CHAPTER - 6
SUMMARY and CONCLUSION

Data on any prevalent community health problem, its causative factors and possible prevention measures is fundamental to the plan of its mitigation strategy and health policy. Pruss-Ustun et al., (2014) reported that the burden of diarrhoea in low and middle income countries amounted to 502000 deaths associated with inadequate water, and 280000 deaths due to inadequate sanitation from a total of 1.50 million diarrhoeal deaths in the year 2012; and regarding this problem in India, Pathak (2015) proclaimed that around 37.7 million Indians are affected by waterborne diseases annually and 1.5 million children are estimated to die of diarrhea alone. Hence, the issue of safe drinking water and sanitation in area of low income setting like Dungarpur district appears imperative to examine. District Dungarpur is located in southern end of Rajasthan state with tribal population over 65% of the total. The human development index (0.409) and health index (0.282) of the district is lowest and infant mortality rate (112/ 1000 births) is highest in Rajasthan (HDR Rajasthan, 2008). So, it is needless to mention that Dungarpur is counted among one of the backward districts of country. The problem of safe drinking water availability and sanitation causing morbidity and mortality in all the age groups in Dungarpur-District has been duly mentioned in Human Development report (2009). In this scenario the hospital data of gastro-intestinal ailment incorporated in this work also imply that gastro-intestinal illness caused by unsafe drinking water and its association with the socio-economic profile of residing community here is cardinal to be investigated scientifically. The appraisal of water storage in Dungarpur water bodies with respect to bacteriological and physiochemical pollution is of immense significance for improving the living standard and quality of life in this region. Data of government departments on socio-economic status and contamination of drinking water is there, but no associative study has been carried out so far encompassing all the aspects of the issue. Therefore, this research work was formulated and undertaken.

The work plan of this study was to analyze the physico-chemical and microbial attributes of water reservoirs used for supply of water in district through
different seasons of the year; and, generate the field survey data of economic and educational status, the drinking water sources and its accessibility, status of water treatment before using and practice of hygiene and sanitation of the populace here. The data from all the government hospitals of district on patients admitted with gastro-intestinal illness usually owing to unsafe drinking water and improper sanitation was also procured.

**Physicochemical parameters** – pH of the surveyed reservoirs was found to be in permissible range except for Sabela talab and Margia dam where it was above 8.5 in summer. Overall, high pH values in some water-bodies indicate the status of waste discharge and microbial decomposition of organic matter there. Turbidity was much higher than permissible limit in all reservoirs in rainy season. High turbidity is also indicative of the bacterial load of water and makes it non-potable, so removal of turbidity before use or supply of the water is essential. Temperature of water was found to be high in summer. High temperature accelerates the process of decay of organic matter resulting into the liberation of large quantities of CO₂ and nutrients lowering the quality of water. So, the potability of water needs to be monitored in summer. Total alkalinity was found to be in moderate and permissible range in every sample of all seasons. It was highest in summer and lowest in rainy month. Total hardness was also in permissible range with all samples, so no any health concern is attributed with this parameter. Seasonal fluctuation of total hardness was similar to alkalinity. Calcium and magnesium hardness in drinking water is a source of essential elements calcium and magnesium in the body and these were well within permissible range except for Sabela pond in summer. Chloride content in samples of all seasons was 50 to 700 mg/l and it was lowest in rainy season and highest in summer. Chloride is one of the important indicators of faecal pollution present in sewage, effluents and farm drainage and synthetic fertilizer, and it was found in maximum concentration in Sabela pond and then Gap sagar, indicating that these two are highly polluted among surveyed water-bodies. Due to the rock bed formation of Dungarpur district, fluoride concentration in ground water is higher than permissible limits in its three blocks. And, fluoride toxicity is a phenomenal menace of the district. Still, its concentration in studied water reservoirs was found to be well below the acceptable limit. Similarly, nitrate concentration was also found
to be acceptable. Total dissolved solids (TDS) were within permissible limit in samples but in Gap sagar and Sabela pond TDS content is very high making the water not potable. Seasonal variation in chloride, fluoride nitrate and TDS exhibited their lowest value in rainy season and highest in summer. However, concentration of fluoride in water samples was lowest in winter and highest in summer. Statistical correlation was noted between physico-chemical parameters demonstrating the dependence of one indicator upon another.

**Microbiological parameters** – The coliform bacterium and *E. coli* are the primary bacterial indicator for faecal contamination in water and are causative agents of gastro-intestinal ailments on consumption. These two indicators of the microbial contamination were analyzed. The counts of total coliform as well as *E. coli* were highest in rainy season and lowest in winter in all water-bodies. Total coliform in Adward samand was from 500 to >1600, in Dimia talab 280 to 900, in Gap sagar 900 to 1600, in Sabela pond >1600 to 900 and in Margia Dam 220 to 900 MPN/ 100 ml. The *E. coli* is the true indicator of faecal pollution in water as it cannot grow outside of the intestine of warm-blooded animals normally, whereas the origin of other coliform may be non-faecal also. *E. coli* count in Adward samand was 60 – 170, in Dimia talab 17 – 70, in Gap sagar 90-110, in Sabela pond 240 – 500 and in Margia dam 30 – 80 MPN/ 100 ml. The seasonal variation pattern was same as that of total coliform. Adward samand may be carrying highest total coliforms, but its low *E. coli* count indicates that pollution load is of non-faecal origin. Count of *E. coli* (and other coliforms) in Sabela talab makes it undoubtedly the most polluted reservoir as it receives the city sewage, faecal and many other anthropogenic wastes. A perfect correlation in the microbial counts between different seasons was noted and counts of total coliform and *E. coli* was observed to have near absolute positive correlation. Microbial loads were also positively associated with parameters like turbidity, pH and temperature.

IMViC reaction test analysis showed that *Escherichia coli* are present in all reservoirs in all seasons except for Margia in winter. *Shigella, Citrobacter, Klebsiella, Enterobacter and Aerobacter* species are present variably in different reservoirs and seasons. The microbial profile also indicated that Gap sagar and Sabela talab are categorically polluted with faecal and animal or human waste while
other water bodies are contaminated with faecal coliform primarily in rainy month only. Adward samand, Dimia talab and Margia dam are laden with micro-flora other than faecal origin.

**Socio-economic profile, water source accessibility and sanitation practice survey** – The data of field survey indicated that the education profile of the family is directly related with their income status, and occurrence of water-borne gastro-intestinal problems was dependent on both the income and education stature of the family. With enhancement in the level of financial earning and education the incidence of disease scales down. Apparently this trend was associated with the practice of hygiene and sanitation measures that augmented with the level of income and education in the families. Drinking water sources are hand-pump, tap water (of PHED), bore-well and open well. With improvement in income the access to the source of drinking water and availability of treated water also bettered. People having income above Rs. 5.0 lakh per annum do not use open well and have access to treated water. Many families of higher income group have water purification system installed at home. So is the condition of at home water treatment in months vulnerable for disease episodes. Measures like boiling of water, use of chlorine tablets/ alum and water guard is more frequent in higher income families. It was noted that 82 to 88% of the families in lower income group do not have the provision of treated water at source, and are more susceptible to the contaminated water ailments.

**Hospital data of water-borne gastro-intestinal disease** – Data of the span of January 2016 to August 2017 for the patients registered with the symptom of disease in government hospitals and health centers of the district was collected. Month-wise minimum patients admission was in the duration of November 2016 to April 2017. Though, in during January to April 2016 monthly figures were higher due to high numbers of patients in Sagwara, Dungarpur and Simalwara blocks. So, may be some epidemic or other episode was responsible for it. Nevertheless, in both the year maximum number of patient registration with gastro-intestinal problems was noted during June to August in both 2016 and 2017. Hence, it may be concluded that upsurge in the number of patients is proportional to the seasonal microbial contamination load of water resources. In five surveyed reservoir the lowest
microbial load was in winter which started rising with the atmospheric temperature and reaches to maximum during rainfall and water run-off. The same pattern was discerned in the number of the patients with said symptoms in hospitals. Mishra (2011) also reported the identical correlation. In his study ground water samples of Dungarpur district was analyzed and same pattern of seasonal variation in microbial counts of water samples and similar hospital data trend was observed. So, somehow the microbial contamination of surface water and run-off reaches the ground-water table. Therefore, hospital data confirms that the source of drinking water plays a strong, positive and significant association with waterborne diseases.

The results of this study specify that other than fluoride the physico-chemical parameters of drinking water sources in the district are not of major concern. Though, fluoride was found under permissible limit in the supply reservoirs, but ground water concentration of this ion in some blocks is a major drinking problem causing the prevalent menace of dental and skeletal fluorosis in the district (Choubisa et al., 2011; Choubisa, 2012). This problem has been extensively worked out earlier. So, except for fluoride issue in ground water, physico-chemically the water in district is safe for drinking. However, the microbial contamination of the drinking water is district is the problem that warrants a proper attention. It is evident from hospital data and its correlation with microbial burden of water that the issue is of prime health concern in district and elsewhere. The problem is wide-spread and when a person suffers from this diseases, he loses working days and consequently his income. WAP (2011) report says that the total annual economic impact of inadequate sanitation in India amounted to a loss of 2.4 trillion or Rs.2180 per capita in 2006). And, in the case of children, these diseases make them incapable of attending school, and it affects their scholastic performance (Bedi et al., 2015) and even causing mortality. It has been indicated in this study the microbial burden of drinking water and its manifestation as the episodes of diarrhoea and is associated with the socio-economic configuration and hygiene and sanitation practices of the populace. Hence, this major community health problem was needed to be examined comprehensively taking its each aspect into account. The work integrating the field survey with microbial profile of water sources and hospital records has been carried out for the first time.
The aspects of the problem as discussed above are upsurge in microbial contamination during late summer and monsoon, accessibility of water sources and treated water among people of lower economic-educational status, fallacy to adopt proper hygiene and sanitation practices or use of treated water among people of lower economic strata and awareness towards causative factors of disease and benefits of proper hygiene and sanitation. Mostly in lower income group awareness is there, but economic constrains compel them to use unsafe water and ignore sanitation or hygiene. For the rise of microbial load in water resources rainfall and runoff may be the reason but it is compounded by reckless and unrestrained sewage, faecal waste and garbage dumping in water-bodies and open defaecation.

When approximately one and half percent of population of district is getting admitted with a preventable health problem, remedial measures are imperative to be initiated through multipronged approach. So, to address this problem following measures are suggested:

1. Less costly homemade sand filters may be provided to poor families on affordable or subsidized rates at community level (one filter that may be used by more than one families), and users should be trained for its proper maintenance. Slow sand filters remove microbial pathogen and turbidity, and could be fabricated at cottage industry level with simple container, sand, gravel, and charcoal etc. (Guchi, 2015).

   Distribution of chlorine tablets by health workers is also a good measure to counter this problem; but its dose (amount) should be duly prescribed. Less quantity would not disinfect the water and high dosing would leave some by products which are of health and regulatory concern (Krassner, 2009; Miranda et al., 2007).

2. Provision should be made to increase accessibility of water particularly in remote areas. More hand-pumps should be installed and regularly maintained. The pipeline network of PHED should be expanded and extended to every village of the district.

3. The water level goes down and reservoirs dry up in summer making the water availability scarce and compelling people to use unsafe water. So,
capacity of water reservoirs should be maintained through desilting and removing encroachment to sustain the capacity to supply even in late summer. Rainwater harvesting may be promoted at the village level.

4. Awareness campaigns should be launched continually at regular basis by both the government agencies and NGOs to educate common, less educated and poor villagers regarding the waterborne gastro-intestinal disease and its causative factors. The community must also be enlightened that the disease (diarrhoea) is not only contagious rather it causes the death of children also. They should also be advised to adopt the affordable practices of hygiene and sanitation to prevent such ailments. Aasha-sahyogini, Anganwadi workers and village level health workers may play a very important role in it.

   Government has already taken the steps to make villages ODF (Open Defaecation Free) under Swachh Bharat Mission for the termination of fecal-oral transmission of microbes causing water-borne disease.

5. Monitoring the water-sources in disease-prone season and strengthening and maintaining the filtration system by PHED is also recommendable.

   Given these findings it can be concluded that increasing safe domestic water access, strengthening source water monitoring programs, improvement in the hygienic conditions and sanitary practices through awareness, upgrading water filtration system and establishing intergovernmental public health policies that can benefit water resource management agendas are the warranted measures to control this community health issue.