under YAP I was 750MLD (Planning Commission, 2007).

“Other supplementary work includes sludge drying beds, rising mains, replacement of old pipes, installation of dg sets, fire-fighting systems, and lining of ponds. The extended phase addressed the non-sewerage related aspects, including public participation and



Photo: A mother and child walk along the dry banks of the Yamuna River

capacity building works.”⁸⁹

Said the Asian Development Bank, “interestingly, while Delhi generates as much as 70% of the total wastewater load, it did not receive proportionate level of investment under YAP. There are two plausible explanations to this. First, the Government of the National Capital Territory of Delhi (NCT) came forward to share the responsibility and second, the water from the Delhi stretch was not perceived to be posing an immediate threat to public health, as it was not being used for drinking water supply for any towns in the vicinity.”⁹⁰

IN DELHI THE YAMUNA ACTION PLAN'S COMPONENTS INCLUDED:⁹¹

- 1 Sewage Treatment Plant (STP) each of



- 10 MLD– Sen Nursing Home Drain
- 1 STP each of 10 MLD– Delhi Gate Drain.
- 1 Electric Crematoria– Sarai Kale Khan
- Community Toilet Complex– 961 Nos (27000 Seats)
- Mobile Toilet Vans– 174
- Mini STPs– 4 (10 MLD)
- Micro STPs– 10 (150 Cum/day)
- Sewer Cleaning Machines–19
- Electric Crematorium (Lodhi Road)–1
- Public Awareness Program

MIXED RESULTS

While a great deal of money, time, and resources went into the original Yamuna Action Plan, many have concluded that results were mostly unfavorable. Reported the World Wildlife Foundation, “Haryana fared better than U.P., as infrastructure work has been completed and is working well, with plants having insufficient sewage to treat. Treated effluents are discarded into drains or canals

and biogas utilization is poor. In both states, improved wood-based crematoria haven’t taken off which were intended to reduce the wood use and time taken by half. In Delhi, the plan’s outcome is yet invisible, even after so much money has gone into it.”⁹²

Interestingly, according to Tokyo Engineering Consultants, a YAP lead team from Japan: “a pilot project in Agra Nagar Nigam was undertaken to enhance the revenue generation by conceptualizing the best practices from other ULBs in the country. Its successful implementation and sustained municipal reform measures were achieved by working in the area of property tax, private sector participation in O&M of municipal services, etc.”⁹³

YAP CONSIDERED A FAILURE BY SUPREME COURT, ENVIRONMENT MINISTER

Just a year after YAP I concluded, the Supreme Court stated: “River Yamuna is lifeline for the citizens of Delhi right from its entry into Delhi till it leaves Delhi, the purity, sanctity and the cleanliness of its water has to be maintained. It is repeatedly claimed that the Government is doing its best and has already spent thousands of crores of rupees in the name of ‘Cleanse Yamuna’ Project. But the common man does not find any visible change. Encroachments on river beds and embankments have become order of the day. No effective steps have been taken to make Yamuna free from encroachments and pollution of all kind.”

In 2009, India’s Environment Minister, Jairam Ramesh, said “I admit with full responsibility that Ganga and Yamuna are no cleaner than 20 years ago.”⁹⁴

FACTORS RESPONSIBLE FOR UNDERACHIEVEMENT

Reported MIT’s Center for Energy and Environmental Policy Research on India’s National River Conservation Plan, of which YAP is a prime component, “NRCP has been

panned in the media for a variety of reasons, including poor cooperation among participating agencies, imbalanced funding of sites, and inability to keep pace with the growth of sewage output in India's cities.”⁹⁵

It is clear that ill-placed decisions led to a proportion of the failures of the first phase of the Yamuna Action Project. For example, while the plan called for the installation of thousands of public toilets in New Delhi in order to curtail the flow of raw sewage into the Yamuna, many of these same toilets dumped their untreated contents directly into the river rather than into a contained septic system.

According to a 2007 study of YAP I by the non-profit advisory organization, Foundation for Greentech Environmental Systems, below are other factors that led to the plan's failures:⁹⁶

- “While wastewater loads from Delhi alone was estimated to be 70% of the total from 15 urban towns, the city-state was completely left out under sewerage/wastewater component of YAP. Moreover, the STP capacity created by the city government concurrently with YAP remains unutilized to the extent from 25-45%, on account of severe limitations in the delivery system. As a result, untreated sewage continues to flow into the river through a series of storm water drains.
- Similarly, STPs in stretch II and IV are under-utilized due to a combination of limitations in delivery system and power availability. Municipalities and line agencies which are responsible for operation and maintenance of the sewerage infrastructure are constrained to maximize the operational efficiency of the system due to a combination of factors related to skills, management systems and upstream sewerage infrastructure.
- Initial estimate for BOD load generation from livestock activities in the study area was as much as 63% of the total. Even if half of this load is assumed to be reaching the river, it constitutes 46% of the total BOD load on the river system. However, the strategy in YAP did not address this non-point source of pollution at all.
- There was an inordinately-high emphasis on public participation and community awareness in Delhi vis-à-vis their potential in achieving reduction in pollution loads from low-income communities. While these aspects are important, the benefits have not been commensurate with the efforts that have gone in. There is a need to refine the strategy for increasing the acceptability of low-cost sanitation interventions.
- From bacteriological water quality point of view, it must be noted that when YAP schemes were being designed, the Indian wastewater discharge standards did not mandate STP effluents to comply on this aspect. The standards on Coliform are of rather recent origin. As a result, the STPs did not include disinfection as the tertiary treatment step.
- The aspect of sewage treatment capacity available along the river needs to be looked at. In YAP, the major consideration was to target and control the immediate pollution loads from domestic sector. Coupled to this, the limited budget availability was the major constraining factor in deciding for a shorter design period.
- Whatever sewage treatment capacity was created, it was designed for 1997 population loads. For instance, YAP was able to create 3.5 million Population Equivalent (PE) of net STP capacity in 14 towns in Haryana and UP. However the present (year 2002) total population of these towns itself is close to 6.7 million and thus the shortfall is 3.2 million PE. When Delhi is also included, the gross available STP capacity is around 14.7 million PE while the present population load is 21.3 million, indicating a shortfall of 6.6 million PE. Furthermore, when all the 33 major, medium and smaller towns along the river are considered, the corresponding numbers are 15 million PE versus 23.3 million and the shortfall in STP capacity is 8.3 million PE.”

FAILURES IN PUBLIC TOILET COMPLEXES

According to the World Wildlife Foundation, YAP I's public toilet scheme was a disappointment.⁹⁷ While some instances of public urination and defecation were eliminated under the plan, it did little to improve the cleanliness of the Yamuna. 30,000 toilets were to be provided to Delhites alone, the majority of whom were slum-dwellers, according to the scheme. Unfortunately, of 26,870 built, only 40% became operational, reported WWF. Of those, 40% incomprehensibly were designed to flush directly into the Yamuna, thereby defeating their reason for being. In addition, under YAP I, 9,000 community toilet complexes were to be run by local NGOs. These have mostly closed, as they proved too costly to maintain.

LESSONS LEARNED FROM YAP I

According to Tokyo Engineering Consultants (leading consultants to YAP):⁹⁸

- “While the wastewater load from Delhi alone was estimated to be 70% of the total load from 15 urban towns, its coverage was proportionally low under the sewerage components of YAP. Moreover, the STP capacity created by the Delhi Government concurrently with YAP remained under-utilized to the extent of 25-45% because of severe limitations in the collection system. As a result, untreated sewage continued to flow into the river through a series of storm water drains.
- Similarly, some of the STPs in Reaches II and IV remained under-utilized due to a combination of limitations in the collection system and power availability. Municipalities and agencies which were responsible for Operation & Maintenance (O&M) of sewerage infrastructure were constrained to maximize the operational efficiency of the system due to a combination of factors related to skills, finance, management systems, power cuts and upstream sewerage infrastructure.
- The strategy in YAP I did not adequately

address non-point sources of pollution such as Dairy Farms, Dhobhi Ghats, Slaughterhouses, etc.

- The Community Toilet Complexes prevented to a certain extent the practice of open defecation and yielded consequent benefits in terms of improved hygiene and sanitary conditions of project towns.
- When the YAP I schemes were being designed, the wastewater discharge standards did not mandate STP effluents to comply with any bacteriological water quality standards. The norms for Coliform reduction stipulated after approval of the schemes for treatment. As a result, the STPs did not include effluent disinfection systems.
- In YAP I the major consideration was to target and control immediate pollution loads from the domestic sector. Accordingly, whatever sewage treatment capacity was created, it was designed for 1998 population loads.”

Yamuna Action Plan II

On March 31, 2003, India's Ministry of Environment and Forests was awarded a 13.33 billion Yen loan from JBIC, covering 85% of the total cost of what was deemed the Yamuna Action Plan II (YAP II). Of the total project budget of INR 6.24 billion, INR 3.87 billion was distributed to Delhi, INR 1.24 billion to Uttar Pradesh, INR 639 million to Haryana and INR 500 million for capacity-building activities.

YAP II officially launched in December, 2004, and was slated for completion by September, 2008. The project was later extended, as many components had not yet reached completion.

According to the Center for Science and Environment, “the plan was to rehabilitate some 30.2 kilometers of defunct sewers. About 50 percent of the fund for Delhi, was to be spent on this. This works out to Rs 5.88 crore per km. of

YAP II PROJECTS⁹⁹

DELHI

Physical Works	• Okhla STP • Kashipur STP • Ring Road Trunk Sewer • Wazirpur Road Trunk Sewer • Ring Road Trunk Sewer
Preparation of Master Plan (MP)	• Feasibility Study • Detailed Project Report for YAP II: Decentralized • City - cum - Waste Management (including MP of Project) • Sewage Treatment Modernization and Waste Management • Jhokhat Bazaar Yojna (including MP of Project) • Arun News Sadak Yojna (including MP of Project)
Slum Rehabilitation Study	
Public Participation and Awareness	• Public Relations • Institutional Strengthening and Capacity Building of The Municipal Corporation of Delhi (MCD)

UTTAR PRADESH

Physical Works - Implementation	• Sewerage (including Sewer, Sewage Pumping Stations, Rising Main, STP) in Northern & Western Zones at Agra
Preparation of Master Plan for YAP II (B Towns)	• Feasibility Study • Detailed Project Report
Public Participation and Awareness	•
Institutional Strengthening and Capacity Building	• Of 7 J.C.Bs and Noida Authority

HARYANA

Implementing Technology Transfer	• Of 11 B.T Towns
Preparation of Master Plan for YAP II (B Towns)	• Feasibility Study • Detailed Project Report
Public Participation and Awareness	•
Institutional Strengthening and Capacity Building	• Of 3 U.P.s

CAPACITY BUILDING OF THE NATIONAL RIVER

MIS, Accounting & stock of art equipment, etc.	
Water Quality Monitoring Program	

sewers rehabilitated.

“In 2006-2007, the Delhi Jal Board introduced its pet interceptor plan—to lay over 60 kilometers of sewers along Najafgarh, Supplementary and Shahdara drains. In the process of giving shape to the massive hardware programme, nothing concrete was done to arrest pollution in the river.”¹⁰⁰

MIXED RESULTS FROM YAP II

While one can see some improvements in certain areas, oxygen levels in locations such as Delhi have reached deadly proportions.

Says the Hindustan Times, “from bad to worst” is how Manoj Mishra of Yamuna Jiye Abhiyan describes the condition over the years of the action plan.¹⁰¹ With nothing much achieved by earlier plans, Mishra said he has ‘no hopes at all’ from YAP III.”

“In absence of any overarching agency to monitor and control multiple agencies in the city, how can a project that states ‘if this and this does so, then this and this will happen’ work?” He asked and added, “The key issue of more water release upstream of

Delhi has always been skirted.”

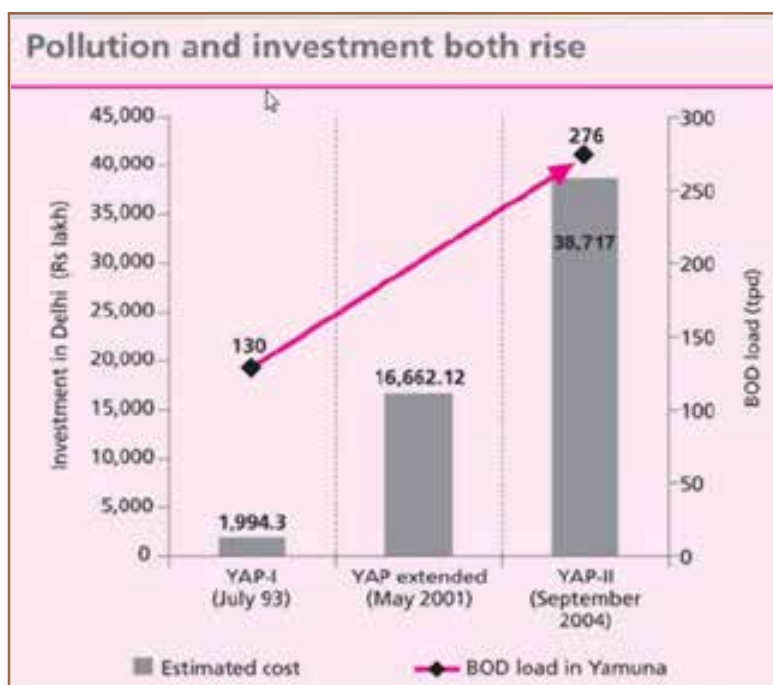
Ramesh Negi, CEO of Delhi Jal Board, claimed the exact opposite. “From 45% to 65%, the sewerage coverage has actually gone up during the last decade. And now we are working on interceptor sewer,” he said. YAP I saw community toilets by the MCD, II saw capacity addition for sewage treatment and in III the DJB expects to take sewage treatment capacity to 700 MGD. Plus, a Sewerage Master Plan 2031 is taking shape.”

While opinions may differ, what can’t be disputed are laboratory results that show that even after the extensive and well-meaning efforts of YAP I and YAP II, the levels of Coliform bacteria, TKN and ammonia concentration upstream of Delhi have also risen. After Delhi, organic pollution and microbial contamination are increasing up to Allahabad, where the Yamuna merges with the Ganga River (see charts on this and the opposite page).¹⁰²

The Failure of Western Models

Western models of waste treatment have enabled once odiferous and toxic waterways, such as the



Chart: CSE¹⁰³

WATER QUALITY DATA FOR RIVER YAMUNA

(Summer Average i.e. March-June)

S.No.	Station/Location	1996		2010	
		DO (mg/l)	BOD (mg/l)	DO (mg/l)	BOD (mg/l)
A.	HARYANA				
1	Taewala/Hamir land	11.70	1.20	8.40	1.00
2	Kalanaur	10.40	1.05	8.95	1.50
3	Palla	13.95	6.00	6.82	1.25
B	DELHI				
4	Nizamudin Bridge 1/2	0.30	25.00	0.0	24.75
C.	UTTAR PRADESH				
5	Agra Canal at Kalina/Kur	0.35	25.50	0.0	16.00
6	Mathura / Palwal	0.50	22.00	1.15	20.25
7	Mathura J/s	8.10	4.00	6.67	11.25
8	Mathura d/s	8.50	2.50	6.57	8.75
9	Agra J/s	10.65	4.50	6.02	8.25
10	Agra d/s	1.65	9.00	9.12	12.25
11	Balteswar	13.90	11.00	12.88	11.75
12	Etawah	11.15	7.00	12.62	11.00
13	JLC	9.71	2.00	8.82	2.00
14	Auraya/Lunika	8.14	5.00	10.98	4.50

Chart: CPCB Delhi

UK's Thames River, to reclaim their natural splendor. It was assumed that such systems would similarly improve the Yamuna River through YAP I and YAP II. Sadly, such assumptions have proven incorrect in India.

Chandra Bhushan, the Associate Director of the Centre for Science and Environment, told the Times of India that "GAP and the YAP failed as they adopted the Thames model, which involved a centralized sewage treatment system. While a huge sum of money and a 24-hr power supply were needed to manage the treatment plants, only 8-hr power supply was available, contributing to the failure of the projects."¹⁰⁴

In addition, the septic systems installed under YAP have proven prone to becoming overwhelmed during India's raging monsoon seasons, leading to dysfunction, flooding, and shut-downs.

Clearly, if future plans such as YAP are to succeed, they must be designed or modified to fit the unique framework presented by India. Recognized in the right light, in which the brilliance of India's engineers and environmentalists is

properly tapped, this can present an outstanding opportunity to improve or create new solutions that can later be adapted by developing nations facing similar challenges.

Yamuna Action Plan III

In December, 2011, the Central Government of India approved the third phase of the Yamuna Action Plan, which, at the date of this paper's publishing, will be exclusively carried out in Delhi. Under the plan, the government plans to rehabilitate trunk sewers that have been damaged in Okhla, Kondli and Rithala. A new Sewage Treatment Plant will also be constructed in Okhala.

The project will furthermore include education and sensitization programs to better inform the citizens of Delhi about sanitation and pollution abatement. No mention has been found of the implementation of alternative technologies under YAP III.

YAP III, similar to YAP II, will receive 85% of its financing from Japan (through the Japan

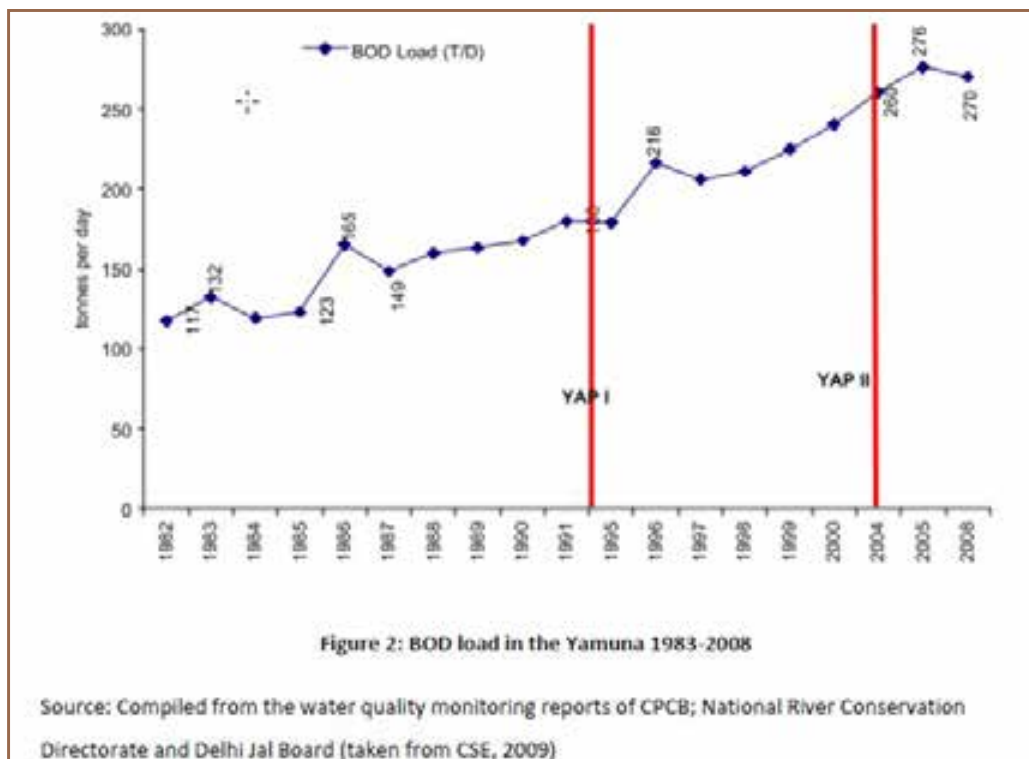


Chart: TERI University

International Cooperation Agency). The rest of the budget will be covered by the GOI. In all, 1,656 crores are scheduled to be spent on the plan.

Suggested Solutions For the Yamuna

1. PLAN SEWAGE TREATMENT FOR ALL

Never should sewage and drinking water mix. Delhi, as well as the rest of India, is in dire need of sewage treatment to protect public health and the environment. It is not acceptable that less than 50% of the city is covered. It is less acceptable that Delhi has the highest rate of sewage coverage in all of India. All sewage must be treated. All new and existing sewage treatment facilities must also be financed and staffed for long-term operations, management and maintenance.

2. RESEARCH AND INVEST IN ALTERNATIVE TECHNOLOGIES

The current system of western-style sewage infrastructure and STP plants does not work in the Indian context in many instances, as they are expensive, difficult to maintain and are easily overwhelmed by monsoon rains and electrical cuts. The Government of India must thoroughly research and invest in alternative technologies, such as anaerobic biodigestion.

3. ELIMINATE OPEN DEFECATION

Open defecation must be eliminated in order to protect rivers such as the Yamuna. Significant investments should immediately be made in not only the construction of toilets, but in their maintenance and in educational outreach activities that enable communities to understand and invite the construction, use and maintenance of toilets.

4. ENFORCE ENVIRONMENTAL LEGISLATION, such as the Water Act of 1974, which makes the dumping of chemicals and sewage into India's waterways illegal and punishable with high fines and jail time.

5. MASS PUBLIC EDUCATION AND

OUTREACH must be mandated by law and carried out by civil society, faith-based organizations and governmental agencies, so that practices such as open defecation, over-extraction, the unhealthy dumping of solid and liquid waste, bodies and other hazards may be abated. Water conservation and stewardship should be taught in all schools as an integral part of the national curriculum.

6. ORGANIC AND WATER-SAVING FARMING should be mandated throughout the entirety of the Ganga River Basin, including the Yamuna, in order to abate agricultural practices which are draining our water tables faster than they can be replenished whilst also polluting our waterways.

7. MANDATED ECO-FLOWS: At least 51% of the Yamuna's natural waters must be allowed to flow within its own riverbed at all times by mandate.

8. INVEST IN MUNICIPAL WATER-SAVING TECHNOLOGIES, RAIN WATER HARVESTING AND INFRASTRUCTURE REPAIR as mandatory expenses in order to ensure sustainability.

9. CREMATION ASSISTANCE: Eco-Crematoriums, which use a small percentage of wood used for traditional crematoria, must be propagated. Those who cannot afford full cremations should be assisted in cremating their dead through governmental aid programmes.

Conclusion: Can India Think Like Ecuador?

In 2008, the South American nation of Ecuador ratified its constitution, which included the first injunction in the world granting inalienable rights to nature, particularly Ecuador's Vilcabamba River. Says the New York Times, 'the Constitution includes a novel set of articles that appear to be the first in any Constitution... One passage says nature "has the right to exist, persist, maintain and regenerate its vital cycles, structure, functions and



The Nearly-Dry Yamuna in Uttar Pradesh

its processes in evolution.”¹⁰⁵

According to the Christian Science Monitor, “No other country has gone as far as Ecuador in proposing to give trees their day in court, but it certainly is not alone in its recalibration of natural rights. Religious leaders, including the Archbishop of Canterbury, the Dalai Lama and the Archbishop of Constantinople, have declared that caring for the environment is a spiritual duty. And earlier this year, the Catholic Church updated its list of deadly sins to include polluting the environment.

“Ecuador is codifying this shift in sensibility. In some ways, this makes sense for a country whose cultural identity is almost indistinguishable from its regional geography.”¹⁰⁶

From its scriptures to sites of worship to places of retreat, the history and culture of India are similarly indistinguishable from its geography. Yet, India’s natural resources, such as the historic, life-giving, and oft-called holy Yamuna River, are in serious peril. One may suggest it is time that India begin thinking like Ecuador, and consider a similar constitutional injunction before its natural treasures are forever lost. That is why the Global Interfaith WASH Alliance and Ganga Action Parivar are pleased to have teamed with the Community Environmental Legal Defense Fund, which was largely behind the Ecuadorian Constitutional chapter, to draft the National Ganga

River Rights Act, which one can learn more about at www.gangarights.org.

At the same time, India must do more on the policy level to ensure that any plan moving forward pay strict attention to the nation’s own unique topography, climate, and technological limitations, such as electrical shortages. In addition, while this issue is not discussed in this paper, lending conditionalities from International Finance Institutions must be closely monitored and challenged when they trend towards unsustainability or begin to infringe on the inalienable human rights to water, livelihoods and land.

Moreover, India must seek more sustainable methods of managing its water, from abating leaks to allowing more water to flow into the Yamuna riverbed. Waste must also be managed more efficiently, extraction must be limited and novel interventions, such as biogas production through sewage waste management, must be explored. Lastly, polluting industries must be put to task via lawsuits, social activism, legislation, as well as better enforcement of existing legislation, protecting both the Yamuna and the millions who depend on it every day.

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