Hindon River: Gasping for Breath

A PAPER ON RIVER POLLUTION

Heather Lewis

JANHIT FOUNDATION

Janhit Foundation

Janhit Foundation is an independent, not-for-profit non-governmental organization, actively engaged in the promotion of human welfare through environmental protection since 1998.

Key areas of work include:

- Groundwater quality protection for human health
- Provision of safe drinking water to marginalized communities
- Protection of river water quality for aquatic ecosystems
- Enhancement of available water resources through water conservation measures
- Promotion of sustainable agriculture by organic farming methods
- Environmental education and empowerment of local communities

Janhit Foundation undertakes this work through scientific research, campaigns, advocacy and grass-root level community involvement.

As a public interest organisation, Janhit Foundation focuses on strengthening local communities through their active participation in decision making, to achieve sustainable development. We believe that environmental degradation can only be addressed adequately if local people are empowered in decision making at all levels and have control over resources.

To achieve our goals, we work in partnership with government, non-governmental, national and international organisations on environment and human rights issues.

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Published by:

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Summary

A comprehensive scientific study has been undertaken by Janhit Foundation to evaluate the presence and extent of toxic pollutants within surface and groundwater resources of the Hindon River catchment. The devastating impacts of this contamination of water resources on the health of those living within the catchment is highlighted.

Rising in Saharanpur district in the lower Himalayas, the Hindon River and it's tributaries (including the Kali River (West), and the Krishni River) flow through six districts of Uttar Pradesh, before it's confluence with the Yamuna River. A highly populated and predominantly rural catchment, the Hindon River is heavily utilized as a water resource for domestic, agricultural and industrial uses, while untreated groundwater is the primary source of drinking water.

This study has found that mismanagement of these vital water resources has lead to dangerously high pollution levels within both the Hindon River and groundwater throughout the catchment.

A wide range of highly acutely toxic organochlorine and organophosphorus pesticides and heavy metals have been identified within rivers and groundwater throughout the catchment, at levels that exceed national and international standards for safe bathing and drinking water by several orders of magnitude.

A detailed health survey of the rural catchment population has identified alarming levels of serious debilitating illness and death which are directly attributable to the presence of dangerously high toxic pesticide and heavy metal contamination within the drinking water of these villagers.

Medical expenses incurred by villagers as a result of consuming contaminated drinking water are also shown to exert a heavy economic burden on a population already economically and socially marginalized.

Organochlorine and organophosphorus pesticides are shown to be entering water resources to toxic levels as a result of over-application of agricultural chemicals. Heavy metals are shown to be present as a direct result of discharge of large volumes of untreated industrial effluents.

The Janhit Foundation has also found that the expected aquatic biodiversity of the Hindon River is entirely absent at almost all locations within the catchment due to a high loading of organic pollutants reducing oxygen levels and causing anoxic conditions in the river.

Untreated industrial effluents are also shown to be the primary source of river suffocation, with untreated domestic sewage a large contributory factor.

Industries within the catchment are clearly shown to be in breach of required effluent treatment standards.

Janhit Foundation calls for immediate action to be taken by the government bodies responsible for the protection of both the Hindon River and health of the population suffering toxic poisoning.

Action must be taken to reduce indiscriminate use of toxic pesticides within agriculture. Existing legislation and guidelines must be enforced to stop the irresponsible dumping of untreated toxic industrial effluents into the Hindon River.

Government bodies must take responsibility for the disease and deaths inflicted upon the poisoned villagers due to their failure to protect these citizens rights to safe water in what is clearly a violation of International Human Rights Legislation.

Foreword

Formerly known as Harnandi, the Hindon River in the near past made Western Uttar Pradesh a centre for agrarian fertility. Up until the 1980's, the Hindon River breathed life and prosperity amongst the rural population of Saharanpur, Muzaffarnagar, Meerut, Baghpat, Ghaziabad and Gautambudh Nagar districts. Today Hindon is a trunk sewer of the urban towns and carries a heavy load of pesticides released from the agriculture runoff from the fields. Can Hindon revive its past glory of carrying potable water? This is a million dollar question which may haunt anybody who will go through this book. For millennia Indians have worshipped the river. The river is also a source of integration since the rich and the poor all take a holy dip in it. The river soothes our pain. Finally our cremation ashes are immersed in the river. Such is the strong relationship of our countrymen with rivers. Today the picture has turned upside down. As such, is it not the human beings who are bent upon suffocating the Hindon? The greed of the community is the major reason for changing the crystal clear Hindon to a black Hindon.

Janhit Foundation has been investigating the causes and extent of pollution in the Hindon River for the past eighteen months. Grassroot level studies and scientific data has given strength towards finding sustainable solutions to this monstrous problem. The paper mills, sugar mills, distilleries, slaughter houses, dyeing and the chemical industries need to adopt strict measures before discharging their effluents directly to the Hindon River. The domestic sewage of towns and cities also need to be treated if government agencies are really serious about putting a check to the growing pollution of this river. The 'Polluter Pays' principle need to be enforced in a stringent way. But above all it is the community which can find long lasting solutions to give a new lease of life to this dying river. Let us all remember that the Hudson and Kayohog rivers were also subject to high pollution loading only a few decades ago, but community participation programs have been so successful that these rivers are now amongst the cleanest rivers in America. Civil Society Organizations have a definite role to play. Unfortunately, none of them have shared the responsibility to save the Hindon River. Janhit Foundation has lighted the lamp instead of cursing the darkness. With the strong background of compiling the data, conducting health study, shooting a documentary film to create awareness amongst the community and by bringing out this important work I think Janhit Foundation would be the instrumental force to see that Hindon flows with clean, clear freshwater and life for everyone. After all the Indian Sabhyata, Sanskriti and Parampara are intermixed with its myriad rivers. I sincerely congratulate Heather Lewis, an environmentalist from U.K., presently working with Janhit Foundation for putting a lot of labour to document this important study. Finally Raman Tyagi and his team who travelled along the polluted Hindon for miles together and worked for long hours investigating the hazardous industries and villages within the Hindon River catchment during the course of this study.

ANIL RANA
Director, Janhit Foundation

Preface

This study of the Hindon River catchment by the Janhit Foundation has identified undeniable links between extreme toxic contamination of water resources and the blighted health and early deaths of the villagers who have no choice but to endure this toxicity.

As is so often the case, it is the poorest and most marginalized in society who are suffering worst from this man-made environmental disaster. The sources of this toxic contamination are well known, the mechanisms for damaged health well documented – yet still the government bodies responsible for action do nothing. It is incredible that in the 21st century, such gross levels of pollution are permitted to occur unchecked by government bodies.

The greatest tragedy is that this situation need never occur. Technology for effective industrial pollution control is available. Natural and sustainable farming methods are well established, yielding the desired results without the need for toxic chemicals. However, industrial pollution control technology is not being adequately installed, while sustainable farming methods are not being widely promoted by the authorities. The weakness that allows this situation to continue is therefore in the lack of imple-mentation, and legal enforcement, of effective pollution control.

The Government of India is clearly violating it's citizens human rights to safe water. Unfortunately, the contamination of the Hindon River is not an isolated case. This is not the first Janhit Foundation study to highlight the deplorable state of India's rivers and it is unlikely to be the last.

However, the drive for change is finally starting to gain momentum and we must maintain this drive for change until the government can no longer hide behind hollow words and inaction.

Mahatma Gandhi once said that 'you must be the change you wish to see in the world'. It is no longer acceptable to passively tolerate this deadly contamination. It is time to speak with one voice and demand government action towards the change we wish to see.

The Janhit Foundation wishes to thank the residents of the villages referenced in this study, for their time and co-operation. We also thank the scientists from the Centre for Science and Environment, New Delhi and Peoples' Science Institute, Dehradun for the water analysis and their scientific inputs.

Finally, Janhit Foundation especially wish to thank Indo-Global Social Service Society for their financial support of this project and for enabling the publication of this important report.

HEATHER LEWIS

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The Importance and Quality of Water in India

The right to safe water is a basic human right, legally defined by the UN Committee on Economic, Social and Cultural Rights as follows;

'The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses'.

The legal definition of this human right reflects the requirement for water to be of adequate quality and not threaten the health of those who use it. Supply of adequate sanitation is inherent to prevent contamination of water with faecal bacteria and other associated contaminants. A healthy sustainable environment is also a basic requirement for suitable water quality.

The right to water for every individual that is sufficient for their needs and that will not cause illness is therefore a legal entitlement as well as a moral obligation. The responsibility for fulfilling this human right falls to the State.

The Government of India has signed up to the International Covenant on Economic, Social and Cultural Rights. Ratification of this Treaty means that India is obliged to implement the provision of this Treaty to fulfill this human right.

Article 21 of the Indian Constitution also guarantees the right to life, defined by the Supreme Court of India to include the right to a pollution-free environment and safe drinking water.

The United Nations have set eight Millennium Development Goals agreed to by all the countries of the world and all the leading development institutions. The Goals aim to promote unprecedented efforts to meet the needs of the world's poorest people. One of these Goals, 'Ensure environmental sustainability' has the specific aim to reduce by half the proportion of people without sustainable access to safe drinking water by 2015. This Millennium Development Goal therefore sets targets for the achievement of this basic human right to water.

India ranks 120th out of 122 countries in terms of water quality. At least 200 million Indian citizens do not have access to safe clean water, a violation of their human right. It is estimated that 90% of India's water resources are

Handpump provision in a village on the banks of the Hindon River contaminated with untreated industrial, domestic waste, pesticides and fertilizers (Source; FIAN International – 'Investigating some alleged violations of human right to water in India'). India therefore faces a substantial challenge to meet the legal and moral obligations towards the provision of safe water.

River ecosystems are of great environmental significance. Healthy riverine habitats support a unique and diverse array of species, a biological diversity that serves a number of social and economic functions, such as providing a source of food. Clean rivers are also essential for a range of non-domestic uses including crop irrigation, hydropower energy generation, navigation and industrial uses. Clean rivers also provide an enhanced landscape in which to live for an increased quality of life. A polluted river is severely restricted in it's ability to meet any of the above functions.

The National Water Policy of India of April 2002 states 'Water is part of a larger ecological system..., it has to be treated as an essential element of environment for sustaining all life forms'.

Wherever water quality is permitted to deteriorate, the delicate balance of nature is disturbed. Species die and riverine ecosystem communities breakdown. A river with it's biodiversity reduced in this way is less able to assimilate contaminants through natural process leading to further water quality deterioration.

As well as providing an essential commodity, rivers also have great spiritual and religious significance within India society.

The Ganga River and the Yamuna River are considered the most sacred rivers in India. As a major tributary of the Yamuna River, the Hindon River is therefore an important component.

The Yamuna River is associated with Lord Krishna who is believed to have fallen into the river as a child and sanctified the waters. Legend also states that Yamuna was the daughter of *Surya* the Sun God, and sister of Yama the God of Death. Popular belief is that those that bathe in the holy waters of the Yamuna will no longer fear death.

Deterioration of water quality within these holy rivers therefore reflects a lack of respect not only for environmental and human health factors, but also for the river's religious significance.

Bathing in the Ganga River

The severe contamination within the Hindon River demonstrated within this report in not an isolated incident. Heavy bacteriological and chemical contamination of rivers is occurring across India. The following are just a few of these cases, while many other rivers remain just as polluted, but as yet, uninvestigated.

Surface water quality within India has been the subject of a number of isolated studies and targeted quality improvement works but these have been limited in both scope and financing.

Water quality in India's rivers is controlled through a series of guidelines established by the Central Pollution Control Board. However, as these targets are guidelines only, they carry no legislative weight and are therefore unenforceable. Routine and systematic monitoring of water quality is not yet established.

River pollution case study 1 – Khari River, Gujarat

Severe pollution was identified as having an adverse effect on local populations. Pressure from public resulted in government action to improve water quality and compensate those adversely affected.

The Khari River, a tributary of the Sabarmati, is heavily used for discharge of chemically contaminated effluents from a large number of industries within the catchment. The main industry is dye manufacture associated with textile mills. Key contaminants associated with dye manufacture effluent include oils, fibres and other suspended particulate matter, as well as containing a range of toxic heavy metals and being strongly alkaline.

Severe contamination of the Khari River has resulted. Groundwater within the region is also subject to high levels of chemical contamination. Groundwater is contaminated as a result of hydraulic continuity with the contaminated river, but also as a result of industries disposing off effluents directly to groundwater through boreholes. Groundwater contamination has been identified to a depth of 185 metres.

The local population have no choice but to use these contaminated water resources for all their domestic purposes, including drinking. Illness attributable to the consumption of contaminated water are widespread and include those illness identified within the Hindon River catchment such as digestive, respiratory and skin disorders.

A number of local villagers successfully secured compensation from the courts for the contamination of their drinking water as a result of effluents disposal.

Following a court order of the Gujarat High Court, major industrial estates within the catchment were ordered to install Common Effluent Treatment Plants, designed to treat effluents to meet standards for a number of physical / chemical parameters and heavy metals. The cost of treatment plant installation fell to industry to ensure that the polluter pays for the remediation of pollution caused. Industrial plants were required to cease operation until adequate treatment for effluent had been installed.

However, despite the above success, contamination of the Khari River remains high due to the leakage of untreated effluents, the presence of numerous small industries with no effluent treatment and the illegal disposal of untreated effluents to surface and groundwater.

Government control of effluent discharge standards is seen to fall far short of that required to ensure compliance by polluting industries with the required standards, as no monitoring program has been established.

(Source: – Janhit Foundation National Conference on Water Pollution and Health: A Deadly Burden, 9 July 2006 – Jaldhara. 'Unclogging the Khari River: Stakeholders come together to halt pollution' Srinivas Mudrakartha, Jatin Sheth, J. Srinath, July 9 2006.)

River pollution case study 2 – Kali River (East), Uttar Pradesh

The increase in industrialization and chemical based agriculture within the catchment of the Kali River (East) in Western U.P. is identified as being responsible for considerable pollution in the river and underlying groundwater aquifer.

Groundwater contamination is identified as arising from the disposal of liquid wastes to the overlying river system, and solid waste disposal to land.

Samples from handpumps in villages in close proximity to the Kali River (East), identified heavy metal contaminants (cadmium, chromium, zinc and iron) within both river water and groundwater. All metals were found to be exceeding, or close to exceeding, permissible limits standards set for drinking water. For example levels of chromium within drinking water supplies at Kudhla Village, Meerut district, are found to be 140 times the maximum permissible limit for drinking water set by the Bureau of Indian Standards for this heavy metal. Groundwater available from handpumps samples was also heavily coloured with an unacceptable odour and taste.

(Source: 'Pollution in Kali Nadi (East) and it's environs in parts of Meerut and Ghaziabad districts, Uttar Pradesh'. Preliminary report of the Central Groundwater Board (Northern Region), M.M. Gaumat, Kali Charan, June 1999.)

River pollution case study 3 – Yamuna River, Uttar Pradesh and Haryana

Within this case study, the ineffective actions of government plans to tackle severe pollution levels, is highlighted.

In 1995 a National River Conservation Plan was initiated for the Yamuna River, with the aim of intercepting, diverting and treating the large volume of untreated municipal wastes entering the Nation's rivers. The Yamuna Action Plan aims to control untreated municipal drainage from a number of towns within the Hindon River catchment, including Saharanpur, Muzaffarnagar, Ghaziabad and Noida. As a major tributary of the Yamuna River, the water quality of the Hindon River should be central to any attempts to improve the Yamuna. However, remediation of the heavy contamination of the Hindon River is not included within the Yamuna Action Plan, which further reduces the likelihood that the Plan will be successful in reducing overall pollution load. However, while substantial sums of money have been spent, the results indicate that the Action Plan has not achieved it's aims.

In a major oversight, the Yamuna Action Plan does not address either diffuse pollution from agricultural run-off, including pesticides, or industrial contamination from effluent disposal. While attempts to increase sewage treatment provision within the catchment is necessary, such treatment does not remove industrial or pesticide contamination from drinking water. This highlights the need to control such discharges at source, as post-discharge treatment is not a viable option. The need for such treatment is known to the Central Pollution Control Board. Their own studies on the Yamuna River have found levels of toxic persistent organic pollutants in the form of organochlorine pesticides that exceed World Health Organization guideline maximum levels for safe drinking water.

The Yamuna River supplies over 70% of all Delhi's drinking water supplies, but such is the poor quality of this water that the Supreme Court of India felt obligated to state that 'the government and it's functionaries had failed in their public duties towards the citizens of the Capital of India'. This situation continues despite the completion of Phase I of the Yamuna River Action Plan.

(Source: 'Homicide by Pesticides, What pollution does to our bodies'. Centre for Science and Environment, Ed. Anil Agarwal. Feb 1997).

2

Hindon River: Western Uttar Pradesh – The Current Situation

The Hindon River, historically known as the *Harnandi* River, is a major source of water to the highly populated and predominantly rural population of Western Uttar Pradesh province.

The river was once considered to be so clean that it's waters were believed to cure the *kaali khansi* (bad cough). However, visit the river almost anywhere along its course and it is obvious that something is very wrong with this important lifeline. A river that once flowed with the clean, clear water of the Himalayas, is now black, odourous and largely devoid of life.

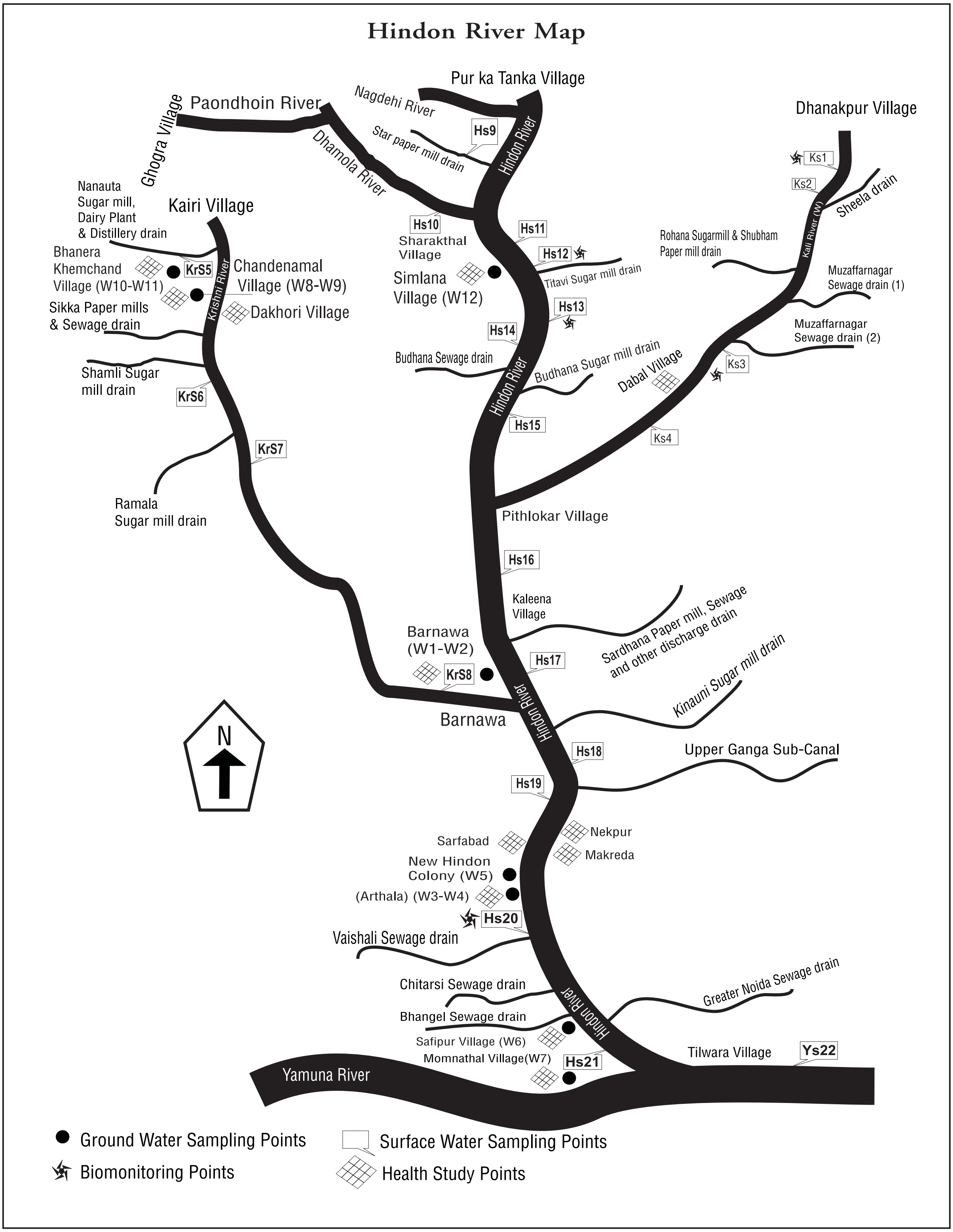
The deterioration of this river has been swift. 60 year old Punna from Malira village located within the Hindon River catchment states '*Arey lalla bees baras pehle to isme ka paani peekare hai*' – '20 years ago the water in this river was drinkable'.

The rich aquatic ecology that is expected to be abundant within this rural state, is now absent. This study was therefore implemented as a result of an increasing awareness of the toxic contamination of the Hindon River, and the compromised human health identified within the population of the river catchment.

The Hindon River originates in the lower Himalayas at Pur ka Tanka village situated in the upper east area of Saharanpur district. The river flows for 260 kms through six districts (Saharanpur, Muzaffarnagar, Meerut, Baghpat, Ghaziabad and Gautambudh Nagar) until it's confluence with the Yamuna River towards south of Tilwara village in Gautambudh Nagar district, downstream of Delhi. The headwaters are ephemeral, with a seasonal monsoon fed flow between July and March only. Low flows in the headwaters is exacerbated by over abstraction of surface and groundwater. The Hindon River has two main tributaries, the Krishni River which originates at Kairi Village and joins the Hindon at Barnawa Village, and the Kali River (West) which originates at Dhanakpur Village and joins the Hindon River at Pithlokar. The Hindon River drains a catchment of approximately 5,000 km^2 of largely agricultural land while also flowing through a number of substantial sized towns and villages.

The following map shows the course of the river, tributaries, major industrial drains, and major population centres. The map also shows sampling locations of this study – surface water, groundwater and biological monitoring points. Full details of these sampling locations are presented within Appendix A.

The Hindon River is utilized by a wide range of industrial uses along it's length. Indeed, the Hindon River and it's two main tributaries, the Kali (West) and the Krishni Rivers, together have 60 industrial manufacturing units. These industries both abstract large volumes of water from the river for their manufacturing processes, and also discharge their industrial effluents, often with nominal or no treatment, directly to the river.



Map 1 – Sampling point locations for groundwater, surface water and biological monitoring points. Map also shows major towns, villages and industrial discharge locations.

Dominant industries include 32 individual paper manufacturing units, of which 24 are located on the Kali River (West), and 15 plants for the manufacture of sugar and distillation of alcohol. Other forms of industry include dairy units, textile manufacture and slaughter houses.

A full list of the major industries discharging to the Hindon River and tributaries, is presented in Appendix I.

The first major industrial effluent discharge is at Saharanpur, where flow increases substantially and is almost entirely composed of the industrial effluents from the Star paper mill. The industrial effluents of the Co-operative Distillery also enter the river in this stretch.

The Kali River (West) tributary has it's confluence with the Hindon River at Pithlokar village, carrying the industrial effluents of the Rohana sugar mill and the Shubham paper mill. Next to enter the Hindon River at Kaleena village is the industrial effluents drain of the Sardhana paper mill.

The Krishni River tributary has its confluence with the Hindon River at Barnawa village in Baghpat district, carrying substantial industrial effluents from four sugar mills (*Kisan Sehkari* Sugar Mills Limited, Bajaj Hindusthan Limited, Shamli Distillery and Chemical Works and Ramala *Sehkari* Sugar Mills), one dairy plant, one distillery and three paper mills at Sikka. Between the join of the Krishni River and the termination of the Hindon at it's confluence with the Yamuna River, the Hindon receives the industrial effluents of one further sugar mill, i.e. Kinauni of the Bajaj group.

This heavy loading of industrial effluent discharge directly into the Hindon River places an intolerable burden on the river's natural ability to assimilate pollutants. Key contaminants identified within the effluents of these industries include a very high loading of organic pollutants and suspended

Sikka paper mill and effluent drain in Muzaffarnagar district

particulate matter (paper mills, sugar mills, distilleries, tanneries, slaughter houses and dairies), heavy metals (sugar and paper manufacture) and frequently pathogens as a result of contaminated raw materials entering the plants.

This current study demonstrates the devastating effect that these toxic contaminants have on the health of the river ecosystem and the human population who are required to use the water.

Dilution of effluent with freshwater is a commonly used and can be an effective treatment. However, this treatment requires good quality and adequate quantity of water within the receiving river. The Hindon River and tributaries receive such a high loading of effluent that dilution with freshwater is no longer a viable treatment. Freshwater flows within the river system are further reduced by diversion of water from the Hindon River through the Hindon Cut Canal to the Yamuna

River, and by the abstraction of high volumes of water for sugar and paper manufacture, and crop irrigation as detailed below.

Agricultural practices within the Hindon River catchment have an important effect on the quality of the river. The river is a primary source of water for irrigation of agricultural land in the locality. Agriculture is the dominant economy of Western U.P. which is largely rural. The main crop grown is sugarcane, a crop that is well known for the large volumes of water required for a successful harvest. Substantial quantities of water are therefore abstracted from the Hindon River and underlying groundwater resources throughout the catchment, for crop irrigation.

Abstraction for irrigation reduces natural freshwater flows within the Hindon River, reducing dilution potential of the river and concentrating the effects of other pollutants entering the river. Irrigation water also deposits on land, the contaminants carried in the water column which then leach through the soil profile to underlying groundwater aquifers.

Surface water run off from agriculture carries with it a number of suspended pollutants particularly elevated suspended sediments due to soil erosion, and agricultural chemicals such as pesticides and fertilizers. Agricultural chemical fertilizers have also been demonstrated to contain heavy metals.

Historically, the water of the Hindon River had a central role in the provision of water for all domestic purposes, including drinking and cooking. However, the primary source of water for domestic usage is now the local groundwater aquifers via a network of handpumps. The Hindon River no longer serves human domestic uses as it is clearly too polluted. The river is now only used for the watering and washing of livestock.

Use of the river for disposal of untreated human sewage is a primary cause of poor water quality within the Hindon River. The river receives large volumes of untreated sewage and municipal wastes from all population centres within the catchment. The wastes of Saharanpur city are discharged directly to the river through the Dhamola drain, followed lower in the catchment, by the municipal effluent of Budhana town as the river passes through. The Kali River (West) tributary carries substantial volumes of municipal wastes from Muzaffarnagar city while the Krishni River tributary carries the municipal wastes of the

Village drain exhibiting obvious signs of pollution by faecal waste villages along it's length. Both tributaries add substantially to the contaminant loading within the Hindon River. The lower reaches of Hindon River catchments receives further heavy loading of municipal effluents of Ghaziabad district, through the three sewerage drains and the Indrapuram Sewage Treatment plant, the only such facility within the whole Hindon River catchment. However, this treatment plant does not have adequate volume capacity and is inadequate to efficiently treat all domestic and municipal wastes in the catchment. There are no other formalized domestic waste water drainage systems along the course of the river which receives raw domestic waste directly from all the villages and towns through which it passes via open channels. Untreated municipal wastes are known to contain a very high level of organic pollutants and suspended particulate matter, disease causing bacteria and other pathogens, as well as heavy metals which are not removed by conventional treatment.

The river also receives a high loading of degradable and non-degradable domestic generated litter.

Some facts about Hindon River

Length of the Sister Rivers of Hindon	
Name of the river	Total length (Kms.)
Hindon	260
Krishni	78
Kali (West)	75
Nagdevi	41
Dhamola	52
Paon Dhoin	20
Major drains related to the river	80
Total	**606**

Source: Hindon Ki Deh, an article by B.B.Singh (Former Principal of M.M.H. College, Ghaziabad)

3

Water Quality of Hindon River and its Tributaries

Samples of river water were taken in 22 locations along the full length of the Hindon River. Map 1 shows sample point locations, indicated by number 1 to 22.

Sample analysis results for all water quality parameters discussed below are available in Appendix B.

The river water was evaluated for physical and chemical characteristics, the presence of toxic contaminants (heavy metals and pesticides) and for biological diversity of river ecology.

Physical, chemical and biochemical parameters where chosen for analysis for each sample taken, including Dissolved Oxygen and Biochemical Oxygen Demand (BOD).

These parameters where chosen for assessment as they give a good overview of general water quality.

Measurements for Dissolved Oxygen were undertaken in the field. All other parameters were assessed in the laboratory according to the standard methodologies prescribed in the Handbook of American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF), 20th Edition 1998.

Biochemical Oxygen Demand and levels of oxygen dissolved in the water column are good indicators of organic pollution levels. Organic pollutants such as sewage and food wastes have a high nutrient loading. These nutrients attract bacteria and other microbes. As these microbes digest the nutrients and proliferate, they consume oxygen within the water column. This reduces levels of oxygen available for the other aquatic organisms that form the populations of a healthy river, such as macro-invertebrates and fish. Under conditions of high BOD, a river suffocates and dies. A high BOD generally corresponds to low levels of dissolved oxygen within the water column.

The Central Pollution Control Board (CPCB) has set the standard for the levels of BOD acceptable for bathing water at 3 mg/l. Levels of BOD acceptable within a drinking water source without treatment is just 2 mg/l. A clean river with low organic pollution levels is also expected to have a BOD level of around 2 mg/l.

The CPCB has also set minimum levels of dissolved oxygen required for bathing water at 5 mg/l, and for drinking water before treatment at 6 mg/l.

BOD levels found within the Hindon River and the tributaries of the Kali River (West) and Krishni River, are shown to massively exceed these BOD standards. Not one sample was suitable for drinking water or even bathing water purposes. Samples taken in the Krishni River are regularly above 1000 mg/l, levels at which the river is entirely devoid of oxygen. As expected, dissolved oxygen levels are zero throughout the length of this river. A river with no oxygen will be devoid of all aquatic life expected of a healthy river ecosystem.

Dissolved Oxygen levels meeting the required standard were found at only two locations, both in the upper reaches of the Kali River (West). See Graph 1 below.

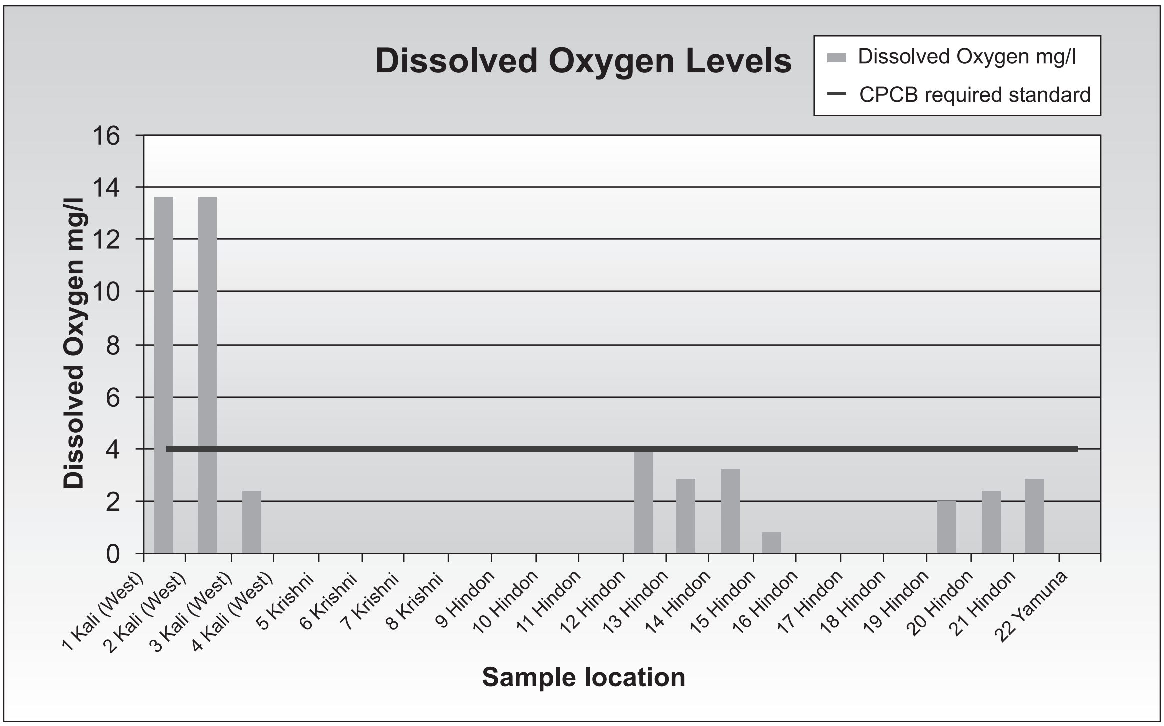
BOD levels within the effluent in the Nanauta Sugar Mill, Distillery and Dairy plant drain were extraordinary at above 9600 mg/l. No river system is able to assimilate such a high nutrient loading.

High volume of untreated sewage and other municipal discharges also add considerably to the high levels of BOD and low levels of Dissolved Oxygen found. Such wastes not only add organic pollutants but also dangerous levels of faecal bacteria and disease causing pathogens.

Effluents from the manufacture of sugar from sugarcane, is characteristically very high in organic pollutants. Untreated sugarcane processing effluent is known to have a Biological Oxygen Demand (BOD) in the range of 1,700 to 6,600 mg/l.

It is due to such extraordinarily high organic pollutant loading, that the Central Pollution Control Board lists sugarcane processing within the top 17 most polluting industries in India. The Hindon River system also receives effluent from the distillation of ethanol from sugarcane molasses. This corrosive effluent, known as 'vinasse', also contains high levels of organic pollutants, and adds to the high BOD / low oxygen level suffocation of the rivers.

Paper mill effluent is also notoriously high in organic pollutants, and is again listed within the top 17 most polluting industries in India. The Hindon River and it's tributaries receives effluent from numerous sugar and paper mills which are a primary contributor to the anaerobic conditions within the river.



Graph 1 – Dissolved Oxygen levels with the Kali (West), Krishni and Hindon Rivers compared against the Central Pollution Control Board specified required minimum standard for drinking water without treatment.

The World Bank Group 'Pollution Prevention and Abatement Handbook' specifies that effluent with a BOD of 50 mg/l of less should be achieved before disposal of industrial effluent to a receiving surface water course. It is immediately obvious that extensive treatment of effluent needs to be undertaken at source before discharge in order that the requirements of the World Bank Group are met.

Industrial effluent from the Bajaj sugar mill drain, exhibiting high loading of organic pollutants

The composition of river bottom dwelling macroinvertebrates is also a good indicator of river health. Sampling for macro-invertebrates was carried out at five samples locations on the River Hindon and tributary River Kali (West).

Full results for the macro-invertebrate sample analysis are located in Appendix C.

Map 1 provides locations for biological monitoring samples.

Biological monitoring for macro-invertebrates works on the principle that families of species exhibit differences in their known tolerances to water pollution. Research has clearly ranked families of species in order of pollution tolerance. Also, some families of species show reduced tolerances to different types of pollutants, so that it may be possible to establish the nature, as well as the extent of the pollutant through a study of the macroinvertabrate community present in the sample. Under increasingly polluted conditions, the diversity of macro-invertebrate families within the community begins to reduce. Less pollution tolerant families of species cannot be sustained, and more pollution tolerant species are seen to increase their population. Under severe pollution conditions, diversity of families is often restricted to a small number of highly tolerant whose individuals dominate the sample.

The macro-invertebrate community are also a good indicator of longer term pollution, as they are relatively sedentary and generally present within the same river reach for their full life cycle (or aquatic stages of life cycle) for one to several

Mayfly larvae (Ephemeroptera) – characteristic of clean river water

Non-biting midge larvae (Chronomidae) – highly tolerant of organic pollution years. Deterioration or improvements of water quality can therefore be monitored over time by assessing changes in pollutant tolerant species within the community.

Specimens taken for the present study were identified to family level, and the number of individual specimens of each taxon was recorded.

The results of the biological monitoring was assessed using a scoring system devised by the Biological Monitoring Workers Party, a group within the UK Government Department for the Environment – known as the BMWP scoring system. The BMWP scoring system provides a structured format within which to determine the quality of a river from the pollution tolerances of the community sampled.

The BMWP scoring figures achieved are then used to determine Water Quality Class based on the macro-invertebrate community composition. The following table is a summary of the Water Quality Class divisions established by the BMWP scoring system;

Of the five biological monitoring samples taken during this study, four scored a Water Quality Class of E - Poor, the lowest possible class. Families within these samples were characteristic of water suffering very high levels of organic pollution and severely limited oxygen levels. The range of biota was limited to a few individuals from just two families, known for their tolerance of extremely polluted waters, which dominate the sample community. All other more sensitive families were entirely absent. This result is expected given the greatly elevated Biological Oxygen Demand (BOD) and negligible Dissolved Oxygen within Hindon, Kali (West) and Krishni Rivers. These results show that the rivers are close to biologically dead

Only the sample taken from the headwaters of the Kali River (West) scored a more reasonable score of C – Fairly Good. Again this result is expected as this sample location is upstream of major industrial effluent discharge drains. The headwaters of the Kali River (West) was the only location where BOD was close to, and Dissolved Oxygen levels were above the Central Pollution Control Board required standards for these parameters in bathing water.

BMWP Water Quality Class	**Quality standards**
A – Very Good	Macro-invertebrate biology of river similar to or better than expected for an average unpolluted river of this size / physical characteristics. High diversity of families. Dominance of particular families is rare.
B – Good	Biology falls a little short of that expected for an unpolluted river of this size/ physical characteristics. Small reduction in the less pollution intolerant families. Small increase in dominance of pollution tolerant families.
C – Fairly Good	Biology worse than expected for an unpolluted river of this size / physical characteristics. Most sensitive families absent, reduction is population of other less pollution tolerant families and corresponding substantial increase in dominance of pollution tolerant families.
D – Fair	Considerable reduction from the biology expected for an unpolluted river of this size/physical characteristics. All sensitive families absent, and other less tolerant families scarce. Marked increase in population of pollution tolerant species.
E – Poor	Biology restricted to the most pollution tolerant families only, whose individuals dominate the community. Total absence of all other more pollution sensitive families. Number of individuals may also be greatly reduced.

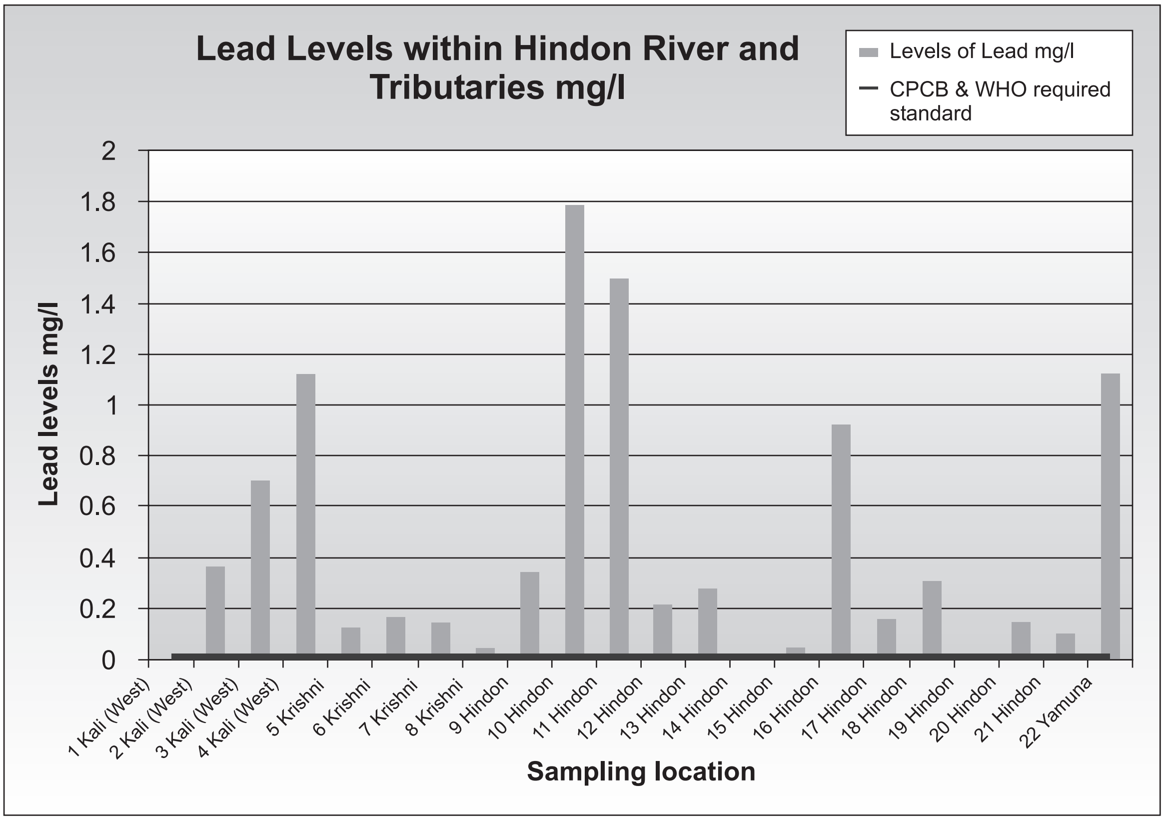
The quality of the biological community within a river is important for more than just aesthetic reasons. A healthy river with a complex community is more able to assimilate and metabolise pollutants, so helping to reduce their quantities within the water column. A restricted community, as seen here, cannot provide any such informal treatment of effluents, so allowing pollution levels to further increase. A river exhibiting such poor aquatic community will have no fish as a potential food source, is likely to be odorous and a source of disease vectors, such as faecal pathogens and mosquitoes. This is indeed the case for the Hindon River.

The river water was also assessed for the presence of heavy metals. Sampling methodology and locations for heavy metals was the same as outlined above for Biological Oxygen Demand and Dissolved Oxygen.

Laboratory analysis was also undertaken for the presence of the following three heavy metals – Lead, Cadmium and Chromium.

Full analytical results for heavy metals in surface waters are presented within Appendix D.

Heavy metals are known to be discharged in the effluents of a wide range of industries present within the Hindon River catchment, including sugarcane and paper manufacture. Research has also identified lead, chromium and cadmium within sewage effluent, both treated and untreated since standard sewage treatment plants are not able to remove metals. Agricultural fertilizers are also known to contain these three heavy metals. It is therefore inevitable that the samples taken from the Hindon, Kali (West) and Krishni Rivers contain these metals at elevated levels.



Graph 2 – Levels of lead within the Hindon, Kali (West) and Krishni Rivers compared against the Central Pollution Control Board required maximum permissible for surface water quality, and the WHO guideline value for safe drinking water.

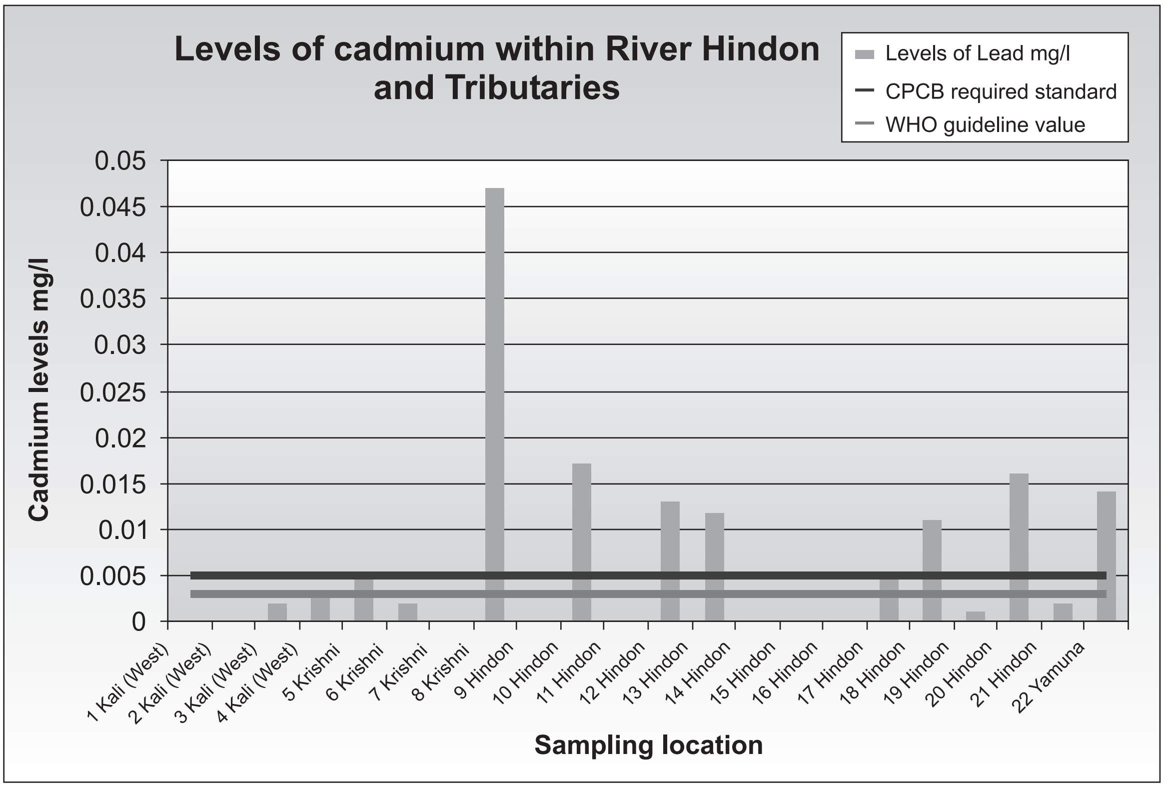
Heavy metals accumulate in river sediments as well as being found within the water column, and are highly persistent as they are not readily broken down or destroyed. All three metals are known to be highly acutely toxic to aquatic organisms. These metals are also highly toxic to human health and the consequences for long term ingestion of water with such elevated concentrations can be devastating.

The Central Pollution Control Board (CPCB) has set a number of maximum permissible standards for the protection of surface waters.

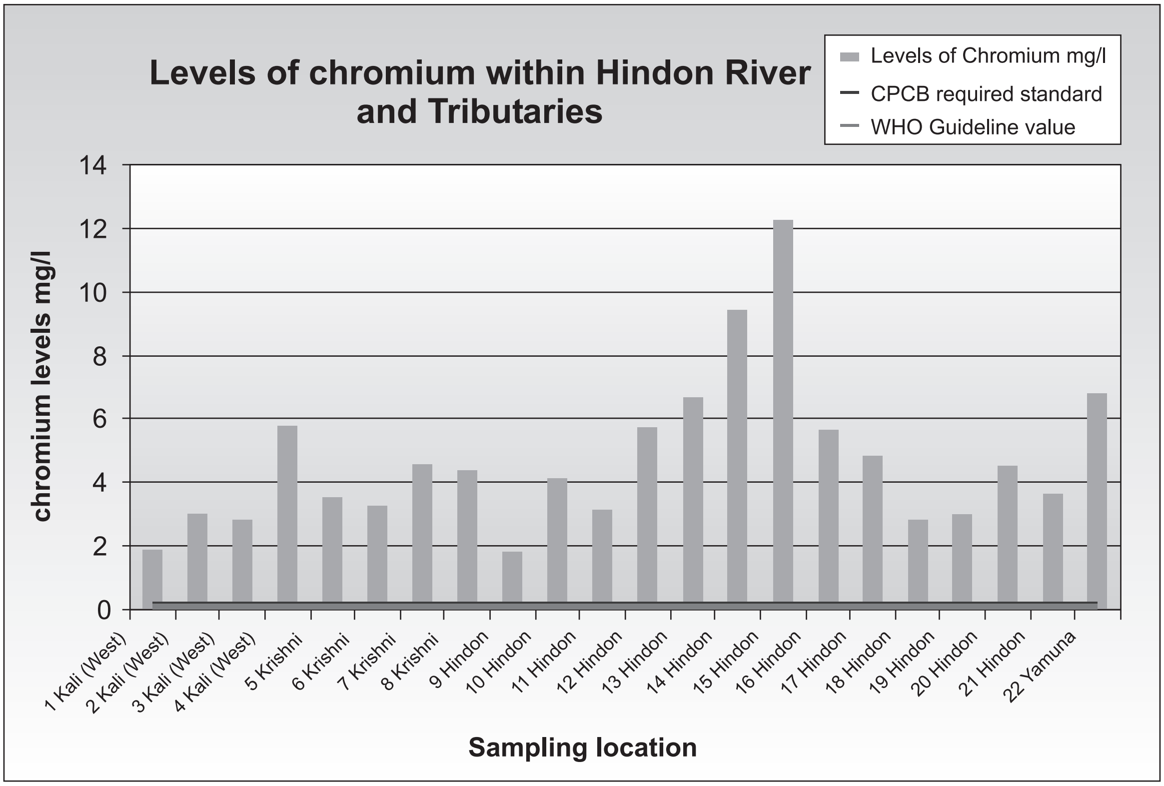
The CPCB standard for maximum permissible levels of lead in surface water is 0.01 mg/l. The World Health Organisation guideline for safe drinking water also specifies maximum lead levels as 0.01 mg/l. As can be seen from Graph 2 above, levels of lead within samples are exceeded at all but three sampling locations. Levels within the Hindon River were identified at up to 179 times the stated permissible maximum and up to 112 times stated maximum within the Kali River (West).

The Central Pollution Control Board maximum permissible standard for cadmium within surface water is 0.005 mg/l. World Health Organisation guideline values for safe drinking water specify a maximum of 0.003 mg/l. As can be seen from Graph 3 below, levels of cadmium are frequently exceeded within the Hindon River. Levels were identified at over nine times the stated permissible maximum for surface water, and nearly 16 times the safe value for drinking water.

The Central Pollution Control Board maximum permissible standard for chromium within surface water is 0.10 mg/l. The World Health



Graph 3 – Levels of Cadmium within the Hindon, Kali (West) and Krishni Rivers compared against the Central Pollution Control Board required maximum permissible for surface water quality and the WHO guideline value for safe drinking water.



Graph 4 – Levels of Chromium within the Hindon, Kali (West) and Krishni Rivers compared against the Central Pollution Control Board required maximum permissible for surface water quality and the WHO guideline value for safe drinking water.

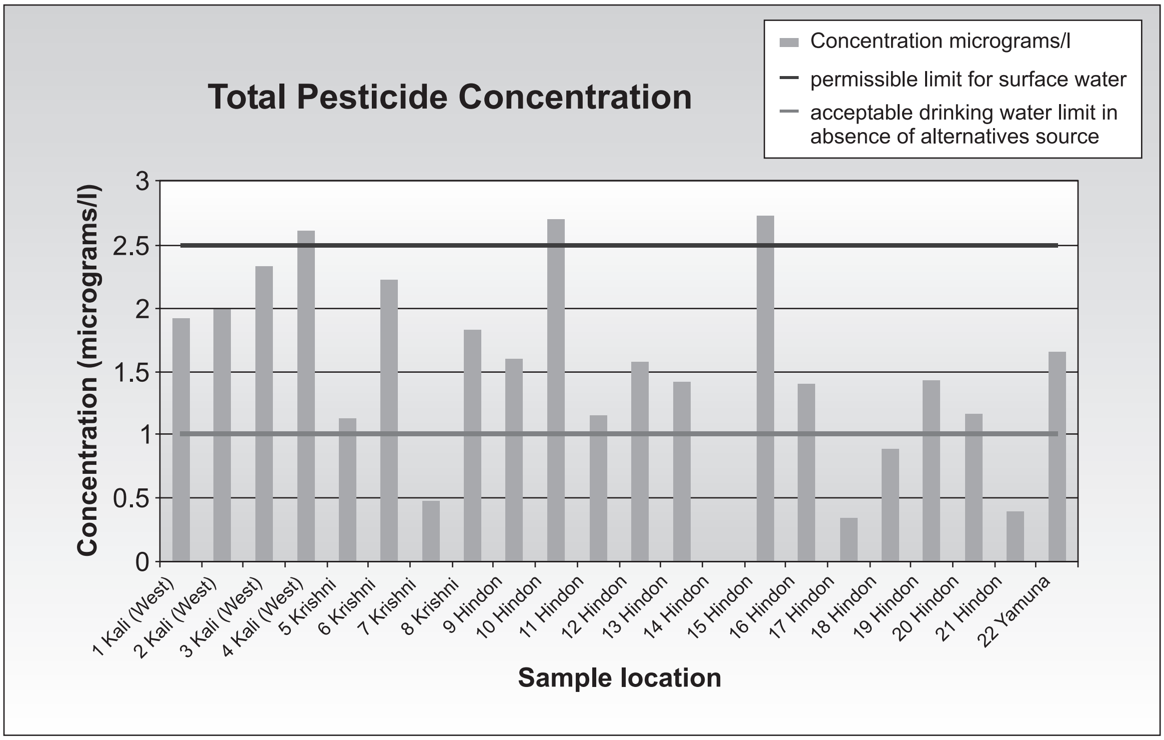
Organisation guideline value for safe drinking water specifies 0.05 mg/l. As can be seen from Graph 4 above, levels of chromium are greatly exceeded at every sample location on all three rivers. Levels were identified (for surface water) at up to 58 times the stated permissible maximum within Kali River (West), up to 46 times stated maximum in the Krishni River and 123 times in the Hindon River. Compared against safe drinking water standards values are doubled, up to an extraordinary 246 times exceedence in the Hindon River.

As these three graphs clearly show, the Hindon River and tributaries are consistently and massively exceeding the maximum permissible values for healthy surface water and for safe drinking water. It is therefore concluded that the water within the Hindon River and tributaries is unable to support a functioning aquatic ecosystem nor is the water safe for drinking due to the presence of toxic heavy metals. At such levels, any person using this water for domestic purposes will undoubtedly exhibit symptoms of heavy metal poisoning.

While this study has evaluated the presence of three heavy metals, it must be assumed that a wider range of other toxic contaminants are also present within the water column and river sediments.

As a largely rural catchment with heavy usage of chemical inputs, the presence of pesticides within the river was also evaluated. Sampling methodology and locations for pesticides was the same as for Biological Oxygen Demand and heavy metals.

Laboratory analysis of surface water was also undertaken for the presence of ten Organo-chlorine pesticides and breakdown products (Endosulfan I alpha, Endosulfan II beta,



Graph 5 – Total pesticide concentrations within Kali (West), Krishni and Hindon Rivers.

Endosulfan sulphate, Alpha BHC, Beta BHC, Other isomers of BHC, Heptochlor, Heptochlor Epoxide, Fipronil and Aldrin). Full analytical results for pesticides in surface water are presented within Appendix E.

All of the pesticides subject to analysis were identified within the River Hindon and its tributaries.

The Central Pollution Control Board has set the maximum permissible loading of pesticides within surface water at 2.5 micrograms per litre (μg/l).

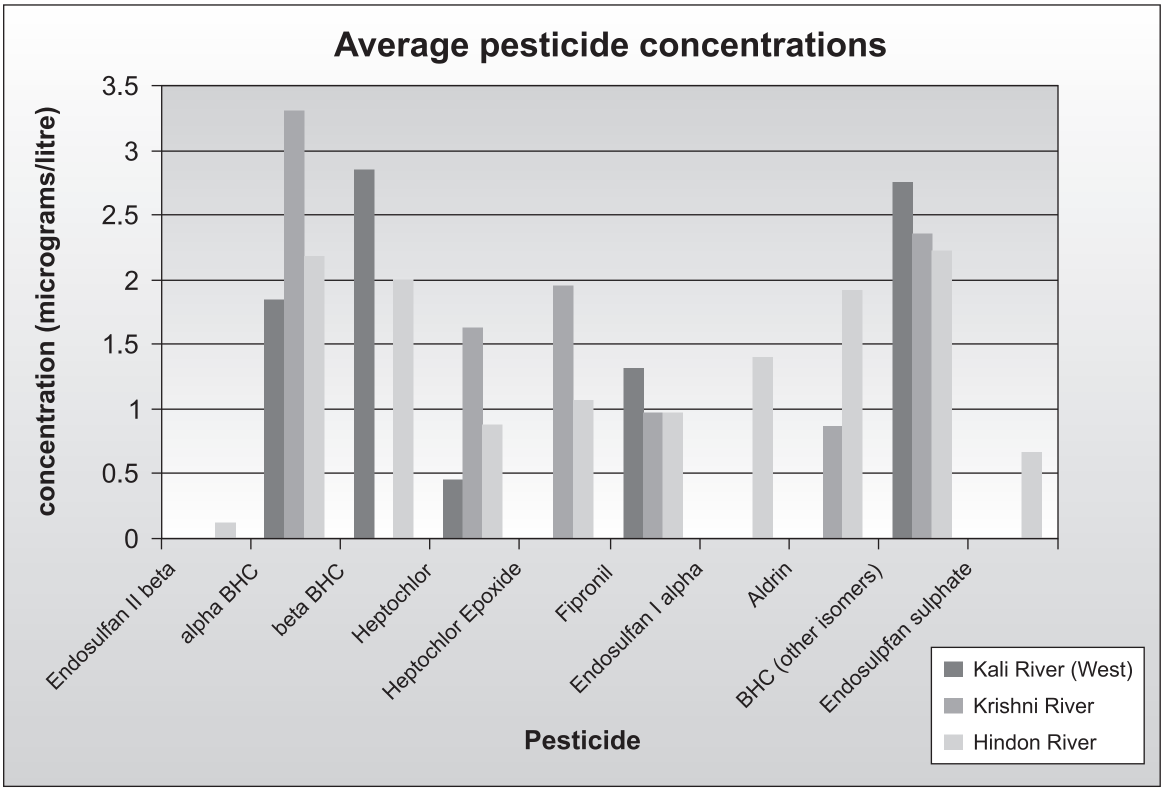
The Bureau of India Standards (BIS) has specified that there is no safe and acceptable level for pesticides within drinking water. The current standard states that it is desirable that pesticides are entirely absent from drinking water and should be below the level if detection, as assessed by standard evaluation methodologies. However the standard also states that in the absence of any other acceptable source of drinking water, levels of total pesticides up to 1 μg/l, may be acceptable.

The Graph 5 above shows the total combined pesticide loading at each sample location of the Hindon River and its tributaries Kali River (West) and Krishni River, compared against the maximum permissible loading for both surface water and drinking water standards.

This graph clearly shows that total pesticide concentrations are found to be in exceedence of the Central Pollution Control Board's maximum permissible limit for surface water at three locations on the reaches of the Kali River (West) and the upper and mid reaches of the Hindon River.

However more worryingly, the BIS standards for maximum acceptable total pesticide concentration for safe drinking water in absence of a more suitable source, is greatly exceeded at almost all sampling locations.

The following Graph 6 shows the average concentration for each pesticide identified within the Hindon River and it's two main tributaries, the Krishni River and the Kali River (West).



Graph 6 – Average concentration of each pesticide identified, at each sampling location on Kali (West), Krishni and Hindon Rivers.

The Graph 6 above clearly shows that levels of pesticides are far above the limit of detection within the water which is therefore not meeting the desired requirements for safe drinking water purposes according to the Bureau of Indian Standards (BIS). Many individual pesticides also exceed the 1 µg/l total pesticide maximum permissible limit in absence of alternative source. The graph also shows this exceedence which is widespread throughout the full course of the river and both tributaries for most of the pesticides assessed.

The World Health Organisation (WHO) has also set guidelines, values and maximum permissible concentration figures for safe drinking water, for many of the pesticides identified within this river system. These guidelines values are far more stringent than those for surface water set by the Central Pollution Control Board as outlined above.

The WHO guideline values and the exceedence of these guidelines within surface water samples, are outlined below for each pesticide identified.

Alpha BHC

WHO guideline value for drinking water	2 µg/l (value for Lindane, parent chemical)
WHO designation	Highly Hazardous
Rivers where average exceeds WHO guideline	Hindon and Krishni Rivers.
Maximum exceedence identified in present study	3.3 µg/l - Krishni River, 1.6 times WHO guideline
Level of toxicity on human health	Highly acutely toxic

Beta BHC

WHO guideline value for drinking water	1µg/l
Rivers where average exceeds WHO guideline	Hindon and Kali (West) Rivers.
Maximum exceedence identified in present study	3.2µg/l – Hindon River, 3.2 times WHO guideline

Other isomers of BHC cause similar toxicity symptoms, and it is alarming that concentrations of these other isomers up to 5.7µg/l are recorded within the Hindon River.

Heptachlor

WHO guideline value for drinking water	0.03 µg/l
WHO designation	Highly Hazardous
Rivers where average exceeds WHO guideline	Hindon, Krishni and Kali (West) Rivers.
Maximum exceedence identified in present study	1.2 µg/l - Krishni River, over 40 times WHO guideline
Level of toxicity on human health	Highly acutely toxic

Heptachlor Epoxide

WHO guideline value for drinking water	0.03 µg/l
WHO designation	Highly Hazardous
Rivers where average exceeds WHO guideline	Hindon and Krishni Rivers.
Maximum exceedence identified in present study	3.82 µg/l - Krishni River, over 127 times WHO guideline
Level of toxicity on human health	Highly acutely toxic

Fipronil

WHO guideline value for drinking water	Not currently available
Rivers where average exceeds WHO guideline	Presence in Hindon, Krishni and Kali (West) Rivers.
Level of toxicity on human health	Moderately toxic

Aldrin

WHO guideline value for drinking water	0.03 µg/l
WHO designation	Highly Hazardous
Rivers where average exceeds WHO guideline	Hindon and Krishni Rivers.
Maximum exceedence identified in present study	3.36 µg/l – Hindon River, 112 times WHO guideline
Level of toxicity on human health	Highly acutely toxic

Aldrin is also listed by the United Nations as Persistent Organic Pollutant. India does not permit this pesticide to be imported into the country.

This assessment clearly shows that the water within the Hindon River is heavily contaminated with a wide range of pesticides and their breakdown products. Standards are exceeded for both World Health Organisation and Bureau of Indian Standards requirements, by several orders of magnitude. Nowhere within the Hindon River and tributaries is the water free from levels of pesticides that are proven to be toxic to human health.

4

Groundwater Quality: Hindon River Catchment

Alluvial sediments are the dominant geology within the Hindon River and tributary catchment. Alluvial sediments are porous and contaminants within an overlying surface water body will pass easily through the sediments to underlying aquifers. River systems are commonly in direct hydraulic continuity with the underlying groundwater aquifer. The likelihood is therefore high that contaminants within the Hindon River system pass directly from surface water to groundwater. As has already been demonstrated, the Hindon River is widely used for agricultural irrigation and is also heavily polluted with a range of toxic chemicals.

Contaminated river water for irrigation and heavy use of pesticides direct to cropland is another major pathway by which contaminants are transferred via percolation through soil to underlying groundwater.

Groundwater is the dominant source of water for domestic usage, including drinking water. Having identified exceedences of heavy metals and pesticides within the surface water, an assessment was undertaken of local groundwater samples.

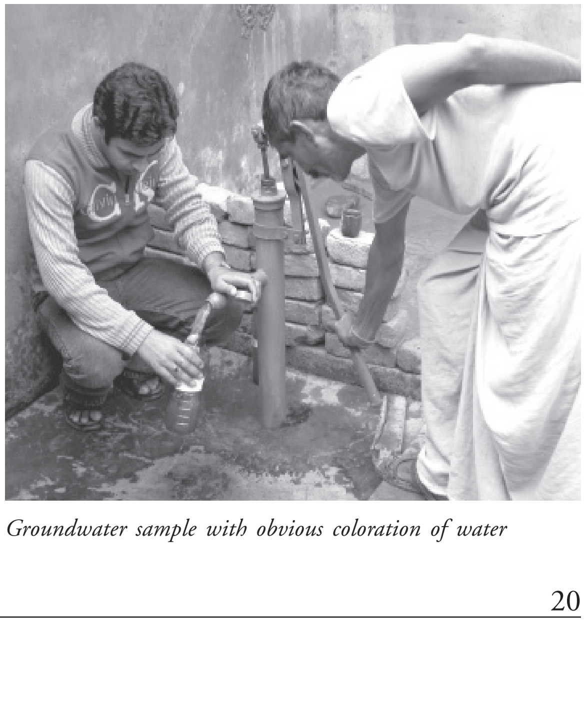
With such a high risk that groundwater sources are also being contaminated, a series of samples were taken from groundwater borehole handpumps in seven villages within the Hindon River catchment;

- Bhanera Khemchand and Simlana Villages (Saharanpur District)
- Barnawa Village (Baghpat District)
- Safipur and Momnathal Villages (Gautambudh Nagar District)
- Chandenamal Village (Muzaffarnagar District)
- Arthala Village (Ghaziabad District)

During sampling, the depth of borehole was identified, aesthetic quality of the drinking water samples was noted and as was locations where handpumps were providing water of a quality that was no longer accepted by the local villagers for drinking.

The groundwater samples were analysed for the same heavy metal parameters (cadmium, chromium and lead) as the surface water samples, detailed in the Chapter above. A range of organochlorine and organophosphorus pesticides and their breakdown products were tested for.

Full groundwater sample analysis results are



Groundwater sample with obvious coloration of water detailed within Appendix F (heavy metals) and Appendix G (pesticides).

Map 1 shows locations of villages and groundwater samples.

Bhanera Khemchand Village, Saharanpur District

Sample details	Sample no. W10	Sample no. W11
Depth of handpump	85 feet	68 feet
Handpump owner	Private	Private
Handpump water usage	No longer used for drinking Bathing, watering of livestock.	
Groundwater taste/colour	Heavily coloured and has an unpleasant salty-metallic taste	
Village population size surveyed	1580	
Location of village	Banks of the Nanauta drain at confluence with the Krishni River. Upper reaches of the Krishni River tributary catchment.	

Nanauta drain carrying effluents from a sugar mill, alcohol distillery and dairy

Chandenamal Village, Muzaffarnagar District

Sample details	Sample no. W8	Sample no. W9
Depth of handpump	35 feet	100-120 feet
Handpump owner	Private	Government, used by local school (200 pupils)
Handpump water usage	No longer used for drinking.	All uses - drinking, bathing, watering of livestock.
Groundwater taste/colour	Coloured yellow, unpleasant taste	Acceptable colour and taste
Village population size surveyed	592	
Location of village	2km from Krishni River, in the upper reaches of catchment for this tributary. 3km south of Nanauta drain confluence with the Krishni River.	

Simlana Village, Saharanpur District

Sample details	Sample no. W12
Depth of handpump	45 feet
Handpump owner	Private
Handpump water usage	No longer used for drinking water. Other purposes - bathing, cooking and watering of livestock
Groundwater taste/colour	Yellow in colour, unpalatable taste
Village population size surveyed	489
Location of village	Banks of Hindon River, upper reaches of catchment.

Barnawa Village, Baghpat District

Sample details	Sample no. W1	Sample no. W2
Depth of handpump	35-40 feet	35-40 feet
Handpump owner	Private	Private
Handpump water usage	Used for drinking and all purposes	Used for drinking and all purposes
Village population size surveyed	341	
Location of village	Middle reaches of Hindon River catchment, upstream of the confluence with Krishni River and downstream of the confluence with the Sardhana Paper Mill effluent drain.	

Arthala Village, Ghaziabad District

Sample details	Sample no. W3	Sample no. W4
Depth of handpump	35-40 feet	30-35 feet
Handpump owner	Private	Private
Handpump water usage	All uses - drinking, bathing, watering of livestock.	
Village population size surveyed	592	
Location of village	Lower reaches of Hindon River, downstream of the confluence with the Krishni river, the Kinauni sugar mill drain, and the Upper Ganga subcanal.	

The World Health Organisation (WHO) has specified Guideline Values for maximum permissible levels of pesticides and heavy metals within safe drinking water.

Regulations have also been set by the Bureau of India Standards (BIS) for a number of

Safipur Village, Gautambudh Nagar

Sample details	Sample no. W6
Depth of handpump	35-40 feet
Handpump owner	Private
Handpump water usage	Used for drinking water and all other purposes.
Village population size surveyed	329
Location of village	Banks of Hindon River, downstream of Indrapuram Sewage Treatment Plant and 4 major untreated sewage and municipal waste drains.

Momnathal Village, Gautambudh Nagar District

Sample details	Sample no. W7
Depth of handpump	35-40 feet
Handpump owner	Private
Handpump water usage	Used for drinking water and all other purposes.
Village population size surveyed	370
Location of village	This Village is also located in the lower reaches of the Hindon River catchment, close to the confluence with the Yamuna River.

contaminants, including cadmium, lead and chromium. As specified above, BIS also requires that safe drinking water does not contain pesticides above the level of detection, however a maximum total pesticide concentration of 1µg/l may be acceptable where there is no alternative source of clean drinking water. The Central Groundwater Board has responsibility for monitoring of groundwater and enforcement of these standards.

Exceedences were identified of WHO and BIS maximum permissible limits for heavy metals and pesticides, within groundwater samples taken at the survey villages.

Lead and chromium were detected in all groundwater samples taken at all villages. Cadmium was detected in the samples of all villages except Momnathal and Simlana. Chromium and cadmium levels were fortunately shown to be below the maxiumum permissible levels for both BIS and WHO.

However, lead levels were seen to grossly exceed World Health Organisation standards for safe drinking water at all villages, and to also exceed the more lenient BIS limits at Chandenamal village. Indeed lead levels at Chandemamal village are almost 35 times the acceptable WHO limit for safe drinking water.

As with surface water samples, the groundwater drinking water samples detected a range of pesticides close in chemical composition to those detected in surface water samples. These pesticides were predominantly organochlorine pesticides and their breakdown products. The same range of pesticides are therefore present within the surface water and groundwater resources of these villages. One organophosphorous pesticide was also identified within the groundwater samples of Barnawa and Arthala villages. Organophosphorous insecticides are also acutely toxic to human health, with a similar range of toxic poisoning symptoms as for organochlorine pesticides. Poisoning effects include endocrine disruption, reproductive and developmental disruption and neurological disorders due to disruption of nervous system functioning.

Pesticides above detectable limit were identified in samples at all villages. The basic standards for safe drinking water as set by BIS are therefore not met at any village assessed for this study. The more lenient requirement for maximum total pesticide concentration of 1µg/l being acceptable where there is no alternative source of clean drinking water, is also exceeded at all villages. The drinking water source for all villages surveyed, for which there are no alternative sources, therefore fail to meet even lenient BIS standards.

The following table details exceedences of WHO and BIS maximum permissible limits within groundwater samples of each village, for both heavy metals and total pesticides.

Pollutant	Guideline value for safe drinking water		Bhanera Khemchand	Chandenamal	Simlana	Barnawa	Arthala	Safipur	Momnathal
Heavy metal	WHO	BIS							
Lead	0.01 mg/l 10 mg / l	0.05 mg/l 50 mg/l	4.5 times permissible limit for WHO	34 times permissible limit for WHO 7 times permissible limit for BIS	1.6 times permissible limit for WHO	4 times permissible limit for WHO	3.5 times permissible limit for WHO	2.5 times permissible limit for WHO	1.1 times permissible limit for WHO
Chromium	0.05 mg/l 50 mg / l	0.05 mg/l 50 mg/l	Detected in all samples, levels below maximum permissible for safe drinking water						
Cadmium	0.003 mg/l 3 mg/l	0.01mg/l 10 mg/l	Detected in all samples, levels below maximum permissible for safe drinking water						
Pesticide	BIS For total pesticides		Above detectable limit	Above detectable limit	Above detectable limit	Above detectable limit	Above detectable limit	Above detectable limit	Above detectable limit
Total pesticides	Below detectable limit OR in absence of alternative source; 0.001 mg/l 1.0 mg/l		3.7 times permissible limit in absence of alternative source	1.6 times permissible limit in absence of alternative source	2.3 times permissible limit in absence of alternative source	2.7 times permissible limit in absence of alternative source	1.6 times permissible limit in absence of alternative source	1.4 times permissible limit in absence of alternative source	1.9 times permissible limit in absence of alternative source

Exceedences of WHO and BIS maximum permissible limits within groundwater samples of each village.

5

Implications of Groundwater Contamination on Health of Riparian Communities

Chapter 3 identifies highly elevated levels of toxic pesticides and heavy metals in river water throughout the Hindon River catchment, levels far in exceedence of World Health Organisation (WHO) and Central Pollution Control Board guidelines for safe drinking and bathing water. Chapter 4 shows that elevated levels of toxic pesticides and lead are also found within the groundwater resources that is the only source of drinking water to a large population in the Hindon River catchment. Cadmium and chromium were identified as present at lower levels. Pesticide and lead levels within this population's drinking water are shown to greatly exceed WHO and Bureau of Indian Standards maximum permissible levels for safe drinking water.

An extensive body of existing scientific research has shown that such exceedences of toxic pesticides and heavy metals will undoubtedly cause toxic poisoning to villagers who are reliant on these water sources for drinking and other domestic needs.

The pesticides identified within the surface and groundwater samples of the Hindon River catchment are organochlorine and organophosphorus pesticides. Organochlorine and organophosphorus pesticides, and heavy metals are acutely toxic and cause a range of characteristic poisoning symptoms. They bioaccumulate in human tissue. Both pesticides and heavy metals are endocrine disruptors, interfering with hormone production and functioning. Symptoms are seen such as growth, development and maturation impairment, meaning children are at particular risk from these range of toxins when consumed in drinking water. As known carcinogens these toxins are have been shown to promote a range of cancers. The toxins have also been shown to act as immuno-suppressants, reducing resistance to disease and increasing rates of secondary infections such as respiratory infections and skin dermatitis.

Organochlorine pesticides are potent stimulants of the central nervous system interfering with neuro- transmitters and causing a range of neurological and behavioural disorders. Some of the organochlorine pesticides found at elevated levels within the Hindon River catchment have been identified by the United Nations as being Persistent Organic Pollutants (POPs). The United Nations is working to ban the production and use of POPs worldwide because of their acute toxicity and dangers to health.

The following table outlines the harm to human health that has been shown to occur following exposure to, or consumption of, water contaminated with elevated levels of the heavy metals and pesticides identified with the drinking water of these villages.

All of the contaminants listed below have been found in surface and groundwater drinking water samples at levels that exceed maximum permissible

Contaminant in Hindon River catchment exceeding safe drinking water standards	Toxic health effect mechanism	Poisoning symptoms expected within local population
Lead Organochlorine pesticides	Accumulates within human tissues	Within the skeleton, it affects the metabolism of calcium causing deformities and skeletal weakness.
Organophosphorus pesticides		Within kidney, impairs kidney function, including kidney stones.
		Within liver, impairment of liver function, cirrhosis, chronic hepatitis.
Lead Organophosphorus pesticides	Toxic to the central and peripheral nervous systems	Neurological and behavioural disorders.
Lead Organochlorine pesticides	Carcinogenic	Range of cancers, including kidney, breast cancer, testicular, prostate.
Lead Organochlorine pesticides	Endocrine disruptor	Interferes with hormone levels and production, disrupting development and maturity.
Lead Organophosphorus pesticides	Transferred through the placenta from the mother to unborn child	Children are therefore particularly at risk from the ingestion of elevated lead levels, even before birth.
Lead Organochlorine pesticides	Interrupt reproductive cycle	Infertility, reproductive disorders.
Organochlorine pesticides	Suppression of immune system	Increased susceptibility to other diseases Respiratory disorders.
Organophosphorus pesticides		Skin dermatitis Gastric disorders.

guideline values for safe drinking water. All the toxic poisoning symptoms refrenced in the above table are therefore expected to occur within the affected population.

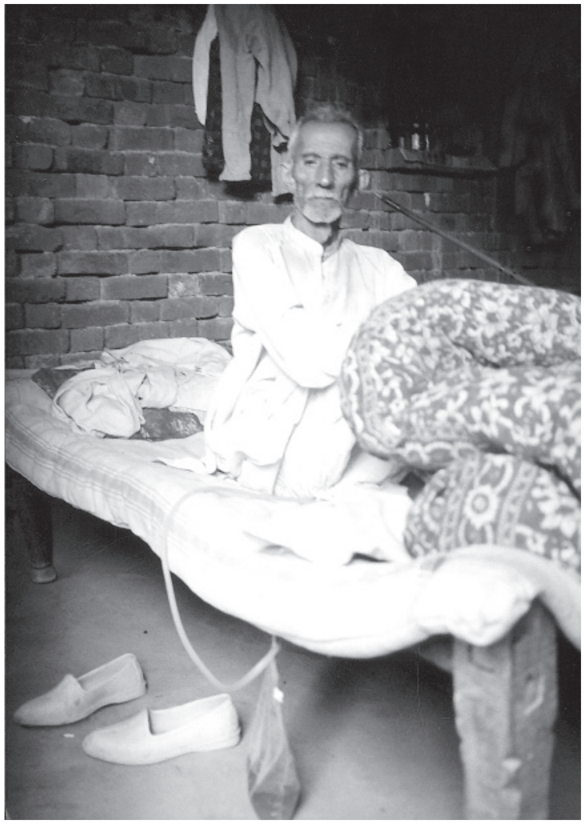
The local villages forced to rely on this contaminated water are therefore at a massive risk of slow and deadly toxic poisoning. The expected health effects outlined in the above table are already being reported by villagers whose symptoms are obvious even to the casual observer.

A detailed survey was therefore undertaken to evaluate the health of the populations within the catchment and identify the extent of the toxic poisoning. The health survey was conducted for the seven villages also surveyed for groundwater contamination in Chapter 4 and a further five villages within the Hindon River catchment.

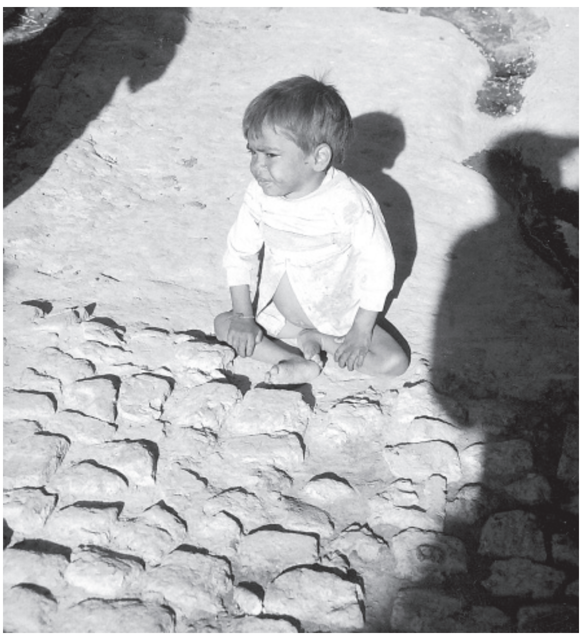
The survey noted the numbers of villagers within the total village population that are currently suffering from serious illness and documents the nature of these illnesses. Monthly medical expenditure of each village incurred as a result of their various illnesses was documented. Numbers of deaths within the village in the previous five years and cause of death was recorded.

Full details of the surveys for all 12 villages are available within Appendix H.

Suffering from serious skin dermatitis - Rajwati of Chandenamal village



Seriously ill with liver cirrhosis, chronic hepatitis and digestive disorders, Jaipal Singh of Chandenamal village



Suffering from skeletal deformities, muscle wastage and digestive disorders – Parul of Bhanera Khemchand village. Parul is unable to walk and at 7 years old, shows delayed growth and development.

Within all villages surveyed, the most commonly observed illnesses include cancers, neurological disorders, stomach/digestive disorders, and skin lesions/dermatitis, respiratory disorders - the same range of illness as outlined above, that are expected as a result of heavy metals and pesticides toxic poisoning.

The evidence is therefore clear that the elevated levels of toxic contaminants found within the drinking water source at these villages will be having a devastating effect on the health of the local population.

This was indeed found to be the case.

The following table details the cause of debilitating illness or death (indicated by X) found within the seven villages where groundwater sampling has proven toxic contamination of their groundwater drinking sources. These illnesses are all

Village	% of population within village currently suffering from serious or debilitating illness	Illness symptom and / or Cause of Death					
		Cancer	Skin dermatitis	Neurological disorders	Heart disease	Digestive disorders	Respiratory disorders
Bhanera Khemchand	42%	X	X	X	X	X	X
Chandenamal	22%	X	X	X	X	X	X
Simlana	14%	X	X	X	X	X	X
Barnawa	21%	X	X	X	X	X	X
Arthala	37%	X	X	X	X	X	
Safipur	19%		X	X	X	X	
Momnathal	25%	X	X	X	X	X	X

characteristic of toxic poisoning by contaminants proven to exceed WHO and Bureau of Indian Standards maximum permissible guideline values for safe drinking water in their groundwater samples. The table also shows the percentage of the total village population that are suffering from toxic poisoning symptoms.

Within the seven villages proven to have toxic contamination of drinking water, 107 people have also died in the last five years alone from the above diseases characteristic of toxic poisoning.

Indeed deaths are so frequent, that Rambeer of Chandenamal village states - '*Iske paani ne to hum maar diye*' , 'The water of the river has killed us', while Ram Niwas of Bhanera Khemchand village states '*Is gaon me to ji bahut log cancer se margey*', 'In this village many people have died of cancer'.

Of the five additional villages where groundwater samples were not analysed, the results of the health survey showed the same unacceptably high levels of illness and death. Again the causes were characteristic of toxic poisoning by heavy metals and pesticides. Every village within the study was therefore shown to be suffering from an unusually high

Forced to drink toxic water and risk serious illness – school children of Chandenamal Village.

Dying from terminal throat cancer - Devi of Barnawa village

Villagers report reduced reproductive success within their livestock. It is expected that such effects are also present within the human population. As well as the obvious burden on human well being from such illness, there is also a substantial economic cost, both for medicines and lost work hours through incapacity. The villages in this study are regularly paying many thousands of rupees per month for treatment of toxic poisoning, with the worst affected villages paying up to 1,02,600 rupees monthly – nearly 500 rupees per month, per family. For a low income rural farming family, this is clearly an economic burden that can only be borne by cutting back on other expenses. It is likely that schooling, clothing and other essential items are neglected so that medical expenses can be paid.

rate of serious and debilitating illness as a result of toxic poisoning. A further 22 people have died in the last five years from illness characteristic of toxic poisoning within these additional five villages studied.

It can therefore be extrapolated that illness due to poisoned drinking water as a result of groundwater contamination, is widespread within the whole of the Hindon River catchment.

Although not subject to this current health study, diseases related to endocrine disruption and reproductive disorders are also likely to be prevalent within these villages, due to the presence of guideline exceeding levels of heavy metals and pesticides within drinking water. These diseases are particularly devastating, as they affect not only the current generation but also the future, through damage to children who are particularly vulnerable.

The results of this health survey within the populations of the Hindon River catchment is therefore undeniable. Villagers forced to drink the contaminated water of the Hindon River catchment are being slowly poisoned and are dying in large numbers as a direct result.

With no alternative sources of safe drinking water, the villagers are faced with a stark choice – to stay in their villages and endure certain illness and early death of themselves and their children, or leave their homes, land and livelihood, and migrate to the cities for a difficult, unknown future.

6

Recommendations

The Ministry of Agriculture and Co-operation, Ministry of Health and Family Welfare, Ministry of Environment and Forests and the Central Pollution Control Board, must take responsibility for controlling and reducing the indiscriminate use of highly acutely toxic pesticides. These government bodies must work to ensure the Bureau of Indian Standards requirement of no detectable pesticides within drinking water, is met for all villages within the Hindon River catchment.

As a signatory of the United Nations 'International Code of Conduct on the Distribution and use of Pesticides', the Ministry of Fertilizers should seek to ban production and import of all World Health Organisation designated extremely hazardous and highly hazardous pesticides. This includes pesticides discussed in this study.

The Ministry of Agriculture should promote the adoption of sustainable natural farming methods, and move policies away from the use of chemical inputs.

The Central Pollution Control Board must end the practice of untreated industrial effluent release direct to surface waters.

The Uttar Pradesh State Pollution Control Board must take action against all industries within the Hindon River catchment that currently discharge untreated effluents. The Central Pollution Control Board and the Uttar Pradesh State Pollution Control Board must ensure that the industry specific standards on industrial effluent discharge quality, as outlined within the Environment Protection Rules 1986, are adhered to by all industries within the Hindon River catchment.

Non-complying industrial plants must be closed until suitable effluent treatment plants are installed.

The Uttar Pradesh State Pollution Control Board must establish a monitoring programme to ensure compliance with required effluent treatment standards.

Enforcement action must be implemented for industries failing effluent treatment standards.

The Central Groundwater Board must take action to remediate groundwater heavy metals contaminant exceedences by enforcing the Bureau of Indian Standards criteria for safe drinking water.

The Uttar Pradesh State Pollution Control Board should prevent further hazardous industries operating and discharging within the Hindon River catchment by ceasing to issue 'No Objection Certificates' to industry applicants, with immediate effect.

The Uttar Pradesh State Health Department should establish a public education programme to raise awareness of basic water and sanitation practices, including the health risks presented by contaminated water.

The Uttar Pradesh Jal Nigam and Health Departments must also provide access to safe drinking water and adequate medical assistance for all villages within the Hindon River catchment affected by contaminated water supplies.

The State has violated Human Rights Legislation obligations to protect the rights of it's citizens to safe water, as the State has not prevented third party polluting industries from destroying those rights. By continuing to take no action against the polluters of water resources within the Hindon River catchment, the Government of India continues to violate internationally accepted Human Rights Legislation.

As a major tributary of the Yamuna River, it is essential that remediation of Hindon River contamination is included as a priority within the existing Yamuna River Action Plan. Such remediation needs to allocate sufficient funds and be implemented within a clearly defined and appropriate timescale.

Remediation of contamination should also address the currently inadequate provision of sewage treatment facilities within the Hindon River catchment.

Immediate Efforts to be Initiated by Janhit Foundation

1. It would be the endeavor of Janhit Foundation to widely circulate the study report entitled 'Hindon River: Gasping for Breath' across the country and a few International agencies like The Ford Foundation (U.S.A), Food First Information and Action Network (FIAN, Germany), Department For International Development (DFID), Water Keepers Alliance (U.S.A) and others to draw attention towards finding long lasting solutions to save the river.

2. The documentary film produced by Janhit Foundation would be screened in various schools, *panchayats* particularly in the villages situated on the banks of Hindon River, government departments like The Irrigation Department of U.P.; U.P. Jal Nigam; The State Pollution Control Board, Lucknow and The Central Pollution Control Board, New Delhi.

3. Powerpoint Presentations would be delivered in the major cities and towns that are discharging their untreated effluents into the river. As a mass awareness campaign, extensive wall writing would be done to create an impact on the minds of the people about the pollution of Hindon River. Important T.V. channels, print media and journals would be contacted to see that the issue finds an important place with them. Since the media has a special role in creating awareness hence, the issue would be raised extensively.

4. In case of a need, Janhit Foundation would knock the doors of the Hon'ble Supreme Court to issue strict orders towards putting a check to the growing pollution of Hindon River by the industries. An interim order would also be prayed in order to stop further installation of any industry on the banks of Hindon River.

7

Consultation, Comments and Support

The report sent by you is horrible. Please contact the government departments concerned and ask to take appropriate action against those who are polluting the holy Hindon River. The court will surely give you justice in this holy work.

Sunil Dutta Trivedi, Maple Orgtech (India) Ltd, Dehradun

It looks most impressive. I do hope you are able to bring pressure to bear on the concerned authorities to improve the situation on the ground.

Vasant Saberwal, Ford Foundation, New Delhi

The main pesticides concentration found in the Hindon River - BHC, Heptachlor, Heptachlor Epoxide and Aldrin, have been banned for use by the Government of India for almost one decade now. It is therefore not understood as to how these quantums have been found in flowing river when these products are no more in use. We would need to look at their water solubility as well as used pattern in the neighbouring areas.

Salil Singhal, PI Industries Ltd, Gurgaon, India

It is a matter of great concern that the river has been contaminated with heavy metals and pesticides, as your study has found.

Nidhi Jamwal, Centre for Science and Environment, New Delhi

The report is disturbing. File a PIL with the Apex Court and pray for justice for lakhs of people residing in the river catchment. This is a noble service rendered by your organisation towards the country.

Rakesh Sharma, Freelance Journalist, Mumbai

The findings of the study are alarming and underline the need to take up correctional measures by civil society organisations and other concerned groups and individuals. We are glad that Janhit Foundation has taken up this job and doing it competently.

Rakesh Kumar, Human Development Society, New Delhi

It is very unfortunate that these areas are being polluted to that extent. NGOs and other organizations should take serious steps in rectifying this, the industries near to it should be shut down that are causing these hazards. Farmers nearby should follow natural farming methods in order to solve these problems.

Manoj Teotia, Aques Water Technology, Meerut

It is indeed discouraging that various sources of pollution are relentlessly discharging the discarded wastes into the river. It will be for the benefit of the society that people like you, bring awareness of these anomalies through such evidences.

Nitin Kaushal, Environmentalist, Lucknow

8

Appendices

A Details of sampling locations on the River Hindon and tributaries

B Surface water quality assessment; Physical / chemical / biochemical parameters

C Surface water quality assessment; Macroinvertebrate biological monitoring

D Surface water quality assessment; Heavy metal concentrations

E Surface water quality assessment; Pesticide concentrations

F Groundwater quality assessment; Heavy metal concentrations

G Groundwater quality assessment; Pesticide concentrations

H Health Survey results

I List of major industries discharging to the Hindon River and tributaries.

APPENDIX A
Details of sampling locations on the River Hindon and tributaries

Sample no.	Sample Code	Detail of sampling locations
A	**River Kali (West)**	
1	KS - 1	50 meters U/S of bridge on road, Manglor to Deoband, near villages Chandrapur and Meerkhur
2	KS - 2	200 meters U/S of bridge on road, Saharanpur to Muzaffarnagar, near village Maleera
3	KS - 3	D/S of Muzaffarnagar at Tabalshahpeer
4	KS - 4	D/S of village Pithlokar, before about 500 meters from confluence with river Hindon
B	**River Krishni**	
5	KrS -5	D/S of Nanauta industries at village Bhanera Khemchand, Distt. Saharanpur
6	KrS –6	D/S of village Salfa- Jhal near Banat, Distt. Muzaffarnagar
7	KrS- 7	D/S of village Bhoodpur Distt. Baghpat, after confluence of Ramala sugar mill effluent
8	KrS- 8	Before confluence with river Hindon,D/S of village Barnawa, Distt. Baghpat
C	**River Hindon**	
9	HS – 9	D/S of out fall of Star paper mill, U/S of Saharanpur
10	HS -10	River Dhamola, before confluence with river Hindon, D/S of Saharnpur near village Sarakthal
11	HS–11	U/S of bridge on road from Budhakhera to Kashipur, about 2 Km D/S of confluence of River Dhamola
12	HS-12	About 200 meters U/S of out fall of Titavi sugar mill
13	HS-13	About 200 meters D/S of out fall of Titavi sugar mill
14	HS-14	U/S of bridge on road Baraut to Muzaffarnagar near Budhana town
15	HS-15	About 200 meters D/S of out fall of Bajaj sugar mill at village Bhaisana (Budhana), Muzaffarnagar
16	HS-16	300 D/S of confluence of River Kali (West)
17	HS-17	D/S of out fall of Paper mill at Sardhana, near village Kaleena
18	HS-18	D/S of out fall of sugar mill at village Kinauni, after confluence of Krishni River
19	HS-19	D/S of Baleni bridge on road from Meerut to Baghpat, 2 km D/S of confluence of Sub canal of Upper Ganga canal
20	HS-20	U/S of Hindon barrage at Mohannagar, Ghaziabad
21	HS-21	D/S of Greater Noida near village Momnathal, before confluence with river Yamuna
22	YS-.22	River Yamuna, after confluence of river Hindon, near village Tilwara

APPENDIX B

Surface water quality assessment; Physical/chemical/biochemical parameters

Sample no.	Sample code	Parameter						
		Trans-parency (cm.)	pH	EC (µmhos)	DO(mg/l)	BOD (mg/l)	COD (mg/l)	Cl (mg/l)
A	**River Kali (West)**							
1	KS- 1	45, top to bottom	8.9	482	13.6	3.2	-	12
2	KS- 2	45, top to bottom	8.4	490	13.6	6.8	-	12
3	KS- 3	20	8.6	520	2.4	14.0	-	27
4	KS- 4	15	7.8	798	Nil	320	-	60
B	**River Krishni**							
5	KrS- 5	Nil	4.8	8290	Nil	>9600	20800	-
6	KrS- 6	Nil	7.3	2365	Nil	1120	1600	250
7	KrS-7	Nil	7.5	2115	Nil	1200	-	190
8	KrS-8	10	7.9	1556	Nil	800	-	150
C	**River Hindon**							
9	HS- 9	Nil	7.2	2525	Nil	-	680	535
10	HS- 10	5	7.0	1088	Nil	3600	-	90
11	HS- 11	5	7.0	1560	Nil	2000	-	270
12	HS- 12	29	8.5	936	4.0	6	-	98
13	HS- 13	23	7.8	944	2.8	120	-	93
14	HS- 14	35	8.6	972	3.2	20	-	85
15	HS- 15	20	8.5	1082	0.8	240	-	97
16	HS- 16	15	7.7	800	Nil	290	-	52
17	HS- 17	10	7.4	878	Nil	-	540	75
18	HS- 18	14	7.8	953	Nil	640	-	90
19	HS- 19	28	8.0	432	2.0	88	-	23
20	HS- 20	25	8.2	430	2.4	18	-	22
21	HS- 21	15	8.5	1590	2.8	140	-	130
22	YS- 22	15	8.0	1683	Nil	320	-	140

(-) Not analysed

APPENDIX C
Surface water quality assessment; Macroinvertebrate biological monitoring

Sample no	Name of the species and family and Biomonitoring feature	Sampling site				
		KS-1	KS-3	HS-12	HS-13	HS-20
1	Gompheade	8	-	-	-	-
2	Thiaridae	79	-	-	-	-
3	Sphaeridae	6	-	-	-	-
4	Unionidae	1	-	-	-	-
5	Nereidae	5	-	-	-	-
6	Planorbidae	3	-	-	-	-
7	Chironomidae	30	12	20	15	-
8	Oligocheta	4	36	45	55	4
9	Total no. of species	136	48	65	70	4
10	SCI	**0.51**	**0.21**	**0.22**	**0.2**	**0**
11	**BMWP**	4.375	1.5	1.5	1.5	1
12	BMWP Water quality class	C	E	E	E	E

(-) Species not present.

APPENDIX D
Surface water quality assessment; Heavy metal concentrations

Sample no.	Sample code	Concentration of Heavy Metals (mg/l)		
		Lead	Chromium	Cadmium
A	**River Kali (West)**			
1	KS-1	BDL	1.88	BDL
2	KS-2	0.36	3.02	BDL
3	KS-3	0.70	2.83	0.002
4	KS-4	1.12	5.80	0.003
B	**River Krishni**			
5	KrS-5	0.12	3.50	0.005
6	KrS-6	0.16	3.25	0.002
7	KrS-7	0.14	4.58	BDL
8	KrS-8	0.04	4.38	0.047
C	**River Hindon**			
9	HS-9	0.34	1.84	BDL
10	HS-10	1.79	4.15	0.017
11	HS-11	1.50	3.17	BDL
12	HS-12	0.21	5.72	0.013
13	HS-13	0.28	6.64	0.012
14	HS-14	BDL	9.43	BDL
15	HS-15	0.04	12.25	BDL
16	HS-16	0.92	5.65	BDL
17	HS-17	0.153	4.84	0.005
18	HS-18	0.304	2.80	0.011
19	HS-19	BDL	3.02	0.001
20	HS-20	0.145	4.53	0.016
21	HS-21	0.10	3.643	0.002
22	YS-22	1.12	6.78	0.014

BDL: Below Detectable limit

APPENDIX E

Surface water quality assessment; Pesticide concentrations, μg/l

Sample no.	Sample Code	Endo-sulfan II	α-BHC	β-BHC	γ-BHC	Hepta-chlor	Hepta-chlor Epoxide	Fipronil	Endo-sulfan I	Aldrin	δ - BHC	Endo sul-phate
A	**River Kali (West)**											
1	KS-1	-	-	2.9	-	0.45	-	-	-	-	2.39	-
2	KS-2	-	-	-	-	-	-	-	-	-	1.98	-
3	KS-3	-	1.85	2.8	-	-	-	-	-	-	-	-
4	KS-4	-	-	-	-	-	-	1.32	-	-	3.9	-
B	**River Krishni**											
5	KrS-5	-	-	-	-	0.94	1.44	0.39	-	0.44	2.36	-
6	KrS-6	-	-	-	-	2.3	3.82	1.46	-	1.3	-	-
7	KrS-7	-	-	-	-	-	-	0.47	-	-	-	-
8	KrS-8	-	3.3	-	-	-	0.62	1.57	-	-	-	-
C	**River Hindon**											
9	HS-9	-	-	-	-	0.65	-	0.28	-	-	0.67	-
10	HS-10	-		3.20	-	-	2.82	1.4	-	3.36		-
11	HS-11	-		2.24	-	0.34	0.4	-	-	-	1.6	-
12	HS-12	-	0.98	2.24	-	-	0.35	-	-	0.57	3.7	
13	HS-13	-	-	0.96	-	0.42	2.6	0.76	-	2.9	2.02	0.26
14	HS-14	-	-	-	-	-	-		-	-	-	-
15	HS-15	-	-	-	0.67	1.8	-	1.6	1.4	2.46	5.7	-
16	HS-16	-	-	-	-	-	1.1	1.7	-	-	-	-
17	HS-17	-	-	-	-	-	0.34		-	-	-	-
18	HS-18	-	-	-	-	0.86	0.66	0.82	-	-	1.2	
19	HS-19	-	-	2.10	-	-	-	-	-	-	-	0.75
20	HS-20	-	-	1.32	-	-	-	-	-	-	-	1.00
21	HS-21	-	0.52	-	-	-	0.32	-	-	0.32	-	-
22	YS-22	0.122	5.05	-	-	1.2	-	0.22	-	-	-	-

(-) Not analysed.

APPENDIX F
Groundwater quality assessment; Heavy metal concentrations

Heavy Metals (Lead, Cadmium and Chromium) detected in water samples collected from villages located on the banks of Hindon River in Western U.P.

Sample	Site	Chromium (ppb)	Cadmium (ppb)	Lead (ppb)
Water 1	Village Barnawa (Private Handpump)	8.93	ND	10.32
Water 2	Village Barnawa (Private Handpump)	10.35	0.13	40.85
Water 3	Arthala (Private Handpump)	5.98	ND	17.07
Water 4	Arthala (Private Handpump)	6.09	0.28	35.78
Water 5	New Hindon Colony (Private Handpump)	6.84	0.09	16.97
Water 6	Village Safipur (Private Handpump)	6.29	0.08	24.50
Water 7	Village Momnathal (Private Handpump)	6.89	ND	11.33
Water 8	Village Chandenamal (India Mark II Handpump)	13.07	0.13	341.66
Water 9	Village Chandenamal (India Mark II Handpump)	6.66	ND	16.48
Water 10	Village Bhanera Khemchand (Private Handpump)	6.74	.31	45.36
Water 11	Village Bhanera Khemchand (Private Handpump)	5.91	ND	8.87
Water 12	Village Simlana (Private Handpump)	5.59	ND	16.29

Note: ND = Not detected

Comments:

- Heavy Metals were analysed as per EPA methodology
- Lead and Chromium were detected in all the 12-water samples.
- Lead is within permissible limit of 50 ppb in 11 samples as per Drinking water specifications IS:10500:1991. In water sample 8 from village Chandenamal, Lead is 6.8 times the permissible value.
- Chromium is within limit of 50 ppb as per Drinking water specifications IS:10500:1991 in all the 12 samples tested.
- Cadmium was detected in 6 samples only and is within limit of 10 ppb as per Drinking water specifications IS:10500:1991.

Disclaimer:

Analysis was done by using standard methodology by Environment Protection Agency (EPA) for multiple pesticide residue analysis.

APPENDIX G
Groundwater quality assessment; Pesticide concentrations

Analytical test results for the water sample

Details of the sample

1. Standard Scan for pesticides :

   Organochlorines : α, β, γ, δ HCH, Heptachlor, DDD, DDT, DDE, Dieldrin, Aldrin, α- endosulfan, β-endosulfan, endosulfan sulfate

   Organophosphorus : DDVP, Acephate, Monocrotofos, Phorate, Dimethoate, Ethion, Malathion, Chlorpyrifos, Quinalfos, Phenthoate, Profenofos, Fentrothion, Diazinon, Fenthion

2. Pesticides detected in Water samples collected from villages located on the banks of Hindon River in Western UP

			Concentration (μg/ml or ppm)								
	Sample	**Site**	**Lindane**	**δ HCH**	**Total HCH**	**α endo-sulfan**	**β endo-sulfan**	**Total endo-sulfan**	**Chlor-pyrifos**	**Total pesti-cides**	**No of time the BIS limit for total pesti-cides**
1.	Water 1	Village Barnawa (Private Handpump)	0.0022	0	0.0022	0.00009	0	0.00009	0.00050	0.00279	2.79
2.	Water 2	Village Barnawa (Private Handpump)	0.0017	0.0001	0.0018	0	0.00006	0.00006	0.00006	0.00192	1.92
3	Water 3	Village Arthala (Private Handpump)	0.0006	0.0007	0.0013	0	0.0002	0.0002	0.00016	0.00166	1.66
4	Water 4	Village Arthala (Private Handpump)	0.0004	0.0003	0.0007	0	0.0001	0.0001	0.00010	0.0009	0.9
5.	Water 5	New Hindon Colony (Private Handpump)	0.0003	0.0007	0.001	0.00004	0.0003	0.00034	0.00007	0.00141	1.41
6.	Water 6	Village Safipur (Private Handpump)	0.0005	0.0006	0.0011	0	0.0003	0.0003	0	0.0014	1.4
7.	Water 7	Village Momnathal (Private Handpump)	0.0012	0.0005	0.0017	0.00009	0.0002	0.00029	0	0.00199	1.99
8.	Water 8	Village Chandenamal (India Mark II Handpump)	0.001	0.0004	0.0014	0.00005	0.0002	0.00025	0	0.00165	1.65
9.	Water 9	Village Chandenamal (India Mark II Handpump)	0.0011	0.0003	0.0014	0.00003	0.0001	0.00013	0	0.00153	1.53

10.	Water 10	Village Bhanera Khemchand (Private Handpump)	0.0019	0	0.0019	0.00006	0	0.00006	0	0.00196	1.96
11.	Water 11	Village Bhanera Khemchand (Private Handpump)	0.0028	0.0005	0.0033	0.00008	0.0003	0.00038	0	0.00368	3.68
12.	Water 12	Village Simlana (Private Handpump)	0.0017	0.0001	0.0018	0.00014	0.0004	0.00054	0	0.00234	2.34

Note:

1. ND-Not detected
2. Desirable limit for drinking water as per IS 10500 :1991 first revision for total pesticide is absent and in the absence of any other source is 0.001 mg/L

Comments :

- Pesticide residues were analysed as per EPA methodology.
- Among 13 organochlorines tested γ-HCH, δ-HCH, α-endosulfan and β-endosulfan were detected in almost all the water samples collected from villages located on the banks of Hindon River in Western UP.
- Lindane (γ-Hexachlorocyclohexane), a potent carcinogen was detected in 100% of the samples analysed in the range of 0.0003-0.0028 mg/L.
- Among 14 organophosphorus pesticides analysed only chlorpyrifos, a suspected neuroterratogen was detected in five samples out of 12 samples analysed in the range of 0.00006-0.0005 mg/L.
- Total pesticide detected in 12 water samples was 1-4 times higher than the total pesticide limit of 0.001 mg/L for drinking water.

Disclaimer :

Analysis was done by using standard methodology by Environment Protection Agency (EPA) for multiple pesticide residue analysis.

APPENDIX H
Health Survey Results

1. Village: Bhanera Khemchand (Krishni River) District- Saharanpur

Total number of families	209
Total Population	1580
Total number of Males	835
Total number of Females	745
Total number of children of age less than 18 years	659
Total number of people of age more than 60 years	94
Monthly medical expenditure	Rs. 102600

No. of patients suffering from various ailments at present

Cancer	5
Skin related	389
Neurological Disorder	33
Heart related	28
Stomach ailments	278
Others	201
Number of deaths in last five years due to serious ailments	55
Cancer	23
Heart Attack	5
Respiratory Diseases	9
Asthma	4
Paralysis	4
Lungs related	2
Other (T.B., Skin related, Fever etc.)	8
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	111
Total number of families using government handpumps as their drinking water source	98
Total number of families using tubewells as their drinking water source	1
Abandoned handpumps	100

2. Village: Barnawa (Hindon River) District-Baghpat

Total number of families	40
Total Population	341
Total number of Males	175
Total number of Females	166
Total number of children of age less than 18 years	143
Total number of people of age more than 60 years	21
Monthly medical expenditure	Rs. 13200

No. of patients suffering from various ailments at present

Cancer	4
Skin related	11
Neurological Disorder	2
Stomach ailments	35
Others	18
Number of deaths in last five years due to serious ailments	18
Cancer	3
Heart Attack	6
Asthma	2
Paralysis	1
Others	6
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	24
Total number of families using government handpumps as their drinking water source	16
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	36

3. Village: Safipur (Hindon River)
District-Gautambudh Nagar

Total number of families	27
Total Population	329
Total number of Males	174
Total number of Females	155
Total number of children of age less than 18 years	120
Total number of people of age more than 60 years	15
Monthly medical expenditure	Rs. 10200

No. of patients suffering from various ailments at present

Cancer	0
Skin related	23
Neurological Disorder	0
Heart related	2
Stomach ailments	19
Others	19
Number of deaths in last five years due to serious ailments	2
Cancer	0
Heart Attack	0
Respiratory Diseases	0
Asthma	0
Paralysis	1
Lungs related	0
Jaundice	1
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	26
Total number of families using government handpumps as their drinking water source	1
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	10

4. Village: Momnathal (Hindon River)
District-Gautambudh Nagar

Total number of families	50
Total Population	370
Total number of Males	174
Total number of Females	196
Total number of children of age less than 18 years	171
Total number of people of age more than 60 years	17
Monthly medical expenditure	Rs. 13850

No. of patients suffering from various ailments at present

Cancer	0
Skin related	80
Neurological Disorder	1
Heart related	3
Stomach ailments	58
Others	31
Number of deaths in last five years due to serious ailments	5
Cancer	1
Heart Attack	1
Respiratory Diseases	0
Asthma	0
Pneumonia	2
Lungs related	0
Jaundice	0
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	48
Total number of families using government handpumps as their drinking water source	2
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	2
Number of families below poverty line	23

5. Village: Simlana (Hindon River)
District-Saharanpur

Total number of families	55
Total Population	489
Total number of Males	269
Total number of Females	220
Total number of children of age less than 18 years	175
Total number of people of age more than 60 years	54
Monthly medical expenditure	Rs. 15800

No. of patients suffering from various ailments at present

Cancer	1
Skin related	18
Neurological Disorder	4
Heart related	1
Stomach ailments	13
Others	32
Number of deaths in last five years due to serious ailments	7
Cancer	1
Heart Attack	1
Respiratory Diseases	0
Asthma	5
Pneumonia	0
Lungs related	0
Jaundice	0
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	14
Total number of families using government handpumps as their drinking water source	41
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	41
Number of families below poverty line	0

6. Village: Chandenamal (Krishni River)
District-Muzaffarnagar

Total number of families	54
Total Population	592
Total number of Males	308
Total number of Females	284
Total number of children of age less than 18 years	217
Total number of people of age more than 60 years	39
Monthly medical expenditure	Rs. 36100

No. of patients suffering from various ailments at present

Cancer	4
Skin related	43
Neurological Disorder	7
Heart related	8
Stomach ailments	26
Others	41
Number of deaths in last five years due to serious ailments	31
Cancer	17
Heart Attack	0
Respiratory Diseases	9
Stomach related	1
Neurological disorder	1
Lungs related	3
Others	0
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	54
Total number of families using government handpumps as their drinking water source	2
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	2

7. Village: Dabal (Kali River West)
District-Muzaffarnagar

Total number of families	39
Total Population	299
Total number of Males	167
Total number of Females	132
Total number of children of age less than 18 years	112
Total number of people of age more than 60 years	26
Monthly medical expenditure	Rs. 15500

No. of patients suffering from various ailments at present

Cancer	2
Skin related	37
Neurological Disorder	3
Heart related	3
Stomach ailments	31
Others	17
Number of deaths in last five years due to serious ailments	6
Cancer	3
Heart Attack	1
Respiratory Diseases	1
Asthma	0
Paralysis	0
Lungs related	1
Other (T.B., Skin related, Fever etc.)	0
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	29
Total number of families using government handpumps as their drinking water source	10
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	10

8. Village: Dakhauri (Krishni River)
District-Muzaffarnagar

Total number of families	18
Total Population	264
Total number of Males	139
Total number of Females	125
Total number of children of age less than 18 years	78
Total number of people of age more than 60 years	25
Monthly medical expenditure	Rs. 5650

No. of patients suffering from various ailments at present

Cancer	0
Skin related	19
Neurological Disorder	1
Heart related	2
Stomach ailments	17
Others	13
Number of deaths in last five years due to serious ailments	2
Cancer	0
Heart Attack	0
Respiratory Diseases	1
Asthma	1
Paralysis	0
Lungs related	1
Other (T.B., Skin related, Fever etc.)	0
Total number of literate females	27
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	16
Total number of families using government handpumps as their drinking water source	2
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	2

9. Village: Arthala (Hindon River)
District-Ghaziabad

Total number of families	47
Total Population	310
Total number of Males	166
Total number of Females	144
Total number of children of age less than 18 years	146
Total number of people of age more than 60 years	19
Monthly medical expenditure	Rs. 15500

No. of patients suffering from various ailments at present

Cancer	0
Skin related	56
Neurological Disorder	1
Heart related	3
Stomach ailments	55
Others	29
Number of deaths in last five years due to serious ailments	3
Cancer	1
Heart Attack	1
Respiratory Diseases	0
Asthma	0
Paralysis	0
Stomach related	1
Other (T.B., Skin related, Fever etc.)	0
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	0
Total number of families using government handpumps as their drinking water source	0
Total number of families using tubewells as their drinking water source	47
Abandoned handpumps	47

10. Village: Makredha (Hindon River)
District-Ghaziabad

Total number of families	28
Total Population	217
Total number of Males	120
Total number of Females	97
Total number of children of age less than 18 years	94
Total number of people of age more than 60 years	17
Monthly medical expenditure	Rs. 12900

No. of patients suffering from various ailments at present

Cancer	1
Skin related	23
Neurological Disorder	0
Heart related	2
Stomach ailments	12
Others	22
Number of deaths in last five years due to serious ailments	2
Cancer	0
Heart Attack	0
Respiratory disease	0
Asthma	0
Throat Infection	1
Skin related	1
Other	0
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	28
Total number of families using government handpumps as their drinking water source	0
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	15

11. Village: Nekpur (Hindon River)
District-Ghaziabad

Total number of families	51
Total Population	459
Total number of Males	234
Total number of Females	225
Total number of children of age less than 18 years	224
Total number of people of age more than 60 years	14
Monthly medical expenditure	Rs. 16700

No. of patients suffering from various ailments at present

Cancer	2
Skin related	91
Neurological Disorder	1
Heart related	7
Stomach ailments	61
Others	13
Number of deaths in last five years due to serious ailments	2
Cancer	2
Heart Attack	0
Respiratory Diseases	0
Asthma	0
Paralysis	0
Lungs related	0
Other (T.B., Skin related, Fever etc.)	0
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	9
Total number of families using government handpumps as their drinking water source	42
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	42

12. Village: Sarfabad (Hindon River)
District-Baghpat

Total number of families	53
Total Population	411
Total number of Males	219
Total number of Females	192
Total number of children of age less than 18 years	183
Total number of people of age more than 60 years	34
Monthly medical expenditure	Rs. 13250

No. of patients suffering from various ailments at present

Cancer	1
Skin related	26
Neurological disorder	2
Heart related	0
Stomach related	6
Other	36
Number of deaths in last five years due to serious ailments	10
Cancer	0
Heart Attack	0
Respiratory disease	5
T.B.	1
Fever	1
Intestinal Problem	1
Liver and skin related	2
Facts related to drinking water	
Total number of families using private handpumps as their drinking water source	0
Total number of families using government handpumps as their drinking water source	53
Total number of families using tubewells as their drinking water source	0
Abandoned handpumps	53

APPENDIX I
List of major industries discharging to the Hindon River and tributaries.

Hindon River

District	S.No.	Industries Name
Saharanpur	1.	Star Paper Mills Limited
	2.	Daya Sugar Works
	3.	*Nagar Palika*, Saharanpur
	4.	The Cooperative Company Ltd., Tapri
Muzaffarnagar	5.	Titavi Sugar Mill, Titavi
	6.	Bajaj Hindusthan Limited, Budhana
	7.	*Nagar Palika*, Budhana
Meerut	8.	Kinauni Sugar Mill and Distillery
	9.	Sardhana Paper Mill
	10.	Dollar Sales Corporation, Sardhana
	11.	*Nagar Palika*, Sardhana
Ghaziabad	12.	Ganga Paper Mill, Masoori Road
	13.	Expliti Trading and Marketing, Masoori Road
	14.	Triyesh Enterprises, Masoori Road
	15.	Ved Pulp Tissues Pvt. Ltd., Masoori Road
	16.	Vimal Organic, Bulandshahr Road
	17.	*Nagar Nigam*, Ghaziabad
Gautambudh Nagar	18.	Sandeep Papers, Ph-I, Noida
	19.	Kwatra Paper Mill, Noida
	20.	Tristar Paper Mill, Noida

Kali River (West)

District	S.No.	Industries Name
Saharanpur	1.	Triveni Engineering and Industries Ltd. Deoband
	2.	*Nagar Palika*, Deoband
Muzaffarnagar	3.	*Nagar Palika*, Muzaffarnagar
	4.	U. P. State Sugar Corporation Ltd. Rohana
	5.	Suyas Craft Pvt. Ltd. Behalna
	6.	Shakumbri Pulp and Paper Mills Pvt. Ltd., Bhopa Road
	7.	Agarwal Duplex and Paper Mills Pvt. Ltd. Bhopa Road
	8.	Shri Sidhbali Paper Mills Ltd. Bhopa Road
	9.	Silverton Papers Ltd. Bhopa Road
	10.	Garg Duplex and Paper Mills Pvt. Ltd. Bhopa Road
	11.	Meenu Paper Mills Pvt. Ltd. Bhopa Road
	12.	Bhageshwari Papers Pvt. Ltd. Bhopa Road
	13.	Polymer Papers Ltd. Bhopa Road
	14.	Balaji Selulose Products Ltd. Bhopa Road
	15.	Tihri Pulp and Papers Ltd. Bhopa Road

	16.	Bindlas Duplex Ltd. I, Bhopa Road
	17.	Bindlas Duplex Ltd. II, Bhopa Road
	18.	Parijat Papers Pvt. Ltd. Bhopa Road
	19.	Silverton Pulp and Papers Ltd. Bhopa Road
	20.	Rana Papers Ltd. Jansath Road
	21.	Shalimar Crafts and Tissuse Pvt. Ltd. Bhopa Road
	22.	K. K. Duplex and Paper Mills Pvt. Ltd. Jansath Road
	23.	Sidheswari Industries Pvt. Ltd. Jansath Road
	24.	Keerti Paper, Jansath Road
	25.	Shalimar Paper Mills Pvt. Ltd. Jansath Road
	26.	Mahalaxmi Craft and Tissues Pvt. Ltd. Jansath Road
	27.	Orient Paper and Board Mills Pvt. Ltd. Jansath Road
	28.	H. J. Tannery Pvt. Ltd. Jansath Road
	29.	*Dugdha Utpadak Sehkari Sangh* Ltd. Beghrajpur
	30.	Sirsadilal Distillery and Chemical Works. Mansoorpur
	31.	Mansoorpur Sugar Mills Ltd. Mansoorpur
	32.	Taj Papers Pvt. Ltd. Jolly Road
	33.	Bansal Eco Friendly Papers, Bhopa Road
	34.	Eriston Gramodhyog Sansthan, Meerut Road
	35.	Gulshan Sugars and Chemicals Ltd.
	36.	Alnoor Exports, Jansath Road

Krishni River

District	S.No.	Industries Name
Saharanpur	1.	*Kisan Sehkari* Sugar Mills Ltd. Nanauta
	2.	U. P. Cooperative Sugar Factory Federation Distillery, Nanauta
	3.	Durga Straw Board Factory, Nanauta
	4.	Singh Straw Board Factory, Nanauta
	5.	S. M. C. Foods Ltd. Nanauta
	6.	Bajaj Hindusthan Ltd. Thanabhawan
	7.	Sikka Paper Mills, Sikka
	8.	Maruti Paper Mills, Sikka
	9.	Shamli Paper Mills. Sikka
Muzaffarnagar	10.	Shamli Distillery and Chemical Works, Shamli
	11.	Upper Doab Sugar Mills, Shamli
	12.	Nikita Papers Ltd. Shamli
	13.	Nagar Palika, Shamli
Baghpat	14.	Ramala *Sehkari* Sugar Mills, Ramala