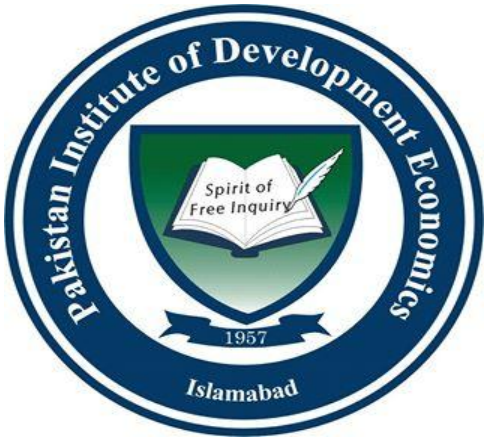
Socio-Economic Impact of Drinking Water from *Toba* on Children's Health: A Case Study of Cholistan



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CERTIFICATE

This is to certify that this thesis entitled: **"Socio-Economic Impact of Drinking Water from Toba on Children's Health: A Case Study of Cholistan"** submitted by Mr. Mahtab Ahmad is accepted in its present form by the Department of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Master of Philosophy in Economics.**

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ABSTRACT

Water quality and shortage is one of the most severe problems which jeopardize the lives of every living entity. To check the impact of drinking water on children's health, the current study was conducted in the water shortage area of Cholistan, Punjab, Pakistan. The focus was given to compare the impact of drinking water sources from *Toba* with well. In this connection primary data was collected through well-prepared, pretested questioners from district Rahim Yar Khan's villages from 120 pastorals at their premises. Logistic regression mode was adopted to capture determinants of children health of household's characteristics having and without health problems. Study confirmed the hypotheses that income, family size, drinking water sources, awareness about waterborne diseases, and adoption of water protection measures have impact on children's health. Pastoral's Willingness to Pay (WTP) for safe and clean drinking water was also captured through Logit Model. The result indicates that household's income, children health and awareness about waterborne diseases have significant impact on wiliness to pay for clean and safe drinking water. Government and other aid agencies should come forward to implement existing and new drinking water schemes, creates awareness about preventive measures of water borne diseases, provision of mobile dispensaries and schools.

List of Abbreviations

Abbreviation	Description
AWBD	Awareness about Waterborne Diseases
AWPM	Adoption of Water Protection Measures
AWTP	Amount of Willingness to Pay
BHU	Basic Health Unit
BWP	Bahawalpur
CAWS	Current Availability of Water Sources
CDA	Cholistan Development Authority
CDHD	Cholistan Desert Health Department
CH	Children's Health
CT	Convenience Type
CWARS	Country Water Resources Assistance Strategy
DDH	Divisional Directorate of Health.
DT	Disease Type
DTH	Distance from *Toba* to House
DWS	Drinking Water Source
ECWBD	Economic Cost of Water Borne Diseases
FS	Family Size
HAI	Human Appeal International
HEF	Highest Education in a Family
Hi	Household Characteristics
HT	House Type
HY	Household Income
HY	Household's Income
KM	Kilometer
NIH	National Institute of Health
OHA	Overall Health Awareness

PCHS	Patients' Current Health Status
PCRWR	Pakistan Council of Research in Water Resources
PSCEA	Pakistan Strategic Country Environmental Assessment
RBG	Receiving any Benefit from Government
RHU	Rural Health Unit
SOE	State of Environment
ST	Settlement Type
TF	Treatment Form
UAE	United Arab Emirates
UN	United Nation
UNICEF	United Nations International Children's Emergency Fund.
VWDS	View about Drinking Water Sources
WB	World Bank
WFS	Water Fetching sources
WHO	World Health Organization
WSA	Water Sources' Appearance
WSS	Water Sources' Smell
WST	Water Sources' Taste
WTP	Willingness to Pay
WWF	World Wide Fund
YS	Income Source

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CHAPTER I

Introduction

Clean water is an integral component of a healthy life. Access to clean water is essential to attain sustainable development objectives because it is a critical source for the nourishment of children and human capital in a given country. An individual cannot survive without adequate availability of water. Therefore, it is essential for a society and individuals to have a clean and proper water supply (WWF, 2007). Clean water is also an important indicator of children's health. Health is the basic component that helps a child to grow and attain their full potential. So, access to safe and clean water is not only a basic human right but also vital for the overall health of society especially for children (WHO, 2011).

Pakistan is blessed with ground and surface water sources. Unfortunately, these are deteriorating due to the rapid urbanization, population growth, increase in industrial activity, agricultural dependency on fertilizer and pesticides. Retardation of drinking water sources raises water-borne diseases, human deaths and economic losses (WWF, 2007). Environmental and human health risks are associated with surface and groundwater pollution by toxic microorganism in Pakistan (Azizullah et al., 2011).

Contaminated water is associated with waterborne diseases which resulted in mortality and morbidity (Ghanzanfar et al., 2017). Strong links between water quality and human health risks have been seen. Contaminated water is responsible for 80% of all hospital cases and 1/3rd of total deaths. Annually, 250,000 children under the age of five died in Pakistan due to the water-

borne diseases and Rs.1.3 billion rupees were spent by Pakistan in curtailing these diseases (Rosinger et al., 2018 & Chaudhry, 2016). Inadequate water quality and poor sanitation are reasons behind various waterborne diseases like typhoid, diarrhea, hepatitis, etc.

Annually, 0.9 million typhoid cases appeared in Pakistan. Pakistan has to apportion millions of Rupees in fighting these diseases faces. There is not only explicit cost like treatment cost, cost of medicines, transportation cost and other medical expenses of these diseases but also an implicit cost like being absent from work and a decrease in productivity (Bhootrani and Atta-u-Rehman, 2017).

A study conducted by UNICEF reflected that poor water quality being the main problem is a threat to public health in Pakistan. Twenty to forty percent (20-40%) hospital beds are covered with patients of waterborne diseases e.g. cholera, typhoid, dysentery, and hepatitis which are responsible for 33% total deaths. Further, irrigation water quality standards below the recommended level are problematic. These caused the vegetable contamination which in turn increases the human health risks (Soomro et al, 2011). The population's deprivation from safe drinking water in Pakistan is the main reason behind the above-mentioned situation. Only 56% (Farooq et al., 2008) and 20% (Ghanzanfar et al., 2017) of the country's population has access to clean drinking water. Eighty-four percent population lacks access to safe drinking water (Khan, 2017).

In Lahore, 37.2% of water samples are unsafe for human consumption (Anwar et al., 2010). In the 12 districts of Punjab and rural areas, 79% and 88%, respectively, are unfit for human consumption (Rasool et al., 2017). The 36% and 16% population of Sindh and Punjab are

compelled to drink contaminated water over with arsenic over 10 ug/L and 50 ug/L, respectively, (Shanjrani et al., 2017). Sewage disposal in water, fertilizer discharge, agricultural pesticides and industrial waste in the water supply are reasons behind this situation (Ghanzanfar et al., 2017). Provision of safe drinking water in rural areas of Pakistan is limited with the accessibility of clean water to 45% population (Farooq et al., 2008) and relatively 20 times less dependency on tap water reflects poor sanitation conditions (Daud et al., 2017).

The situation is worse in remote areas, especially in the Cholistan. According to the PSCEA research study, Pakistan's desert region comprises of mostly saline water and the indigenous population is forced to rely on rainwater. That rainwater is stored in man-made ponds called Toba, presented in the picture section of the appendix but this storage is unhygienic because the water gets saline due to sand in it (Martin et al., 2006). The underground water in the Cholistan is more brackish, hardly used for livestock and found in depth of 30 to 40 meters and contains a 9000 – 24000 ppm salt which makes it unfit for human or livestock consumption. But in some places water with low salt content ranging from 2000 – 4000 ppm is also available (Akram et al., 1997).

Therefore, *Toba*s are the main source of drinking water for human and animals but stored water quality is questionable. This is because after storing the rainwater for two to three months in *Toba*, the quality of water deteriorates exponentially, and it is not safe for human consumption, especially for children. Annually, 250000 children under the age of five died in Pakistan due to water-borne diseases (Rosinger et al., 2018). Thus, there is an urgent need to develop policies that overcome water pollution for a better child's health and sustain drinking water sources.

1.1 Problem Statement

The Cholistan is an extremely underdeveloped area of southern Punjab, Pakistan and surrounded by multiple problems. Water shortage is one of the most severe problems which jeopardize the lives of every living entity. Lack of clean water is due to contaminated and unhygienic water resources like *Toba* and well. Storage of rainwater for two to three months mixes saline in *Toba* water which makes it unhealthy for drinking purposes. Further, continuous usage by livestock and human beings deteriorates its quality which increases the chance of suffering in water-borne diseases. The rise in health's cost is expected in the targeted area due to this problem which effects on the economic condition of the household. So, it's important to highlight what are the costs associated with children's health and how the local community responds to the rising issues and challenges regarding contaminated water. The following questions are highlighted to attain the associated problems with the study.

1.2 Research Questions

The following research questions were investigated in this study:

i. What is the economic impact of drinking water from *Toba* and well on children's health and health cost of the household?
ii. What is the willingness to pay and characteristics of households for clean drinking water in the Cholistan Desert, Punjab, Pakistan?

1.3 Objectives of the Study

The overall objective of the study is to analyze the economic impact of drinking water from *Toba* and well on children's health. Specifically, focusing on the following objectives:

a) To highlight the scope and importance of safe drinking water in the Cholistan desert, Punjab, Pakistan.

b) To analyze the socio-economic impact of drinking water with *Toba* and well water on the children's health.

c) To find out the WTP and characteristics of households WTP for the safe drinking water.

1.4 Significance of the Study

Following statements reflects the significance of the study:

i. This study helps to fill the gap in the literature which is very rarely available in the study area by analyzing a connection between drinking water from *Toba* sources and children's health. It also captured the health cost of households in the Cholistan.
ii. This exploration opens new ways of further in-depth research for coming investigators in this area by expanding the targeted population, health variables, and area of study like livestock.
iii. This research formulated sound policy recommendations to improve water quality and children's health.

1.5 Organization of the Study

The rest of the study is structured as follows: Chapter two deals with the literature review related to the study. In chapter three, the methodology is highlighted and chapter four is associated to the research area specification. While, in chapter five, some conclusions are drawn based on our primary data in descriptive form while also focusing to meet the objectives and hypothesis. Finally, conclusion and policy recommendation based on our collected data is given in the last chapter.

CHAPTER II

Literature Review

Previous studies associated with the problem of contaminated water and its impact on children's health at a global and domestic level has been discussed in this chapter. In the first section, studies at the global level whereas in the second section previous studies conducted in Pakistan have been elaborated.

1.1 Review of Global Studies

It is important to review the international studies to make the better understandings of linkages between the water sources and quality, and its impacts on the children' health. Further, the international review provides a scientific and logical way of conducting a research study that enhances its authenticity and validity. It is widely shared among previous studies that deteriorating water quality has consequential impact on child health due to rampant infectious diseases. As it reported in a study from Sri Lanka that 2458 cases of child diarrhea were noticed in five hospitals of Kurunegala districts. The contaminated water was the cause of child illness. Further, the usage of hand pump water sources for drinking purposes reduced the 46% chance of diarrhea as compared to those children who drink from unsafe water resources. Unprotected water sources lead to 35% more chances of childhood diarrhea as compared to protect well water sources (Mertens et al., 1990).

A study was conducted on drinking water resources, mortality, and diarrhea morbidity among young children in Northern Ghana by taking the sample of 20000 children, collected over the one year found that there is an association between the water sources and diseases like diarrhea and morbidity. The dependence on water resources varies with the variation of seasons. Diarrhea, morbidity, and children death upswings in the monsoon season due to the reliance on rainy water. The borehole water source has fewer chances of mortality compared to the other drinking water sources. Awareness and maternal education shrink the child mortality ricks produced by water-borne diseases (Shier et al., 1996).

Xiang et al. (2003) evaluated the ‘’effect of fluoride in drinking water on children’s intelligence”. The two villages holding different quantities of fluoride in the drinking water were selected. They observed that high fluoride in drinking water hurts children's intelligence, aged 8-13 years old. Paternal education and family income do not influence children's intelligence. There was no impact of age in Wamiao village because of the high fluoride in drinking water but a positive relationship founded in Xinhua village because of the low quantity of fluoride quantity in drinking water. Overall, high fluoride in drinking water had been associated with mental retardation.

The health consequences associated with water quality in developing countries was reviewed by Gundry et al. (2004). They found that contaminated drinking water was a major source of various water-borne diseases. A positive relationship founded between cholera and contaminated drinking water. Improved water sources overcome cholera disease. Cholera and diarrheal diseases can be reduced through the improvement in drinking water quality and storage.

The Association of Drinking Water Resources (ADWR) with childhood diarrhea in the age of below 7 years children were assessed by Plate et al. (2004) in rural east central Mali. The multivariate analysis performed on breastfeeding status, water sources and demographic variables by exerting 1117 children as a sample. They found that spring, stream, and surface sources of drinking water had greater risks of childhood diarrhea relative to the well water source. The chances of diarrhea increased in the monsoon season as compared to other seasons due to the more contamination of the water in this period. There was a need to improve the water quality for better children's health through practical interventions.

Su (2005) assessed the influence of contaminated water on waterborne illness through the logit analysis method. The morbidity and mortality cases were revealed more in dumpsites area as compared to clean areas. The more water contamination in the dumpsite areas relatively was justified to support the results. Household size also affected child mortality. Contaminated water due to dumpsite concerns public health. So, there was a need to clean the environment and drinki9ng water sources.

Heyworth et al. (2006) reported the relationship between the use of untreated tank rainwater and gastroenteritis among children aged between 4 to 6 years. They found no association between the consumption of water from untreated tank rainwater and gastroenteritis among children. There was no difference between the odd of gastroenteritis symptoms of a different person that were drinking from treated and untreated tank rainwater. The results were detected by observing the usage of treated and untreated tank water and symptoms of gastroenteritis every day till six weeks.

The impact of water and sanitation on child health was analyzed by Fink et al. (2011) through a sample of 1.1 million children under the age of five from 70 low- and middle-income countries by taking 171 data set surveys from the demographic health surveys. The positive effect found between improved water sources and child health. The effect of improved water quality was greater than high-quality sanitation. Diarrhea disease and stunted children decreased due to the improved water source and sanitation. High-quality water gave 8% and 9% low odds of diarrhea and stunted, respectively. The improved water quality and sanitation both gave lower odds of 13% and 27% of diarrhea and stunted respectively, in the short run. Paternal and maternal education also affects child mortality.

The results of the effusive effect of water and sanitation on the global burden of diseases showed that the availability of pure drinking water lowers the burden of diseases at the global level. There was a need to highlight the importance of pure drinking water with some practical interventions to improve health and overcome the chances of mortality and morbidity. Overall, improved water sources including water wells overcome the incidence of morbidity and mortality among the under-five children (Schmidt, 2014).

The impact of water and sanitation on childhood mortality analyzed through Cox regression analysis in Nigeria by taking a sample of 63844. The unimproved water and sanitation in Nigeria associated with a higher risk of 38% for neonatal mortality, 24% for child mortality and 14% for post-neonatal mortality. Water sources were significantly associated with post-neonatal and child mortality as well as demographic and socioeconomic variables. The risk of neonatal mortality increased for those Childs who have less weight at the borne time. Whose mother was lived in

rural areas and not giving breastfed to the newborn child. Unimproved water and sanitation associated with a higher risk of 1.06 for neonatal mortality and 1.38 times to post neonatal mortality. Government and community-based interventions ware required to overcome children's deaths [Ezeh et al. (2014)].

It is concluded that there is negative impact of contaminated water on children's health. unhygienic water is responsible for poor children health wither their lower IQ level, diarrhea, malaria, typhoid, hepatitis, higher treatment cost, lower productivity, decrease in saving and investment at household level which disturb their economic and social life. Some intervention had been suggested by different studies to overcome the problem of poor children's in a specific area by providing hygienic water sources to that community.

2.2 Review of Studies in Pakistan

The willingness to pay for safe drinking water in district Abbottabad, Pakistan was investigated using logistic regression technique. The results revealed that education and household income and suffering in waterborne diseases of any family member have a positive significant impact on willingness to pay for safe drinking water. The majority of the respondents showed their WTP between 51-100 and fewer respondents showed their WTP above than 100 for improved and hygienic drinking water sources [Mustafa et al. (2009)].

The impact report of hand pumps and water revealed that access to safe drinking water improved the economic, social and environmental aspects of individuals. Twenty-six percent of respondents responded that water-borne diseases overcome due to the provision of safe drinking water. Fifty-two percent of respondents responded that door water availability saves time,

especially for females. Health-related issues decreased, the wellbeing of children improved in terms of health and economic activity also increased because of the reduction in hospital expenditures. The overall positive impact of the provision of clean drinking water has been seen by [HAI (2014)].

Unsafe drinking water caused water-borne diseases. Low priorities of government to overcome the problems of sewerage, sanitation and the provision of safe drinking water problems were observed. Water sources were becoming scarce due to weak law and enforcement of groundwater abstraction. The lack of implementation of water policies in Pakistan was a major problem. There was a need to define policy objectives for resolving the problems of water and sanitation. Strengthen the institution, financial sustainability, making better and more efficient use of funds and better water management policies are necessary to resolve the problems of unsafe drinking water and sanitation system [WWF (2007)].

Nabeela et al. (2014) reviewed the microbial contamination in Pakistan by taking a sample of 7000 water. He found that 71% and 58% of samples contaminated with total coliform and fecal coliform, respectively, were beyond the WHO standard. Contaminated drinking water is responsible for 20 to 40% of all death in the country. Industrial waste, usage of pesticides in agriculture and lack of filtration plants were the major causes of water contamination which indirectly impacts the citizen's life in a negative manner and causes of death. There is an urgent need to take steps for the provision and arises awareness about the importance of safe drinking water.

Yousaf et al. (2016) assessed the drinking water quality and human risks by taking the tube well and spring source of water as a sample in tehsil of Jamrud and Landikotel of Khyber Agency, Pakistan found that physiochemical parameters like color, odor and taste and mean concentration of heavy metals were within the permissible limit. The water sources were permissible for drinking purposes. The results confirmed that no health risks are associated with these resources because the value of HQ was less than.

Ilyas et al. (2017) analyzed the drinking water and health risk assessment in Dair by taking the sample of 22 to check water quality through various parameters found that all parameters are within the permissible limit of WHO and PEPA. Poor distribution networks are the main cause of water pollution. They concluded that no health risks are associated with these resources because the value of HQ was less.

The water quality and its impact on resident's health in Bahawalpur was evaluated by exerting samples from Islamic Colony, Shahdrah and Satellite town. The water quality was deteriorating in the Bahawalpur especially in Islamic Colony where 48, 55 and 41% of residents have diluted, brackish and water with light smell respectively, for drinking purposes. Thirty-six percent, 18.1% and 22.1% residents in Islamic Colony, Satellite town and Shahdrah were suffering in waterborne diseases, respectively due to drinking contaminated water. There was a requirement for monitoring the existing sources and to install new filtration plants [Mohsin et al. (2013)].

Jabeen et al. (2015) studied the challenges of water pollution and the threat to public health in Pakistan. Pakistan was facing health problems due to poor water quality. Industrial waste, raw sewerage and heavy usage of fertilizers and pesticides to take high productivity, lack of

awareness and growing population are the cause of water pollution. There was a need to assess the links between water quality and human health. Further, it is imperative to ensure the enforcement of water environmental regulations and effective management of water by domestic reforms.

Shakoor et al. (2015) study the health risks and arsenic speciation in groundwater in rural areas of Punjab by taking 62 water samples from three districts Vihari, Rahim Yar khan and Chichawatni. They found that the mean concentration in drinking water was 53% higher than the permissible limit of WHO. Health quotient and cancer risk value were also higher than the recommended values which were an indication of a health threat to the local community. The government took steps to overcome and bring the concentration at the permissible limit.

A study relating to the status of drinking water quality and its contamination in Pakistan revealed that just 20% population has access to safe drinking water. The excessive discharge of sewage into the water supply system is the primary source of drinking water contamination whereas other sources like industrial, agricultural, etc.…are secondary that pollute the drinking water. The water contamination was responsible for 80% total waterborne diseases and 33% total deaths. There was necessitated to take the protective measure by arising awareness to save the water from contamination [Daud et al. (2017)].

The summary of the previous studies shows both positive and no impact of drinking water on children's health. The studies have been conducted in different areas of the world and Pakistan bur very rare literature exists on the impact of drinking water on Children's health in desert areas. So, from the literature, we can conclude that by conducting a study on Cholistan desert we

can able to make a policy recommendation for deserted areas not only in Pakistan but also at the world level.

CHAPTER III

Research Methodology

The methodology is a key part of research to attain the desired objectives of the study. Specifically, the socio-economic impact of drinking water from *Toba* water with well on children's health analyzed during 2019 in the Cholistan. In this section, steps have been discussed that are followed during the study period to obtain the desired objectives and hypothesis.

So, in the initial phase of analysis, our focus is on descriptive statistics to draw some key information through frequency distribution and graphical representation from the prepared questioners. To attain the desired objective and hypothesis, inferential statistics have been used to conclude the population from the sample through using the Logit model due to the qualitative dummy nature of the dependent variable, children's health. A question about the average monthly treatment cost of waterborne diseases to reflect their economic impact on households is asked from households by. The objective of the household's willingness to pay for the provision of safe drinking water is captured with the help of the contingent valuation method (CVM).

Primary data has been collected through the well-prepared questionnaire to meet the objectives by dividing it into different segments based on information specification. Coding- decoding rule is also applied for ease responses of different variables by the responder. Other informal information tools like focused group discussion (FGD), and case study events have been used to

get study-related information. The brief discussion of tools, techniques, and models is discussed below.

3.1 Descriptive Methodology

In this section, tabulation, graphical representation and frequency distribution are has been focused to highlight the main features and characteristics of the sample representing our population. Household characteristics can affect the children's health which might produce misleading results, due to the correlation among the variables. An establishment of an econometric technique is needed to separate the variable's effects separately for the true reflection of results. The dependent variable has a binary response. So, qualitative measuring tools have been adopted for estimation purposes.

3.2 Theoretical Models

This study contains two econometric models. So, it is necessary to give the econometric specification of both models separately which is given below.

3.2.1 Model: 1 – Children Health

The logit model has been used to analyze the impact of drinking water from *Toba* and well on children's health due to the qualitative nature of the dependent variable. The dependent variable takes value one if child health affected from drinking water sources (*Toba* and well) during a specific time (six months), otherwise zero. Coefficients of this technique are not interpretable directly. So, the marginal effect of coefficients has been calculated to interpret the variable's

coefficients. This model also has been used by Su et al. (2005), Heyworth et al. (2006) and Fink et al (2011) in their studies relating to the drinking water and child health

In our study the Linear Logit Model (LLM) is:

$$P_i = E(Y = 1|X_i) = \beta_1 + \beta_2 X_i \quad (1)$$

Where:

$P_i =$ Probability of children's health being affected

$X =$ Independent variables (HY, FS, DWS, AWBD, AWPM)

$HY =$ Household's Income

$FS =$ Family Size

$DWS =$ Drinking Water Sources

$DTH =$ Distance of *Toba* from House

$AWBD =$ Awareness about Waterborne Diseases

$AWPM =$ Adoption of Water Protection Measures

$Y =$ Dependent variable. It has binary responses; one for those children who are affected from drinking water sources otherwise zero.

Now consider the following representation of children's health

$$P_i = E(Y = 1|X_i) = \frac{1}{1+e^{-(\beta_1 + \beta_2 X_i)}} \quad (2)$$

For case of exposition, we write (2) as

$$P_i = \frac{1}{1 + e^{-Z_i}} = \frac{e^z}{1 + e^z} \quad (3)$$

Where:

$$Z_i = \beta_1 + \beta_2 X_i$$

Equation (3) represents (cumulative) logistic distribution function.

It is easy to verify that as Z_i ranges from$-\infty$ to $+\infty$, P_i ranges between 0 and 1 and P_i normally related to Z_i $(i.e., X_i)$ thus satisfying the two requirements considered earlier. But it seems that in satisfying these requirements, we have created an estimated problem because P_i is nonlinear not only in X but also in β's as can be seen earlier from(2). This means that we cannot use the similar procedure to estimate the parameters. But this problem is more apparent than real because (2) can be linearized, which can be shown as follows.

If P_i is the probability of suffer in water borne diseases, is given by (3). $1 - P_i$ is probability of not suffering in water borne diseases is:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \quad (4)$$

Therefore, we can write:

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} = e^{Z_i} \quad (5)$$

Now $P_i \,/\, (1 - P_1)$ is the odds ratio of suffering in water borne diseases- the ratio of probability that a child suffers in water borne diseases to the probability that a child doesn't suffer in water borne diseases.

Now if we look at natural log of (5) we obtain very interesting result, namely:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \beta_1 + \beta_2 X_i \quad (6)$$

That is L, the log of odds ratio, is not only linear in X, but also (from the estimation viewpoint) linear in Parameter. L is called logit and hence the name logit model, for model like (6).

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_1 + \beta_2 X_i + u_i$$

$P_i =$ The probability of child suffering in water borne diseases

$1 - P_i =$ The probability of having a no water borne disease in a child.

Analysis of t-test and p-value has showed the significance and validity of the variables and model. The pseudo-r square gives the result and reliability of overall model. So, conclusion of our logit model is based on t-statistics, p-value and Pseudo-r-Square to show significance and insignificance of the variables as well as model.

3.2.2 WTP for Safe Drinking Water

In Pakistan, drinking water is provided by the government through pipelines, tanks, pumps, and water tanks either free or free for nominal charges. It is not a traded commodity (non-market goods) and as such, a non-market valuation method is needed to estimate the WTP for water. Non-market valuation attempts to estimate economic value in money terms. To check the WTP for safe drinking water contingent valuation method is applied. It is a direct approach in which directly asks how much pay for improved water sources. Contingent Valuation (CV) is a method of estimating the economic value of non-market environmental goods through survey questions that bring out individuals' preferences regarding such goods [Carson (1989)]. CVM has been successfully applied to a variety of sanitation, water supply services. Individuals with preferences over goods (both market and non-market) are represented through utility functions. The consumer wants to maximize their utility function given their budgetary constraints.

CVM surveys describe both quality levels and ask for a willingness to pay for the change in quality. The utility function $U(q, z)$

q = water quality

z = composite of all market goods

The expenditure function $e(p, q, u)$

The expenditure function measures the minimum amount of money the consumer must spent to achieve the given level of utility. The *EF* is an increasing function of 'p' and 'u' and decreasing

function of ‘q’. Since consumer want same utility, it is appropriate to use expenditure minimization.

Min $(z + Pz)$ s.t $U = U(q, z)$, where price of composite goods is equal to one.

$$(Pz = 1)$$

The above minimization problem can be solved using Lagrange’s multiplier to obtain Hicksian demand for the corresponding goods. The Hicksian demand is given by:

$$h_i = h_i(P_q\ , u^*)$$

Minimum expenditure function can be calculated by substituting the values of corresponding Hickisian demand in the minimum expenditure function:

$$e^* = e(p, q, u^*)$$

Where, e is minimum expenditure required to achieve fixed level of utility $u^*$and using the water quality q, and is the function of price of other goods, the fixed level of utility and the quality of water itself. The derivative of expenditure function with respect to price gives corresponding Hicks compensated demand function for good under consideration.

$$\partial_e \Big/ \partial_{p_i} = h_i(P_q\ , u^*)$$

WTP for the change in water services is the integration of marginal WTP to achieve water quality from to q to q^*: This model is adopted from (Mustafa, 2009).

$$WTP = -\int_{q}^{q^*} \partial e(q, u^*) / \partial p \, dp$$

WTP is the maximum amount of money consumer would give up in order enjoy an improvement in water quality. The willingness to pay for improvements in water quality is:

$$WTP = e(p, q, u) - e(p, q^*, u)$$

Where, q is a degraded level of quality and q^* is an improved level of quality.

The difference in expenditure is either compensated surplus or equivalent surplus. If the reference level of utility is initial utility, it is compensating; and if the reference level of utility is final than it is equivalent surplus.

3.4 Econometric Models

For the ongoing study, two different econometric models have been used to fulfill our objectives in the study. Two econometrics models are used in this study are the Children's health model that is Logit based model while the second model is the Household's characteristics of Willingness to pay.

3.4.1 Model: 1 – Children Health

The following econometric model is used to capture the effect of drinking water from *Toba* with pump and without pump on children's health.

$$CH = \beta_0 + \beta_1 (HY) + \beta_2 (FS) + +\beta_3 (DWS) + \beta_4 (AWBD) + \beta_5 (AWPM) + \varepsilon_i$$

Where:

$CH =$ Child Health

$FS =$ Family Size

$HY =$ Household's Income

$DWS =$ Drinking Water Sources

$AWBD =$ Awareness about Waterborne Diseases

$AMWP =$ Adoption of Water Protection Measures

$\varepsilon_i =$ Error Term

3.4.2 Model: Characteristics of WTP for Safe Drinking Water

It is stated by Whittington *et al.* (1990), Briscoe et al. (1990), Altaf *et al.* (1992) and Haq *et al.* (2007) that WTP depends on income, wealth, household education level, distance from existing sources etc. To capture various determinants of WTP the following multivariate regression analysis has been conducted:

$$WTP_i = \beta_0 + \beta_1(H_i) + \beta_2(Satisfy) + \beta_3(CH) + u_i$$

Where:

$WTP_i =$ Households' willingness for continuous and potable water supplies

H_i = Household's characteristics (Highest education level of the HH, income level of the HH)

$Satisfy$ = Household's satisfaction with current services.

CH = Children Health

u_i = Error term

The logit model has been used to capture the willingness to pay for safe drinking water due to the binary dummy response of the dependent variable in the above model. The dependent variable takes value equal to one of the households that show their willingness to pay for safe drinking water; otherwise "0" value.

3.4.3 Hypothesis Formulation

On the basis of basis of objectives and proposed method, the following hypothesis are checked for the significance.

H_{01}: Drinking water from *Toba* has no significant impact on children's health

H_{11}: Drinking water from *Toba* has significant impact on children's health

H_{02}: People are not willing to pay for improved access to safe drinking water

H_{12}: People are willing to pay for improved access to safe drinking water

3.4.4 Explanation of the Variables

To highlight the importance and explanation of variables makes easier to elaborate the basis of the study. So, the reasons for the variable's inclusion in the models and constructions of dependent and independent variables that have been chosen from different sources are explained in this section.

The household's income impacts on the children's health. Families with having a high income have sufficient resources to care about their children's health. While poor families have insufficient resources to combat the water-borne diseases which worsen the children's health. So, family income has a negative expected sign because high income leads to good children's health, means less chances of children's illness and vice versa. This variable also has an impact on the willingness to pay of the households for the improved water source with the positive expected impact. The rich households might have a higher willingness to pay for the improved water sources as compared to poor households.

Su et al. (2005) and Fink et al. (2011) showed in their studies that household size (family size) had an impact on children's health. The reason behind this might be the over-dependency rate on the household's head. So, family size also included in the proposed study as an independent variable with a positive expected sign to capture the drinking water impact on children's health.

The variable, drinking water source has been used in many studies relating to the drinking water and their impacts on children's health. Sheir et al. (1996), Plate et al. (2004), Su et al. (2005), Heyworth et al. (2006) and Ezch et al. (2014) had used this variable in their studies. Drinking water source (*Toba* and well) is used in the proposed study to see its impact on children's health.

Awareness about waterborne diseases has impacted the children's health with negative expected signs. The people having awareness about waterborne diseases might be giving a bottle or boiled water to their children to avoid them from the hazardous effects of contaminated water. In this way as awareness increases, the chances of children's illness might be decreased. This variable also has an impact on the willingness to pay of the households for the improved water source with positive expected sign. Awareness about waterborne diseases might raise the household's WTP for improved water sources.

Safety measures for water protection also impact on the children's health with negative expected sign. The households who adopt safety measure in form of boiling water, using bottle water or taking water from any improved source for drink water to their children's, have fewer chances of bearing water-borne diseases by their children as compared to those households who are not adopting such types of safety measures. The reason behind this is that protection measures for drinking water might overcome the hazardous mosquitoes in the existing water sources and turn leads to better children's health.

The waterborne diseases (children's health) have an impact on willingness to pay for safe drinking water with positive expected sign. It is expected that the willingness to pay for those households is higher whose children would be suffering the water-borne diseases relatively.

In case of satisfaction with current water sources of drinking water reduces the WTP of households for the improved and adequate water supply.

The definition of children varied across the studies with the youngest age definition < 1 year and the oldest age definition < 15 years. Arnold & Colford (2007). But the proposed study considered the children less than 10 years because the children under this age are more affected by the contaminated water. Their illness is asked within the last six months. The effect prevalence of contaminated water until six months is the reason behind recording the illness of children during the six months (Gulzar, 2012).

It is concluded from this section that different variables affect the children's in both positive and negative manner health through different channels. Waterborne diseases also affect the economic condition of the households indirectly because a lot of treatment cost (health cost) is beard by households to combat waterborne diseases. Further, different variables also affect the willingness to pay for safe drinking water through the different channels that already mentioned in the above.

3.4.5 Variable Specification of the both Models

The variables specifications of the both models are presented in the following (Table 1).

3.5 Data Description

Data description is an essential part of research because it helps to understand the processes that have been followed for the collection, processing and analyzing of data. This section is divided into different following subsections based on sampling technique, data collection tools and coding system of information.

3.5.1 Population

Primary data was collected through a well-structured questionnaire from four villages and their surrounding villages of Cholistan to analyze the impact of drinking water sources (*Toba* and well) on children's health. To access the comparison among the children's health villages has been divided into two categorized (*Toba* and well villages) basing on drinking water sources. Two villages along with surrounding villages have been taken from the target group of the population (*Toba*) whereas the remaining two villages have been taken from the control group of the population (well).

Table 1. Variables Specification of the both Models.

No	V	Title	Definition of Variables	Expected sign with source
1	D and I	Child health (CH)	The illness of Children under the age of ten years is recorded for the last six months. It has a binary response; whether children's health is affected or not from *Toba* water.	In case of WTP it has +ve expected sign.
2	D	Characteristics of Willingness to Pay (WTP)	The Households WTP has a binary response, one for those who are WTP and zero otherwise.	
3	I	Family Income (FI)	Households income of a household from all sources including any aid from the government.	-ve expected sign for children's health & +ve expected sign for WTP
4	I	Family Size (FS)	The number of family members using a single kitchen.	+ve [Su et al. (2005) and Fink et al. (2011)]
5	I	Highest Education in a Family (HEF)	The highest education level of any member of a family.	+ve [Su et al. (2005), Fink et al. (2011) and Ezch et al. (2014)]. It also has +ve expected sign for WTP
6	I	Drinking Water	It is a binary response variable. Whether the	*Toba* has +ve expected sign.

		Sources (DWS)	households are drinking water from *Toba* or well.	
7	I	Adoption of Water Protection Measures ($AWPM$)	Adoption of Water Protection measures at home like filtration and boiling.	-ve expected sign.
8	I	Awareness about Waterborne Diseases ($AWBD$)	It is a binary response variable. Whether households have awareness about waterborne diseases or not.	-ve expected sign for children's health and positive expected sign for WTP.
9	I	Satisfy	Satisfaction from the existing drinking water sources	–ve expected sign for WTP

In above table: V= Variable; D= Dependent; I= Independent

3.5.2 Sampling

After the selection of the population, sampling is an important part of a research and helps to determine the accuracy of survey results. The choice of wrong sampling reflects in survey results. So, it is important to choose an appropriate sampling technique to collect the appropriate sample from the targeted population.

Sampling technique has been chosen based on population characteristics of the targeted population. Simple random sampling is an appropriate technique to collect the data because the population was scattered.

3.5.3 Data Collection Tools

The primary data has been used for this study. The required data is collected through a well-structured questionnaire which was a major source of information and contains different sections based on study objectives. Interviews have been conducted because of the low literacy rate in the

targeted area to get the required information. Some non-probabilistic and informal data collection techniques like key information tools (KIT), focused group discussion and participatory reflection and action (PRA) are also been used to get relevant information related to that study.

3.5.4 Coding/ decoding

For the statistical purpose, the process of coding and decoding has been made. Different responses are coded with mathematical numbers to check statistically relationships of variables.

3.5.5 Pre-Testing

To judge the authenticity of the questionnaire pre-testing has been done. For this purpose, after responding from 5 respondents, necessary modification has been made in the questionnaire.

3.5.6 Data Analysis Tools

The entry of data and descriptive analysis has been done by using Statistical Package for Social Sciences (SPSS-V19), where econometric analysis is has been done by using STATA software regarding our hypothesis and objectives of the study.

CHAPTER IV

Study Area Specification

In this chapter features and characteristics of our study area that is the Cholistan desert, Pubjab, Pakistan have been discussed. So, in this section, the features of the reasons to select the study area, population, and lifestyle, livelihood sources with climatic characteristics and health facilities in the desert area and drinking water sources have been elaborated. The water sources are also deliberated in section 9 with following by the quality of water and storage capacity of different sources. Finally, the demand and supply of water in the Cholistan is discussed. The all mentioned section now is conversed in brief.

4.1 Reasons to Select the Study Area

The Cholistan is extreme under develop area of Pakistan. Lack of infrastructure, lower education, poverty and health facilities have been seen in this area. It is surrounding the number of problems. Water shortage is one of these problems. Water quality is poor due to unimproved water sources like *Toba* due to the saline mixture in it. Rainwater storage period for two to three months makes its quality further poor. People and animals are compelled to drink together from *Toba* sources. *Toba*s are a major source of drinking water and daily life requirements like a reservoir. More chances of water-borne diseases are to be expected in the targeted area. Literature showed that children are more affected by unsafe water due to the weak immune system. Increase in health cost is to be expected which indirectly affects the economic conditions of households. So, Cholistan selected due to the problem of its poor water supply system.

4.2 Cholistan

The total area of Pakistan is 79.6 million hectares, out of which about 11 million hectares are deserts including Thar, Thal, Chagi, and Cholistan (Soharwardi et al, 2011). The word Cholistan derived from a Turkish word “chol” which means desert, locally known as “Rohi”, extension of great Indian desert, located in southern Punjab, between latitude 27o 42' and 29o 45' north and 69o 52'and 73o 05' east, spreads 30 KM away from BWP, covers the area of 16000 km2, 6200 square miles, 480 km in length and breadth varies from 32 to 192 km. The Cholistan consists of the three districts namely Bahawalnagar, Bahawalpur and Rahim Yar Khan (Akhter and Arshad 2006).

It is divided into two parts. Upper Cholistan is an area where water is available and lowers the Cholistan where water is not available. Lower Cholistan relatively is a more underdeveloped and vulnerable area of Pakistan because the majority of the population live in poverty due to lack of health, education, infrastructure, and water facilities. Cholistan jeep rally on an annual basis is the biggest sports event.

The whole Cholistan desert can be divided into two geomorphic regions i.e. Lesser Cholistan and Greater Cholistan based on its topography, parent material, soil, and vegetation. Greater Cholistan which borders with India in south covers an area of about 18130 km2. The lesser Cholistan borders canal irrigated areas to the bed of abandoned river “Hakra” in the desert and covers an area about 7770 km^2 (Akhter and Arshad 2006).

4.3 Population's Life Style

The Cholistani community, especially in lower Cholistan, spent semi-nomadic life due to lack of water and seasonal basis availability of water. The Cholistani community lived in "Gopas", made of mud, branches, and leaves of trees. When the water in *Tobas* vanishes, they migrate in some nearer places where water is available for the sake of water and fodder for their animals (Akhter and Arshad 2006).

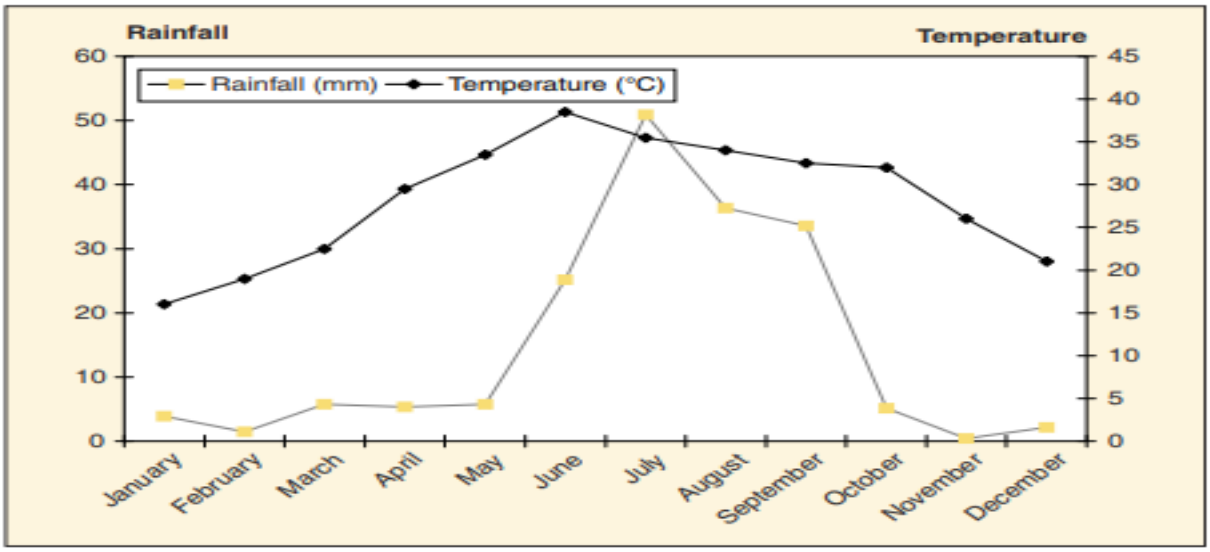
4.4 Livelihood Sources

Livestock and agriculture are the major sources of livelihood, depends on rainwater. Livestock is the backbone, especially sheep, goats, camels, etc. Economically, cattle breeding has great importance to meet the area needs of fat, milk, and meat. Carpet *ajarak, shawls* and *chunri* (type of dupatta) production also supports the people to achieve the basic needs (Akhter and Arshad 2006).

4.5 Rainfall & Temperature

The average rainfall varies from less than 100 mm in the west to 200 mm in the east, usually, rainfall happened in monsoon (July- September) and winter and springs (January to March) temperature vary in summer and winter. The average 240^{C} to 510^{C} temperature exist in summer (May-June) are depicted at Figure 1.

Figure 1. Rainfall and Temperature in Cholistan.



Source: Akhter & Arshad (2006).

4.6 Health Facilities in Cholistan

The divisional directorate of health (DDH) is responsible for health facilities in the Cholistan. Health services are provided by eight basic health units (BHU) namely 2 rural health units (RHU), 3 Zila Council rural dispensaries and two Zila Council mobile dispensaries. These facilities are far in greater Cholistan as compared to lesser Cholistan. The distance of these facilities in lesser Cholistan is almost 8.03 KM to 27 KM. The Cholistan desert health department (CDHD) budget is Rs. 3889668 which is insufficient for the population of 344231 people (estimated 2014). The facilities of BHU/dispensary, commercial bank and are available in greeter Cholistan with the mean distance of 50 Km (Malik and Ali, 2017).

4.7 Educational Facilities in Cholistan

There are 76 schools in the Cholistan and 146 teachers to teach in these schools. Total enrollment in these schools is 6489. Total enrollment in10 *Toba*/mobile schools are 497. Apart from this 50 more community schools and 30 *Toba*s are being opened for the Cholistani community (CDA, 2018).

4.8 Efforts for Provision of Drinking Water in Cholistan

Cholistan Development Authority (CDA), Pakistan Council of Research in water resources and the government of the United Arab Emirates (UAE) have played a significant role in providing water resources in Cholistan.

Punjab government with the help of CDA and PCRWR are trying to explore the improved drinking water resources in the Cholistan. For instance, four water pipelines built in the Cholistan by the Punjab government with the help of CDA for safe drinking water availability to humans as well as livestock. These pipelines cover the area from 108 DB to Khalari (97 Km), 111 DNB to Nawakot (87 Km), Khutri dagar to Tufana (43. 75 Km) and Mirgah to Churi (54.32 Km). 1100 *Toba*s is in functioning (CDA, 2018) 72 *Toba*s are declared common property by PCRWR and tube wells and turbines by CDA (Malik and Ali, 2017).

UAE government has to play a significant role in the provision of drinking water sources in the Cholistan. The water provision projects by the UAE government can be seen in the Cholistan in forms of *Toba*, well, Kund and pipeline. The water projects of the UAE government in the Cholistan are relatively paved and strong in term of project quality and life.

Limited provision of clean water by pipelines and in the execution of most of the pipelines are the problem that appeals to some intervention to increase and provide the availability of clean and hygienic drinking water. For instance, the pipeline project is limited to District Bahawalpur with covering a small area of district Rahim Yar Khan. Further, water pipeline has been made by CDA but in most of the area, these water pipelines are not starting functioning. So, in this situation, the majority of the population is compelled to drink from traditional water sources which are contaminated and had adverse impacts on the household's health, especially on children. A large proportion of literature showed that children are more effective from contaminated water because they are the most vulnerable part of society relatively.

4.9 Water Sources in Cholistan

Rainwater is the main source of drinking water during the monsoon season which stored in manmade pounds locally called *Toba*s. These are common ownership of the Cholistani community but in some areas, people have their *Toba*s. The main reason for using *Toba* water is that the underground much brackish and found in depth of 30 to 40 meters. It is hardly used for livestock. But in some areas, water is less brackish depending on the geographical area of Cholistan (CDA, 2006). 1000 (small and large) *Toba*s are functioning out of 2000 *Toba*s; remaining *Toba*s became useless because these are filled with silt up to the land surface (PCRWR, 2017).

Kunds are another water source, resembling to dug well, made from pucca material (bricks and cement) above the level of groundwater like well shape to store the rainwater. These stored water for a long period relatively to *Toba*s. There are almost 150 Kunds in the Cholistan. When the

water in *Toba* finished than Cholistani community use this source for drinking purpose. The disadvantage of this source is that the water quality of this water source is worse than *Toba* source due to the maximum storage period.

In some areas pucca earthen wells constructed to keep wells strong and it's falling. There are almost 300 pucca dug wells in Cholistan (Malik and Ali, 2017).

4.10 Quality of Water in Cholistan

The underground water in the Cholistan is more brackish even rarely used for livestock, found in depth of 30 to 40 meters with containing 9000 – 24000 ppm salts which make it unfit for human or livestock consumption. But in some places water with low salt content ranging from 2000 – 4000ppm is present (Akram et al., 1986).

4.11 Water Storage Capacity of *Tobas*

The water storage capacity of *Tobas* varies from 500 to 1000 cubic meters with an average capacity of 0.5 million cubic water. Water stored for 2 to 3 three months in *Tobas*, high temperature in the summer season, heavy infiltration rate, seepage, and poor *Toba* infrastructure reduces the water storage capacity by almost up to 50% (Malik and Ali 2017).

4.12 Demand and Supply of Water in Cholistan

Water storage for humans and livestock is 33 million gallons (0.150 million cubic meters) which is insufficient to meet the 2.0 and 0.1 million populations of livestock and human, respectively. The maximum requirement of drinking water is 1700 million gallons (1700 million cubic meters) on an annual basis. Small and large *Toba*s are unable to meet the drinking water requirement (Malik and Ali, 2017).

CHAPTER V

Results and Discussion

This chapter is classified into five sections. The data collection procedure has been described in the 1st section. Demographic features are discussed in the 2nd section. Descriptive statistics have been explained in the 3rd section. The fourth section is for Econometric analysis. Whereas, the last part is specified for the Informal results of the study.

5.1 Data Collection Procedure

After visiting the Cholistani areas in Tehsil of Liaqatpur, Khanpur, and Feroza, of Bahawalpur and Rahimyar Khan districts two *Toba*s along with their surrounding *Toba*s and two well areas based on population availability have been selected as a sample. The visited areas were Sinyasi dame, Murad Faqeer wala *Toba*, Jharay wala *Toba*, keanr wala *Toba*, Cahchanra wala *Toba*, Qeemay wala *Toba*, Mamoo wali tanki, Beer wali tanki, *Toba* Bhondri, *Toba* Nawan Koot, *Toba* Tilla, *Toba* larey wala, Kheersar, and Bijnoot, Bahoo Buhmrean wala, Bhai khan, Islam Grah, Ghunya wala khu, Moonghe wala khu, Kalar wala khu and Bhagla water point.

One hundred and twenty (120) samples from four villages, 60 from each water source (*Toba* and well), 30 from each village of well water area, Kalar wala khu, and Bijnoot have been taken. Further, 25 and 35 samples have been taken from *Toba* Sanyasi Dam and *Toba* Laran wali and their surrounding *Toba*s respectively, based on the population's availability.

The time duration from July to December of 2018, was selected to obtain the required information because of the availability of water in the *Toba*.

5.2 Demographic Description

The demographic characteristics of the selected villages to make their comparison with each other are explained below.

5.2.1 *Toba* Laran Wali

The village is located in Tehsil Feroza. *Toba*s are the main sources of drinking water. The community lifestyle is nomadic. They move in some nearer area when *Toba*s water dried. Livestock and land are the livelihood sources. The majority of the population is poor. Grazing livestock and leisure are the hobbies of the population. There are no facilities for hospitals, schools, road and electricity connections. However, the mosque was present here for worship.

5.2.2 *Toba* Sinyasi Dam

The village located nearer to a paved road in Tehsil Khanpur at T-Chowk. *Toba* is the only source of water to meet the daily life water requirements of humans and livestock. People's lifestyle is nomadic and moves in some nearer areas when *Toba* dried up. There is no hospital, electricity connections and school facility in the village and its surrounding villages. Most of the community is poor and depends on livestock for the livelihood. Feroza is nearer the city where the hospital is accessible at 50 KM distance.

5.2.3 Bijnoot

Bijnoot is a village of Tehsil Feroza, situated at nearer to Pak- India border with a population of near to100 households. There was the permeant settlement of population relative to *Toba* villages. Water wells are the main source to meet the water requirements for both humans and livestock. Livestock is the main source of livelihood for the community. The majority of the population is poor. Guppa and Katcha houses were prepared for accommodation. Each family has a Guppa or Katcha house with one or two rooms and Guppa/ Kutcha for accommodation.

Some families have their well for water requirements. The water is very brackish and salty and also available throughout the year. The health risks associated with this water. *Toba*s and Kunds are alternative water sources and are dependent on rainwater in the monsoon. Each family also has small Kunds in their houses to store the water for emergencies.

The mobile school is present to educate the people, but the majority of the population is illiterate. Market, shops, road, hospital, and electricity connection facilities are missing and accessed with traveling hundreds of miles e.g. traveling costs to access the hospitals in the emergency was almost 15000 to 20000. The daily life requirement purchasing needs travel of many miles.

5.2.4 Kalar Wali

Kalar wali is a village of Cholistan in Tehsil Khanpur with having a population of almost 125 households. There is the un-nomadic lifestyle of the population due to permanent settlement. The majority of the population is richer relative to other areas of Cholistan and some families have their car (jeep) for convenience purposes. Livestock and land are the main sources of livelihood.

Solar water well is the principal source of daily base water requirement. The water is less brackish and salty relative to Bijnoot water wells. *Toba*s are also alternative water sources in the monsoon but well water is available for 12 months.

The Guppa, Katcha and pucca houses used as accommodation but Guppa house is the main accommodation resources. A mobile school is available to educate the people but still, the majority of the population is illiterate. Market, shops, road, hospital, and electricity connection facilities are missing and accessed with traveling many miles. For instance, traveling costs to approach hospitals is almost 8000 to 10000 in an emergency. People usually go to Khanpur to meet the daily life requirements in the form of vegetables, clothes, shoes, and hospitality. One television is ready to keep the community up to date about the current circumstances of the country. The characteristics of selected villages are presented in the following tables.

Table 2. Distance from House to Nearest Market, City, Road, School, Hospital.

Village Name	Market	City	Road (km)	School (m)	Hospital
Toba Sanyasi	50	50	1	No school	50
Toba Laran Wali	140	140	30	No school	140
Bijnoot	150	150	25	5	150
Kalar Wala Khu	80	80	50	5	80

Source: *A primary survey, conducted by the author.*

There was a large distance from a house to access the market in *Toba* Laran wali, Bijnoot, and their surrounding villages relatively. There is no school in *Toba* areas and its surrounding villages, *Toba* Sanyasi and *Toba* Laran Wali village. The remaining two villages have mobile schools at a trivial distance. There was a significant distance of hospitals from respondents' houses.

Table 3. Facilities Information.

Village Name	Shop	Road	Electricity	School	Hospital	Market
***Toba* Sanyasi**	No	Yes	No	No	No	No
***Toba* Laran Wali**	No	No	No	No	No	No
Bijnoot	No	No	No	Yes	No	No
Kalar Wala Khu	No	No	No	Yes	No	No

Source: A primary survey, conducted by the author.

The mobile school is presented to well water areas of villages, Bijnoot, and Kalar Wala Khu. *Toba* Sanyasi Dam villages have a road near it. However, there are no facilities of shop, market, hospital and electricity connections in all selected villages.

5.3 Descriptive Analysis

This section has been divided into subsections to discuss the descriptive analysis regarding households' information, children's health, drinking water sources, health awareness and willingness to pay for safe drinking water.

5.3.1 Descriptive Analysis of Households' Information

The information regarding the descriptive analysis of households' family size, income, education, house condition, settlement type, information about receiving any benefit from government and income sources captured in this section.

Table 4. Household's Family Size.

FS	Observation	Minimum	Maximum	Mean	Std. Dev
Toba	60	3	15	7.12	2.284
Well	60	4	12	7.40	1.870
Overall	120	2	15	7.26	2.064

Source: A primary survey, conducted by the author.

The descriptive results revealed 15 and 12 was the maximum whereas 3 and 4 was minimum family size *Toba* and well population's households, respectively. Relatively, higher average family size was in well water areas. The standard deviation of family size in *Toba* areas was relatively higher. Nomadic type of living standard might because of the higher standard deviation. In spite of these, 7.26 was the average family size of the households.

Table 5. Household's Income.

HY	Observation	Minimum	Maximum	Mean	Std. Dev
Toba	60	15000	80000	46150.00	15528.896
Well	60	18000	105000	50336.67	18727.272
Overall	120	15000	115000	48358.33	17260.484

Source: A primary survey, conducted by the author.

The family income impacts on the children's health. Families with having a high income have enough resources to care about their children's health. Higher minimum, maximum and average family income has been seen in good areas relatively. A further variation of income in well water areas are relatively higher but not so much. Government benefit in the form of land and the number of livestock (cows, goats, camel) in ownership are the cause of so much variation in income. Overall, 48353.33 rupees are average households' income which seems enough, but it is not enough due to higher family size.

Table 6. Household's House Condition.

HT	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Guppa	60	33	93	100.0	55.0	77.5
Kucha	0	7	7	0	11.7	5.8
Pucca	0	6	6	0	10.0	5.0
Guppa and Kucha	0	8	8	0	13.3	6.7
Guppa and Pucca	0	6	6	0	10.0	5.0
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

The 100% and 55% peculation respectively, of *Toba* and well live in "Guppa" with having 3 to 5 years of life. Usually, one family has one Guppa for residency. One Guppa is insufficient for the accommodation for the whole family. So, at night family members slept on land. One of the pictures in the picture section reflects the Guppa type of house. Some households have another

type of houses which are mentioned in the table usually in well water area due to permanent settlement.

Table 7. Household's Settlement.

ST	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Permanent	0	60	60	0	100	50
Temporary	60	0	60	60	0	50
Overall	100	100	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

The settlement of *Toba* village's population is temporary, relatively. Overall, the settlement of Cholistan community depends upon the water source that they are used for drinking purpose.

Table 8. Receiving any Benefit from Government.

RBG	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Yes	31	24	65	51.7	40	54.2
No	29	36	55	48.3	60	45.8
Overall	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Punjab government started a project to raise the income level of the Cholistani community. This project has many phases. Under this project "a lot of land" (a lot of land equals 12 acres) was given to the household's head in each phase. The beneficiaries of this project were 51.7% from

the *Toba* area and 40% from the well water area. Overall, 54.2% of households get benefit from this project.

Table 9. Households Income Source.

YS	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Livestock	23	46	69	38.3	76.7	57.5
Livestock and Land	37	14	51	61.7	23.3	42.5
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Livestock alone and along with land are two major sources of income in the Cholistan. Dependency on livestock alone and along with land is 38.3% and 61.7% respectively, in *Toba* areas whereas this dependency in well water area is 76.7% and 23.3%. Overall, livestock is a major source of income and livelihood in the Cholistan.

5.3.2 Descriptive Analysis of Children's Health

The information regarding the descriptive analysis of children's health, waterborne diseases, convenience type, the economic cost of waterborne diseases and the patient's current health level are captured in this section.

Table 10. Information about Children's Health.

CH	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Yes	46	39	85	76.7	65	70.8
No	14	21	35	23.3	35	29.2
Overall	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Unhygienic drinking water sources are the main cause of poor children's health in the Cholistan as well as other factors. In response to the question of whether children are being suffered in waterborne diseases or not; 76.7% and 65% of respondents in *Toba* and well area respectively, said that children are suffering in diseases. Overall, 70.8% of children under the age of five beings suffer in waterborne diseases within six months which is not a just a loss of health but also an economic burden on households to combat from these diseases. The main reason for their illness was unhygienic water sources.

Table 11. Information about Disease Type.

DT	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Malaria	9	5	14	15.3	8.3	11.7
Typhoid	8	6	14	13.3	10.0	11.7
Hepatitis	4	5	9	6.7	8.3	7.5
Skin	8	2	10	13.3	3.3	8.3
Stone	5	4	9	8.3	6.7	7.5
Throat	2	2	4	3.3	3.3	3.3
Diarrhea	7	5	12	11.7	8.3	10.0
Didn't know	6	7	13	10.0	11.7	10.8
No Disease	14	21	35	23.3	35.0	29.2
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

The children in the Cholistan are suffering from various diseases. In these diseases' malaria, typhoid, hepatitis, skin, stone, throat, diarrhea are included. Overall, malaria and typhoid were more present in children. Then contaminated and unhygienic water was the main reason behind this situation. The summary of these diseases in number and percentage is given in the above table that is under-discussed.

Table 12. Treatment Form of Waterborne Diseases.

TF	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Home Treatment	1	0	1	2.17	0	1.17
Hospital	26	24	50	56.52	61.53	58.82
Religious peer	1	4	5	2.17	10.25	5.88
BHU	0	1	1	0	2.56	1.17
RP and H	18	10	28	39.13	25.64	32.94
Total	46	39	85	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

There are different sources of treatment that have been used by households in the study area to combat waterborne diseases. More than 50% of households of both *Toba* and well areas go to the hospital (usually private hospital) in case of any illness caused by unhygienic water resources. Treatment requires a lot of economic costs which is an economic burden on households in monetary terms. The summary of the treatment form of waterborne diseases is given in the above table which is under discussion.

Table 13. Convenience Type for Travelling Purpose.

CT	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Walk	7	0	7	15.21	0	8.24
Camel	12	2	14	26.09	5.13	16.47
Motorbike	2	5	7	4.35	12.82	8.24
Own Car	0	5	5	0.00	12.82	5.88
Private Car	25	27	52	54.35	69.23	61.17
Total	46	39	85	100	100	100

Source: A primary survey, conducted by the author.

The households have used different transportation sources to access the patent's physician for his/ her treatment. The summary of these sources is given in the above table.

Table 14. Economic Cost of Water Borne Diseases.

ECWBD	Observation	Minimum	Maximum	Mean	Std. D
Toba	46	1000	15000	5065.00	2889.846
Well	39	3000	17000	6500.00	3116.172
Overall	85	1000	17000	5723.53	3063.326

The average economic cost of waterborne diseases is 5065 and 6500 rupees with a standard deviation of 2889. 846 and 3116. 172 in *Toba* and well areas, respectively. Overall, 5723 is the average economic cost of waterborne diseases with a standard deviation of 3063.326. Distance from house to hospital, treatment form, traveling type to travel hospital and type of diseases are the major factors behind high standard deviation. Further, the economic cost of waterborne

diseases includes all types of expenditure in forms of medical, transportation, food, residency and others as well.

Table 15. Patients' Current Health Status.

PCHS	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Good	38	36	74	82.61	92.31	87.05
Bad	8	3	11	17.93	7.69	12.94
Total	46	39	85	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Most of the patients (overall 87.05%) current health status is good which means they are satisfied by their physicians and working as normal as before.

5.3.3 Descriptive Analysis about Drinking Water Sources

The descriptive analysis about drinking water sources, its quality, fetching source, water protection measures and views about water sources has been discussed in this section.

Table 16. Drinking Water Sources.

DWS	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Toba	60	0	60	100	0	50
Well	0	60	60	0	100	50
Total	100	100	120	100	100	100

Source: A primary survey, conducted by the author.

Out of 100% percent, 50% of households as a sample are taken from *Toba* area and the remaining 50% is taken from well water area based on the availability of data and to differentiate the effect of *Toba* and well water sources on children's health.

Table 17. Water Sources' Appearance.

WSA	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Clean	3	49	52	5.0	81.7	43.3
Muddy	4	0	4	6.7	0	3.3
Contain some matter	6	11	17	10.0	18.3	14.2
Muddy and Contain some matter	47	0	47	78.3	0	39.2
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Regarding water sources' appearance, the majority of the respondents respond that there is relatively clean water of well water. On the other hand, *Toba* water is muddy and contains some matter which increases the chances of children's illness in the study area. Further detail of the results is given in the above table which is understudied.

Table 18. Distance from Water Source to House.

DTH	Observation	Minimum	Maximum	Mean	Std. Dev
Toba	60	1	5	3.67	1.10
Well	60	2	8	5.78	1.316
Overall	120	8	1	4.73	1.609

There was no much average difference in *Toba* and well water sources from house to drinking water sources. overall 4.73 minutes by walk-in average difference from house to the water source.

Table 19. Water Sources' Smell.

WSS	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Odd	19	0	19	31.7	0	15.8
Medium	30	7	37	50.0	11.7	30.8
Tolerant	9	0	9	15.0	0	7.5
No Smell	2	53	55	3.3	88.3	45.8
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Water smell is an indicator of water quality. Regarding this, 50% of respondents said that there is a medium smell of *Toba* water which is unhygienic because pure water is smell less. Further, its smell based on the duration of time in which water is being stored in *Toba*. On the other hand, 88.3% of respondents respond that there well water has no smell. Overall, 45.8% said that there is no smell of *Toba* water.

Table 20. Water Sources' Taste.

WST	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Normal	8	0	8	13.3	0	6.7
Bitter	2	7	9	3.3	11.7	7.5
Salty	5	53	58	8.3	88.3	48.3
Muddy	45	0	45	75.0	0	37.5
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Taste of water is also an indicator of the purity of water. *Toba* water has a bitter taste in the sight of 75% of respondents, but its taste also depends upon the duration of time in which water is being stored in it. On the other hand, well water has a salty taste in the sight of 88.5% of respondents which is not good for the purity of water.

Table 21. Water Fetching Sources.

WFS	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Children	5	13	18	8.3	21.7	15.0
Men	5	21	26	8.3	35.0	21.7
Women	50	26	76	83.3	43.3	63.3
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Like as usual in nomadic and rural areas, women are the common source of fetching water in both *Toba* and well area. Further detail of the results is mentioned in the above table which is understudied.

Table 22. Adoption of Water Protection Measures.

AWPM	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Yes	26	20	46	43.3	33.3	38.3
No	34	40	74	56.7	66.7	61.7
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

The adoption of water protection measures has an impact on children's health because clean water leads to fewer chances of diseases. Thin cloth to clean the water is usually used which is the hazardous water protection method because it only prevents seen contaminants from water but not dangerous germs that affect the children health. Most of the households are not used any water protection measures. Due to this, the chances of waterborne diseases in children arise.

Table 23. Current Availability of Water Sources.

CAWS	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Best	7	38	45	11.7	63.3	37.5
Satisfactory	11	9	20	18.3	15.0	16.7
Bad	42	13	55	70.0	21.7	45.8
Total	60	60	120	100.0	100.0	100.0

The current availability of *Toba* water was bad due to its dryness of water. However, well water availability is good because of having an underground supply of water. Further, the results of this have been given in the above table which is under discussion.

Table 24. View About Drinking Water Source.

VDWS	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Extremely -ve	9	14	23	15.0	23.3	19.2
Slightly -ve	24	16	40	40.0	26.7	33.3
Positive	16	15	31	26.7	25.0	25.8
Slightly +ve	11	12	23	18.3	20.0	19.2
Extremely +ve	0	3	3	0	5.0	2.5
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Mixed views have been seen regarding drinking water sources in the Cholistan. There are 40% and 26.7% slightly negative view of *Toba* and well water resource, respectively. Overall, the more slightly negative view has been seen regarding this.

3.5.4 Descriptive Analysis of Health Awareness

In this section, the analysis of awareness about waterborne diseases and overall health awareness has been captured which includes responses of households regarding the awareness about water borne diseases and overall health awareness of the society in Cholistan.

Table 25. Awareness about Waterborne Diseases.

AWBD	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Yes	30	29	59	50.0	48.3	49.2
No	30	31	61	50.0	51.7	50.8
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Awareness about waterborne diseases reduces the chances of illness. In response to asking a question about whether people have awareness about waterborne diseases or not, the percentage response was almost 50, 50. The responses of respondents can be seen in the above table which is under discussion.

Table 26. Overall Health Awareness.

OHA	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Minimum	20	6	26	33.3	10.0	21.7
Average	22	34	56	36.7	56.7	46.7
Maximum	8	9	17	13.3	15.0	14.2
Nil	10	11	21	16.7	18.3	17.5
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

Health awareness has a vital role in attainment of better children's health. The 56.7% respondents respond that there is average health awareness in Cholistan regarding importance of better health and water borne diseases. The remaining responses can be seen in above table which is under discussion.

3.5.5 Descriptive Analysis of Willingness to Pay for Safe Drinking Water

It was important to know about some useful information regarding characteristics of willingness to pay and the amount of money that households were willing to pay for safe and clean drinking water sources for econometric analysis and descriptive analysis of the study. So, for this purpose, this section is devoted to descriptive analysis of characteristics of willingness to pay and amount of money that households are willing to pay for safe and clean drinking water sources.

Table 27. Characteristics of Willingness to Pay.

WTP	Frequency			Percent		
	Toba	Well	Overall	*Toba*	Well	Overall
Yes	29	28	57	48.3	46.7	47.5
No	31	32	63	51.7	53.3	52.5
Total	60	60	120	100.0	100.0	100.0

Source: A primary survey, conducted by the author.

The unhygienic water resources in Cholistan are the major cause of children's illness. So, it was necessary to know about the willingness to pay for safe drinking water. More than 50% households were unwilling to pay for hygienic water resources in forms of pipe line, water tanker etc. In reasoning, they said that give livestock tax (10 rupee per cow) to government. So, it is government responsibility to provide us clean and hygienic water resources.

Table 28. Amount of Willingness to Pay.

AWTP	Observation	Minimum	Maximum	Mean	Std. Dev
Toba	60	0	300	51.00	72.549
Well	60	0	350	56.17	84.935
Overall	120	0	350	53.58	78.695

Source: A primary survey, conducted by the author.

There is no much difference in average willingness to pay for safe and hygienic water resources in Cholistan. The minimum WTP is 0 in both *Toba* and well population whereas maximum WTP is relatively higher of *Toba* population due to more shortage of water. Overall, 58.17 rupees is average WTP in Cholistan.

5.4 Econometric Analysis

The analysis of two regression models has been made using a bivariate logistic regression model (BLRM), due to having a qualitative dummy response of both model's dependent variable in this section. In the 1st section (5.4.1.) econometric analysis of children's health (CH) model whereas in the 2nd section willingness to pay (WTP) for safe drinking water has been done. In both sections, impacts, and significance of variables with the dependent variable, marginal effects of the model to interpret the results, discussion on results and correction of the model has been discussed in detail.

5.4.1 Impact of Drinking Water Sources on Children's Health

Bivariate Logistic Regression Model (BLRM) has adopted to examine the effect of explanatory variables on children's health due to the qualitative response of the dependent dummy variable.

The variables have included in the model after the core study of national and international literature.

Table 29. Marginal Effects of Bivariate Logistic Regression Model for Children Health.

Variables	P. Value	Marginal Effects of the Coefficients
FS	(0.004) ***	.1011042
LHY	(0.071) *	-.185284
DWS*	(0.048) **	.2480844
AWPM*	(0.041) **	-.2572718
AWBD*	(0.075) *	-.2108344

(**Note:** P. value is given in parenthesis. * indicates the discrete change of dummy variable from 0 to 1. ***, **, * show significance at 1%, 5%, and 10%, respectively. Marginal Effect= dy/dx).

In the table, children's health is explained whereas others are explanatory variables. The dependent variable children's health has binary response, one for those children who are affecting (became ill) from water resources otherwise zero. The results revealed that there is a positive and significant relationship between children's health (CH) and family size (FS) of household and drinking water resources (DWS) whereas, household's income (HY), awareness about waterborne diseases (WBD) and adoption of water protection measures (AWPM) have a negative and significant relationship with children health.

The results of this technique only show the relationships and significance of the variable but not tells about the magnitude of relationships among variables. Further, the results of this technique are not directly interpretable. So, for the interpretation of the coefficients marginal effects are also been calculated and explained below.

The log of income had been taken to makes the data reliable in case of results reliability and authenticity. If there is an extra child in the family than as per empirics there will be 10% more chance of getting water disease in children under the age of ten. The logic behind this is that contaminated water has effect on new borne children more relatively due to their week immune system. The studies of [Su, (2005)] and Fink et al. (2011)] on water and its impact on children's health support the results that larger family size worsens the children's health. Basing on results, larger family size harms children's health due to increases in the dependency rate, reduces the income and average expenditures of households to provide hygienic food, water, proper education, and health facilities, etc. to each family member. Therefore, the problems of stunted growth of children due to malnutrition, lower cognitive skills have arisen which grounds a household's income, economic growth, and human development at the household and the country level. The higher treatment costs to combat diseases not only lowers the household's income but may generate a trap of vicious cycle of poverty for the households.

If there is increase in income by one thousand rupees, there is possible reduction of 18% of getting water borne diseases in the children. The reason behind this is that higher income level helps the head of households to provide hygienic food, drinking water and health facilities. According to our established hypothesis income has negative expected sign and that is a negative association with getting water disease. Income has consequential policy implications as higher income leads to less probability of getting water disease in children due to better living conditions and amenity services.

Of water resources, people who have to drink water from *TOBA* have 24% more chance of getting water disease while other sources harm the probability of getting water disease. But as results witness, other sources (well) of water are insignificant. Although both water sources are harmful to children's health, *Toba* water more worsens the children's health due to its storage capacity for two to four months and the saline mix in it increases the chances of children's illness. This situation increases the treatment cost of waterborne diseases which is an economic burden of households. Further, it stagnates and adverse human development growth in the Cholistan. On the other hand, the children who drink water from well are also been suffering in waterborne diseases but the results of these are not interpretable due to its insignificant coefficient. The previous studies of Mertens et al. (1990), Gundry et al. (2004), Fink et al. (2011), Mohsin et al. (2013), Schmidt (2014), Ezeh et al. (2014) and Nabeela et al. (2014) related to water strengthens the results that unhygienic and unpaved water sources harm the children's health. Further, WWF (2007) and HAI (2014) reports on also support theses argument. Plate et al. (2004) revealed that Well water has less chance of children's illness.

People who have adopted water purification and cleanliness from impurities through straining also have lesser chances of getting water-borne diseases. There are 25% fewer chances of getting water diseases in families who have adopted water purification measures. The adoption of water purification techniques cleans the water from arsenic and dangerous germs that became the cause of children's illness. Results of adoption of water protection measure revealed in the form of improved children's health, lower treatment cost and improve the living standard of households.

Awareness about the waterborne disease has a significant negative impact on the probability of getting child diseases; if a family has awareness regarding waterborne disease then it will reduce the chance of getting the waterborne disease by 21%. The head of households who are well aware from the waterborne diseases and its causes may try to provide clean water to their children by using water purification techniques to overcome the chances of poor children health, treatment cost and social life disturbance. This condition leads to increase in savings, investment, productivity, human development and economic growth at household level as well as country level.

From the above discussion, it is concluded that there are various determinants of children' health that have impact on children health via different channels. The justification of the results has been given with the help of different previous studies that has been conducted in different time periods. In case of this study, family size, household income, drinking water sources, adoption of water protection measures and awareness about waterborne are the determinants of children's health.

5.4.2 Willingness to Pay for Safe Drinking Water Model

Water shortage with unhygienic quality was a major problem in the study area which is not just worsening the children's health but also an economic burden on households in the treatment form of waterborne diseases for the better children's health. So, this situation makes it necessary to know-how about the willingness to pay (WTP) for safe drinking water. For this, a bivariate logistic regression model is used, and its results are given in the following table.

Table 30. Marginal Effects of Bivariate Logistic Regression Model for Characteristics of WTP for Safe Drinking Water Model.

Variables	P. Value	Marginal Effects of the Coefficients
HY	(0.000) ***	.0000456
CH*	(0.055) **	.4679592
AWBD*	(0.045) **	.3052618
HEF	(0.259)	.0545231

(**Note:** P. value is given in parenthesis. * indicates the discrete change of dummy variable from 0 to 1. ***, **, * show significance at 1%, 5%, and 10%, respectively. Marginal Effect= dy/dx).

The results of the above regression showed that there is a positive and significant relationship between household income (HY), children's health (CH) and awareness about waterborne diseases (AWBD) with the willingness to pay (WTP) for safe and hygienic drinking water resources. The highest education of any family member in the family has a positive and insignificant relationship with the dependent variable. Constant has a negative and significant relationship with explained variable children's health.

The higher income leads to more willingness to pay, a unit increase in income leads to .0046% more willing to pay. The [Mustafa et al. (2009)] also observed a positive relationship between income and willingness to pay for improved water sources. Water shortage and its poor quality is a major problem in the Cholistan. The households have higher incomes relatively are willing to pay more for safe and hygienic water resources to improve the children's health and reduce the

treatment cost of waterborne diseases. So, income is an important determinant of WTP for safe drinking water in the case of this study.

If a child is suffering a disease, the more is the willingness to pay i.e. 46%. The results supported by the study of Mustafa et al. (2009) that the illness of any household's family member leads to more WTP for safe drinking water. The households whose children are suffered by waterborne diseases have more willingness to pay relatively because they already have been known about the treatment cost of waterborne diseases which are not just economic burden for them but also impacts on their social life. So, children's illness is an important indicator of WTP for safe drinking water.

More awareness about water born disease also leads to more willingness to pay i.e. 30%. Awareness is also an important indicator which impacts on the willingness to pay for safe drinking water because the households that have awareness about waterborne diseases know about the costs of waterborne diseases and they want to overcome the risks of illness in the targeted area by demanding new improved water sources.

The highest education of any family member in a family has an insignificant impact on WTP for safe drinking water due to the trivial literacy rate in the Cholistan.

From the above discussion of results, it is concluded that as like the previous study's income and awareness about health (waterborne diseases) are common determinants of willingness to pay. Whereas, WTP also depends upon children's health which in the case of this study.

5.5 Informal Results of the Study

Nowadays, informal results of the study are becoming an essential section of research to support the authenticity of specific research. Informal survey techniques in forms of focused group discussion (FDG) Key information survey (KIS), participatory rural appraisal (PRA) and some incident as case study tools have been discussed in this section.

5.5.1 Focus Group Discussion

Focused group discussion is a tool of qualitative research and is a helpful tool for this study to get the true picture of problems that are associated with children's health and water quality of water sources in the targeted area. It also helps to get the extra and beneficial information relating to the study that is useful to suggest policy recommendations. Nowadays this tool has become a popular tool because of having a property of providing quick and useful information related to the specific issues. Due to this reason, for taking advantage of this tool, we selected some native people that are well aware and living form many years in the Cholistan. For this, those people have been selected that have a sense of the problems and their effects on human beings and are well aware of the present and past situation of the targeted area.

5.5.2 Discussion with Local Families

Interview of different people having age between 50 to 70 was conducted through a participatory development mechanism to know their ideas relating to the water problems and their impact on human beings. Their views reflect that water scarcity and its pollution are a major problem in the area especially for those residents whose water dependency is on *Toba* water. Having poor water quality of *Toba* jeopardizes the lives of the native community in forms of many epidemic

diseases like skin diseases, throat diseases, typhoid, malaria, and hepatitis, etc. The population who is depending upon well water is also not free from the dangers of health problems. Due to having brackish and salty water of water native community suffered in throat, kidney and hepatitis diseases. They demanded the effective interference of the government to overcome the existing problems relating to water availability and health issues in targeted areas.

5.3.3 Case Study Events

In this section, a few of the case study events that are a danger for the native community have been described. These events are as follows.

5.3.3.1 Child's Death Incident

During participatory rural appraisal (PRA) a question regarding children's problems other than health issues was asked. In response, one person with the name 'Yaseen' expressed his views regarding children's issues associated with *Toba* in the following lines.

He said:

> *"Once a child drops into Toba and died. These types of incident have also happened often in the past".*

5.3.3.2 Well Digging Incident

A person of the local community expressed his views about the well-digging incident in the following lines.

He said:

"The digging is dangerous for well diggers and in often cases deaths of diggers can happen. This danger is associated with diggers due to having less clay in the Cholistan. The way of digging is that at an initial point well width is less, and it is increased as well as its height increases. So, as well as the width of the well from lower-level increases, the chances of falling of initial surface increased which often causes the death of diggers. Many diggers have been died due to this incident".

5.3.3.3 Oasis and Cow's Death Incident

While interviewing a respondent told us about the presence of oasis concept which jeopardizes the lives of livestock in the Cholistan.

He said:

"When Tobas dried up it seems from some distance that there is water at some away but in actual no water exists, it just seems due to sunlight reflection on the sand, this concept known as an oasis. Livestock (cows) deceives from it by moving forward in hope of water existence which causes livestock (cows) death due to the nonexistence of water. This incident happened with the livestock many households".

5.3.3.4 Track Forgotten Incident

A respondent shared a route forgotten incident that happened with predators many years ago. He said:

> *"Some predator comes for hunting but unfortunately, they forget the route in the Cholistan. After some days their dead bodies met to A pastoral".*

5.3.4 Key Information Survey (KIS)

Key Information Survey (KIS) is a method of collecting required information from those people who are well aware of the concerns in an area. Through this method, information related to problems in the area collected by native people, government servants, political leaders, influential persons, doctors, educated person and experts of specific issues by conducting interviews. The key informant's data is helpful regarding the results discussion and policy perspective. To get benefits from this technique we selected some native personalities to highlight the true picture of native's problems. The native personalities are not selected on any hard and fast rule but on having a sense of issues identification. The personalities characteristics and their views regarding health and other issues are discussed below.

5.3.4.1 Major (Retd.) Irfan Mustafa (Country head of UAE)

Major (Retd.) Irfan Mustafa is a country head of United Arab Emirates in Pakistan, head of UAE palace, and supervisor of water provision (water tankers, *Toba*s, well, etc.) and social welfare projects in the Cholistan on the behalf of UAE government. He has also performed their services in the military at the major post. Nowadays, he is living in UAE palace. His contribution remains remarkable in data collection, providing useful and required information on different issues to

make study successful, valuable and interesting. His views are valuable and have great importance for making sound policy to eradicate and overcome the existing problems. He shared his valuable views with us.

He said:

> *"There are three deserts in Pakistan namely Thal, Cholistan and Thar. Thar is toughest whereas Thal is an easier dessert for life survival relative to the Cholistan based on clay factor in the sand. In results, water storage of Tobas in Thar is higher whereas in Thal is least relative to the Cholistan. Although, health problems for children and elders are concerned with unhygienic water sources. However, the Cholistani people have been addicted to these water resources due to living here for many years".*

Further, he added:

> *"Cholistani people are not as poor as they represent. Regarding this, he shared the story of a pastoral. He said that once having lunch at our camp I saw a pastoral. I called him for sharing lunch with him. After lunch he thanked us. Then I started a discussion with him. During the discussion, he said that I am a poor person. At this, I asked who is the owner of these cows which was standing nearby? He responded I'm. Then I asked how much these are? He responded 500 cows. Then I asked how is the owner of these camels? He responded I'm. Then I asked him, how much these are? He said 200. Then I asked him about the goat*

which was standing near to us. He responds, these are also mine and I didn't know how much these are".

5.3.4.2 Ibrahim Misri (UAE government servant; driver)

Ibrahim Misri is a driver of UAE check post in Cholistan desert and serving his duties from the previous 15 years. He is well aware of entire Cholistan and issues that exist in it. He shared Cholistani community problems in the following line.

He said:

"Water shortage is the foremost problem is the Cholistan. The health and water shortage issues are associated with Cholistani peoples due to unhygienic and unimproved water sources in forms of Tobas and wells. Further, he mentioned that often wells digging causes deaths of diggers. There is a need for influential government interference to overcome and eradicate issues associated with Cholistani peoples".

5.3.4.3 Yaseen (UAE government servant; supervisor of check post)

Yaseen is a supervisor of a UAE check post in the Cholistan. He served 15 years in the Cholistan, well aware of entire Cholistan and remains in contact with the community to know their problems. His views regarding the local community problem are remarkable.

He said:

> *"Water scarcity is a significant problem for the Cholistani community as well as other problems. Further, unhygienic water sources increased the chances of children and elder illness. Lack of transportation, roads, and hospitals are the factors that further deteriorate children's health. The effective government interventions regarding problems associated to the Cholistani community will be needed to overcome existing problems".*

Basing on the above-mentioned interviews we can conclude that the Cholistani community surrounded in multiple problems relating to water and children's health. So, there is a need for immediate and effective government interventions to overcome and eradicate the above-mentioned problems.

CHAPTER VI

Conclusion and Policy Recommendation

This chapter is categorized into two subsections. In the first section conclusion of the research elaborated whereas in the second section policy recommendation has been proposed.

6.1 Conclusion

The Cholistan is an underdeveloped area of Pakistan and surrounded in multiple problems. Lack of infrastructure, markets, schools, and hospitals with lower literacy rates are the common characteristics of this area. Water shortage and its poor quality are one of the most important issues due to unhygienic water resources like *Toba*s, well and Kunds. So, health problems are associated with these water sources. Particularly, *Toba* water is more dangerous for children's health because of its storage capacity for two to four months and saline mix in it which jeopardizes the lives of the Cholistani community.

Empirics of this study supports the results of previous literature regarding drinking water and children's health that unhygienic water resources mostly effect to children due to their lower immune system to combat from waterborne diseases. Children are being suffered from waterborne diseases in the Cholistan. The lower income, higher family size, lack of awareness, less adoption of water protection measures are the other factors than water resources that worsened the children's health. The Income, awareness about waterborne diseases, adoption of water protection measures has positive whereas family size has been a negative impact on children's health. Previous studies showed that education is an important determinant of

children's health has a positive impact on children's health but in this study, the effect of education is being insignificant due to trivial literacy rate.

There is a negative impact of mentioned issues on households in economic and social perspectives. Economically, problems of poor health due to unhygienic drinking water appeals to households to combat from waterborne diseases. For this, they have to spend money as a treatment cost which decreases their savings and Investment. Further, affected children and elders do not perform their duties in a good manner due to a decrease in their productivity which is also an economic loss of households. Socially, children's illness also impacts the social life of children and their family members due to absent form daily routine work during the treatment and care of the affected person.

Further informal results showed that health problems are not only associated with children but also elders. So, this situation appeals to some immediate and effective interference by the local community and government to overcome and tackle down associated problems in forms of drinking water and children's health.

6.2 Policy Recommendation

The multiple problems are associated with the Cholistani community that also has been discussed in the above section. So, there is a need to overcome and tackle down all such problems that harm children's health and socio-economic condition of the household. The economic conditions of households are associated with better children's health and hygienic drinking water sources in the study area. Better children's health means to overwhelm in the treatment cost of waterborne disease, increase in income and improvement of economic

conditions of households. For this purpose, the following policy recommendation has been suggested.

i. Awareness has a vital role to overcome and eradicate those issues which are associated with a particular area. There is a need to educate the people to raise awareness by establishing schools in Toba areas as like as well areas. Further, conduction of seminars by local government on clean water and its impacts on health and socio-economic conditions arise the awareness to improve the children's health and overcome treatment cost which is an economic burden of waterborne disease. By this, economic conditions of households would be improved, treatment cost would be overcome, saving increases, investment on livestock and other business increases. As a result, households and country growth gave fruits in the form of better human development.

ii. Larger family size is also a problem in the study area which increases the dependency rerate of family members on households. There is a need to arise the importance of smaller family size and its impact on children's health and socio-economic conditions of households. For this, an active campaign should be executed by lady health workers and doctors. The religious peer can play a positive role in this regard because people follow them more relative to others in the Cholistan.

iii. The adoption of water protection measures has a positive impact on children's health. In the case of our study, more than 50% of households adopt no water protection measures which hurts children's health. Further, the households that are adopting water protection measures to clean the water are not adopting efficient and improved sources of water protection measures. So, there is a need to provide new ways for efficient water

protection measures by the local government and doctors to encourage water protection to make water clean and hygienic.

iv. As mentioned earlier water shortage and its quality are one of the most severe problems in the Cholistan. So, there is a necessitate to solve and overcome water issues to assure better children's health. It is the responsibility of the government to provide hygienic water sources in the Cholistan. Therefore, the government ought to perform their duties in this regard by providing improved water sources which overcome the hazardous effect of health. The local government made it sure to execute existing drinking water pipelines that are developed by Cholistan Development Authority with continuing efforts for development for new improved sources.

v. In case of emergency more than 10 thousand rupees consumed as transportation by the households of Bijnoot and Kalar wala *Toba* due to no availability of hospital. So, it the responsibility of the government to provide the mobile hospital with an ambulance in remote areas to provide the facility of health and reduce the economic costs of waterborne diseases.

vi. Education is a good weapon to tackle down those issues that are suffered by a specific community because education creates awareness and helps to solve a particular problem suitably. The presence of trivial literacy rate appeals to improve the literacy rate in the Cholistan by establishing schools. For this, some education incentives-oriented policies in the form of scholarships at a primary level required to attract the Cholistani community towards education. This will not only improve the living standard of the Cholistani

community by switching to some alternative ways of livelihood but also be useful for the country in terms of its growth and human development.

vii. Income has a vital role in increasing the health of the society because more income means more resources to provide those facilities to children' enhances their health level. So, for this local government should launch such programs which may enhance the income level of households. By this, income of households will be increases which means the better resources to provide health facilities to the children and other family members. It will also increases the productivity, economic growth of the country and overcomes the social disturbance of households and the family members whose children' are being suffered by waterborne diseases.

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Appendix

1 Questionnaire

Socio-Economic Impact of Drinking Water from *Toba* on Children's Health:

A Case Study of Cholistan

I am Mahtab Ahmad, student of MPhil Economics at Pakistan Institute of Development Economics (PIDE) Islamabad. I am doing thesis on **(**Socio-Economic Impact of Drinking Water from *Toba* on Children's Health: A Case Study of Cholistan**)**, as a partial fulfilment of MPhil degree requirement. I do herby request you to participate in this survey. Feel free to express whatever you feel appropriate. I assure you that you will be not to receive any suffer or loss due to what you have expressed in this survey.

Thank you!

Time: _____ Date: _____

Part No.1 Respondent Demographic Information

1. What is your Name? _____
2. What is your Gender? Male=1; Female=2
3. What is your Age? _____ Years.
4. Which is your District? RYK=1, BWP=2
5. What is your Tehsil Name? _____

6. What is your Village Name? _____

7. What is your Marital Status? Married=1, Unmarried=2

8. What is your Education? _____ Years.

9. Are you Head of the Family? Yes=1, No=2

Part No.2 Distance from Nearest

10. School by walk _____minutes.

11. Paved Road _____ KM

12. Nearest Market _____ KM

13. Nearest BHU _____ KM

14. Nearest Hospital_____ KM

15. Nearest City Name _____ KM

Part No 3. Family Information

16. How many are numbers in your family? _____

17. How many are children in your family? _____

18. What is the highest education of any family member in your family? _____ Years

19. How much are the number of employed members in your family? _____

20. Hou much is the total family income from all sources including any benefit from government? PKR_____/ month.

21. What is your House Type? Guppa=1, Kucha=2, Pucca=3, Guppa/ Kucha=4, Guppa/Pucca=5

22. How many are the number of rooms excluding kitchen and store room? ___

23. What is Settlement type? Permanent=1, Temporary=2

24. Do you have Electricity Connection? Yes=1, No=2

25. Do you gain Any Benefit from govt? Yes=1, No=2, If Yes than Specify _____

26. What is your Income Source? Livestock=1, Livestock and Land=2

27. What is the Distance from House to Livestock Place? _____ by walk in minutes.

Part No.4 Family Health Information

28. Was any Children being sick during the last month? Yes=1, N0=2. If no than skip this part and move to part, no 4.

29. How many children being ill from in waterborne diseases_____?

30. How many family members being ill from in waterborne diseases_____?

31. Which diseases was? Malaria=1, Diarrhea=2, Typhoid=3, Hepatitis=4, skin diseases=5, cough=6, flu=7, fever=8, don't know=9

32. How severe sick person affected from diseases? Minimum=1, average=2, maximum=3

33. What was the treatment form? Home Treatment=1, Hospital =2, Religious Peer=3, BHU=4, Religious Peer and Hospital=5

34. In case of Hospital Treatment, Hospital type was? Public=1, Private=2

Part No.5 Economic Cost of Waterborne Diseases

35. What was the travelling form to go to Patient's physician? Camel=1, Walk=2, Motorbike=3, Private Car=4, Own Car=5
36. What was the average monthly treatment cost of entire family on waterborne diseases including medical expense, traveling cost, accommodation cost, food, other expenses and implicit cost in PKR during drinking water from water sources (toba and well)? _____

Part No. 6 Treatment Satisfaction

37. What is the current health status of patients? Good=1, Bad=2
38. Are they working normal as like as before? Yes=1, No=2

Part No. 7 Information, Views about Drinking Water Sources and Awareness

39. What is your drinking water source? Toba=1, Well=2
40. Water source is ownership of? Govt.=1, Private=2, Own=3
41. What is the appearance of drinking water source? Clean=1, Muddy=2, Contain some matter=3, Muddy & Contain some matter=4
42. What is the taste of drinking water source? Normal=1, Bitter=2, Salty=3, Muddy
43. What is the smell of drinking water source? Odd=1, Medium=2, Tolerant=3, No Smell=4
44. Who is water fetching source? Children=1, Men=2, Women=3
45. What is the distance from house to water source by walk in minutes? _____PKR.
46. Are you adopting any water protection measure to clean the water? Yes=1, No=2. If yes than

47. Which type of protection measures are you adopting? Filters=1, Boiling Water=2, Water Purification Medicine=3, Mineral Water=4, Usage of Cloth=5
48. Is there any monetary cost of fetching water is involved? Yes=1, No=2 if yes than who much in PKR? _____
49. What is the general attitude of community about drinking water source? Extremely Negative=1, Slightly Negative=2, Positive=3, Slightly Positive=4, Extremely Positive=5
50. Does community have awareness about waterborne diseases? Yes=1, No=2
51. Do you have awareness about waterborne diseases like diarrhea, hepatitis, typhoid etc.? Yes=1, No=2
52. What is the overall health awareness level in community? Minimum=1, Average=2, Maximum=3, Nil=4
53. How you consider the current availability of drinking water source? Best=1, Satisfactory=2, Bad=3
54. Existing Water Sources are the reason of diseases in your locality? Yes=1, No=2, if Yes than specify: _____
55. Are you considered that livestock is main reason behind unhygienic drinking water sources? Yes=1, No=2. If Yes, how? Specify_____
56. Does any other problem than health is associated to children from drinking water source? Yes=1, No=2. If Yes than specify_____

Part No. 8 Willingness to Pay for Safe and hygienic Drinking Water

57. Do you know any law to provide safe water? Yes=1, No=2

58. If Yes than who is responsible for its implementation? Municipal committee=1, local government=2, provincial government=3, community organization=4, another (specify: ……) =5
59. Suppose that MC decides to provide improved water sources in form of water tanker, filtered plant and pipe lines? Would you accept the new improved water supply system? Yes=1 No=2
60. If yes than what is your willingness to pay for safe drinking water? _____PKR
61. If no than why? Tell the reason_____
62. What should be the time frame for billing of water? Quarterly=1, Monthly=2, Weakly=3
63. What are the reasons you consider more important for changing an existing drinking water source to improved system of water supply? Improved Health and Hygienic Factors=1, Convenience=2, Regular Supply=3, Cheaper Water=4, Any Other than specify_____=5

Part No. 9 General Questions

64. What can role community play to improve the water situation?

_____

_____

_____

65. Have you any suggestion/scheme in mind for the provision of safe drinking water in your locality? Yes=1, No=2. If yes than specify

_____

_____

_____

66. Have you any scheme/ idea to improve the Children's Health in your locality? Yes=1, No=2. If yes than what is the scheme?

_____

_____

_____

2 Survey Pictures

Some pictures have been taken by author during the data collection process which depicts the demographic characteristics of households in the Cholistan. Some of these are labeled in this section.

Figure 2. Toba Water Source of Drinking Water.

Figure 3. Toba Source of Drinking Water Used by Livestock and Humans Together.

Figure 4. Guppa.

Guppa is type of house in which is used as accommodation for the Cholistani community. Usually, a household has one Guppa in their ownership which is insufficient for a household's family. So, usually, most of the family members sleep at ground.

Figure 5. Toba in Dried Form.

Figure 6. A Road by UAE Government in Cholistan.

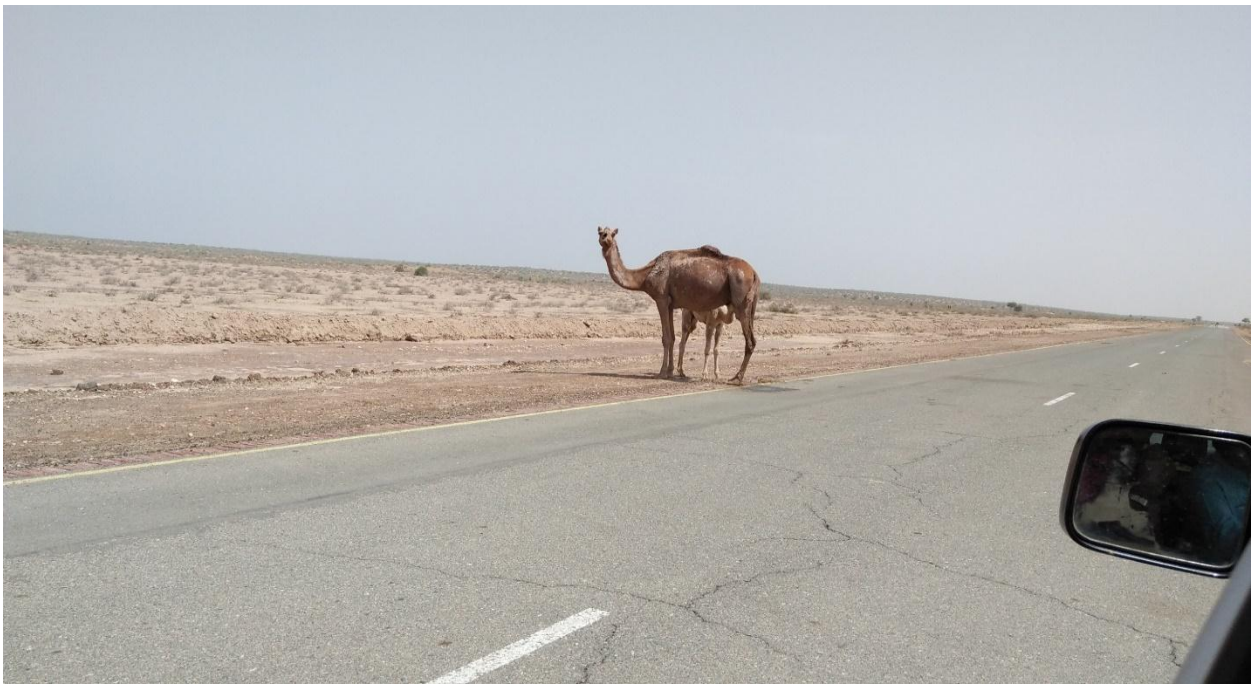

Figure 7. Algae Ridden Toba.

Due to uncleanliness of toba fungus produced in water. It belongs from those tobas which has high water storage.

Figure 8. Toba with Clean Water.

Figure 9. Mumuwali Tanki by Cholistan Development Authority.

Figure 10. The Place for Livestock Vaccination by Cholistan Development Authority.

Figure 11. Well Source of Drinking Water.

Figure 12. Kund Water Source by UAE Government.

Figure 13. Kund Source of Drinking Water by Cholistan Development Authority.

Figure 14. Construction of News Toba by Wildlife Department.

Figure 15. Small Kund in Bijnoot Village in Houses.

Figure 16. Well Sources of Drinking Water in Bijnoot village.

Figure 17. Katcha House in the Bijnoot Village.

Figure 18. Bijnoot Village.

Figure 19. Kalar Wala Khu.