ASSESSMENT OF SURFACE WATER QUALITY IN SELECTED DAMS OF PAKISTAN

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ABSTRACT

This study was conducted on the eight selected dams of Pakistan (Rawal, Simly, Khanpur, Shahpur, Tarbela, Mangla, Tanaza and Naryab dam). To determine, the presences of heavy metal concentration in the water of selected dams and to estimate the other physiochemical properties as well. The selected heavy metals for the study were: Cr, Cd, Cu, Zn and Mn and physiochemical parameters which were estimated : pH, TDS, Cl, NO_3, SO_4 and Hardness. Fifty samples were collected from each dam and analyzed according to standard protocols. The concentration of all heavy metals was found within the standard limits provided by NEQS except the concentration of manganese in Mangla dam which were high where it is twice according to standard. Results indicated that the selected dams are not contaminated with the heavy metals except Mangla for manganese. All heavy metals and physiochemical parameters were within limits of NEQS. The water needs proper filtration. Proper check is required to keep the water within standard limits and good for usage.

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ABBREVIATIONS

WHO	World Health Organization
TDS	Total dissolved solids
TSS	Total suspend solids
PAK-EPA	Pakistan Environmental Protection Agency
AAS	Atomic absorption spectroscopy
CFM	Cubic Feet per Meter
LCD	Liquid crystal display
MCL	Maximum contaminant level
ISO	International Standards Organization
IWQ	Institute for Water Quality
WQF	Water quality file
MAP	Million acre-feet
PLI	Pollution load index
CDA	Capital Development Authority
EPA	Pakistan Environmental Protection Agency
K_2CrO_4	Potassium Chromate
Mg	Magnesium
$NaNO_3$	Sodium Nitrate
NEQ’s	National Environmental Quality Standards
PEPC	Pakistan Environmental Protection Council

PEPA	Pakistan Environmental Protection Act
pH	Negative Log of Hydrogen Ion Concentration
UV	Ultra Violet
As	Arsenic
WWF	World Wide Fund
NIH	National Institute of Health
OECC	Overseas Environmental Cooperation Centre
MAF	Million Acre Feet
WQI	Water Quality Index
ADB	Asian Development Bank
SOE	Standard Operating Environment
WRI	Water Resource Institute
PHED	Public Health Engineering Department
WASA	Water and Sewer Authority
PSI	Pakistan Standard Institution

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CHAPTER 1

INTRODUCTION

We usually take water as a very ordinary substance in our daily life, but it has a huge significance in our life as our life totally based upon the presence of water. Life is not even possible without water. We drink water, use in our bodily functions, used for washing, medium of life for aquatic life. The importance of water can be learned as the huge amount of water because flood destroyed nature and on other hand the less amount of water cause the drought also become danger of nature and human. Water can be taken as very simple compound and as well as very complex solution when it comes to scientific processes. (Chaplin, 2001). Every person needs clean and safe water to carry out normal life activity healthy these activities usually includes drinking, cleaning, personal hygiene. Clean water is need and right of every living organism present on the earth's surface. Our earth has 71 % of water on surface but this water is salty and only 1 % water can be used by living creatures. Water also have some other standard to be called safe (WHO, 2011).

1.1 Presence of water on earth

On planet earth water is present in all forms and states it is the most widely spread subtances on the earth. Water is very important for earth and its system but when talked about the biosphere its importances is unmatchable because its run all the major processes that are responsible for life. Water is only substances that exist in all form on earth liquid, solid, and vapors (gas). Due to its unique features it can be found in the widespread oceans. Small and big lakes, rushing rivers, underground water and topsoil and ice in the poles and high mountains. In liquid state the water found mostly as in oceans, river and lakes. This give us the most convened form of water to use directly this make us 71% of our total earth surface. Human and plants depends mostly on the liquid state water. Water is also found in the hard (solid) state the form of glaciers, ice caps. These forms of water later responsible for the availability of fresh water in ground water channels. The third form of water present in the atmosphere (vapors) are responsible for the rain and humidity in the atmosphere, forming winds and changing seasons around the globe. Water can also be found in the human body, plant cells, upper soil and earth crust. Water because of its unique dynamics contributes in the all major processes of the globe. Water cycle is the most important process going on the earth (Shiklomanov, 1998).

1.2 Ground water and surface water

Water because of its wideness found both on surface of earth and beneath the surface of earth. Underground water is very important for many geological processes, soil enrichment, soil types. energy, food security and ecosystems. Groundwater is usually recharged by the surface water or the stable water body on surface, but this process is very slow depending upon the soil type. The age of underground water is also very important ranging from the few months to several million years. The global distribution and recharged status of underground water is a very complex study. According to some modern calculations of geochemical, geologic, geospatial data and hydrological analysis it is estimated that less than 6% of total underground water is present in the uppermost portion of the earth landmass. The age of this ground water is less than 50 years. The major underground water is present beneath the 3 Km depth (Glcesonet et al., 2016).

Surface water is characterized as the water running and stored above the surface of the water. The most surface water is consisting of rivers, lakes, glacier and ice caps. Surface water are the most difficult to handle because once enter ocean its losses the status of fresh water. It either used from the natural running channels like river, lakes and streams or that are stored in temporary storages likes dam and pools to be used upon need. Surface water has a very important role in functioning and economic of all ecosystem. The surface water has its role in agricultural, industrial and domestic means (Khublaryan, 2009).

1.3 Water quality

The quality of water is mainly referred to the purity and features of water. Anything that enter the water cause impurity but if have an adverse impact is called pollution. This can bring changes in water quality and its features and also has the tendency to interrupt the processes in which water takes the active part. Pollution may enter the water through many routes it maybe inorganic in nature or organic. Organic pollution in water mostly enter through domestic and livestock means, and inorganic pollution may enter through industrial areas or other means and can alter the nature of water. These pollutants have direct impact on consumer like plant, humans and aquatic life. (Chaudhry, 2010). The water quality get low downstream as the water reaches the coastal area its quality faces the constant downfall. More and more pollutant enter in the water system if not artificially or anthropogenically they enter through natural phenomena like rock weathering, sedimentation and landslides. On the other hand, anthropogenic activities also dumped a huge amount of toxic pollutant into the water. For the modern world the assessment and monitoring are the biggest task many countries have worked on this problem and preventive measures against this problem (Debelsetet al., 2005).

The water bodies which are mostly under monitoring are river because it carry huge amount of water downstream only monitoring of pollutant is not enough the allocation of sources of pollution and its impact not only on the water body but also on biota and ecosystem present downstream which going to receive those pollutants. (Jindal and sharma. 2010). The best to monitor a running water body is to make check point on some distances (few Km in case of river) to collect samples and analysis them against standards of water. Assessment of underground water is also very important as it is used as major water source where enough surface water is not present. In most of the agricultural country point sources of water (tube well) are used so quality of ground water is very important. Glaciers and ice caps should also put under consideration of atmospheric pollution as they recharged ground water channels later if polluted the pollution carry to fresh water on later stages (Bordalo et al., 2006)

1.4 Water pollution

Water pollution is generally defined as the addition of the unwanted and undesired substances to water that makes it unhealthy for drinking and unfit for domestic and industrial uses. The huge increase in population lead to speed up the exploration of materials and manufacturing process which recently results in the discharge of toxic and dangerous waste materials. Increase in water pollution is the biggest problem for the world even for the developed countries. The major sources of pollution are discharge of untreated sewage water, industrial discharge and agricultural runoffs directly to the river, lakes and seas. These sources carry most of the pollution load and make the fresh water unhealthy. This polluted water is directly affected women and children at the first place. This polluted water is continuing its way downstream where people consume it. Pollution in water is most dangerous and sometimes proved to be deadly foe the aquatic life. Fish and plant in that aquatic environment accumulated this pollution and when human consume that fish enter the human. Beside the anthropogenic means water can be polluted by the natural ways like weathering, sedimentation, and erosion from the ores. Many preventive measures are taken but still these measures are not enough to control the pollution. Groundwater is also impacted by this pollution and once the ground water is polluted it's very difficult or even impossible to clean it. Water pollution is important to be controlled (Houri et al., 2011).

1.5 Dams

Water is the most important resource on the earth and fresh water is available in very small quantity. So, it's very important storage for fresh water so that it can be used upon need and save large quantity of water to go in waste. Water generally flow downwards (downstream). It can be stored in large quantity by making Dams. The water that stored in dams can further put up do to many tasks like generating hydropower energy, fulfill the needs of agricultural activity and needs of domestic and industrial community (Wildi, 2010). Building dams are not very easy it needs a huge financial resource of the countries, management of dams, impact allocation on local community and purpose in sight to be willful (target population and agricultural areas). Once dams are built, they contribute in national economics and development. Building dams are not easy they need huge amount and manpower. Many things are kept under the consideration in building dams to meet national needs and have capacity to deals with the natural challenges like storms, heavy rains and floods. Dams don't come alone but brings a huge water distribution system to provide water for agricultural, industrial and domestic needs. Some additional advantages that comes with the dams are fish farming, a route to charge aquafer and impact on hydrology, soil prevention and domestication of animal and crops (Wang and Chen, 2011).

Dams are built on huge geological plots and that plot shows the features of the certain dams and water reservoirs and the whole features and Characteristics of dams depends on them. The water quality of dams depends on many factors like rainfall pattern, speed and activity of winds, geological cause of the soil and the nature of water ways entering and exiting the dams. The conditions of climate and the natural vegetation around the area. These are very important factors that plays vital roles in maintaining water quality of the dams (Friedl and Wuest, 2002). The term Limnology is mainly associated with the dams are define as inspection of underground water that includes the examination of organic, chemical and physical characteristics of water (Lewis, 1995) The phenomena of limnology can be understood by divided in to three main categories like riverine zone which is fluvial environment, lacustrine zone which is located near to the dam and the third one is middle transition zone that lies between them (Friedl and Wuest, 2002)

1.6 Physical properties of dam water

Water quality depends on many factors specially when it comes to the physical properties in dam water is stored in huge quantity and great depth because when the water is stored at high depth specifically above few meters, the physical properties of water get altered. They significantly disposed to stratification and this happen because of the alteration of water density with depth due to change in temperatures and the sedimentation of suspended particles or deposition. Due to the high temperatures the process of heat stratification occurs but its regular and natural phenomena this is happen because of the exposure of surface dam water to powerful solar radiations. This process triggers the division of water body on the basis of temperature like Epilimnion which is the vertical layer of warm water that carry loss of oxygen. The second layer is named as metalimnion has the variation among the density of water and temperature. The third and last layer is colder compared to other two and darker too. This layer has the low amount of oxygen and known as Hypolimnion. Thermocline is a term referred to the area of water bodies where temperature falls readily with increase with depth of water and also called shrined zone. Mainly its counted as the part of the metalimnion zone. This technically divides the metalimnion in to two zones like thermocline and adjacent area segment which separate the surface water from the deep water. This is the region of water with high oxygen content and this is due to decomposition of natural residue and is also an anaerobic zone and known as the Hypolimnion (Absdini and Tajfirooz, 2010).

In tropical zones the process of heat stratification is considered to be the process of greater content because the water storages react to abrupt changes in the temperatures. The rapid change in the density of water because of the increase amount of the suspended particulate is more prominent in the water body. This play an important role in temperature changes through warm water and throughout water supply. This is much sloppy water and have a high density. In this slow of water denser water that carry the all sedimentation load of the dams (Abedini and Tajfrooz, 2010).

1.7 Chemical properties of dam

The chemical properties of dams and freshwater bodies can be characterizing as the geochemical, climatic, geomorphological and the conditions of the pollution that impact on underlying aquifer and fundamentally prevailing in the drainage path. The characteristics of aquafer runs inland is ruled entirely by the various environmental conditions which determine the selection of physiological activity and organisms. The formation of phytoplankton and macrophytes as the primary production of the organic matter in the water body. This is more noticeable in dams then it’s in river or flowing water bodies. Some suitable analytical methods are used to determine the chemical property of the dams. While the combination of both qualitative and quantitative method is used to determine the biological methods (Kumke and Ksenofontovia, 2007)

1.8 Seasonal impacts on dam water

In dam and water streams many factors like solar radiations, warm water streams, areas and combinations of suspended particulates contributes in the process of heat stratification. The temperatures profiles change consistently throughout the dam. In spring the solar radiation falls on water at angle which extensively brace stratification. Thin warm water section in the dam can be seen in the dam in winter season by ignoring the thickness inclination and the temperature of the segments of water bodies. This is known as the turnover. In such a way that the material flows remain constant throughout the layers of the water bodies and the materials from the lower layers reaches the top layer on the body. Temperatures are much higher in the spring seasons in these areas the ice vanish from the water surfaces and the days become longer the growth of green vegetation can see in or around the water bodies. The water that do not solidify has blended periods yearly is named as the term meromictic (Abedini and Tajfrooz, 2010).

Polymictic is pre-winter signs shone by the waters that usually covered with ice in the winters. The underlying components are made by the winds in the dams that makes vertically segments in the dams. More profound dissemination is forced by the more grounded winds and extended and in augment addition the epilimnion state. The warm portion of the water body is enormously inflicted is change in course and can stood with the winds. The winds that are strong enough to blow for a long period of time that have impact on the auxiliary warm process of stratification and realize that flat exchange of in a blend in section of the water. Like the lake the pools of the dams are very much influenced by the wind. also, little store likewise can bale to show the turbulences like bigger streams or ebbs and flows and the new incoming water bring the seasoned matter. This new system of turbulence carries the warm based radiations it is able to incline the warm stratification in the many sections of water over and over during the year (Abedini and Tajfrooz, 2010).

Many factors and properties like physical and chemical properties like EC, TDS, phytoplankton and temperature these all have impact on the oceanic life and can impact the potential fish yields and supply from the dams can be impacted. So, it’s very important to breakdown the physical and substances properties of water in the dams, streams tube wells and wells and it provides the major advantages and fundamentals of dam waters (Manjare et al., 2010).

1.9 Water quality and pollution load in surface water

The water quality and pollution load in dam water can be define as the nature and quality of water to fitful the purpose to which it had been stored in the dams. The physical, chemical and biological properties of the water have certain impact on the different processes in which the water plays an important role like if the water quality is impacted by the presences of harmful substances in water (drinking water may limit the pH and that may be the proved harmful for some vertebrates present in the water. In order to avoid that the quality of water must be kept under the constant check. It is important because the water quality can be affected by the certain artificial factors and variety of characteristics (Meybeck et al., 1996).

There are many factors that directly impact the quality of the dam water and they are mostly hydrological, geological and climatic conditions. These are the important factors in determining the quality of water being used. If the quality of water is very low and being used at the large scale, then these impacts are very prominent. It can be notice in the dry beach and dry territories. The water salination is most prominent, and to solve this problem the expensive machinery is needs to desalinate the beach. If this is the case the extensive amount of water is useless because small water quantity is available for drinking after the treatment for bring the water in safe limits of usage. In spite of facts that the biological community present in water is the most effected one in the case of pollution. The biological community shows the biggest variation if the quality of water is changed a little bit. Biological community in water (aquatic life) is very variable to the pollution in water (Meybeck et al., 1996).

Many national and international organizations monitoring the quality of water throughout the world to keep in the safe usage range like the (ISO) International Organization for Standardization is monitoring the characterization of water has stated that the "the modified procedure of inspecting, estimation, and result recording or flagging or both of different water attributes, frequently with the point of surveying adjustment to determine the goals". The water quality management had very clearly defined the goal for the monitoring of water quality is to control the physical, chemical and biological attributes of the water. Management of water may contain the contributes may include contamination controls, methods of utilization and deliberation of water and land utilities like irrigation drinking and industrial use. Water management exercise on ground are mostly controlled by the regular water amount and quality and supply. The water has to serve many purposes like socio-economic framework and ordinary purpose. there is necessity or goals for the management that can be helpfully decided the appropriateness is for a reason or for purposes. Following are the goals and the objective with against the water quality is being tested, checked and monitor. It’s make sure that the water that has been used for the drinking purpose is not containing any chemical because if the prances of the chemical even if in the small amount makes the water unsafe for the drinking purposes. The water used for the agricultural purposes have the different standard this ought to have a low amount of sodium content, while the water that fitful the different purposes like drinking and industrial processes should contain the low amount of the inorganic chemical. another set of standards are used to check water quality to production of biodiversity and other preventive measures are the substantial part of the water quality management. The additional water quality is obtained is required to take measures on contamination controls and long-hard pattern evaluation and furthermore. Ecological community of the water is very sensitive of the water pollution as the flora and fauna is very responsive to even a small amount of pollution in the water. The rising issues of the pollution and contamination, formulating arrangements and the need of the water management and administration. This is to do develop and actualizing the water quality programs, administrative strategies and evaluating the visibility of the water attributes (Bartrum and Helmer, 1996).

Water plays the very important and critical role in the development of soil and the atmosphere. Its place among the most vital component that have the ability to impact its surrounding, surface waters to be used in household and industries. The quality of water is being impacted by the advancement of the community and the industrial processes. As per WHO (World Health Organization) the water is responsible to carry 80% of the diseases in the humans. Once the water quality is lowered or deformed then it is impossible to stored it to original form but by the use of artificial ways and equipment’s it can be returned to the safe limits of usage. It’s very important to maintain the record of water quality data as its help to developed strategies and mention the problem (Dohare et al, 2014).

The main reasons for the increase in the water problems are recent growth of human population, advancement of industrial processes, massive use of fertilizer carry inorganic chemicals and anthropogenic activities. The regular water body are bringing about the fluctuation and substantial pollution in the oceanic environment and resulting in the degradation of the aquatic biota. This is the one reason to test water intensively for drinking purposes because the utilization of water borne diseases. It is very hard to estimate the biological factors since the metabolism of an ecosystem runs the all chemistry of the water and link between the general hydro biological relationships. The physical factors of the water and dependency of all the life procedure. A need to develop a comprehensive pattern to estimate the water quality at the highest possibility to control and monitor the water quality (Manjare et al., 2010).

Mainland water bodies are of very different verity such as small streams, lakes, dams, rivers and supplies and underground water. They are sum up to make the hydrological cycle and running water bodies. Simulated and characteristics both. An example of wetland, flouting plants, alluvial aquifer has many attributes that are naturally hydrological transition between streams, ground water and lakes. Wetland haves many significances regarding to the organic contents (Meybeck et al, 1996).

1.10 Surface water characteristics

The hydrology of the water body has a huge impact on the water quality of that body beside that all the basic information of the all assessable hydrological is incorporated in the water quality system the stream data is generated in a regular release. The warm and cold stratification of the lake, and the river admiration and underground examples. The more extensive issue is sea going conditions that can be portrayed as far as following water quality as the profile picture of the organic life status and displace in the water body. The pattern in which the partials are physically percolate in the water body present the physical settlement pattern in the dam or a water body. (hydrology, nature of lakes, measurements and waterways and other factors). There are many conditions to put under the consideration in order to evaluate the water body quality like consequently, oceanic conditions, require that water quality, natural life, particulate matter and physical and other physical attributes that can be recharged and can be assessed to determine the quality of water body (dams) (Wake et al., 2005).

This process of evaluation can be accomplished through a proper scientific system of examination of water testing (like measure the planktonic green grow and chose part of creatures for examples angle muscles) natural test of water bodies like the potential danger test and the test of estimation of chemical exercises. Dead bodies deposition of organisms including their events, thickness physiology, biomass. More tests like assorted qualities (from which for instance, abiotic record might be created or the microbial and microbiological qualities. Other associate test of physical characteristics like water temperature, pH, conductivity, light entrance, several minerals and the size of particulate materials found in that certain water body, stream speed, hydrological adjacent of the water body, size of the body (Meybeck et al., 1996).

1.11 Surface water quality and pollution load in Pakistan and around the globe

Water plays an important role towards transforming our lifestyles and readily usage of water makes us concerned about the quality of water that we drink. The demand of water varies from season to season the repeat increases in urbanization, wide spread of modern development, wideness and extension of agricultural systems. Use of the fertilizers in large quality carry large amounts of inorganics chemicals. This result into the deterioration of water quality this gives the contaminations to resources and dams this result in the water-borne diseases this alter result into the negative impact on the human health. According to the recent studies about 40% of all the major health problems in Pakistan have their roots in the waters. As matter of facts, a study found that about 250,000 kids in the Pakistan is reaching to limits of the Diarrheal each year I Pakistan alone. In the world out of the 122 countries Pakistan ranked 80^{th} in maintaining the drinking water quality. For the most part of the water quality in Pakistan is very low as the framework and dams, conditions are usually in bad conditions. The defective water channels in Pakistan is one of the major reasons for thus bad water quality. This is the one of the preempted issues of the contaminated in the water. The reason behind this is modern waste and low quality and maintenance of sewage system in Pakistan. This contaminations from the leaked sewage system soiled into the water channels used for the drinking purposes then shows the reals episode of the health concerns. This problem is usually be seen in the urban areas. One of the sources of obtaining is hand pumps but sometimes areas are often saline by lacking large to meet the needs of every single person and household activities. In such situation, the reason of management quality is essential needs of the ears. The huge population of the Pakistan have no chance but to drink water that contain infectious and micro-biological agent carry diseases. Such as an example like Cholera, Typhoid, fever. And many more. The water quality checking and monitoring is a very effective ways to chronic and toxic material in water (PCRWR., 2017)

The situation in Pakistan according to the drinking water is depending upon the natural calamity, the addition of untreated wastewater from different sources, the modern waste and agrarian run offs, is the reason of harming water bodies, humans and agricultural properties. This issue is taken up by the enthusiasm because they are responsible to implementing the laws and effects can't be seen. Pakistan Environmental Act (Alam, 2012).

According to the present data in Pakistan only 1% wastewater is deals with some kind of treatment before reaching it into the water bodies. This is because of the absences of law making and implementation facilities. There is no proper check and balance on industries on releasing of wastewater into the natural water bodies. This decline the quality of water for being used as the drinking, mechanical activities, a grain and diversion purposes (Mumter et al., 2015).

In the country like Pakistan there is no system that can separate the drinking water system and municipal system in the area of large population these waste pipes mostly lead to the open channels which leads this water to nearby rivers and dams that are located nearby. The authorities also don't have any resources to keep the check and balance of the surface water quality. Furthermore, there is no permanent surface water quality standard in Pakistan. In a recent study the correlation of the surface water and effluent extend standard show that most of the contamination in dams and large water bodies are due to the domestic and industrial waste (WWF, 2007).

1.12 Problem statement

A hypothesis is formulated that the recent increases in anthropogenic activities and industrialization growth add a huge amount of the waste in the water revisors and water bodies that deter the quality of the water. These activities add a huge amount of the heavy metals and other toxic metals in the water bodies that later deter the quality of the water and these toxic materials have the ability to cause the major diseases in the human body and can damage the aquatic environment in the large extent. So, in order to address this issue a comprehensive research is designed to monitor the current status of the contamination load in the major dams of Pakistan. For this study eight dams were selected from different regions and different sizes like Tarbela and Mangla dams are biggest of the country, Tanaza and Naryab are the small dams, and Khanpur, Shahpur, Rawal and Simly dams are located in the most populated areas so they are usually under the major stress of the pollution by the nearby area.

1.13 Objective of the Study

This research was carried out to achieve following objectives:-

1) To determine the Physicochemical parameters (pH, TDS, Cl, NO_3, SO_4 and hardness) and heavy metals concentrations (Cd, Cr, Zn, Cu, Mn) in the selected dams of Pakistan
2) To provide the baseline study for future research

CHAPTER 2

MATERIAL AND METHODS

2.1 Study area

For this study following eight dams are selected

2.1.1 Rawal dam

Rawal dam is one of the most famous lakes of Pakistan located in the ICT capital Islamabad. This dam is mostly known for its recreation activities that are associated with it. Geographically this dam is located in the Margalla hills national park. This lake has globally identification as the coordinates of 33^o 42'N 73^o 07'E. Total of 50 samples were collected from the Rawal dam as the sampling points are shown in the figure 2.1.1 This is an earthen banked dam act as the reservoir for water coming from the Margalla hills natural park and its adjacent area. this lake was built artificially in late 70's on Korang river for the purpose to provide water to the city of Rawalpindi. This dam has the catchment area of 106.25 sq. mi (275.2 Km^2) and have the surface area of8.8 km^2 (3.4 sq. mi) with the maximum depth of 102 ft (31 mi). this dam is located just outside the city of Islamabad. This dam has a variety of aquatic life like fishes and other form of aquatic life. As this dam have the capacity to hold water for 30 days usage for the city of Rawalpindi. The live capacity of this dam is measured as the 37,500-acre feet (46,300,000 m^3). Dead storage is measured as 4,500-acre feet (5, 600,000 m^2). Which brings the gross capacity of the dam is 42,000-acare feet. Spillways has the ogee gated structure with the discharge 82,000 ft^3/sq. beside the source of recreation to the people Rawal lake is a main source of water to the people of Rawalpindi. The sole responsibility of Rawal lake is to store rain water and melting snow and provide it to the people of Rawalpindi on need and to sounding agricultural areas.

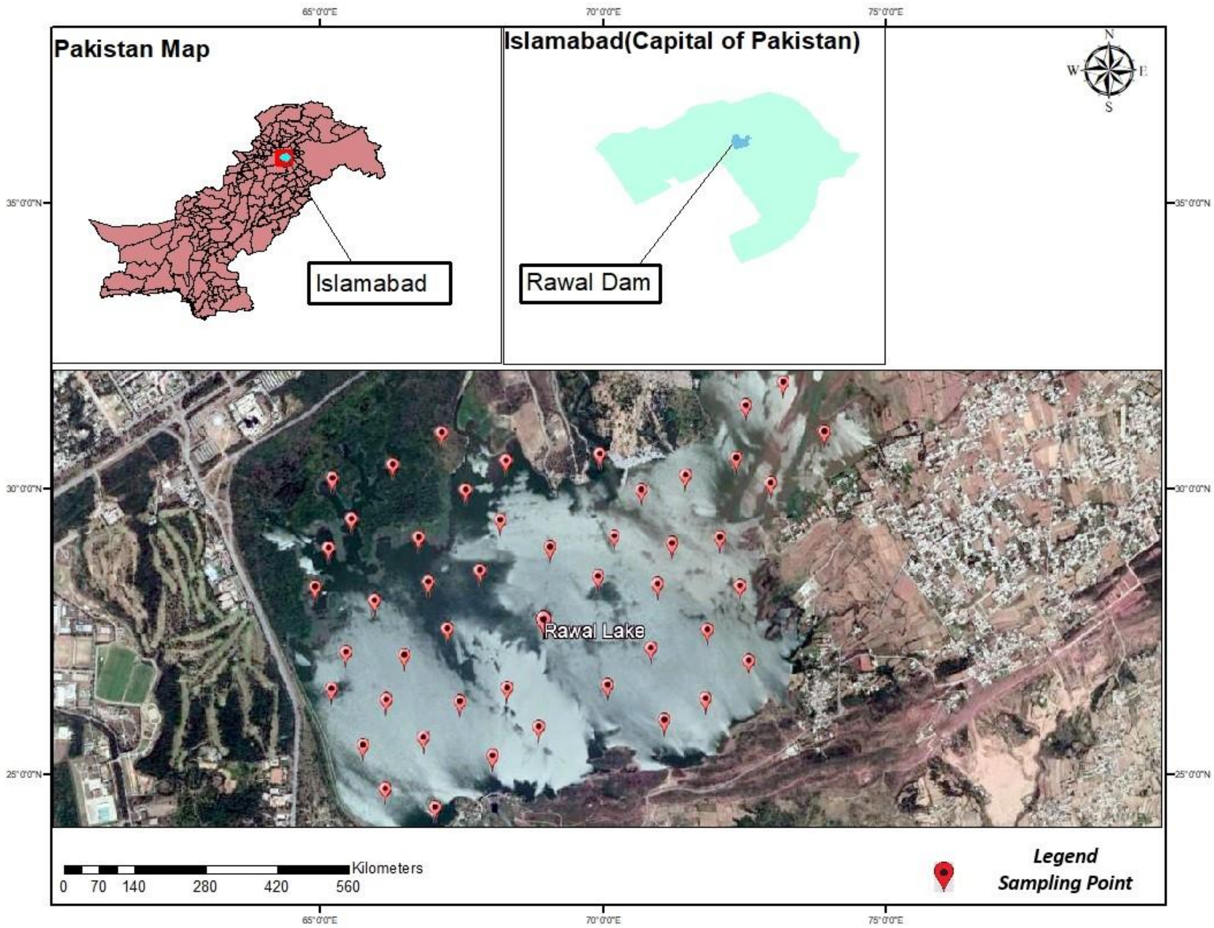

Figure 2.1.1 Map showing the sampling point of Rawal dam

2.1.2 Simly dam

The project of Simly dams was started in 1962 but the project get delay and completed in 1983. The sole purpose of the dam is to provide the water to the city of Islamabad. this dam is located 30 kilometers east of Islamabad. In Rawalpindi district. Build by CDA. This is earth embankment dam with the Hight of 80 meters (260 ft). this dam was built as the reservior for the water coming from the Murree hills as the result of melting snow and natural springs. The dam status remains operational since the opening. This dam is built on soan river. The Simly dam has the global identification of the coordinates of 33^{o}43'08 N 73^{o}20'25 E. Total of 50 samples were collected from the Simly dam as they are shown in the figure 2.1.2. The sole purpose of the dam is to provide water for the drinking water for the people of Islamabad and irrigation water. This dam has the length of 313 meters (1,027 ft) with the dam capacity of 1,977,000 m^3

(2,585,818 cu yd). Simly dam has the ogee overflow with the capacity of 34,405 $m^{3.}$ the total catchment area of 153 km^2 with the total dam capacity of 35,346,000 m^3 and the total surface area of 1.7 km (7 mi) (PPC., 2013).

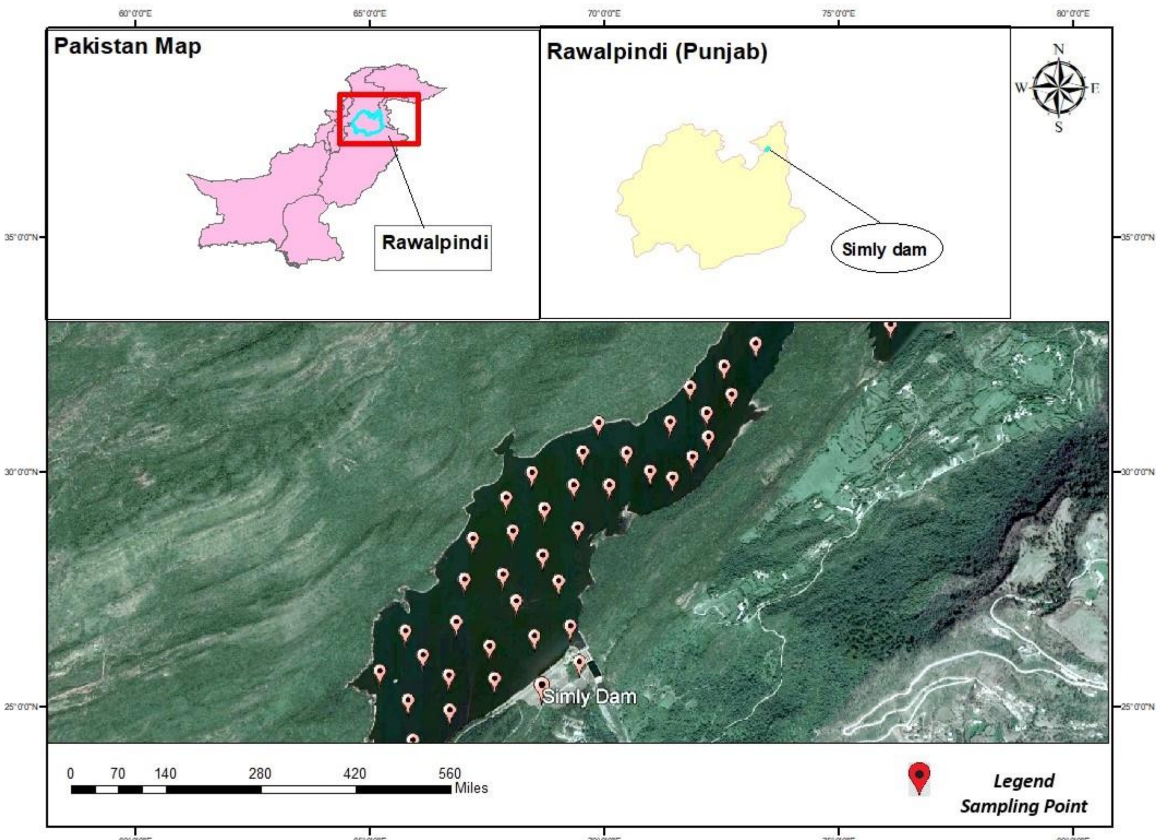

Figure 2.1.2 Map showing the sampling points of Simly dam

2.1.3 Mangla dam

Mangla dam is the seventh largest dam in the world located in Azad Kashmir at district Mirpur. This dam is built on river Jhelum. This dam was built to fitful multipurpose. The project was start in 1961 and completed in 1965 and has operational status since then. Mangla dam have the global identification of coordinates as 33.142083^o N 73.645015^o E. Total of 50 samples were collected from Mangla dam for the analysis se the sampling point are shown in the figure 2.1.3 Mangla dam is earth embankment dam with the Hight of 147 m (482 ft) and the length of 3,140 m (10,302 ft). Mangla dam have the total capacity of 9.12 km^2 (7,390,000-acre feet) with the total surface area of 97 sq. mi (251 km^2). Mangla dam is a hydro power dam has the turbine power of 10 x 100 MW.

With the installed capacity of 1,150 MW. This dam has the responsibility to provide the drinking water to most of the area of Punjab. This dam provides to agricultural sector of Punjab in the season of rice crop Mangla dam coped with the extra burden of supply water (Muir and Alan, 1990).

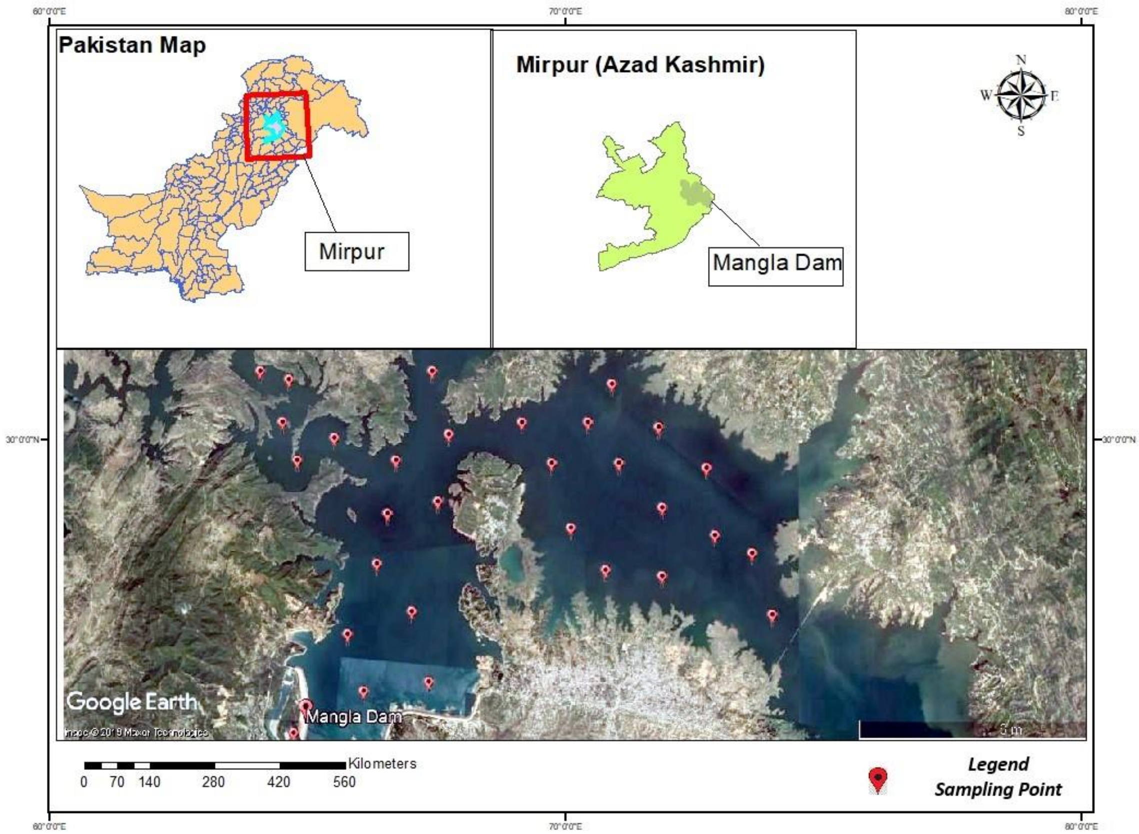

Figure 2.1.3 Map showing the sampling points of Mangla dam

2.1.4 Khanpur dam

Khanpur dam is located in Khyber Pakhtunkhwa in tehsil Khanpur near Potowar plateau on Haro river. It is 40 km away from the capital Islamabad. Khanpur dam has responsibility to provide the drinking waters to twin cities of Islamabad and Rawalpindi. Irrigation water and industrial water to the source surrounding cities. This dam is earth embankment with the total Hight of 165 feet (51 meter) having the total capacity of 110,000 acre-feet. This dam is complete in 1983 of over 15 years construction period. This dam is very famous for the water sports and recreation activities like cliff jumping, jet ski etc. Khanpur dam have the live storage capacity of 79,980 acre-feet with the discharge capacity of 110 ft^3/s. The dam has the global identification of coordinates 72° 539' 3099''E and 33° 439' 2099'' N. Total of 50 samples were collected from the Khanpur dam for the analysis and the sampling points are shown in the figure 2.1.4.This project is act like a revisors and catchment area of all hills area of Potowar plateau. The beneficiaries of the dam are capital development authorities (CDA) and Rawalpindi development authorities (Ali., 1993).

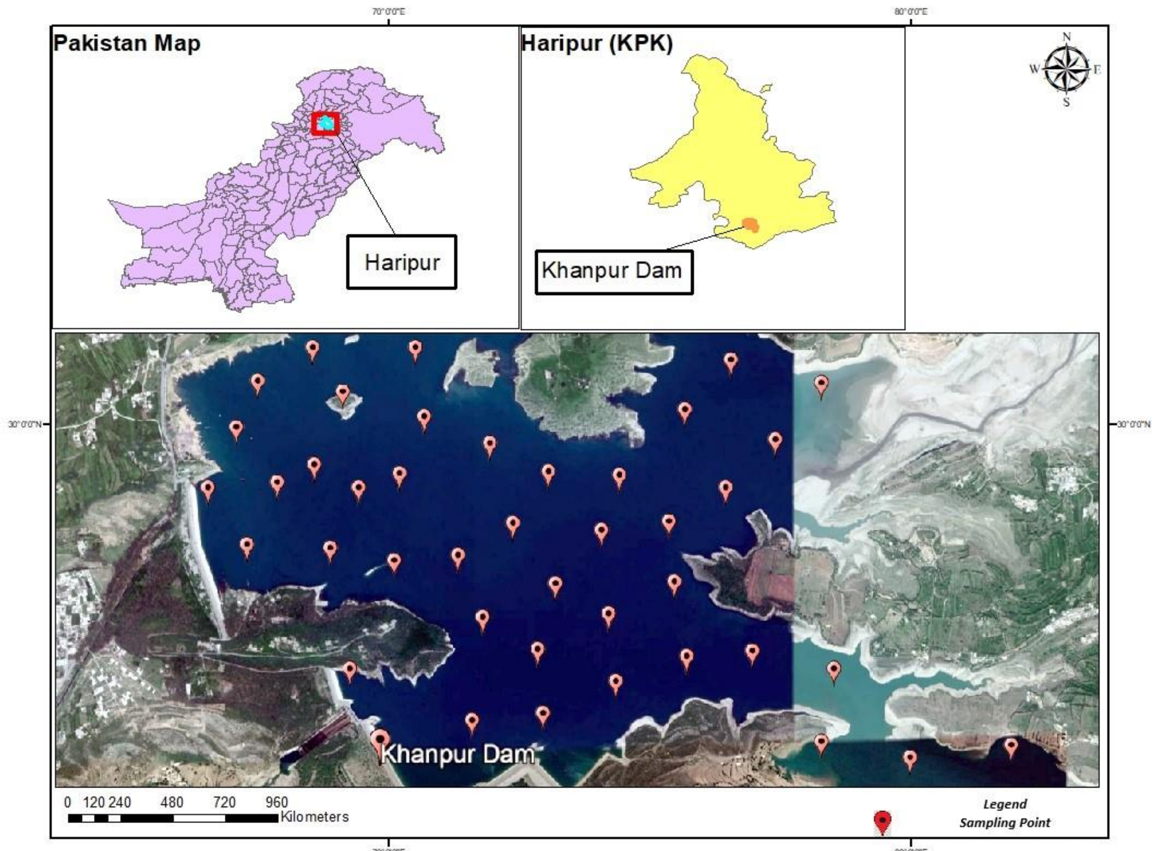

Figure 2.1.4 Map showing the sampling points of Khanpur dam

2.1.5 Shahpur dam

Shahpur dam is located in the district Attock in Punjab. With the global identification of coordinates of 33°37' N 72° 41' E. Total of 50 samples were collected from the Shahpur dam as the sampling points are shown in the figure 2.1.5. This project was completed in 1986.and owned by the small dam organizations government of Pakistan. The total Hight of Shahpur dam is 26 meters (85 feet). With length of 93.26 meters (306 feet). Concrete gravity spillways are used in dam for the discharge of water.

Shahpur dam have the total capacity of 17,620,000 m^3. The Shahpur dam have the responsibility to provide the drinking water to the capital Islamabad and some nearby cities of Punjab. Like Fateh Jang and Attock (IMI report., 2012).

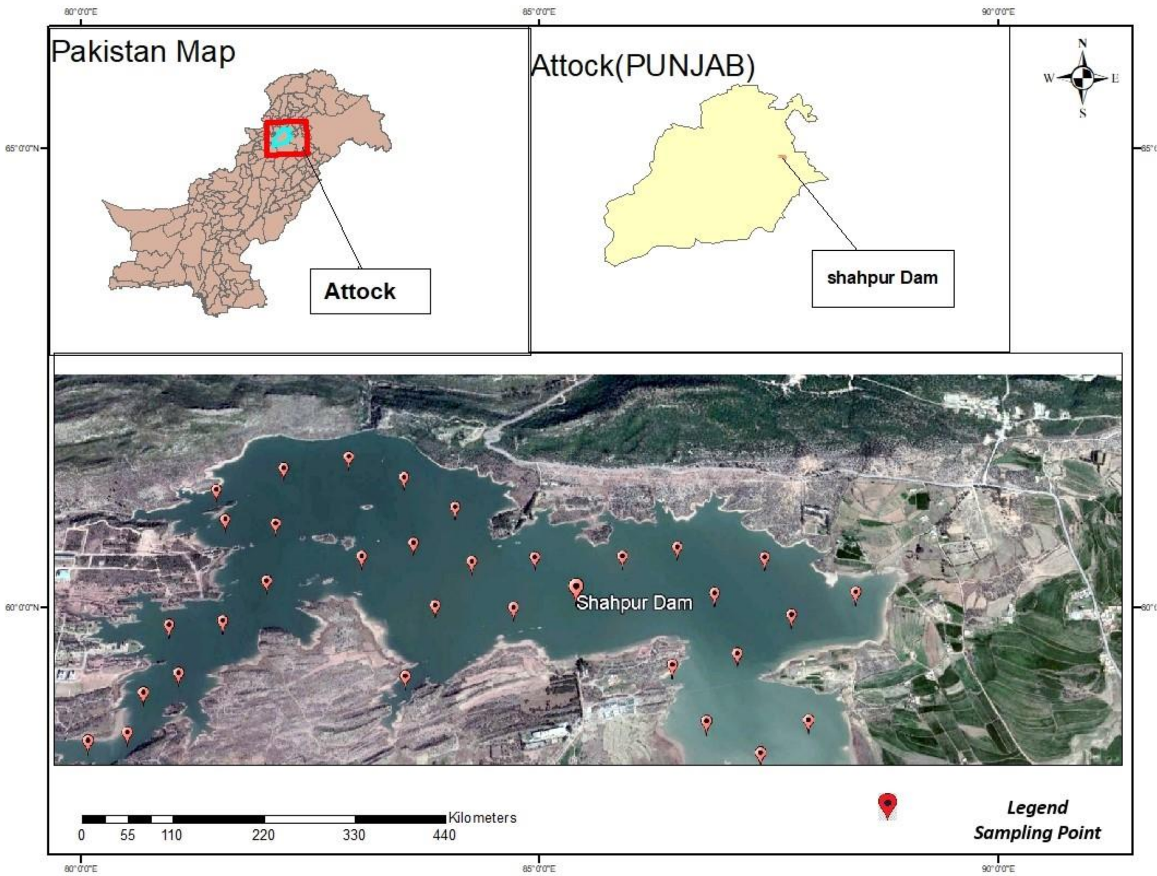

Figure 2.1.5 Map showing the sampling points of the Shahpur dam

2.1.6 Tarbela dam

Tarbela dam is located in the region of Swabi. Khyber Pakhtunkhwa Pakistan. With the global identification on global positioning system falls on coordinates of 34^o 05' 23'' N 72^o 41'54'' E. Total of 50 samples were collected from the Tarbela dam and those sampling points are shown in the figure 2.1.6. The construction of the project starts in 1968 and finally completed in 1976 and remain operational since then. This dam is built on the river indus. Tarbela dam has the total length of 2,743,2 meters (9,000 feet's).and the total Hight of 143,26 meters from the river level. This dam has the catchment area of 168,000 km^2 with total capacity of 13,69 km^2 and surface area of 250 km^2. this is one of the hydroelectric power plants. The turbine capacity of 10 x 175 MW, 4 x 432 MW, 3 x

470 MW. Installed capacity of 4,888 MW. This dam has the responsibility to provide water for drinking and irrigation to Punjab and other provinces (Lorrai and Pasche., 2007).

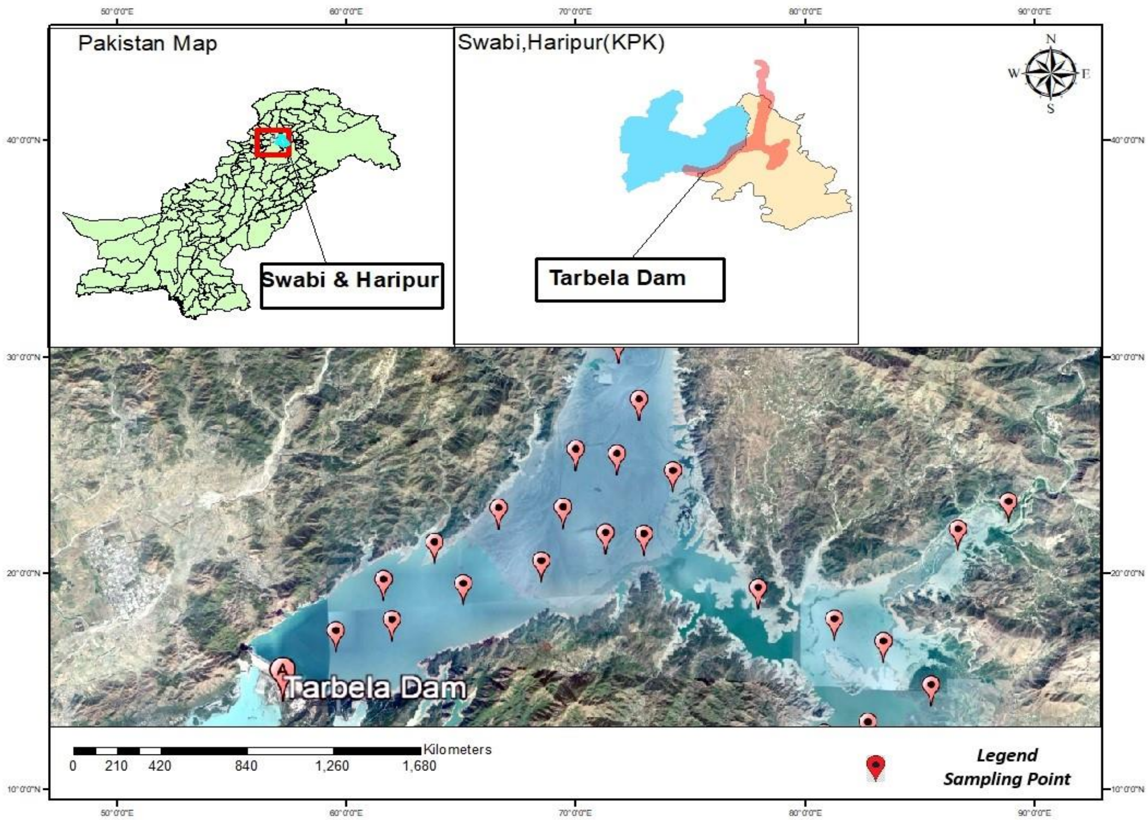

Figure 2.1.6 Map showing the sampling points of Mangla dam

2.1.7 Tanaza dam

Tanaza is a small dam located on the 25 miles (45 km) south west of the capital Islamabad it is located in the Fateh Jang Punjab it a small dam with the global identification with the coordinates of 33^{o} 27' 35'' N and 72^{O} 44' 17'' E. For the analysis total of 50 samples were collected from the Tanaza dam and the sampling points are shown in the figure 2.1.7.Its sole purpose is to give water to the nearby community for drinking and domestic use. This dam is owned and managed by the small dam organization government of Punjab. This dam is built on rainy stream to collect water for the community.

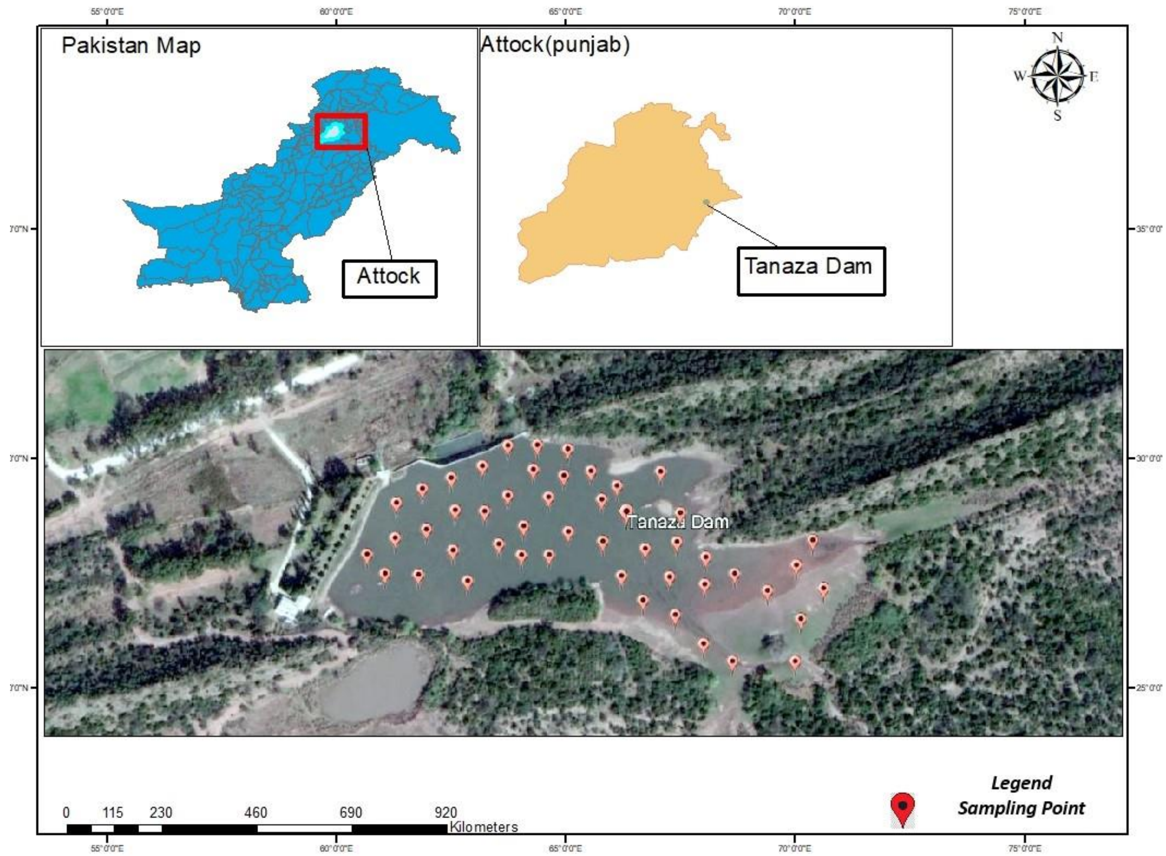

Figure 2.1.7 Map showing the sampling points of Tanaza dam

2.1.8 Naryab dam

Naryab is a small dam that is located in Hangu district in Khyber Pakhtunkhwa. This is a part of the small dam project in Khyber Pakhtunkhwa to provides the water to the people of the province. The sampling points of Naryab dam is shown in the figure 2.1.8. This is a small dam constructed on a small river to act like a reservoir. This is only water reservoir in the area of 55 km^2. The sole purpose of this dam to provide the drinking water to the district of Hangu.

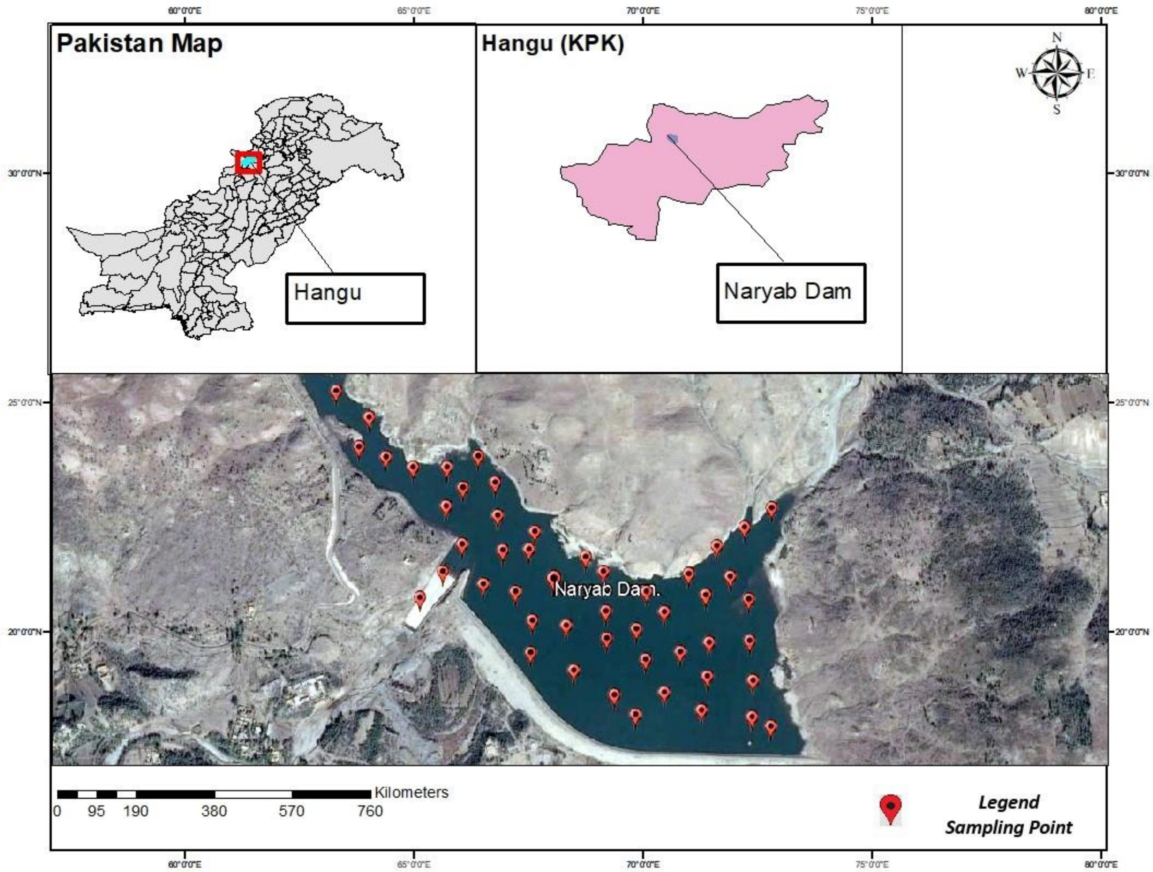

Figure 2.1.8 Map showing the sampling points of Naryab dam.

2.2 Methodology

2.2.1 Sampling

For this study detail sampling of the dams was required. Literature suggest the sampling size of 50 samples from each dam without depending upon the size of the dam. (400 total samples were collected from 8 selected dams) This sampling size is most probably giving the best pictures of the conditions of the dams. The samples were taken from the surface water. This study focusses on two types of parameters physio-chemical and heavy metals concentrations both have a different of sampling protocols. Some parameter was to be analyzed on spot, so the samples were divided in to two parts. Because heavy metals samples need to be preserved by adding nitric acid to the samples, so these samples were collected separately.

2.2.2 Sampling collection methods

All samples were collected in the plastic bottles that were pre sterilize to avoid any possible contaminations. The samples were collected in the 500ml plastic (PCV) bottles, The samples were collected in the two separates bottles for heavy metals and physio-chemical parameters, the bottles with blue caps were used for the heavy metals samples collection and bottles with red caps were used for the physio-chemical parameter analysis. The bottles were kept safe from any foreign particles to avoid any contamination. The samples were collected according to the standard protocols of water collection of PAK-EPA. The bottles were immediately sealed after the collection of water. and code with sample numbers and location along with dam name to maintain systematic analysis and avoid confusion (Siyue et al., 2008).

2.2.3 Sample coding

Samples were collected in 500 ml bottles and bottles were immediately sealed after the samples were taken and coded with the samples name, location (coordinates) and name of the dam. The samples for physio chemicals analysis is collected in red caps bottles and samples for heavy metals were collected in blue caps bottles. The dams were also giving the code name to hide samples location for future lab processes. Like Rawal dams was assign code as R1-R50, Mangla dams was assign as M1-M50, that help to kill the confusion in data analysis processes.

2.2.4 **Physiochemical parameters laboratory analysis**

There are few physiochemical parameters under study have analysis on spot or in lab. These parameters were analyzed by different method. These methodologies are described in detail as below

2.3 Physical parameters analysis

Few of the physiochemical parameters such as pH, TDS and electrical conductivity had to be analyzed on spot by using the pH meter and thermometer. These samples were to be analyzed right after the collection of samples to get the accurate results of the water bodies. The reason behind this is that if the samples were transported to the lab the reading of these parameters would change. To get the reading of pH the electrode of the pH meter was first washed with the distilled water and then placed the electrode in buffer solution of pH 7 were noted and check the calibration of meter. Then electrode is washed again and placed in the samples and reading is noted (Patil et al., 2012).

2.3.1 **pH**

pH stands for the potential hydrogen in the water and the negative logarithm of the hydrogen ions concentrations it is measured from the 0 to 14 on which the scale is further divided in to acidic and basic from 0 to 7 shows the acidic and from 8 to 14 in basic character in water. And neutral is at 7, at 25^{o}C measuring the (pH) is very simple it can be measured by the pH meter and simple by sample dipping the electrode in the sample water prior the samples before the next sample the electrode is dipped into a buffer solution of pH 7 to calibrate the meter. Then checking the pH of distilled water. To cancel the chance of the miscalculation the pH of natural water depends upon the CO_2, HCO_2 with pH that usually lies in the range of 4.5 and 8.5 the samples will read out with the digital pH meter. Usually 50 ml of sample water is taken in the beaker and electrode is first dipped in the beaker and then in distilled water to cancel any chance of miscalculation then the electrode is dipped into beaker contain samples water and shake a little bit. When the reading become stable then the reading is noted for that sample (Atique et al., 2000).

2.3.2 **Total dissolved solids**

Before checking the total dissolved solids, the instrument was calibrated by nullified the rise of the specimens by doing the careful shaking and before using the instrument for reading, it makes sure that the device is Standardized and subsequently. The instrument was used with the standard solution of potassium chloride (0.01 M) and after that the cathode was washed by using distill water and put into the samples and shaken well until the reading is blanked out. That blanked reading was taken as conclusive reading and noted (Patil et al., 2012).

2.3.3 **Estimation of chloride**

The chloride is mostly estimated by using the technique of titration (argento-metric titration) this is a method in which the silver nitrite reacts with the chloride present in the sample and make the white particles of silver chloride that are insoluble in water and clearly visible. The over presences of silver nitrate with potassium chromate is change into fame orange yellow silver chromate. The whole process is the conversion of silver nitrate to silver chlorite. This estimation of chlorite involves some calculations which can be presented in a form of simple numerical

Equations:

$$AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3$$

$$2AgNO_3 + K_2CrO_4 \longrightarrow AgCrO_4 + 2KNO$$

Standard solution: 0.1 M $AgNO_3$

Indicator**:** Potassium Chromate.

End point: Orange Yellow Color

Procedure**:**

In burette $AgNO_3$ is placed and bring to the arrangement on other hand the 25/50 ml of sample water is taken in the flask. After that the indicator is added to the water (K_2CrO_4) this solution is titrate against the $AgNO_3$ the process is continuing slowly until the orange yellow color is obtained. The solution of $AgNO_3$ is stopped and reading is noted.

Observation:

Normality of $AgNO_3$ = N = 0.01

Volume of $AgNO_3$ = V = 100 ml

Volume Sample = v = 50/10 ml

Calculations:

$$\frac{Cl\ (mg)}{L} = \frac{V \times N \times 35.42 \times 1000}{v}$$

By substituting the taken values in the above formula the reading of chloride is obtain that was present in the sample water.

2.3.4 **Sulphate**

Sulphate in water samples is present in the form of the ions and can prevent the water characteristics if exceeds the safe limits of NEQS. To determine the concentration of sulphate ions in the water samples spectrophotometer is used. As the sulphate is mostly present in all-natural waters in appreciable amount. Sulphate is soluble in water and promote the hardness. It can change water taste to bitter if high in concentration.

Apparatus

Whatman no 1 filter paper, spectrophotometer, and magnetic stirrer.

Reagent

Standard sulphate solution, buffer solution, and dry Barium chloride ($BaCl_2$) crystal.

Procedure

Samples was filtered with Whatman no 1 filter paper to remove any particles from the samples. Add 20ml of buffer solution to the sample and set it in stirrer apparatus while stirring add the 0.15 g of barium chloride to the samples and set it in the apparatus for an hour. While this the sulphate of distilled water is noted for the calibration of instrument. As the spectrophotometer was set on the frequency of 420 mm. a calibration curve is made on paper for the reference as the absorbance value strength on X-axis and absorbance @ 420mm on the Y-axis to make the inner model (APHA, 1998).

Absorption value = A+BX sulphate concentration (in mg/l)

By using this this calibration inner model all samples of unknown concentration are find out by using the equation

$$\text{Sulphate concentration (mg/l)} = (1000\text{x mg } SO_4^{2-}) / (\text{ml sample})$$

2.3.5 **Nitrate**

Nitrate is present in the water samples in the form of ions that prevent the water quality and characteristics. Nitrate if exceeds the limits set by the NEQS then it can change the taste of the water and can impose human health disorder. The concentration of nitrate is found by using the spectrometer by using the following method

Apparatus

Unicom SP 500 Spectrophotometer

Reagent

Sulfuric acid 97% reagent grade, Hydrazine sulfate, standard nitrate solution.

Procedure

10 ml of solution in a tube was added and add 0.1 ml of hydrazine sulfate solution in the samples with the help of the burette. With the tap only lubricated with the sulfuric acid. Add 10 ml of sulfuric acid to the solution provided that the solution not come to boil. Rest the sample for 10 minutes then place the tube in the spectrometer set at the 230mm. The difference between the two reading is the concentration. The calibration curve can be obtaining by running descried water sample. Reference model can be obtained by running the sample of known concentrations so, that the samples of the unknown concentration can be determine (Sawyer et al., 2000).

2.3.6 **Hardness**

Hardness is the one of the major factors to determine the quality of the water and its shows the concentration of calcium and magnesium ions present in the water samples. Hardness is measured in ppm (parts per million). If hardness increase, then it deters the lathering of soap. Hardness of the water samples can be measured by the titration method.

Reagent

EDTA, calcium carbonate, Eriochome black T

Procedure

In the titration procedure the solution of EDTA is standardize by the process of titration against the standard solution made from the calcium carbonate. Then the EDTA in the reagents can be used to determine concentration of the sample of unknown concentration. As the both solutions used in the experiment are colorless so, to know the reaction an indicator is used that are normally eriochorm black T. this indicator make a complex red wine solution. When ETDA was added to the solution this set free the Ca^{2+} and Mg^{2+} ions that leaves behind only $MgIn^{-}$. All the Ca^{2+} and Mg^{2+}.ions are converted in to chelates. This indicator added eventually revert into uncombined form and its shy blue in color, marks the end of the titration process. Titration is carried out at the pH of 10 (Zienldien, 2018).

Titration reaction

$$HY^{3-} (aq) + Ca^{2+} (aq) \longrightarrow CaY^{2-} (aq) + H^{+} \text{ (also for } Mg^{2+})$$

End point reaction

$$HY^{3-} (aq) + MgIn^{-} (aq) \longrightarrow MgY^{2-} (aq) + HIn^{2-} (aq)$$

red wine sky blue

2.4 Heavy metals laboratory analysis

There are Five heavy metals under study Cadmium, Chromium, Zinc, Copper and Manganese their concentration was studies in all the samples collected from each dam. For the analysis, the sample of 100 ml was prepared by adding 2 ml of nitric acid for the prevention against the changes. Then filter through the filter paper for the removal of any particulate material Atomic Adsorption Spectroscopy (AAS) (Model ANALYST800). Manufacture PERKIN ELMIER Operated by PCRWR in H8 Islamabad. All samples for the heavy metal analysis were prepared in Bahria university lab and only required volume of prepared samples were transported to the labs for the heavy metal analysis.

2.4.1 Atomic absorption spectroscopy

The Parkin Elmer AAS Analyst 800 high performance Atomic Absorption Spectroscopy with Winlab32 for AA software feature automated motorize atomizer exchange that allows the changing of flames lamps and graphite furnace Atomic Absorption by a simple software command was used. This AAS is already equipped with very high-performance burner system, the gas system is manually control by the lab staff for the flame lamps and inversely heated graphite furnace (THGA). The metals were analyzed on their proposed lamps on the gage the amount of the substances component in the specimen by measuring the integrated radiation of the investigation. Its responsibility is to remove the metals from the samples and produce a shower known as the automizer. For this reason, the spacemen went into the fire i-e capillary is dipped into the samples. The sample was then nebulized, and a mixture is made this way the specimen was made and get signed each material was confined and separated on the basis of the characteristic feeds already to the AAS system. As the light passes wavelength was made and ducted by the sensor on the other hand and the signal was transmitted to the computer system where the software read the signal to give a numerical concentration of the screen attached to the system.

CHAPTER 3

RESULTS AND DESCUSSION

Water is an only substance that grantee the life and sustainability on earth. All organisms from unicellular to multicellular all need water as solvent for their metabolic processes. This solvent is responsible for the ionic transfer and maintain nutrient flow in the body of the organisms (Jameel et al., 2012). From the last few decades as the mankind become more advanced and the anthropogenic footprint grow on the face of the earth precious resource is exposed to the tons of pollution and waste that directly affect the quality of water. Toxic heavy metals deter the physio-chemical and chemical characters of water. These additions are very dangerous for the both aquatic and human populations as they cause diseases and alter the life process of these organisms. (Pham et al., 2007). There are many heavy metals that are closely related to the water quality but responsible for many dangerous diseases like cancers and these are Cr, As and Cd (Martin and Coughtrey., 1982).

The obtained results were noted against each sample and compared with the standard values of NEQS for surface water. Then the noted concentration is mark safe and unsafe accordingly to the standard criteria. The results are then discussed with the potential positive and negative aspects.

Both the physio- chemical and heavy metals are discussed in detailed. The tables show the results obtain against the physiochemical parameters in samples collected from the selected dams. The data size was large, so tables show the minimum, maximum, mean and standard deviation values of all the samples analyzed from the study areas.

These results are separately discussed in detailed as under

Physio-chemical parameters result:-

Table 3 Results of physiochemical parameters of selected dams

Name of Dam		pH	Conc. mg/l				
			TDS	Cl^-	NO_3	SO_4	HARDNESS
RAWAL DAM	MIN	7.500	501	92	12	49	180
	MAX	8.100	522	130	22	149	220
	MEAN	7.756	507	117	15	101	200
	SD	0.207	6	10	2	38	12
KHANPUR DAM	MIN	6.900	124	82	13	14	181
	MAX	7.500	240	130	19	149	218
	MEAN	7.238	160	112	15	109	196
	SD	0.121	21	14	2	35	12
MANGLA DAM	MIN	7.500	499	79	13	48	175
	MAX	8.100	528	135	18	155	222
	MEAN	7.770	508	107	15	115	199
	SD	0.205	7	18	2	32	14
SHAHPUR DAM	MIN	7.500	500	80	10	26	180
	MAX	8.100	525	130	20	149	220
	MEAN	7.780	510	109	15	105	201
	SD	0.209	7	16	2	44	14
TARBELA DAM	MIN	7.500	500	82	9	26	179
	MAX	8.100	530	130	19	150	220
	MEAN	7.752	510	112	15	100	200
	SD	0.197	8	13	2	37	13
TANAZA DAM	MIN	7.500	490	85	13	59	183
	MAX	8.100	527	130	20	149	225
	MEAN	7.788	507	111	16	110	199
	SD	0.207	6	14	2	29	14
SIMLY DAM	MIN	7.500	499	78	10	13	178
	MAX	8.100	545	135	18	150	221
	MEAN	7.774	510	111	15	86	200
	SD	0.216	8	15	2	45	14
NARYAB DAM	MIN	7.500	501	79	13	60	183
	MAX	8.100	535	135	18	150	225
	MEAN	7.808	511	108	15	101	201
	SD	0.207	8	16	2	30	14
NEQS STANDARD		6.5 - 8.5	<1000	<250	≤50	250	<500
WHO		6.5 - 8.5	<1000	<250	50	250	.....

3.1.1 **pH**

pH can be defined as the -log of hydrogen ions in moles per liter this define the acidic and salinity nature of the water. This is measured against the logarithmic table of values ranging from 0 to 14 where 7 is natural and as we go down that show the acidic nature of water as we go up shows the alkalinity of water. (basic in nature). While when we talked about the drinking water the safe limits lie between 6.5-8.5 where anyways either from this range is not consider as safe. In this study the results are compared with the NEQS standard of pH that is set in the range from 6.5-8.5. anything beyond this range is unsafe according to the NEQS limits of pH (Villaverde et al., 1997).

The pH results of selected dams are shown in the table 3 as the Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam Simly dam and Naryab dam are noted as the 7.5-8.1 pH, 6.9-7.5 pH, 7.5-8.1 pH, 7.5-8.2 pH, 7.5-8.2 pH, 7.5-8.2 pH, 7.5-8.2 pH and 7.3-8.1 pH respectively. As the results of all 8 dams are shown in table 3.1, 3.2 ,3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.1.1 shows the comprehensive and comparative pH concentrations in all eight selected dams. As the only Khanpur dam is bit towards little acidity among the all dams remaining dams are bit more basic in nature but the matter of fact they all fall under the safe limits set by the Pak-EPA and NEQSs. At few locations in Khanpur dam the samples were noted high in pH these points are normally near the points where the hotels and restaurants are located, and the inlets are present as the remaining samples from the dam is normal. As all the 50 samples gives the overall picture of the dam pH concentration. According to the international standard set for the pH table ranged from 1 to 14. Where from 7 toward descending are acidic in nature. It becomes 7 which was considered as neutral and buffer when we go up from the value of 7 the water come basic in nature (Vancouver, 2017). pH is a proportion of corrosive base harmony accomplished by water broke down compound just as limit flocculation coagulation procedure of synthetic compounds (Nazir et al., 2015).

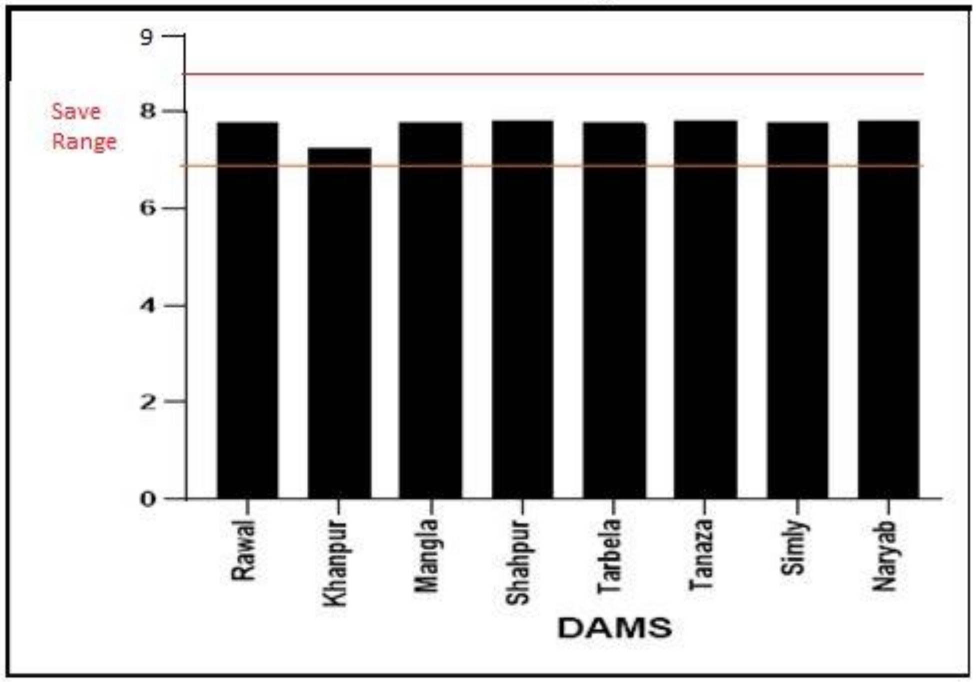

Figure 3.1.1 Mean values of pH in study area

3.1.2 **Total dissolved solids**

TDS is the abbreviation of total dissolved solids that are soluble in water (present in the water) they have major effect on the quality of the water as their nature occurred a huge impact on the character of the water like a solid acidic in nature gives the acidic character to the water it is dissolved in. the samples collected from the dams after analysis gives a complete amount of TDS in respective dams. There are the total sum of cations and anions that are present in the water. If the amount of the TDS rises or drop from the certain set limit, they have effect on the taste of water. The set limits for the TDS by NEQS is less than 1000 mg/l. The limits for the TDS by WHO is also less than 1000 mg/l. So the 50 samples collected from the dam gives a complete picture of the TDS and obtained results are as in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam are noted as the 501-522 mg/l, 124-240 mg/l, 499-528 mg/l, 500-525 mg/l, 500-530 mg/l, 490-527 mg/l, 499-545 mg/l and 501-535 mg/l respectively. As the results of all 8 dams are shown in table 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

As the table 3 shows the value of TDS with mean and the standard deviation among the samples the Figure 3.1.2 shows the comparative concentration of the TDS in the selected dams that show the all dams have the TDS concentration within the safe limits and only Rawal dam have the lowest value of the TDS in it. The TDS concentration are usually found in the area near to the inlets tributaries from where the water enters the dam.

The proportion of TDS in water impacts its taste, the low concentration of TDS makes the water taste better. Numerous people discover drinking water, (for instance, refined) to be unpleasant, and drinking water that has direct proportions of TDS to taste extraordinary. Raised degrees of TDS don't present a medical problem and are in great except if synthetic substances like chlorine and chloramines are accessible. Minerals, for instance, calcium and magnesium are found in hard water and respect has in drinking water. Water with zero TDS is awful for your prosperity for two reasons. In any case, it doesn't supply any minerals, and research exhibit. The subsequent explanation is one of the grounds that it is "greedy Water"- it is anxious for minerals. There is conclusive evidence that water with zero TDS will truly take minerals from your body. Drinking water with direct proportions of TDS may be the best water of all. In the preliminary, water with direct TDS is supported over various sorts of water. Better tasting water is basic to our prosperity on the grounds that if it doesn't taste extraordinary, you won't drink it and in case you don't drink it you will void your body minerals (Kozisek, 2005).

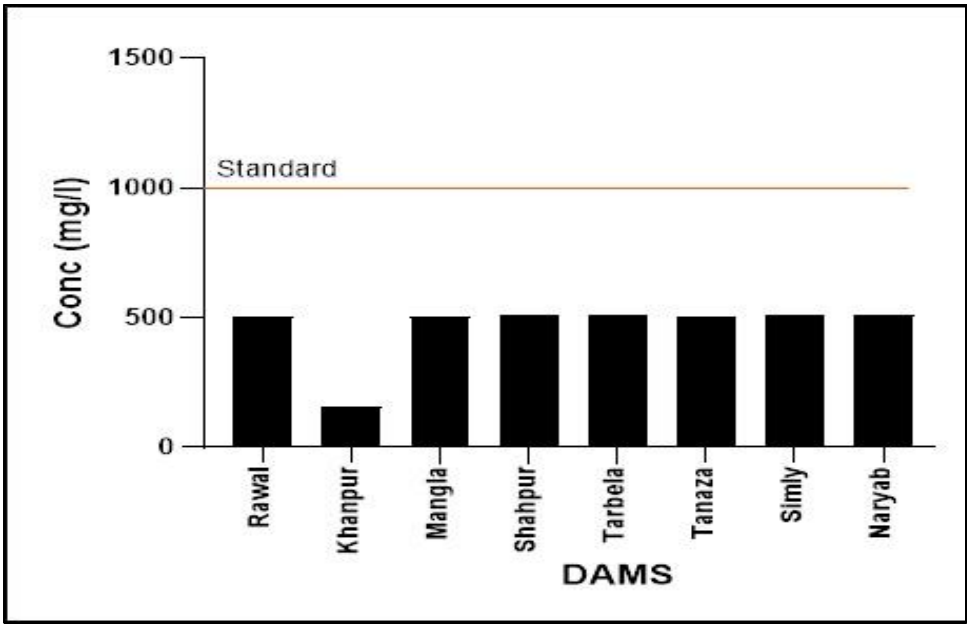

Figure 3.1.2 Mean values of TDS in study area

Chloride is the most widely occurring ion in the water as well as in the surface water of the dams. This usually present in the form of NaCl. They are the most prominent fixation of the ground water. The area in which the seawater is running through the white layer of the salt appears on these areas this further strive into the ground water and effect the water quality. Then the surface water faces the difficulty with the widespread chloride for the assessment of the chloride 50 samples from each dam is collected and processed through the standard analyzed processes and concentration is noted in a statically table 3.

As the concentration of chloride in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam are noted as the 92-130 mg/l, 82-130 mg/l, 79-135 mg/l, 80-130 mg/l, 82-130 mg/l, 85-135 mg/l, 78-135 mg/l and 79-135 mg/l. as these results are shown that all the results are in the safe limits as the standards of NEQS. As the results of all 8 dams are shown in table 3.1, 3.2 ,3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

The figure 3.1.3 shows the comparative concentration of chloride as the standard limits set for Chloride by NEQS and WHO is 250 mg/l. All dams were well within the standard limits of NEQS. This result show that the no dam has the variability against the chloride. As the chloride as power to alter the properties of water if they exceed the safe limit of NEQS.

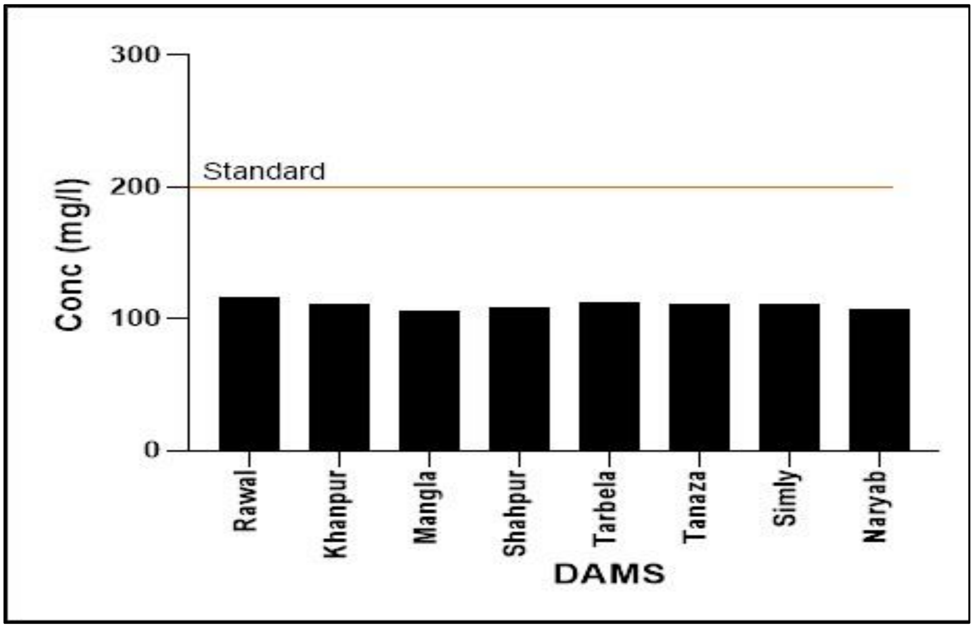

Figure 3.1.3 Mean values of chloride in study area

3.1.4 **Nitrate**

Nitrate can be defined as the salts containing the NO_3 group. If the nitrate is present in the normal quantity in the water, then this have no side effect on the ecosystem and life present in the aquatic life. If the quantity of nitrate exceeds in the water, then condition become difficult for fish to survive in that water. The plant and alga present in the water use this dissolved nitrate in water in the preparation of food and the increases in the nitrate then the preparation of food remain unchecked and this may result in large masses of alga in lakes and water bodies this result in eutrophication of the lake and later caused that particular aquatic system to be totally shut down (dead).

The safe limits set for the nitrate in the surface water and drinking water were <50 by NEQS and same by the WHO. This safe limit declares the proper quality of water to use domestically and it for the aquatic life. 50 samples were collected from each dam for the assessment of the nitrate in the water samples after the analysis the following concentration of nitrate is noted in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam are noted as 12-22 mg/l, 13-19 mg/l, 13-18 mg/l, 10-20 mg/l, 9-19 mg/l, 13-20 mg/l, 10-18 mg/l, 13-18 mg/l, respectively. As the results of all 8 dams are shown in table 3.1, 3.2 ,3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.1.4 below shows the comparative concentration of the nitrate in all the selected dam of Pakistan shows that the Tanaza dam have highest concentration of nitrate among the all dams of the study whereas the Khanpur dam is only dam with the lowest concentration of nitrate. These results show the concentration of nitrate in selected dam are well within the safe range of the NEQS. All selected dams were not vulnerable to the contamination of nitrate.

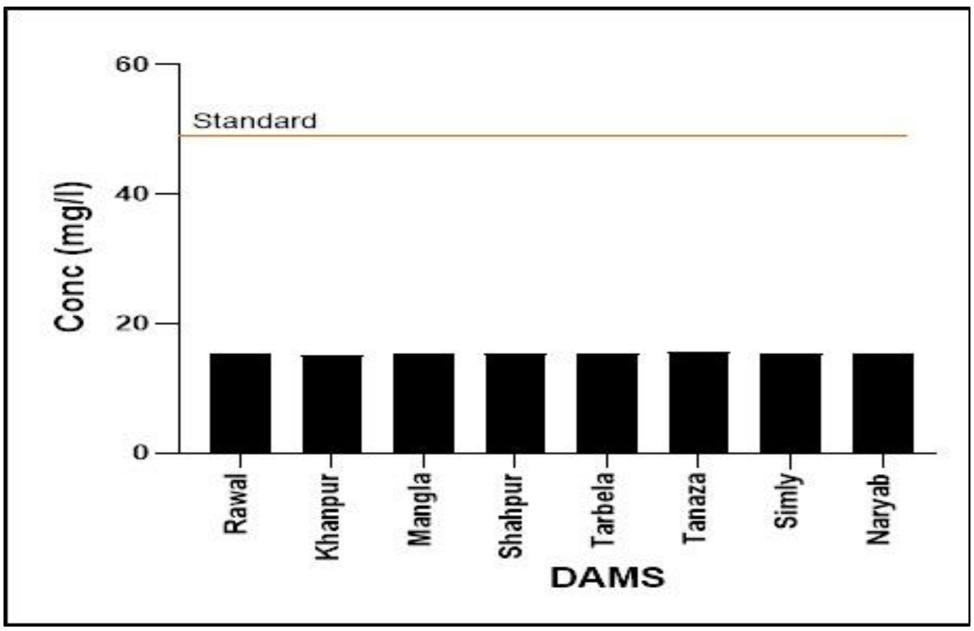

Figure 3.1.4 Mean concentration of nitrate in selected dams

3.1.5 **Sulphate**

Sulphate in water can be define as the salts or ester of any Sulphur acid present in the water is known as the sulphate or another material that react with Sulphur to releases the oxides of the Sulphur. The presences in the water may affect the water quality when its quality exceeds the certain limits of the NEQS and WHO. The permissible limits set by the NEQS is 250 mg/l and the same value is shared by the WHO. For the analysis of sulphate in the dam water the 50 samples were collected from each dam and their concentration were noted for each dam and the following result were obtained in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam as 49-149 mg/l, 14-149 mg/l, 48-155 mg/l, 26-149 mg/l, 26-150 mg/l, 59-159 mg/l, 13-150 mg/l and 60-150 mg/l respectively. As the results of all 8 dams are shown in table 3.1, 3.2 ,3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.1.5 shows the comparative concentration in the selected dams as the all concentration noted in these dams are well within the safe limits of NEQS and they have no adverse effect on the dam directly and or on its aquatic life so, the result shows that none of these selected dams are not venerable to the contamination of the sulphate.

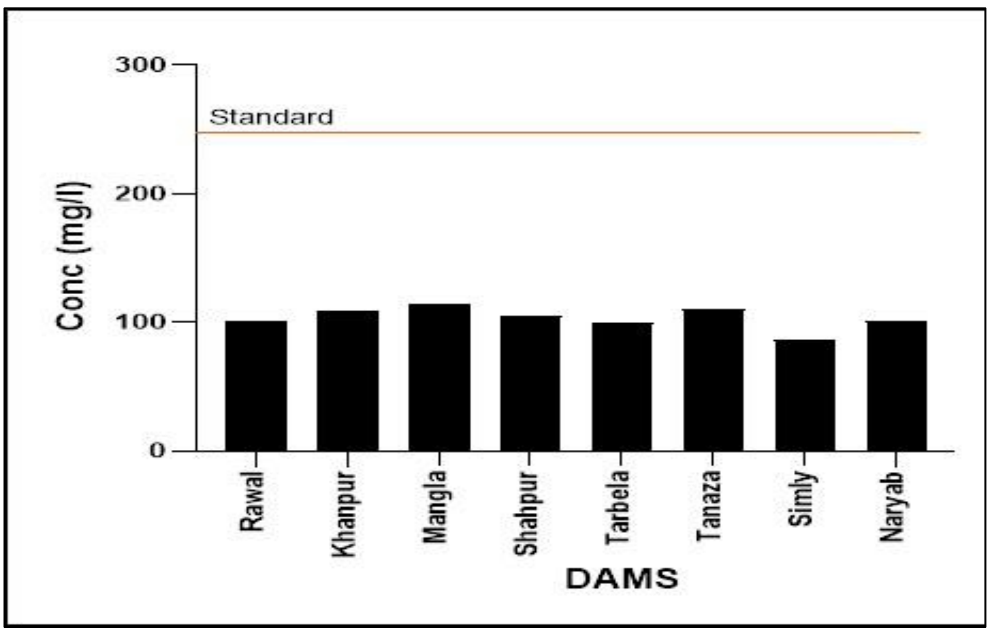

Figure 3.1.5 Mean concentration of sulphate in study area

3.1.6 **Hardness**

Hardness of water can be defined as the measure of the calcium and magnesium salts present in a particular water body. As the salt concentration in the water increases the harder the water got, the unit in which the hardness is measured is milligram per liter (mg/l). The safe limits set for the hardness of water by NEQS and Who is <500 mg/l by the NEQS and not a define value by the WHO. If the water is too hard then it's not good for the domestic and industrial uses. 50 samples were collected from each dam for the concentration of hardness in samples of Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam are noted as 180-220 ppm, 181-218 ppm, 175-222 ppm, 180-220 ppm, 179-220ppm, 183-225 ppm, 178-221 ppm and 183-225 ppm respectively, As the results of all 8 dams are shown in table 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.1.6 shows the comparative concentration of the hardness in ppm all the selected dams have the concertation of the hardness in the safe limits of the NEQS not a big variation among these dams can be seen and the noted concentration is well within the safe limits. No dam exceeds the concentration above 200 ppm. So, the water of these dams is not hard and good for drinking and industrial uses.

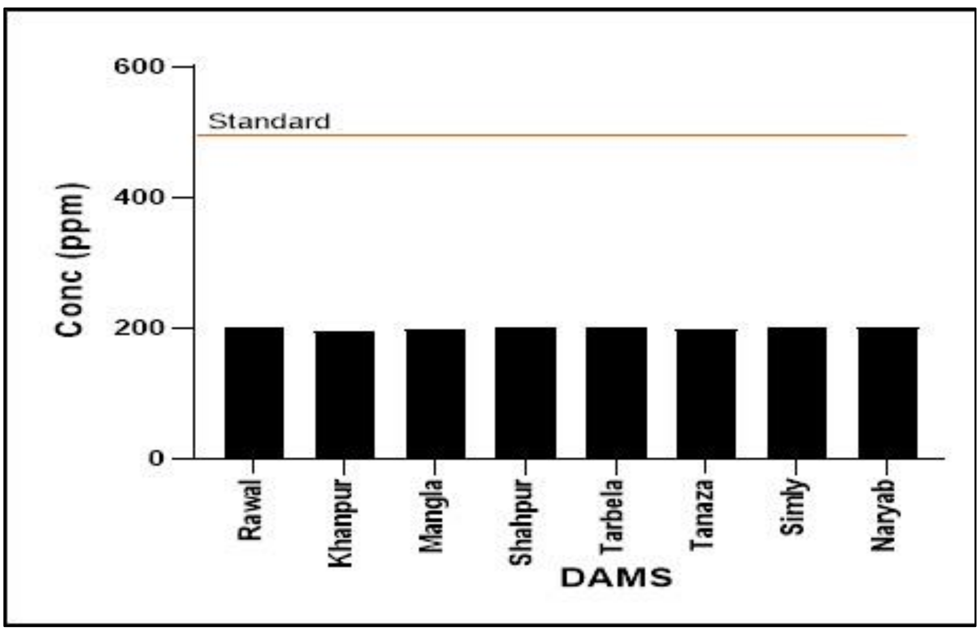

Figure 3.1.6 Mean concentrations of hardness in study area

3.2 Heavy metals result:

The heavy metals concentrations in the water usually depends upon the physiochemical parameters of the water such as the pH, turbidity, TDS and electric conductivity. It can be relating if the concentration of the heavy metals increases the values of pH drops. (the effect can be seen in the surface water profoundly) (Stihi et al., 2014). Heavy metals are present in nature and varies from the concentrations according to the area. In the current situation of the environment, as the anthropogenic activities increased rapid and this enter the huge amount of the heavy metals in nature as pollution which disturbed the ecosystem and biological system in on going in nature. Because of the water contain much more heavy metals that infiltrate in earth and polluted the underground waters. The heavy metals pollution is the area of concern for ecological system because the heavy metals are non-degradable and toxic in nature, they are worthy to be concerned of. Now there are the need to develop an efficient and quick method that can be used to remediations for the pollution of the heavy metals, Pollution have a huge ability to change the physical setting of the water quality (Srikanth et al.,2013).

All samples were preserved right after the collection avoid of any kind of the contaminations and transported to lab to be analyzed by the AAS atomic absorption spectroscopy. The assessment of heavy metals is very important in the drinking water because they can cause many health-related problem inhuman beings and other living organisms like the cadmium and chromium can cause the cancer in human being. The manganese can cause the mental illness and nervous disorder and loss of senses in the human and cause many irrecoverable diseases in the human being. There are many more problem caused by the increased by the concentration of the heavy metal concentration as its most importantly effect the quality of water and alter the function of the aquatic ecosystem and their other life activities like life Spain and life activities. Zinc is also a heavy metal that can impact the human life in large extent if increased in the concentration (Xenophon et al., 2010).

Table 3.2 showing the values of heavy metals that were analyzed. This give the comparative picture of the heavy metal’s concentration.

Heavy metals results:-

Table 3.2.1 Results of heavy metals in selected dams

Name of Dam		Conc. mg/l				
		Cd	Cr	Zn	Mn	Cu
RAWAL DAM	MIN	0.001	0.018	1.400	0.210	0.490
	MAX	0.012	0.069	5.900	0.690	2.230
	MEAN	0.007	0.039	3.626	0.411	1.215
	SD	0.002	0.013	0.965	0.103	0.423
KHANPUR DAM	MIN	0.001	0.011	0.600	0.210	0.009
	MAX	0.018	0.039	3.200	0.490	1.020
	MEAN	0.006	0.022	1.496	0.350	0.050
	SD	0.004	0.007	0.426	0.061	0.141
MANGLA DAM	MIN	0.001	0.015	1.000	0.160	0.300
	MAX	0.019	0.056	4.100	3.600	1.900
	MEAN	0.009	0.034	2.138	1.391	0.950
	SD	0.005	0.010	0.902	1.051	0.445
SHAHPUR DAM	MIN	0.001	0.012	0.280	0.160	0.500
	MAX	0.018	0.057	4.900	2.100	1.950
	MEAN	0.006	0.037	2.354	0.378	1.156
	SD	0.003	0.010	1.461	0.260	0.457
TARBELA DAM	MIN	0.003	0.013	1.600	0.210	0.490
	MAX	0.019	0.069	5.600	0.690	2.230
	MEAN	0.008	0.036	3.484	0.385	1.167
	SD	0.003	0.014	0.866	0.100	0.433
TANAZA DAM	MIN	0.001	0.020	1.200	0.210	0.400
	MAX	0.019	0.340	5.900	0.690	1.800
	MEAN	0.007	0.043	3.280	0.386	1.230
	SD	0.003	0.044	0.960	0.095	0.408
SIMLY DAM	MIN	0.003	0.012	1.900	0.230	0.500
	MAX	0.019	0.052	5.600	0.550	1.950
	MEAN	0.007	0.030	3.598	0.374	1.089
	SD	0.003	0.012	0.815	0.080	0.430
NARYAB DAM	MIN	0.004	0.012	0.018	0.210	0.300
	MAX	0.019	0.052	0.065	0.690	2.230
	MEAN	0.008	0.027	0.038	0.393	1.166
	SD	0.003	0.012	0.012	0.095	0.471
NEQS STANDARD		0.01	≤0.05	5.0	≤0.5	2
WHO		0.003	0.05	3	0.5	2

3.2.1 **Cadmium**

Cadmium is one of the toxic metals of Periodic table known as carcinogen (carcinogen is known as the cancer-causing agent) this have a very low safe limits because its presence is itself a pollution. There are some industries near the selected dams that might be the reason for the pollution of the Cd in the dams, like the presences of glass industries near the Shahpur dam. So, the concentration of Cd might be expected in the water samples. This might affect the quality of the surface water. Specifically, it may be discharged in drinking water by the center of industries waste and the erosion of the pipes. To check the exact concentration of the Cd the samples were preserved right after the collection of the samples. The samples were analyzed by AAS to obtain the results of Cd.

The limits of the Cd set by the NEQS are 0.01 mg/l and 0.003 mg/l by WHO is called safe by these organization. Samples analyzed and checked against these values in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam and concentrations are noted as 0.001-0.012 mg/l, 0.001-0.018 mg/l, 0.001-0.019 mg/l, 0.001- 0.018 mg/l, 0.003-0.019 mg/l, 0.001-0.019 mg/l, 0.003-0.019 mg/l and 0.004-0.019 respectively. As the results of all 8 dams are shown in table 3.1, 3.2 ,3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.2.1 shows the comparative picture of the Cd concentration in the selected dam where the Mangla dam haves the highest concentration of Cd in all selected dams. The all samples show some concentrations of Cadmium, but all falls under the limits set by the NEQS but some in bigger dams like Mangla dam in which some samples exceed the safe limits of WHO that is an area of concern. There is a reason behind the increase concentrations of Cd in the dams because of the major industries activity near the dams because of the availability of water in a large amount from the dams. Like the glass industries near the Shahpur dams add the efficient amount of cadmium in the water. The industries like paint and textiles are usually make plants near dams because their manufacturing processes need large amount of the water. This add pollution in dam water (ARL, 2017).

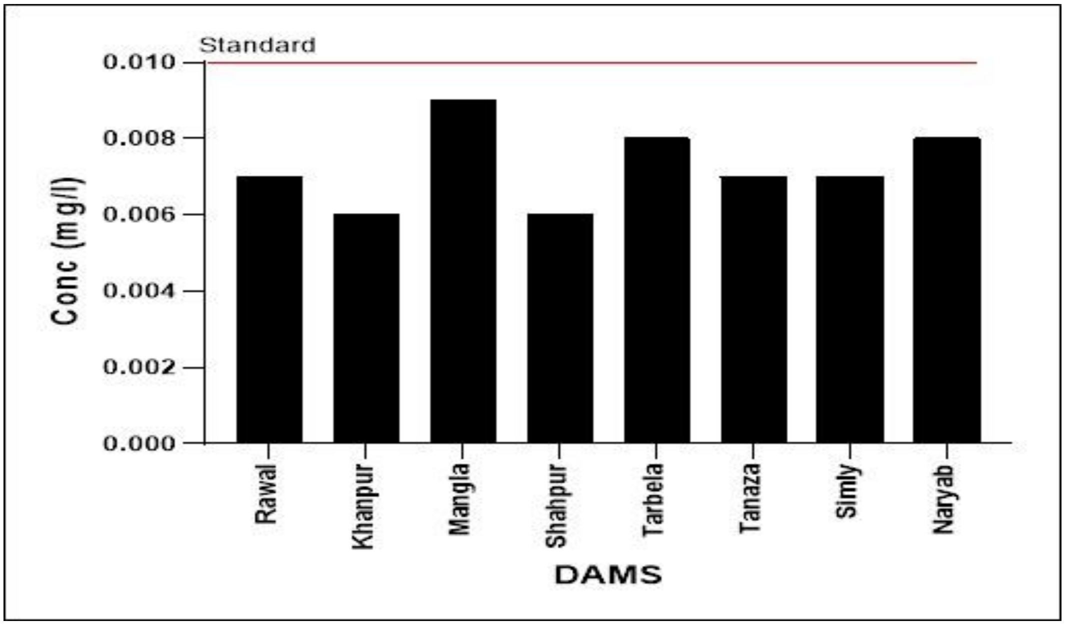

Figure 3.2.1 Mean concentration Cadmium in study area

3.2.2 **Chromium**

Chromium is another toxic metal of the Periodic table that are responsible for the cancer in human if present in the water. It is known as the cariogenic in nature (the elements that cause cancer is known as carcinogen). The presences of the Cr are known as the pollution and have very low limits as safe because of its toxic nature like its limits according to the NEQS is less than 0.05 mg/l and by same by the WHO. These limits are show the toxicity of this elements. The samples were collected and analyzed to check against these values to see the vulnerability of dams against chromium.

Following results are obtained in the analysis process the tables 3.2 carry the maximum, minimum, mean and SD values of the chromium in selected dams as in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam is noted as 0.018-0.069 mg/l, 0.011-0.039 mg/l, 0.015-0.056 mg/l, 0.012-0.057 mg/l, 0.013-0.069 mg/l, 0.020-0.034 mg/l, 0.012-0.052 mg/l and 0.012-0.052 mg/l respectively in these dams. As the results of all 8 dams are shown in table 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.2.2 shows the comprehensive and comparison of concentration of Cr in the selected dams. Tanaza dan in Attock district have the highest value of chromium in the water samples because of some small glass industries near the dam. This is one of the main reasons of high chromium concentration in the Tanaza. While the main Khanpur dam have the minimum value of chromium among the selected dams. Rawal dam ranked second among the polluted dams from chromium. This is because there are many urban settlements near the Rawal dam. If we compare the these reading with the NEQS standard, then some dams like Tanaza are above the permissible reading that make this water unfit for the drinking purpose. Now a day we have more than enough scientific evidence to prove that chromium is a toxic and carcinogen that are the main diseases causing agent in the human. As the main reason of this pollution is small urban and industrial settlement near the dam. These pollution causing sources and the shameful amount of Cr in these water reservoirs without knowing the consequences of this element (Sneddon, 2016).

As the dam water have a little different characteristic then the flowing water because the dam water has the control outflow and dilution factor cause the dam inlet is also control depending upon the water capacity of the dam. So, the dam water maintains this contamination in a long time. This is the reason that the dams are more venerable to the pollutions (Manoj et al., 2015).

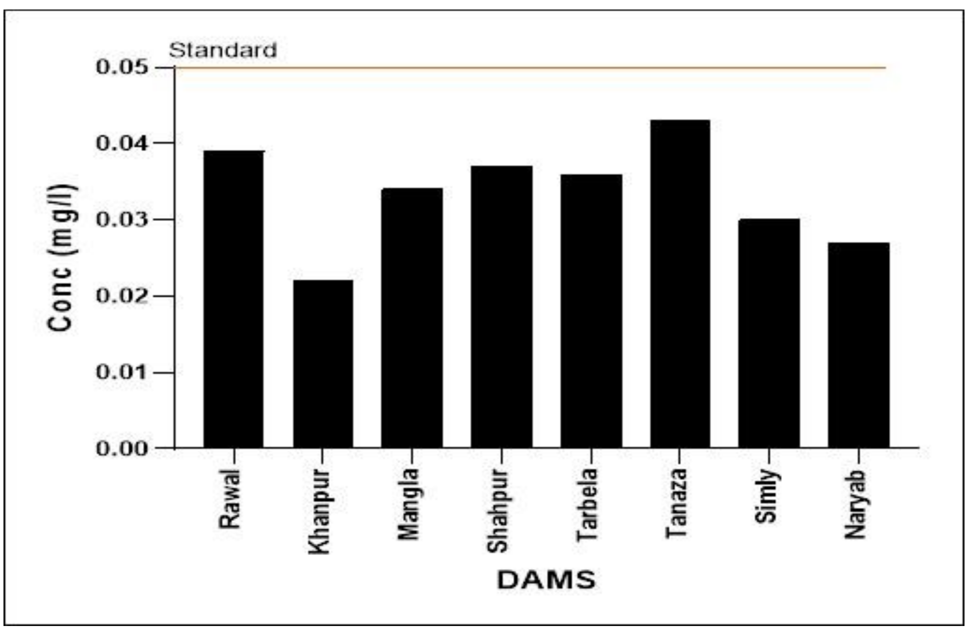

Figure 3.2.2 Mean concentration of chromium in study area

3.2.3 **Copper**

Copper is another heavy metal that are usually found readily in the earth core, the small amount of the copper in essential for the human body but if the concentration exceed particular limit then it can cause major diseases in the human bodies. All the 50 samples from each dam is analyzed for copper and concentration are written below and compared against the standard of NEQS limits of copper which is 2 mg/l and the WHO is also 2 mg/l in the water. As the samples are of dam surface water so they compared with these limits and these limits are obtained. Following Table 3.2 shows the concentration of copper in the collected samples as the concentrations in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam are noted as 0.49-2.23 mg/l, 0.009-1.0 mg/l, 0.30-1.9 mg/l, 0.5-1.9 mg/l, 0.49-2.23 mg/l, 0.4-1.8 mg/l, 0.5-1.9 mg/l and 0.3- 2.2 mg/l. respectively in selected dams. As the results of all 8 dams are shown in table 3.1, 3.2 ,3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.2.3 shows the comprehensive pictures of all the dams only Rawal dam have the lowest values of the copper amongst all the dams while other have the relative high values of concentration while the Tanaza have the highest value among the all these are high is concentration in the dams in which the urban installation is near or in sounding area. Copper is an important metal in human body but in the high amount then the same limits set by the NEQS and WHO. When compared with the limit it reveals that Tarbela, Naryab and Rawal dam are exceeding the safe limits of copper according to the NEQS few samples were but their overall means stays under the safe limits set by the NEQS. Copper is an element that have the tendency to cause many diseases in human body specially regarding the bone diseases (Atique et al., 2000).

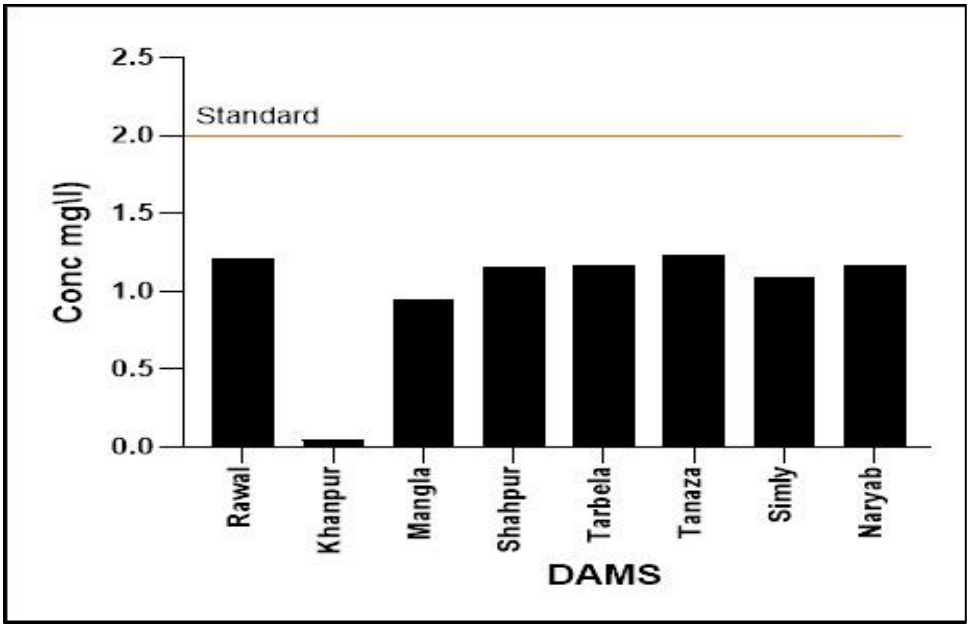

Figure 3.2.3 Mean concentration of Copper in study area

3.2.4 **Zinc**

Zinc is an also a heavy metals that is frequently check against the limits in the water quality cause it is a trace element in the human body and very closely associate with the human health the small amount is very important for the human health and if exceeds that amount is very dangerous but like in some causes that the zinc is very important for the pregnant ladies. 50 samples were collected from each dam for the analysis in lab to note the concentration of Zn in the samples and compared against the limits of NEQS and WHO. The following are the limits of Zn is 3 mg/l according to the WHO and 5 mg/l according to the NEQS. There are a different of 2 mg/l in the safe range of the zinc between WHO and NEQS. That is because of these metals are the part of the earth core and the three are a deficiency in water so there is the difference in limits these limits are noted in the result of analysis processes and are placed in the tables 3.2 show the comparatively study and as in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam the minimum and maximum values are noted as 1.4-5.9 mg/l, 0.6-3.2 mg/l, 1-4.1 mg/l, 0.28-4.9 mg/l, 1.6-5.6 mg/l, 1.2-5.9 mg/l, 1.9-5.6 mg/l and 0.018-0.065 mg/l respectively in all eight selected dams. As the results of all 8 dams are shown in table 3.1, 3.2 ,3.3, 3.4, 3.5, 3.6, 3.7 and 3.8.

Figure 3.2.4 shows the comparative concentration of the Zn in the selected dams. Both the Rawal and Simly dams have the highest values of Zn in all selected dams. And Naryab dam is only one have the very low concentration of Zn. Most of the dams have the average concentration of Zn above the safe limits of NEQS.

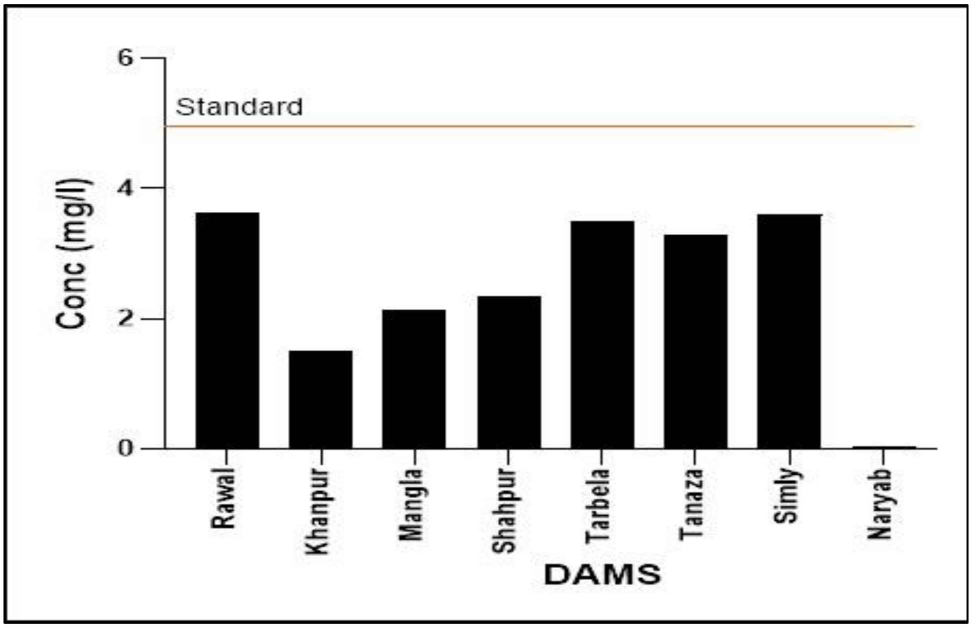

Figure 3.2.4 Mean concentration of Zinc in study area

3.2.5 **Manganese**

Manganese is one of another heavy metals are is trace element in the human body and have the significance in human body function as it is very important in human functions and building major human body orgasm like hair, nails and teeth. Manganese have the safe limit of 0.5 mg/l in NEQS and same in WHO. This safe limit show the Mn have a capacity of alter the water quality and its features. 50 samples were collected from each dam and send for the analysis of Mn. when the Manganese concentration increases in the water this bring the many health disorder in the human that directly impact the respiratory track and brain nerve cells. The results obtained after the analysis processes and reading is noted in the Table 3.2 as the concentration in Rawal dam, Khanpur dam, Mangla dam, Shahpur dam, Tarbela dam, Tanaza dam, Simly dam and Naryab dam following minimum and maximum concentrations are observed 0.21-0.63 mg/l, 0.21-0.49

mg/l, 0.16-3.6 mg/l, 0.16-2.1 mg/l, 0.21-0.69 mg/l, 0.21-0.69 mg/l, 0.23-0.55 mg/l and 0.21-0.69 mg/l respectively in all selected dams.

Manganese values remain quite constant except the Mangla dam where its concentration is reported very high as compared to the safe limit of 0.5mg/l so it can be concluded that the Mangla dam is quite vulnerable to the contamination of Mn. According to the literature the heavy metal manganese if increased in the concentration it can proved very dangerous for human health like it can impact the brain and other organs of the human body.it basically impact the respiratory track of the organisms. Its reach out to the brain and damage the thoughts, fantasies, carelessness and nerve harm. Diseases like Parkinson, lung embolism and bronchitis. The over concentration of Manganese can also do malfunction of the body (Xenophon et al., 2010).

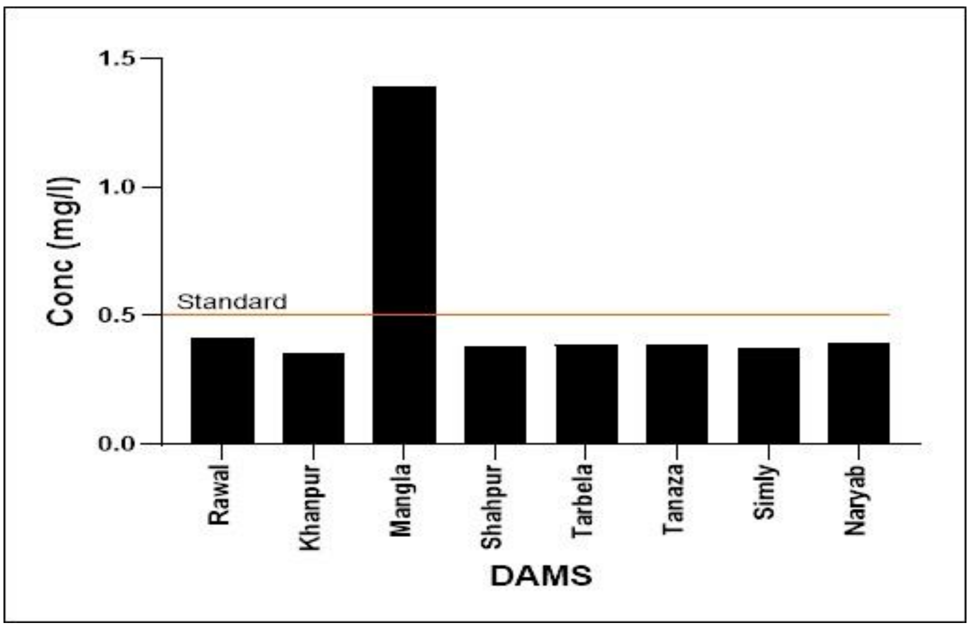

Figure 3.2.5 Mean concentrations of manganese in study area

Table 3.1 Analysis result of Rawal dam

SAMPLES	PHYSICOCHEMICAL						HEAVY METALS					CORDINATES	
CODE	pH	TDS	Cl-	NO_3^-	SO_4^{2-}	HARDNESS	Cd	Cr	Zn	Mn	Cu	N	E
R1	7.7	518	111	14	61	195	0.005	0.039	4.3	0.43	1.1	33°41'33.44"N	73° 7'12.30"E
R2	7.7	501	119	13	67	191	0.009	0.041	3.7	0.39	0.8	33°41'43.52"N	73° 7'43.22"E
R3	7.5	509	110	18	90	202	0.007	0.029	2.9	0.44	1.5	33°41'54.80"N	73° 8'14.89"E
R4	7.9	501	118	18	86	210	0.008	0.033	4.9	0.29	0.5	33°42'16.31"N	73° 8'11.36"E
R5	7.5	503	123	13	73	180	0.007	0.027	5.4	0.52	1.3	33°42'41.09"N	73° 8'3.30"E
R6	8.1	508	106	18	99	180	0.004	0.035	2.7	0.54	0.9	33°42'36.13"N	73° 7'39.05"E
R7	7.5	501	111	14	101	215	0.006	0.044	3.9	0.45	1.9	33°42'28.93"N	73° 7'16.90"E
R8	7.6	507	119	15	127	218	0.009	0.054	3.5	0.38	1.9	33°42'17.72"N	73° 6'52.56"E
R9	8	506	123	18	141	183	0.008	0.049	2.8	0.48	2.2	33°42'3.45"N	73° 6'42.59"E
R10	7.7	504	125	12	149	189	0.009	0.023	4.6	0.69	0.9	33°41'43.53"N	73° 6'47.88"E
R11	7.9	503	115	14	134	199	0.005	0.042	4.1	0.28	1.2	33°41'43.75"N	73° 7'2.24"E
R12	7.6	502	117	15	143	200	0.002	0.036	5.6	0.49	0.8	33°41'53.64"N	73° 7'2.10"E
R13	7.5	501	130	17	145	200	0.008	0.059	3.5	0.41	1.6	33°42'2.62"N	73° 6'56.48"E
R14	7.9	502	126	14	91	196	0.003	0.019	1.9	0.43	1.3	33°42'10.22"N	73° 7'9.12"E
R15	8.1	522	128	16	100	195	0.001	0.049	4.7	0.29	1.0	33°42'3.93"N	73° 7'10.94"E
R16	7.5	511	92	15	59	191	0.008	0.041	1.4	0.48	0.9	33°41'58.48"N	73° 7'14.17"E
R17	7.6	510	96	18	59	202	0.005	0.035	4.3	0.37	0.6	33°41'51.59"N	73° 7'15.09"E
R18	8	509	122	13	98	210	0.007	0.069	2.5	0.21	1.5	33°41'44.20"N	73° 7'14.95"E
R19	7.7	502	123	13	98	216	0.009	0.064	3.6	0.48	1.3	33°41'43.56"N	73° 7'25.14"E
R20	7.6	522	130	17	49	189	0.008	0.047	1.5	0.42	0.5	33°41'53.46"N	73° 7'28.38"E
R21	8	511	115	16	61	187	0.006	0.026	2.9	0.29	0.7	33°42'4.48"N	73° 7'30.81"E
R22	7.7	504	125	13	149	189	0.006	0.045	3.8	0.49	1.4	33°42'15.33"N	73° 7'24.53"E
R23	7.9	503	115	14	134	199	0.007	0.037	4.5	0.28	0.8	33°42'24.84"N	73° 7'29.49"E
R24	7.6	502	117	15	143	200	0.009	0.022	5.9	0.36	0.6	33°42'19.87"N	73° 7'38.60"E
R25	7.5	501	130	17	145	200	0.008	0.059	3.9	0.45	1.5	33°42'15.20"N	73° 7'43.98"E
R26	8.1	503	127	18	123	213	0.006	0.046	2.3	0.28	1.2	33°42'6.64"N	73° 7'45.22"E
R27	8	507	119	17	69	216	0.008	0.064	3.6	0.48	0.8	33°41'55.14"N	73° 7'47.68"E
R28	7.9	509	112	13	133	181	0.005	0.055	4.1	0.36	1.7	33°41'54.17"N	73° 8'0.54"E
R29	8.1	508	111	16	112	180	0.007	0.042	2.8	0.59	1.3	33°42'8.30"N	73° 8'1.93"E
R30	8	501	119	17	66	189	0.006	0.036	3.5	0.4	0.7	33°42'20.52"N	73° 7'55.12"E
R31	7.9	507	110	16	70	187	0.009	0.045	3.1	0.58	0.9	33°42'25.95"N	73° 8'15.82"E
R32	7.8	506	118	13	61	196	0.004	0.023	2.8	0.46	1.3	33°42'35.76"N	73° 8'27.35"E
R33	7.6	504	123	18	83	195	0.007	0.031	3.9	0.25	1.0	33°42'49.78"N	73° 8'34.09"E
R34	7.7	503	125	13	91	191	0.012	0.046	4.6	0.44	1.8	33°42'59.96"N	73° 8'39.72"E
R35	7.5	502	115	13	91	202	0.007	0.018	3.7	0.31	1.0	33°43'14.18"N	73° 8'45.00"E
R36	7.5	501	122	17	101	220	0.005	0.034	3.9	0.27	1.9	33°41'34.23"N	73° 7'23.78"E
R37	7.7	503	126	17	127	220	0.009	0.047	3.7	0.35	1.5	33°41'32.84"N	73° 7'25.97"E
R38	7.6	507	128	15	141	211	0.006	0.052	3.4	0.38	2.0	33°42'16.04"N	73° 6'44.54"E
R39	8	505	100	13	60	200	0.007	0.024	3.5	0.42	0.9	33°42'22.51"N	73° 6'44.99"E
R40	7.7	509	112	13	61	213	0.008	0.018	3.3	0.46	1.4	33°42'24.80"N	73° 6'39.37"E
R41	7.9	508	111	16	67	216	0.009	0.033	3.9	0.38	1.0	33°42'27.64"N	73° 6'34.22"E
R42	7.6	501	124	17	90	217	0.008	0.048	4.5	0.41	1.7	33°42'30.99"N	73° 6'29.11"E
R43	7.5	502	126	16	86	218	0.012	0.029	2.7	0.23	1.4	33°42'24.09"N	73° 6'52.01"E
R44	7.9	511	112	22	119	190	0.008	0.043	4.8	0.47	1.0	33°42'29.20"N	73° 6'48.99"E
R45	7.6	515	111	18	86	220	0.006	0.028	2.2	0.26	1.5	33°42'32.00"N	73° 6'54.60"E
R46	7.5	520	119	14	77	196	0.009	0.037	3.8	0.54	1.7	33°42'38.04"N	73° 6'52.54"E
R47	8.1	522	110	14	129	195	0.008	0.049	2.9	0.39	1.6	33°42'39.39"N	73° 6'58.44"E
R48	8	520	118	16	121	191	0.007	0.035	4.4	0.51	1.3	33°42'42.52"N	73° 7'1.96"E
R49	7.6	507	92	15	145	199	0.004	0.019	3.7	0.43	1.0	33°42'46.12"N	73° 6'57.92"E
R50	7.7	506	96	16	123	191	0.006	0.045	3.4	0.55	1.3	33°42'50.44"N	73° 6'59.95"E

Table 3.2 Analysis result of Khanpur dam

SAMPLES	PHYSICOCHEMICAL					HEAVY METALS					CORDINATES	
CODE	*pH*	*TDS*	*Cl-*	*NO_{3-}*	*SO_4^{2-}*	*HARDNESS*	*Cd*	*Cr*	*Zn*	*Mn*	*Cu*	*N*	*E*
K1	7.3	240	126	14	76	184	0.006	0.011	2.1	0.43	1.02	33°48'48.80"N	72°56'18.32"E
K2	7.3	133	128	13	89	184	0.001	0.016	1.9	0.39	0.04	33°49'1.95"N	72°56'54.74"E
K3	7.2	125	106	18	99	184	0.012	0.017	3.2	0.35	0.04	33°48'38.99"N	72°56'56.58"E
K4	7.3	136	111	14	101	215	0.001	0.019	1.5	0.35	0.03	33°48'18.90"N	72°57'8.18"E
K5	7.4	140	119	15	127	218	0.012	0.02	2.0	0.36	0.05	33°48'7.15"N	72°57'6.81"E
K6	7.2	163	123	18	141	183	0.009	0.023	1.9	0.35	0.04	33°48'10.27"N	72°56'36.61"E
K7	7.3	154	125	13	149	189	0.005	0.021	1.9	0.42	0.04	33°47'59.60"N	72°55'56.12"E
K8	7.3	165	115	14	134	199	0.007	0.014	0.6	0.4	0.02	33°48'27.29"N	72°55'41.48"E
K9	7.1	133	117	15	143	200	0.001	0.024	1.7	0.33	0.01	33°48'55.79"N	72°55'16.61"E
K10	7.2	154	130	17	145	200	0.008	0.025	1.3	0.36	0.01	33°49'20.27"N	72°55'54.10"E
K11	7.3	165	130	16	149	189	0.018	0.012	1.7	0.49	0.03	33°49'1.26"N	72°55'52.30"E
K12	7.3	165	115	15	134	199	0.015	0.012	1.7	0.29	0.04	33°48'49.66"N	72°55'51.77"E
K13	7.4	165	99	14	143	200	0.007	0.015	0.9	0.32	0.04	33°48'50.69"N	72°56'3.32"E
K14	7.2	165	103	17	145	213	0.005	0.019	1.0	0.35	0.01	33°48'42.45"N	72°56'7.44"E
K15	7.3	139	109	13	123	216	0.006	0.025	0.9	0.32	0.07	33°48'41.89"N	72°56'26.38"E
K16	7.3	164	100	15	86	218	0.008	0.026	0.9	0.36	0.05	33°48'44.13"N	72°56'38.63"E
K17	7.1	165	112	16	73	211	0.015	0.021	1.0	0.39	0.04	33°48'29.61"N	72°56'36.09"E
K18	7.3	134	111	17	134	189	0.002	0.017	1.1	0.35	0.03	33°48'25.47"N	72°56'28.43"E
K19	7.4	198	124	18	133	187	0.004	0.026	1.4	0.31	0.04	33°48'12.86"N	72°56'23.23"E
K20	7.3	124	126	14	91	196	0.008	0.019	1.6	0.32	0.03	33°48'12.09"N	72°56'5.40"E
K21	7.2	176	128	16	100	195	0.011	0.021	1.4	0.48	0.04	33°48'39.60"N	72°55'34.42"E
K22	7	145	92	15	69	191	0.005	0.032	1.4	0.46	0.04	33°48'39.36"N	72°55'45.30"E
K23	7.1	143	96	18	14	202	0.004	0.025	1.3	0.29	0.04	33°48'33.49"N	72°55'37.56"E
K24	7.3	125	124	14	98	184	0.004	0.016	1.1	0.35	0.03	33°48'34.02"N	72°55'50.40"E
K25	7.3	165	126	14	76	184	0.003	0.018	1.0	0.38	0.03	33°48'41.72"N	72°55'58.85"E
K26	7.2	166	128	13	89	184	0.002	0.013	1.3	0.33	0.03	33°48'34.18"N	72°56'1.90"E
K27	7.4	145	106	18	99	184	0.002	0.016	1.4	0.29	0.05	33°48'35.43"N	72°56'14.06"E
K28	7	198	111	14	101	215	0.002	0.021	1.3	0.28	0.01	33°48'34.23"N	72°56'27.22"E
K29	6.9	154	119	15	127	218	0.006	0.026	1.6	0.31	0.03	33°48'23.98"N	72°56'20.78"E
K30	7.3	165	123	18	141	183	0.003	0.026	1.4	0.34	0.02	33°48'23.67"N	72°56'38.78"E
K31	7.2	174	125	13	149	189	0.006	0.025	1.9	0.29	0.04	33°48'3.15"N	72°55'33.68"E
K32	7.3	168	130	13	18	191	0.004	0.039	2.1	0.27	0.03	33°47'56.91"N	72°55'27.07"E
K33	7.3	142	115	13	15	202	0.001	0.032	2.3	0.35	0.03	33°47'50.15"N	72°55'21.65"E
K34	7.5	169	122	17	134	210	0.008	0.025	1.4	0.37	0.02	33°47'46.32"N	72°55'13.64"E
K35	7.3	145	121	16	133	216	0.002	0.022	1.6	0.32	0.01	33°47'35.17"N	72°55'0.35"E
K36	7.2	165	83	14	143	198	0.006	0.035	1.7	0.38	0.04	33°47'32.73"N	72°54'49.38"E
K37	7.1	175	82	13	124	190	0.007	0.036	1.3	0.45	0.04	33°47'36.43"N	72°54'34.61"E
K38	7.3	168	126	16	86	218	0.004	0.036	1.2	0.36	0.01	33°47'39.38"N	72°54'28.46"E
K39	7.3	145	128	13	73	181	0.003	0.026	1.4	0.24	0.04	33°47'38.38"N	72°54'19.22"E
K40	7.2	168	92	18	134	186	0.004	0.031	1.3	0.36	0.04	33°47'38.68"N	72°54'11.38"E
K41	7.1	169	96	13	133	184	0.001	0.016	1.4	0.34	0.02	33°48'48.01"N	72°57'12.60"E
K42	7.1	185	89	13	91	184	0.007	0.023	1.7	0.21	0.02	33°48'49.96"N	72°57'28.39"E
K43	7	132	101	17	100	189	0.005	0.015	1.6	0.32	0.02	33°48'59.57"N	72°57'43.57"E
K44	7.4	165	92	15	145	199	0.003	0.016	1.4	0.26	0.02	33°49'17.00"N	72°57'47.92"E
K45	7.3	143	96	16	123	191	0.005	0.014	1.5	0.32	0.01	33°49'28.57"N	72°57'58.64"E
K46	7.3	169	89	17	66	189	0.004	0.013	1.7	0.35	0.04	33°49'34.53"N	72°58'9.29"E
K47	7.2	162	101	19	79	198	0.003	0.027	1.6	0.42	0.03	33°49'46.04"N	72°58'21.60"E
K48	7.1	182	124	14	99	190	0.009	0.026	1.3	0.49	0.01	33°49'51.54"N	72°58'30.39"E
K49	7.2	168	92	15	145	199	0.006	0.032	1.3	0.31	0.03	33°49'57.55"N	72°58'39.52"E
K50	7.3	165	96	16	123	191	0.004	0.017	1.6	0.35	0.04	33°50'9.69"N	72°58'37.12"E

Table 3.3 Analysis results of Mangla dam

SAMPLES	PHYSICOCHEMICAL						HEAVY METALS					CORDINATES	
CODE	*pH*	*TDS*	*Cl-*	*NO_{3^-}*	*SO_4^{2-}*	*HARDNESS*	*Cd*	*Cr*	*Zn*	*Mn*	*Cu*	*N*	*E*
M1	7.6	511	129	15	77	184	0.009	0.036	3.5	0.27	1.4	33° 9'23.80"N	73°38'43.21"E
M2	8	510	88	18	129	180	0.004	0.019	3.1	0.31	1.2	33° 7'57.06"N	73°39'59.55"E
M3	7.7	513	85	15	121	215	0.011	0.029	2.5	0.25	1.5	33° 9'47.53"N	73°41'45.68"E
M4	7.9	516	83	14	143	218	0.009	0.045	1.9	0.4	1.1	33°12'11.13"N	73°41'18.06"E
M5	8.1	517	82	13	124	183	0.005	0.040	2.2	0.43	0.8	33°12'50.00"N	73°40'5.88"E
M6	7.5	525	79	18	100	189	0.019	0.021	4.1	0.33	0.6	33°10'57.56"N	73°43'49.00"E
M7	7.6	500	99	18	155	199	0.007	0.035	1.4	0.26	0.4	33°11'22.37"N	73°47'37.22"E
M8	8	505	100	13	60	200	0.005	0.040	1.4	0.35	0.6	33°13'36.65"N	73°43'55.17"E
M9	7.7	504	125	13	149	189	0.006	0.025	1.3	0.46	0.9	33°15'41.05"N	73°43'52.05"E
M10	7.9	503	115	14	134	199	0.008	0.050	1.1	0.38	0.4	33°17'53.26"N	73°42'33.40"E
M11	7.6	502	117	15	143	200	0.013	0.034	1.0	0.22	1.1	33° 8'42.57"N	73°38'57.85"E
M12	7.5	501	135	17	145	200	0.008	0.018	1.3	0.16	1.6	33° 9'16.66"N	73°40'46.04"E
M13	8.1	503	127	18	123	213	0.005	0.016	1.4	0.2	1	33°10'20.55"N	73°39'50.83"E
M14	8	507	119	17	69	216	0.007	0.040	1.3	0.33	0.3	33°10'40.31"N	73°41'11.10"E
M15	7.7	509	124	13	89	217	0.011	0.032	1.6	0.3	0.3	33°11'32.46"N	73°40'23.08"E
M16	7.9	511	85	18	99	218	0.016	0.028	1.4	0.38	0.4	33°13'1.52"N	73°41'32.96"E
M17	8	515	87	13	101	181	0.009	0.033	1.9	0.26	0.8	33°12'39.74"N	73°43'40.01"E
M18	7.9	507	89	13	127	220	0.007	0.028	2.1	0.31	0.6	33°12'2.60"N	73°44'37.28"E
M19	7.6	502	117	15	143	200	0.016	0.044	2.3	0.25	0.6	33°11'24.98"N	73°45'38.23"E
M20	7.5	501	130	17	145	200	0.013	0.039	1.4	2.1	1.4	33°12'0.98"N	73°46'50.75"E
M21	8.1	503	127	18	123	213	0.01	0.044	1.4	1.9	1.6	33°13'49.69"N	73°40'51.62"E
M22	8	507	119	17	69	216	0.019	0.032	1.4	3.2	1.2	33°14'42.83"N	73°41'12.64"E
M23	7.7	509	124	13	89	217	0.006	0.024	1.3	1.5	0.8	33°15'39.90"N	73°41'49.65"E
M24	7.5	501	111	14	101	215	0.009	0.049	1.1	2.0	1.4	33°16'31.69"N	73°42'4.33"E
M25	7.6	507	119	15	127	218	0.005	0.041	1.0	1.9	0.8	33°16'14.65"N	73°43'6.21"E
M26	8	506	123	18	141	183	0.007	0.018	1.3	1.9	0.5	33°17'2.36"N	73°42'58.55"E
M27	7.9	510	88	18	129	180	0.013	0.020	1.4	0.6	0.7	33°16'38.75"N	73°44'2.48"E
M28	7.6	513	85	15	121	189	0.015	0.025	1.3	1.7	1.2	33°17'30.42"N	73°43'56.45"E
M29	7.7	516	83	14	143	198	0.014	0.030	1.6	1.3	1.6	33°17'14.82"N	73°44'53.40"E
M30	7.8	517	82	13	124	190	0.013	0.029	1.4	1.3	0.5	33°18'4.08"N	73°44'51.52"E
M31	7.9	525	80	18	139	220	0.004	0.033	1.9	1.4	0.6	33° 8'36.68"N	73°38'3.40"E
M32	7.5	501	122	17	101	220	0.006	0.041	2.1	1.7	0.8	33° 8'25.82"N	73°37'59.22"E
M33	7.7	503	126	17	127	220	0.008	0.056	2.3	1.6	0.7	33° 8'17.27"N	73°37'49.82"E
M34	7.6	507	128	15	141	211	0.015	0.039	1.4	1.4	0.5	33° 8'7.74"N	73°37'48.37"E
M35	7.6	509	92	18	149	184	0.002	0.045	4.1	1.5	0.8	33° 8'1.26"N	73°37'52.49"E
M36	7.8	502	96	15	134	180	0.004	0.018	2.6	1.7	0.9	33° 7'55.66"N	73°37'56.27"E
M37	8.1	501	89	14	143	189	0.008	0.048	3.5	1.6	0.5	33° 7'48.03"N	73°38'2.46"E
M38	7.7	502	100	13	145	198	0.011	0.041	1.6	1.3	0.6	33° 7'37.50"N	73°38'3.63"E
M39	7.9	502	117	18	123	175	0.005	0.036	2.4	1.3	0.5	33° 7'25.94"N	73°38'5.18"E
M40	7.5	499	130	15	66	186	0.004	0.032	3.6	1.6	1.8	33° 7'23.41"N	73°38'17.43"E
M41	8	501	127	14	129	190	0.001	0.038	3.1	2.1	1.6	33°18'41.39"N	73°45'7.76"E
M42	7.5	502	119	13	121	222	0.012	0.027	2.8	2.8	1.9	33°19'16.13"N	73°44'36.78"E
M43	7.7	511	111	18	143	196	0.009	0.035	2.5	2.6	0.9	33°19'55.78"N	73°44'43.81"E
M44	7.6	515	119	18	124	191	0.005	0.026	3.6	3.5	0.7	33°20'21.97"N	73°45'14.35"E
M45	7.7	502	96	13	133	184	0.007	0.046	2.8	2.6	1.8	33°21'9.58"N	73°46'0.81"E
M46	7.9	511	89	13	91	180	0.001	0.049	3.1	3.5	1.1	33°21'34.70"N	73°46'14.01"E
M47	7.5	515	101	17	100	189	0.008	0.020	2.9	2.8	0.5	33°21'56.32"N	73°45'58.05"E
M48	8	520	124	16	69	198	0.018	0.040	3.8	3.6	1.5	73°45'58.05"E	73°45'21.34"E
M49	7.5	528	85	14	94	190	0.015	0.015	3.2	2.5	1.2	33°22'49.48"N	73°45'5.89"E
M50	8.1	511	122	13	48	196	0.008	0.040	2.2	3.2	1.3	33°22'45.40"N	73°45'51.71"E

Table 3.4 Analysis results of Shahpur dam

SAMPLES	PHYSICOCHEMICAL						HEAVY METALS					CORDINATES	
CODE	pH	TDS	Cl-	NO_3^-	SO_4^{2-}	HARDNESS	Cd	Cr	Zn	Mn	Cu	N	E
S1	7.7	501	99	18	100	199	0.004	0.035	4.3	0.40	1.5	33°36'50.52"N	72°40'51.81"E
S2	7.9	503	100	13	60	200	0.006	0.03	2.8	0.35	1.2	33°36'47.62"N	72°41'41.96"E
S3	7.6	507	112	13	61	213	0.009	0.043	3.6	0.50	0.8	33°36'23.02"N	72°41'44.17"E
S4	7.5	509	111	16	67	216	0.008	0.029	3.8	0.41	1.7	33°36'5.92"N	72°41'20.00"E
S5	8.1	511	124	17	90	217	0.009	0.057	2.9	0.38	1.3	33°36'26.57"N	72°41'19.85"E
S6	8	515	126	16	86	218	0.005	0.031	3.8	0.25	0.7	33°36'32.78"N	72°41'1.85"E
S7	7.7	507	128	13	73	181	0.002	0.022	3.1	0.36	0.9	33°36'37.59"N	72°40'21.16"E
S8	7.9	518	127	18	149	189	0.008	0.026	2.9	0.26	1.3	33°36'19.73"N	72°39'52.13"E
S9	7.5	501	119	14	134	199	0.003	0.024	3.4	0.44	1.0	33°36'41.67"N	72°39'56.30"E
S10	8	509	124	16	143	200	0.001	0.036	3.8	0.34	1.8	33°37'7.11"N	72°40'11.23"E
S11	8.1	502	126	16	145	213	0.008	0.031	2.5	0.28	1.0	33°36'54.51"N	72°40'7.66"E
S12	7.7	522	128	17	123	216	0.007	0.036	2.9	0.36	1.9	33°36'46.87"N	72°40'12.92"E
S13	7.9	511	106	14	66	217	0.001	0.042	3.6	0.45	1.5	33°36'35.50"N	72°40'4.26"E
S14	7.6	510	111	14	79	218	0.008	0.052	3.8	0.32	2.0	33°36'58.87"N	72°40'20.31"E
S15	7.5	500	119	17	119	181	0.018	0.056	2.4	0.37	0.9	33°36'53.47"N	72°40'27.55"E
S16	8.1	501	124	14	99	190	0.015	0.051	1.9	0.28	1.4	33°36'58.15"N	72°40'40.56"E
S17	8	502	122	17	101	220	0.007	0.042	3.6	0.41	1.0	33°36'49.92"N	72°40'38.69"E
S18	7.7	511	126	17	127	220	0.005	0.038	4.1	0.38	1.5	33°36'41.93"N	72°40'33.37"E
S19	7.9	515	128	15	141	211	0.006	0.023	2.7	0.47	1.7	33°36'39.45"N	72°40'45.99"E
S20	7.5	520	92	18	149	184	0.008	0.041	3.6	0.35	1.6	33°36'45.20"N	72°40'58.63"E
S21	8	522	88	18	129	180	0.008	0.036	4.1	0.37	1.3	33°36'38.86"N	72°40'56.53"E
S22	7.5	525	85	15	121	215	0.006	0.041	2.5	0.26	1.0	33°36'46.85"N	72°41'11.04"E
S23	7.7	513	83	14	143	218	0.006	0.039	3.8	0.24	1.3	33°36'39.79"N	72°41'8.70"E
S24	7.5	509	82	13	124	183	0.007	0.031	4.5	0.48	0.9	33°36'46.62"N	72°41'28.22"E
S25	7.7	502	80	18	100	189	0.009	0.025	4.9	0.40	0.5	33°36'39.18"N	72°41'22.43"E
S26	7.6	507	99	18	145	199	0.008	0.035	3.1	0.34	0.6	33°36'39.18"N	72°41'48.84"E
S27	7.6	509	100	13	60	200	0.006	0.012	3.6	0.28	0.5	33°36'35.10"N	72°41'35.03"E
S28	7.8	511	112	13	61	213	0.008	0.036	2.8	0.40	1.8	33°36'29.07"N	72°41'25.36"E
S29	8	515	111	16	67	216	0.007	0.039	1.9	0.31	1.6	33°36'18.58"N	72°41'30.35"E
S30	8.1	507	119	14	134	183	0.004	0.035	2.5	0.33	1.9	33°36'7.09"N	72°41'36.69"E
S31	7.7	505	128	15	143	193	0.003	0.038	3.3	0.27	0.9	33°36'21.30"N	72°39'37.68"E
S32	7.9	509	92	15	145	199	0.004	0.029	2.5	0.49	0.7	33°36'19.38"N	72°39'35.13"E
S33	7.6	508	96	16	123	191	0.001	0.027	2.4	0.40	1.8	33°36'16.73"N	72°39'32.27"E
S34	7.5	501	89	17	66	189	0.007	0.054	3.4	0.36	1.1	33°36'15.34"N	72°39'29.14"E
S35	8.1	507	110	17	65	189	0.005	0.056	0.52	0.27	0.5	33°36'12.47"N	72°39'28.83"E
S36	7.7	506	119	16	38	187	0.003	0.035	0.54	0.42	0.6	33°36'19.61"N	72°39'26.36"E
S37	7.6	504	122	13	45	196	0.005	0.052	0.45	0.35	1.8	33°36'9.88"N	72°39'26.79"E
S38	7.6	503	123	18	58	195	0.004	0.036	0.38	0.41	0.6	33°36'21.78"N	72°39'23.23"E
S39	7.8	502	130	13	48	191	0.003	0.025	0.48	0.25	1.4	33°36'22.57"N	72°39'19.27"E
S40	8	511	115	13	26	202	0.009	0.034	0.69	0.38	0.7	33°36'23.50"N	72°39'14.61"E
S41	8.1	515	122	17	134	210	0.008	0.042	0.28	0.22	0.6	33°36'3.40"N	72°42'3.01"E
S42	7.7	520	121	16	133	216	0.006	0.04	0.49	0.16	1.4	33°36'7.01"N	72°42'8.26"E
S43	7.9	522	83	14	143	198	0.009	0.051	0.41	0.2	0.5	33°36'11.04"N	72°42'13.67"E
S44	7.6	525	82	13	124	190	0.008	0.029	0.43	0.33	1.6	33°36'6.49"N	72°42'15.73"E
S45	7.9	513	80	20	139	220	0.007	0.043	0.28	0.3	0.6	33°35'50.59"N	72°41'32.33"E
S46	7.6	509	99	18	140	220	0.004	0.025	0.39	0.38	1.5	33°35'38.81"N	72°41'20.47"E
S47	7.5	502	100	13	140	211	0.006	0.049	0.42	0.26	1.4	33°35'40.14"N	72°41'36.03"E
S48	8.1	509	112	10	133	181	0.008	0.046	0.34	0.31	1.1	33°35'35.35"N	72°41'50.67"E
S49	8	511	111	16	112	180	0.004	0.037	0.36	0.25	0.9	33°35'23.71"N	72°41'50.16"E
S50	7.7	515	119	17	66	189	0.005	0.046	0.46	2.1	0.5	33°35'23.00"N	72°42'1.65"E

Table 3.5 Analysis results of Tarbela dam

SAMPLES	PHYSICOCHEMICAL						HEAVY METALS					CORDINATES	
CODE	pH	TDS	Cl-	NO_3^-	SO_4^{2-}	HARDNESS	Cd	Cr	Zn	Mn	Cu	N	E
Tr1	8	503	129	17	91	190	0.007	0.055	2.8	0.44	0.6	34° 6'19.37"N	72°42'8.02"E
Tr2	7.9	502	88	13	91	220	0.005	0.042	3.9	0.29	1.8	34° 7'33.35"N	72°45'24.17"E
Tr3	7.8	501	85	14	100	220	0.009	0.036	4.6	0.52	0.6	34°10'20.91"N	72°47'50.19"E
Tr4	7.6	503	83	14	69	211	0.006	0.045	3.7	0.54	1.4	34°13'57.47"N	72°48'32.03"E
Tr5	7.7	507	82	17	87	181	0.007	0.023	3.9	0.45	0.7	34°15'34.80"N	72°50'21.81"E
Tr6	7.5	509	85	17	88	180	0.008	0.031	3.7	0.38	0.6	34°11'56.38"N	72°50'11.74"E
Tr7	7.9	511	99	15	100	189	0.009	0.046	3.4	0.48	1.4	34° 9'0.45"N	72°50'4.09"E
Tr8	7.5	515	100	18	150	187	0.008	0.018	3.5	0.69	0.5	34° 5'58.53"N	72°52'2.20"E
Tr9	7.5	507	112	15	60	196	0.006	0.034	3.3	0.28	1.6	34° 6'25.46"N	72°47'49.53"E
Tr10	7.7	518	111	14	61	195	0.008	0.047	3.9	0.49	0.6	34° 4'27.09"N	72°45'25.12"E
Tr11	7.7	501	119	13	67	191	0.008	0.052	4.5	0.41	1.5	34° 6'10.27"N	72°44'8.76"E
Tr12	7.5	509	110	18	90	202	0.006	0.036	2.7	0.43	1.4	34° 7'2.97"N	72°45'46.82"E
Tr13	7.9	501	118	18	86	210	0.006	0.059	4.8	0.29	1.1	34° 7'33.22"N	72°47'47.47"E
Tr14	7.5	503	123	13	73	179	0.007	0.019	2.2	0.48	0.9	34° 8'49.02"N	72°47'44.37"E
Tr15	7.5	516	125	13	134	189	0.009	0.049	3.8	0.37	0.5	34° 9'30.83"N	72°48'53.73"E
Tr16	7.7	517	115	16	133	198	0.008	0.041	2.9	0.21	1.5	34°10'51.59"N	72°48'50.25"E
Tr17	7.6	525	117	14	67	190	0.006	0.035	4.4	0.48	1.2	34°11'54.52"N	72°49'5.08"E
Tr18	7.6	500	130	15	90	220	0.008	0.069	3.7	0.42	0.8	34°13'8.02"N	72°49'8.76"E
Tr19	7.8	505	100	15	86	220	0.007	0.064	3.7	0.29	1.7	34°14'14.55"N	72°49'19.58"E
Tr20	7.6	509	112	16	73	211	0.004	0.047	2.9	0.49	1.3	34°15'3.33"N	72°49'24.85"E
Tr21	8	501	111	17	134	189	0.003	0.026	4.9	0.28	0.7	34°16'15.84"N	72°49'29.67"E
Tr22	7.7	509	124	18	133	187	0.004	0.045	5.4	0.36	0.9	34°17'10.50"N	72°50'0.02"E
Tr23	7.9	502	126	14	91	196	0.009	0.016	2.7	0.35	1.3	34°18'17.71"N	72°50'57.42"E
Tr24	8.1	522	128	16	100	195	0.008	0.023	3.9	0.38	1.0	34°19'31.52"N	72°51'24.29"E
Tr25	7.5	511	92	15	69	191	0.006	0.015	3.5	0.42	1.8	34°20'16.49"N	72°51'10.57"E
Tr26	7.6	510	96	18	30	202	0.009	0.016	2.8	0.46	1.0	34°21'6.64"N	72°49'45.79"E
Tr27	8	509	122	13	26	210	0.008	0.014	4.6	0.38	0.5	34°22'3.66"N	72°49'23.12"E
Tr28	7.7	502	123	13	130	216	0.007	0.013	4.1	0.41	1.3	34°22'49.46"N	72°49'19.60"E
Tr29	7.6	522	130	17	146	189	0.004	0.027	5.6	0.23	0.9	34°23'45.80"N	72°49'10.58"E
Tr30	8	511	115	16	61	187	0.006	0.026	3.5	0.47	1.9	34°24'44.63"N	72°49'2.58"E
Tr31	7.7	510	99	14	67	196	0.008	0.032	1.9	0.26	1.9	34° 1'29.10"N	72°38'28.59"E
Tr32	7.9	513	103	14	90	195	0.004	0.017	4.7	0.54	2.2	34° 1'23.94"N	72°38'12.14"E
Tr33	7.5	516	109	15	86	191	0.005	0.047	4.1	0.39	0.9	34° 1'32.37"N	72°38'3.36"E
Tr34	8	517	106	17	73	202	0.007	0.026	2.6	0.51	1.2	34° 0'58.85"N	72°38'32.94"E
Tr35	8.1	525	111	18	72	210	0.011	0.045	3.5	0.27	0.8	34° 0'49.78"N	72°37'56.51"E
Tr36	8.1	500	119	17	98	216	0.016	0.037	1.6	0.35	1.6	34° 0'45.23"N	72°39'37.60"E
Tr37	8	505	110	16	69	200	0.009	0.022	2.4	0.29	1.3	34° 0'24.63"N	72°39'6.13"E
Tr38	7.9	509	118	14	149	213	0.007	0.059	3.6	0.36	1.0	34° 3'18.82"N	72°40'7.72"E
Tr39	7.6	508	123	17	134	216	0.016	0.046	3.1	0.4	0.9	34° 4'5.62"N	72°40'36.85"E
Tr40	7.9	501	125	17	143	217	0.013	0.041	2.8	0.39	1.4	34° 4'17.67"N	72°42'57.76"E
Tr41	7.7	509	115	15	145	218	0.01	0.036	2.5	0.45	1.0	34°21'12.56"N	72°50'51.42"E
Tr42	7.9	502	117	18	123	181	0.019	0.034	3.6	0.25	1.7	34°21'29.14"N	72°50'43.09"E
Tr43	7.5	500	130	15	66	186	0.006	0.032	2.8	0.36	1.4	34°21'46.42"N	72°50'45.25"E
Tr44	8	501	127	14	129	190	0.009	0.024	3.1	0.34	1.0	34°21'56.14"N	72°51'4.78"E
Tr45	7.5	502	119	9	121	220	0.005	0.053	2.9	0.45	1.5	34°22'10.83"N	72°51'9.49"E
Tr46	7.7	511	111	18	143	196	0.004	0.041	3.8	0.26	1.7	34°25'47.39"N	72°48'40.36"E
Tr47	7.6	515	119	19	124	191	0.009	0.029	3.2	0.4	1.6	34°25'48.20"N	72°48'21.42"E
Tr48	7.6	520	110	13	139	202	0.006	0.03	2.2	0.25	0.8	34°25'45.41"N	72°47'56.66"E
Tr49	7.8	522	118	13	140	210	0.004	0.047	3.6	0.34	1.2	34°25'57.60"N	72°47'30.73"E
Tr50	8	530	123	16	150	216	0.005	0.031	2.9	0.22	0.9	34°25'29.90"N	72°47'17.24"E

Table 3.6 Analysis results of Tanaza dam

SAMPLES	PHYSICOCHEMICAL						HEAVY METALS					CORDINATES	
CODE	pH	TDS	Cl-	NO_3^-	SO_4^{2-}	HARDNESS	Cd	Cr	Zn	Mn	Cu	N	E
TZ1	7.7	513	130	16	121	183	0.013	0.042	1.5	0.35	1.0	33°27'39.20"N	72°44'11.52"E
TZ2	7.6	516	115	17	143	189	0.01	0.024	2.9	0.38	0.9	33°27'38.03"N	72°44'14.12"E
TZ3	7.6	517	99	14	124	199	0.019	0.026	3.8	0.42	1.4	33°27'37.34"N	72°44'18.18"E
TZ4	7.8	525	103	14	100	200	0.006	0.034	4.5	0.46	1.0	33°27'35.28"N	72°44'17.72"E
TZ5	8	500	109	17	62	213	0.009	0.041	5.9	0.38	1.7	33°27'34.07"N	72°44'14.65"E
TZ6	8.1	505	106	17	59	216	0.005	0.036	3.9	0.41	1.4	33°27'35.23"N	72°44'11.15"E
TZ7	7.7	509	111	15	61	217	0.004	0.065	2.3	0.23	1.0	33°27'35.27"N	72°44'6.88"E
TZ8	7.9	508	119	18	67	218	0.009	0.035	3.6	0.47	1.5	33°27'35.90"N	72°44'3.97"E
TZ9	7.6	501	127	15	90	183	0.006	0.043	4.1	0.26	1.7	33°27'38.35"N	72°44'5.39"E
TZ10	7.5	502	129	14	86	186	0.004	0.041	2.8	0.54	1.6	33°27'39.46"N	72°44'9.10"E
TZ11	8.1	500	88	17	73	184	0.005	0.031	3.5	0.39	0.8	33°27'36.95"N	72°44'4.98"E
TZ12	7.6	501	85	13	72	184	0.006	0.024	3.1	0.51	1.2	33°27'36.37"N	72°44'5.47"E
TZ13	8	502	124	14	98	184	0.007	0.022	2.8	0.27	0.9	33°27'35.85"N	72°44'5.88"E
TZ14	7.7	511	126	14	76	184	0.009	0.035	3.9	0.35	0.6	33°27'36.40"N	72°44'6.53"E
TZ15	7.9	509	128	13	89	184	0.008	0.029	4.6	0.29	1.8	33°27'37.04"N	72°44'6.25"E
TZ16	8.1	508	106	18	99	183	0.006	0.033	3.7	0.36	0.6	33°27'37.71"N	72°44'5.91"E
TZ17	7.5	501	111	14	101	215	0.008	0.027	3.9	0.4	1.4	33°27'38.40"N	72°44'6.76"E
TZ18	7.6	507	119	15	127	218	0.007	0.035	1.2	0.39	0.7	33°27'37.80"N	72°44'7.08"E
TZ19	8	506	123	18	141	183	0.004	0.044	4.1	0.44	0.6	33°27'37.19"N	33°27'37.19"N
TZ20	7.7	504	125	13	149	189	0.003	0.054	3.2	0.29	1.4	33°27'36.66"N	72°44'8.36"E
TZ21	7.9	503	115	14	134	199	0.004	0.049	2.6	0.52	0.5	33°27'37.40"N	72°44'9.21"E
TZ22	7.6	502	117	15	143	200	0.001	0.023	2.4	0.54	1.6	33°27'38.92"N	72°44'9.74"E
TZ23	7.5	501	130	17	145	200	0.007	0.042	3.8	0.45	0.6	33°27'38.18"N	72°44'10.85"E
TZ24	8.1	503	127	18	123	213	0.005	0.036	1.9	0.38	1.5	33°27'37.14"N	72°44'10.59"E
TZ25	8	527	119	17	69	216	0.003	0.022	1.5	0.48	1.4	33°27'37.80"N	72°44'12.51"E
TZ26	7.7	509	124	13	89	217	0.009	0.041	3.5	0.69	1.1	33°27'36.51"N	72°44'11.89"E
TZ27	7.9	511	85	18	99	218	0.006	0.039	1.5	0.28	0.9	33°27'36.51"N	72°44'13.68"E
TZ28	8	515	87	13	101	183	0.007	0.022	2.6	0.49	0.5	33°27'35.36"N	72°44'13.59"E
TZ29	7.9	507	89	13	127	220	0.008	0.035	2.1	0.41	1.5	33°27'36.28"N	72°44'16.33"E
TZ30	8.1	505	99	17	141	219	0.009	0.044	1.8	0.43	1.2	33°27'35.23"N	72°44'15.38"E
TZ31	8	509	110	16	149	187	0.008	0.049	3.7	0.29	0.8	33°27'31.64"N	72°44'12.32"E
TZ32	7.9	490	119	14	134	183	0.006	0.047	3.9	0.48	0.4	33°27'31.40"N	72°44'14.26"E
TZ33	7.8	501	128	15	143	193	0.008	0.043	3.7	0.37	0.9	33°27'31.09"N	72°44'16.73"E
TZ34	7.6	507	92	15	145	199	0.008	0.035	3.4	0.21	1.7	33°27'30.27"N	72°44'17.74"E
TZ35	7.7	506	96	16	123	191	0.006	0.02	3.5	0.41	1.5	33°27'29.03"N	72°44'19.20"E
TZ36	7.5	504	89	17	66	189	0.006	0.056	3.3	0.38	1.8	33°27'32.47"N	72°44'11.21"E
TZ37	7.9	503	101	18	79	198	0.007	0.024	3.9	0.47	1.4	33°27'31.97"N	72°44'9.42"E
TZ38	7.5	502	124	14	99	190	0.009	0.064	4.5	0.35	1.6	33°27'31.24"N	72°44'6.67"E
TZ39	7.5	501	122	17	101	220	0.008	0.035	2.7	0.37	1.5	33°27'30.60"N	72°44'5.13"E
TZ40	7.7	503	126	17	127	220	0.006	0.026	4.8	0.26	1.3	33°27'30.11"N	72°44'3.59"E
TZ41	7.6	507	128	15	141	211	0.006	0.034	2.2	0.24	1.7	33°27'34.67"N	72°44'5.88"E
TZ42	7.6	509	92	20	149	184	0.005	0.033	3.8	0.48	1.3	33°27'34.26"N	72°44'6.04"E
TZ43	7.8	502	96	15	134	184	0.009	0.038	2.9	0.40	1.6	33°27'34.36"N	72°44'5.42"E
TZ44	8.1	501	89	14	143	189	0.008	0.034	4.4	0.34	1.8	33°27'34.01"N	72°44'5.76"E
TZ45	7.7	502	100	13	145	198	0.006	0.026	3.5	0.28	1.6	33°27'33.79"N	72°44'6.07"E
TZ46	7.9	511	112	18	119	190	0.005	0.041	2.9	0.40	1.4	33°27'34.01"N	72°44'5.17"E
TZ47	7.6	515	111	18	86	225	0.009	0.045	3.7	0.31	1.5	33°27'33.49"N	72°44'5.28"E
TZ48	7.5	520	119	13	77	196	0.009	0.053	3.8	0.33	0.9	33°27'33.76"N	72°44'4.54"E
TZ49	8.1	522	110	13	129	195	0.005	0.04	2.9	0.41	1.5	33°27'33.29"N	72°44'4.66"E
TZ50	8	520	118	16	121	191	0.003	0.34	3.5	0.28	1.6	33°27'33.35"N	72°44'4.02"E

Table 3.7 Analysis results of Simly dam

SAMPLES	PHYSICOCHEMICAL						HEAVY METALS					CORDINATES	
CODE	pH	TDS	Cl-	NO_3^-	SO_4^{2-}	HARDNESS	Cd	Cr	Zn	Mn	Cu	N	E
SI1	7.8	509	100	15	150	189	0.007	0.012	4.5	0.25	1.0	33°42'51.54"N	73°19'57.74"E
SI2	7.6	508	112	18	133	198	0.008	0.012	2.7	0.44	1.8	33°43'8.82"N	73°19'53.51"E
SI3	7.7	501	111	13	112	190	0.009	0.015	4.8	0.31	1.0	33°43'25.54"N	73°20'7.83"E
SI4	7.5	507	119	13	66	220	0.008	0.019	2.2	0.27	1.9	33°43'42.27"N	73°20'18.87"E
SI5	7.9	506	110	17	70	220	0.006	0.025	3.8	0.35	1.5	33°43'44.94"N	73°20'39.29"E
SI6	7.5	504	118	16	61	211	0.008	0.026	2.9	0.38	2.0	33°43'57.46"N	73°20'55.59"E
SI7	7.5	503	123	14	83	190	0.008	0.021	4.4	0.42	0.9	33°44'12.81"N	73°21'18.73"E
SI8	7.7	502	125	15	91	185	0.006	0.017	3.5	0.46	1.4	33°43'58.00"N	73°21'33.09"E
SI9	7.6	501	115	15	91	189	0.006	0.026	2.9	0.38	1.0	33°43'46.12"N	73°21'1.19"E
SI10	7.6	503	117	16	100	187	0.007	0.019	3.7	0.41	1.7	33°43'29.70"N	73°20'36.28"E
SI11	7.8	507	130	17	69	196	0.009	0.021	3.8	0.23	1.4	33°42'57.86"N	73°19'59.39"E
SI12	8	509	127	18	149	189	0.008	0.032	2.9	0.47	1.0	33°43'8.22"N	73°20'2.25"E
SI13	8.1	511	119	14	134	199	0.006	0.025	3.5	0.26	1.5	33°43'10.80"N	73°20'13.43"E
SI14	7.7	515	124	16	143	200	0.006	0.016	4.3	0.54	1.7	33°43'19.64"N	73°20'12.73"E
SI15	7.9	507	126	16	145	213	0.005	0.018	3.7	0.39	1.6	33°43'27.72"N	73°20'15.29"E
SI16	7.6	518	128	17	123	216	0.009	0.013	2.9	0.51	1.3	33°43'23.62"N	73°20'24.97"E
SI17	7.5	501	106	14	66	217	0.008	0.016	4.9	0.43	1.0	33°43'31.46"N	73°20'24.53"E
SI18	8.1	509	111	14	79	218	0.006	0.052	5.4	0.55	1.3	33°43'37.72"N	73°20'28.01"E
SI19	8.1	502	119	17	119	178	0.005	0.024	2.7	0.39	0.5	33°43'35.83"N	73°20'35.79"E
SI20	8.1	522	127	17	86	186	0.009	0.018	3.9	0.35	1.6	33°43'37.79"N	73°20'47.83"E
SI21	7.6	511	129	15	77	184	0.009	0.033	3.5	0.35	0.6	33°43'46.51"N	73°20'49.78"E
SI22	8	510	88	18	129	190	0.005	0.048	2.8	0.36	1.5	33°43'51.70"N	73°20'57.58"E
SI23	7.7	513	85	15	121	215	0.003	0.029	4.6	0.35	1.4	33°43'57.54"N	73°21'1.38"E
SI24	7.9	516	83	14	143	218	0.013	0.043	4.1	0.42	1.1	33°44'5.23"N	73°21'3.01"E
SI25	8.1	517	82	13	124	183	0.01	0.028	5.6	0.4	0.9	33°44'9.28"N	73°21'10.31"E
SI26	7.5	545	78	18	100	189	0.019	0.037	3.5	0.33	0.5	33°44'4.97"N	73°21'9.85"E
SI27	7.6	500	99	18	150	199	0.006	0.049	1.9	0.36	1.5	33°44'4.74"N	73°21'17.47"E
SI28	8	505	100	13	60	200	0.009	0.035	3.5	0.49	1.2	33°44'0.91"N	73°21'20.21"E
SI29	7.7	509	112	13	61	213	0.005	0.019	3.3	0.29	0.8	33°43'56.05"N	73°21'22.60"E
SI30	7.9	508	111	16	67	216	0.004	0.044	3.9	0.32	1.7	33°44'2.03"N	73°21'27.42"E
SI31	7.6	501	124	17	90	217	0.009	0.032	4.5	0.35	1.3	33°43'5.45"N	73°20'36.24"E
SI32	7.5	502	126	16	86	218	0.006	0.033	2.7	0.32	0.7	33°43'0.86"N	73°20'39.38"E
SI33	8.1	499	128	13	73	190	0.004	0.046	4.8	0.36	0.9	33°42'57.74"N	73°20'39.82"E
SI34	8	501	92	18	134	186	0.005	0.033	2.2	0.39	1.3	33°42'56.19"N	73°20'40.04"E
SI35	7.7	502	96	13	133	184	0.006	0.051	3.8	0.35	1.4	33°42'55.64"N	73°20'39.02"E
SI36	7.9	511	89	13	91	185	0.007	0.033	2.9	0.26	0.8	33°42'54.29"N	73°20'37.66"E
SI37	7.5	515	101	17	100	189	0.009	0.034	4.4	0.54	0.5	33°42'53.15"N	73°20'35.21"E
SI38	8	520	124	16	69	198	0.008	0.024	3.5	0.39	0.7	33°42'53.71"N	73°20'32.96"E
SI39	7.5	522	85	14	14	190	0.006	0.036	2.9	0.51	1.2	33°42'51.71"N	73°20'32.33"E
SI40	7.7	525	87	15	17	220	0.008	0.049	3.7	0.27	1.6	33°42'50.66"N	73°20'30.69"E
SI41	7.6	513	89	15	13	221	0.007	0.041	3.8	0.35	0.5	33°44'12.71"N	73°22'8.26"E
SI42	7.6	509	99	16	14	211	0.007	0.035	2.9	0.29	0.6	33°44'25.40"N	73°22'0.41"E
SI43	7.8	502	110	17	14	189	0.005	0.035	2.9	0.36	0.8	33°44'20.64"N	73°22'24.78"E
SI44	8	522	119	16	17	187	0.006	0.019	3.9	0.4	0.7	33°44'21.80"N	73°22'46.45"E
SI45	8.1	511	122	13	17	196	0.009	0.017	3.5	0.39	0.5	33°44'22.69"N	73°23'11.66"E
SI46	7.7	510	123	18	15	195	0.008	0.028	2.8	0.45	0.8	33°44'42.27"N	73°22'5.35"E
SI47	7.9	513	135	13	18	191	0.007	0.049	3.8	0.25	0.9	33°44'54.70"N	73°22'24.82"E
SI48	7.6	522	115	10	15	202	0.006	0.045	4.1	0.36	0.5	33°45'7.72"N	73°22'21.86"E
SI49	7.5	523	122	17	134	210	0.004	0.052	3.9	0.34	0.6	33°45'19.94"N	73°22'26.25"E
SI50	8.1	521	121	16	133	216	0.008	0.04	2.8	0.29	0.5	33°45'24.33"N	73°22'2.88"E

Table 3.8 Analysis results of Naryab dam

SAMPLES	PHYSICOCHEMICAL						HEAVY METALS					CORDINATES	
CODE	***pH***	***TDS***	***Cl-***	***NO_3^-***	***SO_4^{2-}***	***HARDNESS***	***Cd***	***Cr***	***Zn***	***Mn***	***Cu***	***N***	***E***
NR1	7.6	505	79	13	60	185	0.008	0.036	0.024	0.26	1.4	33°29'39.73"N	70°47'56.95"E
NR2	8	510	91	18	61	219	0.006	0.045	0.036	0.54	1.0	33°29'37.97"N	70°48'3.00"E
NR3	7.7	505	95	14	69	220	0.008	0.023	0.031	0.39	1.7	33°29'30.37"N	70°48'11.38"E
NR4	7.9	502	85	15	72	191	0.007	0.031	0.036	0.51	1.4	33°29'28.70"N	70°48'19.53"E
NR5	8.1	501	87	18	98	185	0.007	0.046	0.042	0.43	1.0	33°29'29.77"N	70°48'31.20"E
NR6	7.5	501	89	13	76	200	0.005	0.018	0.052	0.55	1.5	33°29'12.87"N	70°48'35.39"E
NR7	7.6	502	99	14	89	211	0.006	0.034	0.056	0.39	1.7	33°29'16.96"N	70°48'8.11"E
NR8	8	511	110	15	99	215	0.009	0.047	0.051	0.35	1.6	33°29'34.36"N	70°47'54.07"E
NR9	7.7	515	119	17	101	215	0.008	0.052	0.042	0.35	1.3	33°29'40.68"N	70°47'45.45"E
NR10	7.9	520	122	18	127	218	0.007	0.024	0.038	0.36	1.0	33°29'47.28"N	70°47'45.35"E
NR11	7.6	522	123	17	141	183	0.006	0.018	0.023	0.35	1.3	33°29'45.23"N	70°47'43.34"E
NR12	7.5	525	135	16	149	189	0.004	0.033	0.041	0.42	0.5	33°29'40.04"N	70°47'49.57"E
NR13	8.1	513	115	15	134	199	0.008	0.048	0.036	0.4	1.6	33°29'37.20"N	70°47'53.98"E
NR14	8	514	99	14	143	200	0.006	0.029	0.047	0.33	0.6	33°29'35.98"N	70°47'59.32"E
NR15	7.7	519	103	17	145	213	0.009	0.043	0.052	0.36	1.5	33°29'32.34"N	70°47'59.73"E
NR16	7.9	518	109	13	123	216	0.005	0.016	0.024	0.49	1.4	33°29'32.46"N	70°48'4.55"E
NR17	7.5	501	106	14	66	217	0.004	0.017	0.018	0.29	0.5	33°29'28.46"N	70°48'2.77"E
NR18	8	509	111	14	79	218	0.009	0.019	0.033	0.32	1.3	33°29'27.97"N	70°48'8.87"E
NR19	8.1	502	119	17	119	191	0.006	0.02	0.048	0.35	0.9	33°29'22.98"N	70°48'8.17"E
NR20	8.1	522	127	17	86	186	0.004	0.023	0.029	0.32	1.9	33°29'24.46"N	70°48'14.16"E
NR21	8	511	129	15	77	184	0.005	0.021	0.043	0.36	1.9	33°29'21.56"N	70°48'14.89"E
NR22	7.9	510	88	18	129	185	0.006	0.014	0.028	0.45	2.2	33°29'17.60"N	70°48'12.94"E
NR23	7.6	513	85	15	121	189	0.007	0.024	0.037	0.38	0.9	33°29'24.36"N	70°48'22.26"E
NR24	7.7	516	83	14	143	198	0.009	0.025	0.049	0.48	1.2	33°29'25.37"N	70°48'28.23"E
NR25	7.8	517	82	13	124	190	0.008	0.012	0.035	0.69	0.8	33°29'21.02"N	70°48'20.68"E
NR26	7.9	535	82	18	139	220	0.006	0.012	0.019	0.28	1.6	33°29'18.04"N	70°48'18.23"E
NR27	8	502	99	18	140	220	0.008	0.015	0.045	0.49	1.3	33°29'14.42"N	70°48'22.02"E
NR28	8	505	100	13	150	211	0.007	0.018	0.047	0.41	1.0	33°29'16.89"N	70°48'29.03"E
NR29	7.9	509	112	13	133	185	0.016	0.013	0.026	0.43	0.9	33°29'17.64"N	70°48'24.41"E
NR30	8.1	508	111	16	112	185	0.009	0.016	0.045	0.29	0.6	33°29'21.42"N	70°48'26.31"E
NR31	8	501	119	17	66	189	0.007	0.052	0.037	0.48	1.5	33°29'23.17"N	70°47'53.19"E
NR32	7.9	507	110	16	70	187	0.016	0.024	0.022	0.37	1.3	33°29'22.06"N	70°47'52.82"E
NR33	7.8	506	118	13	61	196	0.013	0.018	0.059	0.21	0.5	33°29'21.37"N	70°47'52.06"E
NR34	7.6	504	123	18	83	195	0.01	0.033	0.046	0.48	0.7	33°29'20.67"N	70°47'51.04"E
NR35	7.7	503	125	13	91	191	0.019	0.048	0.064	0.42	1.4	33°29'19.69"N	70°47'50.39"E
NR36	7.5	502	115	13	91	202	0.006	0.029	0.055	0.29	0.8	33°29'19.27"N	70°47'49.39"E
NR37	7.9	501	117	17	100	210	0.009	0.043	0.042	0.49	0.9	33°29'20.80"N	70°47'49.05"E
NR38	7.5	503	129	16	69	216	0.005	0.028	0.024	0.23	1.2	33°29'19.00"N	70°47'48.94"E
NR39	7.5	507	127	14	87	214	0.007	0.016	0.026	0.47	1.5	33°29'18.87"N	70°47'48.80"E
NR40	7.7	509	119	15	88	200	0.013	0.023	0.034	0.26	1.9	33°29'23.26"N	70°47'51.68"E
NR41	7.6	511	124	15	100	225	0.008	0.015	0.041	0.54	1.3	33°29'48.44"N	70°47'41.69"E
NR42	7.6	515	126	16	150	219	0.006	0.016	0.036	0.39	1.1	33°29'49.31"N	70°47'40.20"E
NR43	7.8	507	128	17	60	187	0.006	0.014	0.065	0.51	0.9	33°29'50.65"N	70°47'38.58"E
NR44	8	508	92	18	61	183	0.005	0.013	0.035	0.27	0.4	33°29'51.84"N	70°47'38.09"E
NR45	8.1	522	96	14	67	193	0.009	0.027	0.043	0.35	0.9	33°29'53.52"N	70°47'38.11"E
NR46	7.7	511	89	16	90	199	0.008	0.026	0.041	0.29	2.2	33°29'49.50"N	70°47'45.05"E
NR47	7.9	501	101	16	86	200	0.006	0.032	0.031	0.36	1.3	33°29'48.95"N	70°47'45.04"E
NR48	7.6	522	124	17	73	205	0.005	0.017	0.024	0.4	0.5	33°29'50.14"N	70°47'46.33"E
NR49	7.5	523	122	18	134	204	0.009	0.047	0.022	0.39	0.3	33°29'51.48"N	70°47'47.81"E
NR50	8.1	521	111	13	133	203	0.009	0.026	0.035	0.45	0.6	33°29'53.23"N	70°47'48.24"E

CONCLUSIONS

Results showed that the minimum and the maximum values of pH noted in all selected dams were within the safe limits of NEQS (6.5-8.5). Compliance with the standards of NEQS. The results of TDS were also well within the safe limits and no dam is found vulnerable to high loads of TDS in Khanpur dams is found very low in concentrations of TDS. Chloride results were well within the permissible limits set by NEQS no dams were vulnerable against chloride. The maximum and minimum values of nitrate were noted in the safe limits and none of the sulphate concentrations exceeds the limits and they all fall under the safe limits of NEQS and all dams were found safe against the pollution of sulphate. The results of hardness showed the all dams were within the permissible limits of hardness set by the NEQS. This conclude that all dams were in the safe limits of all subjected physiochemical set by the NEQS.

The results of heavy metals analysis showed that concentration of cadmium was noted within permissible limits but the concentration in Mangla dam was slightly higher as compared to other dams. The result of chromium was in safe limits in all dams as the Khanpur dam had the lowest values but some samples in Tanaza dam exceeded the limits of NEQS. Copper concentration was well within permissible limits but the concentration of copper in Khanpur dam was noted considerably low as compared to the other dams. Copper was not detected in some samples of Khanpur dam. The result of zinc was noted within permissible limits of NEQS and zinc remain undetected in most of the samples in Naryab dam. The results of manganese were remaining within permissible limits except the Mangla dam the concentration in Mangla dam were noted very high in some samples it exceeds the concentration of 3 mg/l. make it contaminated with Manganese.

RECOMMENDATIONS

1. The waste from surrounding areas discharge directly in to dams that cause pollution in dams there should be a proper filtration mechanism to treat the incoming and outgoing water from the dams to reduce the contamination load in the dams.
2. The necessity of setting up of treatment plants near industrial region as well as communal zones.
3. There should be proper check and balance for water supply channel structure in order to monitor the status of subsurface pipes. Because piping oxidization is also one of the chief concerns of heavy metal effluence.
4. Research is expected to be enhanced by the relative adequacy of significant drinking water purification practices. Investigations of the main considerations influencing such viability under treatment plant working conditions are additionally critical.
5. The research provided baseline data that can be extended to the detailed study on toxicity potential of selected dams and comparative study of these dams, and to plan the future studies should carry out.

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