CHAPTER 2

REVIEW OF LITERATURE

2.1 Status and Trends of Wetland Monitoring

Global inland and coastal wetlands cover over 12.1 million km^2, with 54% permanently inundated and 46% seasonally inundated. Natural wetlands are in long-term decline around the world; between 1970 and 2015, by approximately 35%. In contrast, human-made wetlands, largely rice paddy and reservoirs, almost doubled over this period, now forming 12% of wetlands. However, these increases have not compensated for natural wetland loss. Overall Biodiversity suggest that wetland dependent species such as fish, water birds and turtles are in serious decline, particularly in the tropics. Global threat levels are high (over 10% of species globally threatened) for almost all inland and coastal wetland-dependent taxa assessed. Although water bird species have a relatively low global threat level, most populations are in long-term decline (Global Wetland Outlook: State of the World's Wetlands and their Services to People, 2018). As wetland ecosystem provides a wide range of ecosystem services, they lie at the centre stage of sustainable development. Healthy, functioning natural wetlands are crucial to human livelihoods and sustainable development. In general, policy makers often underrate the value of their benefits to nature and mankind. However, during past several decades efforts has been expanded on conservation of nature and natural resources, including wetlands and on educating people about the need for conservation. These efforts have been spearheaded by the IUCN and the WWF.

Conservation does not necessarily imply complete protection against all kinds of human interference but allows for sustainable utilization or 'wise use' of natural resources. The Ramsar Convention promotes wetland conservation and wise use and strives to arrest and reverse wetland loss. Whereas many sites have been protected variously by legislative measure, there is increased global emphasis on sustainable use of wetland resources.

In India, several wetlands have been declared protected areas as sanctuaries, national parks or nature reserves. In case of wetland, conserved outside the purview of the National Wetland Programme, the emphasis remains on one or more particular species and the ecological features of wetlands together with other characteristics species continue to be ignored.

As per the State Action Plan on Climate Change (SAPCC, 2014) of Climate Change Department, Government of Gujarat; Gujarat state broadly falls within the ecological term of semi arid zone and is a naturally water scarcity prone area. To achieve good economic return and provide potable water, regular quality assessment has become the requirement. Here in this research work an effort is made to document the necessity of ecological assessment of wetland with special reference to aquatic pollution using benthic macro-invertebrates as indicators.

The Directory of Indian wetland prepared first by the IUCN as a part of the Asian Wetland directory and revised by WWF-India (WWF and AWB, 1993; Nitin Bassi et al., 2014), forms the basic source of useful information on wetlands in the country. However, the first scientific mapping of wetlands of the country was

carried out using satellite data of 1992–1993 by Space Applications Centre, Ahmedabad (SAC 2011). The exercise classified wetlands based on the Ramsar Convention definition. Information on the ecological functions and values such as ground water recharge, control of floods and erosion or regulation of water quality and their value as habits for waterfowl and other wildlife has been described in some detail. This inventory estimated the areal extent of wetlands to be about 7.6 m ha. National Wetland Atlas 2011, prepared by SAC, is the latest inventory on Indian wetlands. A total of 201,503 wetlands were identified and mapped on 1:50,000 scale. A part from this, 555,557 wetlands (area <2.25 ha) were identified as point features. As per the estimates, India has about 757.06 thousand wetlands with a total wetland area of 15.3 m ha, accounting for nearly 4.7% of the total geographical area of the country. Out of this, inland wetlands area accounts for 69%, coastal wetlands 27%, and other wetlands (<2.25 ha) 4%. In terms of average area under each type of wetland, natural coastal wetlands have the largest area. The water spread area of wetlands varies greatly. Overall, inland wetlands have a water spread area of 7.4 m ha in post monsoon and 4.8 m ha in pre monsoon; and coastal wetlands have 1.2 m ha and 1 m ha in post monsoon and pre monsoon, respectively. Across all categories of wetlands, the water spread area from post monsoon to the peak of summer reduces significantly indicating the uses and losses the wetlands go through. This has major implications for the total water availability of these wetlands and the various functions that they can perform in different seasons. Overall, reduction in water spread area of inland wetlands is highest (35%) followed by that of coastal wetlands (16%). Within inland wetlands,

reduction is significantly higher in man-made types (49.5%), such as surface reservoirs and tanks, in comparison to natural types (24%), such as lakes and ponds, as they are under pressure to meet various irrigational and non-irrigational needs and are also subjected to higher evaporation losses. For the state of Gujarat, the reduction in water spread area of wetlands from post monsoon to pre monsoon was found to be 36%. In terms of contribution of the total water spread area in the country, highest during post monsoon was observed in the State of Gujarat (13.5%) and during pre-monsoon, highest (12.6%) was again in Gujarat (Nitin Bassi et al., 2014).

Water quality trends are mostly negative. Major threats include untreated wastewater, industrial waste, agricultural runoff, erosion and changes in sediment. By 2050, one third of the global population will likely be exposed to water with excessive nitrogen and phosphorous, leading to rapid algal growth and decay that can kill fish and other species. Salinity has built up in many wetlands, including in groundwater, damaging agriculture. Nitrogen oxides from fossil fuels and ammonia from agriculture cause acid deposition. Acid mine drainage is a major pollutant. Thermal pollution from power plants and industry decreases oxygen alters food chains and reduces biodiversity. Wetlands regulate nutrient and trace metal cycles and can filter these and other pollutants. They store the majority of global soil carbon. (Global Wetland Outlook: State of the World's Wetlands and their Services to People, 2018). Thus, it is evident that wetland waters get deteriorated both in terms of quantity and quality.

The quality of water is reflected by the values of physico-chemical parameters of a water body and these parameters change widely due to factors like sources of water, type of pollution, seasonal fluctuations etc. (Parikh, A. N. and Mankodi, P. C., 2011, Vankar J., Tatu K. and Kamboj R., 2018). Researchers have also made attempts to establish correlation among various physicochemical parameters (Goswami, A. P. and Mankodi, P. C., 2012). Understanding water quality requires quantitative knowledge of Physical, Chemical and Biological characteristics and comparing their levels with standards to support for different uses. In continuation with this, attempts are also made to transform the physico-chemical water quality data into understandable and usable information in terms of WQI based on the relative critically of water quality parameters in context with the intended use(s) of the water body (Abdul Hameed et.al., 2010, Anant J. Dhembare, 2012, Gor Ami and Shah Arvind, 2014, Goutam Bala and Ambarish Mukherjee, 2010, Siddhartha Sharma and Akepati S. Reddy, 2013, Stoner J. D., 1978, Yogendra K. and Puttaiah E. T., 2007). Further, the rational planning of any water quality management requires knowing the nature and extent of water quality degradation. It strives to maintain and restore the 'wholesomeness' in terms of 'designated best use concept' (CPCB, 2007 and Chapter 1, Section 1.2). The status of water quality for wetlands of TBS covering a single season with 19 parameters was studied by the Researchers and the water quality was found to be slightly polluted to polluted condition and overall nutritional status to be oligotrophic in nature. It was also concluded in this study to carry out phsysico-chemical analysis of Thol Wetlands water on regular basis taking into consideration the seasonal aspect and the

findings as the basis for further monitoring (Jessica P. Karia, Kauresh D. Vachhrajani, et. al., 2011). GEER Foundation has also carried out a study entitled Ecological Study of Thol Lake Wild life (Bird) Sanctuary and published a report on it in June 2002. The focus was on waterfowl of Thol wetland with emphasis on their species richness and abundance. As far as abiotic component like water quality is concerned only few primary parameters were included for a period of seven months and 8 Physico-chemical parameters were monitored for a single season (GEER Foundation, 2002). Similarly, 'A Study of Ecology of the Piscivorous Birds at Thol Bird Sanctuary has also been carried out (Pathak Chetna P., 2011).

Another serious concern for wetlands is the Heavy metal contamination attributed to waste dumping from industry and settlements in and around the wetlands, mining activities etc. Because of the their toxicity and ability to be incorporated into food chain due to their Bioaccumulation and Biomagnification potentials, these metals poses ecological risk as well as health risk on people growing and consuming food crops and vegetables grown with wetland waters and in the wetland. Wetlands are therefore recognized to be important sinks as filters, retaining heavy metals. (Honggang Zhang, Baoshan CUI, et. al., 2010). Their concentrations are influenced by environmental factors such as surface runoff, groundwater, dissolution from sediment, deposition from the atmosphere and anthropogenic pollutants. Hence, many researchers has considered trace metals as indicators for monitoring changes in the water environment and studied on temporal (seasonal) changes in various components and matrices of wetland

ecosystem. (Harikumar P.S. et. al., 2010, Honggang Zhang, Baoshan CUI, et. al., 2010, Nirmal Kumar J. I., Rana Mukherji, et. al., 2012, Onkar Singh Brraich and Sulochana Jangu, 2015)

Wetland soils and sediments are generally monitored to know the nutrient or contaminant status and especially the surface sediment contain the most recent information about the status of pollution (Zwart and Trivedi, 1994). There is increasing evidence that the condition of the bottom and the exchange of substances between sediment soil and water strongly influence water quality. Sediments are indicators of quality of water column over it. The nature of bottom and peripheral soil plays important function in the nutritional and ecological state of the pond (Parikh and Mankodi, 2014). Erosion of the watershed results in suspended particles of mineral soil and organic matter entering in a wetland through run off, forming a major matrix of sediment in a wetland and it is the chemical nature of sediment that plays important role in betterment of productivity, plankton density and floral components.

2.2 Legal and Institutional frame work for wetland management in India

Though there is no separate legal provision for wetland conservation in India, it is indirectly supported by following legal frame work:

- Indian Fisheries Act 1857,
- Indian Forest Act 1927,
- Wildlife (Protection) Act 1972,
- Water (Prevention and Control of Pollution) Act 1974,

- Forest (Conservation) Act 1980,
- Environmental (Protection) Act 1986,
- Biodiversity Act 2002.

Provisions under these acts range from protection of water quality and notification of ecologically sensitive areas to contributing towards conserving, maintaining, and augmenting the floral, faunal and avifaunal biodiversity of the country's aquatic bodies. However, the term wetland was not used specifically in any of these legal tools. The main institutional attempts leading towards the wetland conservation in India are:

- In 1982, as a signatory to Ramsar Convention on Wetlands, the Government of India identified two sites, i.e. Chilika Lake (Orissa) and Keoladeo National Park (Rajasthan), as Ramsar Wetlands of International Importance.
- In 1985, National Wetland Conservation Programme (NWCP) was launched. Initially, only designated Ramsar Sites were identified for conservation and management. Several measures were taken to arrest further degradation and shrinkage of the identified water bodies due to encroachment, siltation, weed infestation, catchment erosion, agricultural run-off carrying pesticides and fertilizers and wastewater discharge. NWCP guidelines envisaged constituting of 'State Wetland Conservation Authority'.

- In 1993, National Lake Conservation Plan (NLCP), equipped with Guidelines for conservation, was carved out of NWCP. It has focus on urban lakes which are subjected to anthropogenic pressures;
- In 1995, National River Conservation Plan (NRCP), with an objective to improve the water quality of the major Indian rivers in light of 'designated best use' concept.
- In 2006, National Environment Policy, recognises the ecosystem services provided by wetlands and emphasizes the need to set up a regulatory mechanism for all wetlands so as to maintain their ecological character, and ultimately support their integrated management
- In 2012, The National Water Policy by the National Water Resources Council also recognizes the need for conservation of river corridors and water bodies (including wetlands) with an emphasis on the environmental needs of aquatic ecosystem and wetlands.
- In 2017, The Wetlands (Conservation and Management) Rules, for conservation and management of wetlands in accordance with the principle of 'wise use'. It also has made provision for constituting the State Wetlands Authority in each State and also for National Wetlands Committee.

Over the years, number of designated Ramsar Sites has increased to 26, number of rivers under NRCP has increased to 39 and number of wetlands covered by the NWCP and NLCP has increased to 115 and 61 respectively. India is signatory to Ramsar Convention on Wetlands and has recently come out with Wetland

(Conversation and Management) Rules, in 2017, but still no significant progress has been made on the conservation and wise use of wetlands. The main reason is that very less number of wetlands has received considerable attention for conservation and management purpose while the very large number of other wetlands continues to be ignored when compared to the actual extent of wetland ecosystems in the country.