An Evaluation of Ground Water Pollution Risks on Child Health: A Case Study of Inhabitants of Manka Drain, D. G. Khan, Punjab, Pakistan

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CERTIFICATE

This is to certify that this thesis entitled: "An Evaluation of Ground Water Pollution on Children Health - A Case Study of Inhabitants of Manka Drain in D.G. Khan, Punjab" submitted by Ms. Fatima Gulzar, is accepted in its present form by the Department of Environmental Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of Doctor of M.Phil Philosophy in Environmental Economics.

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Fatima Gulzar

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Abstract

Water is life for all living things but due to over population and pollution, its stock is going to deplete. Besides, open drainage system in many developing countries is another major source of ground water pollution. Polluted water poses a serious threat to the health of the population. This study is designed to investigate the health risk to residents living near the Manka drain (an open drain) in D. G. Khan, Pakistan. To know the household's (HHs) socio economic status, their awareness about water pollution and their willingness to pay (WTP) for safe drinking water, primary data was collected from the HHs through a well-structured questionnaire. Bivariate Logistic Regression as well as ordinary least square methods was used to know the HH's WTP in the polluted and non-polluted areas. The study demonstrated that the ground water was depleting because of the drain. On the other hand, higher income and educated group of people living in the selected area were found WTP for safe drinking water facility. Recommendations have been made to minimize the adverse impact on the health of the children and in general the community living in the vicinity of the Manka drain in D .G. Khan.

Key words; *D. G. Khan, Ground Water Pollution, Children Health, Willingness to Pay for Safe Drinking Water*

CHAPTER I

INTRODUCTION

1. Safe Drinking Water

"Water is the resource that covers almost three-quarters of the planet, and upon which all life of earth depends. During the history of world, water sources have been the centers of life, which provided habitat and nourishment for all living things" (UNICEF & WHO 2004).

Water is life but with the passage of time, we exploited it, polluted it, and made the water access difficult. This was mainly because of mismanagement and rapid increase in population, unplanned urbanization and industrialization. Industrialization, particularly in populated urban areas resulted in the increase of air, noise and water pollution. Waste materials, sewage discharged from factories and houses got mixed in fresh water of streams and became acrimonious cause of contamination. Thus these contaminated and polluted streams served as the breeding ground, of mosquitoes, flies and germs that caused diseases. In this way, polluted streams became a regular source of various diseases in general and tremendously in their locality (Khan 1992).

According to the World Health Organization (WHO), all over the world poor sanitary conditions was the root cause of many serious diseases. According to an estimate about 2.6 billion people of the world had no access to proper sanitary system (WHO, 2004). This situation was alarming for the mankind. Estimated 4,000-6,000 children were dying daily due to non-availability of safe drinking water, facility sanitation or lack of cleanliness (WSSCC, 2004).

The target of Millennium Development Goals (MDG) was to minimize these figures worldwide to almost half by providing safe drinking water and a proper sanitation system by the year 2015. Some countries, had witnessed reasonable improvement in the achievements of these objectives. However, most of the developing countries still lacked satisfactory sanitation. Only 36% of the population of Sub-Saharan Africa had satisfactory sanitation (UNICEF and WHO, 2004).

Public health authorities have sounded a warning against this new danger to the public health caused by pollution of streams by sewage and the waste from the manufacturing sector. Reports of conferences on the subject have highlighted the problem. The body of literature contained in official reports and created awareness. Formerly this was purely a municipal problem and was dealt with by the city authorities. Their problem was solved generally when means were provided for dumping the sewage into a stream which thus became a natural sewer (Lapp, 1909).

1.1 Water Pollution

Water pollutants come from point and non-point sources of pollution[1]. Their effects on aquatic systems largely depend on whether polluted waters are standing (lakes and ponds) or flowing (rivers). The major water pollutants are organic nutrients, inorganic nutrients, infectious agents, toxic organics, toxic inorganics, sediment and heat. Organic nutrients come from feedlots, municipal sewage treatment plants, and industry. They promote growth of aquatic bacteria that become the source of water pollution (Combined Federal Campaign, 2011).

[1] Point pollution comes from a point - single source, such as a factory or wastewater treatment plant. Non point pollution comes from the cummulative effect of a region's residents going about their every day activities, such as fertilizing a lawn, driving a car, pesticides, pet waste, motor oil, and household hazardous wastes (Enviromental assesmant policy).

1.2 Industrial and Municipal Pollution

In Pakistan, particularly in the province of Punjab, industrial production is not environment friendly. It generates dangerous waste and chemical contaminant that badly affects the quality of life. Similarly, there are more than 100 sewage water point sources in Punjab, which are disposing off waste water in to the drain/canals/rivers. This water is even unfit for irrigation. This pollution load varies from drain to drain depending upon the number of industrial units and the municipal discharge. The pollution load from industries and municipalities is estimated to be more than 5,000 cusecs. The level and amount of pollution varies from district to district. The untreated industrial and municipal wastes have created multiple environmental challenges for human beings. More than 1,000 industrial units and municipalities are directly discharging more than 5,500 cusecs of untreated toxic effluents into the drains, rivers and natural nallahs. In addition, they are causing ground water pollution. The nature of this effluent varies from toxic to hazardous. The disposal of untreated industrial effluents into the water bodies has become a threat to its various uses irrigation, drinking and sustenance of aquatic life (Govt. of Punjab 2007).

1.3 Quality of Ground Water in Punjab

The standard measure of quality of ground water is area specific and generally ranges from fresh with Total Dissolved Solids (TDS) less than 1,000 mg/1 near the major rivers to highly saline with salinity exceeding 3000 mg/1 TDS. In Punjab province, about 79% of the area has fresh ground water. Some 9.78 million acres are underlain with ground water of less than 1,000 mg/1 TDS, 3 million acres with salinity ranging from 1,000 to 3,000 mg/1 TDS and 3.26 million acres are underlain with ground water of salinity of more than 3000 mg/1 TDS. Ground water with high fluoride content is found in the Salt Range, Kasur and Mianwali. There are also reports of high fluoride content, ranging from 65 to 12 mg/1 in ground water in Bahawalpur area. Ground water samples taken from all districts of Punjab have shown concentrations of arsenic well above the WHO guideline value of 50 g/1. The effluent from tanning industries in Kasur has caused high TDS, chromium, sodium and sulfide contents in ground water. According to an estimated 2.1 million hectares of salt-affected lands exist in Punjab's non-sweet water areas (Govt. of Punjab, 2008).

1.4 Water Pollution Issues

Over exploitation of water, poor solid waste management and sanitation situation are main causes of water pollution. As such availability of safe drinking water is limited today not only in Pakistan but for all over the world.

Inadequate drinking water causes not only more sickness and deaths, but also increases health costs, lower labor productivity and human efficiency. Safe drinking water is an essential component of primary health care and can play an important role for poverty alleviation (Mustafa et al, 2007).

According to World Bank (1994), provision of safe drinking water can reduce mortality caused by water borne disease up to 70%.

Healthy economy depends on water and thriving ecosystem. Water issues deserve priority considering growth of economy health of individuals and of the environment. One fifth of the world's population lives in areas where water is scarce, and a quarter of the population faces shortages due to lack of infrastructure (National Geographic, 2009).

Economically, safe drinking water is important. An increase of 0.3 percent investment in provision of safe drinking water generates one percent increase in GDP. In fact provision of safe drinking water supply is an effective health intervention measure (Mustafa et al, 2007).

1.5 Global view

With the passage of time, lifestyle is undergoing change and now world is moving towards more modern and mechanical way of living. This trend has moved society toward, more urbanization but due to poor governance and management, pollution issues are at their peak. Water pollution issues are now a global issue. Industrial effluent and municipal sewage are the major sources of water pollution. Worldwide, just less than 900 million people have reliable access to safe drinking water which is free from disease and industrial waste. On the other hand, unfortunately 40 percent of the world population does not have access to adequate sanitation facilities. Every day, 4,500 children die from waterborne diseases, mostly from cholera, malaria, and tuberculosis. Another important fact is that 1.8 million people in developing countries die every year from diarrhea and cholera. The result safe drinking water is one of the world's greatest public health crises. (WHO, 2004).

1.6 Sanitation Condition in Pakistan

Pakistan is a developing country with poor management capacity. Puddles like streams are found in almost all big cities of Pakistan which creates serious environmental and health issues especially for poor segments of the society. According to a very rough estimate, 9,000 million gallons of wastewater having 20,000 tons of biochemical oxygen demand (BOD) loadings are discharged daily into water bodies from industrial sector. Similarly, about 6.9 million wet tons of human excreta are annually produced in urban sector. From which around 50% goes into water bodies to pollute them [Surface Water Industrial and Municipal Pollution, Govt. of Punjab (2008)].

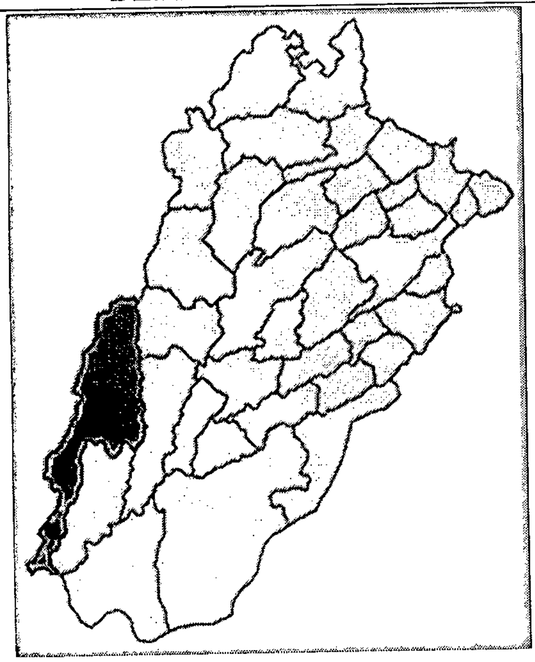
But unlike past, now- a- days people have begun to realize the risks involved in factors like over population, urbanization and industrialization. This realization can be termed as the first and the foremost step towards the improvement of this grave situation. The second encouraging aspect of this issue is that, the officials of the public health departments are actively pondering over this grim issue. They are creating an awaking, among the people about this problem by organizing conferences and bringing a body of literature.

It is interesting to note that in the past this problem was not given due attention. The municipal and other concerned agencies handled this problem by putting the sewage and waste materials into the nearby streams that converted these streams into puddles of waste materials (Khan, 1992).

It is also a noteworthy that in our country municipal and industrial waste water usually gets mixed in some open drain after their discharge. Then this waste water flows in to streams, canals and rivers, and thus fresh water and ground water becomes contaminated. Because of this process, gradually these natural water bodies are converted into sewers. It is a pity that there is no regular monitoring or quality assessment body for the surface water and the ground water. Unfortunately we are unable to create quality standard of ground water in Pakistan. In fact, when the quality of ground water is compared with the standard water quality, we find an alarming ratio of water pollution due to frequent mixing of wastewater into ground water [The World Bank, (2005)].

1.7Reason to Select D. G. Khan as Study Area

Figure 1.7 LOCATION DISTRICT DERA.GHAZI.KHAN



— **District** —
Location of Dera Ghazi Khan District (highlighted) within Punjab province
Country Pakistan

Population (1998) • Total 1,643,118

Time zone PST (UTC+5)

Number of Tehsils; 3

Source; Tehsils & Unions in the District of D.G. Khan - Government of Pakistan (2012)

In Pakistan, D. G. Khan is considered as a backward district in the province of Punjab. The district covers an area of 5,306 m² and it is a long narrow strip, 198 m. in length, sloping gradually from the hills which form its western boundary to the river Indus on the east. D. G. Khan has great importance for its agricultural products and natural resources in the shape of petroleum and gas reserves at Rodho, Zindapir, Afiband, Dhodhak etc. The Koh-e-Sulaiman range constitutes a major part of this area; which is full of natural deposits such as marble and lime stone. A big cement plant DG Cement is also situated in Kofla Sattai Tehsil D. G. Khan.

The population of districts D. G. Khan is 1, 643, and 118 with 7 union councils in urban areas. Male population is 51% and 49% is female in which 2.1% of population is below ten years. Literacy rate is 29.6% (Govt. of Pakistan, 1998).

The people of this area are facing a number of problems due to poor solid waste management and bad sanitation system. They are also facing large number of health risks especially in case of children. A lot of work has been done in the world, but very little information is available about the health risks caused by open drains in backward areas of Pakistan, particularly in respect of D.G Khan. So the need for the present study, which is designed to investigate the health risks to children in the community near Manka drain in D. G. Khan.

1.8 Manka canal in D. G. Khan

The Manka canal passes through the center of the D. G. Khan city; basically this canal was an inundation canal which has risen from Indus river creeks. D. G. Khan canal started functioning in 1962. Its seepage was intercepted and diverted toward, Manka canal which started operating as seepage drain. Its basic purpose was to irrigate the area during monsoon season when the water level in the Indus River rises up. This inundation canal functioned till the construction of Taunsa Barrage (Govt. of Punjab, 2007).

1.9 Socio -Economic Significance of the Study

In many developing countries, water pollution is rising at an alarming rate resulting in higher incidence of cholera, dysentery, malaria etc. and high level of other water borne diseases. Nearly 250 million cases of water borne diseases are reported every year in Pakistan (World Bank, 2005). Nearly 5 to 10 million deaths and diarrheal diseases leave millions of children underweight, mentally and physically handicapped and vulnerable to other diseases. Yet we are falling further and further behind in our efforts to meet these basic challenges. Between 1990 and 1997, more than 300 million people were added to the existing 2,600 million people without adequate sanitation services, a clear indication that the world community is failing to meet the basic needs of the growing population [Peter, Cleick, (1999)].

This study has great importance because; unchecked mixing of domestic and industrial waste in an open drain pollutes the water which influences the health of surrounding settlements and particularly the children who are the most vulnerable segment of the population. In addition poor health has a number of economic and social implications. Economic implication includes loss of productivity inefficiency absenteeism and ill health etc. In addition, sick person are also a continuous source of further spread of diseases. Present study inquires about the socio economic status of the people of D. G. Khan. Therefore, environmental and health concerns associated with open drain passing through urban residential areas need to be investigated for designing the framework to deal with the child health issues.

1.10 Objectives of the Study

The overall objectives of the study are to highlight the importance of clean water and child health risk in D. G. Khan. Specifically the study will address the following issues:

- Highlight the implication of polluted water on the household, especially on children health in the surrounding of D. G. Khan.
- Find out the willingness to pay for access to safe drinking water by the people in the study area.
- Formulate appropriate policy recommendations for improvement of child health.

1.11 Hypothetical Formulations

1. Water pollution affects child health.
2. People are willing to pay for improved access to safe drinking water.

CHAPTER II

REVIEW OF LITERATURE

A bulk of literature is available on water pollution and discharge of sewerage water in clean water bodies. The main aim of review of existing literature is to prove a familiarity with the body of knowledge and establish reliability. A review tells the reader that the researcher knows the research topic. The most important objective of review is to show the path of previous researches and how the present study linked to it. The review provides outlines for the direction of research on a question. A good review places research project in correct context and demonstrates its relevance by making connections to a body of knowledge [W. Lawrence Neuman (2005)].

2.1 Literature on Global Water Pollution

Rangeley (1986) discusses that irrigation and proper drainage system research done on international level has great contribution for developing countries. There are many aspects of this research; some of these range from project management to technical problems for profit ability and large scale productivity. In fact, increased production is large indeed. According to consultative group on international agricultural research (C.G. 1 .A.R) which aimed at areas of large scale production, marginal benefits can be massive in absolute terms by adaptation of better technologies and application of new innovations.

Jusi (1989) argues that in China water pollution has become a serious environmental problem since 1970s. In recent years because of economic development in small cities, towns and countryside, problem of pollution is spread wide. Proper management is necessary to control this water pollution problem. Current situation suggests that water pollution control will remain a difficult task in coming years. If we want to overcome this issue and alleviate shortages of waste water re-use is a practicable and easy way for it.

Witt and Reiff (1991) claimed that in the transmission of cholera contaminated water played a major role. Infected excreta discharged into water courses and without any appropriate treatment that contaminated water when used as drinking water was major cause of cholera. Mostly it's found that infected excreted water mixed into community water distribution systems; created by far the greatest risk. These can affect such large number of people. Environmental health conditions play an important role in the diffusion of cholera and the importance of safe water supplies, sanitary excreta and proper sewage disposal are important in any cholera control program.

Brown (1992) concluded that problems of sewerage and water supply are the result of rapid urban growth infections and infectious diseases are rising. Awareness among people is needed to cope with this grave challenge. Malthus casually included "great towns" among the "positive checks" to population, such as, wars, plagues, famine, extreme poverty and other "miseries." It was not that rural situations were satisfactory but that many elements necessary for good public health-cleanliness, clean water, systems of waste material disposed that would not drench the sub-soil, leach into water supplies, or create breeding ground for flies, good ventilation, and isolation from diseases are much more difficult to achieve in congested and burgeoning cities.

P.H. Gleick, (1998) argued that water is a valuable commodity and a large extent future prosperity will depend on, how well we harness fresh water resources and conserve and treat waste water. The way we use water will have eco-change significantly in the next quarter century, if sustainable development is to be achieved especially in the already water stressed developing countries in Asia and Africa.

Craun and Calderon (2001) reviewed all causes of water borne sudden epidemics during the period of 28 years (1971 – 1998) and found that in the water system of a community almost 30% of 294 sudden epidemics were directly linked with poor system of distribution and 194 illnesses sprang out from each of the above mentioned epidemics. Therefore they considered "contamination of water distribution system" was the root cause of all these water borne epidemics.

Robinson (2003) stated that there lie some institutional hindrances in the way to the improvement of sanitation. For example LGU's (Local Government Units) partly fail in provision of satisfactory facilities of sanitation. Elected official are responsible for the running of these institutions. But unfortunately they lack technical capabilities. They have strong urge to minimize charges and allocate funds for popular plans or activities. Water distribution gets lower priority. It is an unfortunate that financial allocations for water distribution are inadequate. There is only one choice for investment either invests in the provision of sanitation facilities or in the establishment of infrastructure in the affected areas. This situation adversely affects the provision of overall sanitation facilities.

Donnelley (2008) reported that those people, who are busy in the process of community regeneration, have been trying to work in a way in which their focus of attention is on results. This process is being run with the help of local government, development of Single Outcome Agreements (SOAs) and an introduction of Scotland fund to plan for the delivery of health related result oriented program for the community. There are very few practical techniques and methods in this perspective. It could be said that actions taken for the improvement of housing and community regeneration, would improve the general standard of health of the common people but unfortunately health is not given a due importance so far as the activities of regeneration are concerned. So, we cannot hope to get promising result through regeneration. In this way, this prevailing situation may minimize the ability of regeneration to produce desired result for the maintenance of health.

Raza (2008) reported that sewers of today were actually dug to keep rain and flood water but with the passage of time these drains turned into sewers lines. These sewers were to be covered but unfortunately, in almost all developing countries, these drains could not be covered due to the paucity of funds. Further, he says that seepage from such open sewers reach a depth of 200 ft. WASA pumps ground water from a depth of 500-700 ft. to avoid the contaminated ground water. Keeping in mind the above practices, he claims that the water supplied by WASA is absolutely free from any contamination.

Koivisto (2009) reported that millions of people, particularly children die every year due to water borne diseases i.e. diseases transmitted through human excrement in water supply. Millennium Development Goal (MDG), emphasizes to reduce the proportion of the people up to 50% who lack the facilities of pure water and sanitation services. For better ecosystem management, appropriate treatment and disposal of waste water is essential as it reduces the burden on fresh water resources and also protects the health and environment by restricting the transfer of human excreta into main water source.

Yongsi (2009) suggested that healthy environment and proper distribution of services can minimize the rate of diseases. After due analysis, it was shown that poor health was due to poor sanitation. Access to safe drinking water and hygiene support to the explanation of the prevalence and production of pathogens and paths linked with the communicable and blood sucking diseases as well as diarrheal infections.

Cottingham *et al.* (2010) stated that south east Queensland is increasingly becoming a water stress region mainly due to natural, environmental and induced factors. Environmental changes ever time have reduced the availability of water in the region and the rising population has put further pressure on already miserable supply situation. Moreover, government laws have further undermined the availability of water in the region. However, public-private partnership for the provision of water for community along with increasing public interaction with the water governing bodies have kindled a ray of hope for the long term sustained provision.

Yonasi *et al.* (2010) reported that health problem in the urban settings are catching the attention of the developing countries. Development and research institute conducted a program during 2002-2005. Focusing on urban health, Cameroon set two objectives. First, the diarrhea and secondly its risk factors were exploded. After due research it was concluded that the household sanitary management, by the city dwellers were unsatisfactory and were directly linked to diarrhea and it was also explored that the diarrheal attacks were different from one setting to another in urban areas.

2.2 Review of Studies in Pakistan

Emery N Castel(1972) in the publication "Economics and the Quality of Life" expresses much of what economists know about the allocation and use of natural resources from their knowledge of market processes. Careful and rigorous analysis has been made of the conditions under which a decentralized market economy will lead to an ideal allocation and use of natural resources. By knowing these conditions we can better deal with those circumstances when the conditions are not met. In the problems associated with water allocation and development these conditions frequently do not prevail. As a result we have removed water agreement from the market place and subjected it to administrative and judicial control to a great extent.

Environment and Urban Affairs Division, Government of Pakistan (1991) revealed that pollution is a subject on the concurrent legislative list of the constitution of Pakistan. Environmental degradation has taken place in the past and would continue to proceed unchecked unless remedial measures are adopted for combating environmental deterioration as well as securing abatement to pollution and contamination of the environmental media.

UNDP and World Bank report (1997) explained that the growth in Pakistan's urban population has far exceeded the provision of basic urban services and infrastructure, including water supply and sanitation facilities. Despite massive investment, only 60 percent of the urban population has access to sewerage facilities. There has been a rapid deterioration of living conditions in urban slums and shanties over large areas particularly in the larger cities. Due to the dearth of essential services, these settlements are of particular concern to the government. According to an estimate, about 40% of the urban population lives in low-income communities.

Ekaterina Gnedenko *et.al* (1999) paper deals with a contingent valuation of improvements in the drinking water quality, based on the household's perception of the tap-water quality and relevant health risk avoidance behavior. It involves analysis of factors determining household's willingness-to-pay for improved tap-water quality, as well as individual avoidance expenditures undertaken by the households to prevent/reduce health risk from tap-water consumption. Authors compare estimates obtained by means of two different evaluation techniques: actual avoidance expenditures and hypothetical willingness-to-pay for drinking water improvement. A survey has been conducted in the big industrial Russian city of Samara.

Storey and Ashbolt (2003) explored that bio-films used in water distribution systems to provide some grooming conditions to bacterial disease producing germs (pathogens). The people with weak defensive systems against diseases are victimized by these pathogens more severely. The entry of such pathogens (disease producing germs) in water distribution system is through the process of contamination. After this entry; these pathogens replicate and colonize themselves in some parts of distribution system. Some other pathogens such as legionella, pseudomonas, aeruginosa and mycobacterium avium- intracellular are also found there and they may make colonies in some parts of water distribution and plumbing systems of buildings. In this way they serve as producers of water borne diseases. Bio-films used in the water distribution system may also protect viral and protozoan pathogens from disinfection and make their survival longer and longer.

Government of Pakistan (2005) reported that along with the danger of mixing municipal waste water in the industrial water, contamination of ground water by arsenic is becoming an equally dangerous issue. In Sindh and Punjab almost 30 percent of total population is compelled to face the level of contamination that is higher than 10 parts per billion (ppb) and 16 percent of the population faces the contamination level of 50 ppb. Shortage of water along with the problem of pollution results in the destruction of wild life. These biological changes particularly in Sindh province are becoming the root cause of disappearance of many rare species. Thus, the problem of water shortage and water pollution must be solved to avoid this disappointing situation.

Lenton *et.al* (2005) stated that human beings need some basic necessities of life for their survival, growth and development, such as safe drinking water, sanitation and proper hygiene.

But unfortunately, most of the people of the world are deprived of these basic necessities. It is estimated that over 1.1 billion people of the world cannot get drinking water from healthy sources and about 2.6 billion people have basic sanitation. Although safe drinking water and proper sanitation are important for health, grave risks are being accepted with supreme indifference. Millions of schools going children live in dirty surroundings lacking the basic sanitation and proper hygiene. They suffer from intestinal worms and in this way their learning abilities are affected indirectly to some extent.

Govt. of Pakistan (2007) in their "Pakistan Social and Living Standards Measurement Survey" claimed that common households do not have access to pure drinking and deep water. Thus, people suffer from problematic diseases. Government has diagnosed this impairment and is now planning to widen its program of providing pure drinking water and satisfactory sanitation to common people. Government does have to involve common man in the management and maintenance of the water supply system throughout the country with a view to improve their working ability.

Mustafa et al (2009) in "Pro-poor Environmental and Fiscal Reforms in Solid Waste Management" revealed that clean environment was essential for sound health and solid base management was a big issue for health. People were willing to pay for efficient solid waste management system services and that could generate handsome revenues and in fact this act would be environment friendly also.

Mustafa *et al.* (2010), in Household's Willingness to Pay for Safe Drinking Water in district Abbottabad' revealed that safe drinking water was basic need for better health and people were willing to pay for safe drinking water in this district. People showed their willingness to pay for safe drinking water.

From the above literature review we conclude that poor sanitation condition and not provision of safe drinking water have negative impact on health of living things especially on human life. The alarming condition of water pollution issues was creating extra burden of health risk and economic cost on health expenditures. These drawbacks can be controlled with proper research and management. Research also reveals that compared to in industrial productivity, better result can be achieved by the application of innovations and improved technologies that control pollution in real terms.

A great amount of literature and a lot of work has been done in the world wide but very little information is available about the health risks caused by open drains in backwards areas of Pakistan, particularly D.G Khan. The present study is designed to investigate the child health risks for the community nearby Manka drain in D.G Khan because of water pollution in the region.

CHAPTER III

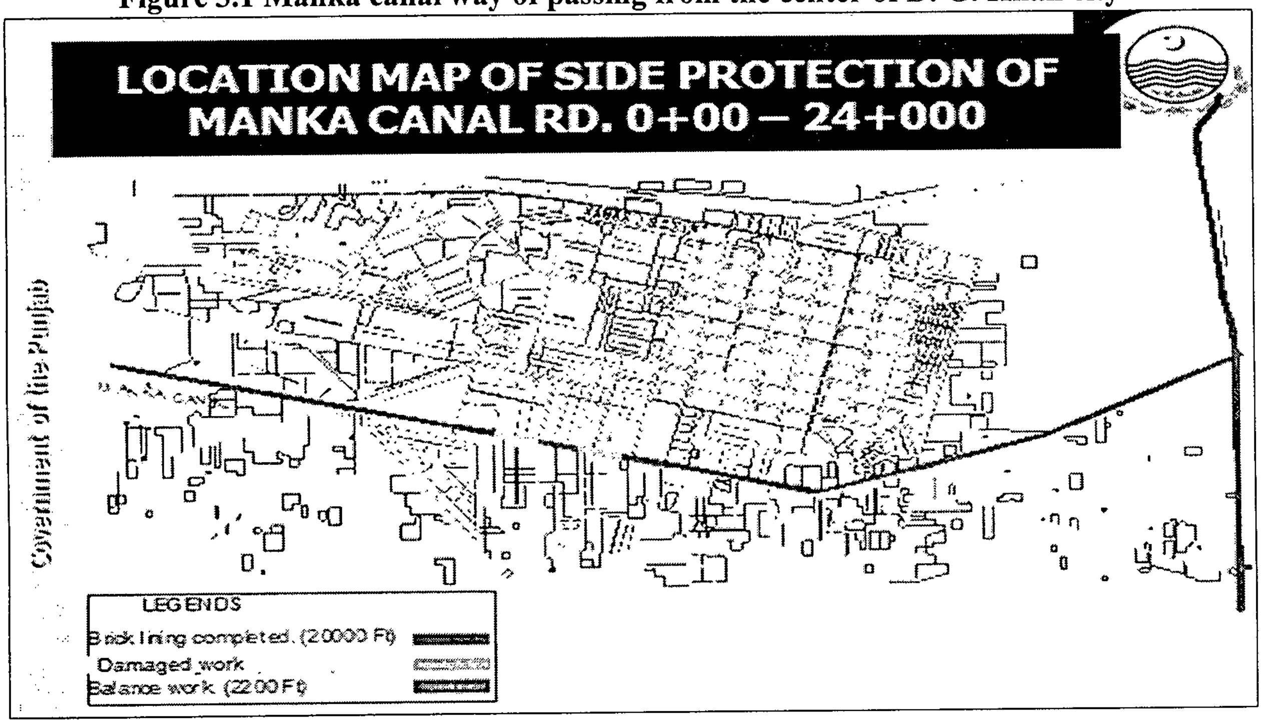
STUDY AREA DESCRIPTION

Research issue "An Evaluation of Ground Water Pollution Risks on Children Health" is investigate from a specific selected area taken from Province of Punjab (Pakistan) is Manka Drain in D. G. Khan. There are several important reasons to select this area as study area. D. G. Khan is a backward District of Punjab; population of this area is poor. Health and poor management issues at higher rate but because of political conflicts Government did not take notice on it. So there is need to investigate and highlight crucial issues. Thus facts and figures could take on front to solve their problems. Brief description about this area of study is given below.

3.1 Brief History of Manka Canal in D. G. Khan

The selected area D. G. Khan is a backward district of province Punjab. Agricultural prospect of this area is very strong and main occupation of this region is also agriculture. Major crops of this region are wheat and cotton so Government of Punjab has established canal and drainage system for irrigation needs and demand of water in this zone.

Figure 3.1 Manka canal way of passing from the center of D. G. Khan city



Source: Government of Punjab (2010)

The Manka Canal passes through the center of D. G. Khan city. Originally this was an inundation canal off taking from right active arm of Indus River. The canal remained in operation till commissioning of D. G. Khan Canal in 1962 and it started functioning as interceptor drain to intercept the seepage through main canal in order to check rise in sub surface water level.

3.2 Government of Punjab Irrigation System 2008 Project

Drains system: The Punjab irrigation system is accompanied with drainage systems. Originally the drains were designed to collect the agricultural surplus water and floodwater. Due to increase in population and industrialization the drains collects the industrial and municipal effluents of varied nature. In general drains are creating pollution problems in the irrigation channels. Much of the drainage effluent is either retained in the Indus Basin or disposed into the rivers and canals. In Punjab the length of total surface drains are 3883 km (Table 3.2).

Table: 3.2 Taunsa Right Bank Drainage Basins

CCMDB*	SDB**	ND**	Out fall	Length (k.m)	C.A^1000 ac	QD*** Cfc
D.G.KHAN	Manka	New Manka	Indus (r)	38.7		
		Manka	Indus (r)	220	96.47	410
	Manka	Drakhast drain	Manka drain	6.1		
	Manka	Tayyab drain	Manka drain	17.5		

Department of Punjab irrigation system (2008)

CCMDB*Canal command main drainage basin, SDB** sub drainage basin, ND** name of drain, C.A^ cusecs area, QD*** quantity discharge, r (river)

3.3 District D. G. Khan Municipal and Industrial Pollution

In district D. G. Khan there is no industrial pollution because there are no prominent industries set up at all so effluent from industries is also negligible. Major disposal of effluents pollution is from municipalities that is 60 cusecs in total. The total number of effluent from sewage water in cusecs is 32 Cs. But important thing is that, in D. G. Khan main cause of pollution is Municipal pollution [Government of Punjab (2008)].

Table 3.3 District D. G. Khan Manka drain industrial, municipal pollution & effluent discharge.

S	Distributary/Drain	RD of Disty/ Drain	Name of Industry/ Municipality	Nature of Industry	Average Effluent Discharge (Cs)	Quality of effluent
1	Manka Drain	143500	Municipal Committee D. G. Khan	Sewage water	28	Unfit
2	Drain No.1	79500	Municipal Committee D. G. Khan	Sewage water	32	Unfit

Source: [Department of *Surface water, industrial and municipal pollution in Punjab, Pakistan (2008)*]

RD* redevelopment

3.4 Reactivation of Manka Canal

Realizing the consequences of effluent pollution Government of Punjab during March 2002 directed the Irrigation and District Government to convert the Drain (in City Area) into fresh water canal to address the environmental degradation within the city limits.

The department planned to deliver fresh canal water from Ghazi District enhancing its capacity by another 100 cusecs running on the north of the city and traversing west to east. The enhanced discharge was put into Manka at off take point of Qasim minor remodeling the head regulator and other allied structures [Government of Punjab (2002)].

3.5 Redevelopment (RD) Side Projection of Manka Canal

On the demand of public representatives, a scheme *"Side Protection of Manka Canal from RD. 0+00 – 24+000"* was approved in September 2007.The project was approved subject to the categorical assurance of TMA (Tehsil Municipal Administration) that it will segregate / have independent disposal system for the city sewerage which at present is being discharged into the canal defeating very purpose of running fresh canal water. Discharging of sewerage / polluted effluent and other waste in the canal is offence cognizable under Canal & Drainage Act / Environmental Act. It is a major retarding factor in execution of work at site.

3.5.1 Impediment in Execution of Redevelopment (RD) Side Projection Work

TMA / Public Health Engineering Department has laid sewerage pipes on both (right and left) sides of Manka Canal but has not connected them with the main disposal pump at RD (Re-Development) 14 in spite of commitment for its early connection. The sewerage water is being dropped into the canal by means of pumps at RD. 10+500/R & 11/L. There are 90 numbers of Inlets of sewerage adjoining abides being dropped in the canal at several points.

These are the main hindrance in execution of the balance work besides causing damage to the already lined part. The work has been abandoned by the contractor since June 2009 because of their corruptions in project budget and Anticorruption Establishment has already investigated and chalked out FIR (First Investigation Report) against the Executive Engineers, Sub Divisional Officers and Sub Engineer and the contractor. The contractor has preferred litigation and filed writ petition in Lahore High Court, Multan Bench. The Honorable Court has issued orders not to take adverse action against the contractor.

The issue came into the notice of Chief Secretary Punjab and he convened a meeting on October, 2010 in his office. Secretary, Irrigation & Power Department deliberated the issues to Chief Secretary. But still now, the problem of mixing sewerage in fresh water is unsolved and higher authorities are doing nothing. Drain causing water pollution and health issues at higher rate without any check and balance [Government of Punjab (2010)].

After the brief account about situation, it can be analyzed that environmental condition is going worse in this area of D. G. Khan but problem is still present and unsettled. Pollution state is at complex rate and causing different problems for surrounding community that have to be solved at urgent basis to reduce it and cure it as soon as possible. Current study is a diminutive footstep to investigate this situation and formulate appropriate measures to incorporate it.

CHAPTER IV

METHODOLOGY

The study was conducted in D. G. Khan, Punjab during August 2011. In order to achieve the objective of the study two models were formulated, one was based on child health problem connected with water pollution and the second was based on willingness to pay for safe drinking water with Contingent Valuation Method (CVM). For both models estimations specific estimation technique was used that fulfilled the requirements of estimation. In case of child health, Bivariate Logistic Model (BLM) was used because of its binary response but for the second model of the study OLS (ordinary least square) method was used. Primary as well as secondary data were used. Primary data was collected with the help of a well-structured questionnaire and that conventional questions were divided in different segments according to variable and information specification. In fact, both models of this study had different explanatory variables according to research issue conditionality. Coding- decoding tool was used for responder help to response and software specification also. Another tool for information which is applied in this study is informal information that is collected with the help of key information survey (KIS), Focused Grouped Discussion (FGD), and case study event. Following descriptive methodology was used in this study.

4.1 Descriptive Methodology

Deducing about the unconditional effects of water pollution (because of Manka drain) and different characteristics of HHs which influence the child health of surrounding community might produce misleading results because these variables might be correlated with each other. So it was essential to establish an econometric model where study was able to separate out the effects of each variable. The study was based on qualitative analysis because dependent variable child health had qualitative variations and nature of this variable was also qualitative. So for estimations some qualitative measuring tool was adopted.

4.1.2 Econometric Specification

Bivariate logistic model was used to estimate the effects of different explanatory variables on child health. In estimation of variables, one binary dependent variable that took the value equal to one if child health was affected by water pollution and zero if CH was not affected by water pollution (Satter, 2007).

The estimated coefficient from these models would not be directly interpretable. Therefore marginal effect[2] of each variable was calculated.

4.1.3 Hypothetical Formulation

Ho =β =0 null accepted

Water pollution had no impact on children health

Alternative

H1 ≠β =0

Null rejected

Water pollution had impact on child health

$$Y = \beta i\ xi + \varepsilon i \ldots\ldots\ldots\ldots\ (i)$$

Y = Binary variable child health.

Xi = Explanatory variable,

εi = Residual.

[2] ME (marginal effects) shows the effect of one unit change in explanatory variable on the estimated probability of child health.

Explanatory variables:

Ground water quality, family size, education of household, family income, safety measures for water purification, house quality where living, distance of house from drain, area and awareness.

4.1.4 MODEL 1

$C.H=\beta_1(F.I)+\beta_2(F.Z)+\beta_3(GWQ)+\beta_4(F.E)+\beta_5(AWER)+\beta_6(DHD)+\beta_7(HOC)+\quad\beta_8(AREA)$
$\beta_9(SAFM)+.......\varepsilon^3 i......................(ii)$

C.H = Children health

GWQ = Ground water quality

F.I = Family income

F.Z = Family size

F.E = Family education

DHD= Distance of drain from house

AWER = Awareness about water born disease

HOC = House condition

AREA= Area / region

There is Proportion as a response; we use a **logistic** or **logit** transformation to link the dependent variable to the set of explanatory variables.

Logit (P) = Log [P / (1-P)]

Logistic regression theory

Let:

Pi = Pr (Y= 1 / X= xi)

---

[3] *E_i is residual value of the following equation*

Then we can write the model:

$\log[pi / (1 - Pi) = \log it\ Pi = \beta o + \beta i\ (xi)$

In terms of the probability of the outcome occurring as:

$Pi = \exp(\beta 0+\beta 1xi)/(1 + \exp(\beta 0+\beta 1xi))$...............(Tranmer, 2005)

So far not included a residual term in the above model, and have instead expressed the model in terms of population probabilities. But now write it as:

$$pi = Pi + fi = \exp(\beta 0+\beta 1xi)/(1 + \exp(\beta 0+\beta 1xi)) + ei$$

ei is not normally distributed, as it was assumed to be for linear regression.

4.2 Model: 2

Ordinary least square model was also used for demand and WTP for the safe water quality provision from municipal corporation (MC) with the help of questionnaire; questions were asked that if safe water quality was provided by municipal corporation (MC) what would be the maximum willingness to pay (WTP). The estimated coefficient from the ordinary least square models was then interpreted. [Mustafa, et. al (2000)]

OLS Regression Model: Second model of the study was conducted for WTP.

$$WTP=\beta_0 + \beta_1 (HC) + \beta_2 (FZ) + \beta_3 (AW) + \mu \ldots\ldots\ldots\ldots\ldots (iii)$$

WTP=HHs willingness to pay provision of safe drinking water

HC=HHs characteristics (education, income/wealth)

WQ=Water quality

ARE=Area /region

AW=Awareness (TV radio, newspaper)

Maximum Likelihood Estimation is used to estimate coefficients of model.

The maximum likelihood estimates solve the following condition:

$$\{Y - p(Y=1)\} X_i = 0$$

summed over all observations, i = 1,…,n

4.3 Pre testing:

To judge authenticity of questionnaire pre-testing was done. Data from 10 respondents were taken and necessary modifications were made in the questionnaire.

4.4 Data Description

In this section, information about data, data sources and tools of information are defined. Data description section is divided in different sub section based on sampling technique, data collection tools, variable determination and coding system for estimation.

4.4.1 Populations

The universe is the population of D. G. Khan city living in the surrounding of Manka drain. Proportional selected areas are Farida-a-bad colony as control group and Bodlah colony as target group with the union council 4 and 7. Both colonies are situated parallel to each other near Manka drain. Reason to select Faredabad- colony as control group is the availability of Government water supply in this region. As target group Bodlah colony is based on ground water facility for their daily uses. The population of the area of study does not have access of Government water supply. The total population of selected area is 56,577. Literacy rate is 63%. [*Statistics Division Population Census Organization, Government of Pakistan (1998)*]

4.4.2 Sampling

After selection of universe of population next stage was sampling technique and sampling which was an important step of research. Systematic proportionality sampling[4] technique was used to collect data from the selected area (*near Manka drain)*. Face to face interviews were conducted from the head of the households *(households included the persons who lived in the house but did not include the guest).*

[4] **Systematic sampling** is a statistical method involving the selection of elements from an ordered sampling frame. The most common form of systematic sampling is an equal-probability method, in which every k^{th} element in the frame is selected, where *k*, the sampling intervals (sometimes known as the *skip*)

Systematic sampling was done according to the following formula,

$$k = \frac{N}{n}$$

Where K is the sampling intervals (skip value)

n is the sample size,

N is the population size.

Using this procedure each element in the population had a known and equal probability of selection. This made systematic sampling functionally similar to simple random sampling. It was however, much more efficient (if variance within systematic sample was more than variance of population).

According to the study, total population of selected area was 56, 577 and without sampling technique was used. According to this technique, if the estimated sample size was large, systematically 70 percent of the estimated sample size was selected. So samples of 150 household respondents were selected through systematic sampling. The sampling of study area was conducted with the following sampling frame.

From the sampling frame, a starting point was chosen at random, and choices thereafter were at regular intervals. We selected a sample of 3 houses from a selected colony street of 12 houses. 12/3=4, so every 4th house is chosen after a random starting point between. When the random starting point was 3, then the houses selected were 3, 7, 11, 15, 19, 22, 26, ……..

4.4.3 Data Collection Tools

In this study primary date was used. The data of the variable described below was collected through well-structured questionnaire and focused group discussion was also conducted as the tool of data collection with the help of open ended questions. The report was prepared after a detailed analysis and special care so that valuable and useful information about any variable of interest was not lost.

4.4.4 Questionnaire

The study used the data from different sources. Personal interviews from different respondents were held with the help of a well-structured questionnaire which showed probabilistic information of data. Some non-probabilistic data collection techniques were also used in it that based on informal data collection techniques like focused group decision, key information tools and participatory rural appraisal (PRA) etc. Beside above tools of data collection, a questionnaire was used as major source of information. With the help of questionnaire data about the water condition and impact of Manka drain on surrounding community health was collected through water assessment section of the questionnaire. Information about socio- economic indicators of the household was also collected with the help of questionnaire. These sections of the questionnaire sought information about members of household health, education, literacy rate, health status of the community, environmental condition of the surrounding community , municipal waste management in the area, and Willingness to pay (WTP) for better water and safe waste management system and people's preferences (For detailed questionnaire see appendix "A").

4.4.5 Variable Specification

An evaluation of water pollution risk on children in district D. G. Khan Punjab because of Manka drain was measured with the help of the following explanatory variables (Table 4.4.5).

4.4.5 Table of Variables description

Variable	Tittle	Definition
Dependent	Child health (CH)	Children of Selected areas, Age group of 1 to 10 years, permanently living in household. Their illness record for the last six months.
Independent	Family Education (FEDU)	Literacy- primary, secondary and higher of all family member education. Decision maker's education as base line unit. FEDU have +ve relation to dependent variable
Independent	Ground Water quality (GWQ)	Use of ground water in household for daily use (laboratory test). GWQ have +ve expected sign.
Independent	Distance of house from drain in Km(DHD)	Distance of the houses from polluted drain in less than or greater than (≤ & ≥) 1 Kilometer (km). DHD have -ve expected sign.
Independent	Area /Region (AREA)	Selected areas, faredabad and Bodlah colonies near Manka drain. AREA also has -ve expected sign.
Independent	Safety measures of water purification (SAFM)	Water purification techniques that are using at home, filter, boiling and mineral water. SAFM have +ve relationship with dependent variable.
Independent	Family income (FI) in Rs	Income from different source for livelihood taking average not only head of HH. This variable also have +ve relationship according to theory justification.
Independent	Water awareness (AWAR)	HH Water pollution affects and about its awareness through different sources of information. +vely associated with dependent variable.

List of variables were presented which had direct and indirect impact on dependent variable. In table 4.4.5, constriction of independent variables had different specification for description. Educations of household include literate, primary and secondary and higher level. Water awareness variable covered information through TV, radio, newspaper, education and society. Ground water quality (GWQ) variable is constructed with the help of sample taken from study area and then tested in laboratory. Different water sources sample that used in selected locality was selected. Two water samples tested in water testing lab selected from filtration plant (because of its same quality just taken two samples) that was the main source of water in selected area. Second source of water was ground water. Samples of this source were selected randomly street to street from particular area and tested them in water testing lab. Last source of water was government water supply randomly 8 (eight) samples of this source was selected for water quality lab testing. Specific number of water samples was collected for water quality test because of time constraints and limited financial resources.

4.5 Coding/Decoding

For statistical purposes the process of coding was made. Different responses/categories were coded with the mathematical numbers so that the relationship of variables could be statistically checked.

5.1.2 Demographic Description

Some demographic variables such as sex, population of male, female, education and religion were collected from Basic Population and Housing Data of the union councils. These variables had great impact on the empirical findings of the survey. Selected area of study was based on urban population of union council No 4, Census circule-11 (Bodlah colony) with population of 3,858 and union council No 7, Census circule-15 (Faredabad colony) with population of 13,750. Population ratio of male and female of the area was respectively 1,900 (male), 1,877 (female) in UC# 4. Similarly, 7,000 male and 6,600 female were in UC #7.

The sample profile showed union council and muhallas demographic information about sex distribution, literacy ratio of selected areas, educational attainment of different age group of the community and religion ratio (Table 5.1)

Table 5.1 Percentage Population by Sex, Literacy RatE, Educational Attainment, Selected Age Group and Religion (in percentage).

Union council/ muhala	literacy		Education				Age		Religion
	M*	F**	Primary but below metric		Metric & above		10 year ≥	18 year≥	Muslim
			M	F	M	F			
(Bodlah colony) UC.4	51	49	11	8	10	4	10	75	100
(areda bad colony) UC.7	52	48	10	8	9	5	8	71	100

Source: Government of Pakistan Statistics Division Population Census Organization (1998).

*M= Male
*F= female

5.1.3 Sample Characteristics

Study describes that the average distance from primary school for male (DPSM), distance from high school for male (DHSM), distance from primary school for female (DPSF), distance from high school for female (DHSF), distance from nearer market (DMARK) and distance from nearer hospital (DHOSP). Sample of one hundred and fifty household (HH) was selected from the both areas. Their demographic characteristics had similarities in some respect, such as religion, distance from drain canal, literacy but characteristics in respect of as water facility was different. Sample results showed that 99% of the population from both selected areas had less than 1 kilometer (Km) distance from primary as well as high school for males because selected areas were from the urban region of District D. G. Khan.

Generally, in urban areas facilities of schools, market, and hospitals are provided at reasonable distance, as sample characteristic have shown (Table 5.1.2). That's way the literacy rate in selected areas was high and was 70 percent for both areas (Table 5.1.1).

Another reason for high rate of literacy in selected area might be that in urban region government schools facilities were available which provided free education up to matric level. As such people preferred to get as much education as possible and sas affordable for them (Table 5.1.2).

Table 5.1.2 Percentage Distance of Household (HH) from High, Primary (Male, Female) School, Market & Hospital (in Km)

N		DPSM*		DHSM**		DPSF***		DHSF*** ^		DMARK* ^		DHOSP** ^	
		≤ 1	≥1	≤1	≥1	≤1	≥1	≤1	≥1	≤1	≥1	≤1	≥1
		51.0	0.9	50.9	0.9	50	0.9	48	1.8	42	9.0	45	1.8
UN	4												
	7	48.1		48.1		48.0		50		48		53.1	
Tota l	%	99.0	0.9	99.0	0.9	99.	0.9	98	1.8	90	9.0	98	1.8

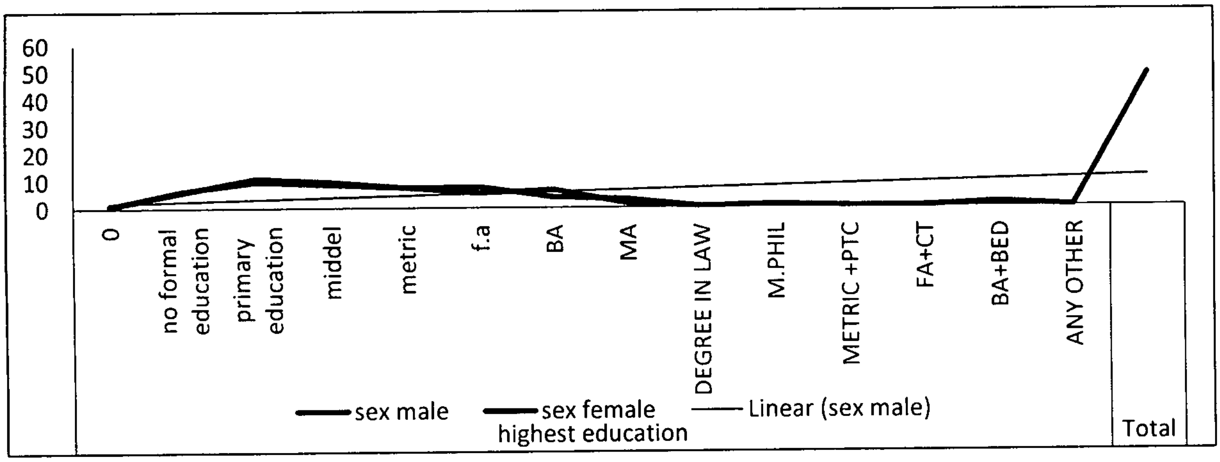
*≥ Equal and Greater than 1 km, **≤ Equal and less than 1 Km, DPSM*, DPSF***, Distance of primary school for male/female
***^DHSM, DHSF, Distance of high school for male/female
*^DMARK, DHOSP, Distance to market/ hospital

Literacy rate in the selected areas were slightly higher compared to the information contained in the Statistic Division Population Census (SDPC). 1998, consequently there are some differences, but the data of the previous study are more recent. There is growing trend of higher education that's why literacy rate is higher now. According to statistics of the present study, there is 87% literacy and the rate of male literacy is higher than female literacy (Table 5.1.3). On an average 88% for male and 86% for female literacy rate was found. The reason might be some gender disparities which caused literacy differences but the difference was not high (Table 5.1.3). Educational disparities in selected areas with educational indicators as primary, secondary and higher levels also indicated the same trend that rate of male literacy was higher than female literacy (Figure 5.1.3a).

Table 5.1.3 Percentage Average educational and sex disparities in sample area

Literacy	Male	Female	Total
Yes	88.5	85.9	87.2%
No	11.5	14.1	12.8%

Figure: 5.1.3a Sample Age Characteristics by Educational Disparities between Sexes in Selected Area



5.1.4 Livelihood Sources of Household Heads (HHHs) in Sample Area

Following is the overview of livelihood patterns in the study areas based on profession information of the head of household (HH). Present survey exposes that; majority of HHs source of income was from Government service as well as private self-employment. The reason might be that the selected areas were urban areas where job opportunities were higher than rural areas. Another important reason was that in urban areas educational and skill learning facilities were available at higher rate. In urban areas government undertakes more developmental works, as further; there are skill development workshops, institutes and educational institutes. As such automatically people of these areas have greater number of job opportunities. Business is also one of the major sources of livelihood in these areas. The basic reason is that people in urban society have better capacity to run their own business because of nearness to market, good facilities of transport, roads, skilled institutes, transport vehicles, availability of skillful manpower. These factors encourage people to do their own business earn more profit and increase their income. On an average 18% from the total sample population, run their own business (Table 5.1.4).

Table: 5.1.4 Livelihood Sources of Household Heads (HHs) in Sample Area (%age)

Colony	Laborer	Civil	Govt.	private	Foreign	Agriculture	Business	Retired	Stock Holder	Any Other
UN 4 7	10.3 3.	5.1 3.7	43.9 39.6	13.7 20.7	3.4 3.7	1.7 0	13.7 22.6	0 1.8	3.4 4.9	3.4 0
Total	6.65%	4.4%	41.75%	17.2%	3.5%	0.8%	18.0%	0.9%	4.15%	1.7%

Labor work stand at fourth in rank but in target group (Bodlah colony) that ratio is higher as compared to control group area with the name of Fareda-bad-colony. In fact both are urban societies but there are some differences in the socio-economic and demographic appearances. The main reason is that Bodlah colony is basically a colony which was established by a private property dealer (PPD) and was built on the left bank of the Manka canal. In the beginning, the land price in this colony compared to other colonies was low. As a result, people from low income groups, such as, laborer party have low income level prefer to get plots in this colony. Thus large segment of population was from labor community but later on as population grew prices of land of this area of D. G. Khan also increased. Another reason for high labor ratio is that these people with little not education have to do low income jobs for their livelihood.

Overall result shows that people of selected area belonged to service sector, but Bodlah colony (UN #4) had higher proportion of labor work compared to control colony.

Table 5.1.4 (a) Average Value of the Household Income (HHI), Number of Employed Persons (ERH) & Family Size (FZ)

Colony	Household Income(HHI)	Employment ratio/HH (ERH)	Family Size (FZ)
1.Bodla colony	7000	1	8
74554552.Fareda-bad-colony	10000	3	6

Income is also an important variable that has direct and indirect impact on health of the family. Mostly, income level determines living standard of a household. If per capita income or the income level of the family is satisfactory, it has positive impact on family health. According to the statistical summary information, average income level of the control group differs from target group. There are several reasons but most important ones are educational inequality, nature of job (Table 5.1.4) and number of employed persons. All these factors could impact on income level of the family.

According to sample characteristics, the number of employed persons on average is three in Faredabad-colony and one in Bodlah colony but compared to this the family size is quite higher than Bodlah colony. Overall, per capita household income in faredabad is higher than in Bodlah colony (Table 5.1.4a).

5.1.5 Available Sewerage System Characteristic

Majority of the household in both survey colonies reported that they were disposing of their used water in an open drainage system. This was 77.2% and 65% in Bodlah colony and

Fareda-bad colony, respectively (Table 5.1.4a). Proper sanitation system played significant role in health related issues. This was a crucial variable for the study. It was worthwhile to mention that these colonies belonged to poor segments of the population. These were selected intentionally in order to measure the impact of open drainage system on poor people health. This finding played a vital role for empirical estimation because open drainage system had direct impact on the health of the surrounding community [Mustafa et al (2010)].

There could be several reasons for poor sewerage system. First and of foremost important factor was that, in this area no proper sanitation facility was available. Another important factor for absence of proper facility of sewerage system could be that selected area for study covered poor population. They were living much below average income level and presence of proper sanitation system availability was quite difficult (5.1.4a). Secondly, administrative inefficiency played a great role in the non-provision of this facility.

Table 5.1.5 Percentage Sewerage System Availability in Study Area

Colony	Open drainage	sewerage system (underground system)
1.Bodla colony 2.Fareda-bad colony	77.2 65	22.8 35
Over all	71	28

*Bodlah colony, union council 4
**Fareda bad, union council 7

5.1.6 Summary Statistics of Manka Drain Canal

The Manka drain canal is open as well as non-bricked and has more seepage influence on aquifer which affects the quality of drinking water. Particularly for those who are fetching ground water for their daily use.

The distance of most houses from drainage canal is less than one kilometer (Table 5.1.6). Distance of drain from household (HH) is an important variable that indicates the impact on health. The polluted drain might be the main cause of bad health of surrounding community. Theoretically speaking, these drains have direct and indirect impact on surrounding community health because of its polluted water and air (Haq. 1972).

Table 5.1.6 Union Council-wise Distance of Houses from Drainage Canal in Km (percentage)

Colony	Distance drainage canal from homes	
	Less than 1 K.m	Greater than 1 K.m
Bodla Colony	66	34
Fareda-bad	72	28
Over all	69%	31%

The community is conscious about the importance of water quality improvement of this drain canal and a vast majority (60%) of the people desire for better management and improvement of water quality with the help of Government. Almost 50% HHs are willing to pay for private management system (Table: 5.1.6a).

Table 5.1.6(a) Acceptance for Improvement of Water Quality of Drain Canal

By Government			By Private System Management	
	HHs	percentage	HHs	percentage
Yes	97	60%	64	49%
No	53	40%	86	51%
Total	150		150	

5.1.7 Household Dwelling Statistical Summary

Statistical summary of household dwelling was estimated on the basis of sample characteristic. Type of houses they live in (Kacha, Paka, both condition) also had impact on the health of the family. House conditions have emotional and physically impact on household health. In paved houses, ratio of germ production was at lower level. In our study from both selected areas, the ratio of Paka houses (just brick but not cemented and furnished house included) was very high in Bodlah colony (UC#4). This ratio was 82%. In other selected areas of this study the percentage was slightly higher at 83%. Since the selected areas were based on urban population, normally there could be such kind of houses but the size of houses was not too large (Figure 5.1.7a).

In urban areas the population growth rate is higher and residential area ares undersized because of commercial development and high prices of property. Both of these factors result in higher demand for small sized houses. The basic purpose of these variable descriptions is that house type and house size may have prodigious impact on child health.

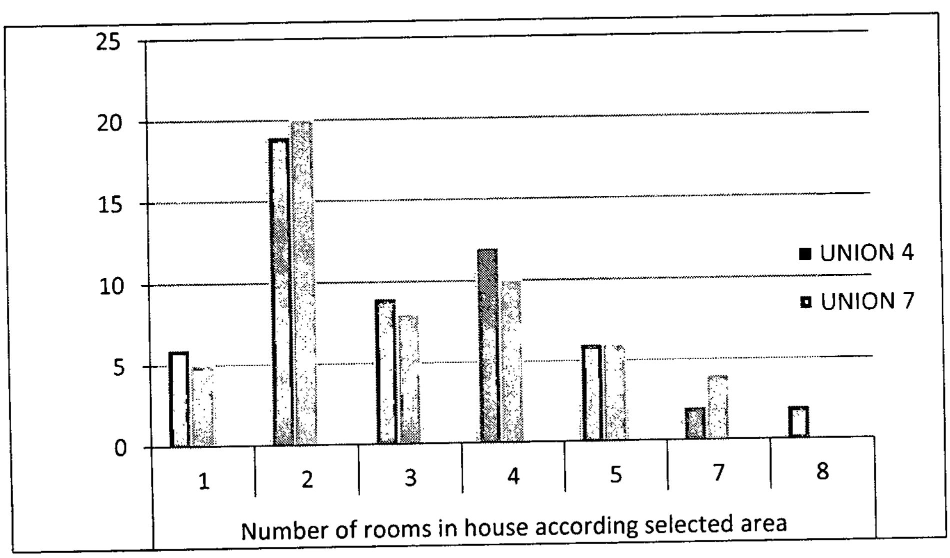
Table 5.1.7 Summary of Household Condition in Selected Area, (Percentage)

*U.C / colonies	kacha	paka	kacha/paka
4-Bodla colony	1.7	8.2	13
7-Fareda-bad colony	0	16	16
Total	1.5	83	82.5

*U.C= Union council

Statistical result showed that in general in both colonies houses size on an average had two rooms. The number of rooms range from 1 to maximum 8, (Figure: 5.1.7a). Overall result shows that in union council 4 (target group) most of the population was living in two room houses.

Figure: 5.1.7a Average Numbers Rooms in House of Selected Areas



5.1.8 Summary Statistics of Available Source of Water and its Quality

In this part, summary statistics of water sources and quality of water are discussed. The significance of this particular variable description is that "water is life" without it living thing cannot survive. Clean water is also an important determining factor of human health condition. This is particularly important for child health due to their sensitivity and vulnerability.

Table 5.1.8 Safety Measure for Drinking Water at Household Level (percentage)

Union Council	Colony	Streams source (SS)	Government Water Supply (GWS)	Private Water Supply (PWS)	Ground water Pump (GWP)
U.C.7	Fareda –bad colony	4	66	12	18
U.C.4	Bodla colony	7	3	20	70
Total		6	34	16	44

Mostly children (newly born and up to 10 yearsof age) suffer from water borne disease such as, diarrhea, cholera and skin infections etc. According to WSSCC, 4,000 _6,000 children are daily dying because of non-availability of safe drinking water [WSSCC (2004)].

Information related to main source of water availability (WSA), quality of water (QW) in selected area, and distance from the water fetching source (DWFS) have been also collected (Table 5.1.8).

The survey revealed that major source of water for daily use is the ground water in the selected target group area. Government pipe line water supply for domestic use is not available in this area. As such, people have no choice but to use ground water for their daily consumption (Table 5.1.8).

On the other hand, Government water supply accessibility is at higher rate because this facility is available in this region. Secondly, higher of available source of water is through private water supply company's tanker services. This source of water is a bit expansive so limited number of people used this facility (Table 5.1.8). But as mentioned earlier in target group average per-capita income is low so they cannot afford this facility (Table 5.8.1 a).For safe drinking water a large number of people is using filtration plant water. Second highest number of household use boiled water very few people to use mineral water.

The major cause of using filtration plant is that it's too cheap and easy to get safe water for drinking, because Government provides this facility to the people of District D. G. Khan free of cost. Low income groups prefer water from filtration plant because it does not have any cost.

Table 5.1.8 (a) Statistical Summary of Safety Measures of Drinking Water

U.N	Colony	Use of Filters	Boiling Water	Mineral Water	Total
7	FaredA-bad	35	14	1	50
4	Bodla-Colony	25	23	20	50
Total		60	37	4	100

Laboratory tests results show that, the quality of ground water which was used in the target area by the majority was not fit for drinking. It was even worse for irrigation. But laboratory sample result of filtration plant water showed that, it was fit for drinking (5.1.8. b)

Table 5.1.8(b) Laboratory Test Result of Ground Water (GW), Filtration Plant (FP) Sample and Drain Water Quality

Sample	PH	(EC 10^6)	(CA+MG)	(NA)	(CO_3) meq/L	(HCO_3)	(CI0	Carbonates	Remarks
Ground water	5.3	4840	30.18	18.2	Nil	28.12	18	Nil	**Not fit**
Filter plant	7.2	476	40.2	8.38	Nil	18.92	8.24	Nil	**Fit**
Drain water	4.2	6254	18.3	22.5	0.12	36.7	15.4	Nil	**Not fit**

1= Electrical conductivity (EC 10^6), 2= Calcium+ Magnesium (CA+MG), 3= Sodium (NA), 4= Carbonate (CO_3) meq/L, 5= Bicarbonate (HCO_3), 5= Chloride (CI0, 6= Residual Sodium Carbonate

Most of the population in the target group was using ground water. Samples of water were collected from the study area and tested in the laboratory. According, to the test reports, quality of ground water was not found fit for drinking and irrigation. Potential of Hydrogen (PH) level was founded very low and other chemical components were at higher level as compared to the Environment Protection Authority (EPA) and WHO (World Health Organization) quality standards (5.1.8b).

According to water quality reports ground water PH value was lower than prescribed standard. It was below the standard scale of 7. According to the standard PH level should be between 7- 8.5 that water was safe for human consumption, but below 7 means presence of acid which was harmful for human health in general, and child health in particular.

It is noteworthy that all the polluted chemical components that caused ground water pollution were also present in drain canal water. According to all these circumstances, ground water get polluted because of rapid pollution of drain and its seepages direct impact on ground water table quality.

5.1.9 Statistical summary of Health Status in Selected Area

The main concern of this study was impact of water on health. In study area incidence of diarrhea was exceedingly high followed by malaria, both were water borne diseases. The incidence was higher in the study area because the HHs were living near the polluted drain (Table 5.1.9).

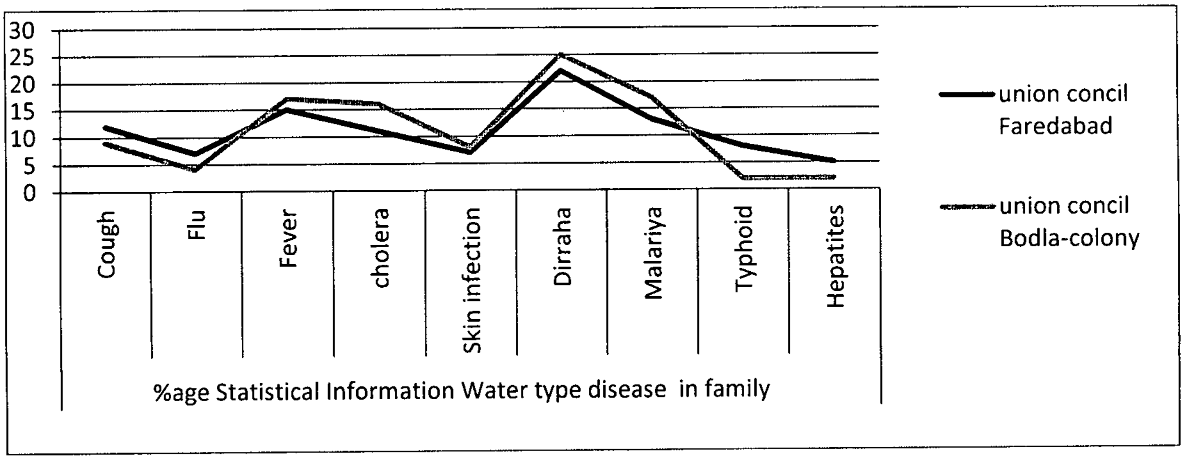
Table 5.1.9 Percentage Statistical Information of Family Sickness Diseases Ratio in Study Area

U.C	Colony	Cou	Flu	Fev	Cho	Skin	Dir	Mal	Typ	Hep
7	Fareda bad	10	12	10	9	6	15	10	5	5
4	Bodlah	13	18	14	10	7	18	10	8	4
Overall		23	30	24	19	13	33	20	13	9

U.C (Unison council), *cou (cough), *fev (fever), * cho (cholera), *dir (diarrhea), *Mal (Malaria), * Typ (typhoid),s* Hep (Hepatitis), *ski (skin infection).

Polluted drain was the breeding ground of the germs which directly impact on the help of the surrounding community. These germs are carried by air, flies and by water which was consumed by households. In fact ground water of study area was not fit for drinking and as well as for irrigation (laboratory test results, Table 5.1.8). Overall results showed that in target group ratio of water borne disease such as diarrhea are more wide spread (Figure 5.1.9a).

Figure 5.1.9a Percentage Statistical Summary of Disease in Study Areas



5.2 Econometric Analysis

In order to quantify the role of different independent variables on children health (dependent) and willingness to Pay (WTP) of HHs for safe drinking water, two econometric models were estimated. To access the impact of ground water pollution on children health willingness to pay (WTP) for the Bivariate Logistic Regression (BLR) method was applied and to the estimate the willingness to pay (WTP) ordinary least square technique was adopted (Table 5.2.1 and 5.2.2).

5.2.1 Impact of Water Pollution on Child Health

Bivariate Logistic Regression model was used to estimate child health risk as well as to determine the dependent variable based on the responses of household whether Manka drain had affected their health or not. Construction of explanatory variables was held after keen review of national and international literature on water pollution and its impacts on health (Castle, Emery N, 2005).

In order to check the robustness of different models, numerous regressions were estimated with different specifications. Particular models were selected with expected relation to dependent variable, significance level and along with the maximum likelihood technique. Significance level was at 5 and 10 percent respectively.

$$C.H = \beta_1(F.I) + \beta_2(GWQ) + \beta_3(F.E) + \beta_4(AWER) + \beta_5(DHD) + \beta_6(HOC) + \beta_7(AREA) + \beta_8(SAFM) + \ldots\ldots \varepsilon i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(ii)$$

Model (A) is as base line model which comprise all variables. DHD, GWQ and AREA variables are the main leading variables of this model (Table 5.2.1).

Table 5.2.1, Marginal Effect of Bivariate Logistic Regression Model of Child Health

Explanatory variable	Model (A)	Model (B)	Model (C)	Model (D)
Distance from drain (DHD)	-0.59 (0.001)*	-0.61 (0.0005)**	-0.57 0.001*	-0..6 (0.001)*
House condition (HCO)	0.30 (0.002)*	0.195 (0.008)**	0.57 (0.032)*	0.35 (0.05)**
Area/ Region AREA	-0.43 (0.003)*	-0.51 (0.002)*	-0.27 (0.039)*	-0.39** (0.06)
Family education (FEDU)	0.231 (0.0021)*		0.261 (0.021)*	0.22 (0.003)*
Ground water Quality (GWQ)	0.44 (0.001)*	0.30 (0.002)*	0.45 (0.002)*	0.43 (0.001)
Awareness	0.57 (0.438)	0.43 (0.54)	1.62 (0.122)	
Safety measure water purification SAFM	0.626 (0.182)	0.37 (0.325)		0.24 (0.021)*
Log likelihood	-223.187	-215.512	-216.41	-226.517
R-squared Adj-R square	0.318 0.283	0.214 0.251	0.315 0.267	0.267 0.278

P- values are reported in parentheses
*Indicates significant level at 5 percent.
**Indicates significant level at 10 percent.

According to the empirical result, DHD (distance of house from drain) variable showing the significant result with negative expected sign, representing that houses near to the polluted drain had negative impact on health. The results were conformity with theoretical justification that there was higher probability of illness among people who were near to these polluted sites compared to those living away from the drain canal. This study also accepted the result that hygiene and sanitation have direct impact on health [Scott et al (2003)].

The results indicated that there was negative relationship between child health and distance to the drainage canal. According to selected sample results from the study area, 37 percent point's households were suffering who lived near the drain (Table 5.2).

Another important explanatory variable was a dummy, which is GWQ (Ground water quality) which is dummy variable and significant at 5 percent. The data of this variable was generated via water quality test from laboratory. The sign of the variable was positive in theory and its coefficient value explained that GWQ variable had 5% level of significance. In Bodlah colony as a control group, there was 44 percent higher probability of worse child health due to ground water quality than their use for their daily use.

Region / area (AREA) was another dummy variable. It was used to measure the difference in the impacts of this drain on child health in selected areas. In construction of this variable one was used for Fareda-bad colony and zero was used for Bodlah colony (near the Manka canal) and the result was significant with expected positive relationship. This finding was very important because null hypothesis was rejected and it was concluded that water pollution had an impact on child health. Disease occurrence in selected area was not only due to drain pollution but there were also a number of socio-economic factors, such as, low educational level, income disparities, house condition and bad sanitation. These were the characteristics of the selected area. Result of variable indicated that Manka drain had adverse impact on child health of the target group.

HCO (house condition) in the selected areas of study showed that which type of houses (Kacha, Paka, both Kacha &Paka) were available in this area. The motive to include this variable in the estimation context was that living condition also had severe influence on health of the family. According, to empirical result, house condition (HCO) variable had positive expected sign. In general, in paka houses (not cemented brick house) probability of germs breeding and ratio of disease was lower than in kacha houses. The study area covered on urban population. In urban societies generally houses are paka houses as shown by the descriptive statistics results (Table 5.1.4, a) which showed that HCO variable had positive relationship with dependent variable. Value of coefficient indicates that if all other variables were constant, there was 30 percent increase in the probability of better child health by living in paka houses.

Although education were an important variable but it did not necessarily meant awareness. Family education and awareness are incorporated separately in the model because both were important in determining child health. Results depicted that family education was statistically significant and its value of coefficient was 0.23 indicating that family education would improve child health by 23 percent.

There were two main sources of awareness through media i.e. electronic and print media. Electronic media includes television and radio while print media includes newspapers and magazines. The sign of awareness was as per expectation but is statistically insignificant. There would be many reasons for this situation. An important factor might be the income. People with low income could not afford newspapers and magazines facility.

On the other hand television and radio are not easily accessible due to electricity crises and poor signals. SAFM (safety measures for water purification at their home) variable shows positive relationship with dependent variable but it is statistically insignificant. The reason could be income constraint as mentioned in descriptive statistics (Table 5.1.4a).

Another reason could be that Government provides filtration plant facility in selected area free of cost and people fetch water from there and avoid taking water purification measures at home.

The results revealed their child health was affected by the distance of houses from drain, ground water quality, condition of residential houses, family size, family income and family education, of Bodlah colony as shown by other studies as well.

5.2.2 Willingness to Pay for Safe Drinking Water

Second model of this study was contingent valuation method (willingness to pay) for improvement of selected area water supply i.e., what would be people's response if MC (municipal corporation) imposed monthly fee of Rs.100 for new improved water supply system, would they accept new system or would like to continue with the existing system and what would be their preference level. Following econometric model was used for this estimation [Ekaterina Gnedenko (2002)].Ordinary least square method (OLS) was applied. For the interpretation of variable, coefficient and P- values was presented in Table 5.2.2.

Table 5.2.2 WTP Parameter for Safe Drinking Water (in rupees)

Explanatory variables	*Coefficient & their probabilities*
Area/Region (ARE) Dummy	0.336 (0.035)*
Awareness about water borne disease (AWARE)	0.037 (0.452)
Water quality (WQ)	0.239 (0.012)*
EDU (Education of HHH; 1-5)	0.021 (0.214)
(Education of HHH; 5-12)	0.325 (0.023)*
(Education of HHH; 12- Above)	0.163 (0.0012)*
INCOME (Income 4000-8000)	6.32 (0.072)**
(Income 8000-15000)	6.452 (0.002)*
(Income 15000 and above)	32.14 (0.001)*
Observation	150
R-square Adj –R square	0.32 0.26

Probability of values here given in parentheses.

* show 5% level of significance** show significance level at 10% or lower.

$$WTP = \beta_0 + \beta_1 (H) + \beta_2 (ARE) + \beta_3 (AW) + \beta_4 (WQ) + \mu \text{..........} (iii)$$

WTP=HHs willingness for safe drinking water supply

H=HHs characteristics (education, income/wealth)

WQ=water quality

ARE=Area /region

AWs=awareness (T.v radio, newspaper)

β_0, β_1........ = *coefficients*

For maximum willingness to pay (WTP) for municipal corporation (MC) question was asked regarding their preference about providing government water supply facility. Using method of estimation of ordinary least square (OLS), for the interpretation of variable, coefficient and their probabilities were presented (Table 5.2.2).

Here explanatory variables were water quality (WQ), different levels of education (EDU), income level per month (INCOM), awareness measures (AWER) and region or area (ARE) as dummy (Table 5.2.1).

Area/region (dummy) variable had positive impact on household's willingness to pay. Result was significant and had accepted positive sign. Result showed that 33 percent higher probability of willingness for Government water supply for target group (Bodlah colony) as compared to the control group. Reason might be that target group people relied on ground water facility for daily usage and want other sources for safe drinking water.

Water quality (WQ) was another important variable in this context. Results of WQ variable were significant with expected positive sign. Coefficient value was 0.024 that determined increase in water quality would lead to the 2.4 percent point increase in willingness decision of target group. The reason might be, people's perception for improved water supply against unfit water quality which they are using.

Education of household also played an important role in willingness to pay (WTP) for safe drinking water. In model[2] construction of education was based in three categories, primary, 5-12 level and 12 - higher to determine what level of education had more impact on household willingness decision. First category based on primary education level showed insignificant results. In the case of second category based, on 5- 12 year education, acceptance sing was significant and last category based on the higher education which is highly significant (5 %) as compared to other categories. HHs in which head's education level was 5- 12 years of schooling the probability of Willingness to pay was 30 percent higher than HHs in which heads were illiterate or having primary level schooling. Results indicated that higher education had positive and strong impact on willingness to pay decision of the HHs for safe drinking water. It was simple and natural that more educated persons easily understand the benefits of safe drinking water and could easily estimate cost benefit analysis of this opportunity as compared to the poorly educated person [Ahmad & sattar, (2007)].

Variable of income was also included in the willingness to pay Model. To estimate the overall impact of this variable was difficult. For simplicity, different HHs income was divided in three different categories. First, category comparison of low income HHs (4,000-8,000), Second category included middle income HHs (8000-12000) and the last is 15,000 or higher. These categories show significant result. The highest income level HHs had shown significant result compared to other groups. It can be easily justified with theory that if ones income level was high, he was more likely to avail such opportunities [Ahmad et. al, (2010)].

Overall result showed that people of selected area were willing to pay for safe drinking water. In the case of HHs with higher education and better income were statistically significant. Here for the result perspective, coefficient values were important. If HH head had education of 12 and higher years of schooling, on average WTP was Rs 50-80 per month as compared to heads of HHs having primary education. There was willingness to pay for safe drinking water but willingness to accept was less than willingness to pay (Rs 100).

5.3 Informal Results of the Study

Another essential part of this study comprised of on informal interviews from selected areas and in this respect very useful informal survey technique of focused grouped discussion (FGD), Key information survey (KIS), participatory rural appraisal (PRA) and some incident as case study tools were used for this study.

5.3.1 Focused Group Discussion (FGD)

Although, the study was mainly focused on qualitative variable but in order to reconfirm qualitative analysis and tools was also included. This present study was based on qualitative response variables; this section describes some qualitative tools as focused group discussion. This qualitative research technique was originally developed to give marketing researchers a better understanding of data from quantitative consumer surveys (Krueger 1988). As a tool for marketing researchers the Focus Group Discussion has become extremely popular because it provides a fast way to learn from the target audience [Debus, 1988 and USDHHS, 1980].

To get information with this tool, some people from selected area were chosen which have sense about research topic or issue. From their life experiences their point of views and observations are interpreted. According to the criteria of FGD, discussion was held with a native family of selected area. They were the native of Bodlah Colony from the last 70 years and they are well aware about the present and past situation of this area.

5.3.1 Discussion with a Local Families

For FGD four respectable persons of age group of 55-70 from different families were selected and asked different questions to get their response.

According to their information in 1970's Manka canal had fresh water flow and population of the area was small. With passage of time population increased result in higher rate of pollution. In the absence of because of proper provision of sewerage system, this canal, converted into a drain.

They said that:

> *"Ground water of this area was fresh up to early 80's and was suitable for human health. Population was less and health issues were not common. However, since decade, this incidence of malaria and other water borne disease in children had risen and ground water of this area had muddy look and unpleasant taste compared to its past"*

In this discussion they also mentioned that with the passage of time ground water sweetness had vanished.

5.3.2 Case Study Events

At the time of the survey some respondents also shared their personal views about the selected area. They were of the view that issues related to this drain could be solved if the drain issue was solved.

- **Summer Session Incident**

When asked from the respondents that what type or kind of waste material was dumped in this drain?

They said:

"*Nearby population (Paki Base) also drop dead bodies and waste materials of animals in this drain that caused obnoxious. About it complaints were made with municipal authorities but they took no action. In fact respondents were saying that because of this drain pollution in summer season surrounding areas population had to face horrible and unbearable smell. Dirty water of this drain becomes more contaminate because of high temperature and heat*"

5.3.3 Key Information Survey (KIS)

Through Key Information Survey (KIS), key informants or experts were connected to get the input for situation analysis for identifying issues. Key informant data can be used alone or in conjunction with other approaches. With the help of KIS identification of a select group of informed leaders, influential persons or experts was made to obtain their opinion on the main issue. It provided for a structured contact with these informants, usually through direct interviews or a focus group format *(Philips, Jones)*.

In this technique of getting information from selected persons the selection criteria was not based on any hard and fast rule. In fact people with higher level of education, vast perception compared to common people any honorable person of that area could be the key informer.

In this study, selected informers for Key Information Survey were previous councilor of the area, President Teacher Association of D. G. Khan, and one was Quari Hafez Editor of urdu daily *"ISLAM"*. On the basis of their vision these personalities were selected.

1. Master Jan Muhammad (President Teacher Association)

Mr. Jan Muhammad is living on the right bank of Manka drain for the last 40 years and served as president, teachers Association President D. G. Khan for many years. During the survey his valuable views were of great help for this study.

He said,

"In 1978, I was appointed as Government school teacher of in this area. At that time Manka canal was a fresh water canal and people used ground water for drinking purposes. In fact, people from main city area of D.G. Khan fetched ground water by pumps or nalkais , but with passage of time and increase of population and urbanization people started to throw their domestic waste in this drain and the drain started to serve as drainage canal by the year start of 2000. With this change, ground water started to deplete and now it has totally changed condition as compared to the past"

2. Qari Hafez (Editor of urdu daily Islam)

Another respondent during survey from Bodlah colony was Qari Hafez; he is editor of daily Islam. About research issue his opinion was,

> *"No doubt pollution of this drain was because of surrounding people negligence but behind it the main factor was the Government's inaction. It did not provide proper sanitation or sewerage system"*

He further said

> *"The area ground water of this area was getting polluted mainly because of this drain pollution and during summer season child health problem attained its peak because of greater use of water"*

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3. Irshad Khorshed (Ex Councilor)

Last, Key informer was an ex-councilor of Bodlah colony because he was the concilor of this area and a lot of info mention about this area. In response to questions

He said

> *"Being a councilor it was my duty to solve this problem of the area from the day I was elected I tried to solve the pollution problem of this drain because in summer this drain became breeding ground of mosquitos that caused malaria for surrounding community, but Government did not pay proper attention to my requests,*

He further mentioned,

> *In this area problem of water is very serious and available source of water is Ground water but government has failed to provide safe drinking water facility to the people"*

All these findings lead to conclude that drain pollution and safe water provision are the main problem of the people of the selected area. Most people of this area have clear perception that Manka canal is now a serious problem for them and their health.

CHAPTER 6

Conclusions, Recommendations and Suggestion

6.1 Conclusions

Water is a basic necessity of life and the life of all living things depend on this natural resource. The study was designed to measure the effect of water pollution of Manka drain in District D. G. Khan on the health of children. In order to quantify this objective, primary as well as secondary data sources were explored and for the empirical findings of the research study, two econometric models were used. The study revealed that Manka drain was causing health hazards. In both sample areas the health of the people in general and those of children in particularly were affected by Manka drain. Research findings illustrated that demographic conditions found badly i.e. literacy and education of the families can play a significant role in the better understanding of the problem.

The empirical estimation measured by Bivariate Logistic Model (BLM) revealed that there was statistically significant effect of water quality on child health of the surrounding community of Manka drain. This study indicated robust effects of econometric result which supported the qualitative analysis.

This study leads to the conclusion that educated and higher income group people as well as household living near the polluted canal were willing to pay higher amount of money to get safe drinking water. The household perception, empirical result and chemical analysis of ground water indicated that Manka drain was the main cause of ground water pollution and had negative impact on the health of the resident's particularly children.

6.2 Policy Recommendations

The followings are the policy recommendations derived out of this study:

1. The urban population of district D. G. Khan is severely affected by the Manka canal. Therefore, it is necessary to improve sewerage and drainage system of the city which is polluting the canal. There is need to reconstruct the canal so that there is minimum seepage which affects the ground water

2. It is worthwhile wise to know that the canal water is used for agricultural purposes. Polluted water is not suitable for human as well as for plant life. Therefore, it is recommended that water treatment plant must be installed to clean this polluted water before it is used for any purpose.

3. In order to involve local communities, it is necessary to formulate participatory drainage management system. This will ensure that sewerage water was not mixed with canal water.

4. There is need to established proper solid waste management system for the whole district. Presently, all the municipal solid waste as well as sewage water is disposed in the Manka canal which is the root cause of the canal pollution. As such, municipality should have proper solid waste management system. Interestingly, people are willing to pay some amount for proper sewerage and safe water system.

5. The polluter pay principal must be applied in order to generate sense of responsibility. There is a need to formulate new rule and regulation. Existing rules and regulations must be properly implemented in the true sprite.

6. Water pollution is a serious issue. Although people to some extent are aware about its implications but still there is need to create further awareness. In this context, electronic media, educational institution, non-government organization (NGO) and other institutions should be involved to come up with a joint line of action.

All the above mentioned policy recommendations call for ending pollution of Manka drain and thus help to safe water provision in D. G. Khan. This will help the people to control the health issues particularly, in the child health problem caused by the polluted water.

REFEREENCES

1. Ahmed, Etazaz and Satter, Abdul, (2007) "Awareness and the Demand of Safe Drinking Water Practices" publish in Pakistan Institute of Developing Economics.

2. Ahmad, Iftikhare, Haq, Mirajul and Satter, Abdul, (2010) "Factors Determining Public Demand for Safe Drinking Water: A Case Study of District Peshawar, Pakistan Institute of Development Economics. (PIDE Working Paper 2010:58). 22 pages

3. Ahmad, Ayaz, Henna Iftikhar, and G.M. Chaudhry (2007) "water resources and conservation strategy of Pakistan" The Pakistan Development Review 46:4, 997-1009.

4. Braginskii, L. K, (2005). "Water quality and protection: Environmental aspects." Water resources, vol 32, No. 2 Pp 163-174.

5. Banuri, Tariq, (1991), "Environment and Urban Affairs Division" Government of Pakistan; publisher, Journalists' Resource Centre - IUCN Pakistan, 164p .

6. Brown, Spencer H (1992) "Public Health in Lagos, 1850-1900: Perceptions, Patterns, and Perspectives", *the International Journal of African Historical Studies*, Vol. 25, No. 2, pp. 337-360.

7. Castle, Emery N. 1972 "Economics and the Quality of Life" *American Journal of Agricultural Economics* 54: 723-735.

8. Cottingham, R, K. F. Delfau and P. Garde (2010) "Managing deffuse water pollution in south east Queensland an analysis of the role of the healthy waterways partnership" Int. wat. Cen. Pty Ltd.

9. Combined Federal Campaign of the National capital area (CFC) report, (2011), access, www.cfcnca.org.

10. Conant, J (2002) "Sanitation and cleanliness for a healthy environment" A report of the United Nations Development Program. Accessed on website: www.hesperian.org

11. Chisholm, Hugh, ed. (1911). "*Encyclopedia Britannica*" (11th ed.). Cambridge University Press

12. Craun, G. F and R. L. Calderon. 2001. Waterborne disease outbreaks caused by distribution system deficiencies. J. Amer. Water Works Assoc. 93(9): 64–75.

13. Castle, Emery N, (1967) 'Economic and Administrative Problems of Water Pollution," in Agriculture and the Quality of Our Environment, publisher, The Plimpton Press, pp. 251-265.

14. Christopher Brown, Policy, World Water Forum Diluted by Scot Fields. Environmental health perspective journal, vol.111, No.10 (August, 2003), pp.A518.

15. Donnelley, R. R (2008) "Good Places, Better Health"A new approaches to environment and health in Scotland. The Government of Scotland, Edinburgh, UK.

16. E.W. Sieel, (1979), "Water supply and sewerage", McGraw hill book company. Vol. 5, pp. 316-317.

17. Ekaterina Gnedenko, (1999) "Contingent Valuation of drinking water quality in Samara city" Moscow State University.

18. Government of the Punjab, Irrigation & Power Department (2007), "SURFACE WATER QUALITY MONITORING PLAN" publisher, Directorate of Land Reclamation Punjab.Canal Bank Moghalpura, Lahore

19. Govt. of Pakistan (2007) "Pakistan social and living standards measurement survey" Ministry of Environment, Islamabad, Pakistan.

20. Govt. of Pakistan (2005) "State of the Environment Report (Draft)" Ministry of Environment, Islamabad, Pakistan.

21. Government of Pakistan "Tehsils & Unions in the District of D.G. Khan ". (2012), Nrb.gov.pk.

22. Haq, I.(1972), Pollution of man's environment. Wpau, Lyallpur (UAF). Pp.1-10.

23. HaqMirajul, Usman Mustafa, and I. Ahmad (2007) "Household's Willingness to Pay for Safe Drinking Water: A Cause Study of Abbottabad District. The Pakistan development Review 46:4, 1137-1153.

24. Henry, F. J. Huttly, S. R. A. Aziz, K. M. A. etel (1990), "Environmental Sanitation, Food and Water Contamination and Diarrhoea in Rural Bangladesh" Epidemiology and Infection is currently published by Cambridge University Press. Vol. 104, No. 2 pp. 253-259

25. Howard, J. Lloyd, B (1977) "Sanitation Unit", 'Discussion on Progress in water Technologies for Rural, Water and Environment Journal.

26. Joel A. Tarr, (October 1975), "Agricultural History", "From City to Farm: Urban Wastes and the American Farmer," *A Study in Boss Politics: William Lorimer of Chicago* (University of Illinois Press, 1971)Vol. 49, No. 4. pp. 598-612. L.

27. John A. Lapp, (1979), "The American Political Science Review", Vol. 3, No. 2. pp. 230-232

28. Jusi, W. (*1989*) "Water pollution and water shortage problems in China". Journal of Applied Ecology

29. Khalil, K. Lindblom, G.-B .Mazhar, K. (1994) "Flies and Water as Reservoirs for Bacterial Enter pathogens in Urban and Rural Areas in and around Lahore, Pakistan", *Epidemiology and Infection*, Vol. 113, No. 3. pp. 435-444.

30. Koivist, K. 2009. Improving sanitation and hygiene practices to achieve millennium development goals in Zimbabwe. Master Thesis Dep. Env. Sci. Uni. Kuopio.

31. Khan, A. 1992. The environment today and its decay. Journal of Rural Development and administration 26(3): 164-174, Sharhad Forest School, Thai, Abbhottabad, Pakistan.

32. Koivist, K. (2009) "Improving sanitation and hygiene practices to achieve millennium development goals in Zimbabwe". Master Thesis Dep. Env. Sci. Uni. Kuopio.

33. Lee, S. H., D.A. Levy, G.F. Craun, M.J. Beach and R.L. Calderon (2002) "Surveillance for waterborne-disease outbreaks in the United States". MMWR 51(8): 1–49.

34. Lenton, R. A, M. Wright and K. Lewis (2005) "Health, dignity and development: what will it take?" A report of United Nations Development Program, New York.

35. Långmark J, *Storey* MV, *Ashbolt* NJ, "Biofilms in urban *water distribution* system: measurement of *biofilm* biomass" publisher, Applied Environment Microbial pp, 826–833

36. Mustafa, Usman (2007) "Environmental Fiscal Reform and Decentralization for Sustainable Development and Poverty Eradication" The Pakistan Development Review 46:4, 1087-1103.

37. Mustafa, usman, Miraj ul Haq, and I. Ahmad, (2009) "Environmental Fiscal Reform in Abbottabad: Drinking Water" Rebecca Roberts. International Union for Conservation of Nature (IUCN) Pakistan, Swiss Agency for Development and Cooperation (LDC), and PIDE, Islamabad. Iv +22 pp.

38. Musekiwa A, Volmink J. Ora, (1991),"vulnerability in Latin America and the Caribbean. J Public Health Policy"Journal of Johns Hopkins Bloomberg School of Public Health, Vol. 12, No. 4. pp. 450-463.

39. Mustafa, Usman and I. Ahmad (2010) "Real Willingness to Pay through Bespoke Contingent Valuation Method" Pakistan Institute of Development Economics, Islamabad. (PIDE Working Paper (forthcoming)).

40. Marvin P. Berry,(1997), "Water Management in Crisis" public administration view, Vol.37, No.05, , pp.482-477.

41. Mustafa, Usman, MirajulHaq, and I. Ahmad (2010) "Pro-Poor Environmental Fiscal Reforms in Solid Water Management Sector' in Peace and Sustainable Development in South Asia: Issues and Challenges of Globalization. Sustainable Development Policy Institute (SDPI) and Sang-e-Meel, Lahore. Pp. 113-135.

42. Nawa-e-Waqt, Sunday Magazine, "World Water Crisis" by Zafar Ali Raja on 5th November 2006.Pg. no.27

43. Oakland, Calafornia, land press Washington D.C Coleveo, California page #3

44. Peter H. Cleick, (1998-1999). The world's water the biennial report on freshwater resources, pacific institute for studies in development, environment, and security.

45. Pakistan Council of Research in Water Resources (PCRWR-1999) conducts a research paper on the project on national water quality monitoring programmed in Pakistan. Report.

46. Robinson, A (2003) "Urban Sewerage and Sanitation Final Report", Lessons learned from case studies in the Philippines. "Water and Sanitation Program" East Asia and Pacific Program, World Bank. 1-23

47. Raza, A. 2008. Open drains cause air pollution, diseases. Accessed athttp://www.thenews.com.pk/daily_detail.asp?id=137604

48. Yerevan, Armenia, (2000-2003) Financing Water Supply and Sanitation in Eastern Europe, Caucasus and Central Asia,ReportWater supply and sanitation for millennium development

49. Scott, R., A. Cotton and B. Govindan. 2003. Sanitation and the poor. Int. Wat. And Sani Centre. 1(15): 70-73.

50. Storey, M. V and N. J. Ashbolt. 2003. Enteric visions and microbial biofilms–a secondary source of public health concern? Water Sci. Technol., 48(3): 97–104.

51. Ruth Meinzen-Dick, (2005), Research Report 105, Ground Water Markets in Pakistan, Participation, publisher, International Food Policy research Institution.

52. Rehman, M. M., Segupta, M.K., Ahamed, S., Choudhury, U.K., Das, N. (2005). "Arsenic contamination of ground water and its health impacts on residents in the village in west Bengal, India," Bull World Health Organ, Vol.83, No.1, Pp.553-590.

53. Raza,A.(2008) "Open drains cause air pollution, diseases" Accessed athttp://www.thenews.com.pk/daily_detail.asp id=137604.

54. Rangeley, W. R. (*1986*) "*Irrigation* management", publisher, American Association for the Advancement of Science.

55. Scott, R., A. Cotton and B. Govindan (2003) "Sanitation and the poor". Int. Wat. And Sani Centre. 1(15): 70-73.

56. Storey, M. V and N. J. Ashbolt (2003) "Enteric virions and microbial biofilms–a secondary source of public health concern" Water Sci. Technol., 48(3): 97–104.

57. The World Bank (2005) "Pakistan country water resources assistance strategy water economy: running dry". Agriculture and Rural Development Unit South Asia region. Report No/ 34081-PK

58. L.Horrigan, (2002),"Thirsty planet Environmental Health Perspective", Report Published by National institute of environmental health science (NIEHS). Vol.104, No.01, (Jan, 1996), p.12.

59. UNICEF and WHO.(2004) "Meeting the MDG drinking water and sanitation target" A Mid-Term Assessment of Progress. A report of UNICEF/WHO, Geneva, Switzerland.

60. United Nation Development Program (UNDP)-World Bank "Water and Sanitation program, Regional Water" workshop (1997)

61. *UNDP*, *WB*, WHO; (*1997)* "Participatory Hygiene and Sanitation Transformation": A New Approach to Working with Communities work shop , 43 pages.

62. Vaz and P. Jha, (2001) "Note on water and sanitation", WHD, CMH working paper series, paper no, WG 5:21, pages 10.

63. World Bank Report, (May 1997) "Economic Review, 11, pp.2:293-325.17.

64. Workshop Report by UNDP-World Bank Water and Sanitation Program Regional Water and Sanitation Group for South Asia—in Multan December 16, 1997.

65. Water Supply and Sanitation Collaborative Council (WSSCC), "Sphere Minimum Standards in Disaster Response" (2004) External Review 2005-2010, Publications The Sphere Project

66. W. Lawrence *Neuman , (2005)* "Social Research Methods" 5th edition

67. Water Supply and Sanitation Collaborative Council WSSCC (2004) "The Campaign: WASH Facts and Figures" Accessed on: http://www. wsscc.org/dataweb.cfm

68. Wang. Jusi, (1989), "The Journal of Applied Ecology", Vol. 26, No. 3. pp. 85 1-857.

69. Witt, Vicente M. Reiff, Fred M (1991) "Environmental Health Conditions and Cholera

70. Yin, (*2005*) "Case Study Research: Design and Methods" *Third Edition*, Applied *Social Research Methods* Series, Vol. 5.

71. Yongsi, H. B. N (2009) "Human settlement, land management and health in sub Saharan" cities. Int. J. Hum. Sci. 4:1.10-17

72. Yonasi, H. B. N, T. M Herrmann, A. L. Ntetu, and C. R. Brvant (2010) "Environmental sanitation and health risks in tropical urban setting" A case study of Impact of Rapid Urbanization on the Rates of Infection by Vibrio cholera O1 and Enter toxigenic Escherichia coliin Dhaka, Bangladesh, Cameroon, Research, Dhaka, Bangladesh, Published, Institute of Biomedicine, Department of Microbiology and Immunology,

APENDEX A

An Evaluation of Water Pollution Risks on Children Health:

A Cause Study of Manka Drain in D.G. Khan Punjab

PART I. GENERAL INFORMATION

Time: Start of the Questionnaire: ....AM/PM and end of the questionnaire: ....AM/PM

Name and father name of the Hsead of Household (HH) .... **S/O**...	2. **Name of Respondent** (If other than HHH) **Code from Roaster:**	3. **Quom/Zaat/Biradari (HH)** .... 4. **Religion**...	5. **Tehsil** ....
6. **Union Council**	7. **Ward/Village:**	8. **Ward/Muhallah:**	
Distance from: **the paved road** .... Km). **highway/main road**......... Km). **Distance from:** **(Male)** **the primary school** .... Km). **the high school** .... Km). **(Female)** **the primary school** .... Km). **the high school** .... Km).	**Distance from nearest** (km) **Market** .... **BHU** .... **District Hospital** .... **Nearest name of the city**...................	**Enumerator's Name** .... Sign	**Checked by** Supervisor's Name .... Sign .... Coordinator.......................... Sign ....

PART II: HOUSEHOLD SOCIO-ECONOMIC AND DEMOGRAPHIC INFORMATION

A: Household Information and Family Profile:

	1	2	3		4	5	6	7	8
ID	Name(s) of the family member (s) List all household members (Do not list guests, visitors name) +	Sex 1=Male 2=Female	Age		Relationship to the Head of Household (see codes below 4)	Marital Status 1= never married 2= currentlymarried 3= widow / widowed 4= divorced 5= separated 6= nikah without rukhsati	Literacy Can read or write in any language with understanding? Yes=1, No= 2	Has (name) ever gone to school 1= never attended 2=attended in past 3= currently enrolled	Highest Education See (See the code)
			If ≥ 1 years record age in years (also> 11 month as 1 year)	If < 1 year record age in months up to 11					
CODE	Name	Code	Years	Months	Code	Code	Code	Code	Code
01									
02									
03									
04									
05									
06									
07									
08									
09									
10									
11									
12									
13									
14									
15									
16									
17									
18									

Code for Q 8………
01=under primary
02=Primary
03=Middle
04=Metric
05=F.A
06=BA
07=MA
08=Degree in Law
09=M. Phil. Ph.D.
10=Metric + PTC
11=FA +CT
12=BA + B. Ed.
13=others (specify)

+ Start with the Head of the HH followed by his/her Spouse and unmarried children.. Then Married children will be listed in similar manner; 4= Relation with the Head of the head of household {1= Head, 2 = Spouse, 3 = Son/Daughter 4 = Son/Daughter in law, 5 = Father/Mother, 6 = Brother/Sister, 7 = Grand son /daughter 8 =Niece/nephew 9 =Other Relative,
10 = Servant, 11= Non-relative, 12= any other (Please specify);

B: Employment, Occupation, and Earning (All Family Members)

	1	2	3	4	5	6	7	8
Name(s) of the family member (s) **List all Employed HH ID CODE**	**Have you done any work for pay, profit or family gain during the last week at least for one hour in any day)?** **1=yes (skip to 5)** **2=no**	**Even if did not work last week, did you have a job or enterprise such as shop, farm or service establishment?** **1=Yes (skip to 4)** **2=No**	**Did help in the family farm/enterprise during the last week?** **1=yes (skip to 5)** **2=no**	**Why did not work last week?**	**What was the nature of work?** **(industry code)**	**What was main occupation?**	**What was employmen t status?**	**How much in cash or kind did earn from the main occupation during last month ?** **(Rs)**
01								
02								

03								
04								
05								
06								
07								
08								
09								
10								
11								
12								
13								
14								
15								

Code for Q 2

1= Yes, a job
2= Yes as enterprise as shop, business, farm or service established (fixed or mobile)
3=No, but plan to take a job within a month
4= No

Code for Q 4 and 10

01= Illness or injury 02= Strike or lockout
03=Holiday 04= Off-season inactivity
05= Bad weather 06=Mechanical breakdown
07=Shortage of raw material
08=Education & 'Training leave
09=Maternity or parental leave
10= Law & order situation
11= Reduction in economic activity
12=Others

Code for Q 5

1= Labourer,
2 = Armed service,
3 = Govt. service,
4 = Private service,
5 = Foreign service,
6 = Pensioner,
7= farmer,
8 =business,
9=retired,
10=shopkeeper,
11=Any other

Code for Q 6

1= Agriculture and hunting, 2= Forestry and logging
3= Mining and quarrying, 4= Manufacturing
5=Textile, wearing and leather industries
6=Manufacturing of wood and wood products
7=Manufacturing of transport equipment
8= Other manufacturing industry,
9=Construction, 10=Transport, storage and communication
11= Real estate and business
12=Machinery and equipment, rental and leasing
13=Community, social, and personal services
14=Personal, household services and domestic services
15= Mislenious personal services (barber, etc)
16.=Tailor, 17= Electrical Work,
18= Any other (Please specify)

Code for Q7

01= Regular paid employee with fixed wage
02= Casual paid employee
03=Paid worker by piece rate of service performed
04= Paid non-family apprentice
05= Employer employing less than 10 persons
06= Employer employing 10 or more persons
07= Own account worker –non agriculture
08= Owner cultivator
09= Share cropper
10= Contract cultivator
11= Unpaid family worker
12= Other, such as a member of a producer's cooperative. etc.

C: Family Health (for all family members):

	1	2	3	4	5	6	6
ID CODE	Name(s) of the family member (s)	Was sick during the last six months? 1=yes 2=no	Diseases Type (See codes below 3)	Symptoms of the disease	Duration (days) of sickness	Treatment from 1 = Private Doctor 2 = Basic HU 3 = DHU 4 = Home treatment 5 = Religious/Peer 6 = Any other (Pl. spec.)	Expenditure on Treatment (TotalRs: ......)
01							
02							
03							
04							
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							

Diseases: 01=Cough, 02=Flu, 03=Fever, 04= Burn, 05= Accident, 06= Measles, 07= Pneumonia, 08= Diarrhea, 09= Malaria, 10= Typhoid, 11= Diabetes, 12= Heart Diseases, 13= Aids, 14= T.B, 15= Cancer, 16= Asthma, 17= Hepatitis (A or B Pl. specified), 18=BP, 19= skin disease, 20= Other (Specify)__________

1. **How much distance you cover to reach the nearest hospital? _______km**

D: Other Expenditures (Household Expenditure during 2007)

Item	Average food expenditure per month	Clothes	Fuel	Firewood	Gas	Electricity	Drinking Water (Fetching, Labor)	Health Expenses	Family Social Events (i.e. marriage)	Education	Telephone /Mobile	Other
Cost/month (Rs.)												

E: ASK ABOUT CURRENT DWELLING

1. What type of house does your family live in? (Katcha=1, Pacca=2, Katcha/Pacca=3) ☐

2. How many rooms do you have in the house where you live?
   (Do not count storage rooms, bathrooms, kitchen or room for business) ....Number ☐

3. What is your present occupancy status? {Owner=1 or Rented=2} ☐

4. How much rent do you pay per month? Rs............__________ ☐

5. Does your house have? Electricity connection (Yes=1, No=2), Gas connection (Yes=1, No=2), Telephone connection (Yes=1, No=2)

F: Area specification / description of area:

1. At what distance drainage channel is from your home? ....

2. What kind of sewerage system is available in your area? (Open drainage=1 , Sewerage system=2, Any other (Pl. spec.) = 3

3. Did you have proper disposal of drain water? (yes=1, no=2)

4. If yes then what is disposal place of sewerage water?

   ....

5. Do you think Manka drain is the main cause of Environmental degradation? (yes =1, no=2) If yes what type of degradation:
   ....

6. Do you have cross drainage channel while moving from home? (yes=1 no=2) .... If yes what kind of problems do you have to face?

   ....

7. Is there any problem for children due to drain channel? (yes=1, no=2) .... If yes what kind of problem? (Children may fell ill=1, mobility restricted=2, any other (Pl. specify = 3) ....

8. What is the general attitude of the member of this community about the drain channel? ☐

(Extremely negative=1, slightly negative=2, positive=3, slightly positive=4, Nothing =5)

9. Did you think that the drain is the main cause of ground water being polluted? (Yes =1, no=2) ....

10. If yes then how?

....
....

....
....

11. Do you face problem of land salinity due to water seepage in drainage channel? (Yes=1, no=2) ....

12. What are the consequences of land salinity in the area? (Land quality degrade=1, land price=2, both a& b=3) ....

13. What source of waste material put in this drain? (Domestic=1, industrial=2, both=3).........

14. What type of waste material put in this drain? (Sewerage waste=1, dissolved solid=2, any other=3 plz specified) ....

15. Do you think that the main cause of your illness was drain channel? (1.yes, 2.no) ....

16. If yes than how?

....

17. Do you think that existence of open drainage channel effects growth of local market? (yes=1, no=2) ....

18. If yes, what kind of affects does it make?

(Low business productivity=1, decreasing market=2, any other=3)plz specified ....

.

19. Do you think drainage channel reduces market value of land of this area? (yes=1, no=2) ....

G. Water assessment:

1. What are the available sources of water in the locality? (Spring =1, Streams=2, Ponds = 3, Wells=4, Lakes=5, Rivers=6, Government water tank=7, Private water supply=8, Pump/Motor (tank) =9, any other=10, Please specify: __________) ☐

2. For what purposes water is used at your home (besides drinking,)? (Washing floors=1, Washing cars=2, watering plants=3, Any other=4, Please specify: __________) ☐

3. Do you have your own water source? (Yes=1, No=2) If No (»8) If yes what is the source? (Well=1, Motor=2, hand pump=3, any others =4, Pl. specify: __________) ☐

4. What the level of ground water table? Feet__________

5. What is the cost of digging well in your area? Rs. _________

5. For how much time you use your water pump per day? _____________hrs

6. What horse power water motor is installed at your home? _____________ HP

7. What is your average home electricity bill? During winter Rs. ______ Summer Rs. _______ [ ]

8. What is the source of tap water in your locality? (Government=1, Private Supplier=2, ground water=3) [ ]

9. Do you have tap water available at your home? (Yes=1, No=2), If No (»12)

10. What bill you are currently paying for tap water? Rs. ______________/ month

11. Does tap water has an unfavorable taste /smell/appearance?(Yes=1, No=2) If Yes Please specify [ ]

    a. Taste (Bitter= 1, Salty = 2, Muddy = 3, Any other = 4, Pl. specify: __________) [ ]

    b. Smell (Odd smell/intensive = 1, Medium=2, Tolerant=3) [ ]

    c. Appearance (Clean =1, Muddy =2, Contain some matter =3, Any Other =4, Pl. specify: __________) [ ]

12. Do you/your family drink bottled water? (Yes=1, No=2) If No (»14) [ ]

13. How much cost you pay for it? (Rs/day) _______ [ ]

14. Do you fetch water from outside sources? (Yes=1, No=2) If No(»18)

15. Who is engaged in fetching water from the available sources at your place?
(Children=1, Women=2, Men=3, Servant=4, Any other =5, Pl. specify: __________) [ ]

Number of person involved (No. /day) _______

16. How much distance is covered for fetching water? ________ km, Time: Winter ______ minutes, Summer ______min

17. Is there any monetary cost involved in fetching water? (Yes=1, No=2,) [ ] If yes __________Rs/day

18. Do you think that local government is responsible for providing water at your place? (Yes=1, No=2) [ ]

19. What is the best way for efficient use of water? (Pay according to use =1, Timings for water (with billing) =2,

Timings of water (without billing) =3, creating awareness=4, Any other =5, Pl. specify: __________) [ ]

____

____

20. What is the best billing option? Fixed=1, Billing by use (water meter) =2, Any other= 3, Pl. specify: ________)

21. What should be the time frame for billing? (Quarterly= 1, Monthly=2, Weekly=3) [ ]

22. Is there any law to prevent any wastage of water? (Yes=1, No=2, I don't know=3) [ ]

If yes who is responsible for its implementation? (MC=1, LG=2, Provincial Government=3, Community Organization=4, other=5, pl. specify________

23. Do you have awareness of the water borne diseases like diarrhea, hepatitis, malaria etc.? (Yes=1, No=2) [ ]

24. What is the source of awareness? (newspaper=1, t.v =2, radio=3, education=4 anyother=5 [ ]

25. Are you satisfied with the present drinking water system? (Yes=1, No=2) If no why? [ ] If Yes (»26)
(No system=1, Contaminated water=2, No regular supply=3, Less supply=4, Poor performance=5, Any other=6, Pl. specify: ________)

26. What are the reasons you consider more important for changing an existing water supply system to an improved system of water supply?
(Improved health and hygiene factors=1, Convenience=2, Regular supply=3, Cheaper water=4, Any other=5, Pl. specify: ________) [ ]

27. What are the measures taken by you for the safety of water?

(Use of filters=1, Boiling water=2, Water purification medicine=3, Mineral water=4, other=5 pl. Specify____________)
If No (»28)

28. What cost you bear? Rs. ________/month

29. Would it be better to setup filtration plant at a common place and maintained by a community? (Yes=1, No=2)

30. Is drainage system available in your area? (Yes=1, No=2) If No (»33)

31. What kind of drainage system is it? (Kachainali=1, Pakkinali=2, Open=3, underground=4, Covered with steel grill=5, Other=6, Pl. specify: _________)

32. Are the water Supply lines passing through the drainage? (Yes=1, No=2)

33. Who maintain drainage system? (Municipal Committee=1, Self maintained=2, Community=3, Any other=4, Pl. specify: _________)

34. What is the state of drainage system within your house?

(Kachainali=1, Pakkinali=2, underground=3, Any other=4, Pl. specify: _________)

35. Is there any poultry farm/livestock farm situated near your house? (Yes=1, No=2), [ ] If No (>>45)

36. Where they store their waste? (Near to the water source=1, Away from the water source=2) [ ]

37. Where these forms dispose their waste? (Sell=1, Dump nearby roads=2, Use community dump=3 Any other (Pl. Specify) [ ]

____

38. How these farms effect you/your home/locality?

____

____

____

39. What is the current health awareness status in the locality? [ ]

(Very good=1, Good=2, Average=3, Minimum=4, Nil=5)

40. How you consider the current availability of safe drinking water in the locality?

(Best=1, Fair=2, Satisfactory=3, Bad=4) [ ]

41.Suppose MC decides that the monthly fee is Rs. 100 per month for the new improved safe water supply system and the 25 percent of your neighborhoods go for the new system. Would you accept the new system or would like to continue the existing system?

(Yes=1, No=2) [ ] If No (>>50) [ ]

42. What is the maximum monthly bill you are willing to pay for this improved and hygienic water supply system? Rs/m ______

[ ]

43. Why you don't want to pay anything for an improved service? (Don't like/trust the MC=1, Don't like/trust the private company=2,

Satisfied with existing system=3, Government responsibility to provide such service=4, Service would probably not be reliable=5, Only few people

would use the service=6, Any other (pl.specify)___________

44. Do you think that water supply has improved in the last 5 years? (Yes=1, No=2)

If No why? [ ]

(a) Increase in solid waste=1,
(b) Increase in polluted/contaminated water=2
(c) No proper drainage=3 [ ]
(d) Poultry farms=4
(e) People throw their waste in water source=5
(f) Any other=6

45. Weather local governments have positively affected the water supply schemes in the locality? (Yes=1, No=2) [ ]

46. What is the best source to create awareness among the people about the safe drinking water?

(Newspapers=1, Community mobilization=2, TV=3, Radio=4, Educational institutions=5, Any other=6, Pl. specify: __________) [ ]

54. What role community can play in improving the situation?

____

____

____

55. Have you any suggestion/schemes in mind for the provision of safe drinking water in the locality?

____

____

____

I: General Questions

1. How you consider environmental degradation in D.G.Khan? (Worse=1, Bad=2, Satisfactory=3, Fair=4), [ ]
   Any comment:______________________________

   ____

   ____

2. What are the main causes of environmental degradation? [ ]

   ____

   ____

   ____