CHAPTER-2

REVIEW OF LITERATURE

WATER QUALITY ASSESSMENT

Water as extraordinary substance, exists in three states as gases, liquid proved important for survivability of life (Simpi *et al.*, 2011). Water quality has direct relation with aquatic productivity (Shrestha and Kazama, 2007). Riverine system comprises both main course and tributaries, carrying the one way flow of sediment with load of dissolved matter and particulate phases coming from natural and anthropogenic sources (Rani *et al.*, 2011). River also serves for domestic, industrial and agricultural disposal, transportation, getting food resources and for recreational activities (Dhote and Dixit, 2011). Urbanization found to be root cause of water contamination. Animals use same water for drinking and can also contaminate through direct defecation and urination. Immersion of idols during festivals found to be one of the reasons of river pollution. Industrial waste including detergents produces mass of white foam in the river waters on the other hand heavy metals, acids, dyes, alkalies and other chemicals change pH of water which becomes toxic to aquatic fauna. Aquatic organisms need a healthy environment. Maximum productivity depends on optimum level of physicochemical parameters (Sadia *et al.*, 2013). Assessment of riverine water was carried out by assessment of its physicochemical parameters (Rao and Vaidyanadhan, 1979; Muniyan and Ambedkar, 2011). Taking account of vast release of toxicants and other chemical we have decided to analyze the quality of water from Narmada river as is extreme need of time to take a some preventive measures and to sustain the aquatic fauna inhabiting in it.

Water quality research had gone more than 100 years and cover physical, chemical, and biological aspects of water quality. All these aspects had profound impact on aesthetical and usability to consumers, they are linked and inseparable to ensure water quality kept at utmost (Meybeck *et al.*, 1996; Kazanci and Dugel, 2000; Bordalo *et al.*, 2001; Tuzen *et al.*, 2001 and Viswanathan *et al.*, 2010). Rivers and streams are very important natural environment and linked to human lives, animals, and vegetations (Haase and Blodgett, 2009 and Wu *et al.*, 2010). Rivers and streams are usually exposed to loads of polluting substances that come from sources such as sewerage and effluent from waste water treatment plants (Petersen *et al.*, 2005), as well as from diffuse discharge sources such as surface water runoffs (Petersen *et al.*, 2005; Mcleod *et al.*, 2006; Earles *et al.*, 2008; Gurr and Nnadi, 2009; Lefkowitz *et al.*, 2009). Physico-chemical analyses cannot yield enough information on the whole health of the river ecosystem (Viswanathan *et al.*, 2010).

Limnological work of Indian rivers was attemped by Iyenger and Venkataraman (1951) and Dad (1981). Limnological studies were carried out by many workers like Gaufin and Tarzwell (1956), Brinkhurst (1965), Rai (1974), Michail (1980), De Pauw and Vanhooren (1983), Wetzel (2000), Wetzel & Likens (1991), Khanna and Bhatia (2003), Pathak and Mudgal (2005). Ahipathi and Puttaiah (2006), Raja *et al.* (2008) studied evaluation of physical and chemical parameters of river Kaveri, Tiruchirappalli Tamilnadu, India. Sharma *et al.* (2011) studied water quality of Behlol nullah Jammu (J & K).

Verma (1964), Khan and Khan (1985), Adholia (1986), Kant and Riana (1990); Joshi and Bisht (1993), Ali *et al.* (2000) and Hussan and

Ahemad (2002) studied on Physico-chemical conditions of different rivers and ponds. Batcha (2003) investigated water chemistry and biology in a shallow lake of Pamootis (Greece). Kanungo *et al.* (2006) studied physico-chemical characteristics of Doodhadahri pond of Raipur, Chhattisgarh. Amin *et al.* (2010) studied the evaluation of industrial and city effluent quality using physicochemical and biological parameters. Water is vital to our existence in life and its importance in our daily life makes it imperative that thorough physico-chemical examinations conducted on water. Potable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikaran, 1999; Chakraborthy and Das, 2006).

The public health significance of water quality cannot be over emphasized. Many infectious diseases are transmitted by water through the fecal-oral route. Diseases contacted through drinking water kill about 5 million children annually and make 1/6th of the world population sick (WHO, 2004). Water quality assessment may be attributed to the fact that in the overall potability of water, such parameters should not be ignored (Osuinde and Enuezie , 1999). The Maintenance of ecosystem process will contribute to the conservation of biodiversity since it may insure that all important biological process persist (Karr, 1991; Angermeier and Karr, 1994 and Margules and Pressey, 2000). Application of biological method in river water quality studies started to increase and example of this can be seen in studies of Azrina *et al.* (2006), Lee *et al.* (2008) and Al-Shami *et al.* (2010a, 2010b).

Earlier work done in India was all based on studied of surface water Ganpati (1960), Michael (1968), Rai (1974), Reddy and Venkateswarlu

(1987), Das and Chand (2003), Brauns *et al.* (2007) and Smitha *et al.* (2007). The studies on different fresh water organism have been done by many workers in India George (1966), Rao & Shrivastava (1989), Krishnamurthy (1990), Joshi and Bisht (1993), Rao *et al.* (1999) and revised by Zutshi and Gopal (2000). Water quality and pollution status of Chambal river in National Chambal sanctuary, Madhya Pradesh have been done by Saksena *et al.* (2008).

WORK ON RIVER NARMADA

Limnology of river Narmada has been studied by various workers Shrivastava (1999), Verma (2006), Bakawale & Kanhere (2013) and Verma *et al.* (2013). Studies of Physico-Chemical and Microbial parameters on water quality of Narmada River, India (Soni *et al.*, 2013). Comparative Physicochemical studies of two reservoirs Punasa and Omkareshwar of Narmada River, MP, India (Kumari *et al.*, 2014). Physicochemical studies in Narmada river of West Nimar (M.P.) India (Mukati *et al.*, 2014). Physico-chemical studies in Narmada River, Khedighat, Barwaha M.P. India (Yodha, 2016).

All physicochemical parameters determined in the Abeokuta Nigeria, Bhavani river, Challawa river and Narmada river by Shittu *et al.* (2008), Varunprasath and Daniel (2010), Indabawa (2010) and Sharma *et al.* (2012) respectively. Limnological studies were carried out by many workers like Sharma and Rawat (2009) and Sarkar (2012).

Water is one of the most important natural resources essential for all forms of life. This resource is being contaminated everyday by various anthropogenic activities, such as rapid growth of population, urbanization and industrialization that ultimately make the environment polluted. In

Omkareshwar reservoir the Narmada River has always been the most important fresh water resources. However the Narmada water is used in every sector of development like agriculture, industry, transportation, aquaculture, public water supply etc. Huge load of wastes from industries, domestic sewage and agriculture practices find their way into the Narmada, resulting in large scale deterioration of the water quality and affect the physico- chemical parameters of water. The status of the Narmada river water is very much useful as it determine the physiological life cycle of plants, animals and human kingdom. Recently biological waste treatment is emerging as a natural environment friendly, permanent and greater public acceptance as less expensive and minimal site distribution technique of waste elimination.

Water contamination by various routes and agents are liable to cause clinically signified outbreaks of intestinal infections in both animals and man. The demonstration of pathogenic bacteria, would obviously constitute the most direct proof of a hazardous impurity; but these pathogens, if present are so scanty that the technical difficulty of their isolation makes the test impractical for ordinary purposes and they are very sensitive even to a slight change of environmental factors and difficult to isolate. Hence, it is impractical to attempt directly to detect the presence of all the different kinds of water borne pathogens, any of which may be present only intermittently. Thus, we rely on tests that reflect the presence of commensal bacteria of intestinal origin such as those of the coliform group, which are more numerous, more easily tested and are the most reliable indicators of fecal pollution (Senior, 1989). Each person discharges 100 to 400 billion coliform organisms/day in addition to other kinds of bacteria. These coliforms do not themselves constitute a hazard since they are harmless to

man and are in fact useful in destroying organic matter in biological waste treatment processes. But they indicate that faecal matter has entered and that the water is therefore, liable to contamination with more dangerous organisms (Senior, 1989). Presence of coliform organisms is thus taken to indicate possible presence of pathogenic organisms. Coliform monitoring being rapid, inexpensive easy to perform, proved effective (Leclerc *et al.*, 2000). Coliform was the term first used in 1880s to describe rod-shaped bacteria. Coliform group of bacteria is functionally-related groups belong to a single taxonomic family Enterobacteriaceae and comprises many genera and species. The term coliform organisms refers to gram-negative, rodshaped bacteria capable of grow in presence of bile salts or other surface-active agents with similar growth-inhibiting properties and able to ferment lactose at 35°C-37°C with the production of acid, gas and aldehyde within 24-48 hours (Clesceri *et al.*, 1998). They are also oxidase-negative and non-spore-forming and display beta galactosidase activity (Arora, 2003).

Traditionally coliform bacteria were regarded as belonging to the genera *Escherichia, Citrobacter*, *Enterobacter* and *Klebsiella.* MacConkey (1909) defined coliform types and this number was increased to 256 by a system developed by Bergey and Deehan (1908). However, as defined by modern taxonomic methods, the group is heterogenous consisting of as many as 32 genera (Leclerc *et al.*, 2001). Some of these can be found in both faeces and the environment (nutrient-rich waters, soil, decaying plant material) as well as in drinking water with relatively high concentration of nutrients and may multiply. Eg. *Serratia fonticola, Rahnella aquatilis, Buttiauxella agrestis.* Coliform bacteria can be indicators for potential pathogens responsible for various waterborne diseases (Hunter *et al.*, 2004) or be pathogens themselves, such as certain strains of *E. coli.* In the present

experiment we tested water samples of Narmada River for abundance and species richness of coliform and other environmental bacteria. We hypothesized that river with more human or animal anthropogenic activities or watershed with agricultural or sewage runoff would have higher bacterial abundance and species richness.

High coliform incidence is influenced by the entry of surface runoff water from nearby areas that carried higher levels of suspended matter and nutrients on their surface. Similar observations were made by Venkateswarlu (1986) in the rivers of Andhra Pradesh. According to Keller (1960) access of soil and organic matter and increase in temperature is responsible for the increase in bacterial numbers in river water after rain and during summer. This is supported by Singh *et al.* (2001) who carried investigations in Narmada River at Hoshangabad. In Lake Windermere, Taylor (1940) has observed that there is a close relationship between the bacterial content of the water and the rainfall in the drainage area during the preceding week. Subramanyan and Bhaskaran (1948), Voelkar *et al.* (1960) noted a considerable decrease in the number of coliforms in dug wells during cold months.

The Council for Scientific and Industrial Research (CSIR) reported that almost 2.11 million people in South Africa lack access to any safe water infrastructure (CSIR, 2015). Population growth coupled with increased industrialization, livestock farming and urbanization have led to frequent contamination of river systems. This is further exacerbated by the lack of adequate sanitation facilities in rural areas resulting in faecal contamination of surface water with its attendant negative effects on human health and the environment (Gemmell & Schmidt, 2012). Contamination of river systems by point and non-point sources of pollution degrades water quality and

affects its use for domestic, agricultural, recreational and aesthetic purposes (Ebdon *et al.,* 2007). Microbial contamination of water is a major threat to public health as water associated diseases comprise about 9.1% of global disease burden (Pruss-Ustun *et al.,* 2015). Contaminated water endangers both the physical and social wellbeing of all people and it is an offense to human dignity (WHO, 2003). Drinking and use of faecally contaminated water has far reaching negative health effects such as cholera, diarrhoea, ring worm infestation and shistosomiasis, among others (WHO, 2015 and Kabanda, 2015).

Above mentioned literature indicates that today in India most of the rivers are facing pollution problems mainly due to anthropogenic activities. In order to minimize the pollution and increases disease problems of such rivers, one of the key steps is to properly study and assess the existing water quality status. Generally, the downstream of the river was more contaminated than the upstream. It is recommended that the water should be properly disinfected before any use. Measures should be put in place to discourage abstraction of water from this river in order to protect the health of the communities that rely on it for domestic, agricultural and recreational purposes.

Very little work is done on the physicochemical and bacteriological of Narmada River of the Nimar region in M.P. This was the first attempted to carry out the Physicochemical and Bacteriological Studies of Omkareshwar dam reservoir at river Narmada with special emphasis on Human Health.

Since Looking these importance the aim of present study was "Physico-chemical & Bacteriological studies of Omkareshwar dam reservoir at River Narmada with special emphasis on Human health"