1 INTRODUCTION

Water, merely having two atoms of Hydrogen and one atom of Oxygen, appears to be a simple and primitive compound unlike some of the polymers that are artificially synthesized. In spite of such simple chemical structure, there are enormous important properties possessed by water. High specific heat of water and high heat of evaporation are two of the properties with which water tends to moderate the temperature very effectively. Ice, the solid form of water is having less density than liquid form and as a result it floats on liquid water. This is a unique property due to which life exists in water bodies of sub-zero temperature even when the surface has turned to ice. Due to its high polarity, water is an excellent solvent and is responsible as a carrier of various nutrients to plants as well as animals. Nonetheless, the same property also enables water to carry contaminants to the living systems. There are many miraculous properties of water due to which it is often referred to as “Elixir” to life.

Considering its global spread, the water covers nearly 70% of the Earth’s surface in the form of oceans and seas which approximately contains 97% of the total water available on the earth. The higher salinity limits its use for human consumption but harbour very high biodiversity; much of which is still unexplored. They are important to humans as pathways of transportation, aquaculture and fisheries, recreation etc. On the global scale, they are also responsible for heat transfer from the equatorial region to distant parts through thermo-haline circulation which acts as an oceanic conveyor belt. This is the reason why the temperatures near the European coasts are moderate. Further, they are a promising source of renewable energy that can be harvested from the tidal action where suitable topography is available. Though, these huge reservoirs of water have great importance largely influencing human life as well biotic and abiotic constituents; the high salt concentration limits their utility to a larger extent. The remaining approximately 3% consists of freshwater (with low salinity and low dissolved solids); out of which only 0.013% is present in lakes, reservoirs and rivers and directly accessible to humans. Major portion of this freshwater is exist in lentic water bodies such as lakes, reservoirs, ponds, impoundments etc. This, along with the existing groundwater reserves fulfils the freshwater need of more than 7.5 billion human individuals besides acting as a resource

and a habitat for the global diversity of flora and fauna. Utility of groundwater at many places are limited due to the depth of water tables, high salt concentration or inaccessibility due to the sub surface geological conditions. This further elevates the pressure on surface freshwater resources. In addition to this, surface water resources are readily available to be put to various uses compared to other water resources.

1.1 Freshwater Resources: Importance & Utilization

Freshwater resources provide ecological as well as economic benefits to human beings. They act as sources of freshwater for urban and rural population, agricultural uses, habitat for aquatic animals and bird species, places of recreation etc. (Sharma, 2012). Riverine systems are of prime importance for humans which is indicated by some of the greatest civilizations developed on the banks of major rivers. These systems are open to utilization of freshwater and thus, many human activities have direct impact on the health of such systems. Some of the major rivers supply water throughout the year whereas small rivers and tributaries supply water for limited period of time during the year. Dumping of solid and liquid waste into rivers further limits their optimal value as fresh water source (Nathanson, 2011). This holds true even for the lake systems; when it comes to human interactions. Unlike rivers draining the freshwater into seas and oceans, the lakes and reservoirs hold water for considerably extended period of time. This also means that contaminants once added to lentic water bodies such as lakes and reservoirs, take longer to disintegrate or neutralize. In many of the cases, where the input of such element is in surplus to the output, their concentration continuously built up in the system.

Any natural water body modified or managed by embankment or dam to provide water for fulfilment of human demands or developing new activities are generally referred to as reservoirs. These reservoirs are generally fed by precipitation, rainwater run-off or diversion from nearby flowing river. Smaller lakes and ponds, either naturally formed or constructed by mankind, have a key role in supplying local water needs especially for irrigation and aquaculture. Considering their small sizes, they are often neglected but they are crucial in determining the local habitat and climatic conditions. They also attract some of the avifauna which are highly acclimatized to such habitats. In addition to this,

such systems are often characterized by high density and diversity of fauna and flora which make them quite important from ecological point of view.

1.2 Nutrient Input and Cycling

Geomorphology of a lake plays a major role in the lake's metabolism as it controls the nature of its drainage, the input of nutrients to the lake and the volume of influx from the surrounding drainage basin. Any changes to the physical structure and the geomorphic processes of the catchment area, directly affects the hydrology of the reservoir. Water quality of these bodies largely depend upon the amount of rainfall and water coming from other sources viz., channels, canals, surface runoff, etc. Rainwater tends to dilute the concentration of elements and compounds in existing water quality whereas channels and canals bring the properties of the source region to such smaller lakes. Surface runoff from the surrounding region on the other hand adds a vast variety of compounds and elements depending upon the land use activities, application of chemicals and fertilizers, type of surface; to name a few. Apart from these sources, some of the contaminants are added directly by human activities such as bathing and cleaning, washing, oil from motor boats (often present where aquaculture is being performed), etc. Land use changes in the catchment area of the reservoir such as, modification in the shoreline structures, armouring of the banks, high-density livestock operations and removal of riparian vegetation for agricultural practices, contribute the most to soil erosion and runoff of silt, nutrients and addition of pollutants to freshwaters (Carpenter *et al.,* 1998; Quinton *et al.,* 2010). Conversion of natural reservoir to alternate utility such as an agricultural land results in decreased evapo-transpiration and increased run-off resulting in mobilization of salts and nutrients from surface sediments. These inputs to the reservoirs depend on the time, frequency and magnitude of the run-off events; which gets amplified when the catchment area have disturbed soil and vegetation which is often attributed to anthropogenic activities. The capacity of the reservoir to either transform or retain the added solutes depends on the inputs, hydrology and biogeochemical processing which may vary with temperature, chemical composition and biota of the reservoir (De, 2010). The compounds and elements added to the water do not remain suspended in the water column, besides they gradually settle down at the bottom in the form of sediments. Such nutrient rich sediments in the shallow lakes and ponds do generally harbour good biological diversity.

Nutrient cycling from the sediments to the water and from water to the sediment is a complex yet important process where the living biota, water currents and productivity of the system play a major role. Small and shallow lakes and ponds resemble the wetland habitat and they support notable biodiversity. Higher ecological productivity is attributed to higher nutrients availability and other favourable conditions. Increased nutrient inputs promote the primary production and ecosystem respiration which accelerates the growth of the hydrophytes as well as phytoplankton. It is due to denser mass of phytoplankton that the water in such bodies appears to be greener. Abundance of primary producers in turn attract the herbivores living in the system and ample food availability results into increased density and number of zooplankton as well as herbivore fishes (Sharma, 2012). Moving further above the trophic structure; it results into increased density of carnivore fishes and other fauna diversity in the system. In totality, such bodies are enriched with food and nutrition at each of the trophic level and thus many of the wetland birds are also attracted to such water bodies. Such status of the system can be considered to be ideal but the issue arises when the nutrient loading is in excess to nutrient removal from the system and the plant nutrients are in very high concentration; referred to as Eutrophication (Santra, 2005). Excessive plant productivity in such conditions leads to algal blooming which ultimately covers the whole surface of the water body. This inhibits the gaseous exchange from the water to atmosphere and vice versa leading to gradual depletion of Dissolved Oxygen (DO) level in the water. This in turn leads to gradual death of aerobic fauna; especially the fishes, present within the system which further decay within the system itself further reducing the DO levels. If such conditions prevail for longer period of time, it leads to the collapse of the ecosystem and the integrity of the system is lost. Thus, for a healthy aquatic system, the water quality and the sediment quality both are of higher significance and understanding their seasonal variability may help in better understanding for management and conservation.

1.3 Purpose of the Study

Freshwater reservoirs provide numerous ecosystem services of great importance. Hence, the water quality of the reservoir is very significant for recreation, aquaculture, irrigation etc. as well as for ecosystem management. Water fluctuation in the reservoirs during rainy and non-rainy season, aquaculture practices, use of fertilizers and chemical nutrients in the catchment area are some of the factors which deteriorate the quality of

the water. Thus, carrying out studies on smaller lakes and water bodies give a clearer picture about many of the complex interrelations among various biotic and abiotic components. Understanding the behaviour and trends in such components will enable sustainable use of such systems as freshwater reserves without compromising the requirements of existing biodiversity in the system. Such studies are equally helpful in identifying the health parameters of the system and based on the results; recommendations for the remedial measures can be made when needed.

Vadodara district in Central Gujarat has many natural and man-made surface reservoirs. The scope of the present work was to study the temporal variation in water quality and sediment quality of three small reservoirs, which are primarily used for irrigation and aquaculture. These reservoirs are man-made and have earthen embankments to maintain the water level. Since the study specifically emphasizes on nutrient dynamics, the parameters for examination were chosen accordingly. The study was conducted considering the interdependence of various water quality parameters and their similarities or differences in the resultant properties of the reservoirs. The research work also encompasses the investigation of avifauna and phytoplankton, where checklists were prepared during the study period in order to throw some light on dependence of biodiversity on these reservoirs.