# Chapter I

# INTRODUCTION

## Water – A Global Concern

Water is second to oxygen as being essential to life. People can survive days, weeks or even longer without food, but it is very difficult to live without water to drink. Water acts as a lifeline of the ecosphere that connects us to one another, the biodiversity, and to the entire planet as it has fundamental importance to all life forms on the earth. The terrestrial ecosystems, from equatorial to polar region, from the plains to the mountain regions and from the coastal to desert region and human beings depend on fresh water for their livelihood and survival. According to Dorota, (1986) water adds to aesthetic value of the landscape and thus provides opportunities for developing pilgrim places, tourist centres, places of recreation and sports. Because of importance of water, the pattern of human settlement throughout the history has often been determined by its availability. Fertile river valleys with abundant water supplies were the centres for beginning of civilisations.

Water thus forms the most important visible and invisible constituent of the nature supporting various life forms on the earth. It provides man with his necessities, comforts and leisure. Water is needed to fulfil diverse requirements in so many ways. It is rightly said that everything is originated in water and everything is sustained by water. Hindu philosophy therefore describes 'water as life'. It is the main life support system on the only living plant 'the earth' in the entire known galaxy.

The availability of plentiful and safe water for domestic use and adequate sanitation has long been known to be fundamental to the development process (Gadgil, 1998). The demand for quality drinking water has changed considerably with the ever increasing pressure of growth in the modern era. In older days the only modest requirement of drinking water was that it should be clean, free flowing and non turbid. Now a days, due to increase in urbanisation and industrialisation, worldwide several problems are associated with availability of lack of clean and fresh water. In both, industrialised and developing nations, growing number of contaminants are entering in to water supplies due to human activity.

Waterborne diseases are significant global issues. Billions of people lacking access to reliable supply of clean drinking water. It is estimated that around 1.2 billon people lack access to safe drinking water and 2.6 billion have little or no sanitation facility. Millions of people die annually, specially children are mostly affected every day from diseases transmitted through unsafe water or human excreta (Nature,2008). The consumption of drinking water contaminated with pathogenic microbes of fecal origin is a significant risk to human health in developing world, especially in remote rural areas with over 3 million deaths per year attributed to waterborne diarrhoeal diseases, especially among infants and young children in poor communities in Africa, Asia and south America (Reed,2000) India with vast rural poor population is no exception to this and therefore needs urgent solution to the problem of accessibility to adequate clean drinking water

**Drinking Water Quality and Human Health:**

The potable water is defined as one having acceptable quality in terms of its physical, chemical, bacteriological and acceptability parameters so that it can be safely used for drinking and cooking (WHO, 2004). WHO defines drinking water to be safe as long as it does not cause any significant health risks over a lifetime of consumption and an effort should be made to maintain drinking-water quality at the highest possible level.

In many parts of the developing world, including India, drinking water is collected from different unsafe sources outside home and stored in household vessels. This water may get contaminated at the source or during its storage. The risk of contamination of drinking water during household storage was noted in surveys conducted by the WHO (2004). According to a study in rural Bolivia (Quick et al., 1997), many people were unaware of the link between water contamination and diarrhea. So, undoubtedly, awareness about the quality is as essential as the demand for safe drinking water.

Waterborne infectious diseases are transmitted primarily through contamination of water sources with excreta of humans and animals who are either active cases or carriers of the disease. These diseases are caused by contamination of water with virus

(viral hepatitis, poliomyelitis), bacteria (cholera, typhoid fever, and bacillary dysenteries), parasites (amoebiasis, giardiasis, worm infestation, guinea worm) or chemicals (WHO, 2003).

Such diseases are of immense public health importance in India because of (i) high morbidity and mortality (ii) potential for causing large and explosive epidemics (for example, cholera) which create panic in the community (iii) non-availability of specific treatment for some viral diseases such as Viral Hepatitis E, and (iv) increasingly difficult treatment due to anti-microbial drug resistance in bacterial diseases such as typhoid fever and bacillary dysentery. Intestinal parasitic infections and diarrhoeal diseases caused by waterborne bacteria and enteric viruses have become leading causes of malnutrition owing to poor digestion of the food eaten by people sickened by water (Lima, 2000, Behrman 2004). More importantly, young children bear a huge part of the burden of disease resulting from the lack of hygiene in addition to poor quality drinking water. Almost all of these deaths are in developing countries. In India alone, there are more than a million child deaths per year resulting from waterborne diseases like diarrhea (Parikh et al., 1999).

Although methods are now available to enumerate the concentration of various specific bacterial contaminants in water, these methods are commonly complex and time consuming and hence impractical for routine monitoring quality of water used for potable purpose. A more expedient approach is to test for the presence of an 'indicator bacterial species' that would signal fecal contamination. The main indicator of sanitary quality of drinking water is the coli form bacteria count (MCL = average of 1 per 100 ml). A high count of these bacteria is an indication of level of contamination from a septic system or other fecal pollution source. The presence of coli form bacteria, which can be found in the feces of humans and animals, indicates that there is a high probability of presence of other pathogenic organisms (Dorota, 1986).

**Indian Scenario of drinking water resources:**

India faces an increasingly urgent situation because its finite and fragile water resources are stressed and depleting while different sectoral demands are growing

rapidly. At independence, India's population was less than 400 million and per capita water availability over 5,000 cubic meters per year. Today, population has grown to over a billion and per capita water availability has fallen to hardly more than 2,000 cubic meters per year and the actual usable quantity is around 1,122 cubic meters per year (India Assessment, 2012).

According to the National Sample Survey Office (NSSO, 2012) as per the Indian norms, access to improved drinking water supply exists if at least 40 liters/capita/day of safe drinking water are provided within a distance of 1.6 km or 100 meter of elevation difference, to be relaxed as per field conditions. In the 12th Five Year Plan the focus is on provision of piped water supply and reducing dependence on hand pumps (Budget of Govt. of India, 2013).

**Drinking Water Quality in Rural India :**

Water quality is affected by both point and non-point sources of pollution. These include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Water quality is also affected by floods and droughts and can also arise from lack of awareness and education among users. The rural population of India comprises more than 700 million people residing in about 1.42 million habitations spread over 15 diverse ecological regions. It is true that providing drinking water to such a large population living in diverse geomorphic and topographic regions is an enormous challenge. Our country is also characterised by non-uniformity in level of awareness, socio-economic development, education, poverty, practices and rituals and also urban and rural setup which add to the complexity of providing water (Water Aid, 2008).

According to Census (2011), tap water (treated plus untreated) was the major source of drinking water with access to 43.6 percent household in India followed by hand-pump (33.5%), well (covered plus uncovered) 11% and tube-well/borehole (8.5%). In rural India, hand-pump (43.6%) was the leading source followed by tap water (treated-18% and untreated-13%) and well (covered-1.5% and uncovered-12%) as the main source of drinking water in the household. Whereas in urban India, tap water (treated-62% and untreated-8.6%) was the main source of drinking water in 2011 (Shrikant, 2009, Ashwani Kumar, 2014)

Besides bacteriological contamination, presence of fluoride and arsenic in ground water is another major issue in rural India. According to Rural Marketing Survey, Final Report,(2012), on safe water supply, high fluoride concentration in ground water, beyond the permissible limit of 1.5 ppm has come to stay as a major issue affecting a large segment of rural population to the tune of 25 million, spread in over more than 200 districts in 17 states in the country. The population at risk was estimated at around 66 million. The presence of excess Arsenic in ground water has also been reported from West Bengal. Nearly 13.8 million people in 75 blocks were reported at risk. It was also reported that around 0.2 million people in West Bengal have arsenic related skin manifestations (Arankalle *et al.*, 1993, 1994, Marra, 1999).

**Methods for treating drinking water in rural area:**

In most cases the urban people are privileged to have supply of potable drinking water through pipe. In socio-economically developed household modern water purifying gadgets like different types of water filters, UV based water purifiers, membrane filters, etc. are common drinking water purifying systems/ gadgets. However, the rural population does not get any options to purify the contaminated water they get due to lack of awareness, financial resource and technical support. According to Shrikant,(2009) also in the rural areas, modern water purification technologies are not be viable. Also, in absence of centralized treatment systems, the responsibility for making drinking water safe entirely falls back on rural community. At present the central and state agencies promote chlorine bleach (bleaching powder) for disinfection of community water sources, including wells on an ad-hoc basis and therefore, no guidelines have been adopted for regulating dosage and contact time of chlorination. Bleaching powder is often seen dumped indiscriminately into the large water-storage tanks/wells, leading to excess residual chlorine (Clasen, 2005).

It is realized that lack of awareness about waterborne diseases, water purification methods and poor economic conditions are the major constrains in this situation. In villages, it is important that simple in expensive technologies that are easy to use and can be operated without much technical know-how be promoted. There is now conclusive evidence that simple acceptable, low cost interventions, at household

level and community level, are capable of dramatically improving the microbial quality of household stored water and reducing the risks of diarrhoeal diseases (Agarwal, 2009) . A World Health Organization sponsored literature review also concludes that simple, acceptable, low-cost interventions at the household and community level are capable of improving the quality of household stored water and reducing risks of waterborne disease and death (Sobsey, 2002). Attempts have been made to evaluate the efficacy of household water treatment by some workers.

**Water: Kolhapur region**

Kolhapur district is the southernmost district of Maharashtra state. Kolhapur city, capital of the district, is situated on banks of river Panchganga. The district is blessed with ample of water, fertile soil, natural vegetation, animal wealth and minerals. The district is known for progressive agriculture, mainly sugarcane and milk production and agro industry associated with it. though in general the socio-economically developed district is relatively affluent as compared to many other districts in the state, this wealth distribution is not uniform and many people are still poor, particularly in the rural area. Kolhapur being a former princely state has historical importance, and a famous religious destination due to the temples of the deities Mahalaxami and Jyotiba. Therefore, it is one of the well known tourist destinations in the state. According to Census 2011, the population of the city is around 5 lakh. The proposed city expansion (2002) is going to include 14 villages in the Kolhapur Municipal Corporation (KMC) limits, and the total population of the region than would increase tremendously which would bring greater pressure on the available water resources as well as would produce large quantity of sewage in absence of sewer lines in major part of the district. With the help of funds under Government, KMC has recently installed an STP, however, it is to fully functional as the pipelines to carry treated sewage to river are not layed. Similarly, other STP at Dudhali is yet to be complete. The major problem of surface water pollution in the city is discharge of untreated sewage from 12 neighboring villages, now semi urban areas into the city sewage system as an additional burden. This needs to be checked and treated at village level. For this a proposal is being proposed and submitted to the state government to decrease the load of waste water. The major problem of water pollution in the city, besides surface runoff of untreated sewage is

percolation of sewage, in absence of sewers, into ground water contaminating the resource, which in turn is used through hand pumps by people for drinking purpose.

Lomate, (2002) carried out study on drinking water pollution of Kolhapur city. In this study, it was revealed that the major cause of drinking water pollution was faulty pipeline water supply system in the city which was quite old and aligned very close to the sewage drainage system. The greatest risk from microbes in water is associated with consumption of drinking water which is feacally contaminated. The pathogens that are transmitted through water are diverse and is a major concern to people. Another study related to assessment of bacteriological quality of pipeline drinking water in Kolhapur city by Nakade, (2013) revealed that all drinking water samples were found contaminated with total coliforms as well as fecal coliforms indicating non-potability of water samples. Another study related to treatment of drinking water at different water treatment plants in Kolhapur city reported that there is need to improve the treatments in the Water Treatment Plants as well as to improve the distribution of water through pipeline system (Mohite, 2013)

The rural and semi urban areas located on the periphery of Kolhapur city are also facing the problem of poor water quality. Another study related to studies on the ground water quality from some villages around Kolhapur city showed that the quality and quantity of water available remains unsatisfactory in most of the semi urban areas and fringe villages (Bhosale, 2004).

**Research Problem:**

Since most of the rural areas lack centralised water treatment plants, it becomes necessary to treat the water at point-of-use at household level and make it fit for drinking purpose. Though there are many modern gadgets used to purify the drinking water, they are either expensive or unsuitable for the rural people. In villages, it is important that simple and user friendly technologies, that are easy to use and maintain, and can be operated without much technical know-how be promoted.

Few years ago, Kolhapur was known as "Water Surplus" area in Maharashtra. The jurisdiction of Kolhapur Municipal Corporation covers an area of 66.82 Sq. Km. with

population of more than 5 lakh (ESR, 2012). Expansion of the KMC boundary is long overdue, for over three decades and once announced it would include about 48 villages on the fringe of the city (Lomate, 2002). The recently modified proposal in 2014 includes only 12 villages out of the original list which have common boundary with the existing KMC boundary.

Now a days, due to increase in urbanisation, apathy towards protection and conservation of water resources, improper sewage treatment and waste management, the water quality is being drastically deteriorated. Considering the serious problems of drinking water contamination in the state, the rural area around Kolhapur city was identified and studied as a test case.

The present study was undertaken to evaluate the drinking water quality conditions in the six identified areas located with semi urban and rural background in the immediate vicinity around Kolhapur city. These semi urban and rural areas are coming under increasing influence of the changing urban environment including over exploitation and its mismanagement of drinking water sources. Different physicochemical and microbial parameters in the water samples were analysed during the study. This study involving examination of quality of drinking water, assessment of efficacy of existing water purifying methods could offer a desirable solution for multiplier effect in the region for better health of the common people.