*Minor Research Project Report on*

# WATER POLLUTION AND ITS IMPACT ON RURAL HEALTH; A MICRO ANALYSIS BASED ON RIVER PAMPA, KERALA, INDIA

**By**

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## *DECLARATION*

This is to certify that the project report entitled "**WATER POLLUTION AND ITS IMPACT ON RURAL HEALTH; A MICRO ANALYSIS BASED ON RIVER PAMPA, KERALA, INDIA"** submitted to University Grants Commission is a bonafide record of original research carried out by us and that no part of this work has been submitted for any other University or for assistance from any other agency.

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# CERTIFICATE

I Certify that the thesis entitled "**WATER POLLUTION AND ITS IMPACT ON RURAL HEALTH; A MICRO ANALYSIS BASED ON RIVER PAMPA, KERALA, INDIA"** is a record of original studies and bonafide research carried out by Thomas George Associate Professor of Economics , St . Thomas College, Kozhencherry and Shaju K. John, Assistant Professor of Economics, St. Thomas College, Kozhencherry as part of the UGC assistance received for the completion of the project study in the 11th plan period. The Work presented in this thesis has not been submitted earlier for the award of any other degree, diploma, title or recognition or grant from any other institution.

Prof. Dr. Roys P.David

Principal

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# CHAPTER 1
# INTRODUCTION

## 1.1Introduction:

Environmental issues have attained public, academic and governmental support during the past two to three decades, which was contributed to a paradigm shift in the global agenda on environment. Concern on environment has changed from peripheral to the centre of the development issues of the economies. Human civilizations originated, developed and thrived in places where there is an easy access to fresh water sources. Rivers being dynamic systems are subjected to physical, chemical and biological variations due to diverse human activities. Urbanization, agricultural and pilgrimage activities cause an increase of nutrient content in the water; resulting in increased productivity and increased concentration of dissolved substances to such an extent that the water becomes polluted. There is a closer link between pollution and health damages. Five million people die each year because of polluted drinking water, poor sanitation and domestic unhygienity around the world (WHO, 1996). In India alone, nearly 1 million people die annually because of waterborne diseases (World Bank 2001). Dirty water and poor sanitation cause more than 500,000 infant deaths a year in the Asia pacific region (Economic Review 2005).

One of the oldest records regarding water pollution in history is that of direct dumping of human wastes into water in the city of Venice. The residents of the city badly experienced the effect of such dumping, in the form of water borne diseases. They constructed a pipeline covering a very long distance in order to dispose the wastes in the first century B.C. In the late 1800's New Yorkers found that the rivers were seriously polluted by garbage dumping which had been officially permitted. This results in the outbreak of Typhoid, Cholera, Dysentery and infective Hepatitis. Frequent outbreaks of waterborne diseases in Germany during the Seventeenth Century led to the development of the entire Sanitary Science. The first reported industrial pollution occurred in Japan in the $20^{th}$ century. Hundreds of people died due to the dumping of Chisso- factory waste containing Methyl Mercury into the Minamata Bay ( Koshy.M 2001).

Water contaminants include bacteria, viruses, protozoa, and parasites. These contaminants may be caused by human activities (like large scale farming).It can cause extreme health problems. Waste from humans, paper, pulp plants and tanneries are discharged into a stream, river or lake, the organic materials decomposed by using large quantities of oxygen from water. If too much oxygen is removed and it takes too long for it to be restored, there may be serious pollution. Toxic waste like DDT and Mercury are poisonous when consumed or contacted by plants and animals. Use of pesticides and herbicides and wash off the land into the sewers are other examples of dangerous water pollution. Water pollution causes losses to the health of the economy like human deaths, health expenditures, loss of man days, and reduction in agricultural output, reduction in

fish population etc. River pollution has been quite alarming in recent years as a result of waste discharges from industries, sewage outfall from townships, pilgrimage centers etc.

In the past human wastes were deposited in natural systems, but with increasing population, the load of human waste has far exceeded the natural systems absorption and cleaning rate. Rapid rural urban migration is also contributing to pollution (Deshpande, 1971). Water quality has been steadily degraded by a combination of factors including saline, intrusion; sewage and industrial effluents and agricultural runoff. Bio Chemical Oxygen Demand (BOD) in Asian rivers is 1.4 times the world average and 1.5 times OECD levels.

From the point of view of water resources, Kerala is having both abundance and scarcity. The average annual rainfall of the state is 3000 mm. About 60 % of the annual rainfall in the state is received, during the South-West Monsoon (June-August) 25% during North-East monsoon (September-November) and remaining during the summer months. Though it has 44 rivers, most of these monsoon-fed, short rivers dry up during summer (State of Environment Report: 2005).

Kerala is one among the most thickly populated regions and as a result of the measures to satisfy the needs of the huge population, the rivers of Kerala have been increasingly polluted from the industrial and domestic wastes and from pesticides and fertilizers in agriculture. Industries discharge hazardous pollutants like Phosphates, Sulphides, Amonia N, Fluorides, heavy metals and insecticides into the downstream

reaches of the river. The river Periyar and Chaliyar are very examples for the pollution due to industrial effluents. The major water quality problem associated with rivers of Kerala is bacteriological pollution. The assessment of rivers such as Chalakkudy, Periyar, Muvattupuzha, Meenachil, Pampa and Achenkovil, indicate that the major quality problem is due to bacteriological pollution. There are local level quality problems faced by all the rivers especially, due to dumping of solid waste, bathing and discharge of effluents. The presence of fluoride in ground water above permissible limits is reported in Palakkad and Alapuzha districts. Open wells of Kerala have the problem of bacteriological contamination. Studies have shown that faecal contamination is present in 90 % of drinking water wells.

**1.2 Origin of the research problem**

Kerala state is blessed with 44 rivers, numerous lakes and ponds, estuaries and back water system. Unfortunately, these aquatic systems which sustain the life and greenery of the state are at the verge of severe deterioration due to over exploitation of natural resources from active channels and flood plain areas. The rivers of Kerala have been increasingly polluted from the industrial and domestic wastes and from pesticides and fertilizers in agriculture. The river Periyar and Chaliyar are very examples for the pollution due to industrial effluents. (State of Environment Report 2005) The major water quality problem associated with rivers of Kerala is bacteriological pollution

Pampa, otherwise called as southern Ganga, is the sacred river of Kerala. It is the third largest river in Kerala (176 km.) and has the fourth largest catchment area (2235

km.). The river originates from Pulanchimala, having an elevation of 1650 m in the Western Ghats. It flows through Iddukki, Pathanamthitta and Alleppey districts and is the lifeline of Central Kerala. River Pampa is the holy river of the Hindus in South India because of its historical relation with Sabarimala Temple and the epic of 'Lord Ayyappa'. The famous forest shrine of 'Swami Ayyappa' is situated in the northwestern foothills of the Pampa plateau. It has become one of the most popular pilgrim centres and millions of pilgrims visit the shrine particularly during the months of November, December and January and also during the first of every Malayalam month. During the season around 50 million people visit Sabarimala Shrine. Around thirty thousand people stay at Sabarimala for two months for rendering services to these pilgrims. It is on the sand beds of this river, that Asia's largest Christian congregation, Maramon convention is held every year. The river is also related with the cultural belief of central travancore people, such as 'Aranmula boat race' and 'Thiruvonathoni.'

The river stretch around the Sabarimala is seen polluted very much due to the pilgrim factor. River around the downstream municipalities and in parts of Kuttanadu is also known for poor quality of water. The conventions held on the river bed, and the direct discharge of untreated hospital and municipal wastes and agricultural runoff are causing untold damage to the river and seriously affecting the quality of life of the people who depend on Pampa river. Indiscriminate mining of sand from the river too caused the deterioration of the aquatic system. Large numbers of pumping stations are operating in the pampa river and the polluted water flow to surrounding communities without proper

and effective treatment. Focusing on these issues the study has been carried out with the following objectives.

### 1.3 Objectives of the study

Following are the major objectives of the present study.

1. To identify the major sources of pollution of River Pampa
2. To make a survey on the best uses of river by the communities
3. To estimate the health impact of pollution of River Pampa

### 1.4 Methodology and Data Base

The research was explorative, descriptive and analytical in nature. Both primary and secondary data sources are relied on .Secondary data was collected from journals, books, publications and from the reports of Kerala State Pollution Control Board (KSPCB), centre for science and environment and Pampa Parirakshana Samiti. A sample survey was conducted in the banks of river Pampa for primary data collection. River Pampa is flowing through 15 local panchayats of Pathanamthitta district and one municipality of Alapuzha district in Kerala. Out of which, five ( Ranny Perunadu, Seethathodu, Vadasserikkara, Kozhencherry and Aranmula) panchayat and Chengannoor municipality was selected for the study and the required data was collected from 180 households purposively. Responses of the respondents who are residing on the banks of the river were selected using simple random sampling technique with a well-structured interview schedule. Variables included in the generally

applicable techniques of valuing environment are used for analysis. The study made use of appropriate statistical tools for the analysis of data like ratios, percentage and averages.

## 1.5 Chapterisation

The scheme of the study is organized in five chapters. Chapter one presents the introduction to the study. Chapter two provides a detailed review of the related literature in the field of study. The third chapter provides the analysis of secondary data related to the sources of pollution. Fourth chapter deals with the analysis of primary data. The last chapter presents the summary, findings and suggestions.

## 1.6 Limitations

The study is subject to many limitations. Time and finance are the major constraints experienced. Economic valuation of environmental goods is not easy, which itself is the major constraint experienced in the study.

# CHAPTER II

# REVIEW OF LITERATURE

There exists comprehensive literature, on water pollution and its impact on quality of life and environment. Most of the studies are scientific in nature dealing with various aspects of water pollution. Innumerable attempts have already been done at national and international levels to study the social, economic and environmental aspects of water pollution. Very few attempts have been done to analyse the impact on the economy and health due to the pollution of river pampa. This chapter gives a brief review of the related literature. Available studies have been chronologically given: - 1) Studies on sources/causes of water pollution 2) Studies on impact on the economic activities and health.

## 2.1Studies on sources/causes of water pollution.

Manveer Singh. K. (2007), in his article 'Pilgrim Regress' tried to examine the extent of pollution in Ganga river at the time of "Ardh kumbh at Allahabad". The study identified the various sources of pollution as: a) effluents discharged from tanneries located in Kanpur, b) paper and distillery units along the banks of Dhela and Kosi rivers. c) City sewages and d) the mela itself. He argues that, studies conducted by the Central Pollution Control Board (CPCD) indicate that, the total coliform count on 'shahisnan'

days January 14 and 15, 2007, were 1,3000 and 11,000 MPN/100 ml respectively. He conclude that it was against the CPCB's standards for bathing waters (500 MPN/100 Ml). So long term strategies and its implementation are needed at institutional levels to control the problem of Ganga pollution.

Rama Rao, et al (2006) in the article "Pollution through Aqua Culture", explained the link between human intervention and the destruction of environmental balance, by taking the case of Kolleru wild life sanctuary, one of the Asia's largest fresh water lake. They argue that, government had assigned lands in the lake area to the scheduled and backward castes, and they had converted it in to fish tanks and agricultural lands. At the time of repeated floods in 70's, government encouraged them to convert agricultural land into fishponds and tanks. At that time some rich enterprising farmers, taking the advantage of government policy took the land area on lease from the people and used it for aquaculture. The problem with the aquaculture is that, it needs saline water, chemical fertilizer, gobar manure, chicken wastes etc. Once the harvest is over, these water stagnates and pollutes the surrounding water. Together with these agricultural run off, untreated water from neighbouring industries and domestic sewage contribute to heavy load of pollution. It resulted in to frequent fish kills, scarcity of drinking water and contamination of ground water around the lake in Krishna and West Godavari districts of Andhra Pradesh.

"Down to Earth" magazine reveals that pollution levels are rising in the Lidder river in Pahalgam, the base camp of pilgrims going to the Amarnath Cave in Jammu and

Kashmir. Pilgrims are the major polluters of the river and they were generating tonnes of waste every day, dumping of garbage, sewage and night soil generated from hotels, camps and local residential areas, directly discharged into open drains, which then flows to Lidder river, the unscientific management of waste generated by domestic and commercial activities - all these leading to untold damages to the river Lidder.

Reddy and Reddy (2002), in their study "The Physico–Chemical quality of underground water in slum areas and developed areas of Adarshangar, Andhra Pradesh" brings out the suitability of ground water for domestic purposes. The sources of pollution identified by them are: a) the absence of proper drainage and garbage collection systems and the b) unhygienic habits of the slum people. Domestic sewage pollution and agricultural fertilizers causes high nitrate concentration in the water and may cause serious health hazards if used, for longer periods. An immediate action is suggested to reduce the ill effects of the problem.

Tortajada (2001), in the study "The Chapala Lake in Mexico" reveals the, major sources of water pollution in Mexico. The Chapala lake provides 60% of the water supply needs of the Mexico's second largest city (Guadalajara) and supports the socio-economic development of the region through fisheries, agriculture and tourism. The major polluters of the lack are, municipal, industrial and agricultural run off. More than 12 kgm Chromium and more than 4 kgm of Zinc are deposited every day in the lake. The absence of political correctness aggravated the problem of pollution

Hoque et.al. (1998), in the study "Surface water pollution concerns in public health perspectives of Bangladesh" brings to light the sources and impact of water pollution. Wastes, including human excreta, industrial wastes together with agricultural and chemical runoff are the principal sources of water pollution in Bangladesh. The surface water is heavily polluted with organic pollutants and faecal bacteria. Nearly 80% of the rural people of Bangladesh use it for cooking, bathing, washing and for domestic purposes. National guidelines on environmental qualities are needed to protect the environment and to improve the quality of life.

Y. Sharma (1997), in his study "The Ganga River" analyses how the holy river gets polluted and how far the Ganga Action plan helped in solving the pollution problem. He identified, two factors - deforestation and urbanization - contributing to pollution. Deforestation resulted in top soil erosion and has increased the silt deposits which raises the river bed, leads to floods in rainy season and stagnant flow in dry season. As a result of urbanization the river is transformed into a channel for transporting wastes. The other identified sources of pollution are: agricultural run off containing residues of harmful pesticides and fertilizers, animal carcasses and half burned and unburned human corpses thrown into the river and mass bathing and ritualistic practices. The study appreciated the strategies under taken by the Central government to prevent pollution and to improve the water quality (Ganga Action Plan).

Sinha (1986), in his work "Ganga Pollution and Health Hazard" deals with different aspects of pollution of the river Ganga: sources, level of pollution, geo

chemistry of river sediments etc. The sewage, sullage, septic effluents, hospital wastes, burning of dead bodies are identified as the potential sources of river pollution. It is seen that, the pH value of water in the river varies with season. It is minimum during the monsoon and maximum in dry season.

P. Ray (1981), in his article; "Impact of man on Hoogly Estuary" studied the impact of human and industrial activities on the ecology. The ecology of estuary has changed due to deposition of large amounts of silt during monsoon, high amounts of suspensoids in the water through out the year and discharge of industrial, domestic and municipal effluents. The study points out the need for an environmental impact assessment (EIA) of thermal plants on the estuarine system.

**2.2 Studies on impact on the economic activities and health**.

The study conducted by Jing Zhang (2010) titled "The impact of water quality on health: Evidence from the drinking water infrastructure programme in River china" indicated that most of the diarrheal diseases occur through oral-fecal or hand-to-mouth transmission. Therefore, environment is considered as an important factor for people's health since they may work interactively with drinking water.

K.P.Kannan studied about the ecological and socio- economic consequences of water control projects in the kuttanad region of Kerala. The study revealed that, a sharp decline in the catch of shrimps and fish which are brought into the Vembanad lake along with the intrusion of saline water and which grow best in saline waters mixed seasonally with the fresh water in the lake; a phenomenal growth in the

aquatic weed, African Payal, with serious effects on the cultivation of paddy, and on transportation and fishing. In his opinion the pollution of fresh water in the lake and other water courses in the Kuttanad area is caused by the African Payal, which interrupted the natural ebb and flow of tidal water into and from the water body, with deleterious effects on the health of the population in the region.

The study conducted by Sukumaran Nair (1999) found that sewage pollution in the river Pampa is due to the absence of sufficient sanitary facilities at Sabarimala. According to him during the pilgrimage season coliform bacteria in the river was very high. Indiscriminate and illegal sand mining transformed the river to a river skeleton. This has also lead to the depletion of ground water which aggravated water shortage in the river surroundings.

Srinivas et. al (2006), in their study the "Khari River in Gujarat" analysed the socio-economic impact of water pollution. Small and medium scale dye and dye–stuff manufacturing units are the major polluters of the river. The impacts are studied on the basis of a) health related problems-including skin diseases, stomach and intestinal ailments and bronchial problems b) Impact on livestock economy and c) Impact on natural resources. One of the important social impact identified by them is that, there is steady reduction in marriage proposals in the affected area. The study also emphasized the role of NGO's in monitoring the problem of pollution.

Environmental impact assessment is a Herculean task. This is what is attempted by Venkatachalam L. (2003), in his study " Factors influencing households willingness to pay for (WTP) water" using willingness to pay (WTP) approach. He identified the determinants of household decisions regarding improved water supply services in a semi-urban town of Tamilnadu. The study focussed on the households willingness to pay for individual water supply connections particularly advance payment and monthly tariff. Contingent valuation methods were used for stating the preferences and semi-log model regressions were used for identifying the determinants of willingness to pay. The study revealed that, the efficiency, equity and sustainability of water supply project depend on the extent to which household preferences are taken into account in the water supply policy making process. The provision of drinking water to household should not be seen as revenue generating activity, rather it aims at maximizing the welfare of individuals.

Behera and Reddy (2002), studied the economic impact of water pollution using willingness to accept (WTA) and contingent valuation techniques. The study entitled "The impact of industrial pollution on the rural communities" reveals the economic impact of water pollution on the rural economy of Andhra Pradesh. Three important variables were identified: a) such as impact on agricultural production, b) human health and c) live stock. Contingent valuation, Effects on Production (EOP), Replacement Costs (RC) and Human Capital approaches (HC) were used for assessing the impact and damage estimation. The average loss per household, due to health impact of pollution is estimated to be Rs. 9366 per annum. The average loss of agricultural income due to

pollution is Rs. 9627 per acre. It is reveled that, the Willingness to Accept (WTA) for pollution damage is consistent with the crop loss.

The nature and extent of industrial pollution in Angul – Talcher area in Orrissa is studied by Misra. M and Sahu. N C (2001), in their work "Industrial development, Environmental Pollution and Health Hazards". The primary objective of the study is to quantify the health effects of industrial pollution. For assessing the money value of human health damage, dose- response technique of environmental valuation is used. It is estimated that, an average number of 105 patients die every year due to pollution related diseases and the value of each life lost is estimated at Rs. 1.5 lakhs. More over the air and water pollution cause as many as 15 types of diseases in the region; and are responsible for human health life damage worth Rs. 6176.71 crores annually.

Mathew Koshy (2001), in his study, "The Hydrochemical and Bio-geochemical Characteristics of River Pampa" analyzed the hydrography, bio-geo organics and trace metals in the river Pampa due to the environmental deterioration. A sample water analysis for a period of one year (From November 1996 to October 1997) for analyzing the physio-chemical characteristics of river Pampa is the methodology used for the analysis. The study brings to light that River Pampa is not under heavy pollutional stress, but warned that, the sewage out fall into the river, the bacterial contamination, urbanization as well as the anthropogenic activities of the pilgrims and local people are increasing the pollution load every year.

Susy Abraham (2001), in her study, " Minor Water bodies in Kottayam Municipality Area. A bio-ecological study", tried to find out the number, age and physiochemical characteristics of minor water bodies in Kottayam municipality area and their pollution levels. It is revealed from the study that, there is 48 minor water bodies in Kottayam municipality and their age varies between 10 to 40 years. The physio-chemical characteristics of the water bodies revealed that only 6.94 % of them were fairly clean to use for any domestic purpose. The major sources of pollution are identified as industrial waste, town drainage, sewage from houses and hotels, and also organic wastes.

Sukharomana (1998), studies the water quality improvement benefits for 'Nebaraska' using both Contingent Valuation (CV) and Averting Expenditure (AE) methods based on a mail survey of randomly selected households. Using censored logistic regression, willingness to pay for water quality improvements were estimated. The mean WTP was $ 9.50 per month per household for a nitrate programme and $ 9.72 per month for reducing all contaminants. The households with highest WTP were young with high income. Averting expenditure were analysed using a two stage Heckman model. It is estimated that the average averting costs are much lower than the CV results at $ 6.0 and $ 8.20 per month per household for nitrates and all contaminants respectively. A comparison of the CV and Averting expenditure results show that the true willingness to pay for improved water quality lies between the lower bound established by the averting expenditure approach and the upper bound established by the CV analysis.

Hanchar et al (1997), analyses how non point sources adversely affect water quality or how agricultural practices contribute to water pollution. It is found out that, farmers employ nutrients in the form of feeds, fertilizers, mannures, pesticides and other chemicals to produce marketable commodities Diary farms and other livestock farms often concentrate livestock in certain areas or farms. Livestock mannures contain nutrients such as nitrogen and phosphorous, sometimes it flows to the river and may cause untold damages to water quality pollution can have a negative externality. It affects the health of the downstream users of the water, people other than those directly involved in the production and consumption of the product from the farm.

Cho (1996), used contingent valuation method to determine, how much the consumers would be willing to pay to improve their water quality and what factors influence consumers willingness to pay (WTP). It is based on a study conducted in South Western Minnesota. It is estimated that, individuals were willing to pay $ 5.25, $ 4.33, $5.33, and $ 4.38 per month to reduce the level of iron, sulfate, hardness and copper in the water. Probit and Censored Tobit analyses were used to identify the socio-demographic characteristics that affect WTP. It reveals that, higher income, housing values and education level significantly increases the consumer's willingness to pay. However WTP is negatively related with higher water bills.

Roy (1996) in his article "Development, Environment and Poverty", classifies the environmental problems into, 1. Global (greenhouse warming and ozone depletion), 2.

Regional (acid rain and desertification), 3. National (deforestation) and 4. Local (soil erosion, contamination of fresh water resources and urban pollution). The article is focussed the interaction between development and environment at the global and national levels. The nexus is illustrated with the help of key global conventions and national policies to bring sustainable development. It is understood that structural adjustment programmes have created pressure on governments to over exploit nonrenewable resources, which hit the poorest groups more adversely.

Smitha Misra (1996) assesses the benefits of regulatory practices related to water pollution abatement in an industrial estate in Gujarat, (India), using a contingent valuation survey. The general contingent valuation technique has been carefully adapted to relate to the local situation. The empirical results show that predominant user and nonuser values exist even among the relatively uneducated and low income groups in India. Values are estimated by conducting an urban survey in Vadodara city and a rural survey in six villages, surrounding Nandesari industrial estate. The total willingness to pay for user values and nonuser values, estimated for urban Vadodara are Rs.140.14 million and Rs. 119.15 million per annum respectively. The total willingness to accept for user values in rural area is Rs. 83.26 (based on OLS model) and Rs. 120 million (based on logit model) per annum. The total willingness to pay for nonuser value is Rs. 1.32 million per annum. It is noticed that, there are clear economic linkages between conservation efforts and the benefits derived from these efforts. Large potential welfare gains are generated because of water pollution abatement practices.

A study conducted by the team from the World Bank (Brandon & Homman 1995), is based on an assessment of the nationwide health cost of water pollution in India. It is in fact an assessment of the negative health impacts of domestic pollution, that could be avoided through extending the coverage of clean water supply and sanitation to all the population. The economic impact is calculated with the data provided by the "Global Burden of Disease" project, using the human capital approach. The estimated major annual environmental costs for India was US $ 9.7 billion.

A report of the World Bank titled "Investing in Health" (World Development Report, 1993) reveals the nexus between development and environment. By exposing the pollution episode in Japan, the issue of "Minamata" the report states that, "the establishment of Chisso Fertilizer Corporation is in 1908, and by 1920's it becomes a serious issue, and by 1956 patients with severe neurological affliction (later called Minamata disease) were observed. The disease was because of intake of seafood containing high concentrations of Methyl Mercury. The heavy concentration of Methyl Mercury into the Minamata bay is done by the Chisso Chemical Corporation". The report states that, by 1992, 2,248 people (1,004 of whom had died) had been certified as suffering from 'Minamata disease'. If the discharge of Mercury continued, the estimated annual cost of damage including patient treatment and compensation, sediment dredging and losses to fisheries would have been $ 97 million a year.

Pearce and Warford (1993), argued that the most important and immediate consequences of environmental degradation in the developing world take the

form of damage to human health. Diarrhoea, is a common occurrence in many developing countries with three to five million cases recorded every year. Each case is estimated to involve a loss of 3-5 days amounting 9 billion working days lost in a single year.

Bruce and Ellis (1993), argue that urbanization and industrialization can bring pollution problems in developing countries. Tax revenues in these countries are too low to support adequate infrastructure for treating and disposing of the wastes, that leads to a market failure. Two types of policies are suggested to correct this. 1) Command and Control Policies (CAC) and 2) Market Based Incentive Policies (MBI). But they warned that, taxing polluting inputs and output is an attractive policy, but it often lacks experience in administration and enforcement in developing countries.

Oodit and Simonis (1993), in the article "poverty and sustainable development" revealed the relationship between poverty, environment and development. They argue that the rural poor suffer from ill health, mainly on account of under nutrition or malnutrition. Their health is further affected by pollution, because the rural poor depends on water; bodies for drinking water; which are heavily polluted with pesticides and chemical fertilizers as well as with human and animal wastes. Similarly, in the urban areas water is contaminated with industrial pollutants and sewages. The relationship between poverty, environment and development is like a "Vicious circle.

Lucas et al (1992), in "Economic Development, Environmental Regulation and the International Migration of toxic Industrial Pollution" analyzes whether environmental

controls imposed in the industrial economies diverted pollution intensive activities off-shore. Based on the general test of the displacement hypothesis, a time series estimate of manufacturing pollution intensity of developed and developing countries between 1960 and 1988 is developed. The empirical analysis showed that,

1. The more rapidly growing high-income countries have enjoyed a negative growth in toxic intensity of the manufacturing mix.
2. Stricter regulation of pollution intensive production in the OECD countries have lead to significant locational displacement with consequent acceleration of industrial pollution intensity in developing countries. The poorest economies seem to have the highest growth in toxic intensity.
3. Pollution intensity has grown most rapidly in developing economies that are relatively closed to world market forces.

Parikh (1991), identified the possible environmental consequences of intensive agriculture in the study "4 % growth rate in agriculture over the 1990's" the study highlighted the need for dramatic changes in policy which includes, the development of infrastructure, producer incentives, expansion of irrigation, intensification of adaptive research and extension of bring the new HYV technology etc. Applied general equilibrium models were used, to explore the macro economic implications of agricultural growth. Environmental consequence of agricultural growth are mainly arising from the intensity in the use of land and particular technologies involving intensive use of water and chemicals.The possible environmental consequences of intensive agriculture are;

1. Deforestation, soil erosion and increased flooding due to disturbances caused during the construction of large dams and irrigation systems.2. Extensive use of land may result in deforestation and soil erosion.3. Intensive use of land may also lead to accelerate soil erosion. 4. Irrigation when drainage is inadequate may lead to water logging and

salination of soil 5. Irrigation requiring large quantities of water over the surface, as in the case when water is used to weedicide in rice cultivation can lead to build up of salts in soil. 6. Waters to which saline ground waters flow show higher levels of dissolved salts. When nitrate content increases, this can lead to eutrophication. 7. Improper and excessive use of pesticides can lead to build up of toxic chemicals in the food chain. 8. Excessive pumping of ground water lowers water table, which in coastal areas can lead to sea water intrusion. The study brings out that, it should be possible for India to attain 4% growth rate over the 90's if we expand irrigation. If we take, appropriate action at the right time, we can check environmental problems.

Pinock (1978), analyzed the effects of different levels of water quality on output and income in irrigated agriculture. Three Electrical Conductivity (EC) levels of irrigation water and the impact on crop yield and budgeted income are calculated using time series data EC = 1.25 (1960), 1.44 (1980). The estimated damage for two points are given, For 1980 it is $ 1,350 for crop loss and other one is projected damage for 2010 at $ 854.679 for crop loss.

Vincent and Russell, also attempted similar studies. In 1978, they have done a joint effort to analyse, saline water damage in the Colorado River basis in the US and revealed the losses to the municipal, industrial and agricultural sectors as well as the indirect economic losses to the regional economy. They estimated the total damage cost for the 1980 at $ 26 million - $ 27 million.

The results of a study by Moore (1978), indicate that the total concentration of dissolved salts expressed in electro conductivity is the most important single criterion for irrigation water quality. The deterioration of water quality in the Colorado river at the Imperial Dam from a 1974 level of EC = 1.5 to the propertied level for the year 2000 of EC = 2.0 would cause a decline in the returns to land and water about 14 percent for imperial valley farmers. Further deterioration of water quality in the lower Colorado river to EC = 3.0 would cause a decline of about 26 percent in net returns.

However, Kneese and Bower (1978), argued that although water quality deterioration is reflected in crop yields, the extent to which the crop yields are reduced is a function of interrelated factors including soil types and farm management.

Walsh and Warren (1978), have estimated mortality and morbidity form water borne diseases in Africa, Latin America and Asia. Water borne diseases due to water pollution have a definite impact on morbidity and mortality, and ultimately it has a serious negative impact on economic activities in the form of loss of working days, death of trained workers, expenditure for hospitalization and so on.

Pearce et al (1978), estimated national health cost of pollutted water on the basis of the studies conducted in the US. Outbreaks of the disease were monetarised on the basis of days lost and income and resource cost of a five days stayed in the hospital. It was estimated that the unit social cost per case was $100 and there were approximately one million cases of gastroenteritis each year in the US. Two million working days are lost in the US each year due to accute gastroenteritis and diarrhoea and at an average wage loss of $ 30 a day. It is estimated that the value of 1,000 deaths due to hepatitis infection per year is around $ 100,000 per life.

The studies reviewed here shed light on the various causes of water pollution and its negative impact on economic activities. Several factors contributes to the contamination of water bodies. The effluents discharged from tanneries, paper, mills, distillery units, domestic and municipal sewages, the saline water, chemical fertilizers gobar manures, chicken wastes associated with aqua culture, agricultural fertilizers, industrial effluents, hospital wastes, dumping of half burned dead bodies, night soils from hotels, camps and residential areas are the major contributing factors. The negative impact on economic activities is calculated on the basis of health related problems, man

days lost, expenditures on hospitalization, impact on natural resources, loss in lives, live stock loss, agricultural productivity loss and reduction in marriage proposals etc. Environmental impact Assessment and evaluation of losses / damages are examined using appropriate Environmental Impact Assessment (EIA) techniques, such as Willingness To Pay (WTP), Willingness To Accept (WTA) Contingent Valuation (CV) techniques, avoidance cost, dose - response techniques (for assessing money value of human health damage). Averting Expenditure Method (AE) etc. Policies to correct market failure, such as, Command And Control (CAC) and Market Based Incentive (MBI) are also explained in brief.

# CHAPTER 3
# ANALYSIS OF SECONDARY DATA

This chapter provides a detailed analysis of the factors causing the pollution of river pampa. This chapter is based on secondary data sources. For the present study, the researcher used the reports and analysis made by the pollution control board of the state as well as the Pampa Parirakshana Samiti and independent researches.

## 3.1 Sources of Pollution

The river stretch around the Sabarimala is seen polluted very much due to the pilgrim factor. The major source of pollution is associated with the visit of large number of pilgrims during the Sabarimala festival season. The problems are aggravated due to the lack of adequate toilet facilities. Large numbers of temporary latrines constructed for the use of the pilgrims en route to Sabarimala. The sewage from these latrines reaches the river directly and leads to pollution.

The environmental problems at Sabarimala are many when a large congregation of people from different places stays for short period (November to January every year) that too in a limited area without adequate basic infrastructure. In order to cater the needs of the pilgrims, Sabarimala will turn to an urban centre with many temporary hotels, shops and other commercial establishments. Open defecation by the pilgrims on the bank of the river is the main threat to the quality of water in the river. The sewage from the toilets and waste from hotels and other establishments are collected in

pits provided on the river side and pumped into soak south pits constructed at Cheriyanavattom very near to the river. The pilgrims bring all things required for their living. Many of the devotees prepare their food on the bank of the river. The solid waste generated, comprises of packing materials, vegetable wastes and food wastes are dumped on the riverbank. Apart from this, the commercial establishments throw their solid wastes into the riverbank, causing serious pollution problems. At the time of "Pampa Snanam" a large number of devotees perform the "Pampadanam." This is a peculiar offering made by the devotees. The clothes and other materials used during the pilgrimage are thrown into the river. There are limited arrangements to collect and remove such materials from the river. It is a great threat to the bacterial quality of water in the river.

River around the downstream municipalities and in parts of Kuttanadu is also known for poor quality water. None of the panchayats/ municipalities located on the banks of the river is having any sewage or solid waste collection, treatment and disposal system. The wastes generated in these townships have significant impact on the quality of the water.

Industrialization on the stretch of the basin is very little. There are no large/medium scale industries in this area discharging significant quantity of effluent. Only few small scale industries, mainly rubber processing industries are located in the river basin, these industries together generate a 566 cubic meter/ day of effluent contributes to a BOD load of 471.4 kg/day (KSPCB, 1999). Most of these industries have their own effluent treatment plant to treat the effluent, though some of them are

inadequate to control the pollution completely. Kozhencherry is the major town near to the Pampa River. There are six hospitals, several hotels, shops and the market is near to the River Pampa, of this only a few of them have proper waste treatment facilities; others are depositing it in the river. Direct discharge of untreated hospital waste, wastes generated from markets, hotels, trade centres', slaughterhouses and poultry selling shops are causing untold damage to the river water quality which seriously affecting the quality of life of the people who depend on Pampa River.

Pathanamthitta district in Kerala is a hilly district, and the major agricultural activity is associated with rubber. The major agricultural activity in the stretches of the river is rubber plantations, which depends largely on chemical fertilizers and the runoff from these plantations is acting as a major non point source of pollution.

Two religions conventions, namely Maramon convention, Asia's largest Christian congregation and 'Cherukolpuzha Hindu Mata Parishat', Kerala's largest Hindu congregation, were held on the sand beds of Pampa, near to an urban centre Kozhenchery, during the February of every year. At that time, Kozhenchery becomes a trade centre. More than 4 lakhs of people visits the conventions within a week. Large number of temporary hotels, restaurants and shops were operated on the sand beds and on the banks of the river. These generate huge amounts of wastes, like food wastes, plastics and paper, most of them are deposited in the river. Together with this the effluents from the temporary latrines in the sand beds also causing high amount of bacteriological

contamination of the river. The low level of flow of the river during the summer months especially during the festival season is also aggravating the pollution of the river.

### 3.2 Level of Pollution

In order to assess the water quality in different stretches of the river, the state pollution control board has established a network of 17 monitoring stations in the river and its tributaries. The seasonal variation analysis reveals that large variations in water quality occurred during the winter (January –february) and post monsoon seasons (October –December ) of the year. The reason behind this type of a large variation is the increase in the load of pollutants during these months .The Sabarimala pilgrimage and conventions on the sand beds are the major contributory factors of pollution during this time. The low discharge of water in these months aggravated the problem of pollution of the river. BOD and total coli form counts are increased at a faster rate during pilgrim season over the years. The water quality in the upper reaches of the river at Sabarimala is affected mainly during the festival seasons, starting from November to January. Examination of the water quality data shows that the upper reaches of the river upstream of Pampa river (Triveni) are not significantly affected by any human activities. The water quality in these stretches of Pampa river is good and does not require any up gradation. The quality of water downstream of Pampa up to Perinad was seen affected considerably due to activities of the pilgrim during festival season. The water quality below Perinad up to Chenganoor was also seen affected mainly due to excessive usage of water by human settlement.

**TABLE 3:1**

**Water Quality parameters of river Pampa**

| parameter | Year | Pampa | Vadaserikara | Edathua |
|---|---|---|---|---|
| pH | 2007 | 6.345 | 6.19 | 6.1 |
| | 2008 | 6.5 | 6.59 | 6.3 |
| | 2009 | 7.02 | 6.69 | 6.8 |
| | 2010 | 6.91 | 6.9 | 6.7 |
| | 2011 | 6.9 | 6.41 | 6.4 |
| BOD | 2007 | 7.38 | 0.80 | 1.26 |
| | 2008 | 3.50 | 1.07 | 0.99 |
| | 2009 | 7.50 | 0.95 | 0.85 |
| | 2010 | 8.30 | 0.59 | 1.07 |
| | 2011 | 15.0 | 0.95 | 0.64 |
| Faceal coliform | 2007 | 4704 | 779 | 763 |
| | 2008 | 1982 | 992 | 910 |
| | 2009 | 16021 | 230 | 260 |
| | 2010 | 9849 | 299 | 271 |
| | 2011 | 6950 | 307 | 412 |
| Total coliform | 2007 | 6300 | 2067 | 1950 |
| | 2008 | 3632 | 2510 | 1657 |
| | 2009 | 17335 | 547 | 603 |
| | 2010 | 14678 | 759 | 735 |
| | 2011 | 14729 | 498 | 666 |

KSPCB Pampa river monitoring various years

Central Pollution Control Board (CPCB) lays down the following norms for the classification of rivers in the country. According the norms set by the CPCB, the inland surface water is classified in five classes (A to E) on the basis of the designated best use. The criteria of classification and the designated best uses are depicted in the following table 2&3

**Table 3.2**

**Criteria for Classification**

| Sl. No. | Designated Best Use | Classification |
|---|---|---|
| 1 | Drinking water source without conventional treatment but after disinfection. | A |
| 2 | Outdoor bathing, swimming and water contact sports | B |
| 3 | Drinking water source with conventional treatment | C |
| 4 | Propagation of wildlife and fisheries | D |
| 5 | Irrigation, industrial cooling and controlled waste disposal | E |

Source: CPCB

**Table 3. 3**

**Primary Water Quality Criteria for the Designated Best Use**

| Criteria | Designated Best Use | | | | |
|---|---|---|---|---|---|
| | Class A | Class B | Class C | Class D | Class E |
| Dissolved Oxygen (mg/l) maximum | 6 | 5 | 4 | 4 | - |
| BOD (mg/l) | 2 | 3 | 3 | - | - |
| Total Coliform count *MPN/100ml maximum | 50 | 500 | 5000 | - | - |
| P.H Acceptable Range | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | 6.0-8.5 |
| Free Ammonia mg/l | - | - | - | 1.2 | - |
| Conductivity at $25^{o}$c | - | - | - | - | 2250 mohs/cm |
| Sodium Absorption Ratio | - | - | - | - | 2.6 |
| *Boron mg/l* | - | - | - | - | 2 |

*MPN: Maximum Probable Number

Source: CPCB

Kerala state pollution control board (KSPCB) conducted a detailed survey in the river basin to collect data on the uses water by the people living at various stretches of the river in 1999 to assess the quality of water in the Pampa river basin. The study revealed

that, river water is being put to a mixed pattern of uses by the rural communities and even by the poorer sections of the urban community on all stretches of the stream, which include bathing, use of water for washing clothes, utensils and sometimes for cooking and drinking purposes. Based on this, the designated best use of various stretches of the river is identified and classification of the river is made accordingly. It gives minimum desirable water quality levels for different uses. The designated best use classification of Pampa river and the existing values are given in table 4.

**Table No 3. 4**

**Desired and Existing Water Quality**

| River Stretch | Quality | | Critical Parameters |
|---|---|---|---|
| | Desired | Existing | |
| The upper reaches of the Pampa and its tributaries above Chenganoor | A | C,D | Total Coliform BOD, DO |
| The stretches below Chenganoor up to point of confluence with Vembanad lake | C | C | The quality of water conforms to the desired classification hence no critical parameters. |

Source: KSPCB, 1999.

.Most of the rural water supply projects in Pathanamthitta and Alappuzha Districts are constructed along the river Pampa. The water is distributed without having treated or purified properly. Now the water is unsafe for drinking and other domestic purposes.

# CHAPTER 4

# ANALYSIS OF PRIMARY DATA

This chapter is the most important chapter of the present study which constitutes the analysis of primary data. Valuation of environmental goods and services has received increased attention in recent years. Economic valuation of environmental impact means, a careful identification and measurement of the biophysical changes produced by a project or alternative project designs. In other words, it offers a way to compare the diverse benefits and costs associated with eco-system by attempting to measure them and expressing them in a common monetary unit. Three criteria for identifying significant impacts on environment were suggested is the "World Conservation Strategy". The first concerns the length of time and geographic area over which the effect will be felt. These include an assessment of the number of people affected, how much of particular resource would be degraded or eliminated. The second contention is urgency. It means how quickly a natural system might deteriorate and how much time is available for its stabilization or enhancement. The final criterion is to assess the degree of irreversible damage to communities of plants and animals to life support systems, soil and water. Systematic methodologies of Environmental Assessment (EA) are one designed to produce this information.

## 4.1. A brief description of sample area

River Pampa is flowing through 15 local panchayats of Pathanamthitta district and one municipality of Alapuzha district in Kerala. Out of which, five ( Ranny Perunadu, Seethathodu, Vadasserikkara, Kozhencherry and Aranmula) panchayat and One (Chengannoor) municipality was selected for the study and the required data was collected from 180 households purposively. Responses of the respondents who are residing on the banks of the river were selected using simple random sampling

technique with a well-structured interview schedule. Variables included in the generally applicable techniques of valuing environment are used for analysis.

The river pampa flowing through Idukki, Pathanamthitta and Alleppy districts in Kerala, is the lifeline of central Kerala, lies in between lat $9^{o}15'$N and $9^{o}30'$N and long. $76^{o}20'$ E and $77^{o}15'$ E. The river originates from Pulanchimalai, having an elevation of 1650 m in the Western Ghats. The river basin has a catchment area of 2235 sq.km wholly in Kerala. The total yield of the basin is 4641 million cubic metre per annum. The utilizable yield comes to 3164 million cubic meter (KSPCB, 1999). A network of rivers and streams traverses the Western Ghats. The rivers are perinnial. The main tributaries of pampa are Kakki, Kakkad and Kallar. The pampa takes its origin from the ridge formed by Chinnamel malai, Poochi malai, Nanga Malai and Sundara Malai and flows in South West and North West direction with a number of falls. Then it turns and flows South Westerly courses till it is joined by Kakki River at Anavattom. Kakki, river joins the pampa at Triveni near Chalakkayam. The Kakkad river formed by the rivers Moozhiyar and Maniyanar which joins the Pampa at Perinadu. The rivers Chelikkal Ar, and Wackal Ar which originate from the hills north east of Chembalakar and south of Valanjakatu Malai from the main Kallar flows in a northwest direction and joins the pampa at Vadasserikkara. There the river takes a North-Western Course up to Ranny and south western course upto Kozhancherry and then to Pandanadu. The Manimala, river which originates from Mothivana hills, joins the river pampa at Valanjavattom. The Achenkovil river flowing from Parukidamedu and Rishimala joins the pampa at Veeyapuram. Finally the river Pampa flows north and drains into Vembanadu lake system (Mathew Koshy

2001). The average width of the river is 40m. The depth of the river varies between 1 m and 10 meter depending on the season, sandmining and the nature of the land. One recent study conducted by the CESS and Central Water Commission shows that, indiscriminate mining of sand from the river has resulted in the level of sand bed going down by five meters in the past 25 years. (Rivers and Sand Mining Report of CESS, Trivandrum).

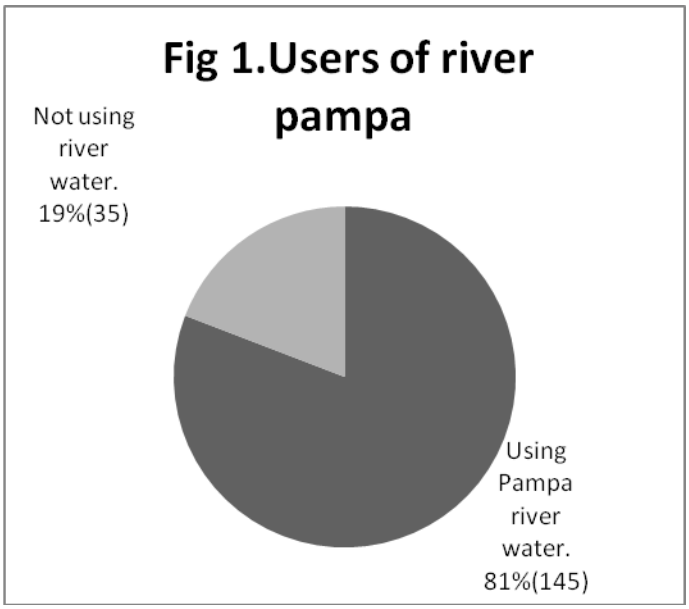
The Sabarigiri hydro electric project, the second major hydel project in Kerala, is situated in this river basin. Two storage dams, one across the pampa and another across the Kakki, a tributary of pampa river have been constructed with a tunnel interconnecting the two reservoirs. The power tunnel takes off from Kakki reservoir and leads the water to the powerhouse situated on the right bank of Moozhiyar another tributary of pampa river. 230 MN of power is generated from his project. The highlands are mostly reserved and protected forest with patches of tea, cardamon and coffee estates, in the midland, coconut, rubber, pepper etc are grown Paddy, coconut and arecanut are cultivated in low land region.

River Pampa, is the holy river of the Hindus in South India because of its historical relation with Sabarimala Temple and the epic of 'Lord Ayyappa'. The famous forest shrine of 'Swami Ayyappa' is situated in the northwestern foothills of the pampa plateau. It has become one of the most popular pilgrim centers and millions of pilgrims visit the shrine particularly during the months of December and January and also during the first of every Malayalam month. During the season around 50 million people visit Sabarimala Shrine. Around thirty thousand people stay at Sabarimala for two months for rendering services to these pilgrims. 'The Cherukolpuzha Hindu matha Parishat' the largest Hindu

congregation in Kerala, is also undertaken on the sand beds of the Pampa river. River Pampa is linked to the Christian belief also, it is on the sand beds of this river, Asia's largest Christian congregation, 'The Maramon Convention' is held every year.

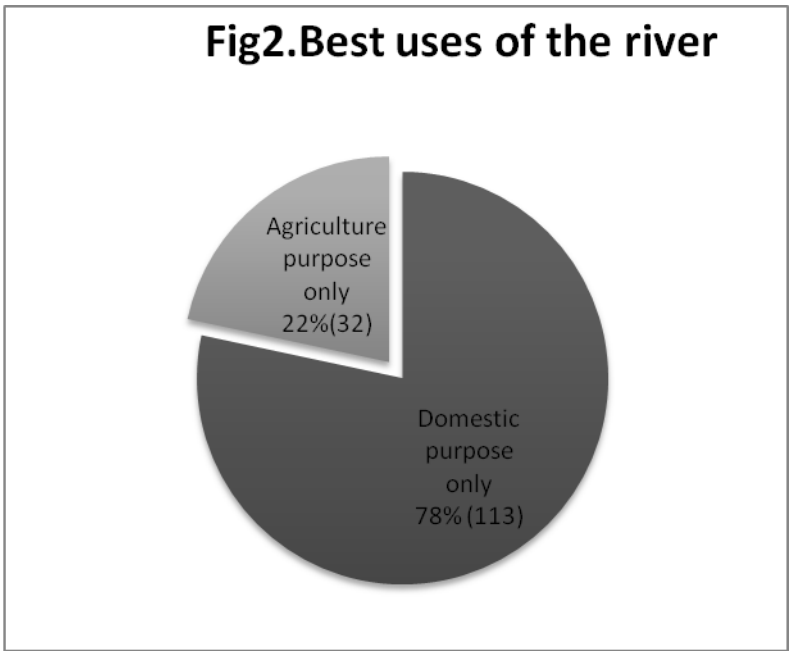
**2.3 Best uses of the River**

The primary survey conducted by the researcher reveals that majority (81%) of the respondents are using the river water either for domestic or for agricultural purposes. People residing on the banks of the river have a mix of domestic best uses of the water. The study reveals that the respondents in the sample area used the river for domestic purposes and for agricultural operations.




Drinking, Bathing , Washing of clothes, Washing of cooking utensils and toilet usage are the major domestic best uses of the river water by the respondents in the study area. 85

percent each of the total users used the river water for bathing and washing of clothes. 37 percent of the respondents used the river water for drinking purposes during the summer seasons and 31 percent used the water for toilet purposes.




Irrigation and washing of animals are the major agricultural uses of the water by the nearby communities. It is revealed that 22 percent of the respondents surveyed uses the river for such purpose.

**Table 4.1**

**Domestic Best Uses**

| Sl. No. | Domestic Best Uses | No. of Households (%) | Total users |
|---|---|---|---|
| 1 | Drinking | 54 (37) | 145 |
| 2 | Bathing | 124(85) | 145 |
| 3 | *Washing clothes* | 124 (85) | 145 |
| 4 | Washing cooking utensils | 31(21) | 145 |
| 5 | Toilet usage | 45(31) | 145 |

Source .Primary survey

**2.4 Health impact of pollution**

To identify the health impact of water pollution the study used the information provided by the respondents regarding the occurrence of diseases. The present study covered a total population of 581 individuals. 142 cases of water borne diseases reported during last four years in the study area. Skin diseases in the form of itching etc was largely reported, infectious hepatitis/Jaundice, Diarrhea, Schistosomiasis in the form of continuous cold and other related problems, and typhoid are mainly reported during the past years. Table 6 shows the type water borne diseases attacked the respondents.

## Table 4. 2

## Waterborne Diseases Attacked

| Sl. No. | Type of Disease | No. of cases Reported |
|---|---|---|
| 1 | Infectious Hepatitis/ Jaundice | 19 |
| 2 | Diarrhea | 24 |
| 3 | Skin Disease | 58 |
| 4 | Schistosomiasis in the form of continuous cold, and other related problems | 29 |
| 5 | Typhoid | 5 |
| 6 | Malaria | 1 |
| 7 | Other diseases | 6 |
| 8 | Total cases reported | 142 |

Source: Primary Survey,

## Table 4.3

## Hospitalized cases.

| SL. NO. | Status | No of individuals (%) |
|---|---|---|
| 1 | Number of hospitalized cases | 91 (64%) |
| 2 | Not hospitalized | 51(36%) |
| 3 | Total | 142 (100) |

Source: Primary Data

The cost of illness analysis reveals that out of the 142 respondents who have been affected by waterborne diseases majority (64 %) are hospitalized. Of which majority (95%) are hospitalized for less than 10 days only a few are hospitalized between 10-20 days. Disease affected individuals lost an average of 5.43 days in hospital because of the disease and they had lost an average of 13.81 working days and they spend an average of rupees 1271.92 for hospitalization and for treatment.

**Table 4.4**

**Number of Hospitalized Days due to Disease**

| | Days Hospitalized | No. of Individuals |
|---|---|---|
| 1 | Less than 10 | 87 |
| 2 | 10-20 | 4 |
| 3 | 20 above | 0 |
| 4 | Total | 91 |
| 5 | Not Hospitalized | 51 |
| 6 | Grand Total | 142 |

Source: Primary Survey

# CHAPTER 5.
# SUMMARY, FINDINGS AND CONCLUSION

## 5.1 **Summary**

The past two - three decades witnessed a growing concern regarding the close nexus between poverty, environment and economic development. Technological change, innovation and the drive for wealth accumulation lead to the creation of new high growth industries required for macro economic growth. These high growth industries foster environmental change. Thus the same forces that lead to economic growth are responsible for changing the natural environment. Rivers being dynamic systems are subjected to physical, chemical and biological variations due to diverse human activities. River pollution has been quite alarming in recent years as a result of waste discharges from industries, sewage outfall from townships, pilgrimage centres etc. Rivers are linked with religious beliefs of the people around the world. The river Pampa is seen polluted very much due to the pilgrim factor. River around the downstream municipalities and in parts of Kuttanadu is also known for poor quality of water. The conventions held on the river bed, and the direct discharge of untreated hospital and municipal wastes and agricultural runoff are causing untold damage to the river and seriously affecting the quality of life of the people who depend on Pampa river.

## 5.2 Findings

1. The major source of pollution of river Pampa is human centered. The Sabarimala pilgrimage and the conventions on the sand beds cause an increase in the load of pollution every year. Wastes from townships, trade centers, Crepe mills, Hospitals, Chemical fertilizers used in agricultural activities contribute to an increase in the load of pollutants in the area. The level of industrial pollution is comparatively low in the stretches since there are no large industries in the stretch. The level of pollution is high during slow flow summer seasons. It is understood that the lack of adequate infrastructural facilities in the form of waste treatment plants aggravated the problem.

The seasonal variation analysis reveals that large variations in water quality occurred during the winter (January –february) and post monsoon seasons (october – december ) of the year. The reason behind this type of a large variation is the increase in the load of pollutants during these months .The sabarimala pilgrimage and conventions on the sand beds are the major contributory factors of pollution during this time. The low discharge of water in these months aggravated the problem of pollution of the river. BOD and total coli form counts are increased at a faster rate during pilgrim season over the years. The water quality in the upper reaches of the river at Sabarimala is affected mainly during the festival seasons. The water quality below Perinad up to Chenganoor was also seen affected mainly due to excessive usage of water by human settlement.

2. Water scarcity is a problem experienced by the residents in the banks of the river. As a whole, 81% of households depend on the river for their routine needs. It is seen that 78% of them use the river exclusively for domestic purposes. 22 % of them are using the river for agricultural purposes. Bathing and washing of clothes are the major domestic uses. It is noteworthy that 37 percent of the respondents are using the river water for drinking purposes with traditional disinfection called boiling during the summer season. The absence of an efficient water supply scheme in the study area added many problems to them.

3. Riverbank environments are potential areas of waterborne diseases like diarrhea, hepatitis and dysentery. 142 cases of water borne diseases reported during last four years in the study area. Skin diseases in the form of itching etc was largely reported and are common , infectious hepatitis/Jaundice, Diarrhea, Schistosomiasis in the form of continuous cold and other related problems, and typhoid are mainly reported during the past years. The cost of illness analysis revealed that individuals hospitalized on an average of 5.43 days because of the disease and they had lost an average of 13.81 working days and they spend an average of rupees 1271.92 for hospitalization and for treatment

## Conclusion

The relationship between poverty environment and development is like a vicious circle. Structural adjustment programmes have created pressure on governments to over exploit non renewable resources which hit the poorest groups. Urbanization and deforestation can bring pollution problems in developing countries. Since, there exist a close nexus between poverty, environment and development. The poor, both rural and urban, suffer most. They suffer from ill health, mainly on account of malnutrition and it is further aggravated by pollution of water bodies. “Poverty is greatest pollution” (Indira Gandhi) in the case of India. Likewise, the poorest economics seem to have been adversely affected due to international migration of toxic industrial pollution. The brunt of the negative externality has always been borne out by the poor.

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