01. INTRODUCTION:

Inland fisheries resources are based on rivers, canals, reservoirs and lakes, which are usually scattered around the national territory and are an intricate part of economic, social aspect and climatic landscapes. Hence, the inland fisheries sectors are diverse, and rarely large enough to be scientifically important to require exclusive attention at the national level. These areas can only be managed efficiently on an individual basis (Welcomme, 1998). In India, numerous numbers of artificially constructed fresh water impoundments are being built for last few numbers of years. Such freshwater impoundments are referred as reservoirs. In due course of time, the scope of dams has expanded and at present, these are constructed for multiple objectives viz. water storage for public supplies, for irrigation reserves, for hydroelectric power, navigation, recreation, development of fisheries and angling (Desai, 2006). Although these impounded water bodies hold tremendous fisheries development potential, still they are contributing very less to the total freshwater fish produced in the country as contrasted to their overall potential. Unlike rivers, which are under increasing threat of environmental ruin, reservoirs offer abundant scope for fish yield optimization through suitable management. The total magnitude of the resource helps to enable considerable increase in production even by a modest improvement in yield. Thus, further attempt to increase productivity in freshwater fisheries has to depend mostly on reservoirs.

Reservoir is considered as an elementary component of inland fishery resources of India with gargantuan potential not only to increase the freshwater fish production in the country but also to contribute nutritional support to natives, besides providing different prospects for employment generation and livelihood. Reservoirs are human-engineered habitats that occur in almost all main river basins. In India, total 19,370 numbers of reservoirs occupy around 3.15 million hectare surface area within 15 states (Desai, 2006). Although, production of fishes from diverse reservoirs remain considered as an extra product that have not produced any remarkable progression across the country (Vass and Sugunan, 2009), however, the majority of executives and administrators of many water and power projects within the country have now appreciated the significance of overall reservoir management for enhancing the fisheries resources.

According to UNESCO (1978), the surface water area of world's reservoirs is up to 6,00,000 km^2. In India, however, reservoirs cover an area of approximately 31,533 km^2 (Desai, 2006), spread over different types of soils and exposed to diverse agro-climatic conditions.

Reservoir fisheries act a central role in enhancement of India's economic and trending social progress for ages. From the socio-economic aspects, reservoir fisheries have become an imperative field that generates employment and caters to the demand of food for the millions of human inhabitants in India. As the area of reservoir increases yearly, with addition of more and more impoundments, there is vast scope for increasing fish production with the help of accurate scientific and technology based reservoir management practices and enhanced understanding of ecological principles underlying fish production. In spite of differences between reservoir and natural lakes, it is significant to preserve and develop the proper physicochemical, ecological and conservation status of the reservoir.

Though immense potential for fisheries has been point out in numerous reservoir ecosystems, the average production of fish in these reservoirs was noticed to be very low (20.13 kg/ha/yr) (Desai, 2006). The low fish yield from the reservoirs maybe largely due to require of understanding of physicochemical nature and biodiversity of the ecosystem, irregular efforts of management, inadequate knowledge of connection between food-chain organisms leading to a characteristic nature of energy flow through communities (Natarajan and Pathak, 1983 ; Schiemer and Duncan, 1987). According to Jhingran (1988), productivity of a water body can be generally put into three types viz. edaphic, morphometric and climatic. The factors like wise temperature, annual rainfall, wind speed etc. has great function on the reservoir productivity. The methodical management of fisheries in a water body requires an understanding of its trophic structure, their population parameters and the local environment cycling of nutrient component with a view to achieve optimum fish productivity (Deorari, 1993).

Reservoirs are located in different latitudes and longitudes differ in the quantity of incident light energy and rainfall. Wind is another important climatic factor which has great implication on the thermal features of the aquatic biotopes and helps in circulation of heat. The extent of drainage area, erosion and total runoff determine the nutrient load into the reservoir. Soil basin quality influences the reservoir productivity up to the pick. The fertility within reservoir depends mostly on the diverse physico-chemical nature of different catchment areas than the bottom soil (Natarajan, 1976). Areas, average depth of water and shore development index are other important morphometric factors determining the efficiency of large water bodies. Among the chemical parameters, water and air temperature, secchi depth, pH, carbon dioxide, conductivity, TDS, total alkalinity, DO (dissolved oxygen), total hardness, and chlorine are often used as indices of productivity (Welcomme, 1976;

Singh and Swarup, 1980; Jhingran, 1988; Cornett, 1989; Sommer, 1989; Tarapchak and Russel, 1990; Jhingran, 1991).

Water governance is important to grant an integral approach to the real water issues and has turn into a necessity due to the interrelated nature and complexity of issues like availability of water, its quality and flood problems. The need of the hour is to handle and coordinate the progression for sharing, identifying and solving these problems in a multi-disciplinary way and involve all the stakeholders concerned (Van Dijk, 2012).

Collaboration of efficient governmental and private segments would enable effective management and problems have to be dealt in further effective, efficient and unbiased manner (Watson, 2004). All the countries should move toward and participate positively in the administrative process and planning of freshwater resources involving public authorities and users (Salman and Bradlow, 2006).

Usually, water quality assessments entails analysis of some biological, microbiological and physico-chemical parameters and reflect the ecological system. Such view, in turn, helps in planning, utilization and formulating conservation strategies for their future sustainable use. Since twentieth century, the stress on freshwater resources has dramatically increased. In progressive countries, random population growth has lead to bigger stress on producing adequate food and this requires more water. Irrational irrigation practices multiply the dilemma of accessibility of freshwater in several countries. Persistent droughts and floods in several countries including India are causes of concern for the society. The available amount of water is being significantly abridged due to water contamination, which may be caused by the discharge of wastewater and run off from irrigated fields into natural water system. Until and unless water resource is wisely managed, hazards and shortages of water are obvious to become a serious impediment for social and economic progress. A pre-requisite planned water management is comprehensive, accurate and timely data availability on hydrology with facts about the social, economic and environmental dimensions. However, adequate information is not possessed by several countries about the system for managing and collecting information on water management.

Fish represent an excellent protein source and considered as staple food in the world. Consequently, maximum capitulate fish from usual waters and assurance of a recurring plentiful harvest of fish, without depleting the resources and wastage of fishing efforts are

required for the growth of economy in the nation (Das, 1988). The reservoirs would contribute considerably to increase the production of fish in the country, provided it is developed scientifically for fisheries. Besides adding sustainability to fish production, this resource may also offer considerable employment opportunity through fishery activities especially to rural population, which are displaced during the formation of reservoir.

The main three fundamental components for water conservation can be stated as (Foerster, 2011), sustainable allotment fresh water resources, use of tools to protect water loss and proper management principles for fresh water resource conservation.

Limnology deals with study of different characteristics of inland freshwater fisheries, their complex interrelationships and influence of extra aquatic factors in water and biological environment. The expansion of any reservoir, whether for fishery or recreational activity, involves the continuous monitoring of its ecological characteristics so as to conserve its water excellence and its usefulness. The limnological studies also have a greater significance in this circumstance. In their metabolic processes and dynamics, reservoirs look alike natural lakes. However, reservoirs due to high inflow of sediments have comparatively shorter life span. Since the water volume to surface area ratio is less in reservoirs, the process of ageing is comparatively quicker due to higher amount of allochthonous matter. A closer assessment of any freshwater habitat would reveal many interesting interactions between various biological and non-biological factors.

From the earlier part of twentieth century, the feasibility for production of fishes in the reservoir was considered globally. So, it has become essential to characterise the parameters of different water bodies, so that the lack of information on these aspects does not constitute an important bottleneck in the improvement of reservoirs. As mini reservoirs are hot-spots for biodiversity (William et.al., 2004), efforts should be given to avoid the degradation of the reservoirs. Development of reservoir ecosystems by humans has made radical change in ichthyology faunas, which led to extinction of indigenous endemic species and increase of introduced species. Usually, conservation ecologists consider these contrasting forces as the main reason for biological combination and consider natural blending as negative consequences of urbanization.

Since ages, human are dependent entirely on surrounding biodiversity. Biodiversity is a significant contributing factor for existence of man on the planet since human needs of food,

shelter and cloth are fulfilled by a range of components of the biodiversity. The estimate recommends that perhaps around 30 million species live on the Earth, however, only around 1.5 million have been analysed for their economically important properties (Miller et.al., 1995). Diversity study of biotic community of a system is essential to know whether the system is viable or not. Biodiversity is therefore, the variability between lively organism from all resources viz. inland, marine and land ecosystems and their different ecological complexes. These include diversity among species, between dissimilar species and different ecosystems.

The diversity becomes a vital resource for the well-being of the human populace. It is the heart of economic productivity and livelihood generation today; hence its conservation and reasonable use are an absolute necessity to achieve sustainable development. In addition, its conservation and preservation is an insurance policy for future. Levin (2000) has extensively addressed the aspects of diversity and its relationship to human security, including the biodiversity that supports and the origin of evolution of the biodiversity along with the ecological process underlying patterns and trends.

The maximum biodiversity reflected by tropical regions because of climatic uniformity, its suitability for primary and secondary producers as well as stability of areas. India, being part of tropics, have a large variety of habitats. Presently, it estimated that India, which occupies merely 2.4% of world's geographical area, sustains 7 to 8% of world's fauna and flora. However, the decline several species of fauna and flora began with the human civilization. It is estimated that India harbours 1,20,000 illustrated and perhaps 4,00,000 non-illustrated species of fauna and flora distributed over the country's 329 million hectare land (Pullaiah, 2002).

The term "Biodiversity" is determined by the quantity of species that make up the biological ecosystem and considered as an important aspect of community organization and structure. However, it is often used abruptly to describe the population of a community or location. The key basic of biodiversity is described by richness of species and species abundance relativity. The conservation of fish and its aquatic biodiversity has attracted lots of attention from various scientific workers. Myers (1988b & 1990) identified important areas for freshwater high diversity termed as "hotspots". Many aspects of aqua biodiversity in Asia, including thoughtful discussion of taxonomy, hotspots and policy were reviewed (Kottelat and Whitten,

1996). Guegan (1998) reviewed that a clear manifestation of the familiar global diversity gradient, diversity of species increases with decrease in latitude.

The analysis of fish catch statistics bearing in mind the prevailing ecological conditions advocates the necessity for eco-friendly management of fisheries for boosting the production. The enormous expanse of tropical reservoirs offers immense scope of increasing in production by application of extensive aquaculture techniques. To achieve sustained optimum production from reservoirs, it is convenient to study the prevailing ecological conditions with a major thrust on the assessment of suitable fishery potential. Knowledge of limnological parameters, trophic status and kinetics of trophogenic and tropholytic zones is thus mandatory.

Reservoirs were classified by the Ministry of Agriculture and Farmers Welfare, India, as large reservoir denoted as >5000 ha, medium reservoir as 1000ha to 5000 ha and small reservoir mentioned as (<1000 ha) to segregate and manage the reservoir separately based on its size. The reservoir constitutes the largest inland fisheries resources based on the size and potential for large-scale fish production. Although ichthyo-fauna of the parent river constitutes the faunal diversity of the reservoir, fish species diversity suffers an impediment on impoundment (Sugunan, 2000). The varying devise and purpose of respective dams make each reservoir distinct in its morpho-edaphic dispensations. The different diversities make reservoir a unique ecosystem and a remarkable biotope. It is also markedly different from its natural counterparts, being a combination of fluviatile and lacustrine systems.

In reservoirs, the ecosystem oriented management practices lay considerable on the optimum utilization of the existing fish food communities through stock manoeuvring. Therefore, detailed location specific investigations on these biotic communities will go a long way in understanding the ecosystem. Though many of the investigations in Indian reservoirs centred on the limnochemical analysis, biotic communities did not get the attention they deserved. The study concentrates on piscine fauna excluding the planktons. It is expected that the information create through this study fill a gap in the knowledge of Doyang reservoir, which remains unexplored until date. This is also a research to illustrate a tropically rich reservoir yielding poor fish harvest due to inadequate population management.

Major objective in the research work is to provide an explanation of the piscine diversity and species composition in Doyang reservoir. The information from this research work will provide as a base data for other researchers and the Department to accomplish supplementary

studies on conservation, ecology, sustainability and feasibility managing of fisheries resources in the reservoir. Evaluation of limnological parameters and piscine diversity of Doyang reservoir were carried out during February 2015- January 2018 to formulate suitable management practices within the reservoir. In view of the latter, the current research work of contemporary importance was conceived wherein efforts are being made to unravel the factor of both biological and abiotic aquatic environment within the reservoir. A base data, which hitherto remain unexplored, is likely to generate in relation to the impact of physico-chemical variations on aquatic biodiversity and production functions especially in fisheries. In this circumstances, observing the rising importance in reservoir fisheries, an appropriate study on the present status thereof, was the requisite of the hour. The current study is envisaged to evaluate the ichthyo-faunal diversity, water quality and eco-fishery status, besides, addressing the management practices of Doyang Reservoir.

The elevated demand of protein-loaded food through worldwide, the production in fishery is increasing rapidly as the years passes by. Aquaculture production was 10 million ton in 1989 but in 2012 it has become 66.60 million ton (Brander, 2007; FAO, 2013).

Poor fish yield is partly attributed to unscientific management policies of reservoirs and partly to inadequate understanding of reservoir ecosystem (Natarajan, 1979). Among the three main biotic communities that contribute to the aquatic production systems viz., plankton, benthos (including periphyton) and nekton. The nekton generally constitutes the trade harvest. The other two, form the food for nekton and therefore are directly accountable for the latter's quantitative and qualitative abundance. For this particular reason, sufficient understanding on these two communities and the factors governing their abundance is a prime requisite in evolving management strategies in a reservoir.

Nagaland, the sixteenth state of India with 16,579 sq.km areas lies between 25.06^0 and 27.04^0 latitude north and involving the longitudinal lines of 93.020^0 and 95.015^0 east. The State has boundary with Manipur in south, Assam in northern and Western part and in northeast have Arunachal Pradesh. It shares an international boundary in east with Myanmar. The hilly state is lies between 194 m to 3048 m high from mean sea level. People of mongoloid features inhabit the Nagaland state. The population consists of 16 key tribe groups with diverse languages and cultures. The state have eleven district namely – Mokokchung, Kohima, Tuensang, Wokha, Phek, Mon, Dimapur, Peren, Longleng , Zunheboto and Kiphire.

My research work emphasizes on fish diversity and the water parameters of Doyang reservoir, which is located in Wokha district. Initially, M/s North Eastern Electric Power Corporation (NEEPCO) which is a Government of India undertaking and was inaugurated during the 2001 constructed the Doyang reservoir for generating hydro-electricity. The dam length is 525 m; the base width is 445 m; the width of top is 10 m and the height of dam measures 92 m. The maximum water level of dam is 336 m during heavy rainfall.

Seeing the potentiality of the reservoir, the Department of Fisheries and Aquatic Resources, Nagaland took the initiative of stocking the reservoir yearly since 2006 to sustain fish production within the state and also to create employment generation and improve the socio-economic condition of the fish farmers residing within the periphery of the reservoir. The department has also installed a cage culture development in the reservoir for fish seed production and to boost fish production. However, until date, less scientific evaluation was done in the field of research at Doyang reservoir, which is why the Department was not able to exploit the full potentiality of the reservoir. This research will get a broader picture on the quantity of fishes available in the reservoir and about the water parameters. With this research work, the Department will also get an idea on what type of fish species are dominating over the diminishing fish species and what measures needs to be taken for balancing the population of different fish species.

In reservoirs, the ecosystem oriented management practices lay considerable highlighting on the optimum utilization of the existing fish food biotic communities through stock manipulation. Therefore, detailed location specific investigations on these biotic communities will go a long way in understanding the ecosystem. Though many of the investigations in Indian reservoirs centred on the limnochemical analysis, biotic communities did not get the attention they deserved.