“Water resource management and its impact on public health”

A dissertation submitted in partial fulfillment of the requirements for the award of

Post - Graduate Diploma in Health and Hospital Management

By

Dr.Rashi Gupta

PG/10/34

IIHMR DELHI

International Institute of Health Management Research

New Delhi - 110075

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Under the Guidance of

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Certificate of Approval

The following dissertation titled **"Water resource management and its impact on public health"** is hereby approved as a certificate study in management carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite for the award of **Post – Graduate Diploma in Health and Hospital Management** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

Dissertation Examination Committee for evaluation of dissertation

Name	Signature
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Rashi Gupta

PG/10/034

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Abbrevations

AIIH&PH	All India Institute of Hygiene and Public Health, Calcutta
IFH	International Scientific Forum on Home Hygiene
Lpcd	litre per capita per day
MoHFW	Ministry of Health and Family Welfare, Government of
NICD	National Institute of Communicable Diseases
NICED (ICMR)	National Institute of Cholera and Enteric Diseases
NIE (Chennai)	National Institute of Epidemiology
NIOH (ICMR)	National Institute for Occupational Health
UNICEF	United Nations Children's Programme
UT	Union Territory
WB	World Bank
WHO	World Health Organization
GFATM	Global Fund to fight Aids Tuberculosis And Malaria
IMCP	Intensified Malaria Control Programme
M&E	Monitoring & Evaluation
MIS	Malaria Information System

Abstract

Introduction

Potable water is a limited resource for human consumption in developing countries like India. The share of sweet water is only 3% out of total available water on earth which is about 35 million km$^{3.}$ The share of India is 4% of the total available sweet water whereas its population is 16% of the world population..

The major source of water pollution in India is untreated industrial waste, sewage, pesticides. The polluted water is major source of disease like diarrhoea, cholera, typhoid, hepatitis, amoebic dysentery.

Objective

The main objective of study is to understand the water resource management and its effect on the water borne disease in India

Methodology

Secondary data from various sources like census of India, National Sample Survey. WHO bulletein and SRS bulletein is used. Secondary data from various sources like census of India, National Sample Survey. WHO bulletein and SRS bulletein is used. Based on the status of water, sanitation & hygiene reported from various studies. The macro-level data on community water supply and environmental sanitation in the states and cities collected from Govt. sources.

Conclusion

The impact of water borne disease due to water pollution is increasing over the past two decades.. There is a definite relation between water pollution and population. Cities with more population generated more water pollutants and showed population was at high risk of acquiring water borne disease

Keywords: Water borne disease, India, Sewage, Population, Potable water

Internship Report

1.1.1 Organization Profile

The Futures Group International India Pvt. Ltd specializes in the design & implementation of Public Health and Social Programs. Its mission is to develop and deliver innovative, locally relevant, evidence- based solutions to improve health and well- being of people worldwide. Since its inception in 1971, it has had a presence in over 100 countries in Asia, Africa, Middle East, Central and Eastern Europe, Latin America, Caribbean. In India, it has been working in the states of Orissa, Bihar, Uttarakhand, Maharashtra, Tamil Nadu, West Bengal, Jharkhand, Northeast Region, Uttar Pradesh and Chattisgarh. The staff consists of more than 1400 full time employees and a large number of short- term and long- term consultants. In India it has more than 70 highly qualified staff and a large pool of consultants located in the country office in the NCR region and in its various project offices in the different states.

The Futures Group's core expertise includes Public Health, Monitoring and Evaluation, Training Capacity, Operational Research, Economics and Health Finance, Demography, Epidemiology, Gender, Social Marketing and Communications, Public Policy, Law and Human Rights.

Early on, Futures Group focused on helping the corporate world use the computer-based modeling programs developed in conjunction with MIT scientists. Highly innovative, these methods quickly gained recognition for the company.

In 1977 the United States Agency for International Development (USAID) awarded Futures Group the RAPID (Resources for the Awareness of Population Impacts on Development) project, which focused on the impact of population factors in social and economic development.

Utilizing Futures Group's analytic tools, for the first time, developing countries received personalized population data and projected impacts of population growth, giving national teams knowledge and insight to "make the data their own." This work established Futures Group's reputation in global population programs.

In the 1980s, Futures Group expanded into social marketing with the USAID-sponsored Social Marketing for Change (SOMARC) project, cementing its hallmark as an organization well known in government circles for its policy analysis and social marketing.

By the mid-1990s, Futures Group's projects included RAPID IV, SOMARC III, MEASURE Evaluation, OPTIONS for Population Policy II, and the USAID |Health Policy Initiative (HPI), which provided Futures Group a rich, deep base in population planning with added focus on issues such as HIV/AIDS and gender.

Four decades later, Futures Group continues to follow the footsteps of its founders. We discover innovative solutions for a better world and provide meaningful insight in policy work, health systems strengthening, private sector engagement and family planning, while also broadening our technical expertise to include health informatics, efficient and effective approaches to HIV/AIDS prevention and gender.

Futures Group has been implementing large scale projects in India and elsewhere in the areas of HIV & AIDS, Family Planning and Reproductive Health, Maternal and Child health, Malaria, Tuberculosis, Avian Influenza, Environmental Health and Geosciences.

Its key clients in India include Government of India (GOI), State Governments, DFID, USAID, GFATM, World Bank, BMGF, UNAIDS, UNDP, NGOs and Professional Associations, Indian Nursing Council, Indian Medical Association, CBCI

1.2 Area of Engagement

Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) Round 9

Intensified Malaria Control Project-II (IMCP-II)

1.2.1 About the IMCP - 11

The GFATM Round 9 IMCP--II aims to scale up effective preventive and curative interventions in those areas of India, where the intensity of transmission is the highest and the health care delivery system constraints are the most severe. GFATM Round 9 IMCP—II is complementing the efforts of the National Vector Borne Diseases Control Programme (NVBDCP) of the Government of India (the other PR1) to scale up effective preventive and curative interventions in the seven North Eastern (NE) states in India covering 48 districts and 5663 villages.

Key roles of Caritas India consortium in IMCP—II.

1. Distribution of Long Lasting Insecticide treated Nets (LLLIN) to eligible villages/households.
2. Diagnosis and treatment of positive malaria cases (Pf).
3. Community outreach and behavior change communication.

4. Training of ASHAs, Community Health Volunteers and Private Health Care Provider to improve service delivery in project areas.
5. M&E/MIS

1.2.2 Area of Involvement:

In internship I was involved into two parts of the programme which is as follows

- Project M&E and MIS
- Training of private health care service providers in 07 NE states.

Coordination with various staff members and Supervision of staff for successful implementation of the projects were the broad objectives.

- Scheduling and conduction of training of Informal and Formal Service Provider
- Scheduling and conduction of field supervisory trip for Monitoring and Evaluation
- Provided support in conducting Training need assessment for PSP
- Provided support in developing training module for PSP.
- Scheduling and conduction of Field Work. It included extensive field work by me as well. It included surveying the implementation on IMCP II.
- Was part of the planning and review meetings at national, sub-national levels.
- Contributed to preparation and submission of performance reports every month/quarter and development synthesis of performance reports.

- Provide support in preparation of performance reports and annual report and other information products—newsletter/bulletins/briefs
- Provided support in timely data collection, reporting, compilation, analysis related to performance indicators.

- Provided support in conducting random checks on data quality as well as coordinated with the other personnel for the same.

1.3 Reflective Learning's

My internship at March has been a tremendously valuable learning experience. I felt like part of the team. I was given the same work as a full-time employee

During the entire process of implementation of projects, various phases gave various types of knowledge varying from soft skills, stress handling to technical advancements

Supervising the workers, assigning work to them and getting it done on time is a challenging task. If not done on time, may further delay the project deadlines. It included managerial skills and I have learned a lot from completing these tasks.

I also learned ground realities being faced by the ground workers. Since my project area is north-east India the accessibility is a real time problem. I learned how immense efforts are needed for the success of the project.

Dissertation Report

Chapter: 1

Introduction

Water is essence of life. Water supports all forms of fauna and flora. Water is also essential development of country. It contributes to economic development of country, food production and other general use.

The contribution of water to a development of country is indispensable. There is no substitute for water.

Out of total water available on earth only 4 % of water is potable .India shares only 4% of this available fresh water where as its population is 16% of the world's population. Global fresh water reserve is rapidly depleting and is expected to leave a significant effect on densely populated areas.

India has been endowed with large fresh water reserves, but increasing population and over exploitation of surface and ground water has created an alarming situation. The growth in the Indian economy has derived increased water usage by different sectors. Waste water is increasing significantly and in the absence of treatment and management of waste water, fresh water bodies are getting polluted.

Although India occupies only 3.29 million km geographical area, which forms 2.4% of the world's land area, it supports over 16% of the world's population. The population of India as on 1 March 20011 stood at **1,210,193,422 (1.21 billion)** Thus, India supports about 1/6th of world population, $1/50^{th}$ of world's land and 1/25th of world's water resources. The total utilizable water resources of the country are assessed as 1086 km.

In the past, several organizations and individuals have estimated water availability for the nation. Recently, the National Commission for Integrated Water Resources Development estimated the basin-wise average annual flow in Indian river systems as 1953 km3. Utilizable water resource is the quantum of withdrawable water from its place of natural occurrence. Within the limitations of physiographic conditions and socio-political environment, legal and constitutional constraints and the technology of development available at present, utilizable quantity of water from the surface flow has been assessed by various authorities differently. The utilizable annual surface water of the country is 690 km3.

The annual potential natural groundwater recharge from rainfall in India is about 342.43 km3, which is 8.56% of total annual rainfall of the country. The annual potential groundwater recharge augmentation from canal irrigation system is about 89.46 km3. Thus, total replenishable groundwater resource of the country is assessed as 431.89%. After allotting 15% of this quantity for drinking, and 6 km3 for industrial purposes, the remaining can be utilized for irrigation purposes. Thus, the available groundwater resource for irrigation is 361 km3, of which utilizable quantity (90%) is 325 km3.

Community water supply is the most important requirement and it is about 5% of the total water use. About 7 km3 of surface water and 18 km3 of groundwater are being used for community water supply in urban and rural areas. Along with the increase in population, another important change from the point of view of water supply is higher rate of urbanization. According to the projections, the higher is the economic growth, the higher would be urbanization. It is expected that nearly 61% of the population will be living in urban areas by the year 2050 in high-growth scenario as against 48% in low growth scenario. Different organizations and individuals have given different norms for water supply in cities and rural areas. The figure adopted by the NCIWRD was 220 litre per capita per day (lpcd) for class I cities. For the cities other than class I, the norms are 165 for the year 2025 and 220 lpcd for the year 2050. For rural areas, 70 lpcd and 150 lpcd have been recommended for the years 2025 and 2050. Based on these norms and projection of population, it is estimated that by 2050, water requirements per year for domestic use will be 90 km3 for low demand scenario and 111 km3 for high demand scenario. It is expected that about 70% of urban water requirement and 30% of rural water requirement will be met by surface water sources and the remaining from groundwater.

Chapter:2

Literature Review

India's water crisis is predominantly a manmade problem. India's climate is not particularly dry, nor is it lacking in rivers and groundwater. Extremely poor management, unclear laws, , and industrial and human waste have caused this water supply crunch and rendered what water is available practically useless due to the huge quantity of pollution. The tragedy of India's water scarcity is that the crisis could have been largely avoided with better water management practices. There has been a distinct lack of attention to water legislation, water conservation, efficiency in water use, water recycling, and infrastructure. Historically water has been viewed as an unlimited resource that did not need to be managed as a scarce commodity or provided as a basic human right. These attitudes are changing in India; there is a growing desire for decentralized management developing, which would allow local municipalities to control water as best needed for their particular region.

Since independence India's primary goals have been economic growth and food security, completely disregarding water conservation. This has caused serious ramifications being felt today, as many citizens still operate under these principles. Unlike many other developing countries, especially those with acute water scarcity issues such as China, Indian law has virtually no legislation on groundwater. Anyone can extract water: homeowner, farmer or industry as long as the water lies underneath their plot of land. The development and distribution of cheap electricity and electric pumps have triggered rapid pumping of groundwater and subsequent depletion of aquifers. There are approximately 20 million individual wells in India that are contributing to groundwater depletion. The owners of these wells do not have to pay for this water, so there is no incentive to conserve or recycle it; in fact they are incentivized to overdraw resources. Generally, the more water they use, the more they can produce. Industry applies the same logic, and rather than reusing the water used for cooling machines, they dump it back into rivers and canals, along with the pollution it has accumulated. India needs to keep boosting agricultural production in order to feed its growing population, but to do so without jeopardizing the amount of water available, farmers must switch to less water intensive crops.

The central government in India also lacks the ability to store and deliver potable water to its citizens, especially as supply shrinks. There is currently a water storage crunch, because means for storage, such as temple tanks and steep wells, have fallen apart. China is able to store 5 times as much water per person as India, making it blatantly clear how poor India's water management is. e fact that almost of all of that water is too contaminated to use. None of the 35 Indian cities with a population of more than one million distribute water for more than a few hours per day.

Meanwhile, the quantity of sewage is constantly increasing due to population growth. Those not connected to sewage lines end up dumping their waste into canals, which empty into a storm drain that runs into the Yamuna, dumping all of the waste into the river. When the water reaches downstream cities they have to heavily treat it, which subsequently drives up the cost.

Every river in India is polluted to some degree. The water quality in underground wells violates the desired levels of dissolved oxygen and coliform, the presence of which is one measure of filth, in addition to having high concentrations of toxic metals, fluoride, and nitrates. India's rivers also have high fluoride content, beyond the permissible limit of 1.5ppm, which affects 66 million people. The polluted water then seeps into the groundwater and contaminates agricultural products when used for irrigation. Over 21% of transmissible diseases in India are related to unsafe water. Millions of the poorest are affected by preventable diseases caused by inadequate water supply and sanitation.

Water related diseases are the most common cause of deaths. The paucity of clean water for domestic use has led to the increase in the number of deaths in both the urban and rural parts of developing economies. And India is no different. Water Related are classified as follows :A water related disease is one which in some way is related to water or to impurities within water (BRADLEY CLASSIFICATION (1977)

Water related diseases and Causative factors

Name of the disease	**Causative organism**
1. **Water-borne diseases**	*Salmonella typhi*
Bacterial	*Vibrio cholerae*
• Typhoid	*Slmonella parayphi*
• Cholera	Enterotoxigenic *Escherichia coli*
• Paratyphoid	Variety of *Escherichia coli*
• Gastroenteritis	Hepatitis-A virus
• Bacterial dysentery	Polio-virus
Viral	Rota-virus, Norwalk agent, other virus
• Infectious hepatitis	
• Poliomycetis	

• Diarrhoeal diseases • Other symptoms of enteric diseases **Protozoan** • Amoebic dysentery	Echono-virus, Coxsackie-virus *Entamoeba hystolitica*
2 Water-washed diseases • Scabies • Trachoma • Bacillary dysentery	Various skin fungus species Trachoma infecting eyes *E. coli*
3 Water-based diseases • Schistosomiasis • Guinea worm	*Schistosoma* sp. Guinea worm
4 Infection through water related insect vectors • Sleeping sickness • Malaria	*Trapanosoma* through tsetse fly *Plasmodium* through Anaphelis
5 Infections primarily due to defective sanitation	Hook worm, *Ascaris*

• Hookworm	

Water-related diseases are a human tragedy, killing millions of people each year, preventing millions more from leading healthy lives, and undermining development efforts. About 2.3 billion people in the world suffer from diseases that are linked to water.

Some 60% of all infant mortality is linked to infectious and parasitic diseases, most of them water-related. In some countries water-related diseases make up a high proportion of all illnesses among both adults and children. In Bangladesh, for example, estimated three-quarters of all diseases are related to unsafe water and inadequate sanitation facilities. In Pakistan one-quarter of all people attending hospitals are ill from water-related diseases.

Providing clean supplies of water and ensuring proper sanitation facilities would save millions of lives by reducing the prevalence of water-related diseases. Thus, finding solutions to these problems should become a high priority for developing countries and assistance agencies.

While water-related diseases vary substantially in their nature, transmission, effects, and management, adverse health effects related to water can be organized into three categories: water-borne diseases, including those caused by both fecal-oral organisms and those caused by toxic substances; water-based diseases; and water-related vector diseases. Another category-water-scarce (also called water-washed)-diseases consist of diseases that develop where clean freshwater is scarce.

Water-Borne Diseases

Water-borne diseases are "dirty-water" diseases-those caused by water that has been contaminated by human, animal, or chemical wastes. Worldwide, the lack of sanitary waste disposal and of clean water for drinking, cooking, and washing is to blame for over 12 million deaths a year.

Water-borne diseases include cholera, typhoid, shigella, polio, meningitis, and hepatitis A and E. Human beings and animals can act as hosts to the bacterial, viral, or protozoal organisms that cause these diseases. Millions of people have little access to sanitary waste disposal or to clean water for personal hygiene. An estimated 3 billion people lack a sanitary toilet, for example. Over 1.2 billion people are at risk because they lack access to safe freshwater.

Where proper sanitation facilities are lacking, water-borne diseases can spread rapidly. Untreated excreta carrying disease organisms wash or leach into freshwater sources, contaminating drinking water and food. The extent to which disease organisms occur in specific freshwater sources depends on the amount of human and animal excreta that they contain.

Diarrheal disease, the major water-borne disease, is prevalent in many countries where sewage treatment is inadequate. Instead, human wastes are disposed of in open latrines, ditches, canals, and water courses, or they are spread on cropland. An estimated 4 billion cases of diarrheal disease occur every year, causing 3 million to 4 million deaths, mostly among children.

Using contaminated sewage for fertilizer can result in epidemics of such diseases as cholera. These diseases can even become chronic where clean water supplies are lacking. In the early 1990s, for example, raw sewage water that was used to fertilize vegetable fields caused outbreaks of cholera in Chile and Peru. In Buenos Aires, Argentina, a slum neighbourhood faced continual outbreaks of cholera, hepatitis, and meningitis because only 4% of homes had either water mains or proper toilets, while poor diets and little access to medical services aggravated the health problems.

Toxic substances that find their way into freshwater are another cause of water-borne diseases. Increasingly, agricultural chemicals, fertilizers, pesticides, and industrial wastes are being found in freshwater supplies. Such chemicals, even in low concentrations, can build up over time and, eventually, can cause chronic diseases such as cancers among people who use the water.

Health problems from nitrates in water sources are becoming a serious problem almost everywhere. In over 150 countries nitrates from fertilizers have seeped into water wells, fouling the drinking water. Excessive concentrations of nitrates cause blood disorders. Also, high levels of nitrates and phosphates in water encourage growth of blue-green algae, leading to deoxygenation (eutrophication). Oxygen is required for metabolism by the organisms that serve as purifiers, breaking down organic matter, such as human wastes, that pollute the water. Therefore the amount of oxygen contained in water is a key indicator of water quality.

Pesticides such as DDT and heptachlor, which are used in agriculture, often wash off in irrigation water. Their presence in water and food products has alarming implications for human health because they are known to cause cancer and also may cause low sperm counts and neurological disease. In Dhaka, Bangladesh, heptachlor residues in water sources have reached levels as high as 0.789 micrograms per litre-more than 25 times the WHO-recommended maximum of 0.03 micrograms per litre. Also, in Venezuela a study of irrigation water collected during the rainy season found that the water was contaminated with a number of pesticides. Examination of pregnant women in the area found that they all had breast milk containing DDT residues-toxins that can be passed to an infant.

The seepage of toxic pollutants into ground and surface water reservoirs used for drinking and household use causes health problems in industrialized countries as well. In Europe and Russia the health of some 500 million people is at risk from water pollution. For example, in northern Russia half a million people on the Kola Peninsula drink water contaminated with heavy metals, a practice that helps to explain high infant mortality rates and endemic diarrhoeal and intestinal diseases reported there.

Improving public sanitation and providing a clean water supply are the two steps needed to prevent most water-borne diseases and deaths. In particular, constructing sanitary latrines and treating wastewater to allow for biodegradation of human wastes will help curb diseases caused by pollution. At the least, solids should be settled out of wastewater so that it is less contaminated. It is important that a clean water supply and the construction of proper sanitary facilities be provided together because they reinforce each other to limit the spread of infection.

Many studies link improvements in sanitation and provision of potable water with dramatic reductions in water-related morbidity and mortality. A review in 1991 of over 100 studies of the effects of clean water and sanitation on human health found that the median reduction in deaths from water-related diseases was 69% among people with access to potable water and proper sanitation.

Providing clean water and sanitation greatly reduces child mortality. According to a review of 144 studies from the 1980s, infant and child deaths fell by an average of 55% as a result of providing clean water and sanitation. In a study of countries where infant mortality rates dropped dramatically-as in Costa Rica, where the decline was from 68 deaths per 1,000 live births in the 1970s to just 20 per 1,000 in the 1980s-researchers attributed three-quarters of the mortality decline to water and sanitation projects provided as part of rural community health programs.

While the cost of building freshwater supply systems and sanitation facilities is high, the costs of not doing so can become staggering. In Karachi, Pakistan, for example, a study found that poor people living in areas without any sanitation or hygiene education spent six times more on medical care than people who lived in areas with access to sanitation and who had a basic knowledge of household hygiene.

Water-Based Diseases

Aquatic organisms that spend part of their life cycle in the water and another part as parasites of animals cause water-based diseases. These organisms can thrive in either polluted or unpolluted water. As parasites, they usually take the form of worms, using intermediate animal vectors such as snails to thrive, and then directly infecting humans either by boring through the skin or by being swallowed.

Water-based diseases include guinea worm (dracunculiasis), paragonimiasis, clonorchiasis, and schistosomiasis (bilharzia). These diseases are caused by a variety of flukes, tapeworms, roundworms and tissue nematodes, often collectively referred to as helminths, that infect humans. Although these diseases usually are not fatal, they can be extremely painful, preventing people from working and sometimes even making movement impossible. The prevalence of water-based diseases often increases when dams are constructed, because the stagnant water behind dams is ideal for snails, the intermediary host for many types of worms. For example, the Akosombo Dam, on the Volta Lake in Ghana, and the Aswan High Dam, on the Nile in Egypt, have resulted in huge increases of schistosomiasis in these areas. Also, in Mali a survey conducted in 225 villages in different ecological settings found that the prevalence of urinary schistosomiasis was five times greater in villages with small dams (67%) than in the drier savanna villages (13%).

Individuals can prevent infection from water-based diseases by washing vegetables in clean water and thoroughly cooking food. They can refrain from entering infected rivers, because many parasites bore through the feet and legs. In areas where guinea worm is endemic, people can use a piece of cloth or nylon gauze to filter out guinea worm larvae, if clean water is unavailable. As with water-washed diseases, providing hygienic disposal of human wastes helps control water-based diseases. Also, for irrigation channels and other constructed waterways, building fast-flowing streams makes it more difficult for snails to survive, thus eliminating the intermediary host.

Some water-development schemes have started disease control programs along with construction of facilities. In the Philippines, for example, where the development of water resources is a high priority, the National Irrigation System Improvement Project in Layte, begun in 1979, included specific provisions and funding to control schistosomiasis. As a result of these measures, the prevalence of water-based diseases fell from 24% in 1979 to 9% in 1985. Because fewer people fell ill, the average increase in productivity was an estimated 19 days of work per person per year, worth an additional US$1 million in wages.

Water-Related Vector Diseases

Millions of people suffer from infections that are transmitted by vectors-insects or other animals capable of transmitting an infection, such as mosquitoes and tsetse flies-that breed and live in or near both polluted and unpolluted water. Such vectors infect humans with malaria, yellow fever, dengue fever, sleeping sickness, and filariasis. Malaria, the most widespread, is endemic in about 100 developing countries, putting some 2 billion people at risk. In sub-Saharan Africa malaria costs an estimated US$1.7 billion annually in treatment and lost productivity.

The incidence of water-related vector diseases appears to be increasing. There are many reasons: people are developing resistance to antimalarial drugs; mosquitoes are developing resistance to DDT, the major insecticide used; environmental changes are creating new breeding sites; migration, climate change, and creation of new habitats mean that fewer people build up natural immunity to the disease; and many malaria control programs have slowed or been abandoned.

Lack of appropriate water management, along with failure to take preventive measures, contributes to the rising incidence of malaria, filariasis, and onchocerciasis. Construction projects often increase the mosquito population, as pools of stagnant water, even if they exist only briefly, become breeding grounds. For example, in West Africa an epidemic of Rift Valley fever in 1987 has been linked to the Senegal River Project. The project, which flooded the lower Senegal River area, enabled the type of mosquito that carries the virus to expand so much that the virus was transmitted to humans rather than remaining in the usual animal hosts.

The solution to water-related vector diseases would appear to be clear-eliminate the insects that transmit the diseases. This is easier said than done, however, as pesticides themselves may be harmful to health if they get into drinking water or irrigation water. Also, many insects develop resistance to pesticides, and diseases can emerge again in new forms.

Alternative techniques to control these diseases include the use of bednets and introducing natural predators and sterile insects. In Gujarat, India, for example, an important part of an integrated project to control disease vectors was breeding guppies-fish that eat mosquito larvae-in bodies of water, while eliminating the use of insecticides altogether. An inexpensive approach to controlling insect vectors involves the use of polystyrene spheres floating on the top of bodies of static water. Because the spheres cover the surface of the water, the mosquito larvae die from lack of air.

Water-Scarce Diseases

Many other diseases-including trachoma, leprosy, tuberculosis, whooping cough, tetanus, and diphtheria-are considered water-scarce (also known as water-washed) in that they thrive in conditions where freshwater is scarce and sanitation is poor. Infections are transmitted when too little fresh water is available for washing hands. These diseases, which are rampant throughout most of the world, can be effectively controlled with better hygiene, for which adequate freshwater is necessary.

Some parasitic diseases not usually considered water-related and previously limited in their reach have been rapidly expanding as populations grow and water supplies become more polluted. For example, cysticercosis, a disease usually produced by tapeworms found in undercooked pork and limited to rural areas, expanded rapidly in Mexico City in the early 1980s. As the city's population soared, the parasite multiplied in the highly polluted water of the Tula River, which supplies much of the drinking water for the makeshift settlements on the city's outskirts. Tens of thousands of people downstream from the city sewage system were infected.

Chapter 3

Research Methodology

Objective

The main objective of study is to understand the water resource management and its effect on the water borne disease in India.

Methodology

Secondary data from various sources like census of India, National Sample Survey. WHO bulletein and SRS bulletein is used. Based on the status of water, sanitation & hygiene reported from various studies. The macro-level data on community water supply and environmental sanitation in the states and cities collected from Govt. sources.

Constraints & Compounding Factors.

The risk factor for water-sanitation-hygiene and health include the following transmission pathways, although not all of them are accommodated in the assessment to follow:-

- Transmission through ingestion of water - such as during drinking and, to some extent, bathing.
- Transmission caused by lack of water linked to inadequate personal hygiene.
- Transmission caused by poor personal, domestic, or agricultural hygiene. This includesperson-to-person transmission of fecal-oral pathogens, food-borne transmission of fecal–oral pathogens as a result of poor hygiene, or use of contaminated water for irrigation or cleaning.
- Transmission through contact with water (through bathing or wading) containing organisms.

Chapter:4

Discussions

In the year 2000, 92% of the urban population had access to a community water supply, though the quality, safety and reliability of the supply was often questionable. The poorer section of the population in under-served urban areas had very poor access to public water supply systems. Out of 1,422,646 rural habitations, 1,183,212 are fully covered and 213,331 partially covered. There are still 26,121 uncovered problem villages that do not have an adequate provision of drinking water. Rural water supply coverage increased from 73% in 1990 to 86% in 2000.

Norms of coverage

The norm for coverage of rural water supply is 40 litres per capita daily (lpcd), or one hand pump for 250 people within a walking distance of 1.6 km, or an elevation difference of 100 mm in hilly areas. An additional 30 lpcd of water is required for cattle (rural water supply). Variations in water requirements include 40 lpcd where only spot-sources are available; 70 lpcd where there is a piped water supply but no sewerage system; 125 lpcd where there is a piped water supply and a sewerage system, and 150 lpcd for large cities. Additional demands on water are called upon for in urban situations, including industrial, commercial, institutional, fire fighting and for gardens (urban water supply).

Environmental sanitation

Only 237 of more about 4700 towns have a partially complete sewerage system. There are still 400,000 scavengers and 7,210,000 dry latrines, of which 5,400,000 are in urban areas. Less than 60% of the urban populations have access to sanitation, that is, safe disposal of human excreta, while in respect of the rural population less than 20% had facilities for sanitary disposal of human excreta in 2000. Present figure is near about 35 to 40%. Open defecation is still the most

popular means of toileting in rural India. In urban areas less than 60% of solid wastes is collected and disposed of on a regular basis.

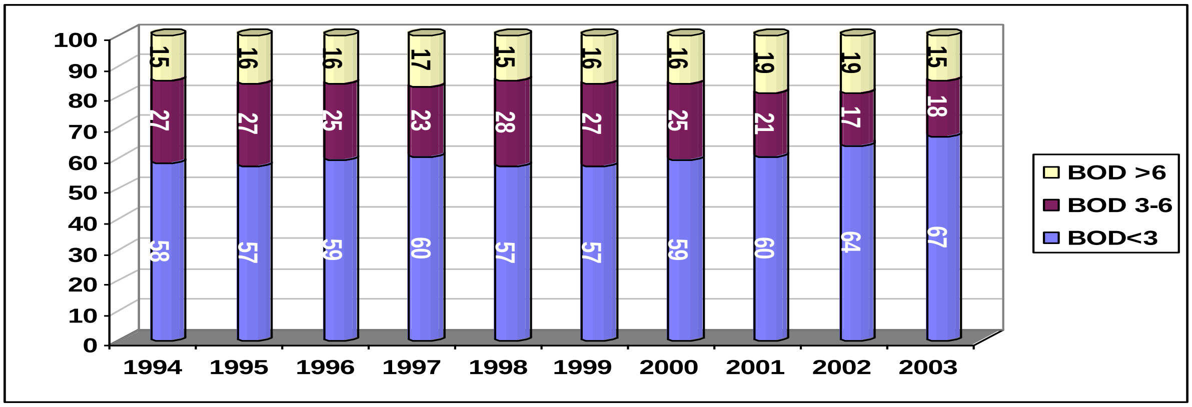
The drainage infrastructure for storm water and sullage is extremely poor in urban, periurban and rural areas. There are other problems too. Rivers and other bodies of surface water are grossly polluted, where, for example, faecal coliform count would vary between 5,000 and 50,000 mpn 100 ml^{-1}. The holy river of the Ganges is one such river, which in most parts is unfit for bathing.

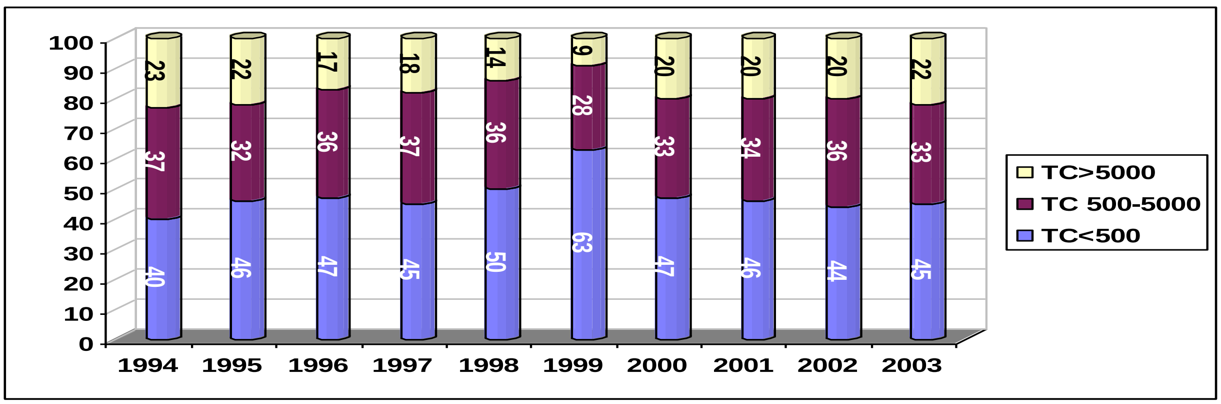
Quality of water in public distribution systems

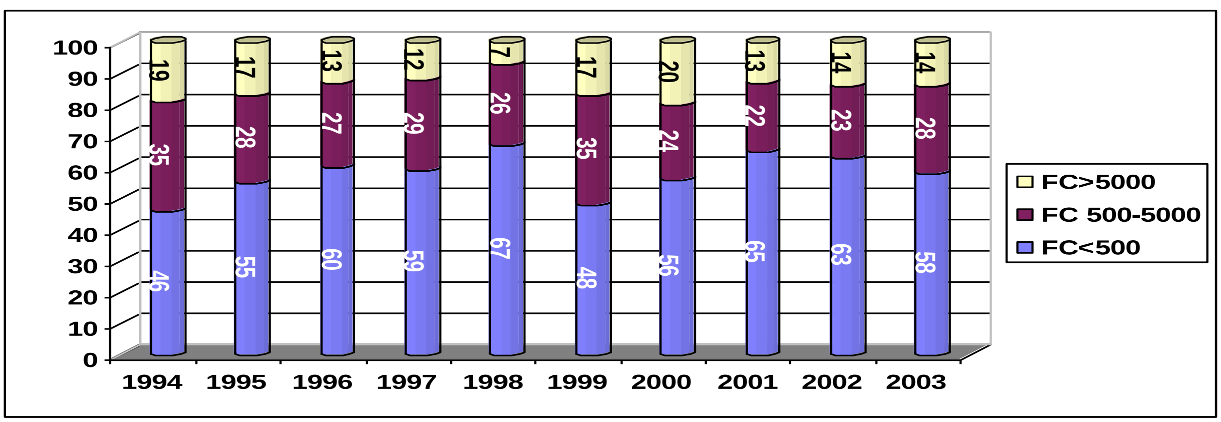
Almost all urban water supply systems in the country are of intermittent supply and prone to disruption and leakage. As a result, faecal contamination of the distribution systems is universal in most cities and towns. Water quality monitoring and surveillance is inadequate and irregular, expect in a few Metro cities. The situation in small and medium towns is worst. Ground water drawn from tube wells and dug-wells is often contaminated by chemicals, minerals, pesticides or bacteria. Fluoride and arsenic contamination of ground water has become a serious health risk for almost 80 million people in the country.

The efforts put by the Ministry of Rural Development, GOI, in recent years and various state Govts, have resulted in higher coverage of habitations in the rural areas, with improved water supply. However, quality related problems and the problems of sustainability of the rural water supply facilities created under the programme, have often adversely affected the same.

WATER QUALTIY STATUS & TREND FROM 1994 TO 2003







Status of Water Supply in Class-I Cities and Class-II Towns

There is an increasing trend in the population of Class-I Cities, due to which demand of water is also increasing and so that sewage generation.

- There are 498 Class-I cities, having water supply of 44769 Millions Liter Per Day (MLD).

- The population of Class-I Cities is projected 22.76 Crore.
- Among all the states Maharashtra is most populated and has maximum water supply that is 12482MLD (27 % of total water of all 498 class-I cities)

- Next to Maharashtra, Uttar Pradesh has the water supply of 4382 MLD, which is 9.7% of total water supply of all class-I cities.

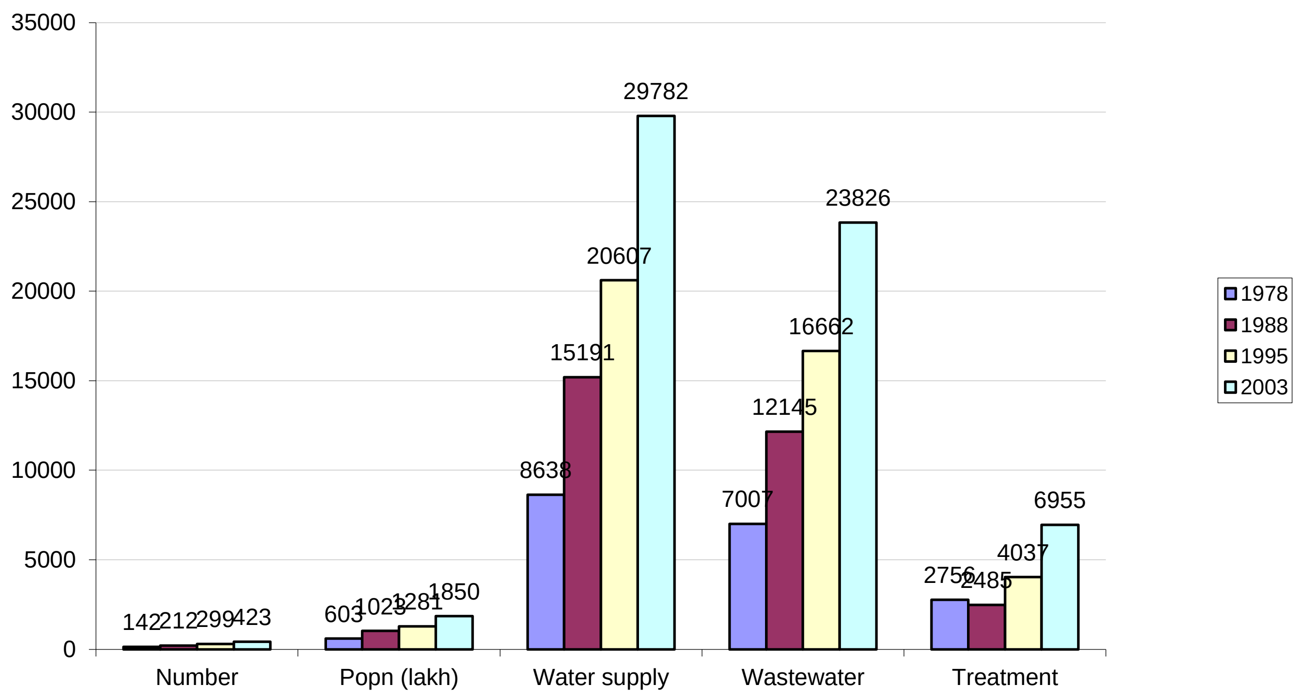
- Among all the States/UTs per capita water supply of Chandigarh is maximum (540 MLD) followed by Maharashtra with 310 MLD.
- National average for per capita water supply is 179 considering Chandigarh as outlier

S.No.	State/Union Territory	No. of Cities	Population in Year 2008	Water Supply in Class-I Cities (in MLD)	Per Capita Water Supply
1	Andaman & Nicobar	1	107200	15	139.93
2	Andhra Pradesh	47	20143050	2205	109.47
3	Assam	5	1417820	427.70	301.66
4	Bihar	23	5783554	1262.15	218.23
5	Chandigarh	1	994820	537.20	540
6	Chhattisgarh	7	2515100	438.09	174.18
7	Delhi	1	14858800	4346	292.49
8	Goa	1	122330	12.24	100.06
9	Gujarat	28	14678240	2101.18	143.15
10	Haryana	20	5494110	783.39	142.59
11	Himachal Pradesh	1	163490	36.18	221.3
12	Jammu & Kashmir	2	1910060	267.42	140.01
13	Jharkhand	14	4964171	1038.1	209.12
14	Karnataka	33	15102373	2238.04	148.19
15	Kerala	8	3778516	718.97	190.28
16	Madhya Pradesh	25	10795000	1560.91	144.6
17	Maharashtra	50	40255170	12482.87	310.09
18	Manipur	1	249870	43.43	173.81
19	Meghalaya	1	186030	26.05	140.03
20	Mizoram	1	282550	39.56	140.01
21	Nagaland	1	171810	24.05	139.98
22	Orissa	12	3335930	825.94	247.59
23	Pondicherry	2	504130	70.58	140
24	Punjab	19	6329860	1837.18	290.24
25	Rajasthan	24	9611490	1727.96	179.78
26	Tamilnadu	42	16852940	1346.54	79.9
27	Tripura	1	214327	30	139.97
28	Uttar Pradesh	61	25762280	4382.58	170.12
29	Uttrakhand	6	1249380	221.21	177.06
30	West Bengal	60	19818471	3723.53	187.88
	Total	**498**	**143083804**	**44769.05**	**179.02**

Status on Sewage Generation in Metropolitan Cities:

Discharge of untreated sewage in water courses both surface and ground waters is the most important water polluting source in India. Out of about 38000 million liter per day of sewage generated treatment capacity exists for only about 12000 million liter per day. Thus, there is a large gap between generation and treatment of wastewater in India. Even the treatment capacity existing is also not effectively utilized due to operation and maintenance problem. Operation and maintenance of existing plants and sewage pumping stations is not satisfactory , as nearly 39% plants are not conforming to the general standards prescribed under the Environmental (Protection) Rules for discharge into streams as per the CPCB's survey report.. In a number of cities, the existing treatment capacity remains underutilized while a lot of sewage is discharged without treatment in the same city.

Water supply and sewage disposal status in class I cities



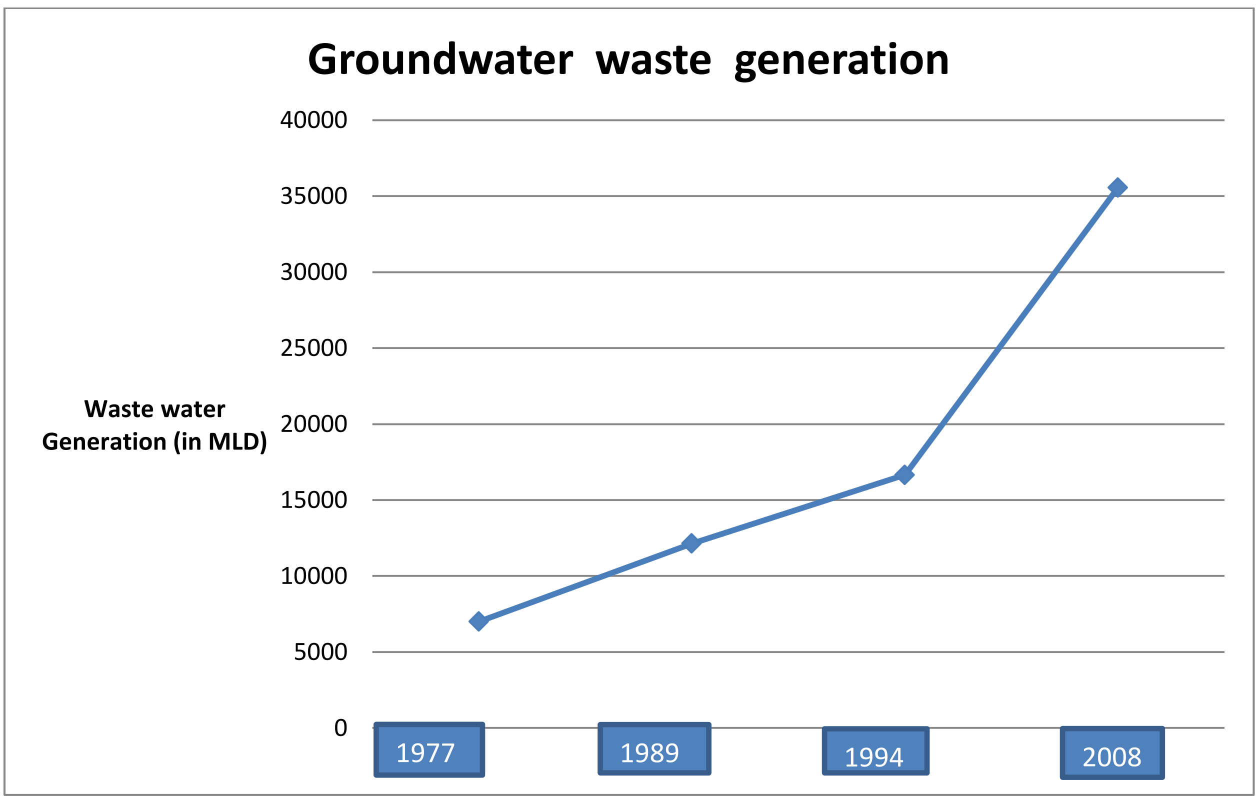
Major Factors Responsible for WQ Degradation

- Domestic: 423 class I cities and 499 class II towns harboring population of 20 Crore generate about 26254 mld of wastewater of which only 6955 mld is treated.
- Industrial: About 57,000 polluting industries in India generate about 13,468 mld of wastewater out of which nearly 60% (generated from large & medium industries) is treated.
- Non-point sources also contribute significant pollution loads mainly in rainy season. Pesticides consumption is about 1,00,000 tonnes/year of which AP, Haryana, Punjab, TN, WB, Gujarat, UP and Maharashtra are principal consumers.
- Domestic sewage is the major source of pollution in India in surface water which contribute pathogens, the main source of water borne diseases along with depletion of oxygen in water bodies.
- Sewage alongwith agricultural run-off and industrial effluents also contributes large amount of nutrients in surface water causing eutrophication
- A large part of the domestic sewage is not even collected. This results in stagnation of sewage within city, a good breeding ground for mosquitoes and contaminate the groundwater, the only source of drinking water in many cities.

Chapter :5

Conclusions

The impact of water borne disease due to water pollution is increasing over the past two decades. Cities with more population generated more water pollutants and showed population was at high risk of acquiring water borne disease.



The evidence cited in this review shows that water borne disease is a significant problem worldwide, and is a concern in India. A significant part of this disease relates to the consumption of contaminated drinking water, and could be prevented by provision of adequate water and sanitation, and promotion of household hygiene practices such as handwashing and point-of-use water treatment and safe storage.

The detrimental environmental consequences of over-exploitation of groundwater need to be effectively prevented by the Central and State Governments. Overexploitation of groundwater should be avoided, especially near the coasts to prevent ingress of seawater into freshwater aquifers. Clearly, a joint management approach combining government administration with active people participation is a promising solution16. In critically overexploited areas, bore-well drilling should be regulated till the water table attains the desired elevation. Artificial recharge measures need to be urgently implemented in these areas. Amongst the various recharge techniques, percolation tanks are least expensive in terms of initial construction costs. Many such tanks already exist but a vast majority of these structures have silted up. In such cases, cleaning of the bed of the tank will make them reusable. Promotion of participatory action in rehabilitating tanks for recharging would go a long way in augmenting groundwater supply. Due to declining water table, the cost of extraction of groundwater has been increasing over time and wells often go dry. This poses serious financial burden on farmers. Hence, special programmes need to be designed to support these farmers. Finally, the role of government will have to switch from that of a controller of groundwater development to that of a facilitator of equitable and sustainable development, However, because people have triggered this crisis, by changing their actions they have the power to prevent water scarcity from devastating India’s population, agriculture, and economy. .

In view of the existing status of water resources and increasing demands of water for meeting the requirements of the rapidly growing population of the country as well as the problems that are likely to arise in future, a holistic, well planned long-term strategy is needed for sustainable water resources management in India. The water resources management practices may be based on increasing the water supply and managing the water demand under the stressed water availability conditions. Data monitoring, processing, storage, retrieval and dissemination constitute the very important aspects of the water resources management. These data may be utilized not only for management but also for the planning and design of the water resources structures. In addition to these, now a days decision support systems are being developed for providing the necessary inputs to the decision makers for water resources management. Also, knowledge sharing, people's participation, mass communication and capacity building are essential for effective water resources management

Chapter:6

Recommendations

- To protect the aquifers from overexploitation, an effective groundwater management policy oriented towards promotion of efficiency, equity and sustainability is required.

- The exploitation of groundwater resources should be regulated so as not to exceed the recharging possibilities, as well as to ensure social equity. The detrimental environmental consequences of over-exploitation of groundwater need to be effectively prevented by the Central and State Governments. Overexploitation of groundwater should be avoided, especially near the coasts to prevent ingress of seawater into freshwater aquifers.

- Clearly, a joint management approach combining government administration with active people participation is a promising solution. In critically overexploited areas, bore-well drilling should be regulated till the water table attains the desired elevation. Artificial recharge measures need to be urgently implemented in these areas. Amongst the various recharge techniques, percolation tanks are least expensive in terms of initial construction costs. Many such tanks already exist but a vast majority of these structures have silted up. In such cases, cleaning of the bed of the tank will make them reusable.
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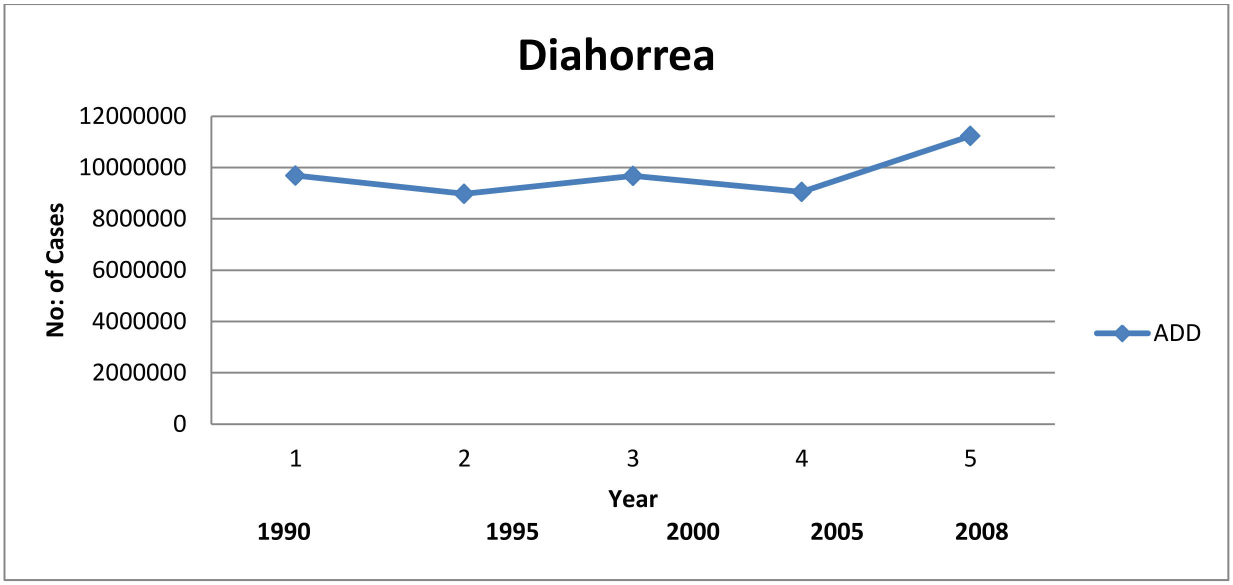
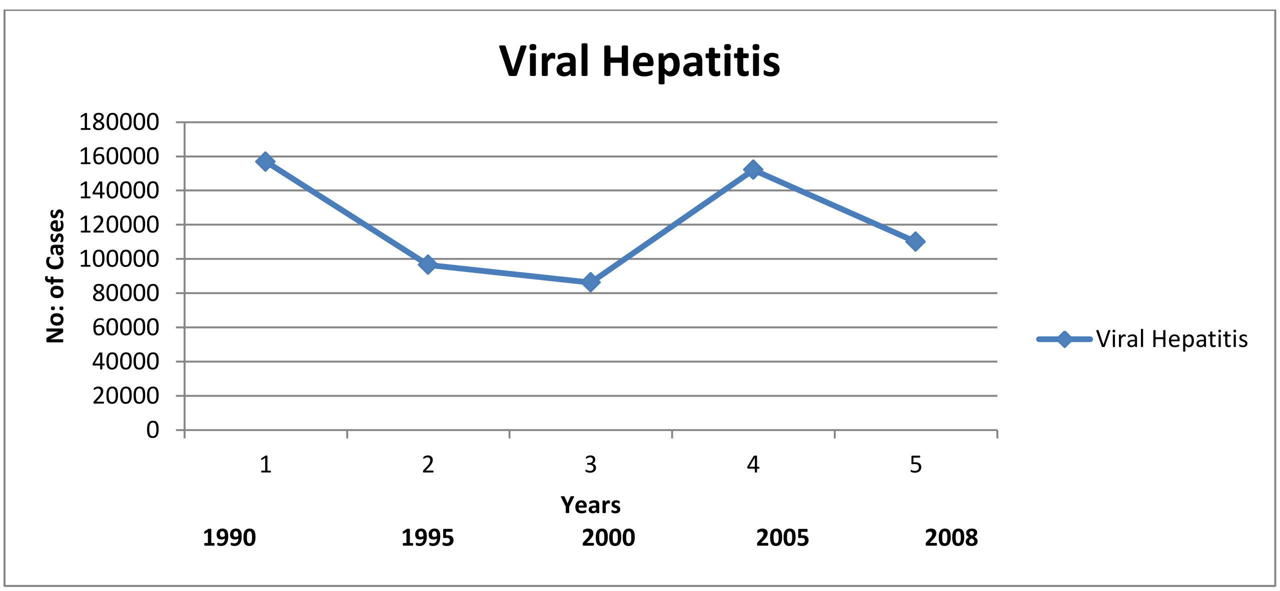
Annexures

Graphs

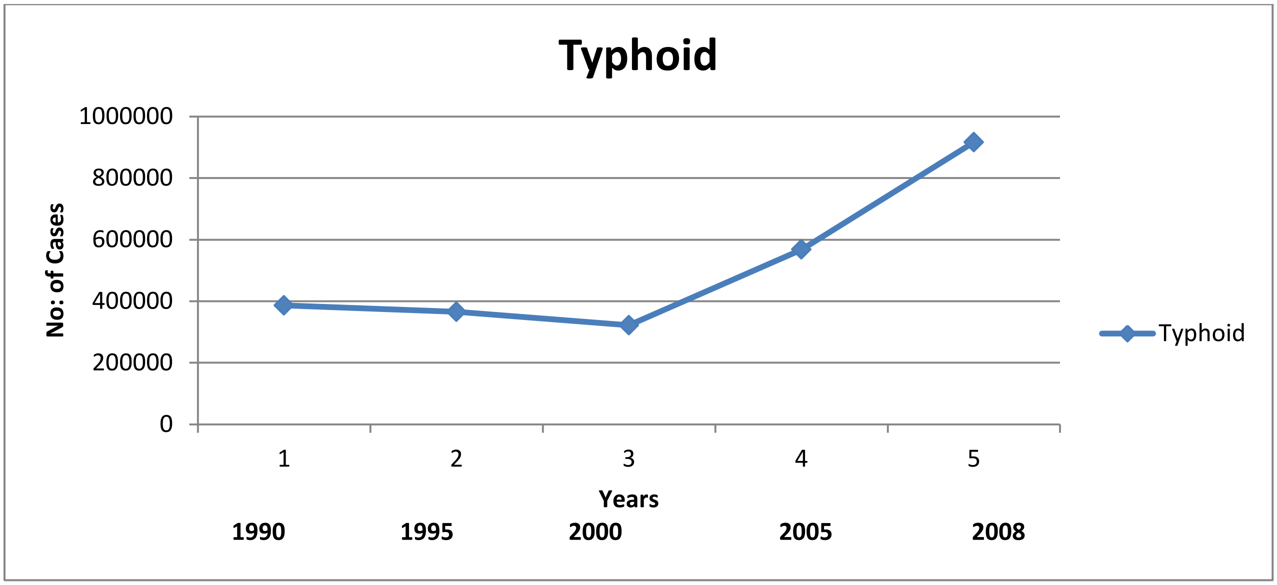
Graph:1



Graph:2



Graph:3



Graph:4