THE EFFECT ON LIFE AND HEALTH OF WASTEWATER DISCHARGED FROM SEWAGE TREATMENT PLANTS

A Case Study of Three Villages in Varanasi District of Uttar Pradesh

Dissertation submitted to the Jawaharlal Nehru University in partial fulfillment of the requirements for the award of the degree of

MASTERS OF PHILOSOPHY

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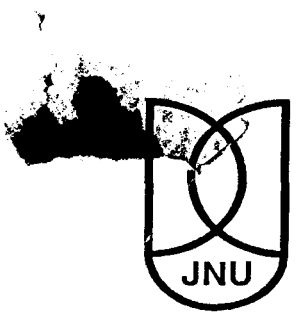

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Certificate

This is to certify that the dissertation entitled ***The Effect on Life and Health of Wastewater Discharged from Sewage Treatment Plants: A Case Study of Three Villages in Varanasi District of Uttar Pradesh*** submitted by Sanjeev Kumar in partial fulfillment of the requirements for the award of the degree of ***Masters in Philosophy*** of this university has not been submitted for any other degree of this university or any other university and is my own work.

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डा० नीति भाई को,

जिन्होंने हर कदम पर
अपने काम को अंतिम आदमी
की निगाह से देखना सिखलाया

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INTRODUCTION

Sewage (waste water) can be regarded as water borne waste products. Sewage contains everything discharged to the sewer including material washed from roads and roofs. When the human race was thinly scattered over the earth and tended to be nomadic, the disposal of waste matter was not at all a serious problem. That time (and even today) nature was able to break down small concentrations of waste matter into harmless end products. Difficulties arose when man started to congregate in large communities such as metropolis cities.

Last century witnessed the transferring of filth from the streets, industries and houses to the rivers and streams.

During the Industrial Revolution in 18th Century, England underwent a dramatic change in technology of production. Technological changes included the use of iron and steel, new energy sources, invention of new machines that increased production (including the spinning jenny), development of the factory system, and important developments in transportation and communication (including the steam engine and telegraph). There was capital investment in terms of heavy machineries for new production-units called factories. Production had become centralized and it was totally different from earlier home-based small-scale units. Therefore to recover the investment, demand of skilled labor had come up, and drought and epidemics in rural Europe had fulfilled this demand.

In the beginning of industrial revolution, workers houses were situated around the industries in an ad hoc or unplanned manner. Most of the workers were migrants and long working hour (16-20 hour in a day) compelled them to live in unhygienic and unpleasant living conditions and led to increasing growth of squatters and slums. The workers made demands for better living conditions as well as to mitigate epidemics like typhoid and cholera and enlightened self interest led to the initiation of various measures like 'Public Health Act' and 'Sanitary Reforms' in late 19th century.

During colonial era, same thing occurred in India. Natural disasters, damage of local handlooms, division of country forced rural migration to cities. After independence,

more availability of economic, educational and health services in cities increased the processes of urbanization. Sewage of entire city falling into the river at a single or multiple places may have occurred in the earlier time but the scale at which this occurs now is a cause of grave concern.

Today in 21st Century, when urbanization has come up as an essential and special feature of civilization and industrialization has been strengthened, environmental degradation has become a serious problem. Today a large amount of untreated industrial wastewater and domestic sewage generated in cities is directly or indirectly to the rivers and polluting it. To solve this critical problem we need to have some strong actions, stringent measures and pro- people strategies.

Nature of Domestic sewage water

Sewage water is a complex mixture of natural inorganic and organic material mixed with man-made substances. Sewage contains 99.9 percent of water and barely 0.1 percent is partly organic and partly inorganic.[1]

Most domestic sewage has a high content of organic fecal matter, a high content of microbial load, a high percentage of organic vegetable material from garbage disposal and cellulose, chemicals such as soaps, detergents and other household wastes. Domestic sewage consists of 99.9 percent water coming from washing, rinsing, flushing and other activities.[2]

In its broadest sense, wastewater can be split into domestic wastewater (sewage water) and industrial wastewater. Domestic wastewater also contains industrial waste because of non-specific location of industries (small scale) and their discharges. Therefore, we can say that municipal waste is a mixture of the above two.

Problems Caused by River Water Pollution

A river becomes polluted when the water in it is altered in composition or condition, directly or indirectly as a result of the activities of man so that it is less suitable for any or all of the purposes of which it would be suitable in its natural state. Some other

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[1] Bolton, R. L. and Klein, L., *Sewage Treatment: Basic Principals And Trends*, London, Butterworths Publication, 1971, p. 9.
[2] Ibid.

agents other than sewage causing pollution are inorganic salts (originating from industry), mineral oils and radioactive wastes.

As discussed above, with the rapid increase in urbanization and number of cities in India, condition of public services in cities has become worse. Today more then one-third of our population is living in cities. Local bodies have found the easier way for discharging sewage water by bypassing it into the streams without any treatment by which domestic sewage water (wastewater) has become a major source of river water pollution. Though the water treatment work is being done in some cities, they have not been able to do it properly.

The Effects of Sewage Water on the River

Sewage water affects the river by any of the three ways mentioned.

- Its adds intestinal bacteria which have to be inhibited or screened out if the water is be consumed for domestic purposes otherwise disease like cholera, dysentery, staphylococcal infection, infectious hepatitis and some other forms of vector-born disease can spread in the community.
- It may add toxic residue, and this is especially so, if it is in combination with industrial effluents including detergents, which causes the river to foam.
- Sewage contributes organic matter, which stimulates growth of organisms that may use up the entire dissolved oxygen available in water body.[3]

Wastes from distilleries, dairies, tanneries, refineries, paper mills, fertilizer and sugar industries cause serious damage to the water quality of the river. Such wastes are strong enough to exhaust the oxygen content of streams even when present in smaller volumes. Due to river pollution, fish and other living creatures in water are killed.

This critical situation warrants immediate measures to provide proper means of sewage disposal, or else it will lead to a number of environmental problems like, unsightliness and unpleasant odour, breading of flies and mosquitoes, pollution of soil and water supplies, contamination of food, increase in the incidence of disease, especially enteric and helminth diseases in different sewage connected areas.

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[3] Manivasakam, N, *Environmental Pollution*, New Delhi, National Book Trust, 1984, pp. 36-53.

Varanasi City and the Ganga River

The River Ganga is a lifeline for millions of people in India. Through the ages it has had a major impact on the culture, civilization, health and well being of the largest concentration of population in South Asia. But with the ever-increasing density of population, with increasing industrialization intensifying agricultural practices and ever increasing demands for irrigation, the Ganga basin is facing environmental problems of unprecedented magnitude. It is being used for disposal of effluents from domestic and industrial sources, which has caused great damage to its water quality. According to one estimate the total urban domestic and industrial wastes generated in the Ganga basin carry about 2000 tons of biological oxygen demands (BOD) per day for final disposal either on land or in surface water. Each year about 1,15,000 tones of fertilizer are washed away with agricultural wastewater into the Ganga including 88,600 tons of nitrogen, 17000 tons of phosphorous and 9,200 tons of potassium.[4]

The holy city of Varanasi also adds its unholy pollution to the river Ganga. The initial settlement of Varanasi city was restricted to the area around the *ghats* on the left bank of the Ganga and the cause was ritual and religious practices on the *ghats*. After independence, city was expanded gradually towards the Varuna River in the north and Assi River in the south. Today, in the *Nagar Nigam* (municipal body) limits of the city spreading over an area of about 70 sq. km, boasts a population of about 1.5 million and, it hosts a floating population (comprising tourists) of around two lakhs of people every day. More than 60,000 pilgrims take a dip in the river daily. In Varanasi, about 40,000 bodies are cremated in just two *Ghats* of the city every year, generating 15,000 tons of ash per month.[5] Several corpses are dropped straightaway into the river. Approximately one-lakh cattle (mostly cows and buffaloes) also live in the city, contributing further to the pollution load on the river Ganga.[6] This is also another factor of pollution in the Ganga.

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[4] De Kumar, Anil : "Environment Chemistry," New Age International, New Delhi, 2002, p 279-289
[5] Ritu, Gupta " Rite? Wrong," *Down To Earth*, June 15, 2004, p. 50
[6] Ibid.

Sewage Water Treatment and Impact of Partially Treated Wastewater on Agriculture and People's Life

At present numbers of sewage treatment plants (STP) have been established in cities to reduce pollution load from the rivers. Modern sewage treatment plants are based on biological principles of purification, where the purification is brought about by the action of anaerobic and aerobic bacteria.

The treatment of sewage may be divided into two stages, primary treatment and secondary treatment. In primary treatment, the solids are separated from the sewage partly by screening and partly by sedimentation and subjected to anaerobic digestion, which is the first stage in purification; in secondary treatment, the effluent is subjected to aerobic oxidation, which is the second stage in purification. A brief procedure of sewage treatment is discussed in appendix.

Today partially treated sewage water has been seen as a contemporary option to combat water shortages. The perception is that, reuse of sewage water for farming will conserve the fresh water resources and it is also seen as a low cost method for sanitary disposal of municipal wastewater.

But there are several negative effects interlinked with sewage water farming. In some cases, sewage water irrigation increases crops yield but vegetables grown by sewage water contain abnormal proportion of toxic elements that are injurious to health. Increase in toxic element may lead to several health hazards like damage of nervous, endocrine and reproductive systems and particularly to the development of abnormalities in children.[7]

Other than these health problems, wastewater in sewage water farming can reach ground water level and there is always a possibility of ground water contamination. Agricultural land turns into saline land because of high amount of salts and of detergents in treated sewage water. Sewage water irrigation and sludge drying beds (open) of the treatment plant work as breeding ground of mosquitoes and flies. Malaria, skin diseases and gastric problems are found in such areas through out the year.

[7] *The Times of India*, March 27, 2003

SCOPE OF THE PRESENT STUDY

In this study investigator is examining a part of a Government programme, Ganga Action Plan (GAP), which was launched in June 1986 in Varanasi to improve water quality of the river Ganga by using multi-pronged strategy. In beginning this plan was considered as the "people's plan". But unfortunately in this plan, people were least considered. At present, the first phase of Ganga Action Plan has finished its work. In this phase, Ganga Action Plan achieved only 39 percent of its primary target.

In this study investigator is analyzing the problems in achieving the targets to clean up the Ganga River and problems in the Ganga Action Plan. One of the major steps taken in the first Phase was establishment of Sewage Treatment Plants in 27 class- I cities near the River Ganga. However, these STPs are playing a major role in reducing pollution load from the Ganga River on one hand and on the other, they are creating problems in the areas that are receiving partially treated sewage water.

Today villages near these Sewage Treatment Plants that receive wastewater are facing numerous environmental and health problems. Thus the usefulness and efficiency of these treatment plants have been put to question. Everywhere we are talking about good health and healthy environment, and it is a matter of great concern to what extent the Ganga Action Plan is beneficial for these wastewater-receiving villages. Most of the studies done on Ganga Action Plan or efficiency of Sewage Treatment Plants are basically environmental in nature. They mainly talk about the different elements of nature like soil, water quality and vegetation but not on human beings and their socioeconomic life. Therefore this study is an attempt to discuss the problems caused by Sewage Treatment Plant and River pollution from social and public health aspects.

CHAPTERISATION

This study is divided into 8 chapters. The introductory Chapter 1 contains the problem statement and the explanation of chapterization.

Chapter 2 is designed to review the literature on the impact of Sewage water reuse and farming. It also looks at the history of establishment of municipal board in Varanasi. The main review of literature is to analyze the effect of sewage water and Sewage

Treatment Plants (STP) on life of the exposed population of wastewater receiving area. The review looks at the Ganga Action Plan (GAP) because Sewage Treatment Plants of the city was constructed in Ganga Action Plan. Objectives of the Ganga Action Plan, work done in Varanasi under GAP, problems with proper functioning of Sewage Treatment Plant have been reviewed. This chapter also uses the global experiences of sewage water farming and suggestions recommended from those studies.

Chapter 3 is the conceptualization and methodology of the study. The conceptual base of the study is formed on the basis of the literature review. The chapter explains the various dimensions of the problem, the rationale behind the selection of the problem and the objectives of the study. As review of the study area is given in the chapter. It also discusses the procedure of the sampling methodology as well as the tools for data collection. The limitations of the study etc are also explained in this chapter.

Chapter 4 portrays in detail the study area (three villages near the Sewage Treatment Plant). It explains the location of the research area, ecological and major economic activities of the area and some other specific characteristics.

Chapter 5 deals with the 121 households selected for the study. The socioeconomic conditions, occupation caste distribution of the households are analyzed in this section. This helps in developing an understanding of the characteristics of livelihood in those areas, which suffer more due to Sewage Treatment Plant (STP) and the canal.

Chapter 6 deals with availability of safe drinking water for the villagers, health problems due to Sewage Treatment Plants and the canal and lastly, it also looks at the availability and accessibility of health services in the area.

Chapter 7 chapter examines the effects of sewage water (canal) farming on different aspects and socioeconomic problems emerged due to the canal. It also examines the common people's participation involved in building the STP and canal.

Chapter 8 is the concluding chapter and it summarizes the findings of the study within public health dimensions.

CHAPTER II

REVIEW OF LITERATURE

INTRODUCTION

In this chapter we have reviewed studies on whether to use sewage water for agriculture purposes or not. Also evaluation of the Dinapur Sewage Treatment plant by different agencies has been reviewed. An attempt is made to locate in literature the village level situation, in the context of a value- based question, that is the comparison of the economic dimensions of sewage water farming to human health.

The literature reviewed for this study also includes the brief history of establishment of municipal board in Varanasi city as well as Ganga Action Plan (GAP), its objectives, achievements and problems.

Establishment of Municipal Board in Varanasi

In the Pre Mugal Period only storm water flowed into *Ganga* during 75 days of rainy season through five open channels.[1] These channels joined between the upstream and down stream ends of the city, where the two smaller rivers *Assi* and *Varuna* respectively flowed into the *Ganga*. In 1970 during the Mugal period, a large storm water drain was constructed to supplement these channels.

Before the creation of Varanasi Municipal Board by Britishers in the year 1866, there were no toilets in Varanasi. Public toilets were built in Varanasi for the pilgrims in 1860.[2] The first attempt at drainage on modern scientific lines was undertaken at '*Dasashwamedh Ghat*'. A Sewer passing through the entire old city of Varanasi was constructed in 1899 discharging down stream at Rajghat the other end of the city.

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[1] Study Report, civic societies and urban environment advocacy, Development associates Lucknow. December 1995.
[2] Ibid.

This beginning of the pollution of Ganga by sewage is most closely linked to the culture of flush toilets and sewerage system, which began to spread after 1917. The city has now 325 km of sewerage pipeline with a breadth of 150 mm to 2400 mm and it covers near about 50 percent of the area of the city.[3] A big part of trans Varuna Region of city has no sewage facility still.

However, since the early 20th century, the pollution load of Ganga at Varanasi has steadily increased. The city has been producing about 230 million-liter of sewage water per day.[4] But capacity for the treatment of wastewater in the city is only 102 million-liter per day. Therefore surplus wastewater falls into the Ganga River after the 'Pretreatment Procedure'. The pollution of Ganga at Varanasi due to sewage disposal has been over 85 percent of the total pollution discharged by the city into the river.[5] Cremation of large number of dead bodies (about 40,000 annually) and disposal of human and animal carcasses in the river is also a big problem for polluting the Ganga River. At present the city accounts about 23 percent of the total pollution load on this river.[6]

Ganga Action Plan (GAP)

The Ganga Action Plan was launched by late Prime Minister Sri Rajeev Gandhi on 14 June 1986 in Varanasi.[7] This plan had been prepared on the basis of survey done by Central Pollution Control Board in 1982-83, on the town wise pollution load and industrial pollution load on the river Ganga. This report formed the basis of an action plan for the prevention of pollution of Ganga and was prepared by the Department of Environment in December 1984. The main objective of Ganga Action plan was to improve the water quality of river Ganga using multi–pronged strategy financed with 100 percent Central assistance.

This Action plan envisaged interception and diversion of wastewater reaching the Ganga and installation of Sewage Treatment Plant for its treatment. It also included other pollution control activities such as solid waste management, installation of crematoria, river front development and provision of low cost sanitation facilities.

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[3] *Annual Report*, Ganga Pollution Unit, UP Jal Nigam, 2003

[4] Ibid.

[5] Study report, civic societies and urban environment advocacy, Development associates Lucknow. December 1995.

[6] Ibid.

[7] Ministry of Environment and Forest, National River Conservation Directorate, Documents 2002.

In phase - I, 25 class–one towns were to be covered under this.[8] An apex body, namely Central Ganga Authority, was set up under the Chairmanship of the Prime Minister to cover the implementation and to coordinate the efforts of the various agencies involved at the central and state levels. A steering committee under the chairmanship of secretary, Ministry of environment and forest was constituted to consider the approval of schemes, annual allocation of funds and review of progress of implementation of schemes.

A monitoring committee was also constituted to monitor progress of implementation of scheme. Ganga project directorate was set up in June 1985 as a part of ministry of environment and forests to service the steering committee, the monitoring committee and the central Ganga authority and to help coordinate the implementation of Ganga Action Plan.

Objectives of Ganga Action Plan-

1. Renovation [cleaning/desilting / repairing] of existing trunk sewers and out falls to prevent the overflow of sewage into the Ganga.
2. Construction of interceptor to divert the flow of sewage and other liquid wastes away from the Ganga.
3. Renovation of existing sewage pumping stations and sewage treatment plants, construction of new sewage treatment plants to recover the maximum possible resources, especially energy to operate the pumping and treatment plants, and derive the maximum possible revenue to cover at least the operation and maintenance cost of these plants.
4. Arrangements for bringing human and animal wastes from locations proximate to the sewage /sludge digesters for sanitary disposal and production on energy and manure.
5. Providing sludge or sewage pumping stations at the out fall points of open drains to divert the discharge going into the river into the nearest sewers and treatment plants.
6. Alternative arrangements to prevent discharge of animal waste from cattle sheds located on the riverbanks.

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[8] List of the 25 class 1 towns under GAP phase 1,**Uttar pradesh:** (1) Hardwar- Rishikesh, (2) Flbad and Fathehgarh, (3) Allahbad, (4) Kanpur, (5) Varanasi, (6) Mirzapur. **Bihar:** (7) Chapara, (8) Bhagalpur, (9) Munger, (10) Patna. **West Bengal:** (11) Bahrampore, (12) Nawdwip, (13) Hugli Chinsura, (14) Chandan Nagar, (15) Serampore, (16) Bally (17) Kalyani, (18) Bhatpara, (19) Titagarh, (20) Panihati, (21) Howrah, (22) Calcutta CorpN.Area, (23) Baranagar, (24) Kamarhati, (25) Naihati.

7. Low cost sanitation schemes in area adjoining the river to reduce or prevent the flow of human wastes into the river.
8. Biological conservation measures based on proven techniques for purification of streams.
9. Pilot projects to established cost effective system for diversion of wastes now flowing into the river, their treatment and resource recovery.
10. Pilot projects to establish feasibility of technology application in the treatment of wastes and resource /energy recovery.

Components of Ganga Action Plan

The Ganga Action plan was launched nation–wide, to cover almost all cities and towns along the Ganga starting from Rishikesh to Ulberia in West Bengal. Pollution abatement works under this plan have been taken up in 25 class 1 towns [population above 1 lakh in 1985] of which six are in U.P., 4 in Bihar and 15 in West Bengal. The action plan primarily addressed itself to accomplish this task, 261 schemes of pollution abatement concerning municipal activities have been sanctioned under the GAP. These include 88 schemes of interception and diversion, 35 of sewage treatment plants (STP), 43 of low cost toilets, 28 of electric crematoria, 35 of river front development and another 32 of miscellaneous category. So far, 259 schemes have been initiated.[9]

The remaining two schemes of STP's are in Bihar. Meanwhile, GAP phase-1 scheme has been closed as of 1- 4-2004. All the functioning STP put together have a sewage treatment capacity of 865 MLD created under the programme so far.[10]

Presently the GAP is in its second phase. The second phase was launched in 1998. In the first phase, budget was 462.04 crore. In that phase, central government got Rs. 33.04 crore from the World Bank and Rs 47.32 crore from the Government of the Netherlands.[11] On state level, the entire funding has been provided by the central government.

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[9] *Annual Report 1990-2000*, Ministry of Environment and Forest, Government of India.
[10] In 13 towns of U.P, 7 in Bihar, and 15 in West Bengal.
[11] National River Conservation Directorate- *http://envfor.nic.in/*

In phase-1 GAP achieved only 39 percent of its primary target.[12] To improve its achievements a comprehensive evaluation of GAP was concluded in April 1995. The evaluation of the Ganga Action plan phase –1 was done by experts from the Roorkee University, Aligarh Muslim University, IIT Kanpur and All- India Institute of Hygiene and Public Health Calcutta. The evaluation concluded that the reduction of discharge of organic matter a necessary first step in restoring the water quality –has been achieved to fair level and the GAP as conceived and implemented is an appropriate programme for replication in other river basins also. However they also said that the other component of the target has not been met.

It further recommends appropriate intervention to reduce the microbial pollution of the river, rigorous qualitative and quantitative characterization of the sewage for adopting the most appropriate technology of treatment completed with resource recovery from the treated wastewater. The findings have been incorporated in the proposals of Ganga Action Plan (GAP) Phase-2 and National River Conservation Plan, which have been approved by the cabinet committee on economic affairs.

The Main Activities of the Plan

1. **Interception and diversion schemes-** These schemes implement the main component of the Action plan. There is construction of trunk sewers and renovation when needed. Diversion of the flow of sewer water to the small pumping station and further from their to main pumping stations (In case, the pumping stations are non-functional, renovating or construction of new pumping stations in order to ensure the proper diversion system.). Interception of the open drains taking the sewer water to the river and diversion of their flow to the pumping stations through new sewer system (in case of existing, renovation of the sewer system). These schemes for the interception and diversion of the sewer water are given relatively more weightage because sewage is considered to be the major source of pollution.

The total number of schemes for interception and diversion under Ganga Action Plan are 88. Out of which 40 are in Uttar Pradesh. 17 in Bihar and 31 in West Bengal .The major works undertaken under these schemes are laying sewers, installation of small

[12] Ibid

pumping station and main pumping stations, construction of the infrastructure for interception and diversion of sewage water (renovation in case it is existing).

2. **Sewage treatment plants-** The schemes of sewage treatment plants are aimed at implementing the components of the action which specify the disposal of sewage with feasible prospects of production of energy and manure. The scheme also incorporates the renovation of the existing treatment plants which discharge effluents into the river but are unable to recover the energy and manure. The sewage treatment plants aim to treat the sewage water [after few processes through aeration and filtration, the sludge is separated and taken to digester], and to separate sludge, which produces gas when taken to digester. The sludge flows into the sludge drying bed and is later used as manure. While the treated water is used in agriculture fields for irrigation propose. The scheme of sewage treatment plants under Ganga Action Plan has been assigned a major role in reduction of pollution load.

3. **Renovation and Augmentation** of capacity is also a component of scheme under sewage treatment plants. The constructed sewage treatment plants are based on the established aerobic treatment techniques including activated sludge trickling filters etc. But in a few locations in the state of U.P, the new techniques of sewage treatment plants such as 'Up-Flow Anaerobic Sludge Blanket'(UASB) treatment technology is being used, in Jajmau, near Kanpur and Mirzapur as part of the 'Indo- Dutch Integral Sanitation Project'. As stated above the renovation and capacity augmentation of STP's also falls under this head of scheme.

4. **Low cost sanitation-** As the sewage networks is not extensive in many towns; the numerous schemes of low cost sanitation facilities involving construction of public toilet complexes. Construction of new pour flush latrines and conversion of dry latrines specifically on the riverbanks in almost all locations are taken up under the Ganga Action Plan. These schemes aim to provide the people with an alternative location for defecation, instead of river Ghats and its direct flowing into the river water.

5. **Electric Crematorium-**In order to prevent the throwing of dead bodies into the river, construction of electric crematorium has been given a special place among the schemes under Ganga Action Plan.

6. **River front facilities-** Under the Ganga Action Plan schemes have been taken up at certain locations for the development of the river front area for preventing the pollution of the

river. These relate to river front development, protection of slopes of Ghats, construction of the Ghats [including beautification] construction of the community toilets, improvement of lanes and by-lanes, provision of street lighting etc.

7. **Other schemes**- Other schemes include construction of cattle sheds, bio-monitoring of the water quality, construction of *Dhobi-Ghats*, river side development schemes etc, and any other schemes which aims to reduce pollution load.

PROBLEM AREAS UNDER GANGA ACTION PLAN (GAP) IN VARANASI

The Ministry accepts the evaluation of GAP-1 that programme had achieved only 39 percent of its primary targets.[13] For Varansi this means that the various actions taken by GAP have also not achieved their primary targets. These schemes include, interception and diversion of sewage water from the city, functioning of electric crematorium, and working efficiency of existing sewage treatment plants.

Some problem with cleaning up Ganga in the city is that, the electric crematorium has been out of order for last two years. Funds for repairing key parts were lacking and now the bricks from the inside have been stolen.[14] The GAP moved the Assi River to a place upstream where we can see that raw sewage from thousand of homes from Assi Nalla falls freely into Ganga upstream of the city of Varanasi. All this sewage flows into the river before the drinking water for the City is taken out of Ganga.

Now if we can take a look on efficiency of sewage treatment plants in Varanasi we find that, in Dinapur Sewage Treatment Plant (costing Rs 25 crore), the present technology that is adopted is of activated sludge type is heavily dependent upon electricity. It has high operating and maintenance costs (Rs 3 crore annually). It generates a lot of sludge but does not remove fecal coliform bacteria. Additionally interception and diversion of sewage to the Ganga is faulty and incomplete, while that for the Varuna River is totally absent.[15]

Actually Dinapur Sewage Treatment Plant is of inadequate capacity, low BOD removal efficiency, and fecal coliform removal is absent. The biogas formation is scanty resulting in poor generation capacity.[16]

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[13] Ibid.
[14] Ibid
[15] *Survey Report* of Sankat Mochan Foundation.
[16] Ibid

In Varanasi, non governmental organization *Sankat Mochan Foundation* is regularly monitoring water quality of the Ganga river and they found that, GAP Phase –1 suffered from several shortcomings.[17]

- The sewage pump to Konia terminal, when run to its capacity causes heavy surcharging of the old trunk sewer. It causes erosion of the sewer lining and also spillage of sewage from manholes in low- laying areas of the city.
- Over 115 MLD sewage, which could be easily handled by the Konia terminal, is actually being diverted to Dinapur sewage Treatment plant. The Dinapur STP can handle only 80 MLD, resulting in by- passing of 35 MLD untreated sewage into Varuna and eventually into Ganga. This is also very expensive in term of energy consumption.
- Power breakdowns, which are common in Varanasi, cause a sudden back pressure in the system and massive spilling of sewage into the roads and streets of the city.
- The plant at Dinapur has to be shut down completely during monsoons. Thus for three to four months in a year all the sewage goes untreated.
- The biogas generator in the Dinapur STP does not function, hence the plant is ineffective due to shortage of power. Tens of thousand rupees have been wasted on its construction, while the villages around the Dinapur STP suffer from polluted water, borne disease and mosquitoes.
- BOD[18] in the religious bathing area remains dangerously high even after completion of the GAP-1. The BOD is high as 25 mg/l (primary water quality criteria for bathing, 3 mg/l) at the confluence of Ganga and Varuna.
- The fecal coliform count varied from 70000-mph/1000 ml to 1.5 million/1000 ml. According to GAP the fecal coliform count must remain below 2,500 million / 1000 ml. The BOD and fecal coliform levels increases from upstream to downstream as more and more untreated sewage enters the river.
- Even in the treated sewage coming out from the Dinapur STP, the BOD is dangerously high at 50 mg/l against a maximum permissible value 20 mg/l. Suspended solids are 100

[17] *http:// cleanganga .com/*

[18] Bacteria utilize the oxygen content of water thus causing depletion. This would mean a certain amount of oxygen would be needed to polluting levels to normal. This amount is termed BOD.

mg /l. Fecal coliform levels remains as high as that entering the STP, since there is no arrangement for controlling it.

SEWAGE WATER FARMING AND ITS EFFECTS ON HEALTH AND AGRICULTURE

Today when debates on direction of the development is going on, it is also necessary to rethink and reframe environmental debates and ensure that, in 21st century we will provide healthy environment to every body without any discrimination of social or economic status.

Studies done in different countries on reuse of sewage water for farming are eye opener. But main problem with most of these studies is that, they are pure-scientific in their nature and mostly deals with natural components, like soil texture, quality of treated water, efficiency of technology rather than human being and its socioeconomic consequences.

In India use of wastewater for growing vegetables is practiced from a long time. Now municipal bodies are supporting it because it is seen as a recycling of wastewater and reducing pollution burden from the rivers. Farmers near to Chandhigarh City are also practicing it.

However a study on "*Recycling of sewage and Industrial Waste on Land: A Monitoring and Surveillance Report On Chandhigarh Sewage Farm*" carried out by Central Board for The Prevention and Control of Water Pollution (1985-86)[19] found that in villages where farmers were using treated sewage water for farming, the water table of the area was almost up to the ground level, because of heavy application of sewage water for cultivation of paddy crops causing water logging. Improper drainage, poor land management, heavy hydraulic load and the type of crops (particularly rice) were the cause of water logging in the area.

A questionnaire survey among the cultivators of this area also revealed the fact that the quality of grain and the yield of paddy and wheat were also not satisfactory.

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[19] Central Board for The Prevention and Control of Water Pollution, *Recycling of Sewage and Industrial Waste on Land: A Monitoring and Surveillance Report On Chandigarh Sewage Farm*, New Delhi, 1985.

While a luxurious vegetative growth of the paddy plants after 45 days was observed, the accumulation of heavy metals in sewage irrigated soils were seen to be high compared to paddy fields receiving tube well irrigation. Plant tissue monitoring showed that plant uptake of heavy metals (i.e. Cr Ni, Pb and Cd) was abnormally high in 45 days old paddy plants. The bacteriological contamination (Total/ Faecal Coliforms Count) of ground water was observed even in deeper zone (92/14 MPN/100 ml). This is also seen as not a good sign.

The study concludes, "Heavy metals probably are the most harmful elements in the system and in excess amount it is not only causes phytotoxicity but also contaminates surface or ground water body either by surface run off or by leaching."

Therefore from this study it has been observed that, the application of wastewater to land for a long period in an unsystematic (Uncontrolled irrigation) way may affect the living system and ecology of the area. This is because of the propagation of the pollutants through different avenues). And sewage water farming is not a good practice if not practiced with care.

While we can see the importance of this study for present study, it is no less significant that, this study of villages near to Chandhigarh was conducted in 1985- 86. That time use of treated sewage water had been practiced in the area from last 10- 15 years. Interestingly the capacity of Sewage Treatment Plant was 70 MLD. It is more or less equal to our study sewage treatment plant (80 MLD).

At present in our area duration of using sewage water for farmers is also (from 1991) near about 10-15 years and equal to Chandhigarh villages. Therefore it would be interesting to cross check and if possible match the results. However no such study has been done in the area irrigated by Dinapur sewage treatment plant.

A study "Analysis of socioeconomic and environmental impacts of waste stabilization pond and unrestricted wastewater irrigation; interface with maintenance'' was conducted by Agunwamba. J C, in 2001 in Nigeria. [20]

This study was carried out as it was seen that poor farmers living near to the University of Nigeria, Nsukka Campus, used the effluent discharged from the University into

[20] Agunwamba. J C., "Analysis of Socioeconomic and Environmental Impacts of Waste Stabilization Pond and Unrestricted Wastewater Irrigation; Interface with Maintenance", *Environment Management*, May 2001,27(3) pp. 463-76.

the waste stabilization ponds (WSPs) for irrigation. Therefore there was fear that the poorly maintained WSPs and the reuse practice were contributing to environmental degradation and health hazards for these farmers.

In this study the environmental and socioeconomic impact of the WSPs and reuse were evaluated based on data collected from questionnaires and a literature search. The engineering and agricultural properties of soil in the irrigated and nonirrigated areas were also compared. Comparison of the health status of the farmers and nonfarmers, of consumers of crops irrigated with wastewater and nonconsumer was also performed using student's t test and z – score test. The occurrence of diarrhea, typhoid fever, and malaria among the various groups were used as indices.

Findings showed that the health status of the farmers and consumers is poorer than, those of non-farmers and non-consumers at the 5 percent level of significance. Vegetable cultivation using WSP effluents is a means of sustenance to the farmers and, provides affordable means of satisfying their nutritional deficiencies. However, the poorly maintained WSPs create odor and mosquito nuisance, trap, destroy livestock, and flood nearby compounds with waste debris. At both 1% and 5% levels of significance, community around the ponds (< 300m) suffers malaria more frequently than those who live far away (> or = 300m).

The study uses a cost – benefit analysis to argue in favor of improvement of WSP management and irrigation reuse of wastewater. Dredging of ponds, training workers and farmers, and adopting appropriate maintenance and monitoring strategies will greatly enhance the socioeconomic status of the urban poor farmers.

Another study " Risk of Communicable disease infection associated with wastewater irrigation in agricultural settlements." By Katzenelson E et al (1976)[21] examined the incidence of enteric communicable disease in 77 agricultural communes in Israel, practicing wastewater spray irrigation with partially treated non-disinfected oxidation pond effluent. This was with enteric communicable disease compared in 130 Kibbutzim (agricultural communal settlements) practicing no form of wastewater irrigation.

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[21] Katzenelson E, Buium I, and Shuval, H I., "Risk of Communicable Disease Infection Associated with Waste Water Irrigation in Agriculture Settlements", *Science*, Nov 26, 1976; 194 (4268), pp. 944-6.

The study shows that the incidence of water borne diseases like shigellosis, salmonellosis, typhoid fever, and infectious hepatitis is two to four times higher in communities practicing wastewater irrigation. But no significant differences are found for the incidence of non-water borne infections like streptococcal infection, tuberculosis, and laboratory- confirmed cases of influenza. There was no difference found for enteric disease rates during the winter non-irrigation season.

Therefore the study recommends proper wastewater treatment measures, including effective bacterial and viral inactivation through disinfection for all cases of sewage irrigation or land disposal near residential areas in light of the potential public health risks involved.

In Israel another study had been conducted by Fattal B, Waxy et al.[22] to know, health risk associated with wastewater (untreated) irrigation by analysis of morbidity pattern. It found seasonal twofold, excess risk of "enteric" disease in 0-4 year old age group.

This differences was seen during the summer months in those years in which wastewater was used for irrigation, compared with the parallel summer months of non wastewater irrigation years in the same cooperative agricultural settlements (kibbutz). But on the year round rates basis, little or no excess enteric disease was found in all age groups wastewater-irrigating communities.

In study area sprinkler irrigation system was used and farmers were not using wastewater in vegetable or salads crops. In this study researcher found that if anyhow over-irrigation is controlled, risk from wastewater will also be decreased. This is because in fields farmers were using sprinkler irrigation system.

[22] Fattal B, Waxy et al., "Health Risk Associated with Wastewater Irrigation: An Epidemiological Study", *American Journal of Public Health*, August 1986, 76(8) pp. 977-9.

As study " Post – Irrigation impact of domestic sewage effluents on composition of soils, crops and ground water- a case study." by Yadav R. K, Goyal, B. et.al. (2002)[23] Says that long- term irrigation with sewage water adds large amount of carbon, major and micronutrients to the soil. They compared the spatial distribution of N, P, K and other micronutrients and toxic elements in the top 0.6 m of an alluvial soil along with their associated effects on the composition of crops and ground water, after about three decades of irrigation with domestic sewage effluent as a function of distance from the disposal point. It was seen that accumulation occurred with varying distribution. Indicators of groundwater contamination were also observed.

Results from the study showed that, use of sewage for irrigation in various proportions improved the organic matter to 1.24- 1.78 percent and fertility status of soils especially down to a distance of 1 km along the disposal channel. However in the study, contents of heavy metals in crops sampled from the area were below to permissible critical levels. Though the study confirms that the domestic sewage can effectively increase water resource for irrigation but there is a need for continuous monitoring of the concentration of potentially toxic elements in soil, plants and ground water. Study on, " Long – term effects of municipal sewage on soil and pastures." by Van de Graaff etl (2000) in Melbourne, Australia, state that, land application of municipal wastewater is widely practiced worldwide as a mean of treating wastes and obtaining benefit from the water and nutrients by growing pastures, trees and sometimes edible crops such as vegetables, fruit and fiber etc

Irrigation of pastures by treated and untreated sewage near Melbourne, Australia for more than a century has increased heavy metals concentration in the soil, but appears not to have increased their concentration in the herbage and in animal tissue of animals grazed on these pastures. Therefore he strongly says that, *"There seem to be sound reason why this practice may be sustainable."* Even in the Indian study there are increase with in permissible levels but monitoring has been considered necessary, something Van de Graaf ignores.

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[23] Yadav R. K, Goyal, B. et.al, *Post – Irrigation Impact of Domestic Sewage Effluents on Composition of Soils, Crops and Ground Water- A Case Study*, Institute of Urban Affair, New Delhi, 2002.

In India to look the impact of sewage water farming, another study reviewed is "Evaluation of groundwater pollution potential of sewage- irrigated vegetable growing areas of the eastern fringe of Calcutta City" by Mitra, A. and Gupta, S.K.(2000).[24]

In this study it has come out that in recent years recycling of wastewater in agriculture is common method of disposal or utilization of wastewater. However recycling of wastes may cause contamination of groundwater by toxic elements like heavy metals, cationic and anionic contaminants, and pathogens. Groundwater of shallow and deep tube wells was contaminated during 1991 to 1997 from sewage effluents and irrigated garbage farming areas on the eastern fringe of Calcutta City.

In this study it is also found that most of the ground water contained undesirable pH, total dissolved solids, total hardness, calcium, magnesium, phenolic compound, iron and manganese. And the observed values or concentration were much above the maximum desirable limits specified by World Health Organization (WHO) and Bureau of Indian Standards (BIS) for use as drinking water. Study done by Jain, C.P. on "Decentralized Concept of Sewage Treatment to Prevent Flowing of Waste Water in Surface Drains and River Yamuna in Delhi"[25] reveals that wastewater collection at centralized place is more expensive than its very treatment. And a large number of people get affected in the catchment area in case of any failure.

In this study bben that silting in long sewers du to anaerobic action is inevitable and there are also difficulties in involving community/user participation in operating and maintenance to high-tech functioning of big sewage treatment plants. Therefore study recommends the decentralized concept of mini STPs, and state that there are technologies available which can treat the wastewater effectively by reducing BOD.

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[24] Mitra, A. and Gupta, S. K., *Evaluation of Groundwater Pollution Potential of Sewage- Irrigated Vegetable Growing Areas of the Eastern Fringe of Calcutta City,* Schriftner Ver Wasser Boden Lufthyg, 105, 2000, 261-7.

[25] Jain, C.P. (2003): "Decentralized Concept of Sewage Treatment to Prevent Flowing of Waste Water in Surface Drains and River Yamuna in Delhi", *The Indian Journal of Public Administration*, Jan –Sep. Vol-XLIX No-3, pp. 421-435

PERFORMANCE OF DINAPUR STP AND SEWAGE WATER FARMING

There are very few studies, conducted on Dinapur Sewage Treatment Plant to know the affect of sewage water farming on villagers' health. In past one or two were conducted, but they were basically focussed on groundwater contamination.[26] But recently one important research project "*Cost Benefit Analysis of Ganga Action Plan*" conducted by Ministry of Environment and Forests, funded by the Overseas Development Administration was carried out by Industrial Toxicology Research Center (1996) in Varanasi (80 MLD) and Kanpur(5 MLD).

Finding of this research project is complied by Markandya and Murty in *2002.*[27] In this study it has seen that, present sewage treatment plants (STPs) are basically designed to reduce the organic load, and they are not very effective in reducing the levels of metals and pesticides. Therefore large fraction of toxicants present in the wastewater are retained with the sludge generated by STPs and are going out with the treated wastewater / effluents. Therefore unfortunately long-term disposal of these toxicants in high level in environment will be hazardous to population.

Table 2.01

Characteristics of soil near Kanpur and Varanasi

Kanpur	Ph (1:5) (mean)	Tot-N (ug/g)	P (ug/g)	Na (ug/g)	K (ug/g)	Ca (mg/g)	Mg (mg/g)
Exposed	8.1	738.5	5.96	148.3	93.7	3.36	0.81
Unexposed	8.71	556.0	4.16	50.6	34.86	2.47	0.80
Varanasi							
Exposed	8.09	1108	6.36	78.8	83.74	NA	NA
Unexposed	8.43	1071	10.76	87.66	97.6	NA	NA

Source: Cleaning – up the Ganges A cost benefit Analysis of the Ganga Action Plan(2002).

[26] *Survey Report on ground watercontamination*, Sankat Mochan Foundation, Varanasi.

[27] Markandaya, A and Murty, M. N., *Cleaning –up the Ganges A Cost –Benefit Analysis of the Ganga Action Plan*, New Delhi, Oxford University Press, 2002.

In the study it has been seen that, in the sewage irrigated farms, the mean level of Cd (cadmium) and Cr (chromium) in soils near Kanpur and Cd (cadmium), Ni (Nickel), and Pb (lead) in soils near to Varanasi (in the same area of our study) are above their respective tolerable limits for agriculture crops.

Table 2.02

Mean Metal Discharged through Treated Waste Water

STP	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Kanpur								
(g/d)	0.06	1.84	0.16	2.08	0.83	0.25	0.27	0.67
(kg/yr)	0.02	0.67	0.06	0.76	0.30	0.09	0.097	0.25
Varanasi								
(g/d)	1.90	1.62	2.57	28.5	13.5	4.47	4.56	11.60
(kg/yr)	0.694	0.59	0.94	10.4	4.92	1.63	1.66	4.23

Source: Cleaning – up the Ganges A cost benefit Analysis of the Ganga Action Plan(2002).

The exposure of the population to heavy metals and pesticides may cause neurobehavioral disorders such as fatigue, insomnia, decreased concentration, depression, irritability, gastric symptoms, sensory symptoms, and motor symptoms etc. They noticed significant difference in the mean level of heavy metals (as mentioned in Table 2.02) in different parameters between the unexposed and exposed population groups to sewage water, near Kanpur But in Varanasi was no significant change was seen, though mean metal on waste water were more. But authors says that, "However this does not mean that there is no significant exposure to heavy metals and pesticides or risk to the population near the Varanasi area receiving treated wastewater from the Dinapur STP (80 MLD). One of the possible reason seems to be the duration of disposal, as the area near Kanpur had been receiving wastewater for several decades, while the one near Varanasi started receiving it only during the last few years."

Metal and pesticide residue levels in the vegetation/ crops, vegetables/ food grains etc., as consumed by cattle and human beings, are also much higher in the waste water disposal areas than those not receiving the waste water. But, because the pH value of the

waste waters as well as the receiving soils is more than 8 [Kanpur 8.1(mean) and in Varanasi 8.09(mean)] therefore the metal mobilization and plant uptake would be restricted by the alkaline pH and metal uptake by the crop plant would be controlled even though, the level of a few metals in soils were above their critical limits. This seems that there is no adverse impact of metals and pesticides on agricultural crops in these areas.

Table 2.03

Pesticide Discharged through Treated Wastewater

STP	r- BHC(lindane)	Total DDT
Kanpur		
(g/d)	0.045	2.85
(kg/yr)	0.061	1.04
Varanasi		
(g/d)	0.760	2.28
(kg/yr)	0.277	0.83

Source: Cleaning – up the Ganges A cost benefit Analysis of the Ganga Action Plan(2002).

However, the author also point out that farmers report that, the crops yield has declined (90%) over the past few years, in Kanpur. While there is an enhanced in yield (65%) near to Varanasi. Here author states, "The decreased productivity in the previous case was due to high solids / bacterial biomas making the soil- root interface more susceptible to plant root disease and the enhanced yield in the later case may be due to more irrigated water available with high nutrient / fertilizer (N, P, K, organic C, etc) levels."

However, today eight years later the farmers of Varanasi are also complaining of a sharp decrease in crop yield. This may be because of unbalance of intake of metal and some other elements in soil texture, as suspected for Kanpur. The above study also carries out an examination of the sludge from the STPs in Kanpur and Varansi reveals that in the sludge of both two STP's of Kanpur and Varansi the level of Cadmium, chromium and Nickel levels are above to their tolerable levels as prescribed for agricultural purposes. Therefore the sludge is unfit for agricultural purposes.

Table 2.04
Mean Metal Levels in STPs Sludge (g/ kg)

STP	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Kanpur	0.041	8.11	0.393	6.40	0.22	0.214	0.091	1.18
Varanasi	0.054	1.30	0.543	7.21	0.31	0.293	0.129	1.51
Tolerable amount	0.02	1.20	1.20	-	-	0.20	-	3.00

Source: Cleaning – up the Ganges A cost benefit Analysis of the Ganga Action Plan(2002).

In terms of the fertilize value (N, P, K, etc), of the sludge it has been estimated that approximately 14 kilograms of nitrogen (N), 6.75 kilograms of Phosphorous (P), and 4.25 kilograms of potassium (K) would be available per ton of the generated sludge and its value at existing market rates would be about Rs 486. But interestingly the cost to the farmers due to the heavy metal and pesticide pollution is not counted.

Table 2.05
Mean N, P, K Contents of STPs Sludge and its Cost Economics

Ingredient	Rate per kg (Rs)	Per ton of sludge Ingredient	Per ton of sludge Cost (Rs)
Nitrogen (N)	7.6	14.0	107
Phosphorus (P)	37.0	6.75	243
Potassium (K)	32.0	4.25	136

Source: Cleaning – up the Ganges A cost benefit Analysis of the Ganga Action Plan (2002).

When the study looked upon the impact of waste water toxicants (metals and pesticides) on human health in the areas receiving wastewater through a standard questionnaire- based survey (which covered neurobehavioral) of the exposed and unexposed population groups near Kanpur and Varanasi STP's author says that,

" There has been a considerable impact of toxicants (metals and pesticides) on human health in the exposed areas."

For calculating an "Environmental Exposure Risk Analysis", four population groups were selected. (Two exposed and two unexposed). The approached was based on evaluation of the Risk Quotient (RQ) for each individual toxicant by first computing the Total Daily Intake (TDI) of each one through the major routes [drinking water (2.5 l/d), food grains(600g/d), vegetable(300g/d), milk(200g/d) etc.] And then comparing with respective Acceptable Daily Intake (ADI).

RQ = TDI / ADI

The final value of RQs indicates that although in none of these cases did the RQ value exceed 1.0 (positive risk), but the RQ values for all the metals and pesticides for the two exposed areas were 2 to 4 times higher than their respective unexposed population groups and it supports the premise that there is considerable risk through metal and pesticides exposure to human health.

In the study the above impacts were further confirmed through biomonitoring of the metal and pesticide levels in human blood and urine of different population groups under study. It comes up that the level of both metals and pesticides in the human blood and urine samples of the two exposed population groups (Kanpur and Varanasi) were considerably higher than those of the respective unexposed population groups.

However while this study was done in 1996 it seems nothing has been done to utilize the results. Most of the findings from studies done in India and abroad indicate that there is a considerable risk and impact of heavy metals and pesticides on human on its environment in the exposed areas, receiving the wastewater from sewage treatment plants. And if there should be any provision for sewage water farming, sewage water should be treated properly and there should be appropriate technology for wastewater treatment & maintenance of STPs. Monitoring strategies for irrigation (controlled irrigation) and public health surveillance is also needed.

CHAPTER III

CONCEPTUALIZATION AND METHODOLOGY

Conceptualization of the Study

Water pollution may be defined as the adverse change in composition or condition of water so that it becomes less suitable for the purposes for which it would be suitable in its natural state. The changes include physical, chemical and biological changes. Water pollution is considered not only in terms of public health but also in terms of conservation, aesthetics and preservation of natural beauty and resources.

The sources of water pollution are numerous. Most industrial effluents are discharged into rivers without proper treatment. They contain both organic and inorganic hazardous and non-biodegradable materials.

The next principal contributor to water pollution is municipal sewage. Most municipal sewage receives no treatment before discharge into rivers. In combination with industrial wastes, this kind of waste produces serious problems related to public health. With an increase in population growth, the quantity of wastewater is also increasing, in addition to the production of large quantities of sewage. Treatment of sewage deposits the suspended materials at the bottom known as sludge and the liquid waste contains ions such as sodium, potassium, calcium, ammonium, manganese, chloride, nitrite, nitrate, bicarbonate, phosphate and sulphate in dissolved condition.[1]

The first and foremost source of pollution is burgeoning growth of metro cities. Population growth in these cities leads both to vast pure water requirements and generation of sewage and waste products. Now most of the cities are overcrowded and their population consume huge amount of resources and create waste in return. This kind of unbalanced growth of cities has a lot to do with increase in pollution and leaves a negative impact on the environment. For example, increase in modern human habitation results in increase of dischargeable human wastes.

To summarise, population density in the cities as a result of industrialization and urbanization is considered to be a general indicator of pollution sources. When a country

[1] Manivasakam, N., *Environmental Pollution*, New Delhi, National Book Trust, 1984, p. 35.

or region moves towards higher levels industrialization, it is likely to undergo environmental deterioration. It should be noted that civilization itself couldn't survive if the natural environment collapses. So, man must have to nurture the resources of the planet earth if he has to survive.

REUSE OF SEWAGE WATER FOR IRRIGATION

Today the problem of shortage of water for different purposes is coming up everywhere. In the literature review of this study, it is seen that a feasible option for sorting out the problem of water shortage is the prudent reuse of wastewater. One of the contemporary options to combat water shortage is looking for ways and means to reuse wastewater discharged from different sources i.e. domestic and industrial. The use of sewage water (partially treated) for irrigation has become a well-known step. The common perception regarding this is that it will conserve the water resources, save foreign currency (in term of reducing demands of chemical fertilizer), will increase crop yield and reduce pollution in the rivers.[2]

In many countries, programmes and incentives for utilizing partially treated sewage water for irrigation are going on.[3] Today in our country, sewage water irrigators are producing income-generating crops such as vegetables and flowers.[4] In semi-arid areas, the use of sewage water has come up as a major water source that is supporting the livelihood of thousands of farmers.[5] In some places farmers are fully dependent on sewage water and accept the side effects.

There are both positive and negative effects of sewage water irrigation. Reports published in different newspapers say that the vegetables grown in sewage water contain abnormal proportion of toxic elements that are injurious to health. According to an Indian daily newspaper, excessive amount of lead in spinach or ladies finger may cause damage to nervous, endocrine and reproductive systems and lead particularly to the development of abnormalities in children.[6]

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[2] *Science Reporter*, June 2004, pp. 11-13.
[3] As discussed in Review of Literature.
[4] Markandaya, A and Murty, M. N., *Cleaning -up the Ganges A Cost -Benefit Analysis of the Ganga Action Plan*, Oxford University Press, New Delhi. p. 195.
[5] As discussed in Review of Literature.
[6] *The Times of India*, 27 March 2003.

Sewage water irrigation usually raises ground water table and therefore, there is always a possibility of water contamination. Over-irrigation results in water logging and thus breeds increasing number of mosquito and flies. The end result of this a is growing number of malaria and diarrhea cases. Physical contact between farmers and sewage water also invites respiratory and skin problems. Additionally producers and consumers of vegetables are different, most of the time consumers are ignorant of what are they consuming.

There are no clear-cut choices for policy makers, farmers, environmentalists, or health practitioners to decide whether to use sewage water (partially treated) for irrigation or not.

SEWAGE WATER FARMING

One of the most important things about sewage water farming is that it is a reliable source of water and available throughout year. Use of partially treated sewage water is seen as a low cost method for sanitary disposal of municipal wastewater, which is considered as a burden for rivers. It will reduce pollution of rivers, canals and other surface water resources and conserve fresh water sources. Use of sewage water is also a method of increase in crop yields and conservation of nutrients by reducing the need for artificial fertilizers.

But as mentioned above some side effects are also linked with sewage water farming. There is a health risk for irrigators and communities due to prolonged contact with sewage water. Vegetables irrigated and produced with wastewater also possess hazardous health risks for the consumers. There is also a continuous danger of contamination of groundwater (nitrates).[7] Sewage water farming can also build chemical pollutants in the soil in form of heavy metals; pesticides and most of the time unbalance the soil texture (N.P.K). There are also possibilities of creation of habitats for disease vectors. Therefore, from the public health point of view, there is an urgent need for multidisciplinary research to see the problems and prospects of this serious issue from different angles.

[7] *Science Reporter*, June 2004, pp. 11-13

This study makes an attempt to explore and understand the problems related to sewage water farming that could social sufferings of the people living near the sewage water receiving areas. Focus of the study is to understand social aspects of the problem, which are lacking in pure environmental studies and other government sponsored developmental schemes.

A number of questions emerges about the impact on people who are using sewage water for irrigation, kinds of changes in crops if metal levels increase and last but not the least, the effect of Sewage Treatment Plant and the canal on the health quality of life and how effective the health services available in the study villages are in managing these problems. Therefore some other questions of this study are - Is it true that utilization of sewage water for farming will reduce pollution in the rivers? Is sewage water providing reliable water supply to farmers? Will wastewater reduce the demand of chemical fertilizers? Is there really any increase in crop yield? What are the major agricultural shifts, which have come after the introduction of sewage water for farming? What is the overall impact of sewage water farming on life and health of the population (including users and non-users of sewage water)? Is there any difference between the view of users and non-users about use of sewage water for farming purpose? What does healthy and clean environment really mean for the poor? Why do people have a negligible part in developmental programmes?

METHODOLOGY

The broad objective of the study is to understand the environmental hazards caused by wastewater irrigation in the area covered by the canal dealing Dinapur Sewage Treatment Plant to the river Ganga. The Study examines the socioeconomic and health problems of the people living nearby Sewage Treatment Plant. A factor that is least considered in pure environmental studies and developmental programmes. In addition to the present problem faced by farmers, an attempt would be made to understand the history of establishment of the plant, planning process and level of people's participation in government programmes.

Sub objectives set for the study are:

- To review the 'Ganga Action Plan' (GAP) and work done under Ganga Action Plan in Varanasi City.
- To find out socioeconomic profile of affected people in the wastewater disposal area.
- To assess the impact wastewater discharged from Sewage Treatment Plant on overall life and agriculture.

- To assess the health problems caused by the wastewater, availability and accessibility of existing health services, to see how the problems are dealt with in this area.
- To assess the planning process of establishment of Sewage Treatment Plant and people's participation.

AREA OF THE STUDY

All the three villages selected for the study are situated in Chiraigaon Block of Varanasi district. The area of the Block is 19599.29 hectares. According to 1991 Census, population of Chiraigaon Block was 1,85,521. Out of this population, 52.8 percent were male and 47.2 percent were female. Population of schedule castes was 3,80,44 (20.5 percent). This part of the district is famous all over the world, for its hand made *'Banarasi Saree'*, and pickles known as *'Chiraigaon Ka Achar'*.

This area is also recognized as a part of *'Adi-Kashi'* (ancient Varanasi). It is about 766 kilometer away from New Delhi, the national capital of India. Varanasi railway station is at a distance of about 8-km from the Chiraigaon Block office. Sarnath, where Lord Buddha had preached his first sermon is about 3 to 4 km away from the study villages in west direction.

In Varanasi city, there are three Sewage Treatment Plants. One in Bhagwanpur with capacity of 10 (2 + 8) million liter per day (MLD); Second in 'Diesel Locomotive Works' (D.L.W.) with a capacity of 12 MLD, and the third is in Dinapur village with a capacity of 80 MLD. All the three Sewage Treatment Plants were established after the implementation of the Ganga Action Plan in 1986. Dinapur Sewage Treatment Plant is situated in Dinapur Panchayat of Chiraigaon Developmental Block of Varanasi District.

For this study, Dinapur Sewage Treatment Plant and three Panchayats i.e. Dinapur, Kamouli and Sehbar, which are close to the plant and its canal, are selected.

Dinapur Sewage Treatment Plant was established in 1991. Area of the plant is about 70-75 acres. First the solid materials from sewage water is separated in Konia Pump house and after that it comes to Dinapur for treatment. In Dinapur Sewage Treatment Plant, there are three parallel units. Total sewage water is divided into three parallel units for treatment.

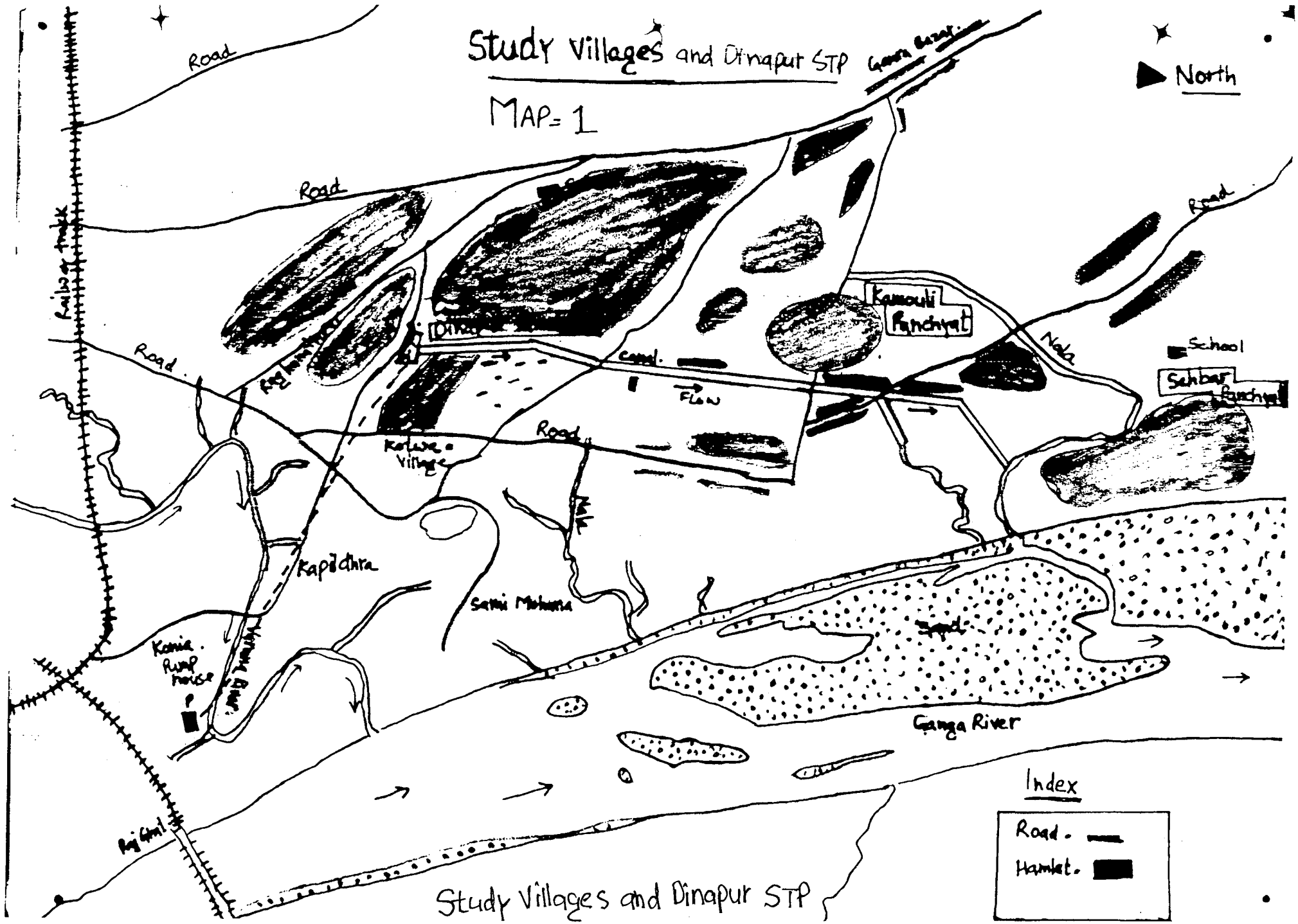
In the plant, treatment of sewage is divided into two stages such as primary treatment and secondary treatment. In primary treatment, the solids are separated from the sewage partially by screening and partly by sedimentation and subjected to anaerobic digestion, which is the first stage in purification. On the other, in secondary treatment, the effluent is subjected to aerobic oxidation, which is the second stage of purification. After the secondary treatment, this water goes to canal for irrigation purposes.

Dinapur Sewage Treatment Plant is chosen for this study; because it is bigger than the other two sewage treatment plants of the city. It also provides regular and large amount of treated sewage water (80 MLD) for irrigation. The capacity of the two other sewage treatment plants of the city is only 12 MLD and 10 MLD. From Bhagawanpur treatment plant (10 MLD) treated sewage water mainly goes to the Assi River, a tributary of the Ganga. The Diesel Locomotive Works (12 MLD) plant also provides water for irrigation, however, due to its low capacity, the plant is not playing a major role in supplying water for irrigation purposes.

Sampling of the villages

The first panchayat selected for our study is Dinapur. It is one of the four panchayats that surround Dinapur Sewage Treatment Plant are Raghunathpur, Salarpur, Kotwa and Dinapur. Majority of the farmers of this area are using treated sewage water form the canal in their fields. The sewage treatment plant is situated in Dinapur and the land that is acquired for the plant is also from Dinapur. In Dinapur, main problem for villagers is not only from treated sewage water (canal) but also from sludge and sewage gases, which are released from the plant from time to time.

Second panchayat for the study is Kamouli, which is divided into eight hamlets. Kamouli is selected for this study because, the canal coming from the plant carrying


Study Villages and Dinapur STP
MAP- 1
North
Road
Railway tank
Road
Road
Kamouli Panchyat
Nala
School
Sahbar Panchyat
Canal
Flow
Road
Kolwa Village
Kapildhra
Sami Mahuna
Kania Pump house
Ganga River
Index
Road
Hamlet
Study Villages and Dinapur STP

32.A

treated sewage water passes through the village it self. Therefore, Kamouli is one of the most affected villages by the sewage water and contamination of water resources. In Kamouli, contamination of ground water resources is main problem therefore Kamouli is selected in order to better understand the affect of sewage water on agriculture, life, and health of the villagers.

The third Panchayat for the study is Sehbar. Sehbar is selected for this study because the canal ends here. This is the last village along the 8-km long canal. The economic activities of this village are different from other two villages. Here the Fishermen community '*Mallah*' is in majority. Majority of the villagers are land less and dependent on the River Ganga for their livelihood. Sehbar is selected in order to understand the impact of canal water on the livelihood of the fishermen population. Sehbar is also a good place to understand the problems because despite being six km away from the Sewage Treatment Plant. Therefore, this would be an attempt to understand the effects of the canal on people's lives from different perspectives.

Present study has been planned as an exploratory study using qualitative as well as quantitative data.

PROFILE OF SAMPLE VILLAGES

Dinapur Panchayat

Dinapur Panchayat is located in the north direction on outskirts of Varanasi city. It lies along a historical and religious circuit around the city called *'panchcose marg'*. Dinapur Panchayat is located on 'Balua-Ghat' road. Area of the village is 177.66 hectare.[8] Main hamlet of the village is one kilometer away from the main road. Private means of transportation is available from the main road to city. There is no facility of transportation to the village from the main road. For traveling this distance or to city common means of transportation is cycle or motorbike. In 1991, the population of Dinapur was 2,498 out of which, 52.5 percent were male and 47.5 percent were female.[9] According to family register of Dinapur, 2002, population of the village is 3,682. Out of

[8] Chiraigaon Block Office Records, 2004
[9] Data for Census 2001 is not available.

this, 51.8 percent are male and 48.2 percent are female. It means that while the population has increased there does not seem to be much change in sex ratio.

In the village, the caste structure is dominated by Other Backward Castes (OBC) and main caste groups are *Bhar, Yadav, Harijans, Maoryaa, Sonkar, Nai, Koohar, Sonar, Talee,* and *Rajpoots.* According to 1991 census, the population of scheduled caste in the village was 15.2 percent, other backward castes were 76.0 percent, and general castes were 8.5 percent. Total number of literates in the village was 635 (25.4 percent). Literacy among male was 37 percent and among female a mere12.6 percent.

At present, number of families living below poverty line is 60 (14.0 percent). When making calculation of the families below poverty line (BPL), the administration had not collected information about their castes. This put the investigator in a difficult situation in getting reliable information about caste representation in BPL list.

In Dinapur, there is one primary school and one Public Distribution System shop but no other government facility like health center or post office. In the Panchayat, according to Gram Pradhan, 80 percent of the families have electric connections and may be they are using it illegally. Local market for the villagers is *'Panchcoaci'* which is three kms. away from the village. There is one Government tube-well for irrigation. A Non Governmental Organisation named 'Sankat Mochan Foundation' has also dug one deep tube-well for providing drinking water to villagers.

Kamouli Panchayat

Kamouli is the second Panchayat, which has been chosen for our study. Area of the panchayat is 334.69 hectares.[10] Kamouli Panchayat is divided into seven hamlets such as Gopalpur-Lakrawo, Nawapura, Bheeta par, Mukhya basti, Anusuchit basti, Aiherana, and Bari par. Main road is about 1.5 km. away from the village, but there is no means for public transportation to and from the main road. From Kamouli, Sewage Treatment Plant is about four km away. But the village stands along the canal. The canal is hardly 25 meters away from the main hamlet.

[10]Chiraigaon Block Office Records, 2004.

According to 1991 census, population of Kamouli village was 3,315. Out of this 54.9 percent were male and 45.8 percent female.[11] Population of scheduled caste in the village was 8.77 percent of the total population. In 1991, the total number of literates was 1,229 (37 percent). Out of this, among male the rate was 50.25 percent and among females it was 21.7 percent.

In family register of year 2002, total numbers of families were 571. Out of this, 13.5 percent families were from scheduled castes, 63.6 percent from other backward castes (OBC), 18.2 percent from general castes and 4.7 percent families from Muslim community. According to Block records, in Kamouli Panchayat, 37 (6.47 percent) families were living below the poverty line. In Kamouli, main castes are Brahaman, Rajpoot, Musalman, Rajbhar, Yadav, Goud, Nau, and Sonkar.

In the village, there are two government schools, one post office, a Public Distribution System shop and one primary health center. One government tube-well is there in the village for irrigation purposes.

In Kamouli, also there is a deep tube-well dug by the NGO Sankat Mochan Foundation. This tube well is situated in the hamlet for the Scheduled Castes. But it has been defunct since long time because of poor facility of electricity. Kamouli is well electrified, but only 10 to 15 percent of scheduled caste families have access to electricity. Local market is *'Goura'*, which is situated on the main road.

Sehbar Panchayat

Sehbar is the last Panchyat chosen for our study. Sehbar is dominated by fishing community *'Mallah'*. This community has been recognized as Other Backward Caste in Uttar Pradesh. Although traditionally in the area this community is termed as lower caste. Area of the Panchayat is 334.69 hectare.[12] There is no pitch road and no means of public transportation. Usually villagers use sand-loaded tractors for transportation. At Present, *Kacha* road of the village is damaged but it remains busy because of sand mining work.

According to 1991 census, population of Sehbar was 1,057. Out of this, 52 percent were male and 48 percent were female. Population of scheduled castes in village

[11] Data for Census 2001 is not available
[12] Chiraigaon Block Office Records, 2004.

was 11.54 percent. In 1991, total number of literate in village was 199 (18.8 percent). Male literacy was 30.4 percent and female was 6.3 percent. In the Panchayat there are approximately 200 families. According to Block Office records, in the village, 69 families are living below poverty line. Therefore if there are 200 families 200 families are below poverty line. In Sehbar, there are two hamlets and in comparison to other two villages, this village is very poor. Some main castes of the village are Yadav, Nishad, Brahaman, Rajbhar, Chamar, Gupta, and Prajapati.

In the village, there are two government tube-wells for irrigation purposes. There is another newly bored tube-well at the door of Gram Pradhan's house (dug by the NGO Sankat Mochan Foundation), but it is also not working.

In this Panchayat, there are two-government schools and one Public Distribution System shop. Nearest market to the village is 'Gaura Bazar', which is three km. away from the village. But villagers prefer to go to 'Rajghat Bridge' for marketing and shopping purposes, which is seven km away from here. At present, fishermen are now involved in sand mining on daily wage basis. In the village, only few 'Yadav' families have access to electricity.

PROCEDURE FOR SAMPLING

The initial plan was to carry out a systematic random sampling on 10 percent of the village population. Panchayat household register was obtained from the Panchayat office. After the first household being randomly chosen, every 10^{th} house was selected for the study purpose.

However, though the Panchayat register gave a certain number of households, it was observed while picking up the many samples that many families who were living separately considered themselves as members of a single household. Though they were not sharing the same roof or kitchen, they still considered themselves as one unit. When the sample numbers would involve two such household series, they would state that the information they had to give was the same as the other household. They would share their experiences in the group discussion but would not give information for the interview schedule either for socioeconomic or other data. This affected the sampling process. Therefore, a new procedure was devised. First the houses were divided by caste. From

the different strata, a somewhat similar procedure was carried out except that if the 10th house refused to participate in the interview process, the researcher took the next house enrolled in the family register that would belong to the same caste, but did not say it belonged to a household selected previously.

This was done in Kamouli and Dinapur, but not in Sehbar. For Sehbar, however, there was no family register. The people of the village gave an estimate of 200 families approximately living in this village. The 1991 census data was used for better understanding. Here a purposive sampling was carried out talking more to the *Mallah* 'fishermen' families. From Sehbar 20 families were selected out of which 13 were Other Backward Castes and 7 from Scheduled Castes. In order to understand the impact of sewage water on the lives on the poorest families, 7 were chosen from schedule castes i.e. the poorest in the village.

Sample size

Villages	Total number of families (From Panchayat Register)					Selected number of samples				
	Gen	OBC	S.C.	Mus	Tot	Gen	OBC	S.C.	Mus	Tot
Dinapur	36 (8.4)	326 (76.2)	66 (15.4)	-	428 (100)	4 (9.0)	33 (75)	7 (15.9)	-	44 (100)
Kamouli	104 (18.2)	363 (63.6)	77 (13.5)	27 (4.7)	571 (100)	10 (17.5)	36 (63.2)	8 (14.0)	3 (5.3)	57 (100)
Sehbar*	-	-	-	-	-	-	13 (65)	7 (35)	-	20 (100)
Total	140 (14.0)	689 (69)	143 (14.3)	27 (2.7)	999 (100)	14 (11.6)	82 (67.7)	22 (18.2)	3 (2.5)	121 (100)

* 1991 Census.

Total number of families in Dinapur is 428. For this study, 44 (10.3 percent) families were selected; four (9 percent) from general castes, 33 (75 percent) families from other backward castes (OBC), and 7 (15.9 percent) families from scheduled castes (SC).

Out of the 57 (10 percent) families selected in Kamouli, 10 (17.5 percent) are from general castes, 36 (63.1 percent) from Other Backward Castes, 8 (14.0 percent) from Scheduled Castes, and 3 (5.3 percent) families from minority Muslim. Total numbers of families in Kamouli are 571.

An overall picture shows that 121 families were interviewed. 11.6 percent from general castes. 67.7 percent from Other Backward Castes, 18.2 percent from scheduled castes and 2.5 percent from minority Muslims.

TYPE AND KIND OF DATA COLLECTED

Data was collected to obtain information regarding the villages, the people and their perception about Sewage Treatment Plant and sewage water farming. Personal at the Sewage Treatment Plant as well as key informants in the village were also interviewed. It is obvious from the conceptualization that the people affected by Sewage Treatment Plant and the sewage water (canal) are the central focus of the study.

The socioeconomic condition of households was assessed by collecting data on caste along with information on land ownership and monthly income of the household. This is based on the fact that in rural India, where agriculture is the major economic activity, land ownership can explain the socioeconomic condition of the household to a large extent. Data on livestock, housing, electricity, etc was also collected to help this assessment.

The above details will help to understand the socioeconomic conditions of the household in its totality. In this area, agriculture being the major economic activity, the lives of people are examined by collecting information on the day to day activities of people, the type of occupation and the work involved in it along with their working conditions.

TOOLS OF DATA COLLECTION

In the initial stage, secondary methods were used to know about the Ganga Action Plan, working of sewage treatment plants and sewage water farming with their side effects on life and health of the people living nearby.

In the second stage, primary methods were used to collect adequate data for the study. The primary sources used for data collection are:

- Observation Method
- Informal Group Discussion
- Close- ended Interview Schedule
- Open-ended Interview Schedule
- Structured Interview Schedule
- In-depth Interviews and
- Case Study.

OBSERVATION METHOD

Observation is a major tool to collect first hand information regarding type of housing, drinking water source, physical nature of the area people activities etc.

In our exploratory study, observation has been an important method of data collection mainly at the village level. The environmental conditions in which people live are better understood by observation. Understanding people's life, their day-to–day behavior and the type of work involved in agriculture and the village structure like type of roads and other infrastructure of the village are all results of observation. It is also a good method for cross checking information.

INFORMAL GROUP DISCUSSION

Informal Discussions in the village were carried out on different occasions especially in the evening with different kind of villagers and the folk women. Sometimes it was done and sometimes it automatically happened. The investigator had his limitations in managing time and area to be covered. But informal discussion provided a chance to explore the problem from different angles and dimensions. It also gave leads as to the importance issues concerning the canal and peoples lives.

CLOSE-ENDED INTERVIEW SCHEDULE

This was carried out on 121 households to collect economic and demographic profile.

OPEN ENDED INTERVIEW SCHEDULE

This schedule was used to collect information from the selected households to know the environmental hazards, health related problems, availability of health services, new agricultural shifts, social stigmas, benefits and problems related to wastewater farming and the Sewage Treatment Plant. This schedule was open-ended. The respondent was questioned on his opinion and the qualitative information, was noted down.

STRUCTURED INTERVIEW SCHEDULE

This Interview schedule was used to get information about the village, history of the area, different institutions, and their functioning. Respondents of this schedule were Gram-Pradhans, Block Officers and Panchayat Secretaries. It helped to get unofficial data on the functioning of sewage treatment plants and problems with sewage water treatment and Ganga Action Plan. These interviews were conducted in the Sewage Treatment Plant, in different pump houses, with concerned authority and sometimes with the available staff. Local leaders, doctors, schoolteachers and some conscious villagers of the area have also given their views. Later the information provided by them was crosschecked by the people's responses.

IN- DEPTH INTERVIEWS

In–depth interviews were carried out to collect majority of the qualitative primary data. In depth interview were carried out with families and individual to collect majority of the qualitative primary data. It helped to get detailed information about the effect of the STP and the canal on people's lives.

CASE STUDY

The type of difficulties people face due to the Sewage Treatment Plant and the canal can be well documented by using case study method. The unit of study was the family of those who are living along the canal or the plant. Cases were selected and the

focus was to understand 'how' sewage water is influencing day-to-day life of the villagers. Case study also helped to understand other linkages within the study.

SECONDARY SOURCES

Secondary sources of data collection include review of literature from different libraries. Data from office settings and reports and documents collected from Panchayat and Pollution control board. Relevant literatures collected from different libraries were reviewed to understand social context of sewage water pollution in general and the Ganga Action Plan in particular. It also helped to know the objectives of sewage water farming and also to conceptualize the study.

Data on current situation of Ganga Action Plan was collected through Ganga Pollution Control Unit of Varanasi and from Annual report of Ministry of Environment and Forest. From Panchayat office, the village profile including available institutional details was collected.

DATA ANALYSIS

Data analysis was carried out at different stages of the study. As quantitative and qualitative data comprise the set of data collected, analysis also was of different types. The quantitative data included the details of the household. Through the schedule, quantitative as well as qualitative data was collected. In the schedule, each question was taken separately and answers were coded separately. Later on, the frequency for each code was examined.

For qualitative data like observation, in-depth interview, informal discussion and case study, a field diary was maintained in which the whole experience was recorded and later on consolidated to generate adequate information. Government documents and other institutional documents were reviewed for more information.

Quantitative data helped in developing a profile of the responses to understand the distribution of the problem, where as qualitative data helped in gaining an understanding to explain the reasons behind it. Qualitative data also helped to understand the burden of the problem and the complex linkages existing in the lives of the people in the village.

TIME SCHEDULE

Time period for the data collection was December 2003 and January 2004. Investigator worked from 9 am to 1 pm and in evenings as well. But due to problem in selection of the respondents, fieldwork was extended for another fortnight. In this time period, there was a lot of opportunity to understand the life of the villagers and depth of the problem.

LIMITATIONS

The study on the impact of sewage water farming on life and health of the people is an exploratory case study of three villages. As there was constraint of time and cost, the study confines only to the three specific villages, whose results cannot be fully generalized. The change in sampling technique may have affected the data collection, since to same extent we sampled only from those who were willing to give information. However the problem is pervasive that the bias introduced is probably not significant.

The area of the study villages is very interior from the main road and there were no means of public transportation. Another major problem cropped up during the data collection was the apathy of the people. Frequent visits and interviews made by different people (for research studies and media) made the villagers to state that they were getting nothing out of these studies.

Time was a major constraint for the study. After 12 o'clock in noon, it was difficult to work because of farmers' daily routine [usually they were out of their houses]. Plant authorities were often not agreed to talk on sensitive issues like quality of treated water and functioning of the plant. The Panchayat officials and plant personnel did not give important data related to the study.

CHAPTER IV

AREA DESCRIPTION

HISTORY OF THE AREA

Varanasi is one of the oldest living cities of the world. It is famous around the world as a religious and spiritual city. The common belief among the Hindus is that this city has existed since the beginning of the world. One such story is that Kashi - now known as Varanasi is situated on the *'Trishul'* of Lord Shiva and is parallel to three mythical world i.e. *Svarg*, *Narak*, and *Pathal Lok*. This area is *'Avimukt'* kshetra because it is the permanent abode and liking of Lord Shiva. Varanasi is also accepted as the city of death and liberation.

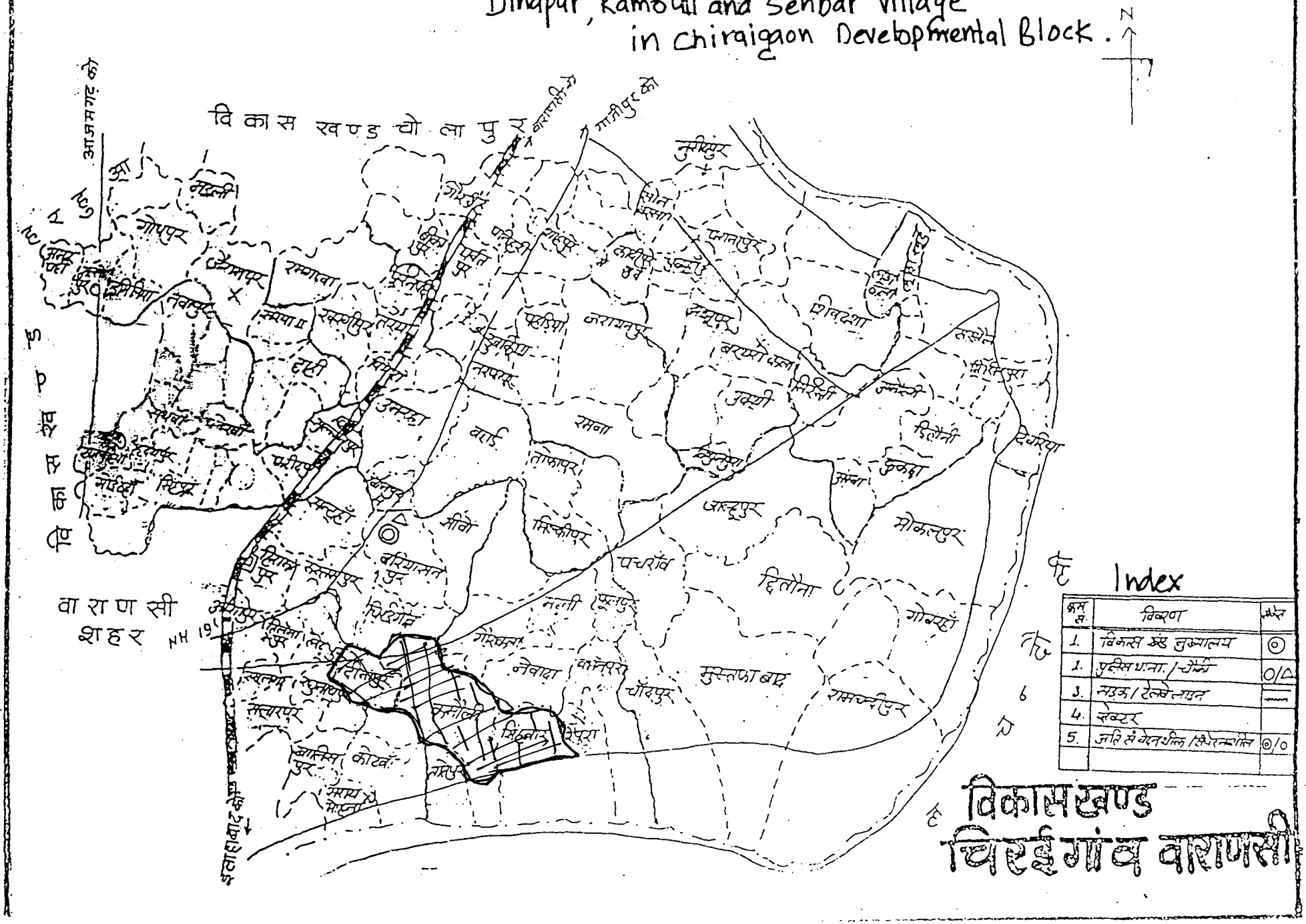
Varanasi has recorded history of more than three thousand years. In sixth century BC, Buddha preached his first sermon at Sarnath near Varanasi. Four of the *Jain* Prophets were born here. Sheikh Ali Haji of Iran who had come to Varanasi and lived for some time in the city, wrote " I would not leave her, as she was the house of prayer for all ".

The old name of Varanasi was *'Kashi'*. Kashi has generally been associated with King Kash of the dynasty of Ayu (Brahman and Vayu Puran). Kash was the 7th King in the Chandra dynasty. However, some historian believes that *Kasis*, who were one of the Arya tribes, established themselves in the Ganga valley near Varanasi at a date supposed to be between 1400-1000B.C. The city was named as Kashi after that tribe.

Dr Motilal and Vasudev Sharan Agarwal argue that Varana was a kind of a tree, which was found in abundance in the area where Varanasi is situated today. Large tracts of forest now extinct or unidentified surrounded the human habitation of this place, which took its name after these trees as Varnasi, which latter becomes Varanasi.

Dr. Vasudev Sharan also believed that since the area was mostly marshy and full of tall grass of *'kush'* and *'kas'* varieties, it also came to be known as Kashi. The first reference of Varanasi in the Vedic literature is found in the *'Atharvaveda'* but the *'Shatpath Brahman'* also mentions an Arya king by the name of Shataneek Satrajit who had defeated the king of Varanasi. The common belief is that the city of Varanasi has been confined between the river Varuna and Assi. According to *'Varuna Purana'* the

Dinapur, Kamoli and Sehbar Village in Chiraigaon Developmental Block.



Varuna and Assi rivers were originated from the body of primordial person at the beginning of time itself.

Aurangzeb tried to change the name of Varanasi as Mohamnadabad but the people of the city never accepted this name. A few documents of Aurangzeb era bear testimony to this effort.

GEOGRAPHICAL LOCATION

Area of the study, Dinapur Sewage Treatment Plant and selected three villages are situated in the north direction of Varanasi city on Varanasi- Gazipur high way and, it is about 8 km away from district collectorate.

Geographical feature of the area is that it is located down stream of Ganga river. All the three selected villages have different characteristics, even though they are from the same developmental block and hardly 5 km away from each other. In past, this area was known as ancient *Kashi*. The major economic activities of the villages are farming, weaving (including world famous *Banarasi-sarees*, carpet, bags etc), fishing, garland making and food processing activities.

Now if we take an overview of district, total area of the district is 1550 sq. k.m.[1] The district headquarter is located at Varanasi. Total population of the district in 2001 was about 3147924.[2]

The scheduled castes and scheduled tribes population of the district was 17.3 percent and 2.0 percent respectively.[3] Population of Scheduled Caste and Scheduled Tribe in Chiraigoan Block was 20.5 percent[4]

The population density of the district in 2001 was 1995 person per sq/k.m. But density of the Block was 947. Literacy rate of Varanasi in 2001 was 67. Female Literacy was 48 per hundred.

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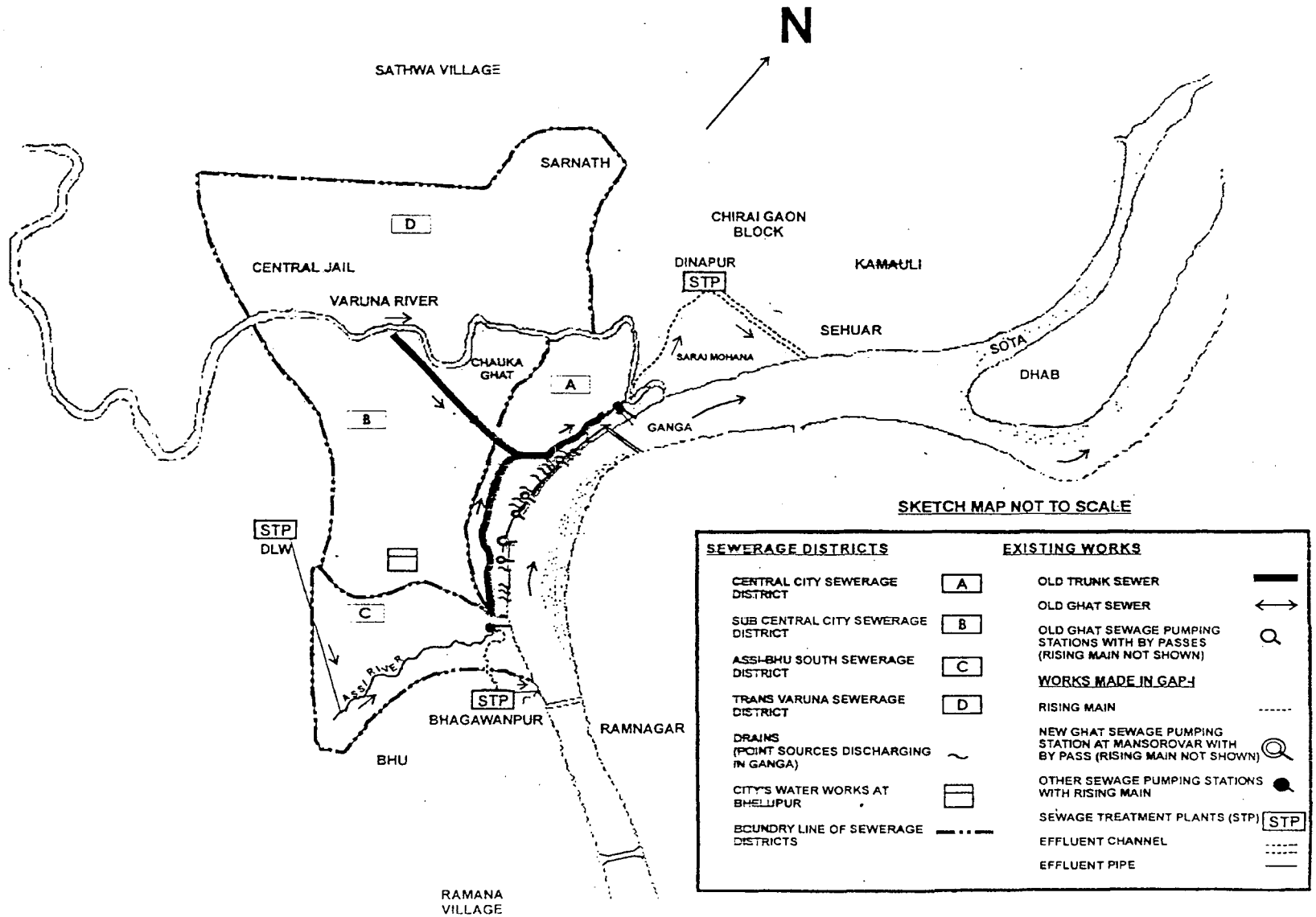
[1] Government of India, *Statistical Year Book* (2003), Varanasi District
[2] GOI (2001): Census
[3] GOI (1991): Census.
[4] Ibid.

MAP 3 : SEWAGE DISPOSAL SYSTEM OF VARANASI



SANKAT MOCHAN FOUNDATION, VARANASI. JULY 2003

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Average height of the district from the sea level is 258146 feet. The average maximum temperature of the district is 46.48'c.and minimum is 3.2'c.Geographical location is on longitude 83.0E and latitude of 25.20N. Average rainfall (1997) of the district is 1019 mm.[5] *Kharif* and *Rabi* are two main crops grown in the district. Situated on the Grand Trunk Road the district has well laid out road and rail links. The service of both Northern and North East Railways are available in the district. There are three National Highways and state Highways passing through the district. In districts, Air services are also available.

In Varanasi district, there are two *Tehsils*, first one is Varanasi Sadar and second is Pindra. There are eight development blocks such as Kashi Vidyapith, Cholapur, Badagaon, Chiriagoan, Harahua, Pindra, Arajiline and Sevapuri. Number of Panchayats in district is 698. Total number of villages in the district is 1336. Out of this 1336, 1262 are inhabited.[6]

The district is well placed in the matter of medical facilities. The number of allopathic hospitals in district is 61, Ayurvedic Hospitals 28, Unani hospitals 1, Homeopathic 13, Primary Health Centres-31, Family welfare centre 35, Family welfare sub centre-234, TB Hospitals 2, Leprosy 1.[7]

Varanasi is famous all over the world for handicrafts, beautiful brocades, gossamer fabrics and carpets. Handloom weaving is also very important industry of the district. Silk weaving industry enjoys countrywide market and it is also exported abroad. Wooden toys and brassware industries are also prominent in the city. The important commodities of the district are Diesel engines, silk *sarees* and rice. Main languages spoken in district are Hindi, Urdu, Bengali and Bhojpuri.

SEWAGE DISPOSAL SYSTEM OF VARANASI

Sewage System of Varanasi city is divided into four parts, (a) Central City Sewage (b) Sub Central Sewage District (c) Assi -B.H.U South Sewerage District and (d) Trans Varuna Sewerage District.

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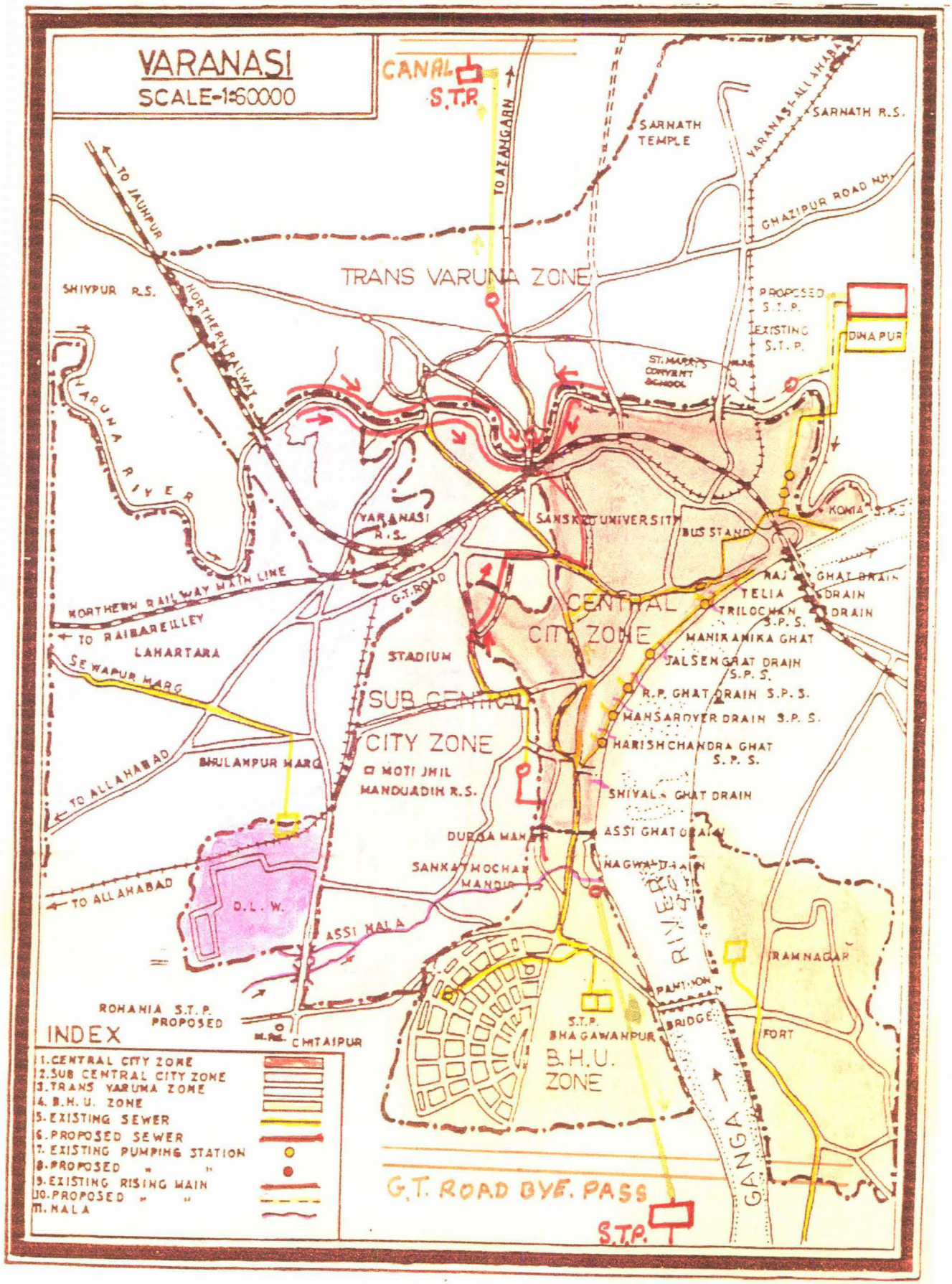
[5] *Government of India Statistical Year Book*, (2003) Varanasi District.
[6] Ibid.
[7] Ibid.

Dinapur Sewage Treatment Plant and Varanasi City.

MAP = 4



Sewer line of Varanasi was started in 1917 for a projected population of two lakhs. At present, more then 15-lakh people live in the city. Trunk sewer of city is 80 year old. The total length of sewage line is 325 km with the breadth of 150 mm to 2400 mm.[8]

For Trans Varuna Sewerage District, there are no sewage-lines and drainage of this area directly falls in river Varuna. For Assi-BHU, South Sewerage District, there are two sewage treatment plants. One belongs to Diesel Locomotive Works (DLW) and the other to Banaras Hindu University (BHU) and Jal Nigam. This plant was established by BHU, but now it has been handed over to Jal Nigm. In Dinapur, Sewage Treatment Plant (STP), sewage water for treatment mainly comes from Central City Sewage District. But before the construction of Dinapur Sewage Treatment Plant (started in 1989 and competed in 1991), sewage water of Varanasi was directly flowing into the river Ganga.

At present, in Varanasi there are 7 sewage water pumping stations, which pumps all sewage water to Old Konia Sewage Pumping House (KPH) near to Raj Ghat in north direction of the city and on down stream of Ganga river for pre-treatment of sewage water.

KPS was built up in 1962-63 by Jal-Nigam. Canal of Dinapur STP was also constructed at the same year. KPH has a facility of pretreatment of sewage water. After the pretreatment and screening of sewage water, KPH sends that water to Dinapur for water and sludge treatment. The capacity of Konia pump house is 100-million liter per day. But the capacity of Dinapur Plant is only 80 million-liter per day. At the same time out-let or production of sewage water in the city is more than 250 million liter per day in 2003.[9] Therefore at present KPH, by passes surplus of sewage water i.e. is 150 million liter to the Varuna River, a tributary of the Ganga and from the Varuna straight to Ganga.

During investigator's fieldwork (Dec 03 – Jan 04), there was daily electricity cut at Konia, from 9 a.m. to 2 p.m. in noon. Dinapur Sewage Treatment Plant was also not working between 9 a.m. to 3 p.m. daily because of intermittent power cuts. Cleaning of holy Ganga was stopped that time due to this. The electric connection of both units is from same electricity - line. And there was no electricity.

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[8] U.P. Jal Nigam *Annual Report*, (2003)

[9] When the Ganga Action Plan was launched in 1986 the production of sewage water in city was 147 MLD.

Whole sewage water of city was directly falling into the Ganga and the Varuna River, because there was no money to run the electric generators. One generator of KPH needs 100 litres of diesel for an hour and at a time to run the water pumps there is a need of at least two generators that means 200 litres diesel per hour, to run the water pumps. There is no fund to run these generators. The problem with the KPH is that they can't stop the sewage water to falling in Varuna River at the time of power cuts because if they stop sewage water, city will fill with sewage water and sewer line will become choked. They have no option other than to bypass sewage water to River Varuna. This non-functioning of pump-houses and the sewage treatment plant is officially known. But there are complaints that in addition to non-treatment of sewage from 9 a.m. to 2 p.m., in late nights KPH bypasses whole water to the Varuna River without pretreatment because on the screening platform there is a need of supervision, and in cold nights operators prefer to sleep rather than monitoring.

DINAPUR SEWAGE TREATMENT PLANT AND THE CANAL

Area of the Dinapur Sewage Treatment Plant is about 70 to 75 acres. Capacity of the plant is to treat 80 million-liter of water per day (MLD). In plant, there are three parallel units to treat sewage water. There are 29 sludge-drying beds, measurement of 30m>< 30m =25, 30m><20m=3 and 30><15m =1. Production of sludge in a year is near about 16000 to 18000 cubic meter. It takes 25 days to dry the sludge and in a month (30 days), one bed becomes full.

After the treatment of sewage water, Dinapur sewage treatment plant is releasing this water through, six km long canal to the Ganga. The capacity of this canal is to irrigate 1000 hectars of land of eight villages nearby.

Farmers of the area are using this water for irrigation. Chargers for using water for irrigation are Rs. 300 *per Bigha*. Farmers of this area are using canal water for their fields because there is no other proper means for irrigation. Sewage Treatment Plant also provides dry sludge in the name of non-conventional fertilizer. Rate of sludge is Rs. 85 per cubic meter. Local farmers of the area are not using this so called non-conventional

fertilizer in their fields, and presently this sludge is taken by small and medium manufactures to make organic fertilizer. However, this sludge contains high level of detergents, chemical, and heavy metals. Consumers of other areas are being sold this as organic fertilizer. Manufacturers are mixing sand, chemical fertilizer like urea (nitrogen), chaff of rice etc. to give a look of organic fertilizer.

There are three digesters in this plant, which produces gas regularly. This gas is highly flammable and contains near about 60 percent of methane. Plant is using this gas to run their generators during power cuts and to run their fans and tube-lights. Generators are utilizing gas into a ratio of 9:1(Nine parts of gas and one part of diesel). Plant is not able to utilize this gas properly because of lack of technology and funds. In night and even in daytime, when there is electricity, plant burns this gas or releases it into the air, which creates breathing problems for villagers.

DINAPUR PANCHAYAT– A DESCRIPTION

Dinapur is the first Panchayat of our study. Orchards surround this Panchayat. Sewage Treatment Plant is situated here and, it is nearest village to the city than two others. Main economic activity of Dinapur is farming. Because this village is near to city, most of the farmers grow flowers, fruits and vegetables.

In Varanasi, near about sixty thousand pilgrims take a dip in Holy Ganga daily.[10] There is increasing demand of flowers. There are large numbers of farmers growing flowers. In winter, visit to the village is a memorable one. We see fields full in colours. In morning, it is interesting to see small children plucking buds from flower-fields in deep fog.

Another cause behind present agriculture pattern of flowers, vegetable and fruit is that this village is dominated by small farmers *'Mouria*" and they are traditionally vegetable growers. Small land holdings, availability of water for irrigation and over burden on lands have further kept the traditional patterns of family.

[10] *Down to Earth*, 15 June 2004. p. 50

At present in Dinapur, almost each and every farmer is experimenting new techniques and growing hybrid seeds to get more production. Wheat and rice are grown in the village for consumption at home.

From fruits, vegetable to food preserving (making pickles and jam-jelly), weaving sari and carpet are the other major economic activities of the village. In the village, majority of the general castes and other backward castes are involved in horticulture and scheduled castes are weavers.

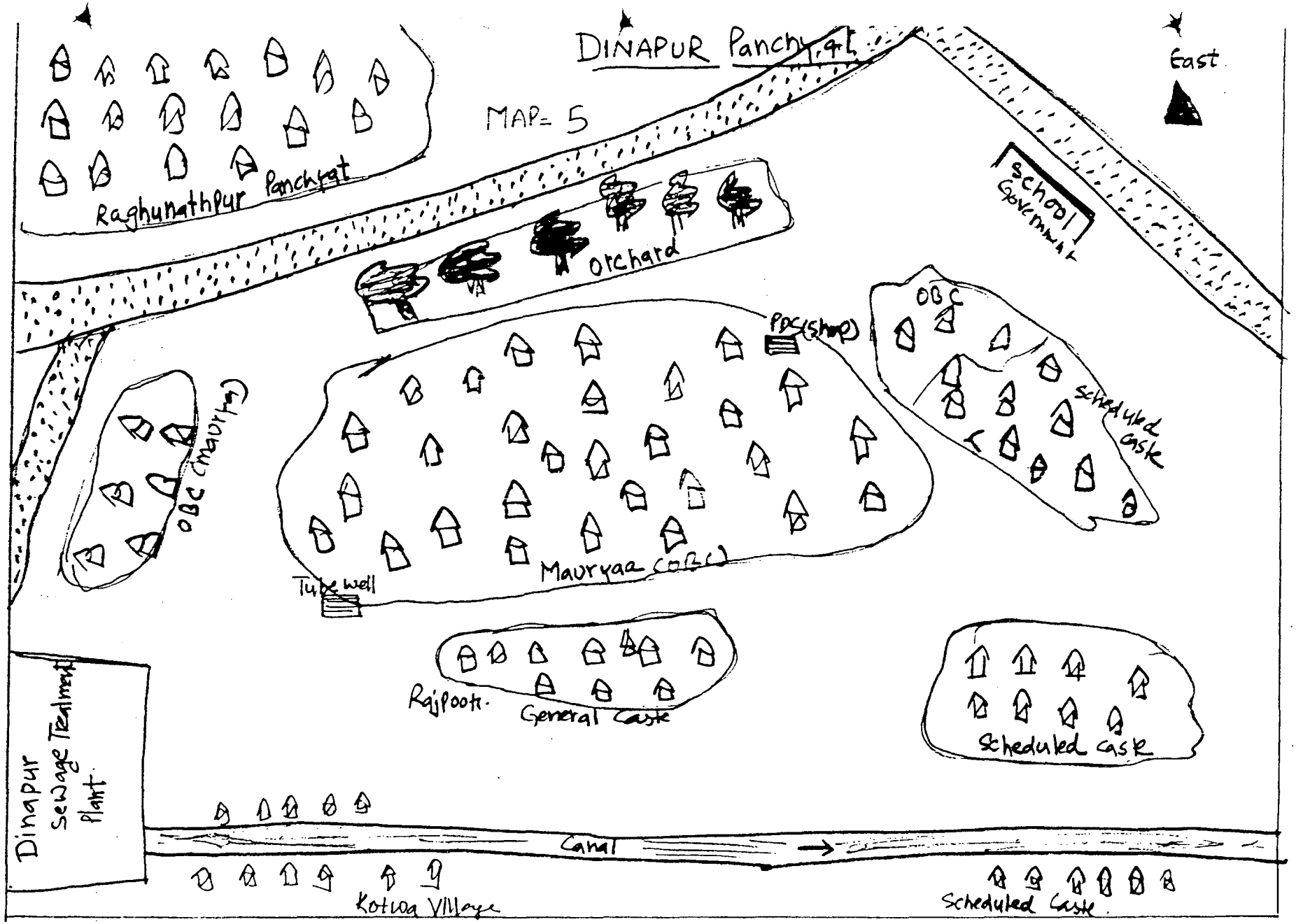
To visit Dinapur, we get into a private bus on *'Balua Ghat Road' from 'Chandra Chock'*. In every half an hour, there is a private bus. Buses are in very poor condition. these buses are crammed with canes of milk, bicycle, school children, and vegetables.

However, there is no means for public transportation. Villagers manage with their own means of transport. Village fields start from the road therefore usually villagers have to walk down. Area of the village starts from the main road but village habitation is not found on a single place, it is scattered. To cover whole village, one has to walk more than 3 km. Houses in the village are congested. Government primary school is located at the centre of the village. Children found playing near a building makes a guess that this may be a primary school. Near the school there is a pond.

No other government facility in the form of health centre or post office is available. Pitch and brick roads connect houses and we find most of the time farmers working on their fields. The road to the Panchayat passes through gardens and vegetable fields. There are also newly constructed houses on the road. In the village, there are some small pan, tea and cigarette shops. But grocery shops are on the main road.

Sewage treatment plant is situated here on the East Side of the Panchayat near to Kotwa Scheduled caste *Basti* and Ragunathpur village. Canal passes thorough the centre of fields and it is very close to some houses.

In the village, there are three Aganwari centres, one PDS shop, eight private doctors practicing allopathic medicine without MBBS degree. There is no public phone both in the village. But some of the families have their personal telephone and mobile.



Dinapur Panchyat.

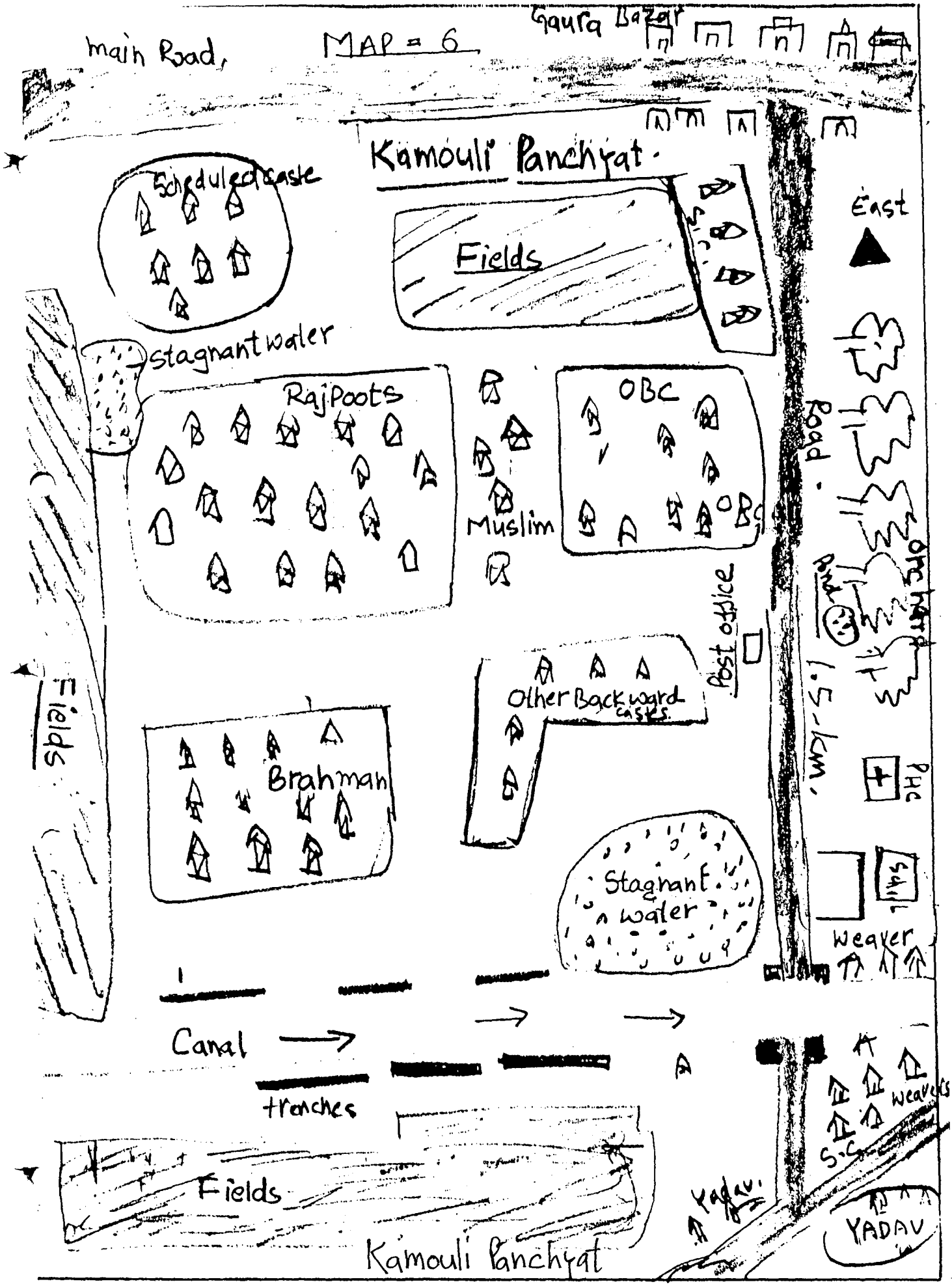
ADMINISTRATION OF PANCHAYAT

In Dinapur Panchayat, there are 13 wards and each ward has one member. 7 ward members are male and 6 are female. 3 members are from Scheduled Caste; two of them are male and one is female. From backward caste there are 9 members, of them 5 are male and 4 are female. 1 female member is from general caste. Name of the Pradhan of Dinapur Panchayat is Shri Ramjeet Prasad Mouria. He is a schoolteacher and belongs to other backward caste. Panchayat Secretary of the Panchayat is Sri Kanta Prasad Yadav. From Dinapur Panchayat, two members are elected for Panchayat Samiti [Block level body]. They are Sri Mangala Yadav and Sri Mahendra.

KAMOULI PANCHAYAT– A DESCRIPTION

Kamouli is the second Panchayat for our study. It lies on '*Balua Ghat Road*' after 1 km from Dinapur bus stop. After getting down to '*Gaura Bazar*' one can go to the village. From main road there is no means of transportation. Villagers use their own means of transportation. Main hamlet is one and half kilometer from the main road. When one enters the village, he can see one big orchard, health centre, post office and cooperative. Upper caste Brahmans and Rajputs are dominant castes in the village. Second dominating caste of the village is *Yadav*. Houses of every caste are situated in the main hamlet of the village. Muslims are at the centre of the hamlet. Muslim houses are very congested and most of them are *kacha*. There is no proper facility of drainage. They are poorest in the village. Main economic activity of Muslims is weaving. Usually whole family involved in weaving. In the village there are also some power looms. They also belong to Muslims. Scheduled Caste houses are in the southwest direction of the village.

Another Scheduled Caste *Basti* is situated along the canal in west direction of the village. Most of them are weavers and land less. Canal is situated in the West direction of the village. Poorer are the worst sufferers of the canal water. Main economic activity of the village is agriculture. Lower and minority caste people are involved in sari weaving. One another important business of the village is dairy. All most every Yadav family is involved in it. But the manner of keeping dairy cattle is traditional. Agricultural pattern of Kamouli is different from Dinapur. Landholding is mainly in the hands of upper caste.


MAP = 6
Gaura Bazar
main Road,
Kamouli Panchyat
Schedulect caste
Fields
East
Stagnant water
Rajpoots
Muslim
OBC
Road.
Orchard
Pond
1.5 km.
Post office
Other Backward castes
Fields
Brahman
PHC
Stagnant water
School
Weaver
Canal
tranches
Fields
weavers
S.C
Yadav
YADAV
Kamouli Panchyat

Major crops of the village are wheat and rice. Sewage canal is hardly 20 metres away from the main *Basti.* Between village and canal there is a pond. We find pond is always full with canal water. Few families from upper caste have government jobs.

Near the village there is one Primary Health Centre running in '*Gobaraha village*', which is under Kamouli Panchayat. Treatment charge for 15 days is two rupees here. It provides mainly reproductive and child health services. Almost all the time of fieldwork, investigator found that there was no sign of functioning of it and the health centre was closed. It was noticed that from morning till the evening children were playing cricket on the floors of the health centre.

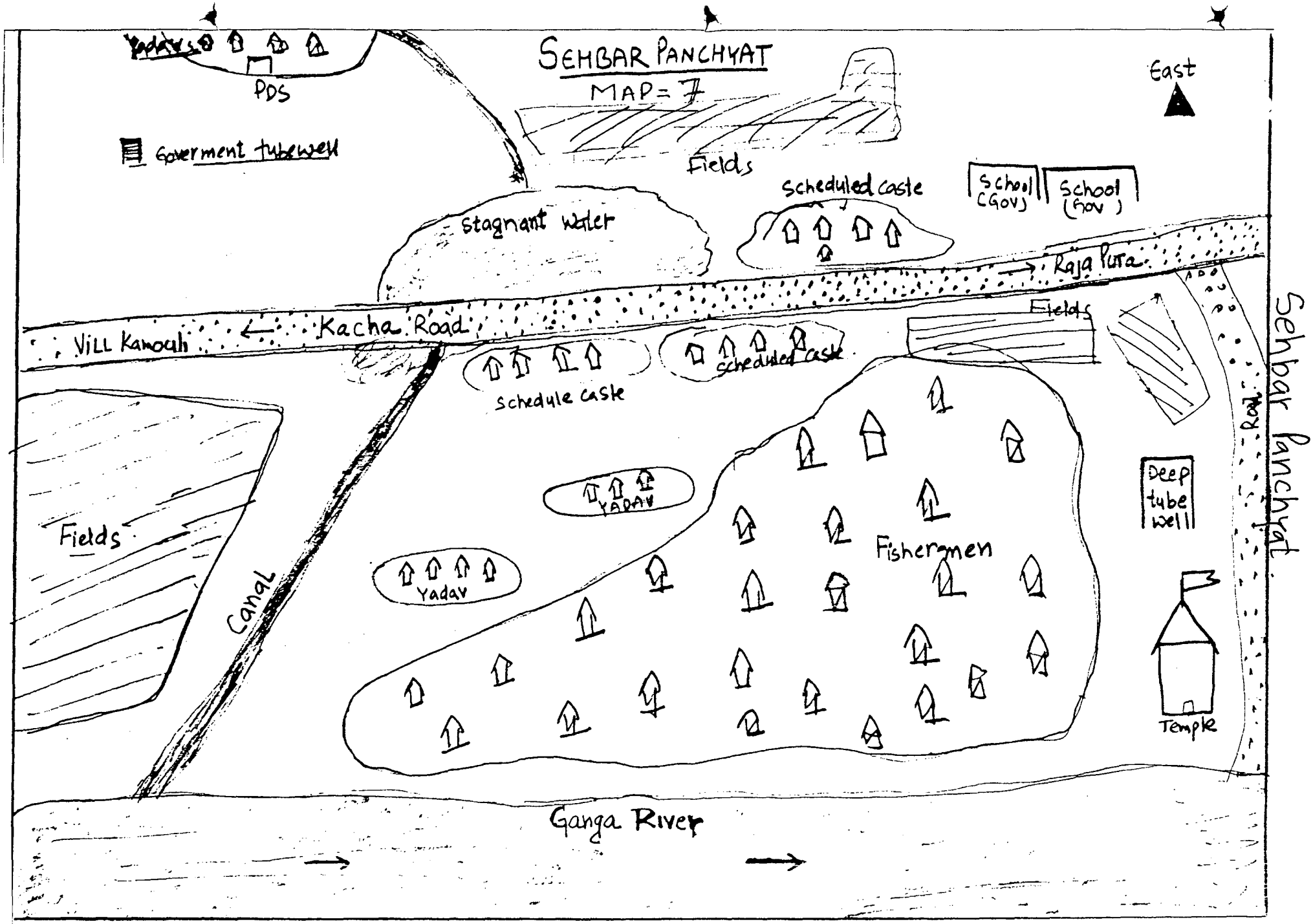
At present in Kamouli, there are private doctors practicing allopathic medicine. Number of private doctors is not certain because in every three months either it increases or decreases. In Kamouli, there are three Aganwari centres. Two out of them are located in forward caste *Basti* and one in other backward caste *Basti.* There is no public phone booth in the village. But some of the families have their personal telephone.

ADMINISTRATION OF PANCHAYAT KAMOULI

Name of the Gram Pradhan of Kamouli Panchayat is Mrs. Gayatri Devi, w/o Sri Surender Tiwari. She is a housewife. She has been elected as a Gram Pradhan, because of reservation for women in Panchayat. In Kamouli, there are two Panchayat Secretaries, Sri Sita Ram Yadav and Sri Kailash Parasad Yadav. In Gram Panchayat, there are 15 ward members. . 7 of them are male and 8 are female. 7 of them are from general castes, 6 from other backward castes and 1 from Scheduled Caste. There is also one ward member from Muslim community (minority).

SEHBAR PANCHAYAT– A DESCRIPTION

Sehbar is the last Panchayat of our study. Sehbar is situated on the West Bank of Ganga. This is a historical village. Name of the village is also mentioned in Hindu's holy book "*Shiv Puran.*" Broken parts of archeological statues are found here and there in the village. Incident of stealing these statues is common. One very old *Shiv Temple* is also situated in the village. No body knows when and who built it. At present, there is no pitch


SEHBAR PANCHYAT
MAP = 7
East
PDS
Goverment tubewell
Fields
Scheduled caste
School (Gov)
School (Gov)
Stagnant water
Raja Pura
Vill Kanoudi
Kacha Road
Fields
Schedule caste
Scheduled caste
Sehbar Panchyat
Road
Deep tube well
YADAV
Fishermen
Yadav
Canal
Fields
Temple
Ganga River

road in the village. This village is near about 2 km away in north direction from Kamouli Panchayat. From Kamouli, one *semi-pucca* road goes to Sehbar. There is no means for transportation for Sehbar. Sometimes luckily one sees empty tractors going to the village to bring sand.

This village is mainly dominated by *'Mallah'* i.e. fishermen caste. At present main economic activity of the village is sand mining. Whole village in involved in it. In Sehbar, most of the villagers are land less therefore they are dependent on their labour for their livelihood. Lower caste people like *Harijans* are also landless and but they are involved in sari weaving. In Sehbar, Yadav and upper caste families have land and their main economic activity is agriculture. Pattern of agriculture in Sehbar is traditional and landowner mainly grows wheat, millet and rice. Millet is grown for fodder purpose.

Canal of the sewage treatment plant falls into the Ganga just before the village. It has resulted in sharp decline in quantity of fish and therefore fishermen are turned up into daily wageworker in sand mines. At present, for Loading a tractors of sand they gets 30 rupee. One labourer gets one or two chances to work there in a day. There is no other work in the village therefore whole family is dependent on earning of one or two male members. In Sehbar, there is one Aganwari Centre. It is located in *Yadav-Basti* and it is near about 1.5 km away from the Main *Basti*. P.D.S shop is also situated in *Yadav-Basti* and away from the village. In Sehbar, there are two private doctors but in the village, but there is no health centre, public phone both or post office.

ADMINISTRATION OF PANCHAYAT SEHBAR

In Sehbar village, there are 11 ward members. 6 of them are female and 5 are male. 1 female member is from Scheduled Caste and 5 are from other backward caste. Name of the Gram Pradhan is Sri Sangram Sahani. He is ' *Mallaha*' (fisherman) by the caste and illiterate. Panchayat Secretary of the village is Sri Vansh Narayan Tiwari. He joined the Panchayat recently. Few months ago, he was suspended on scandal charges.

SUMMARY

The chapter tries to present a picture of the area of study by discussing the geographical, demographic, historical, economic and climatic condition of the area.

Varanasi is one of the easternmost districts of Uttar Pradesh. Average rainfall in the district is more then 1019 mm. It is known as a religious city and for its handicrafts. The administration of study Panchayats are similar to other panchayats of Uttar Pradesh. Three-tier system of self-government is also present here. In Kamouli, Gram Pradhan is female otherwise in rest two villages they are male. The Gram Pradhan of Kamouli is female but her husband does all administrative works.

This whole area is agriculturally developed, but Dinapur is better than other two villages. At present, farmers of Dinapur are utilizing new techniques more than Kamouli and Sehbar. Pattern of agriculture in Kamouli is still conventional. Wheat and rice cereal are the main crops of the village. But in Dinapur, farmers are growing vegetables, fruits (like papaya) and flowers with cereals. Lower and minority caste people are mainly involved in weaving or they daily wage labour in the city. In Dinapur, all castes are living separately. But in Kamouli, more or less all castes are on the same place with reasonable distances. In Sehbar, one big *'Yadav Basti'* is separate but houses of other castes are also located in the same hamlet. But interestingly poor caste people houses are more congested in all three villages. STP is located in the east side of Dinapur. It is effecting all the three villages and lives of the people. Dinapur is facing environmental pollution. In Kamouli, main problem is from canal water and non-availability of safe drinking water. Fishermen's of Sehbar have turned up into daily wage labourers in sand mines because of the canal pollution in the Ganga river.

The major transportation facility in all three villages is private buses along the main roads. For those residing in the interiors, walking to reach main road is only a way. But Kamouli has more government facilities than rest two villages. It has health centre, post office and cooperative. None of the other villages has these facilities. Primary and secondary schools are in all three villages but health facilities are very poor. Sehbar is the most underdeveloped Panchayat among the three. It is interior also. In facts, this chapter sets the context for the analysis in the next chapter.

CHAPTER V

PROFILE OF THE PEOPLE UNDER STUDY

People of Dinapur, Kamouli and Sehbar Panchayat are the most important part of this study. To understand the effect of Sewage Treatment Plant (henceforth STP) on the people and environment, they are being interviewed.

As per the methodology, data was collected from three villages near Dinapur Sewage Treatment Plant. The total number of 121 households from the above mentioned villages were interviewed, both at the individual and family level, and the focus was their socioeconomic, health and environmental conditions.

Socioeconomic status of a household as mentioned in the methodology has been understood here by considering the castes, the sum total of the monthly income of the households, social status determined by the occupation of the members, livestock and landholding status. Household possessions are also linked to the caste they belong and educational status.

Table 5.01

Caste Groups of the Sample Families

Village	General	O.B.C	S.C.	Muslim	Total
Dinapur	4 (9.0)	33 (75)	7 (15.9)	-	44
Kamouli	10 (17.6)	36 (63.1)	8 (14.0)	3 (5.3)	57
Sehbar	-	13 (65)	7 (35)	-	20
Total	14 (11.6)	82 (67.8)	22 (18.2)	3 (2.5)	121

Caste is an important form of social structure in Indian society. Caste determines social, political and economic conditions of a person in our society. Till today, caste-panchayats decides and even influences local level developmental programmes launched

by the government. Even in our study areas, the influence of these caste panchayats has been found.

As mentioned earlier, our study area consisting of three villages is situated in Eastern Uttar Pradesh. In our study area, other backward castes (OBC), *Maurayaas* dominate. They are vegetable growers and in last few decades they have achieved success in vegetable production and earned money, name and fame for themselves.

It is also evident from Table 5.01 that Other Backward Castes (67.8 percent) are in majority in this area. But the Other Backward Castes not only include Maurayaas but *Yadavs* and *Mallah* (fishermen) as well. Though in some states, *Mallah* are considered in government records as Scheduled Castes (SC), but in Uttar Pradesh, they come under the Other Backward Castes label.

Other Backward Castes, with a clear-cut majority population in this area, dominate the local politics. The Member of Parliament elected from this area usually belongs to *Maurayaa* caste. However *Mallah* who are officially Other Backward Castes, but they are not considered as Other Backward Castes. Their social status in the villages remains same as the status of Scheduled Castes because traditional they are scheduled caste. Scheduled Caste population in our study area is about 20 percent but now they have become politically aware. In last few years they have become very active politically. Muslims are in minority and over all general castes are less than fifteen percent.

Table 5.02

Family Size of the Sample by Member in Household

Villages	0-4 member	4-8 member	>8 member	Total
Dinapur	5 (10.6)	19 (43.2)	20 (45.4)	44
Kamouli	1 (1.8)	20 (35.0)	36 (63.2)	57
Sehbar	1 (5)	8 (40)	11 (55)	20
Total	7 (5.8)	47(38.8)	67 (55.4)	121

To know and understand any community, it is imperative to know the size of the family. In our study area, while visiting the families, it was seen that most of the families are joint families. Over all percentage of joint family i.e. > 8 members was more than fifty percent. In Kmouli, joint families are highest in number with a staggering 63.2 percent of the total. In Kamouli, majority of households have land (87.7 percent) and they are medium and big farmers. Land is perhaps the major factor behind the existence of these joint families. In some families, mostly among the general castes of this village, it is also seen that paternal family members are staying in urban areas or outside their birthplace, but they still consider themselves to be the part of the parent family because land and house are not divided. So, they have been recorded as joint families.

At the same time, it is also seen that in Dinapur nuclear families are more (10.63 percent) in comparison to other villages of our study. This is because of the fact that 70 percent (See Table 5.08) of the families are small farmers and further land divisions don't affect them in economic terms.

EDUCATIONAL STATUS

Educational status of this area is poor. According to 1991 census, average literacy rate these three villages was 27 percent. In Sehbar, women's literacy rate was 6.3 percent. There are government schools in all three villages, but functioning of these schools is not satisfactory.

As per the statistics, Dinapur has only one primary school, but in Kamouli and Sehbar there are secondary schools (till class 8^{th}). At present, number of enrolments in Dinapur Primary School is about 300. In Kamouli, number of enrolments in Primary school is 300 and in Secondary school, it is 150. Total number of students in Primary School of Sehbar is about 250.

In addition to government schools, Dinapur has two private schools. In Kamouli, there are three private schools, two of which are from nursery to class 8^{th} and one is up to class 10^{th}. Total number of students in these schools is about 800. Students from different nearby villages study in these schools but majority of the students are from Kamouli. Average tuition fee for all the private schools is Rs. 20 per month. Economically sound families prefer these schools for their children's education.

Near to Sehbar is *Raipura* village, where there is one private school. Children from Sehbar studying in this school are mainly from *Yadav* castes. However, some fishermen and schedule caste families send their children to this school for better education. This shows the educational awareness of the poorer castes. For further studies, students have to go to other villages. Nearest High –School for all the three villages is situated in *Gaura Bazar*, about two kilometers away from Dinapur.

From this data it is evident that most of the families are sending their children to government schools. It is corroborated by the responses of the households that families, who cannot afford to provide their children education in private schools, prefer government schools. Apart from the above, non-availability of private school near the household is another important factor, which prompts them to admit their children in government schools.

Out of 1264 members of the 121 sample households, 30.5 percent (385) are less than 15 years. Of the remaining 879 members, 69 percent (607) are illiterate, 16.8 percent (148) are primary passed, 7.9 percent (70) have education up to till eighth, 4.3 percent (38) have studied class 10^{th}, and only 1.8 % (16) have education above class $12^{th.}$

In Dinapur, it was found that from selected households 11.4 percent (5) families all members were literate and in Kamouli this percentage was 24.6 (14). But in Sehbar, no all-literate member family was found.

There is high rate of dropouts. Parents don't prefer to send their adolescent daughter even to their own villages for education. Other Backward Castes and Scheduled Castes prefer their children to help in their daily work. Children usually contribute to the family's economy. This compels them to stop their study after primary school. Baby-sitting or taking care of the small children in their family is the main cause behind low literacy of girls. But general caste (upper caste) people send their children to nearby villages or cities to pursue higher education. At present most of the literate or some educated people are working in their own village except few people who are in private sector in Varanasi city. They are staying in their village and commute to their working places every day. Some others who are in defence services like army or in paramilitary mainly belong to Other Backward Castes or General Castes.

SOCIO-ECONOMIC CONDITIONS OF THE HOUSEHOLD

Table 5.03

Land Ownership of the Sample in Acre

Village	Land less	< 1 acre	1-3 acre	3-5 acre	>5 acre	Total
Dinapur	4 (9.0)	31 (70.5)	6 (13.6)	3 (6.8)	-	44
Kamouli	7 (12.3)	11 (19.3)	21 (36.8)	13 (22.8)	5 (8.77)	57
Sehbar	16 (80)	-	3 (15)	1 (5)	-	20
Total	27 (22.3)	42 (34.7)	30 (24.8)	17 (14.0)	5 (4.1)	121

Primary characteristic of the study area is heavy pressure on agricultural land as well as unequal distribution of land. In the state of Uttar Pradesh, after independence, land reforms have not been implemented fully and firmly. Consequently, 22.3 percent of population in the study villages (mainly scheduled castes and minority) is land-less.

In Dinapur, majority of the Other Backward Castes households have small landholding (< 1 acre) But in Kamouli general castes have big landholdings (> 5 acre) than other castes. In Kamouli situation of other backward caste is satisfactory and they have medium landholdings (3-5 acre) but in all the three villages, though scheduled castes have nominal land (< 1 acre), but majority of them are land-less. The selected three Muslim families in Kamouli are land less. In Sehbar, fishermen are more in number but all of them are land less. In this village, landholdings mainly belong to (20 percent) Yadavs (other backward castes). Therefore, they are financially sound and dominate other castes in socio-economic terms.

Therefore an overall picture of the area shows that majority of the households are small and medium (less than 3 acres of land) farmers. In our sample households, 22.3 percent of the families are land less and most of them belong to scheduled castes. Their houses are located near the STP or the canal.

Cultivation patterns in these villages are different from each other. In Dinapur, farmers mainly grow vegetable and fruits. But in Kamouli and Sehbar farmers grow cereals.

Caste is another cause behind present cultivation pattern. Cultivation of fruits and vegetables needs more labour and *Mauryaas* (Other Backward Castes) of the area are well known for their labour and have been cultivating vegetables for generations.

Table 5.04

Main Occupation of the Sample Households

Occupation	Dinapur	Kamouli	Sehbar	Total
Agriculture	30 (68.2)	33 (57.9)	4 (20)	67 (55.4)
Service	9 (20.5)	16 (28.0)	2 (10)	27 (22.3)
Weaving	2 (4.5)	7 (12.3)	3 (15)	12 (9.9)
Laborer	1 (2.3)	-	11 (55)	12 (9.9)
Shopkeeper	2 (4.5)	1 (1.8)	-	3 (2.5)
Total	44 (100)	57 (100)	20 (100)	121 (100)

It is evident from the above table that the main occupation 55 percent of the selected population of the study area is agriculture or agriculture related activities. 22.3 percent of the population of the sample households are in services, most of them are in private services. Weavers and agricultural and manual labourers come next.

In study area, caste and occupation is interlinked. Businessmen are small shopkeepers and they are from Other Backward Castes or Scheduled Castes and landless. Most of the families, who are into weaving, belong to scheduled castes and Muslims. Today fishermen (*Malah*) of the area turn into daily wage labourers because river water pollution took away their earlier profession. The canal falls into the Ganga near Sehbar and because of this sewage water pollution into the river, fish are dying and this forces them to work in sand mines as daily wageworkers.

Table 5.05

Monthly household income (Rs / month)

Village	Less than 3000	Between 3000 - 5000	More than 5000	Total
Dinapur	38 (86.4)	4 (9.0)	2 (4.5)	44
Kamouli	39 (68.4)	8 (14.0)	10 (17.5)	57
Sehbar	19 (95)	-	1 (5)	20
Total	96 (79.4)	12 (9.9)	13 (10.7)	121

In the study villages, sources of income are irregular and most of the time income is not in monetary terms, but in form of kind. Therefore, it is difficult to calculate it. Government data is also not reliable because different government programmes are running on the basis of household income.

In this study, families are divided into three categories. First, families with an income less than 3000 rupee per month, second with 3000-5000 rupee per month and third above 5000 rupees. This includes total family income from all the sources. It is found that in study area 79.4 percent of the families are living in income of below Rs. 3000 per month. In Dinapur, 86.4 percent of families are living below an income of Rs. 3000 per month. But in Sehbar, near about all the selected families are living below to income of Rs. 3000 per month. This again shows that households of Sehbar are poorer in comparison to other two villages. In Kamouli, highest number of families 17.54 percent among other two has an income more than 5000 rupees. They are big farmers and some of them have also other sources of income like dairy or services.

Families in the study villages with an income below three thousand rupees are basically weavers, small vegetable growers, and laborers. For example, work in sand mines is seasonal and fishermen get job only in winter season and rest of the months they remain unemployed. Same thing happens to vegetable growers also. Winter is good

season for them than summer, because production of vegetable is higher in winter. In rainy season, because of heavy rain and water logging their work suffer. Demand of saris is also seasonal. During marriage season, demand of saris increases and rest of the year their work slows down.

Table 5.06

Livestock Ownership of the Sample

Village	Yes	No	Total
Dinapur	22 (50)	22 (50)	44
Kamouli	42 (73.7)	15 (26.3)	57
Schbar	9 (45)	11 (55)	20
Total	73 (60.3)	48 (39.7)	121

In the study villages, livestock is seen as an asset for a family. It is evident from Table 5.6 that more than 45 percent of the families have livestock. But in Kamouli nearly about 74 percent of the households have livestock. This is because *Yadavas* of Kamouli are involved in to dairy business. Villagers of the area feel that livestock is not only a source of income for them, but it is also a symbol of happiness and prosperity. On the time of interview in Dinapur, one old farmer replied "*because of mechanization in agriculture, number of livestock, especially number of bullocks in their village, has decreased but there is an increase in buffaloes.*"

In all the three villages main livestock are cows, buffaloes, goats and pigs. But majorities of the scheduled castes have goats or pigs rather than buffalo or a cow. In the study area, *Yadavas* have more cow and buffalo than other castes, because most of them are involved in dairy business. Only one general caste family of Kamouli from our sample has bullocks. In the study area nobody prefers to keep bullocks because they feel that keeping bullock for cultivation is costly rather than getting tractor on rent for ploughing.

Table 5.07

Housing Pattern of the Sample Household

Village	Kacha	Pucca	Kacc-pacc	Total
Dinapur	20 (45.5)	19 (43.2)	5 (11.4)	44
Kamouli	8 (14.0)	33 (57.9)	16 (28.0)	57
Sehbar	5 (25)	12 (60)	3 (15)	20
Total	33 (27.3)	64 (52.9)	24 (19.8)	121

Type of houses in the study villages reflects social and economic status of the family rather then the needs of the family (according to family size). It is evident from Table 5.07 that more than half of the families have *pucca* houses. But in the area one third of the families are still living in *kacha* houses. If we see it village wise, in Dinapur near about 50 percent of the families have *kacha* houses. But in Kamouli and Sehbar, majority of the families have *pucca* or *kacha-pucca* house. Among all the three villages Sehbar has the highest number of families with *pucca* house.

Mud walls of *kacha* houses in the area fall down due to water logging. Therefore, majority of the families in Kamouli that is closest to the canal lives in *pucca* houses. But in Dinapur near about (45 percent) half of the villagers are still able to live in *kacha* houses because they are away from the canal, and this village is big and scattered. Therefore, some houses of the village are safe from water logging. Secondly, in Dinapur majority of the villagers are small vegetable growers (Other Backward Castes) and their economic situation is not good. Therefore, they are living *kacha* or *kacha – pucca* houses.

In Kamouli either families from very poor economic status (like land-less labourer) or big farmers have *kacha* or *kacha-pucca* houses. This is entirely different from the situation in Dinapur. In Kamouli, land-less families have no resource or money to build *pucca* houses. They are living in kacha houses, and some big farmers of the area are also living in *kacha* or *kacha- pucca* houses. At present, they have no other income

source other than agricultural and income from agriculture is not sufficient to build *pucca*-houses. The same thing is also found in other two villages.

In Sehbar, 60 percent of families have *pucca* houses. Sehbar fishermen are earning wages in cash from sand mines and some of them are engaged in providing boating facilities to tourists in the Ganga River, which fetches them some amount. In addition to this, they get sand free from the Ganga River and their whole family provides the labour for the construction of their houses. But in these houses, there are no windows, doors, and white wash on the walls. These houses are built at a very cheap cost, and have poor ventilation system and unhygienic condition. Drainage system of Sehbar is also very precarious because there is no proper road, only lanes and bylanes are found in the village. So majority of the sample household have *pacca* houses.

Governmental programmes for providing houses to poor like *Indira Awas Yogana* and *Community Development Programmes* have played a significant role in providing *pucca* houses to scheduled caste families and in all the three villages some families has taken house under this scheme. But rooms of these houses are very small and there are no windows and proper doors. Another cause behind *pucca* houses in the villages is non-availability of old craftsmen, local grasses, bamboo and fact that the maintenance of *kucha* houses is dearer than the *pucca* houses.

Table 5.08

Number of Rooms in a household

Village	Less than 2 rooms	Between 2-5 rooms	More than 5 rooms	Total
Dinapur	23 (52.3)	14 (31.8)	7 (15.90)	44
Kamouli	16 (28.0)	21 (36.8)	20 (35.0)	57
Sehbar	16 (80)	2 (10)	2 (10)	20
Total	55 (45.5)	37 (30.6)	29 (23.9)	121

Number of rooms in a household in the study villages shows economic status of the family, sometimes family size and dearth of lands in villages. As it is evident from the Table 5.08 that near about half of the families are living in less than two rooms. Another one third of them have 2-5 rooms.

This shows *pucca* houses are not a complete indicator of economic wellbeing. In the area, only 23.9 percent of families have more than 5 rooms. Majorities of them are big landowners; big family or they have good business like dairy.

In earlier Table 5.07, it was found that majority of the families in Kamouli (57.9 percent) and Sehbar (60 percent) have *pucca* houses, even though some of them are small farmers, weavers, labourers and fishermen. But present table has made it clear that even though they have *pucca* house, 80 percent of those in Sehbar are living in less than two rooms.

Table 5.09 A

Number of Families Having Access to Electricity

Village	Have	Have-not	Total
Dinapur	32 (72.7)	12 (27.3)	44
Kamouli	43 (75.4)	14 (24.6)	57
Sehbar	8 (40)	12 (60)	20
Total	83 (68.6)	38 (31.40)	121

Having electricity connection in a house in the study area shows the living condition of a household and economic development of the village. It is evident from the Table 5.09 that all the three villages of this study are electrified. 68.6 percent of families have electricity. But access to electricity is lowest in Sehbar village i.e. 40 percent.

Table 5.09 B

Electric Connection by Caste

Caste	Yes	No	Total
Gen	11 (78.6)	3 (21.4)	14
O.B.C	56 (68.3)	26 (31.7)	82
S.C.	14 (63.6)	8 (36.4)	22
Muslim	2 (66.7)	1 (33.3)	3
Total	83 (68.6)	38 (31.4)	121

In hamlets of scheduled caste people and fishermen in Kamouli and Sehbar, the electricity provision is not up to the mark. In the scheduled caste hamlets of Kamouli, the condition of electric poles and wiring system is very poor. Because of this the only tube well in this village does not function and thus denies them any access to safe drinking water. There have been incidents of cheap tricks played by general caste people in damaging electric poles in the hamlets of scheduled caste people in order to decrease power load of electricity in the area. A good number of families from all the three villages irrespective of their caste are using electricity illegally.

Table 5.10

Number of Families Have Pit latrines

Village	Yes	No	Total
Dinapur	9 (20.5)	35 (79.5)	44
Kamouli	7 (12.3)	50 (87.7)	57
Sehbar	-	20 (100)	20
Total	16 (13.2)	105 (86.8)	121

A household with toilet facilities in the study villages again indicates the living standard of the family, population density of the village and sanitation practices of the area. In all the three villages, majorities of the population have no toilets. Water logging may be cause behind this, because pit latrines can't work in water logging areas. They go to the fields for defecation. But at present, increase in population has aggravated this problem particularly for old age people, women and girls.

Table 5.10 shows that in our sample households, only 13.2 percent of families have toilet facility. In Dinapur, 20.5 percent families have toilet facilities and in Kamouli, it is a mere 12.3 percent. In Sehbar, not a single family has toilet facilities. All the socioeconomic indicators are showing that Sehbar is the poorest village among the three.

Table 5.11

Families Where Female Works in Fields

Villages	Don't work	Work in Own fields	As labourer	Both	Total
Dinapur	20 (45.4)	16 (36.4)	3 (6.8)	5 (11.4)	44
Kamouli	23 (40.4)	30 (52.6)	3 (5.3)	1 (1.7)	57
Sehbar	10 (50)	5 (25)	2 (10)	3 (15)	20
Total	53 (43.8)	51 (42.1)	8 (6.6)	9 (7.4)	121

Participation of female in economy often depends on social -economic and cultural factors. In some part of our country, women (of different classes) work in fields and in others they don't. Most of the times it depends on regional and cultural set-up. For example, in the study area, women from upper caste [or from well-off family] usually don't work in their fields. The condition of the women is very bad. Patriarchy has a major say in the study area.

Table 5.11 shows that 43.8 percent of females from households are housewives and their work include mainly cooking, taking care of the children and livestock management. Usually they don't work in the fields. Majority of the women belongs to

general castes and some are from minority and other backward castes. This tendency is more or less same in all the three villages because of social customs and sometimes because of economic strength. But in Sehbar, there is no work for women. Most of the families in the village are land less and thus do not have their own agricultural work. In addition to this, as their traditional work is fishing not agriculture, they are not as skilled as schedule caste women. Women of this village don't work in sand mines because work in sand mines hardly provides employment to everybody in the village and work at night do not suit the women.

Half of the remaining women work only in their own fields. These females are mainly from other backward castes. In Dinapur, females of *Mauryaa* (Other Backward Castes) families work only in their vegetable fields, not anywhere else. In Kamouli, same thing is found in *Yadav* families. Females from their families help the male members.

The remaining 6.6 percent of the women are from the landless households and they belong to scheduled castes. A female from poorer families first works in her house and then goes to fields to work as a daily wageworker. In some scheduled caste families, those have lands, their female members do the household chores as well as work in their own fields and in the fields of the landlords especially during harvesting season. It can be assumed that social, educational and health situation of schedule caste women is very precarious than women from other castes of the study villages.

SUMMARY

The basis of the socioeconomic conditions of the households in sewage water receiving areas for irrigation purposes are caste of the family, educational status of the families, landholdings, housing, ownership of livestock, monthly income and status of women in the family.

It is found in the study area that other backward castes are in majority (76 percent). Most of the people here are still living in joint families (55.4 percent).

In the area, literacy rate (27.0 percent) is still very low. Drop out rate (near about 50 percent) among school going children is very high. Poverty has come up as a major

cause behind this. Children help their parents in work. However, there are a number of private schools despite the low literacy level in the study villages. Families with sound financial background send their children to private schools for education

In the area, one third of the families have *kacha* houses. In Kamouli, number of *pucca* houses (57.9 percent) is more than other villages. This is because of canal water logging which damages the mud wall and thus people prefer *pucca* houses. Another cause behind *pucca* houses in Kamouli is that majority of general and other backward castes have good landholdings and other business like dairy. They have also other sources of income like dairy. In Dinpur 45.5 percent have *kaccha* houses because they are not close to canal and partly because the majority cannot afford the cost. In Sehbar 60 percent of the families have *pucca* houses. This is because to build *pucca* houses for fishermen is cheaper. They get sand free from the river and they do the construction work themselves. But drainage and ventilation facilities of this village are poor than other two villages. Majority of the fishermen (80 percent) are living in less than two rooms.

All the three villages are fully or partially electrified (68.6 percent). But in Sehbar, only 40 percent of the respondents have access to electricity. Poverty is main cause behind not having access to electricity.

In study villages, toilet facility is available only to 13.2 percent of the families. In Sehbar, from our sample it is found that not a single family has toilet facility. People go to field for defecation.

In the study, villages main occupation of majority of the households are small or medium farmers (59.5 percent) and they have less than 3 acres of land. Number of land less families (23.3 percent) is also high. In Sehbar, 80 percent families are land less. But in the area, more than half (55 percent) of the families are involved in agriculture or agriculture related activities like preparing pickles and garlands.

It has seen that majority of the weavers and daily wage labourers are from lower castes. Canal water is polluting the river and the work of weaving suffers due to water logging. Therefore, majority of fishermen and weavers are turning up into daily wage labourers.

In the area 79.3 percent of the respondent families have an income of below three thousand rupees per month. In Sehbar, this representation is higher (95 percent) in comparison to other villages.

Near about half of the women from selected families are housewives and do mainly household chores like cooking, nurturing the children and livestock management. Females from other backward castes are working only in their fields. In Sehbar, majority of the women are housewives because they have no work outside the house. Among the sample household in all the three villages more than fifty percent respondents have livestock.

To sum up, the study area belongs to the agriculture-dominated area. Other backward castes are the dominant caste and scheduled castes like fishermen and weavers are the worst sufferers because of bad economic condition. In our selected villages Kamouli seems best off but it is closest to canal. Sehbar is poorest but though fishermen have lost their livelihood they have some occupation to daily wage laborer. In Dinapur majority of the villagers are vegetable growers and they have more problem from the STP rather than canal. In our next chapter we would examine the various kinds of impact the STP and canal have had on the lives of these villages and is the impact is most in the poorest.

CHAPTER VI

IMPACT OF SEWAGE TREATMENT PLANT (STP) ON ENVIRONMENT, AVAILABILITY OF SAFE DRINKING WATER, HEALTH AND HEALTH SERVICES OF THE AREA

Introduction

According to World Health Organisation (WHO), almost 80 percent of the diseases in the world are attributed to unsafe and inadequate water supply and the problems of poor sanitation. The 34th World Health Assembly, in a resolution emphasized that safe drinking water is a basic element of "Primary Health Care," which is the key to attainment of "Health for All by the year 2000 AD".[1]

The causes of many communicable diseases, which affect humanity, especially in the developing countries, can be traced to lack of safe and wholesome water supply. In our study area, we try to understand whether the sewage water meant for irrigation purposes can have a negative impact on drinking water, environment, and aspects of people's health. There are difference between problems faced by people of Dinapur, Kamouli and Sehbar. Major problem of Dinapur is as well as water logging from sludge dust, air pollution (because of gas emissions from the plant), ground water contamination, non-availability of health services, insects and social stigma. In Kamouli, major problem is from, water logging and groundwater contamination.

In Sehbar, the villagers are facing problems from river water pollution rather than side effects of sewage water on agriculture or ground water contamination. The canal falls into the Ganga near Sehbar. There is decrease in quantity of fish, which is a main support for livelihood of the villagers. Now fishermen are compelled to do other works for their survival. Thus, we see in Dinapur, there is two-problem i.e. environmental pollution and non-availability of safe drinking water. In Kamouli, problem is non-availability of safe drinking water, water logging, and increase in water borne diseases. In

[1] Park, K., *Preventive and Social Medicine*, Jabalpur, India, Banarasidas Bhanot Publishers, 1997, p. 469

Sehbar, question is survival of the fishermen. Though these problems look different from each other they are inter-linked.

ENVIRONMENTAL EFFECTS OF THE SEWAGE TREATMENT PLANT

The Sewage treatment plant has a capability to treat 80 million liters of sewage water per day. The plant supplies this water for irrigation. Farmers are using this wastewater for irrigation in uncontrolled way because mode of payment for using canal water is annual and not by amount of water used. Therefore, there is no control on water used for irrigation and leads to water logging. Other than this, there are 28 open sludge-drying beds (measurement of 30 x 30 m), in the plant. These have resulted in tremendous increase in mosquitoes and flies. In summer, dust of dry sludge blows in the air and foul smell increases at night. In peak hours when inflow of sewage increases (like morning and evening), problems also increase.

Table 6.01

Views of respondents whether Sewage Treatment Plant is causing pollution or not.

Village	Yes	No	Cant' say	Total
Dinapur	35 (79.5)	7 (15.9)	2 (4.5)	44
Kamouli	54 (94.7)	1 (1.8)	2 (3.5)	57
Sehbar	19 (95)	-	1 (5)	20
Total	108 (89.3)	8 (6.6)	5 (4.1)	121

The Plant burns sewage gas in the daytime. But at night they release un burnt gas into the air. This creates respiratory problem for villagers living near by. Because of organic material, this sludge has inflammable quality. It burns like charcoal. But we can also see sludge lying here and there. In summer, there is always danger of combustion in this sludge. In past, one accident had happened.

The plant sells this sludge in the name of non-conventional fertilizer. Trucks and tractors are used for sludge transportation. But due to pits on the road, this sludge falls on the road. When the tractors are empty drivers drive them very fast, leaving dust particles in air. The road near to plant sees trucks and tractors passing by most of the times. Due to

this, the area always remains dusty and polluted. There is a school hardly 15 feet away from the plant boundary. There are 300-400 students in the school. Their classes extend till out side the rooms. The distance between the class and boundary is hardly 10 feet. Students are prone to unhealthy smoke and dust, which are responsible for respiratory diseases in long run. The principal of this school Sri Shiv Murat Mauryaa has put forth this problem many times but no action has been taken. Now he complains because he thinks that as his school is private it will affect the school because after knowing this, people will stop sending their children to his school.

Also along the roadside, there are sweet shops and teashops. It is found that these shops contains of these are always covered with sludge dust.

The canal water flowing out of the STP has foul smell. Also the edges have slippery moss. Some times this moss becomes the causes of accident. A merchant's bullock slipped on the moss drowned in the canal and died. Greenery in area is responsible for increase in insects like '*kutki*' throughout the year.

It is evident from Table 6.01 that most of the respondents (89.3 percent) living near to sewage treatment plant and the catchment area of the canal feel that STP is itself a unit of spreading pollution rather than reducing it. There is also a small segment of respondent (6.6 percent) who thinks that plant is not spreading pollution.

These people are landless, they are getting some benefits from the plant, like work on ad hoc basis, or they are living far from the plant. There is one another segment of population who (4.1 percent) were not able to say anything because they are new residents of the area.

One of the main purposes of establishing Dinapur Sewage Treatment Plant was to reduce pollution load at the Ganga from Varanasi. But Dinapur plant is not working properly. During power cuts, it officially does not work, but sometimes at night it also does not work.

In addition to the problems mentioned, There is problem of water logging throughout the year, ground water contamination, increase in malaria and diarrhea and other problems caused by unsafe water. In past, plant had distributed chlorine tablets for clean drinking water, but since last three four years it has been stopped.

Table 6.02

DDT spray or health camps organized in the area (2003-2004)

Village	Yes	No	Can't say	Total
Dinapur	12 (27.3)	32 (72.7)	-	44
Kamouli	6 (10.5)	50 (87.7)	1 (1.8)	57
Sehbar	2 (10)	18 (90)	-	20
Total	20 (16.5)	100 (82.6)	1 (0.8)	121

It is evident from the Table 6.02 that at present plant or health department is not carrying out DDT spray in the water logging areas. According to the people in the area the problem is becoming worse day by day. However 16.5 percent of the respondent replied that this year plant has sprayed DDT near their houses because only in some places near the plant, authority has chlorinated the wells. But this is very limited. Health camps by PHC or district health services have been not organized for the past few years. One respondent was not in position to say any thing because every morning he goes to city to work and does not know what happens here in daytime.

CONTAMINATION OF GROUND WATER

Other than the three villages studied, there are twelve to thirteen more villages in this area. All are affected by the passage of the canal due to groundwater contamination. There are trenches 50 to 100 m long and 3 m deep on both sides of the canal. These trenches were dug during the construction of the canal but were not filled in. In rainy season the canals overflow in fields fills the trenches thus when water logging occurs the groundwater becomes contaminated. Farmers of Dinapur mainly grow vegetable and in Kamouli and Sehbar farmers grow paddy in winter season. Also since the rent for irrigation by canal is paid annually, farmers don't care much about water wastage and most of the times allow overflow of water. This has resulted in surface water contamination.

The water logging also lead to ground water contamination. Sankat Mochan Foundation carried out a study that shows that ground water is contaminated up to 30-

50m. In Dinapur and Kamouli, water of wells and hand pumps is stated to be unsafe for household use. In addition there are 3 'Sludge Digesters' and 28 sludge-drying beds in the plant, the role of which in water contamination is always under question.

ACCESS TO SAFE DRINKING WATER

Due to hand pump and well water contamination, there is no sufficient and safe means for drinking water in the three villages. In Kamouli, construction of a government tube-well for drinking water was approved. But it has not been dug yet. While there are few deep tube wells dug by the NGO, Sankat Mochan Foundation but only 2.5 percent of the population have access to safe drinking water.

Table 6.03

Main sources of drinking water in the villages

Village	Hand pump	Well	Tube well	Total
Dinapur	34 (77.3)	7 (15.9)	3 (6.8)	44
Kamouli	31 (54.4)	26 (45.6)	-	57
Sehbar	16 (80)	4 (20)	-	20
Total	81 (66.9)	37 (30.6)	3 (2.5)	121

Most of the sources of drinking water are public property. Personal hand pumps are rare as a pump costs more than ten thousand rupees. The government has bored 15 – 20 hand pumps per village. These pumps go to a depth of about 150 feet. Personal hand pumps are also present but they go depth of less than 100 feet's. Thus the farmer tend to draw clean water. Almost 70 percent of villagers use these government hand pumps the water of which is not always safe. About 30 percent use well water, which is also contaminated. While the government hand pump are used for drinking water of the wells and personal pumps are used to draw water for rest of household work. It is evident from the table that most of the villagers (66.9 percent) are dependent on hand-pump the water of, which is not always safe as, mentioned above. Rest one third of the population (respondents) are using well water that is highly contaminated. All these facts show that sources of safe drinking water in the area are limited and major segment of villagers are using contaminated water for their household use.

Table 6.04

Quality of water from households point of view

Village	Contaminated	Safe	Can't say	Total
Dinapur	28 (63.6)	15 (34.0)	1 (2.3)	44
Kamouli	33 (57.8)	21 (36.8)	3 (5.3)	57
Sehbar	10 (50)	10 (50)	-	20
Total	71 (58.7)	46 (38.0)	4 (3.3)	121

In the study villages, water from most of the wells and hand pumps becomes yellow if kept for a while. Foods like *Dal* and some others take more time to cook. Water from hand pumps and wells smells same as sewage water. Local people face these problems throughout the year. About 58.7 percent of the household of the study area feels that water they are using is contaminated. Some families (38 percent) whose houses are far from the canal or sewage treatment plant think that to some extent water of their drinking source is safe. Actually at present, of the 15 –20 government hand pumps in each village people are accessing about 8-10 hand pumps, because it is believed that this water is good in terms of smell, colour and taste. But often water source is more than 200-500 meters away from household, which is a big problem for women to bring water from such a distance.

Table 6.05

Availability of safe drinking water because of Sankat Mochan Foundation's tube wells

Village	Available	Not Available	No response	Total
Dinapur	4 (9.1)	32 (72.7)	8 (18.2)	44
Kamouli	5 (8.8)	43 (75.4)	9 (15.8)	57
Sehbar	-	20 (100)	-	20
Total	9 (7.4)	95 (78.5)	17 (14.0)	121

A Non Governmental Organization, Sankat Mochan Foundation has dug tube wells in each of the study villages to provide safe drinking water to villagers. But they have not been able to provide drinking water to the whole village because their coverage is very poor. They are far from dense populated areas.

In Dinapur, only 6-7 families are getting benefits from this tube well. In Kamouli, tube well has not been working since long time. In Sehbar a new tube well is bored and therefore it is yet to start functioning. Only 7.4 percent of the household think that because of these tube-wells there has not been any significant change in availability of safe drinking water. This is because of the fact that the coverage of these tube wells is very poor.

Maintenance of tube wells is to be done by village but is not satisfactory. Sometimes there is conflict between caretaker of tube well (he is also from the village) and the remaining villagers. Not having electricity in time and poor electricity connections are also a problem in running tube wells.

HEALTH PROBLEMS IN THE VILLAGERS DUE TO STP AND CANAL

Table 6.06

Effect of Sewage Treatment Plant on villagers' health

Village	Positive	Negative	No effect	Total
Dinapur	3 (6.8)	38 (86.4)	3 (6.8)	44
Kamouli	11 (19.3)	43 (75.4)	3 (5.2)	57
Sehbar	1 (5)	17 (85)	2 (10)	20
Total	15 (12.4)	98 (80.9)	8 (6.6)	121

When villagers of all the three study villages were asked about the advantages and disadvantages of the plant for their health, most of the respondents (80.9 percent) stated that because of this canal there is negative effect on their health. Some of them (6.6 percent) were not in a position to say any thing, because either they are staying far from the plant or livelihood is a bigger question for them rather than health. However, 12.4 percent of them think that plant has been good for their health. Because their houses are far away from the plant or they are getting some financial benefits i.e. someone from

their house or their relative is working in the plant. Some big farmers say that plant had good effect for their health because they are using canal water for irrigation in land that was barren pervasively. But in the study villages, majority of the villagers state that they are facing health problems from the plant.

In the study villages, health related problem increases differently in different months. For example, in Dinapur, summer is really bad because of mosquitoes, flies, and sewage smell. In Dinapur, at least one person from each household is suffering from stomach ailments.

Table 6.07

Most problematic months for the villagers from Sewage Treatment Plant

Villages	Winter	Summer	Rainy season	Whole year	No problem	Total
Dinapur	-	29 (65.9)	7 (15.9)	7 (15.9)	1 (2.2)	44
Kamouli	1 (1.7)	20 (35.0)	30 (52.6)	5 (8.7)	1 (1.7)	57
Sehbar	-	15 (75)	1 (5)	1 (5)	3 (15)	20
Total	1 (0.8)	64 (52.8)	38 (31.4)	13 (10.7)	5 (4.1)	121

In Dinapur, when women dry wet clothes in the sun, colour of the wet clothes becomes black because of sludge dust in the air. Because of sludge dust in air not only human beings but dogs and buffaloes on street also start coughing. Over moisture and irrigation are responsible for increasing greenery and providing excellent survival place for insects and the weed parthenium. In summer, there is rapid increase in parthenium. The canal has turned into a source of spreading parthenium. Increase in parthenium creating problem for the farmers. Now they need more ploughing and pesticides in their fields. Flies in this area are seen to be bigger than normal flies. In the period between the month of February and June, there is tremendous increase in number of flies. There is a fly called '*Ghoda keda*', *which* creates trouble for people travelling on roads in the evening.

In all the three villages, there is an increase in skin diseases especially in rainy season. There has been a rapid increase in cases of malaria. In study area, mosquitoes and cases of malaria are found throughout year. Cases of diarrhea are also common in the area.

In Dinapur, rainy season is good because this time sewage water smells less and there is decrease in quantity of gases and relief from dust. But in Kamouli, problem increases in rainy season because of canal and water logging. There is water everywhere and the trenches along the canal turn into a breeding ground for mosquitoes. Problem of groundwater contamination also increases in this month. Weavers cannot work in their looms; However, other months are less problematic for them.

Topography of Sehbar is different from the other two villages. In rainy season, farmers of Sehbar do not want canal water for irrigation because of heavy rain. Rainwater and flood in the river decreases water pollution which results in an increase in quantity of fish and now fishermen can catch fish. But in summer, canal water smells foul. Sehbar also faces a new problem. This year earthen work was done on the link road of Sehbar. This stopped the flow of canal towards the river, and a large body of stagnant partially treated sewage water has come up near to Sehbar.

It is found that perception about suffering differs from person to person and village to village. It is found that more than fifty percent (52.8 percent) of the respondents face more problems in summer. The respondents, who said that they face more problems in rainy season, either are living very near to the canal or they are weavers or agricultural labourers, who have to work in water logged fields.

Some families have no such problems with the canal because they are either land-less or away from the plant and canal. Interestingly, 15 percent of the respondents from Sehbar said that they have no problem with canal or STP, because most of them are land less and they don't have problem from the sewage treatment plant directly.

Table 6.08

Physical or health related problems during working in canal-irrigated fields.

Villages	Feel problem	No problem	Can't say	Total
Dinapur	22 (75.8)	5 (17.2)	2 (6.9)	29
Kamouli	34 (79.0)	9 (20.9)	-	43
Sehbar	2 (100)	-	-	2
Total	58 (78.3)	14 (18.9)	2 (2.7)	74*

*** Farmers using canal water**

In the absence of regular health facilities and health check-ups the situation has become worse. In the study villages at least one person from almost every family, is suffering from stomach problem. There diarrhea is a common recurring problem among children and there is also an increase in eye disease. Malaria is found throughout the year. Also because of sludge beds the population of flies is uncontrolled. Farmers of the area are compelled to use sewage water in their fields and thus have complaints about the side affects of this on their health.

It is evident from the Table 6.8 that 78.3 percent of the respondents were facing side effects of the canal water during the irrigation. Farmers complained that the canal water smells very bad. During the period of irrigation, their clothes become wet and they wear it for long time, which again is a cause of several skin diseases When they work in paddy fields they get afflicted with skin diseases like itching. As precaution or treatment some of them use mustard oil on their body.

Occasionally they find black spots on their bodies especially in hands and legs. Small wounds take long time to heal. During work in the fields, farmers chew tobacco by using their wet hands, which is not at all hygienic. But in the study villages, some households (18.9 percent) think that sewage water only smell badly but they have no such health related problem due to work in fields. Two respondents did not reply because may be, livelihood is a big question for them rather then their health.

Table 6. 09

Sickness and treatment sought
(Nov 03- Jan 04)

Villages	Yes	No	Total
Dinapur	22 (50)	22 (50)	44
Kamouli	21 (36.8)	36 (63.2)	57
Sehbar	7 (35)	13 (65)	20
Total	50 (41.3)	71 (58.7)	121

Villagers define 'sickness' as a problem due to which they are not able to do their work and usually needed some medication. It is evident from the Table 6.09, in Dinapur fifty percent of the households say that there had been at least one member sick in last

three months. In all the three villages, 41.3 percent of the total respondents say that at least one family member was sick in last three months. This also includes 41 maladies of children

In the study villages, major problems suffered during previous three months were gastric problems, diarrhea, fever, black spots on body of children, itching, cough, and cold and respiratory problems. However, respondents feel that incidence of diarrhea and other digestion related problems as well as skin diseases are very high throughout the year. The black spots, itching, and diarrhea could be due to the poorer environmental due to pollution by the canal.

In our literature reviewed we had seen studies that corporate our findings, in Markanday and Murity's study done in the Dinapur sewage treatment area had stated that the exposure of the population to sewage water may cause not only the similar complaints to the above but it also may cause neuro-behavioural disorders such as fatigue, insomnia, decreased concentration, depression, irritability, sensory symptoms and motor symptoms.[2]

Another study done showed that health status of the farmers applying wastewater in their fields and consumers of those products are poorer than those of non-farmers and non-consumers of sewage water products.[3]

Katzenelson found that the incidence of shigellosis, salmonellosis, typhoid fever and infectious hepatitis is two to four time higher in communities practicing wastewater irrigation. The study recommends strong wastewater treatment measures, including effective bacterial and viral inactivation through disinfecting for all cases of sewage irrigation or land disposal near residential areas in light of the potential public health risks involved.[4]

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[2] Markanday, A & Murity, M.N., *Cleaning – up the Ganges A Cost – Benefit Analysis of the Ganga Action Plan*, New Delhi, Oxford University Press, 2000, pp. 164-183.

[3] Agunwama, J.C., "Analysis of Socioeconomic and Environmental Impacts of Waste Stabilization Pond and Unrestricted Waste Water Irrigation: Interface with Maintenance, Environmental Management, May 2001,27(3) pp. 463-76.

[4] Katzenelson E, Buium I, and Shuval, H I., "Risk of Communicable Disease Infection Associated with Wastewater Irrigation in Agricultural Settlements, *Science*, Nov 26, 1976; 194 (4268), pp. 944-6

TREATMENT SEEKING

Table 6.10

Families went for treatment.

Village	Yes	No	Total
Dinapur	21 (95.5)	1 (4.5)	22
Kamouli	20 (95.2)	1 (4.8)	21
Sehbar	7 (100)	-	7
Total	48 (96)	2 (4)	50*

* Number of families where some body was sick

It is evident from the table that of the families where somebody was sick in last three months, 96 percent of them went for treatment and four percent of them did not. Of the households from where they did not go for treatment, in Kamouli one household reported failure of previous by private practitioner. The second family was unable to meet the cost of the present treatment. In the study villages, health problems occurred due to the sewage treatment plant and the canal are so common that villagers are accustomed to live with it and only complains when the problem is sever enough to need treatment.

Table 6.11

Institution where respondent went for treatment

Village	Government	Private	Trust	Total
Dinapur	4 (19.0)	13 (61.9)	4 (19.0)	21
Kamouli	2 (10)	17 (85)	1 (5)	20
Sehbar	-	7 (100)	-	7
Total	6 (12.5)	37 (77.1)	5 (10.4)	48*

* Families went for treatment

It is evident from the Table 6.11 that of families where any member was sick and had sought treatment in last three months, the majority (77.1 percent) went to private practitioners (or hospitals). In the study area, government health centers are not working properly. Local doctors in the villages do the treatment at cheaper costs. They have good rapport with villagers and are available even in holidays. Since they live in the village they see patient even at nights.

Some households (10.4 percent) prefer the trust hospital Punjabi Aspatal, which is near the study villages and cost of prescription is free. But 12.5 percent of the household went to government hospitals. Interestingly most of them (4 of 6) prefer district hospitals in the city, not in Primary Health Centre (PHC) or Community Health Center (CHC). Because the well equipped community health center is 3 to 4 km away from the village near to the block office and there is no direct means of transportation. The primary health centers has no medicine for treatment and also do not have necessary equipment and it provides poor care.

Villagers feel that there is no '*fayada*' (use) in going to Primary Health Center (PHC) because there is no female doctor, no medicine and if doctor prescribes five medicines they have to buy three from market and they have to go for test in private pathologies. The two respondent who went to PHC, one was from scheduled caste and another was Muslim women.

Table 6.12

Special Provisions in Primary Health Center for affected people

Village	Yes	No	Can't say	Total
Dinapur	-	43 (97.7)	1 (2.3)	44
Kamouli	4 (7.0)	51 (89.5)	2 (3.5)	57
Sehbar	-	20 (100)	-	20
Total	4 (3.3)	114 (94.2)	3 (2.5)	121

Table 6.12 shows that 94 percent of the families feel, there is no facility for the problems caused by STP such as malaria, skin diseases etc for local people in the local primary health centre. But in the study villages, there is a small percentage of people (3.3 percent), who thinks that, 'Pulse-Polio' is a special facility for them, which is provided by government because of pollution and they are getting it free of cost.

Summary

In our study area, we need to understand how the sewage water meant for irrigation purposes, can have a negative impact on people's health. There are differences between problem of Dinapur, Kamouli and Sehbar. Problem of Dinapur is due to water logging, ground water contamination, sludge dust, air pollution (because of gas release from the plant), from insects and social stigma. But in Kamouli, major problem is from water logging and groundwater contamination. In Sehbar, problem is different, where villagers are facing problem from river water pollution.

Though everybody knows that groundwater of these village is contaminated. They are still using it because they have no other options. Most of the wells of the area are working and people manage a few buckets of water for drinking, but for cattle and washing purposes they are still dependent on sources nearby. i.e. personal well or hand pump. There is problem of water logging through out the year, ground water contamination, increase in malaria and stomach and water related problems. In past, plant had distributed chlorine tablets for clean drinking water, but from last three four years this has been stopped.

It is evident from Table 6.01 that most of the respondent (89.3 percent) living near to sewage treatment plant and the catchment area of the canal feel that STP is itself a unit of spreading pollution rather than reducing. When villagers were asked whether the plant is beneficial or harmful for their health, most of the respondents (80.9 percent) stated that because of this canal there is negative effect on their health. It is found that suffering differs from person to person and village to village. It is also find that more than fifty percent (52.8 percent) of the respondents face more problems in summer. According to 78.3 percent of the respondents they have been facing side effects of the canal water during the irrigation.

Other than the three villages studied, there are twelve to thirteen more villages in this area. All are affected by the passage of the canal due to groundwater contamination. While there are few deep tube wells dug by an NGO only 2.5 percent of the population

use safe drinking water. 45 percent of the households are still dependent on public sources for drinking water. However personal sources re contaminated.

About 58.7 percent of the household of the study area feels that water they are using is contaminated. Not having electricity in time and a poor electricity connection are also a problem. Plant authority is well aware of villager's woes.

In Dinapur, fifty percent of the household say that at least one member in each household was sick in last three months. In all the three villages, overall 41.3 percent of the respondents say that at least one family member was sick in the last three months. Families where somebody was sick in last three months, 96 percent of them went for treatment and four percent of them did not. Families where at least one person was sick and they went for treatment, it was found that majority (77.1 percent) went to private practitioners (or hospitals). After knowing all these problems, there has no special facility for local people in the local primary health centre.

CHAPTER VII

IMPACT OF STP AND CANAL WATER ON LIVELIHOOD AND LIVES OF THE PEOPLE

INTRODUCTION

Before the construction of this canal in the 1950s and 60s, there was no proper means of irrigation in the area. Farmers of the area demanded irrigation facilities from the government and thus the canal was constructed. There was no sewage treatment plant in Dinapur at that time. Sewage water for the canal was delivered from old Konia Pump House. The water was untreated and its quantity and flow was very low. Despite this, people did not feel any problem. As earlier, before the establishment of Dinapur Treatment Plant, water in the canal was running only for one to two days in a month. But after the establishment of sewage treatment plant[1] wastewater continuously flew through canal.

For a few years after the establishment of the plant, the crop yield of the area was very good but it gradually started declining. Sugarcane, gram, oil-crops and peas are not cultivated any more due to high level of moisture in soil. A decrease in number of trees along the canal is also reported.[2] Fields are gradually turning into barren land, water of wells and hand-pumps has become contaminated and there is negative impact on cattle health.

Presently farmers pay Rs. 500 per acre annually to use water from the canal for irrigation. The *Amin* surveys the area and decides the charges once a year. Whether a farmer irrigates his land once or ten times per day, he has to pay the amount fixed by the *Amin*. So, farmers in the area are becoming careless about the amount of water that flows into their fields. The maintenance the canal is very poor. Half of canal water goes to fields and half outside. Local ponds always remain full of stagnant sewage water. Farmers tend to over irrigate their land, which results in salinity and water logging.

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[1] Started in 1989 and completed in 1991.
[2] Interview.

Water pumps of wells do not work because of high level of water level. In some places, there are government tube wells. People hardly like these, because of the irresponsibility of the operator. They do not fulfil the demand and their coverage is also very poor. Operators demand money from farmers very often.

Other than the villagers, around 300 families who have migrated from Chhotnagpur and are now working in a brick kiln between Dinapur and Kamouli also face all these problems.

IMPACT OF CANAL ON LIVELIHOOD

Impact On Agriculture

As, earlier in the study villages there was no means of irrigation. After the coming up of the canal, few pump sets (commercial) that existed earlier were closed, because the canal water was cheaper than the 'Irrigation Pump Sets' (IPS). Mode of payment for canal water is totally different. Now farmers are free to use as much as water they can. The cheaper annual rent according to the area of land has played a big role in closing most of the existing IPS that failed to cope with the canal and closed.

Irrigation

Table 7.01

Families Have Own Means of Irrigation

Village	Have	Have not	Not working	Total
Dinapur	9(22.5)	31(77.5)	-	40
Kamouli	6(12)	44(88)	-	50
Sehbar	1(25)	3(75)	-	4
Total	16(17)	78(83)	-	94*

*** Total Number of respondent having own land.**

It is evident from Table 7.01 that out of 94 families who have land, 83 percent of have no means of irrigation. Today in the study area, only few farmers have irrigation, and their own pump-sets (17 percent). In Dinapur, those farmers are vegetable growers.

As the canal water is not good for their crops they use their own pump-sets. Though the groundwater of the study villages is contaminated but it is comparatively better than the canal water.

However, farmers who do not own pump sets don't get clean water. There are few private pump sets but they are available only when their owners do not need them. Coverage of government tube-wells is poor. Their maintenance is also not good. They are insufficient to cope with agricultural demands.

Table 7.02

Families Using Canal Water for Irrigation

Village	Use	Don't use	Both	If helpless	Total
Dinapur	25 (57.5)	11 (27.5)	5 (12.5)	1 (2.5)	40
Kamouli	37 (72)	7 (14)	6 (12)	1 (2)	50
Sehbar	2 (50)	2 (50)	-	1	4
Total	61 (64.9)	20 (21.3)	11 (11.7)	2 (2.1)	94*

*** Total Number of respondent having own land.**

It is found from the selected household that out of those who have land, 64.9 percent of are dependent on only canal water. 11.7 percent are using both canal and tube-well water. This is because canal water reaches only some part of their lands. 2.1 percent are using only when they are helpless. 21.3 percent of farmers are able to manage fresh water for their fields. From this 21.3 percent, some of them are big farmers, but many of them are small people like vegetable growers (it doesn't mean that vegetables growers are not using canal water) or away from the canal or they have unproductive or very small piece of land. This group also includes these who do not have any personal means of irrigation but hire the government tube well who have. While this means they pay more they prefer it as the water they get is less contaminated than the canal

Table 7.03

Sources of Water Used by Farmers not Using Canal Water

Village	Private Well	Government Tube well	Private Tube well	Total
Dinapur	2 (18.2)	2 (18.2)	7 (63.6)	11
Kamouli	2 (28.6)	1 (14.3)	4 (57.1)	7
Sehbar	-	1 (50)	1 (50)	2
Total	4 (20)	4 (20)	12 (60)	20

The table shows that of those farmers, who are not using canal water, the 20 percent who do not have own means of irrigation of them are dependent on government tube-wells and 80 percent have their own irrigation pump sets or private wells.

Table 7.04

Farmers' compulsion for using canal water

Village	No other means of irrigation	Manure in water	Economical	Total
Dinapur	28(96.6)	1(3.4)	-	29
Kamouli	43(100)	-	-	43
Sehbar	2(100)	-	-	2
Total	73(98.6)	1(1.4)	-	74*

***Total number of farmers using canal for irrigation**

In the past that there was no means of proper irrigation, and except for the canal water, today the situation remains the same. Majority of the farmers in the study villages are small peasant and their landholdings are less than 1 acre. Though they have enough money to have their own irrigation pump sets, the small size of their landholding makes this economically unviable. Without having any other option, canal water becomes the last resort.

It is evident from Table 7.04 that 98.6 percent of the household continues to use canal water because there is no proper means of irrigation.

Table 7.05

Proposed action of Farmers if fresh water irrigation is available

Village	Leave the canal water	Don't leave	Can't say	Total
Dinapur	29 (100)	-	-	29
Kamouli	41 (95.3)	1 (2.3)	1 (2.3)	43
Sehbar	2 (100)	-	-	2
Total	72 (97.2)	1 (1.4)	1 (1.4)	74*

*** Total number of household using canal water**

Today in the study villages majority of the villagers don't want canal water for irrigation. But they are helpless. Only one respondent from Kamouli said 'no' and one can't say. These two farmers think that canal water is cheaper and more convenient for them and so prefer it to other sources of irrigation.

It is clear from farmer's response that using the canal water is their compulsion, not a choice and reuse of wastewater for irrigation is not user friendly. But majority (97.2 percent) of the farmers said "*On the first day when we will get fresh water we will stop using this canal water.*'

Impact on Fertility of Land

Table 7. 06

Present Consumption of chemical fertilizers

Village	Use	Don't use	Total
Dinapur	26 (89.7)	3 (10.3)	29
Kamouli	38 (88.4)	5 (11.6)	43
Sehbar	2 (100)	-	2
Total	66 (89.2)	8 (10.8)	74*

*** Total number of farmers using canal for irrigation**

One of the objectives of providing sewage water for irrigation was that it would reduce the demand of chemical fertilizers and save foreign currency. But here majorities of the farmers (89 percent) are still using chemical fertilizer. This proves the above calculation wrong. In the study area, use of sewage water has made negative impact by

decreasing fertility of the land. And every year, the quantity and demand of fertilizer is increasing. The 10.8 percent of farmers in study who replied 'No', to use of chemical fertilizer are actually using natural fertilizer and manure.

Table 7.07

Changes in use of chemical fertilizers after the introduction of canal water

Village	Increased	Decreased	No change	Total
Dinapur	5 (19.2)	-	21 (80.8)	26
Kamouli	9 (23.7)	1 (2.6)	28 (73.7)	38
Sehbar	-	-	2 (100)	2
Total	14 (21.2)	1 (1.5)	51 (77.3)	66*

*** Total number of farmers using chemical fertilizer**

77.3 percent farmers using chemical fertilizer from our study sample feel that there is no change in quantity of fertilizer after using sewage water. But 1.5 percent of them think that to some extent there is decline in quantity of fertilizer. They are mainly those farmers who think that canal water is good for their crops. 21.2 percent state they need to use more urea in their fields than previously.

Table 7.08

Consumption of sludge produced in STP

Village	Use	Don't use	Total
Denapur	-	40 (100)	40
Kamouli	-	50 (100)	50
Sehbar	-	4 (100)	4
Total	-	94 (100)	94*

*** Total number of household having land**

Dinapur Sewage Treatment Plant is producing near about 16,000 to 18,000 cubic metres of sludge annually. The plant sells that sludge at Rs. 85 per cubic meter. But not a single farmer selected for our study is using sludge sold by the plant under the name non-

conventional fertilizer, because this sludge contains high level of detergent and chemical salts.

One big industrialist of the area *'Jhunjun wala'* started manufacturing fertilizer from this sludge. After learning from him, small and medium manufacturers of the area have also followed suit. After mixing rice, straw, sand, and sometimes urea, these manufacturers are selling the sludge openly out side the state under the name of organic fertilizer like *'Maha Shaktiman'*.

Selling of sewage sludge in the name of organic fertilizer is false. But apparently plant or other government agencies are not supervising who the buyers of the sludge are and what are they doing with this sludge. Some local farmers are also involved in this activity. But plant is continuously selling the sludge, which is an exploitation of innocent farmers.

Effect of Canal Water on Crops

Table 7.09

Effect of canal water on crop yield

Village	Improved	Not improved	Decreased	Total
Dinapur	4 (13.8)	10 (34.5)	15 (51.7)	29
Kamouli	6 (13.9)	10 (23.3)	27 (62.8)	43
Sehbar	-	2 (100)	-	2
Total	10 (13.5)	22 (29.7)	42 (56.8)	74*

*** Total number of farmers using canal for irrigation**

At present, crops irrigated with canal seem to grow very well. It looks deep green, but size of fruit is small. Some plants like cucumber and *Amala* grow very well, but do not bear fruits. People think that canal water is good for cabbage, wheat and rice cultivation. Cabbage and cauliflower sometimes grow to the weight of 10 kg. Weight of one potato goes up to 1.25 kg. But durability of these vegetables is very less. One can find water inside potato same as in coconut.

When respondents were asked whether there is improvement in crop yield because of sewage water, 56.8 percent of them replied that in beginning there was increase, but at present there is sharp decrease. Now the more than average weight of vegetable is a

problem for them. The abnormal size of the vegetable indicates that it may be from Dinapur and no body wants to buy them. In past, this area was famous for guava, but at present there is not even a single tree of guava is found here. The local customers do not like vegetable of this area, so the farmers sell their vegetables in other markets. Because of contaminated water, pulses take much time to cook. Watery substances in are found in cooked rice. Insects are found in molasses. Because of sewage water juice of sugarcane smells same as canal water.

However, 13.5 percent of the respondents feel that because of this canal water they are getting good crops especially paddy. Paddy grows well but its production has decreased. Some of the respondents replied that canal water is good for production of flowers, bamboo and '*Patlo*', a local grass. They told, "because of this canal water we are in position to cultivate. And in absence of the canal, this land will change into wasteland. Therefore we think that this water is good for our fields." But one farmer Sri Bacha Singh, who is growing rose flower, told, " my production of flowers is always less than others who are using clean water." Majority of the farmers are not in favour to use canal water for irrigation and they state that, now they clearly feel decline in crop yield.

Table 7.10

Consumption pattern of crop yield in households

Village	Use all	Sell all	Some use some sell	Total
Dinapur	14 (48.3)	4 (13.8)	11 (37.9)	29
Kamouli	29 (67.4)	-	14 (32.6)	43
Sehbar	-	2 (100)	-	2
Total	43 (58.1)	6 (8.1)	25 (33.8)	74*

*** Total number of household using canal water**

We made an inquiry among the 74 farmers using the canal water and it was seen that actually 58.1 percent of the farmers have not enough yield to eat therefore there is no question of selling. With small land holdings, these farmers are economically poor and not in a position to buy and eat. But on the other hand, there is a small segment of farmers (8.1 percent) who are selling their canal-irrigated crop in a market and buying

fresh crop for their own consumption and for their home consumption they are using fresh water from tube-wells.

There are also some farmers (33.78 percent) those who have no other means of income other than a land they sell some of the crop and use the rest at home. But most interestingly, weavers, labourers and fishermen are also consuming the same crop because they get grain from the village on credit and it is not possible for them to buy few kilograms of grain from any city or market. We see, therefore, that these landless labourers are not having even a marginal benefit of irrigation as they have no land. They are suffering because the quality of the crop they eat is poor.

Thus while talking to the farmers we saw that many of them are selling their crops in the market and buying grain another for their own consumption. But landless laborers suffer most and this canal has not been beneficial for them.

Table 7. 11

Farmers' view on the Suitability of Crop for Seeds

Village	Suitable	Don't suitable	Can't say	Total
Dinapur	13 (44.8)	11 (37.9)	5 (17.2)	29
Kamouli	28 (65.1)	15 (34.9)	-	43
Sehbar	2 (100)	-	-	2
Total	43 (58.1)	26 (35.1)	5 (6.8)	74*

*** Total number of household using canal water**

Almost 60 percent of the respondents felt that seed from canal-irrigated water is suitable. Actually it depends on what farmers are cultivating. For example, farmers those who are producing wheat and rice have no problem to keep seeds (If size and quality of grain is good). But a farmer producing potato, onion or cabbages is not in position to keep seeds, even for a month because these seeds are less durable. After a few days vegetable will be rotten. They have no option other than to sell it immediately. Because there is a city with big market nearby, and size of their fields is smaller, they cultivate vegetables. When a buyer knows that vegetable is coming from nearby Dinapur, they don't buy.

Farmers hide large produce down in vegetable pile and then sell. But for farmers growing flowers, some however do well and other don't. It depends on what flower he or she is growing.

Impact on Livestock

Table 7.12

Impact of canal-irrigated fodder on cattle's health

Village	Positive	Negative	Can't say	Total
Dinapur	7 (31.8)	13 (59.1)	2 (9.1)	22
Kamouli	15 (35.7)	20 (47.6)	7 (16.7)	42
Sehbar	2 (22.2)	4 (44.4)	3 (33.3)	9
Total	24 (32.9)	37 (50.7)	12 (16.4)	73*

*** Total number of household having cattle**

Canal water is affecting production and health of cattle's. Fertility of cattle has decreased. Now they hardly go for three to four births. During inquiry, 50.7 percent of the respondents said that there are problems with canal-irrigated fodder. They feel that because of this fodder cattle are suffering from poor health. They also believe that this fodder is responsible for infertility of cattle. They complained that dung of their cattle is thinner than other cattle. There are increasing complaints of wounds in hooves of animals and because of canal water wounds take to more time to heal. Straw meant for cattle become rotten if kept for the entire night. Despite having all these problems, farmers are giving same fodder to their cattle because they have no other option. However, some respondents (16.4 percent) were not in position to say anything because their cattle don't eat grass near the canal or irrigated by canal water because of its foul smell.

A good segment of respondents (32.9 percent), most of them are milkmen, think that this fodder is not bad for their cattle. They fear a negative impact on their business if they say that the fodder is bad.

Table 7.13

Effect of fodder on milk and meat production

Village	Increase	Decrease	No change	Total
Dinapur	-	3 (42.9)	4 (57.1)	7
Kamouli	-	4 (26.7)	11 (73.3)	15
Sehbar	-	-	2 (100)	2
Total	-	7 (29.2)	17 (70.8)	24*

*** Total number of household feels impact of fodder on cattle health**

However out of the respondents who said that fodder was good, 29.2 percent felt though fodder is good but there is decrease in milk production. 70.8 percent of them were assured that of canal water has is no effect on milk or meat production.

Impact on Livelihood of Weavers and Fishermen

Table 7.14

Effect of canal water on weaving and fishing.

Village	Negative	No affect	Can't say	Total
Dinapur	2 (66.7)	1 (33.3)	-	3
Kamouli	5 (71.4)	2 (28.6)	-	7
Sehbar	14 (100)	-	-	14
Total	21 (87.5)	3 (12.5)	-	24*

*** Total number of weaver and fishermen**

It is shown in the above table that majority of the weavers and fishermen (87.5 percent) feel that the canal is affecting their livelihood. 12.5 percent of the respondents are weavers whose houses are either far away from the canal or situated on some height and due to this, they are safe.

There are many hamlets of weavers along the canal. In rainy season, because of water logging and over irrigation in paddy fields, pits of looms are covered with water and weavers could not work. Moisture damages the thread '*zari*'. To keep loom on proper

place is also a problem. Looms are made up of wood. Over moisture in working place and wet soil decrease the longevity of wooden looms.

In Kamouli, weavers' families complain that water of hand pumps near to canal is also contaminated. A small weaver and farmer of the village, Mahendra (aged 41) told that his whole family is in weaving occupation. He lives along the canal. Distance between his house and canal is hardly 10 to 15 feet. A *Harijan (SC)* by caste, he told that in rainy season, water enters into the pit of their looms, which affects their work for one to two months. If he drains out water from his pit, it gets filled again only in one hour. To keep the loom in proper position he put brick against the pillar. Due to moisture in soil *zari* of *sarees* becomes black. Small traders in market are not ready to buy the discoloured sarees. He swore that two years back, , he was forced to sell a Rs. 5000 *sarie* only in Rs 1600. Silk of *saries* does not get affected or discoloured. But this water highly affects *zari* of their *saries*.

Mahendra does not produce vegetable in his field because fruits become infested. There is a tube-well in his hamlet, which is defunct because of high electricity load and poor wiring on poles. Upper caste people also damage it from time to time. He feels fertility of cattle has been decreased. He has a buffalo, which is not getting pregnant due to the fodder. He complained that dung of his cattle is thin and watery. At present in his village no body is sowing oil-seeds and pulse '*Arhar*'.

In Mahendra's house, moisture is found everywhere. During the time of canal construction, contractor told his father that this canal would change their life. He left them in dark that this canal will contain sewage water. Mahendra realizes his social status in the village and said, "because we are 'Harijans' and at that time our father had no voice, so we didn't succeed to do any thing."

Mahendra is not in favour of throwing untreated sewage water into the Ganga. Instead he only wants his problem to be solved. He said that the Ganga is also holy for him. He pleads to cover the face of the canal near his hamlet in the greater interest of the population. He also suggested that plant should mix clean water 4 to 5 times in the canal water. He thinks this would reduce the problem of toxic chemicals in the canal water.

In Kamouli, families from weaker sections had been given land by the government far away from the canal. But the dominance of upper castes had been depriving them their land. After long struggle in 1990s, though some trenches of the area are given to them, many of them still wait for justice.

In Sehbar, pollution causes death of canal fish. It is hard to find fish on the bank of the canal. Fishermen of the area complain that there is a sharp decline in number of fish. After a whole night struggle, they get hardly 2-4 kg of small fish only. Some fish like *'Rohu'* are not found there. One old fisher man *Purane* said that there is no doubt about the sharp fall in the quantity of fish in rivers every where, but the truth is that this canal has played a big role in the decrease of fish in this area.

IMPACT ON LIVES

Community Participation in Establishment of STP

Area of the Dinapur sewage treatment plant is near about 75 acres. For the establishment of plant, land of 80 farmers of Dinapur was accrued.[3] But only 12 persons got compensation of a paltry Rs. 100-150 per *'Biswa'*, when the market price was Rs. 3500 per *Biswa*. Many of them have gone to court, but of no avail. If land is found disputed, owner of that land could not compensation.

Table 7.15

Role of Villagers in establishment of STP

Villages	They played a role	No role	Can't say	Total
Dinapur	1 (2.3)	36 (81.8)	7 (15.9)	44
Kamouli	5 (8.8)	38 (66.7)	14 (24.5)	57
Sehbar	-	19 (95)	1 (5)	20
Total	6 (4.9)	93 (76.9)	22 (18.2)	121

[3] The land accrued for the plant belonged to Sri Vijay Singh, Lalbahadur Singh, Amar Bahadur Singh, Babu Nandan 'Rajbhar', Suknandan 'Rajbhar, Mulchand 'Mourya' and Lal Chand 'Mourya'.

Regarding government procedures for the implementation of programmes and role (participation) of villagers in establishment of STP, 76.9 percent of the respondents said that we had no role or information about this plant or canal. But 4.9 percent of them said that at least they had knowledge that here government was going to establish a Sewage Treatment Plant to treat wastewater of the city. 18.2 percent of them said that this incident is very old, so they didn't remember what actually had happened.

Table 7.16

Awareness among plant authority about villagers' problems

Village	They are aware	Don't aware	Can't say	Total
Dinapur	42 (95.5)	-	2 (4.5)	44
Kamouli	50 (87.7)	3 (5.3)	4 (7.0)	57
Sehbar	20 (100)	-	-	20
Total	112 (92.6)	3 (2.5)	6 (4.9)	121

Because of this STP, groundwater of the area has become contaminated. There are several side affects on health, crop yield and environment. During the inquiry regarding the frequency of plant authority awareness, 92.6 (112) percent of the respondents felt that at least on local level, plant authority is well aware about villagers' problems. But they are doing nothing. This shows the attitude of government employees towards villagers and sensitivity and accountability of government machinery towards poor citizens of our country. Interestingly the plant Authority State that the people of the area are trying to get the plant shut down for their personal vested interested.

Table 7.17

Local leaders and Panchayat's stand on the STP

Village	They took	No stand	Can't say	Total
Dinapur	-	42 (95.5)	2 (4.5)	44
Kamouli	5 (8.8)	49 (85.9)	3 (5.3)	57
Sehbar	1 (5)	19 (95)	-	20
Total	6 (4.9)	110 (90.9)	5 (4.2)	121

In the beginning, local people took some steps, but at present every effort has been put to halt. Villager's suffering is not an issue during elections. Not a single political party has come forward to solve the problems faced by the villagers. Village Panchayat is helpless because of limited rights, lack of awareness and divergence of views and interests. During inquiry, 90.9 percent of respondents told that no local leader of any political party has any stand on plant issue. But 4.9 percent of the respondents said that the local leaders had taken a stand in 1990's However the villagers spoke about the initiatives taken by local leaders in past.

In mid 1990s, local villagers protested against the plant authorities under the leadership of local farmers.[4] They demanded hospital, safe and potable drinking water, right compensation for farmers and employment for local people in the plant.

But plant authority was successful in breaking the leadership and the agitation against them. They started giving contracts to some of them. It is heard that one of them got job on ad hoc basis in one of the pump houses. One got a contract of sludge extraction. Some of them got contract of repair and earthen works. Old leaders were turn up into *'Thekedars'*. They started working for the plant and protecting the interests of the plant authority. Now when experts come for supervision, they defend the plant authority. Recently once one of the local leaders brought a big cauliflower to convince the experts about the progress of the farmers. However, their struggle also got some results. Villagers were able to persuade the plant authorities to relocate the sludge factory far away from the area. Making mass consensus among the villagers on the Plant issue was anther achievement.

[4] Under the leadership of Dalit farmers like Sri Ram Sawak, Vinod Kumar Morya, Gram Pradhan of Sarai Mohana Sri Virendra Sinha and some other villagers.

IMPACT ON LIVES OF PEOPLE

Social Stigma

Table 7.18

Feeling of social stigmas among the respondents

Village	Feel	Don't feel	Can't say	Total
Dinapur	18 (40.9)	17 (38.6)	9 (20.5)	44
Kamouli	23 (40.4)	27 (47.4)	7 (12.3)	57
Sehbar	14 (70)	2 (10)	4 (20)	20
Total	55 (45.5)	46 (38.0)	20 (16.5)	121

There are many complaints that, because of this sewage treatment plant local residents are facing social stigma. No body wants to come to reside here. The pressure of Plant is stopping city from spreading to the villages. Relatives do not want to stay at night because of mosquitoes. There is decrease in land prices. Problem in marriage is acute, as there said to be decrease in fertility of resident in the area. This directly or indirectly leads to increase in dowry. There is dearth of appropriate places for marriage purpose. During the inquiry, 45.5 percent of the respondents said that they feel social stigma. 38 percent of them said that it is only a rumour. 16.52 percent were not in a position to say any thing rather they preferred a middle path supporting both the views.

Economic Impact

Table 7.19

Change in land prices in last ten years

Village	Stagnant	Decrease	Increase	Cant' say	Total
Dinapur	15 (34.1)	18 (40.9)	7 (15.9)	4 (9.1)	44
Kamouli	16 (28.0)	18 (31.6)	21 (36.8)	2 (3.5)	57
Sehbar	2 (10)	6 (30)	5 (25)	7 (35)	20
Total	33 (27.3)	42 (34.7)	33 (27.27)	13 (10.7)	121

Because of sewage treatment plant there are complaints of stagnant or decrease in land prices. Pollution and contamination of drinking water are the major causes behind this state of affairs. Out of the respondents, 27.3 percent said that because of this plant price of our land is stagnent from long past. 34.7 of them think that there is a decrease. When both the responses are added, it will be found that 62 percent of the respondents think that there is a negative impact of plant on land prices. However, 27.27 percent of the respondents think that land price is increasing day by day. 10.74 percent respondents were not in a position to say anything, because they are land less. Location of plant has stopped the growth of city in this area.

In Salarpur (behind Dinapur village), rate of lands for residential purposes per *Biswa* is Rs. 1.5 lakhs. But in Dinapur, it is 50-60 thousand rupees per *Biswa.* In one interview, Sri Shiv Murat a schoolteacher in Raghunathpur Panchayat told that getting a chance "he will sell his whole land and go away from this village." He is worried about his future generation. He adds that "in future, Dinapur and nearby areas are going to become Hiroshima and Nagasaki."

Table 4.20

Job availability in plant for local villagers (selected households)

Village	We got	Don't	Total
Dinapur	4 (9.1)	40 (90.9)	44
Kamouli	4 (7.0)	53 (92.9)	57
Sehbar	-	20 (100)	20
Total	8 (6.6)	113 (93.4)	121

Majority of the employees in the plant are outsiders. But there are some jobs, which are being done by local people like helper in different pump stations, especially in sludge and sewage-water related works. Out of the total respondents, 93.4 percent replied that no body from their family is working in the plant or has got any monetary benefit. From 6.6 percent of the households held the view that there was somebody from their

home who got some work in past but the job was mainly related with sewage water (on ad hoc basis) and sometimes they got earthen work i.e. loading sand on tractors or some construction works.

Actually in this plant, there is no much employment for local people. Sludge extraction contracts are in the hands of big contractors. Some lower caste people mainly do this work. It has come up during the inquiry that hardly 4 to 5 people from this area are working in this plant. Most of them are employed in sludge and sewage related activities. They are on ad hoc basis and employed by the private contractor, not the plant. Population of the area is in thousands and it is not possible for the plant to give employment to each and every one. But here the question is that Isn't it a problem in our human resource management that we deprive local people of local jobs and other job opportunities in the establishments in their area which are based on their resources and sometimes at the cost of their lives.

SUMMARY

Dinapur Sewage Treatment Plant, from the point of view of villagers of Dinapur, Kamouli and Sehbar has caused severe damages to the villagers. Moss along the bank of canal is slippery and dangerous for children and animal. In past some accidents have occurred due to this. Now villagers have become resigned to problems and they have no hope of help from anywhere. We found that now the bound of the canal has turned into playing ground for children a path along the canal that is used to travel to villages. It has also come grazing land for herdsman, a place for preparing cow–dung cake, small bridges where youngsters loiter. Slowly but gradually the people have begun to get used to he smell and dirt.

Water is always found in small canals. *Kacha* houses of the area are damaged. Vegetables and grains don't have any taste. Foods can be eaten only when it is fresh, but after one or two hour it becomes impossible to eat. It smells like sewage water. Rice gets fermented. There is a black layer on curry. Fields of the area are becoming saline. No body wants to purchase vegetable from this area. Farmers are selling their vegetables in other markets outside these villages. Canal water is affecting crop yield. Production from fields is decreasing. When farmers wash wheat, the colour of water becomes black, same as the colour of canal water. There is no shine on cattle's skin.

There are increasing complaints of wounds in hooves of animals. After 3-4 deliveries, cattle become infertile. Black spots on the body of children are a normal problem. In the river there is no more good fish. Only '*Saure*' fish survive in this water. Fish smells same as the canal water. Fish of the river are tasteless. In summer, fish automatically die in water. Fishermen have turned into daily wage labourer in sand mines. In rainy season, weavers are not able to work because of water in their looms. Threads of their *Sarees* get damaged due to moisture. They don't get proper wage for their work. They are forced to sell their *Sarees* in low prices, very less from actual cost.

Many local residents of the area complained that at night the pump operator sleeps due to which from 9.00 pm to 5 am sewage water of city directly flows into the Varuna River without any treatment. There are also power cuts from 9 a.m. to 2 p.m. due to which sewage water of city directly falls into the Varuna river. Operator of the pump house (Konia) argues that if sewage water is not bypassed into the Varuna River it will flood the city and without electricity, plant does not work. There is also dispute between Nagar Nigam and Jal Nigam for funds.

The road in front of plant is damaged for the last 12 years. There are a lot of pits on it. In rainy season, these become a major cause of accident. Political parties have no stand on it and local leadership from villages defends the plant side.

Now if we can try to see the positive side of the plant we see that small and medium manufacturers are selling plant sludge under forged name of organic fertilizer in other parts of the state. There is no doubt that production of wheat, paddy, cauliflower, and maize has increased. But to the utter disappointment of the villagers, this yield has not been suitable for consumption. To some extent, it gives benefit only to the medium and big farmers. Some farmers of the area sell their crops in the market and purchase fresh grains from other markets for their own consumption. But for small farmers it is not at all practical and possible.

CHAPTER – VIII

SUMMARY AND CONCLUSION

The major objective of the present study is to evaluate the effect on the life and health of the sample population due to sewage water farming in the three study villages i.e. Dinapur, Kamouli and Sehbar in Varanasi district of Uttar- Pradesh.

For this, the socioeconomic conditions of the affected villages, the major environmental and health problems caused by the sewage treatment plants and the canal is examined as well as the role played by the health services available in treating diseases. A historical review of the establishment of the Sewage Treatment Plant (STP) and canal has also been done.

To review the problem in its totality the political conditions operating in the study area have also been studied. For this study, three villages affected by the STP and the canal but with different and unique characteristics have been chosen. Of the 230 mld of sewage water generated by the city 150 mld of untreated sewage is discharged directly into Varuna and passes into the Ganga only 80 mld passes into the STP. This passes through the canal in our study area and drains into the Ganga.

Primary and secondary data was collected regarding villagers profile as well as their day-to-day suffering. An attempt has been made to analyze this in the socioeconomic context. Since this is an exploratory case- study of three villages, it will be incorrect to generalize the findings to the entire sewage water receiving areas of country. However, through this study an attempt has been made to identify areas that need further research.

Profile of the sample households

This study is carried out on 121 households of three villages, Dinapur-44 households, Kamouli-57 households and Sehbar-20 households. These villages are close to Dinapur Sewage Treatment Plant and its sewage water-carrying canal. The study was during December 2003 and January and March, 2004. In this area, about 78 percent (i.e. 94 families) of the households have land, of which 83 percent of have no means of

irrigation. Of these 78 families 74 are dependent totally on canal water for irrigation activities. Other farmers of the villages are using government tube-well or they have private tube-well or private well. It is found that in the area majority (55.4 percent) of the households are fully dependent on agriculture/ horticulture or other agriculture related activities for their livelihood. 19.8 percent are weaver and fishermen. 79 percent of the families are earning below three thousand-rupee monthly 10 percent have monthly income 3000- 5000 and rest 10 percent have more than 5000 rupee per month income.

Problem due to STP and canal

From the present study, it is found that in Dinapur, the major problem arises from dry sludge, sewage gases and ground water contamination. In Kamouli, villagers are facing problems from canal water irrigation, which has resulted in ground water contamination. Walls of Kacha houses of the area have been damaged. In the Kamouli, weavers are unable to work in their looms in rainy seasons because of high level of ground water and water logging near their hamlets. Canal water is also damaging thread of *sarees*. These weavers are mainly from scheduled caste. In past, District Magistrate had ordered the relocation of scheduled caste hamlet in Kamouli, as it is suffering from water logging. However due upper caste dominance on this public land of. the panchayat, the people have not been relocated.

Sehbar is facing problem of river water pollution which also raises the critical question of livelihood of the fishermen. Fish in the river Ganga are dying because of river water pollution caused by the sewage canal falling near the Sehbar village. This has compelled the fishermen to turn up into daily wage workers in sand mines.

Effect on water and livelihood

Because of the treatment plant, groundwater of all the study villages has become contaminated and it is unsafe for household use. The major part of the population of the study villages are dependent on wells and water hand pumps (97.5 percent) for drinking water. However the Health Department has already declared most of them unsafe for household use. Some deep tube-wells dug by a non-governmental organization Sankat Mochan Foundation, but they are mostly defunct.

Impact on agriculture and livestock

Agriculture has been adversely affected in this area. The fields have become saline due to over irrigation. While crop yields had initially improved, now they are decreasing. Vegetables and cereals do not have staying quality and the vegetables are sold in markets distant from the area as in the area people do not want to buy these. This is because they tend to smell of sewage water when stored.

Similarly villagers who can afford to buy grain from outside for consumption do so. However the majority (92 percent) are dependent on the crops in the village either because they are not rich enough to buy grains from the market and many of them get their wages in kind not cash. Cattle of the area are also suffering from different problems like wounds in hooves, infertility, and diarrhea because of the fodder poisoned by sewage water.

Health problems and quality of health services

Sludge drying beds (open) of the plant has turned up into a breeding ground of mosquitoes and flies. Therefore, malaria, skin diseases, and gastric problems are found throughout the year. There is only one primary health center among all the three villages. But it does not open regularly for OPD, doctors are irregular and medicines unavailable. Hence villagers are dependent on the local non-MBBS practitioner for their ailments. Also, preventive measures by the PHC or the plant like spraying of DDT for mosquito, putting chlorine tablets in wells or health camps in the study villages have not been organized for the past 3-4 years.

Impact on daily lives

In study villages, there is decrease in land prices because of pollution. Relatives of the local don't visit or stay back here because of foul smell, mosquitoes and unhealthy conditions. Sometimes this is considered as a social stigma. Small and medium manufacturers of the area are making organic fertilizer from plant sludge by mixing straw, urea, and some other materials. In the study villages, no one is buying this 'organic fertilizer' and, manufacturers are selling it out side the area to unsuspecting buyers.

In the establishment procedure of the plant there was no people's participation. Many families whose land was acquired for the establishment of plant have not got any

compensation yet. Local leaders or regional political parties have no interest on the problems being created by the plant. Some of the village leaders are in favor of its continuing as it is they who are getting contract of earthen work and sludge extraction from the sludge drying beds of the plant. Keeping in view the present situation in the study area, there is a need to understand the politics of the problems in these three villages of the study area. Lastly, community participation through awareness programme is very essential.

CONCLUSION

Today there is an urgent need in Varansi that there should be total interception of sewage flowing into the Ganga and Varuna rivers. Sewage water of the city should be treated. The condition of existing Sewage Treatment Plant (STP) should be improved. For this the possibility of mini sewage treatment plants needs to be explored. Workers who are involved in sludge extraction in the Sewage Treatment Plant and other activities related to sludge extraction should report to the concerned authority about the damaged equipment and get it replaced.

Additionally in Dinapur, a hydrogeolic assessment of the site must be done. The plant administration should control the hydraulic load required for irrigation. In this connection, they can consult with Banaras Hindu University or concerned departments of state and central Bodies. Non-government organizations should come forward to help in monitoring ground water level and contamination possibilities in different seasons. Utilization of produced sewage gas for industrial or household consumption should be considered in the nearby villages.

In the study villages, the ground water quality should be improved. The frequency of ground water monitoring should be increased. The soil of the study area should be monitored once in each year before sowing the next crop. The different parameters for soil pH, organic matter, metal etc should be monitored. These Parameters should be analyzed at different depths of a soil profile. Plant authority should keep record of this data and provide it to villagers into simple language. The concerned authority should carry out a survey for background metal concentration in soil, plants, blood (animal and man) for comparison of data with irrigated and non-irrigated area. This would help in

finding out the level of contamination as well as the environmental impact analysis. However, none of this is possible unless there is larger political and structural change in the present system.

अध्ययन हेतु
जातीय समूहों के आधार पर

ग्रुप डिस्कशन-

(अ) क्या दीनापुर में स्थित सीवेज ट्रीटमेन्ट प्लान्ट (STP) एवं नहर को बनाने की जो नियोजन प्रक्रिया थी; उसमें आप लोगों ने भाग लिया था। वास्तव में इस सीवेज ट्रीटमेन्ट प्लान्ट की कहानी क्या है?

अध्ययन हेतु
जातीय समूहों के आधार पर

-फोकस ग्रुप डिस्कशन-

(ब) क्या इस सीवेज ट्रीटमेन्ट प्लान्ट एवं नहर के बन जाने की वज़ह से आप लोगों के जीवन में किसी प्रकार के परिवर्तन आये हैं?

अध्ययन हेतु
जातीय समूहों के आधार पर

-फोकस ग्रुप डिस्कशन-

(स) क्या वर्तमान समय में सरकार आप लोगों द्वारा बतलायी गयी तकलीफ़ों को दूर करने के लिए कोई कार्य कर रही है?

अध्ययन हेतु
जातीय समूहों के आधार पर

-फोकस ग्रुप डिस्कशन-

(द) क्या आप लोग पंचायत या सामूहिक स्तर पर अपनी तकलीफ़ों को दूर करने के लिए कोई कार्य कर रहे हैं?

APPENDIX-2

अध्ययन हेतु
चयनित परिवार से

पारिवारिक अनुसूची

गांव का नाम.....

प्र. 1 उत्तरदाता का नाम ..... लिंग 1. पुरुष 2. स्त्री

प्र. 2 जाति 1. सामान्य 2. अन्य पिछड़ी जाति 3. अनुसूचित जाति/जनजाति

प्र. 3. आयु 1. 18–30 2. 30–50 3. 50 से ज्यादा।

प्र. 4. परिवार में सदस्यों की संख्या एवं उनकी शैक्षणिक स्थिति
कुल ..... पु0.....म0.....बालिग..... निरक्षर.....

प्र. 5. घर का प्रकार
1. कच्चा 2. पक्का 3. आधा कच्चा आधा पक्का।

प्र. 6. घर में कमरों की संख्या .....

प्र. 7. क्या उत्तरदाता के घर में बिजली है?
1. हां 2. नहीं 3. पहले थी अब नहीं है

प्र. 8 क्या उत्तरदाता के घर में शौचालय है?
1. हां 2. नहीं

प्र. 9. क्या उत्तरदाता के पास कृषि योग्य भूमि है?
1. हां 2. नहीं

प्रा.10 यदि हां तो उसका विवरण
1. एक एकड़ से कम
2. 1–3 एकड़ के बीच
3. 3–5 एकड़ के बीच
4. 5 एकड़ से ज्यादा

11. यदि नहीं / हां तो आपका परिवार आय के लिए कौन सा कार्य करता है?
    1. कृषि / मजदूरी
    2. नौकरी (सरकारी / प्राइवेट)
    3. बुनाई
    4. शहर में मजदूरी
    5. एक से ज्यादा .....Rs

12. क्या आपके परिवार की महिलायें भी कार्य करती हैं?
    1. हां 2. नहीं

13. यदि हां तो 1. घर का 2. बाहर का 3. दोनों

14. क्या आपके पास सिचाई का अपना साधन है?
    1. हां 2. नहीं 3. खराब पड़ा हैं

15. क्या आप सिंचाई के लिए नहर के पानी का प्रयोग करते हैं? और क्यों!
    1. हां 2. नहीं 3. दोनों 4. सिर्फ मजबूरी पड़ने पर।

16. यदि नहीं तो किसका
    1. कूयें का 2. सरकारी नलकूप का 3. निजी पम्पों का

17. क्या वर्तमान समय में नहर का पानी आपकी / लोगों की फसलों के लिए लाभदायक है? और क्यों
    1. हां 2. नहीं 3. कह नहीं सकते

18. क्या नहर के पानी के उपयोग से खेतों में उत्पादकता बढ़ी है? और क्यों?
    1. हां 2. नहीं
    3. कह नहीं सकते 4. पहले बढ़ी थी अब घट रही है

19. यदि इस नहर का पानी आपकी / लोगों की फसलों के लिए हानिकारक है तो आप / लोग इसका प्रयोग छोड़ क्यों नहीं देते? और क्यों?
    1. इस नहर के अतिरिक्त सिंचाई का कोई ठोस साधन नहीं है।
    2. इसमें पोषक तत्वों की मात्रा है जो हमारे खेतों के लिये लाभदायक है।
    3. उत्पादकता घटने एवं स्वास्थ्य पर प्रतिकूल पड़ने वाले प्रभावों के बावजूद नहर का पानी आर्थिक दृष्टि से फायदेमंद है।
    4. कई ..... ।

20. क्या आप/लोग वर्तमान समय में खेतों में रासायनिक खादों का प्रयोग करते हैं? और क्यों?
1. हां 2. नहीं 3. कह नहीं सकते

21. यदि हां / नहीं तो उसकी मात्रा मे आयी कमी या बढ़ोतरी से आप/लोगों को साल में कितने रुपयों का लाभ/नुकसान हो रहा है। और क्यों?
1. लाभ ..... 2. नुकसान ..... ।

22. क्या आप/लोग प्लांट में उत्पादित स्लज का प्रयोग करते हैं? और क्यों?
1. हां 2. नहीं 3. कह नहीं सकते

23. क्या यह नहर रात में चलती है? और क्यों
1. हां 2. नहीं 3. कह नहीं सकते

24. यदि आप/लोगों को सिंचाई के लिए नलकूप का पानी मिले तो आप इस नहर का उपयोग छोड़ देंगें? और क्यो?
1. हां 2. नहीं 3. कह नहीं सकते

25. आप/लोग वर्तमान समय में कौन सी प्रमुख फसलों का उत्पादन कर रहे हैं? और क्यो? ..... ।

26. आप/लोग अपने खेतों में उत्पादित फसल/दूध इत्यादि को कहां बेचते है और क्यों?
..... ।

27. क्या आप/लोग उत्पादित फसलों इत्यादि में किसी प्रकार का परिर्वतन महसूस कर रहे हैं? यदि हां तो उसका विवरण
1. हां 2. नहीं 3. कह नहीं सकते

28. क्या आप/लोगों के खेतों में उत्पादित अनाज इत्यादि बीज के लिए उपयुक्त है? और क्यों?
1. हां 2. नहीं 3. कह नहीं सकते

29. आप/लोग उत्पादित अनाज/दुध इत्यादि का उपयोग किस प्रकार करते हैं और क्यों?
1. सारा उपयोग में लाते हैं 2. सारा बेच देते हैं
3. कुछ उपयोग में लाते हैं कुछ बेच देते हैं

30. क्या आप/लोग नहर द्वारा सिंचित खेतों में काम करते समय किसी प्रकार की समस्या का अनुभव करते हैं? और क्यो?
1. हां 2. नहीं 3. कह नहीं सकते

31. आपको इस प्लांट / नहर इत्यादि से सबसे ज्यादा परेशानी किस समय महसूस होती हैं और क्यो?
1. सर्दी 2. गर्मी 3. बरसात
4. साल भर 5. कोई पेरशानी नहीं है।

32. क्या आपके पास दुधारु या अन्य किसी प्रकार के पशु हैं?
1. हां 2. नहीं

33. क्या आपको लगता है कि इस नहर द्वारा सिंचित चारे के उपयोग से इन पशुओं के स्वास्थ्य एवं उत्पादकता पर कोइ असर पड़ा है? और क्यों
1. हां 2. नहीं 3. कह नहीं सकते

34. यदि हां तो
1. दूध/मांस बढ़ा है 2. दूध/मांस घटा है
3. कोई परिवर्तन नहीं है

35. क्या आपके पास पीने के पानी का अपना स्रोत है?
1. हां 2. नहीं

36. आप अपने दैनिक कार्यों के लिए कहां से पानी प्राप्त करते हैं?
1. चापाकल 2. कूआं 3. गहरे ट्यूबवेल का
4. अन्य 5. एक से अधिक .....

37. क्या आपको लगता है कि आप द्वारा प्रयोग में लाया जा रहा पानी आपके हिसाब से स्वच्छ एवं उपयुक्त है?
1. हां 2. नहीं 3. कह नहीं सकते

38. क्या आपको लगता है कि इस सीवेज ट्रीटमेंट प्लांट/नहर की वजह से आपलोगों के स्वास्थ्य पर कोई प्रभाव पड़ा है?
1. साकारात्मक 2. नाकारात्मक 3. कह नहीं सकते

39. क्या आप के परिवार में वर्तमान समय में या पिछले तीन महिनों में कोई बीमार रहा है?
1. हां 2. नहीं 3. पिछले तीन माह में बीमार थे अब ठीक हैं।

यदि हां तो बीमारी ..... अवधि .....

40. क्या इसके लिये आपको इलाज की आवश्यकता पड़ी थी?
1. हां 2. नहीं 3. कह नहीं सकते

41. यदि हां तो इलाज कहां चला?
1. सरकारी (अ) प्राथमिक स्वास्थ्य केन्द (ब) जिला अस्पताल
2. निजी डाक्टर 3. मिशनरी या ट्रस्ट

42. क्या आप इस प्लांट एवं नहर के बगल में रहने की वजह से किसी प्रकार का सामाजिक अलगाव महसूस कर रहे हैं और क्यों?
1. हां 2. नहीं 3. कह नहीं सकते

43. क्या फाउंडेसन द्वारा लगाये गये ट्यूबवेलों से पानी की उपलब्धता में कोई फर्क आया है? और क्यों?
1. हां 2. नहीं 3. कह नहीं सकते

44. क्या इस प्लांट एवं नहर की स्थापना के समय संबंधित विभाग द्वारा आपलोगों के बीच किसी प्रकार की चर्चा चलाई गयी थी?
1. हां 2. नहीं 3. कह नहीं सकते

45. क्या प्लांट/स्वास्थ्य विभाग आपलोगों की समस्याओं से परिचित है? और कैसे?
1. हां 2. नहीं 3. कह नहीं सकते

46. क्या प्लांट या स्वास्थ्य विभाग द्वारा आपके गांव में वर्तमान समय में या पिछले एक दो सालों में स्वास्थ्य शिविर/दवा इत्यादि का छिड़काव किया गया था?
1. हां 2. नहीं 3. कह नहीं सकते

47. क्या प्लांट एवं नहर की वजह से आप/लोगों की जमीनों की कीमत में किसी प्रकार का परिवर्तन आया है? और क्यों?
1. स्थिर है 2. कम हुयी है
3. वढ़ी है 4. कह नहीं सकते

48. क्या आपके परिवार का कोई व्यक्ति प्लांट में कार्य कर रहा है?
1. हां 2. नहीं 3. कह नहीं सकते

49. क्या आपके निकटवर्ती स्वास्थ्य केन्द्र पर आपलोगों के लिये कुछ विशेष सुविधायें उपलब्ध है? और क्यों?
1. हां 2. नहीं 3. कह नहीं सकते

50. क्या आपको लगता है कि यह प्लांट एवं नहर आपके आसपास के पर्यावरण को प्रदुषित कर रहा है?
1. हां 2. नहीं 3. कह नहीं सकते

51. क्या क्षेत्र की पंचायत/राजनैतिक पार्टियों का इस समस्या के समाधान हेतु कोई प्रयास किया गया है?
1. हां 2. नहीं 3. कह नहीं सकते

सिर्फ बुनकरों या मछुआरों से

52. क्या इस नहर के बन जाने की वजह से नदी में मछलीयों की संख्या में कोई कमी आयी है? और कैसे?
1. हां 2. नहीं 3. कह नहीं सकते

क्या इस नहर एवं प्लांट की वजह से बुनाई के काम पर कोइ असर पड़ा है? और कैसे?
1. हां 2. नहीं 3. कह नहीं सकते

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नोट :

अध्ययन हेतु
सांख्यकीय सूचनाएं

1. गाँव का नामः—..... 2. ग्राम पंचायत का नाम :—.....

3. कुल वार्डो की संख्याः— ..... 4. क्षेत्र पंचायत का नाम :—.....

5. ग्राम पंचायत की कुल आबादी .....

i) महिला :.....

ii) पुरुष : .....

iii) बच्चे : .....

कुल : .....

6. प्रमुख जातियाँः .....
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7. कुल परिवारों की संख्या :

i) अनुसूचित जाति : .....

ii) पिछड़ी जाति : .....

iii) अल्पसंख्यक :.....

iv) सामान्य जाति : .....

कुल : .....

8. गरीबी रेखा के नीचे जीवन यापन करने वाले परिवारों की संख्या :

i) अनुसूचित जाति : .....

ii) पिछड़ी जाति : .....

iii) अल्पसंख्यक :.....

iv) सामान्य जाति : .....

कुल : .....

9. ग्राम प्रधान का नाम :–.....

10. पंचायत सचिव का नाम :–.....

11. महिला पंचायत सदस्यों की संख्या :.....

12. क्षेत्र पंचायत सदस्य संख्या एवं नाम : .....

13. कुल क्षेत्रफल :–

i) बोया गया: .....

ii) चारागाह : .....

iii)बंजर : .....

कुल : .....

14. जाति एवं जमीन का विवरण

i) अनुसूचित जाति : .....

ii) पिछड़ी जाति : .....

iii) अल्पसंख्यक :.....

iv) सामान्य जाति : .....

कुल : .....

15. भूमिहीन परिवारों की संख्या :

i) अनुसूचित जाति : .....

ii) पिछड़ी जाति : .....

iii) अल्पसंख्यक :.....

iv) सामान्य जाति : .....

कुल : .....

16. सीवेज़ ट्रीटमेन्ट प्लान्ट एवं नहर से गाँव की दूरी :–

i) सीवेज़ ट्रीटमेन्ट प्लान्ट : .....

ii) नहर : .....

17. गाँव में पीने के पानी के स्रोत कौन–कौन से हैं :–

i) कुएं : .....

ii) चापाकल : .....

ii) अन्य : .....

18. क्या गाँव में सरकारी जल की व्यवस्था हैः– .....

19. प्राथमिक स्वास्थ्य केन्द्र से गाँव की दूरी :– .....

. शुल्क लगता है :–.....

प्राथमिक स्वास्थ्य केन्द्र में प्रयोगशाला है :– .....

दवाएं मिलती हैः– .....

महिला डाक्टर है :– .....

भर्ती होने की व्यवस्था हैः– .....

एम्बुलेन्स है :– .....

प्राथमिक स्वास्थ्य केन्द्र मे जाने का साधन :– .....

20. गाँव में,

- विद्यालय – प्रा0 / मा0 / इण्टर / नहीं है .....कि0मी0
- आँगनबाड़ी – है / नहीं है .....संख्या
- सरकारी गल्ले की दुकान– है / नहीं है .....कि0मी0
- क्या मिलता है (सामान / रेट / मात्रा) :–

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- उप स्वास्थ्य केन्द्र / नहीं है .....कि0मी0
- डाक्टर / दाई / नहीं है .....
- उपलब्धता :

  हमेशा / दिन में / कभी–कभी / आकस्मिकः..... ।

- प्राईवेट डॉक्टर हैं/नहीं हैं: .....कि0मी0
  कितने रुपयों की दवा देते है:– .....दिन की
- कितने परिवारों के पास अपना शौचालय है:–
  - i) अनुसूचित जाति : .....
  - ii) पिछड़ी जाति : .....
  - iii) अल्पसंख्यक :.....
  - iv) सामान्य जाति : .....
  - कुल : .....
- लेटर बाक्स है?:–..... कि0मी0
- मुख्य सड़क से दूरी .....कि0मी0
- सवारी मिलती है?हाँ/नहीं ..... घण्टे पर/ रात में भी
- बिजली है? हाँ/नहीं .....घण्टे
- कितने परिवारों के पास कनेक्शन है?:–.....
- कितने परिवार बिजली जलाते है?:– .....
- स्थानीय बाजार .....कि0मी0

अध्ययन हेतु
सम्बन्धित अधिकारियों से

-साक्षात्कार अनुसूची-

1– गंगा नदी में प्रदूषण के कारण कौन–कौन से हैं?

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2– यदि हम आप द्वारा बतलाये गये प्रदूषण के कारणों के पीछे के तथ्यात्मक स्रोतों को जानना चाहें तो उनके स्रोत कौन–कौन से हैं? क्या गंगा कार्य योजना को प्रारम्भ करने से पूर्व किसी प्रकार का अध्ययन किया गया था जिससे यह पता चल सके कि गंगा नदी के प्रदूषण के मुख्य कारण कौन–कौन से हैं? और उन्हें कैसे और किन–किन विधियों द्वारा दूर किया जाय।

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3– वाराणसी शहर में गंगा कार्य योजना के अन्तर्गत तय किये गये Water Quality Level को प्राप्त करने के लिए कौन–कौन से उपाय प्रयोग में लाये जा रहे हैं।

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4– गंगा कार्य योजना के तहत वाराणसी शहर के Sewage को साफ करने के लिए कौन–कौन से प्लान बने थे। वर्तमान समय में इन लक्ष्यों को प्राप्त करने में कौन सी समस्याएं सामने आ रही हैं? और ऐसा क्यों है?

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5– गंगा कार्य योजना के तहत महानगर के सीवर उपचार की जिम्मेदारी जल–निगम को सौंपी गयी । क्या जल निगम इन जिम्मेदारियों को निभा पाने में अपने आप को सक्षम पा रहा है?

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6– क्या गंगा कार्य योजना को विदेशों से किसी प्रकार की कोई सहायता प्राप्त हो रही है?

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7– क्या सिर्फ महानगर के सीवर को साफ कर देने से गंगा प्रदूषण पर पूरी तरह से नियंत्रण किया जा सकता है?

8– क्या गंगा कार्य योजना में स्थानीय नागरिकों एवं निकायों की सहभागिता का कोई प्रावधान है? यदि हाँ तो वाराणसी शहर में इस दिशा में कौन से कार्य सम्पन्न हो रहे हैं?

APPENDIX- V

WATER QUALITY LEVEL AFTER GAP PHASE –1 IN VARANASI

Year	Up stream (DO in ml / l)	Down stream (B.O.D in ml / l)	Up stream (DO in ml / l)	Down stream (B.O.D in ml / l)
1986	> 5.00	> 5.0	< 3.00	< 3.00
1987	5.6	5.9	10.1	10.6
1988	8.4	8.6	4.1	4.8
1989	8.6	8.1	3.3	4.3
1990	7.7	7.5	3.0	4.0
1991	7.8	7.2	2.6	5.9
1992	7.6	6.8	1.2	1.9
1993	7.3	7.1	0.9	1.4
1994	8.2	7.6	0.8	1.0
1995	7.2	5.8	1.4	2.9
1996	8.5	8.0	1.4	2.6
1997	8.0	7.7	2.2	2.8
1998	8.8	8.7	2.4	3.1
1999	8.8	6.6	2.9	4.3
2000	8.2	8.4	2.2	3.1
2001	6.5	7.2	2.5	4.4
2002	10.8	7.5	3.0	2.5

Source: Ganga Pollution Control Unit Varanasi, U.P Jal Nigum.(U.P.J.N), 2003.

APPENDIX- VI

WORK DONE BY OTHER DEPARTMENTS IN VARANASI UNDER, GAP-1

S.n	Work Done	Approved budget	Expense	Agency
1	**Construction of common toilets**	52.89	52.89	N.N/ VDA
2	**Construction of common toilets and low cost sanitation programmes**	109.25	113.07	N.N/ VDA
3	**Low cost sanitation prog, in *pacca mahal.***	27.02	27.05	N.N
4	**Renovation of Dr Rajendra Prasad Ghat**	5.20	5.00	N.N/ VDA
5	**Improvement for Traffic circulation**	74.02	74.02	PWD
6	**Renovation of lanes near to Ghats**	36.00	36.00	N.N
7	**Electrification of lanes near to Ghats**	18.78	18.78	N.N
8	**Solid waste management**	50.47	50.47	N.N
9	**Facilities for pilgrims and traffic circulation of lanes near to Ghats.**	33.40	33.40	N.N/ VDA
10	**Renovation of ponds and religious *'kunds'***	24.02	23.10	N.N/ VDA
11	**Relocation of *'Dhobi Ghats'***	46.08	41.12	N.N/ VDA
12	**Electrification of Ghats**	49.37	39.90	VDA
13	**Construction of drain in Nagva**	13.84	22.00	I.D
14	**Protection of Ghats and Slopes**	43.94	43.94	I.D
15	**Integrated development of maze ghats (from Trilochan to Raj ghat)**	296.98	295.54	I.D
16	**Construction of steps on Ghats and its extension.**	52.96	62.96	I.D
17	**Breeding of Fresh water turtles**	34.52	34.52	F.D
18	**Micro level monitoring of river water**	8.78	7.89	P.C.B
19	**Security provisions in the river**	27.00	22.28	P.D.
20	**Construction of STP in DLW**	75.00	75.00	DLW
21	**Cleanliness of sewerage lines.**	72.46	68.52	J.S.
	TOTAL	1151.98	1147.54	
	GRAND TOTAL	4743.83	4955.46	

Source: Ganga Pollution Control Unit Varanasi, U.P Jal Nigum. (U.P.J.N), 2003.

N.N : Nagar Nigum, **V.D.A.** : Varanasi Development Authority, **P.W.D**: Public Work Department, **I.D.**: Irrigation Department, **F.D.**: Forest Department, **P.C.B.**: Pollution Control Board, **J.S.**: Jal Sansthan., **P.D.**: Police Department, **D.L.W**: Diesel Locomotive Works.

APPENDIX- VII

WORK DONE UNDER GAP PHASE -1 IN VARANASI AND BUDGET

(In lakhs)

S.no	Work Done	Approved budget	Expenses	Agency
1	Renovation of Ramnagar pump house	9.75	9.75	U.P. J.N.
2	Renovation of Ghat's pumping house	96.00	96.00	U.P. J.N.
3	Laying Rising main in DLW, STP	88.00	88.00	U.P. J.N.
4	Interception and construction of Pumping House for Mansarovar drain.	99.76	100.77	U.P. J.N.
5	Interception and diversion of Raj Ghat and Taleya Nala.	74.23	69.64	U.P. J.N.
6	Work done on Dr R. Prasad Pump House	75.35	76.88	U.P. J.N.
7	Sewerage plan for Ram Nagar	47.74	68.55	U.P. J.N.
8	Disconnection of Trilochan drain	12.13	7.95	U.P. J.N.
9	STP, BHU	313.62	344.96	U.P. J.N.
10	Konia pretreatment and Dinapur STP	2524.84	2680.58	U.P. J.N.
11	Renovation of farm channel of Dinapur	97.54	110.82	U.P. J.N.
12	Flow measuring devises	7.55	7.60	U.P. J.N.
13	Renovation of sever line of Ordali Bazar			U.P. J.N.
	TOTAL	3591.85	3807.92	

Source: Ganga Pollution Control Unit Varanasi, U.P Jal Nigum.(U.P.J.N), 2003.

APPENDIX- VII

DESIGNATED BEST USE CLASSIFICATION OF INLAND SURFACE WATER

Class	Designated Best Use	Primary water quality criteria
A	**Drinking water source without conventional treatment but after disinfection.**	(a) ph: 6.5 to 8.5 (b) dissolved oxygen: 6mg/l or more (c)biochemical oxygen demand :2mg/l or(d) total colifrom: 50MPN/100ml
B	**Out door bathing (organized)**	(a) ph: 6.5 to 8.5 (b) dissolved oxygen: 5mg/l or more (c)biochemical oxygen demand :3 mg/l or (d) total colifrom: 500MPN/100ml
C	**Drinking water source with conventional treatment less followed by disinfection.**	(a) ph: 6.5 to 8.5 (b) dissolved oxygen: 4mg/l or more (c)biochemical oxygen demand :3mg/l or(d) total colifrom: 5000MPN/100ml
D	**Propagation of wild life and fisheries**	(a) ph: 6.5 to 8.5 (b) dissolved oxygen: 4mg/l or more, free Ammonia : 12mg/l
E	**Irrigation, industrial cooling and controlled water disposal.**	(a) ph: 6.5 to 8.5 (b) Electrical conducity: 2550 mhos/ cm, Solid Absorption ratio: 26, Boron: 2mg/l

Source: Central Board for the Prevention and Control of Water Pollution, New Delhi.

WATER QUALITY OF THE RIVER WATER AS GAP

- Bio- Chemical Oxygen Demand (BOD) – 3 mg / l maximum.
- Dissolved Oxygen (DO) – 5 mg / l minimum
- Total coliform count – 10000 MPN per 1000 ml.
- Fecal coliform count – 2,500 MPN per 100 ml.

(**Source** Annual Report 1999-00, Ministry of Environment and Forests, Government of India.)

APPENDIX- IX

SEWAGE TREATMENT PLANTS CONSTRUCTED UNDER GAP-1

UTTAR PRADESH

Swarag Ashram,Rishikesh. (2) Lakarghat, Rishikesh. (3) Kankhal, Hardwar. (4) Farrukhabad, (5) Kanpur (Jaj Mau), (6) Kanpur (Jaj Mau), (7) Chrome Recovery Pilot Plant, Kanpur, (8) Kanpur. (9) Allahabad. (10) Mirzapur (11) BHU, Varanasi. (12) DLW, Varanasi. (13) Dinapur, Varanasi.

BIHAR

(14) Chapra, (15) Patna Saidpur, (16) Patna Eastern Zone, (17) Beur, Patna. (18) Patna Southern Zone, (19) Munger, (20) Bhagal pur.

WEST BENGAL

(21) Chandan nagar, (22) Behrampur ,(23) Nabadwip,(24) Kalyani, (25) Bhatpara group E, (26) Bhatpara group B, (27) Titagarh, (28) Panihati ,(29)Baranagar – Kamarhati , (30) Garden reach , (31) South Suburban(east), (32) Howrah,(33)Serampore, (34) Bally (35)Cossipore – Chitpore.

COST (BUDGET)

In 1988, when most of the schemes had been firmed up, the cost of the Action plan (only schemes) was estimated at Rs 256 crore. This cost was revised to Rs 462 crore in August 1994, which is also the present approved cost of the action plan. The different components of the approved cost are shown in table.

STATE –WISE SANCTIONED COST OF GAP PHASE 1

State	Rupee in crore
Uttar Pradesh	184.84 (40.0%)
Bihar	53.29 (11.5%)
West Bengal	181.83 (39.4%)
Operation & Maintenance	25.30 (5.5%)
Establishment	16.75 (3.6%)
Total	462 (100)

The entire funding has been provided by the central Government. The Cost includes external aid component of equivalent to Rs 33.04 crore from the World Bank and Rs 47.32 crore from the Netherlands.

STATUS OF COMPLETION OF SCHEMES UNDER GAP-1 (AS ON 30.9.1999)

S.no	Type of scheme	U.P.	Bihar	W.B	Total
1	Sewage interception & diversion	40 (40)	17 (17)	31 (31)	88 (88)
2	Sewage Treatment Plant	13 (13)	5 (7)	14 (15)	32 (35)
3	Low cost sanitation	14 (14)	7 (7)	22 (22)	43 (43)
4	Electric Crematorium	3 (3)	8 (8)	17 (17)	28 (28)
5	River front facilities	8 (8)	3 (30)	24 (24)	35 (35)
6	Other schemes	28 (28)	3 (3)	1 (1)	32 (32)
Total		106 (106)	43 (45)	109 (110)	258 (261)

(Number): Completed

Source: Ministry of Environment and Forests, Government of India.

APPENDIX- X

SUMMER AVERAGE VALUES FOR WATER QUALITY ON MAIN STREAM OF RIVER GANGA UNDER GAP-1

Station	Distance	Dissolved Oxygen (mg/l)*		Biochemical Oxygen Demand (mg/l)*	
		1986	2002	1986	2002
Rishikesh	0	8.1	8.30	1.7	1.10
Haridwar D/S	30	8.1	7.90	1.8	1.60
Garhumutkeshwar	175	7.8	-	2.2	-
Kannauj U/S	430	7.2	7.65	5.5	1.17
Kannauj D/S	433	NA	6.50	NA	4.23
Kanpur U/S	530	7.2	6.27	7.2	3.80
Kanpur D/S	548	6.7	6.75	8.6	4.90
Allahabad U/S	733	6.4	13.00	11.4	-
Allahabad D/S	743	6.6	8.20	15.5	3.80
Varanasi U/S	908	5.6	10.80	10.1	3.00
Varanasi D/S	916	5.9	7.50	10.6	2.50
Patana U/S	1188	8.4	7.08	2.0	1.88
Patana D/S	1198	8.1	7.10	2.2	1.95
Rajmahal	1508	7.8	7.93	1.8	1.48
Palta	2050	NA	7.25	NA	2.66
Uluberia	2500	NA	5.43	NA	1.94

* Mean value for the month of March to June when the temperatures are high and flows are low.

NA – Data not available

U/S – up stream.

D/S– down stream.

Source – Annual Report 2001- 2002, National River Conservation Directorate

APPENDIX- XI

PROCEDURE OF SEWAGE WATER TREATMENT

Primary treatment

1. Screening

Sewage arriving at a disposal work is first passed through a metal screen, which intercepts large floating objects such as pieces of wood, rags, masses of garbage and dead animals. Their removal is necessary to prevent clogging of treatment plant. The screen consists of vertical or inclined steel bar usually set 5 cm (2 in) apart. In some plants, the screens are of the fixed type while in others, the screens are of the moving type. The screenings are removed from time to time either manually or mechanically, and disposed of by trenching or burial.

2. Grit chamber

Sewage is then passed through a long narrow chamber called the grit chamber or detritus chamber. This chamber is approximately 10 to 20 meter lengths; it is so designed as to maintain a constant velocity of about 1-foot per second, with a detention period of 30 seconds to 1 minute. The function of the grit chamber is to allow the settlement of heavier solids such as sand and gravel, while permitting the organic matter to pass through. The grit, which collects at the bottom of the chamber, is removed periodically or continuously and disposed of by plain dumping or trenching.

3. Primary sedimentation

Sewage is now admitted into a huge tank called the primary sedimentation tank. It is a very large tank, holding from ¼ to 1/3 the dry weather flow. There are various designs in primary sedimentation tank. By far the commonest is the rectangular tank. Sewage is made to flow very slowly across the tank at a velocity of 1-2 feet per minute. The sewage spends about 6-8 hours in the tank. During this long period of relatively still conditions in the tank, a very considerable amount of purification takes place mainly through sedimentation of suspended matter. Nearly 50- 70 percent of the solids settle down under the influence of gravity. A reduction of between 30 to 40 percent in the number of colifrom organism is obtained. The organic matter that settles down is called sludge and is removed by mechanically operated devices, without disturbing the operation in the tank. While this is going on, small amount of biological action also takes place in which the micro- organisms present in the sewage attack complex organic solids and break them down into simpler soluble substances and ammonia. Central amounts of fat and greasers to the surface to form scum, which is removed from time to time and disposed of. When the sewage contains organic trade waste, it is treated with chemicals such as lime, aluminum sulfate, and ferrous sulfate. Addition of one of this chemical precipitates the animal protein material quickly.

Secondary treatment

The effluent from the primary sedimentation tank still contains a proportion of organic matter in solution or colloidal state, and numerous living organisms. It has a high demand for oxygen and can cause pollution of soil or water. It is subjected to further treatment, aerobic oxidation, by one of the following methods:

- Trickling Filter method
- Activated sludge process

Trickling filter

The trickling filter or percolating filter is a bed of crushed stones, 1 to 2m (4-8 ft) deep and 2 to 30m (6-100 ft) in diameter, depending upon the size of the population. The effluent from the primary sedimentation tank is sprinkled uniformly on the surface of the bed by a revolving device. The device consists of hallow pipes each of which have a row of holes. The pipes keep rotating, sprinkling the effluent in a thin film on the surface of the filter. Over the surface and down through the filter, a very complex biological growth consisting of algae, fungi, protozoa and bacteria of many kinds occurs. This is known as the " zoogleal layer''. As the effluent percolates through the filter bed, it gets oxidized by the bacterial flora in the zoogleal layer. The action of the filter is thus purely a biological one, and not one of filtration as the name suggests. The term "filter" is a misnomer. The trickling filters very efficient in purifying sewage. They do not need rest pauses, because wind blows freely through the beds supplying the oxygen needed by the zoogleal flora. The biological growth or zoogleal layer lives, grows, and dies. The dead matter sloughs off, breaks away, and is washed down the filter. It is a light, flocculent material and is called " humus." The oxidized sewage is now led into the secondary sedimentation tanks or humus tanks.

Activated sludge process

Activated sludge process is the modern method of purifying sewage, in place of the trickling filter. The "heart" of the activated sludge process is the aeration tank. The effluent from the primary sedimentation tank is mixed with sludge drawn from the final settling tank (also known as activated sludge or return sludge; this sludge is a rich culture of aerobic bacteria). The proportion of activated sludge to the incoming effluent is of the order of 20 to 30 percent. The mixture is subjected to aeration in the aeration chamber for about 6 to 8 hours. The aeration is accomplished either by mechanical agitation or by forcing compressed air continuously from the bottom of the aeration tank. This latter method, also known as ' diffuse aeration' is considered a better method of aeration. During the process of aeration, the organic matter of the sewage gets oxidized into carbon dioxide, nitrates, and water with the help of the aerobic bacteria in the activated sludge. The typhoid and cholera organisms are definitely destroyed, and the coliforms greatly reduced. Activated sludge plants occupy less space, require skilled operations. One acre of activated sludge plant does the work of 10 acres of percolating filter. Activated sludge process is therefore, best suited for larger cities and the percolating filter for smaller towns because they are cheaper to install and easier to operate.

Secondary sedimentation

The oxidized sewage from the trickling filter or aeration chamber is lead into the secondary sedimentation tank where tank it is detained for 2-3 hours. The sludge that collects in the secondary sedimentation tank is called ' aerated sludge' or activated sludge, because it is fully aerated. It differs from the sludge in the primary sedimentation tank in that it is partially inoffensive and is rich in bacteria, nitrogen, and phosphates. It is valuable manure, if dehydrated. Part of the activated sludge is pumped back into the " aeration tanks" in the activated sludge process and the rest pumped into the sludge digestion tanks for treatment and disposal.

Sludge digestion

One of the greatest problems associated with sewage treatment is the treatment and disposal of the resulting sludge. One million gallons of sewage produces 15-20 tones of sludge. The sludge is a thick, black mass containing 95% of water, and it has a revolting odor. There are number of methods of sludge disposal:

- Digestion: modern sewage treatment plants employ digestion of sludge as the method of treatment. If sludge is incubated under favorable conditions of temperature and pH, it undergoes anaerobic auto-digestion in which complex solids are broken down into water, carbon dioxide, methane and ammonia. The volume of sludge is also considerably reduced. It takes 3-4 weeks or longer for complete sludge digestion. The residue is inoffensive, sticky and tarry mud, which will dry readily and from excellent manure. Sludge digestion is carried out in special tanks known as " sludge digestion tanks." Methane gas, which is a by- product of sludge digestion, can be used for heating and lighting purposes.
- Sea disposal: seacoast towns and cities can dispose of sludge by pumping it into the sea.
- Land: Sludge can be disposed of by composting with town refuse.

Decomposition of Organic matter

The decomposition of organic matter in sewage takes place by two processes: aerobic and anaerobic processes

1. Aerobic Process: it is most efficient method of reducing the organic matter in sewage. The process requires a continuous supply of free dissolved oxygen. The organic matter is broken down into simpler compounds namely CO2, water, ammonia, nitrites, nitrates, and sulfates by the action of bacterial organisms including fungi and protozoa.
2. Anaerobic Process: where the sewage is highly concentrated and contains plenty of solids, the anaerobic is highly effective. The end- products of decomposition are methane, ammonia, CO2, and H2. In anaerobic decomposition, the reaction are slower and mechanism of decomposition extremely complex.

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