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DIFFERENT PERSPECTIVES ON WATER QUALITY OF LOCAL FILTRATION PLANTS IN PAKISTAN

[a] Aruba Waqar, [b] Mehak Ali

a: Institute of Environmental Sciences and Engineering, National University of Science and Technology, Islamabad, Pakistan, aruba.ccrd@gmail.com
b: Department of Microbiology, Watim Medical College, Rawat, Pakistan, drmehakali15@gmail.com

Abstract- Water is very important for the survival of all living beings on earth. Water quality plays an important role for health of human beings, especially when it comes to potable water. The main sources include ground and surface waters. In this paper, a review is made on different perspectives about water quality of filtration plant for use by the common people. These include water quality importance, processes involved in filtration, different tests on quality and guidelines for safe water supply. The main aim of this literature research is to document necessities required for filtration plants for safe water so that an easy to implement ways from water supply to quality water can be proposed. Many aspects are discussed in detail to recommend some practical line of action for regulatory authorities. For efficient output, government and private organizations should work together. A proper coordination is must between regularity bodies and public.

Keywords- Water quality, filtration plant, water supply, quality tests and guidelines, regulatory authorities

1 INTRODUCTION

One of the basic necessities of life is good quality safe potable water for human beings. But, in developing countries, many people are deprived of safe drinking water, hygiene and appropriate sanitation. The powerful environmental element of health depends on the quality of drinking water and it can prevent and control waterborne diseases. The transmission of such diseases comes from many factors of faecal-oral pathways. Stored domestic water as a result of germ-infested handling, water in the distribution system, and uncleanness of potable water storage (e.g., by coliform enterobacteriacial pathogens of human or animal faeces) are few examples. The nontoxic collection, treatment, and storing potable water can be ensured using the parameters prescribed by the World Health Organization (WHO) to ensure the quality of drinking water. Those waters have no health risk which has bacteriological quality i.e. the nonappearance of gauge organisms in drinking water. Conventionally, total coliform bacteria specify the existence of faecal pollution. An exemption is Escherichia coli (E. coli), a thermo-tolerant coliform, and the utmost frequent of the total coliform group present in animal or human feces, hardly grows in the environment. Therefore, it is taken as the utmost precise indicator of faecal contamination in potable water. The existence of E. coli offers robust indication of latest faecal uncleanness. It can guess disease risk. For drinking purpose, it is mandatory that the colonies per 100 ml of coliform enterobacteriaceae Escherichia coli should be null. Guaranteeing the availability of usable potable water is an uninterrupted procedure requiring the check and balance of monitoring of many essential microbiological and physio-chemical factors. Below the earth's surface, there is groundwater which is collected in abysses of rocks and soil. It is main source of water for springs, wells and boreholes. Such water is always not safe. Worldwide, a main health alarm is from water related diseases. Every year, 1.8 million teenagers die from diarrheal diseases (i.e. one in every fifteen seconds). Globally, the utmost concerned deaths of children below five years old are from waterborne diseases. Annually, many persons die from unsafe water than from any other cause (including war).

In different countries, majority of people depend on groundwater to meet their daily requirements. Particularly, the reliable source of water supply in the arid and semi-arid regions is groundwater. But, due to population growth and global climate change, the rainfall in such regions is expected to decrease, thereby increasing the demand of groundwater. The groundwater quality and associated health risks are badly affected by both human activities and natural factors. The significant impacts are due to the land use/land cover changes. Therefore, in few cases, groundwater might be saline and not safe under extreme human activities. This can be unsuitable for direct intake and can lead to waterborne diseases to human. Nano-filtration and reverse osmosis are tertiary treatments that efficiently eliminate pharmaceuticals from effluent and drinking water. Water is utilized in numerous ways, e.g. personal and domestic hygiene, drinking, cooking, cultivation, and rituals. Organoleptic features like flavor, smell, color and core temperature are essential in the insightful detection of water quality. Water quality degradation is broadly known in many parts of the world, and establishes one of the major risks affecting human health. In addition, there are the abundant consequences of water shortage, especially of low water supplied areas of the societies. The implications of climate change, uncleanness, population explosion and the high per capita cost for new hydric infrastructures are few features which auxiliary bound the provision of water. As a usual matter, supply and/or treatment systems are rare or insufficient in way that the individuals still commonly obtain their required water directly from the nearby streams, or some other ground water source or through rain catching in some parts of world. Many such practices have no surety of obtained clean water quality, which is directly affecting human health. This is so because water can become a source of disease transmission and spread. As per WHO, the foremost parameters affecting water quality in terms of fit for utility proposes regarding the human health, microbial (the presence of coliform enterobacteriaceae like Escherichia coli or thermo-tolerant coliforms), and heavy metal contaminants including arsenic and fluoride. The basis of river ecosystem health management is based on evaluating the water quality of rivers according to physical, physio-chemical, and biological factors. Recently, the assessment of evaluate underground and surface water quality can be done suing various water quality assessment approaches [1]. One such method uses the approach of integrating many water quality factors into a dimensionless value, expressed as water quality index (WQI) which can be regarded as the overall water quality. Latest studies disclose that approximately 65% of groundwater around globe is used for drinking purposes; around 20% for agriculture and 15% is used for industrial needs [1]. It is reported that about a quarter of the world population utilizes groundwater for drinking, particularly developing countries like China and India. It is important to monitor the groundwater quantity and quality. In a race for the advancement, the industrialization of the global world has led to the exploitation of nature and many contaminants are mixing with fresh water sources. Industrial waste containing heavy metals, pharmaceuticals waste and many personal care products, agriculture related pesticides, and micro-pollutants (e.g., endocrine disrupting compounds and nitrosamines) are such contaminants. Long lasting problem in form of serious health problems are also due to pollution of water because of heavy metals. On the other hand, few heavy metals like Zn, Cu, and Co are nutrients for the living organisms. The extreme existence of such heavy metal contamination in potable water poses toxic effects for humans and aquatic ecosystem. In last two decades, wastewater treatment technologies are employed on efficient recycling and treatment of heavy metals and low-concentration pollutants from normal water, wastewater, and already biologically treated wastewater effluents. Such methods are now opted apart from the conventional biological, physical and chemical treatment methods, such as the newly solicitations such as membrane bioreactors, advanced oxidation, reverse osmosis, etc. But, these techniques are frequently considered incompetent due to the huge requirement of feeding of many chemicals and/or energy, high capital/operational costs, and high requirement of supportive infrastructure and engineering and biochemical expertise which prevent their practices in many parts of the world. The existence of iron (Fe) and manganese (Mn) in ground waters is a communal anxiety. The exceeding limits of Fe and Mn in water supplies have affected the health of consumers. The consumption of high concentrations of Fe and Mn can lead to minor indications such as anorexia and weight issues, weakness and lassitude, apathy and learning and/or understanding problems especially in children. And it may also lead to severe diseases such as Parkinson's or Alzheimer's disease. Thus, refinement of groundwater having such metals is very important in social and environmental safety.

In Pakistan, Indus is the main river, coming from Karakorum ranges to south and ultimately goes to Arabian Sea. Blessed by nature, Pakistan has enough resources of surface and ground waters. Figure 1 represents water status of Pakistan i.e. water supply in provinces and per capita water availability decreasing trend [2]. Declining trend is alarming. The large stress on water resources has been put by rapid population growth, urbanization and industrialization. As already stated above while reviewing international scenarios, water plays an important significance in life progressions including evolution and advance industrialization. It is important for every field of our life. However, because of technological developments, potable water is subjected to many impurities of different nature like physical, bio-chemical. Among these, microbiological organisms related pollutants are among the most hazardous impurities which can lead to human health problems or even lead to death in extreme cases. Underprivileged treatment services are reasons for spread of severe faeco-oral water related diseases. In Pakistan, water quality is deteriorated due to intermixing because of leakages as parallel lines are rub for the drinking water, sanitation system and drainage lines. In many cities, the ground water supply is elementary source. Every year a large group of population is affected by these diarrheal related pathogens including viruses, bacteria and some protozoa, which can increase the mortality rate due to diarrhea and its complications. According to one estimate around 2.5 million deaths occur every year due to these diarrheal pathogens. Chlorination is the common technique for disinfection of potable water at treatment plants. It is a technique to have potable water safe and to minimize epidemic diseases. As it is well known that free from color, turbidity, odor, and microbes are the characteristics of the potable water. It should be visually pleasing. As per Pakistan National Conservation Strategy, drought, a reduced amount of rain, and non-development of different water assets decrease water obtainability and rise water scarceness. Inappropriate and deprived water supply for drinking purpose has a excessive health risk to the common people. The water quality is deteriorated due to mixing of toxic chemicals from urban communities and industries in water bodies. It may lead to bad effects to public. Due to prevailing situations, WASA (water and sanitation agency) is mainly concentrating on water quantity due to increased needs instead of water quality. The main reason behind this seems to be the lack of consciousness, competent personnel, quality checking, treatment technology and equipment. Due to presence of micro-pathogens like bacteria, numerous mineral deposits, and carbon-based substances in unsafe potable water, human health is adversely affected. A noteworthy percentage of inhabitants in developing countries are suffering from health-related issues due to unsafe potable water and microbial contamination. The deprived water supply was triggered by the deficiency of water availability. The key causes of water related illneses in potable water are the mixing of industrial wastewater and metropolitan sewage at many locations of the water dispersal system as well as deficiency of water decontamination and water quality checking at treatment plants in Pakistan. Waterborne diseases are ameobiasis, giardiasis, cholera, typhoid and diarrhea/dysentery, intestinal protozoans, gastroenteritis and poliomylitis infections. Such diseases have acquired a huge burden on the statistical mapping of the morbidity and mortality graph in world, about 80% of all the diseases are related with diseases due to sanitation problem and are responsible for 33% of mortality. In this work, different perspectives about water quality of filtration plant are reviewed for use by the common people. Different sources of water supply are briefed. The discussions about water quality importance, processes involved in filtration, different tests on assessment of water quality and guidelines for safe water supply are made. The key goal of this study is to highlight the areas where improvement can be suggested and investigated in future. For this to happen effectively, this literature research is made collaboratively from perspectives of engineering (water supply) and medical (microbiology).

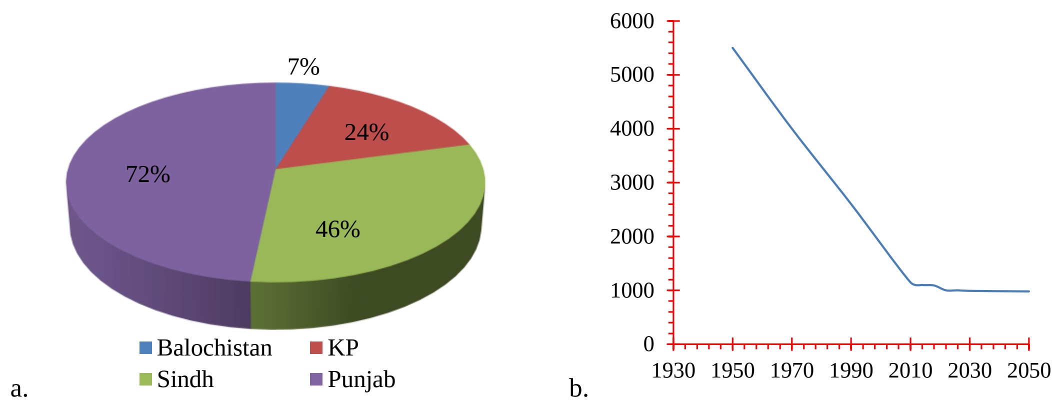

Figure 1: Water status in Pakistan by Daud et al. [2], a) Water supply in provinces, and b) per capita water availability (Note: graphs are reproduced for better quality)

2 RESEARCH SIGNIFICANCE AND IMPORTANCE OF WATER QUALITY FOR HUMAN HEALTH

The quality of drinking water has a great influence over the health of community. The mixing of sewage and water supply creates a lot of problems. Faecal material can make water contaminated due to insufficient safety of the reservoirs, insalubrious use by the community at that point, and inadequate domestic administration practices. Fecal contamination is a CrAssphage, bacteriophages are normally present in human feces and their detection can be done for the assessment of swage contamination in the water. This was done by Ahmed et al. [3] with the help of PCR and gene detection. The sewage tracking mechanism can help in tracking and removing the source. In another study by Gizachew et al. [4], the amount of microbiological contagion of potable water resource from safe water location to houses and its usage among recipient family unit of Boloso Sore woreda, Wolaita zone, Ethiopia was assessed. The bacteriological analysis of water in a cross-sectional survey was made. There were 545, 75 and 18 samples of households for water handling practices, stored water from homes and water for faecal coliform test, respectively. Faecal coliform was positive for 60% superficial wells, 60% of dwindling hand-dug boreholes, and 25% of secure on-spot springs. In addition, it was positive for 44% of water source samples and 91% of household water samples. Unsafe water usage was found in 38% households. World Health Organization water quality guideline was non-compliance. Adeyemi et al. [5] has reported that one of the primary reasons of deaths and diseases around globe is water contamination. It is accounting for the mortality of around >14,000 individuals each day, preponderance being under the age of 5 years. Thus, frequent monitoring of municipal water supplies is very important. Using standard microbiological approaches, bacteriological content was determined for relative micro-bacteriological analyses of 25 stored borehole water samples at different hostels in Oyo State. The micro-organisms contents and existence of enteric-coliforms pathogenic organism upraised serious alarms as WHO allowable perimeters for over-all coliforms and viable count are 0 MPN/100 mL and 100 cfu/mL, respectively. The organisms secluded are of public health importance as consumption of water contaminated by these organisms might result in gastroenteritis, especially *Escherichia* which is probable fecal contamination. Wu et al. [6] declared groundwater vital to ensure water supply in the Ordos basin, China. A total of 35 groundwater samples were analyzed for seventeen physicochemical factors. The model recommended by the United States Environmental Protection Agency (USEPA) was used to quantify the health risk. Also, to assess the overall groundwater quality, water quality index (WQI) is used with human health risk weighting. Adults were at lower risk than children. For both adults and children, many groundwater samples were at undesirable health risks. Many samples were not good for drinking because 11.43 % and 17.14 % of all tested samples were poor quality water and very poor quality water, respectively.

Micro-pollutants (or emerging contaminants) are comprised of a widespread collection of natural and synthetic substances, e.g., personal care products, pharmaceuticals, agrochemicals, and steroid hormones (Quesada et al. [7]). Many such compounds are released into the environment uninterruptedly via domestic sewage treatment systems. There are low-cost adsorbents which can remove main pharmaceuticals traces in runoff water, concentrating on municipal and agro-industrial wastes as precursors. In the arid environments of Patagonia (Argentina), water is a scarce resource for human consumption (Morales et al. [8]). Considering local perspectives and scientific contributions, water quality was assessed through an ethnolimnological, interdisciplinary methodology. Variances were perceived between scientific and local viewpoints in terms of water quality (microbiological and chemical). Many water sources utilized by population showed water of deficient quality for human use (61%).One the other hand, users considered the water to be fresh, transparent, and delicious. Generally, users do not identify the worsening of their water supply. Daud et al. [2] reported that potable water quality is getting deteriorated on daily basis in Pakistan due to shocking increase in rapid industrialization and population. Around 20% of the Pakistan's whole population is having safe potable water. The rest 80% of population is enforced to use unsafe potable water due its scarcity. The main basis of uncleanness is sewage (fecal) which is broadly mixed into potable water supplies network. Inferior basis of micro-pollution is the dumping of fertilizers from agriculture sources, insecticides, and toxic chemicals from industrial effluents into the water storage bodies. There is instantaneous necessity to take protecting actions using management tools to incredulous unhygienic circumstance of potable water supplies in Pakistan.

3 MECHANISMS INVOVLVED IN FILTRATION PLANTS

A big issue is membrane fouling in the ultrafiltration (UF) for removing natural organic matter (NOM) from water (Yang et al. [9]). Different aspects like transition fouling the initial intermediate pore blocking, and the final stage of limited cake growth can predict the leading membrane fouling patterns. A substantial decrease of cake filtration coefficients and a small reduction in pore blocking coefficients were detected with extended UV/TiO2 pretreatment time. One the other hand, photocatalytic pretreatment showed a small effect on the mitigation of irretrievable fouling that was largely dominated by HPI fractions.

3.1 Water supply to filtration plant

In Malaysia, almost every house is presently having outdoor water filtration (OWF) system as part of home appliance (Kamil et al. [10]). The quality of water supply needs to be improved using filtration plant. The aim was to understand qualitatively the prerequisite of OWF system through consciousness of the users. Also, the performance of the system was determined by measuring residual chlorine for sample of seven houses. The efficiency was in the range of 76% to 96% and the users were rarely aware of filter media types and water factors related to effluent water quality. National standards for drinking quality water [2] are provided in Figure 2. This shows the standard values for Pakistan and also comparison is shown with WHO standards.

Parameters	Standard values for Pakistan	WHO standards
	Biological	
All water intended for drinking (*E. coli* or thermotolerant coliform bacteria)	Must not be detectable in any 100 mL sample	Must not be detectable in any 100 mL sample
Treated water entering the distribution system (*E. coli* or thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100 mL sample	Must not be detectable in any 100 mL sample
Treated water in the distribution system (*E. coli* or thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100 mL sample In case of large supplies, where sufficient samples are examined, it must not be present in 95% of the samples taken throughout any 12-month period	Must not be detectable in any 100 mL sample In case of large supplies, where sufficient samples are examined, it must not be present in 95% of the samples taken throughout any 12-month period
	Physical	
Color	≤15 TCU	≤15 TCU
Taste	None	None
Odor	None	None
Turbidity	<5 NTU	<5 NTU
Total hardness as $CaCO_3$	<500 mg/L	—
TDS	<1000	<1000
pH	6.5–8.5	6.5–8.5
	Chemical	
Essential inorganic	mg/L	mg/L
Aluminum (Al) mg/L	≤0.2	0.2
Antimony (Sb)	≤0.005 (P)	0.02
Arsenic (As)	≤0.05 (P)	0.01
Barium (Ba)	0.7	0.7
Boron (B)	0.3	0.3
Cadmium (Cd)	0.01	0.003
Chloride (Cl)	<250	250
Chromium (Cr)	≤0.05	0.05
Copper (Cu)	2	2
Toxic inorganic	mg/L	mg/L
Cyanide (CN)	≤0.05	0.07
Fluoride (F)*	≤1.5	1.5
Lead (Pb)	≤0.05	0.01
Manganese (Mn)	≤0.5	0.5
Mercury (Hg)	≤0.001	0.001
Nickel (Ni)	≤0.02	0.02
Nitrate (NO_3)*	≤50	50
Nitrite (NO_2)*	≤3 (P)	3
Selenium (Se)	0.01 (P)	0.01
Residual chlorine	0.2–0.5 at consumer end, 0.5–1.5 at source	—
Zinc (Zn)	5.0	3
	Organic	
Phenolic compounds (phenols) mg/L		≤0.002
Polyaromatic hydrocarbons (PAH) g/L		0.01 (by GC/MS method)

* indicates priority health related inorganic constituents which need regular monitoring.

Figure 2: National standards for drinking quality water by Daud et al. [2]

3.2 *Filtration processes and their efficiency*

A technique for large-scale treatment of water in rural areas is proposed to remove arsenic by Kim et al. [11]. This should be easily customized, not rely on electrical power and low-cost. The proposal was a three-dimensional (3D), printed water-filtration system to remove arsenic. In adsorptive filtration, a filter with a smaller internal surface area was less effective than one with a larger surface area. At low temperatures (Average 0.5 °C), the impact of chemical pretreatment and filter design to remove *Cryptosporidium* surrogates present in filter influent water was determined using pilot-scale direct filtration challenge experiments (Liu et al. [12]). The optimization of filter configuration and chemical pretreatment to remove *Cryptosporidium* oocysts surrogates in cold-water conditions in granular media water filtration procedures was emphasized. The desirable procedure is deep bed with optimized chemical pretreatment condition for removing Cryptosporidium surrogates in potable water and can be well-thought-out in full-scale application.

4 DIFFERENT PERSPECTIVES IN WATER QUALITY TESTS

Wu et al. [13] is of the opinion that, to improve water resources management strategies, river water quality evaluation is one of the utmost significant features. Water quality index (WQI) is regarded as one of the utmost regularly used assessment tools. It can be calculated using 17 water quality factors, namely pH, temperature, dissolved oxygen (DO), conductivity, biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total phosphorus (TP),ammonia nitrogen (NH3-N), volatile phenol (VP), oil, sulfide, fluoride, lead (Pb), surfactant, zinc (Zn), arsenic (As) and copper (Cu). It came out to be 88.15, 71.70, 78.92, and 90.12 in winter, spring, summer, and autumn, respectively, for Beiyun River. This indicated the water quality as "good". Passman and Peter [14] used water-miscible metalworking fluids (MWFs) to remove metal. Microorganisms in the environment are vastly varied and fungi and bacteria are recovered from these waters at population densities of > 106 CFU mL-1.

Yazdanbaksh et al. [15] assessed the coastal water quality index (CWQI) and microbiological quality in the Persian Gulf (Bandar Abbas city). Five water samples were taken from different coastal locations in summer and spring seasons. To evaluate the quality of microbiology: Fecal Coliforms, Total Coliforms, Clostridium perfringens and Fecal Streptococci were determined. In addition, CWQI was calculated using 08 physicochemical factors (BOD, DO, Turbidity, TSS, pH, Temperature, Phosphate, Nitrate). It was found that the limits of microbiological indicators were exceeded the guideline and national standard values. Also, weak quality of water was reported with the computed CWQI. Adimalla et al. [1] conducted tests on 105 groundwater samples. These included electrical conductivity (EC), pH, total hardness (TH), total dissolved solids (TDS), magnesium (Mg2+), calcium (Ca2+), potassium (K+), sodium (Na+), sulphate (SO42−), chloride (Cl−), fluoride (F−) and nitrate (NO3−). As per water quality index (WQI), 36% and 60% of groundwater samples were in good and excellent categories, respectively, for drinking purpose. It is advised that groundwater for drinking purposes with high nitrate and fluoride concentration should be avoided.

Ali et al. [16] designed a bench scale study for removal of regeneration and zinc (Zn2+) efficiencies of functionalized-MWCNT (f-MWCNT) membranes. The f-MWCNTs had been merged into polyvinylchloride (PVC) hollow fiber membranes (HFMs), which represented as a substrate and a barrier for MWCNTs leaching to water. The results revealed that, for the synthetic water, over 98%of Zn2+ was removed through f-CNT membranes. Piazza et al. [17] exposed the microbial communities of two natural water management plants from Argentina to elongated term presence of Mn(II). Numerous choosy media had been utilized to culture Mn-oxidizing bacteria (MOB) and a huge number of known MOB and numerous isolates that were not testified before as MOB had been cultivated. These bacteria were categorized to choose that with the maximum Mn(II) oxidation and biofilm formation capacities. The isolation of numerous bacterial strains was to mature an inoculum applicable to progress Mn(II) removal efficiency of sand filter water treatment plants.

5 GUIDELINES FOR POLICY MAKERS

Induced bank filtration, an economical and trustworthy drinking water fabrication technique, customarily has an emphasis on practices affecting the drinking water quality [18]. The current filtration mechanisms are not effective enough to remove small sized microbes that can cause antibiotic resistant diseases so there is need of broad-scale surveillance and monitoring of the proliferation of bacteria containing antibiotic resistance genes in drinking water [19]. Water supply and treatment is considered an issue progressively valued under financial and environmental sustainability focus in any water sector. There is a need for proper utilization of available resources for the water quality improvement [20]. From managerial point of view, an effort should be made to educate, monitoring and awareness of the people, drinking water distribution lines up gradation and protection of sources from contamination, and their proper maintenance. Since legislation of potable water supplies has a poor framework, potable water quality standards should be tentatively made for the treatment/ maintenance of potable water distribution system. The similar approach is also recommended by Daud [2]. To guard water resources and control pollution from its source, WASA (Water and Sanitation Agency) along with the assistance of public and private establishments may take action. An excessive care is likewise essential to prevent the saltwater/hard water mixing with the fresh clean natural ground water assets. To minimize the waterborne diseases spread, an effort should be made for appropriate operative, scrutiny, and specimen analysis (three times in a year) to guarantee harmless potable water as per value standards. To kill pathogens, appropriate repairs of water dissemination system and chlorination is required as per law and regulations. Many studies [15, 16] suggested this procedure. Community consciousness campaigns at all levels (school, college, university, and offices) are good for awareness of safe potable water. Boiled potable water decreases danger of waterborne diseases. Economic and social circumstances of the families also have a key role in reducing diarrheal disease. Maternal education on the living style can also be associated to the potable water quality and to progress their health status. This aspect should also be focused.

6 CONCLUSION

Following conclusions can be drawn from the conducted literature research:

- Established fact cannot be denied about drinking water quality. Its access can reduce waterborne diseases.
- Economical and easy to maintain filtration plants in sectors of societies can help significantly. Public awareness is also important.
- Government and private institutions should work together for efficient output.
- Scientific knowledge is sufficiently available to assist regularity bodies and public; a proper coordination is must.

These facts enforce to think for a national level plan for any developing country to ensure healthy life for its population. The implementation should be made at local level so that common people can benefit from it.

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