Chapter 03: Review of Literature

3. REVIEW OF LITERATURE

3.1 Water body

The inland water bodies are directly or indirectly fed by the major rivers and its branches. While India accounts about 4% of world's total water resources. Freshwater resources of India consist of 1,95,210 kilometres stretches of rivers and canals, 2.9 mha of reservoirs, 2.4 mha of ponds and lakes, and 0.8 mha of flood plain wetlands and associated water bodies (FAO 2016) .

West Bengal state covers 7.5% of the India's total water resources which is becoming scarce and insufficient to meet the need of huge population load. This shortage of water is also due to irrigation and other developmental works. The river basin wise water availability in West Bengal consist 27446.99 mcm ground water and 51010 mcm surface water.

Annual ground water availability is 1.76 m.ham and 2.38 m.ham (million hectare meter). as per estimation record of the Central Ground Water Board and Irrigation Commission of India respectively (Mogalekar, Canciyal et al. 2017).

The usable surface water is less than 40% of the existing plane water in West Bengal. One major challenge of water management is to reduce this crucial gap. The irrigation sector consumes large quantity of water and then by inland navigation sector. There is a report on need of freshwater for agriculture in year 2025 would be 10.98 m.ham which is very high than the available water resources. Therefore, a proper management of water conservation is very much essential which can be achieved creating additional storage and scientific exploitation (FAO 2016).

Water logged districts of West Bengal state are North 24-Pargana (area 140,000 ha), West & East Midnapur (area 96,000 ha), Murshidabad (area 62,000 ha) followed by Hoogly, Nadia, Burdwan, South 24-Pargana, Howrah, Malda, Uttar Dinajpur, Bankura, Purulia. So, there are vast waterlogged zones in West Bengal and provides the fine opportunity for fisheries and pisciculture (Goswami 1995).

Freshwater map of West Bengal revealed that the districts within it contain freshwater areas as rivers, ponds, bheels, channels, dams etc. which supports the fishery industry. Among the all districts, Murshidabad contain more than 20,000 ha as river network. North 24-Pargana, South 24-Pargana having more than 5,000 ha as bheels followed by Malda, Nadia and Hooghly containing less than 5,000 ha water areas. Only three districts South 24-Pargana, North 24-Pargana and Midnapur (West & East) contain brackish water areas in West Bengal (Rudra 2013).

3.2 Fin fish fauna

As noted the most diverse ecosystems in the planet are the freshwater ecosystems (Ramachandran, Sundaramoorthy et al. 1998). Where the freshwater fish shares a major part in this varied biodiversity (Saunders, Meeuwig et al. 2002). Freshwater wetland support 20% of total biodiversity in India (Prasad, Ramachandra et al. 2002). The freshwater ecosystems conversely receive various anthropogenic impacts like urbanization, industrialization and other developmental works and destroying the freshwater ecology and diversity (Malmqvist and Rundle 2002).

Presently, worldwide 34000 fish species has been reported by FishBase, 2018; whereas in India there are 2529 species reported. Among them 963 numbers from freshwater and 1644 from saltwater (Prasad, Ramachandra et al. 2002) of which 197 endemic species, 212 threatened species and 257 are commercially important species. CAMP (1998) recognised 227 freshwater fishes which are declared under threatened category by IUCN in the year 1994 (Malmqvist and Rundle 2002). In West Bengal 171 freshwater fish species (Froese and Pauly 2018) has been identified of which 39 species likely to become locally threatened (Molur and Walker 1998).

In Asia total 121 inland families of fish have been found and characterised (Barman 2007). Loss of fish biodiversity in reservoirs after construction of dam on water ways has been reported in a few instances from Asia (Mijkherjee, Praharaj et al. 2002). The established similarity observed in different genera of fish fauna between Southeast Asia and India proved that most of the fish species migrated from the South-east part of Asia (Yan, Zhenyu et al. 2001; De Silva, Nguyen et al. 2006). Survey on fish fauna in Tropical Asia like China and India is incomplete and is present in exploratory phase (Menon 1992). Many species have still to be described or to be discovered and rates of species loss may be higher than currently estimated (Hora 1937). Relevant fish data are very scanty due to not having proper survey work and documentations.

Today, hundreds of freshwater finfish have been extinct from the natural aquatic environment. Maintenance of such fish biodiversity is a critical test whether water use and ecosystem modifications are sustainable and effective. However, to be fully competent protection of freshwater bodies requires prime control over upstream drainage system; surrounding land mass and downstream reaches for migrating aquatic fauna. But these requisites are very difficult to control and manage.

Freshwater ecosystems are being considered most endangered among the ecosystems in present world (Dudgeon, Arthington et al. 2006). The freshwater fish vulnerability resulted due to heavy load on fish and freshwater bodies to meet the rising demand of gradually increasing population in global scale. Various pressures or undesired stress have been increased on the existing inland waters and degrading the freshwater fish diversity status (Nelson 2006).

3.3 Remote sensing and GIS in fishery

There are two approaches for applying remote sensing lead to biodiversity assessments: (i) direct observations of organisms and communities, and (ii) indirect observations of environmental proxies of concerned biodiversity (Sala, Chapin et al. 2000). Airborne observations have been used for census of large mammal abundances, for example in Kenya (Dudgeon, Arthington et al. 2006). Indirect remote sensing depends on environmental parameters like discrete habitats (for e.g, woodland, wetland, etc.) or primary productivity. This has been applied in GAP analysis program of US (Turner, Spector et al. 2003). Remote sensing is increasingly used to map habitats (Broten and Said 1995). Another important indirect use is the detection of habitat loss as well as fragmentation to estimate the implications of biodiversity, based on species-area relationships or other model approaches.

Satellite remote sensing has contributed to water resources applications and research for many decades. Remote sensing data are especially useful in watershed hydrologic modeling. They are normally used for the base-map preparation, infrastructure mapping, management, natural resource exploration, transportation mapping, and planning the construction of new highways, bridges, and buildings (Scott, Davis et al. 1993). Geographic Information System with remote sensing are very effective tools for conservation and management practices of freshwater areas (Alaric 1994).

It is used for assessing structural as well as geomorphological conditions with conventional survey techniques. Remote sensing with the GIS is an effective tool in case of groundwater studies (Prasad, Ramachandra et al. 2002; Shamsi 2005).

RS-GIS can identify the favorable hydrogeomorphological areas for studying various kind of water resources (Saraf and Choudhury 1998). It gives multi-spectral, temporal and sensor data of earth's surface (Krishnamurthy, Venkatesa Kumar et al. 1996). Spatial and temporal data are very much crucial for the analysis and validation of objects (Rais and Javed 2014).

Remote sensing covers large areas by direct observations allow interpretation of landforms and other structures and there by minimize need of interpolation from point observations of these significant features.

Research on remote sensing of river landscapes has flourished since 1972 launch of Landsat program satellite (Choudhury 1999). Remote sensing analysis data on rivers are temporal variation so far the types of water and its properties are concerned among earliest report (Saraf 1999).

Most revolutionary advance to monitor planet using remote sensing satellites has been made possible by use of Google Earth® making virtual discovery. The Google Earth has proven to be a practical model of real earth. Many scientists have started adapting Google Earth technology to their research work and development (Mertes 2002).

GIS is a system based on computer that allows for the input, storage, management, analysis, and generates spatial data (McCauley and Yarger 1975; Aronoff 1989; Butler 2006). Aerial photographs offer long-term coverage with high spatial resolution, large spatial extent compared to other crucial data sources (Aronoff 1989).

GIS has developed rapidly in past decade and been used in aquaculture and fisheries sectors. Various sector studies have been undergone viz, in African continent (Aronoff 1989), at Costa Rica (Kadmon and Harari-Kremer 1999), at Johor, Malaysia (Kapetsky 1994), in USA (Kapetsky, McGregor et al. 1987) and at Ghana (Kapetsky 1989).GIS had been used for catfish culture technology (Kapetsky, Hill et al. 1990), salmonid culture (Kapetsky, Wijkstrom et al. 1991). GIS has been executed for aquaculture in regional, country or sector studies using human resources and other important socio-cultural resources (Kapetsky, Hill et al. 1988).

In India RS-GIS technique was used for water resource development in Sai-Gad watershed in the district Almora of Uttar Pradesh state (Ross, QM et al. 1993) .

Another significant work was reported based on Tamil Nadu, Nicobar Islands in India from 1989 -1996 by earlier worker (Meaden and Aguilar-Manjarrez 2013). GIS study was made on

Hooghly estuarine water of West Bengal with the help of IRS LISS II imaginary (Mohan and Shrestha 2000).

Ground water resources mapping was done at Keonjhar district, Odisha (Ramachandran, Sundaramoorthy et al. 1998).Work on drainage system of Jharia, Bihar reported by other researcher (Sasmal and Raju 1996). Sustainable utilization of freshwater resources using RS-GIS technique was done in 'Chotanagpur' plateau of Bihar (Das, Behera et al. 1997).

GIS helps human societies in the development of water distribution system very effortlessly and also it is time saving and cost effective. It presents model oriented results for non-technical audiences.

GIS is useful in the development of wetland inventories for effective natural resource management practices and other analytical capabilities (Srivastava 1997). It analyzes temporal change, determines spatial relationships between physical and biological features, find out spatial characteristics, and analyzes the direction and magnitude of changes (Johnson, 1975). Satellite imagery was overlaid in a GIS to quantify changes within wetland systems in Zambia from 1984 to 1994 (Munyati, 2000).

Spatial mapping of distributed water bodies

Recently number of organisations have initiated various levels of mapping of wetland, forest, watershed, irrigation system etc. Government of India also initiated multiple projects through Central Inland Fisheries Research Institute (ICAR) to delineate all water bodies from Indian Remote Sensing data (IRS-P6, PAN). National Natural Resources Management System (NNRMS) and *Ministry of Environment and Forests* (MoEF) in India along with various state remote sensing application centers developed nation-wide inventory on freshwaters and completed in 1997. The Space Application Center (SAC) has mapped out the wetlands at 1:250000 scale on the mainland as well the islands part. Coarse resolution satellite gathered data by visual interpretation were mapped at scale 1:50000 of West Bengal, Sikkim, Punjab, Goa, Himachal Pradesh, Haryana, Delhi, Chandigarh, Lakshwadeep, Dadra.

The changes in Ganga-Padma river course was studied and recognized the vulnerable zones using visual interpretation in identifying and delineating various geomorphological and geological features (Kumar 1999).

3.4 Conservation of water area

In the global field it is seen that Freshwater ecosystems are poorly protected, and there is a degradation in their wild condition (Woodcock, Sham et al. 1990). It also requires conservation measures in an urgent mode (Hazra and Bhattacharya 1999).

Freshwater areas are impacted by several distinct processes like water pollution, over exploitation, flow alteration, invasive species, climate change and human-mediated habitat loss including eutrophication (Paria and Konar 2003).

Freshwater ecosystems offer biodiversity and ecosystem services which are essential for protection and restoration of ecosystems (Dudgeon, Arthington et al. 2006). The scientific literature about freshwater protected areas is very less (Abell, Allan et al. 2007). Conservation of few rare fish species done by conserving the freshwater in Western United States (Schröter, Cramer et al. 2005).

In India, conservation of inland fisheries resources are not properly considered during planning for any development of the freshwater resources (Abell, Allan et al. 2007), but in the year of 2002 the Biological Diversity Act is one of important laws constituted by Parliament of India. There are about 1550 numbers of large reservoirs encompassing about 1.45 mha and approximately 100000 small and medium reservoirs covering 1.1 mha of water area in India (Means and Johnson 1995).

Aquatic biodiversity depends largely on hydrological conditions and necessary steps are being taken to conserve freshwater reservoirs biodiversity. The first and foremost task in order to achieve conservation is to assess the existing diversity resources by identifying those and marked the vulnerable resources which are irreplaceable (Sarkar, Deepak et al. 2005).

Conservation efforts must incorporate research for accurate recognition of problems, promoting stability of the protected areas and considering the multiple-user framework with natural flow system and without introduced species. The conservation efforts must be focused on headwaters and riparian zones. Many of these closed water areas were not actually designed with the intention specifically to protect fish and fisheries (Gopal 1994).

Development of conservation methods for designing marine and terrestrial protected areas has already been made (Groombridge and Jenkins 1998; Crivelli 2002). Such methods would also be applicable to freshwater systems (Sarkar, Pressey et al. 2006). Partcular feature Conservation requires protection of river parts which are distant geographically from biological features

(Knight, Cowling et al. 2008). Freshwater conservation components include management of catchment-scale, continuation of natural flow regime and exclusion of invading species (Abell, Allan et al. 2007).

It exerts a quantitative method in priority conservation considering the observed species distributions (Lake, Bond et al. 2007). Such perpetual methods are also started applying in freshwater systems. Distributions of valuable habitat types, naturalness, productivity or other variables that would be indicative of high conservation value in river systems (Fitzsimons and Robertson 2005). RS-GIS technique has been used by some workers for conservation of biodiversity following the landscape ecology (Margules and Sarkar 2007). A researcher forecasted on applications related to biodiversity conservation is the area where remote sensing will be playing a key role in future studies (Abell, Allan et al. 2007).