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DIVERSITY OF PHYTOPLANKTON IN ADAN RESERVOIR, KARANJA (LAD)

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PREFACE

Phytoplankton are microscopic organisms that live in water. They are the foundation of the aquatic food web, and they play an important role in the cycling of nutrients.

The Adan Reservoir is a freshwater reservoir located in the Karanja (Lad) taluka of Maharashtra, India. The reservoir is home to a diverse community of phytoplankton, including diatoms, dinoflagellates, and cyanobacteria.

This book provides a comprehensive overview of the diversity of phytoplankton in the Adan Reservoir. It includes a description of the different types of phytoplankton found in the reservoir, as well as their distribution and abundance. The book also discusses the factors that influence the diversity of phytoplankton in the reservoir, such as water temperature, nutrient availability, and light intensity.

This book is a valuable resource for anyone interested in the ecology of phytoplankton or the Adan Reservoir. It is also a useful tool for scientists and managers who are responsible for the conservation and management of freshwater resources.

- Dr. Renuka S. Ghude
Author

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- Dr. Renuka S. Ghude

DEDICATED TO…………..

MY LOVING PARENTS

MRS. SMITA & LT. MR. SUBHASH GHUDE

MY DEAR PARENTS IN LAW

MRS. LAXMI & LAXMAN KEOLE

INTRODUCTION:

Water is probably the only natural resource to touch all aspects of human civilization from agricultural and industrial development and having the cultural and religious values. Water is a necessity for all living beings, without it; there would be no life. Life originated in water and ultimate basis of it, the protoplasm is a colloidal solution of complex organic molecules in a watery medium. Water is essential at all levels of life, cellular to ecosystem. It is essential for the circulation of body fluids in the plants, animals and it stands as the key substance for the existence and continuity of life through reproduction and different cyclic processes in nature. It plays the central role in mediating global scale ecosystem processes, linking atmosphere, lithosphere and biosphere, by moving substances among them, and enabling chemical reactions to occur. Humans depend on these resources for all their needs of existence and survival (Joshi *et al.,* 2012).

Understanding such aquatic life requires a sound knowledge not just of the organisms themselves but also of these external influences of media that affects them. From this aquatic life, the phytoplankton is a group of microscopic plants which are minute and able to spend their whole life floating on water is called planktons. The phytoplankton is the autotrophic segments of the tiny fish network and a key piece of seas, oceans and freshwater bowl environments. The term phytoplankton includes all photoautotrophic microorganisms in sea-going nourishment networks. Be that as it may, in contrast to earthbound networks, where most autotrophs are plants, phytoplanktons are an assorted gathering (Thurman, 2007). The most vital gatherings of phytoplankton incorporate the diatoms, cyanobacteria and dinoflagellates, albeit numerous different gatherings of green growth are spoken to (Quinn and Bates, 2011). Diverse sorts of phytoplankton bolster the distinctive trophic dimensions inside shifting the biological systems. In oligotrophic maritime locales, for example, the Sargasso Sea or the South Pacific Gyre, phytoplankton is ruled by the little estimated cells, called picoplankton and for the most part made out of cyanobacteria and pico-eukaryotes like Micromonas. Inside progressively profitable biological systems, ruled by upwelling or high earthly data sources, bigger dinoflagellates are the more overwhelming phytoplankton and mirror a bigger segment of the biomass (Calbet, 2008).

The phytoplanktons are photosynthesizing minute biotic living beings that occupy the upper sunlit layer of practically all seas and collections of new water on Earth. They are operators for primary production that the formation of natural mixes from carbon dioxide broke down in the water, a procedure that supports the oceanic sustenance web. Phytoplankton acquires the vitality through the procedure of photosynthesis and should along these lines live in the sufficiently bright surface layer of a sea, ocean, lake, or other waterway. Phytoplankton represents about portion of all photosynthetic action on Earth. Their combined vitality obsession in carbon mixes is the reason for most by far of maritime and furthermore numerous new aquatic ecosystem. While practically all phytoplankton species are committed photoautotrophs, there are some that are mixotrophic and other, non-pigmented species that are really heterotrophic. Of these, the best known are dinoflagellate genera such as Noctiluca and Dinophysis that get natural carbon by ingesting different life forms or detrital material (Michael, 2001).

Phytoplankton absorbs energy from the Sun and nutrients from the water to produce their own food. In the process of photosynthesis, phytoplankton release molecular oxygen (O_2) into the water. It is estimated that between 50% and 85% of the world's oxygen is produced via phytoplankton photosynthesis. The rest is produced via photosynthesis on land by plants. Furthermore, phytoplankton photosynthesis has controlled the atmospheric CO_2/O_2 balance since the early Precambrian Eon.

Phytoplanktons are crucially dependent on minerals. These are primarily macronutrients such as nitrate, phosphate or silicic acid, whose availability is governed by the balance between the so-called biological pump and upwelling of deep, nutrient-rich waters. However, across large regions of the World Ocean such as the Southern Ocean, phytoplankton are also limited by the lack of the micronutrient iron. This has led to some scientists advocating iron fertilization as a means to counteract the accumulation of human-produced carbon dioxide (CO_2) in the atmosphere. Large-scale experiments have added iron (usually as salts such as iron sulphate) to the oceans to promote phytoplankton growth and draw atmospheric CO_2 into the ocean. However, controversy about manipulating the ecosystem and the efficiency of iron fertilization has slowed such experiments (Monastersky, 1995).

Phytoplankton depends on Vitamin B for survival. Areas in the ocean have been identified as having a major lack of Vitamin B, and correspondingly, phytoplankton. The effect of anthropogenic warming on the global population of phytoplankton is an area of active research. Changes in the vertical stratification of the water column, the rate of temperature-dependent biological reactions, and the atmospheric supply of nutrients are expected to have important effects on future phytoplankton productivity. The effects of anthropogenic ocean acidification on phytoplankton growth and community structure has also received considerable attention. Some phytoplanktons also contains the calcium carbonate cell walls that are sensitive to ocean acidification. Because of their short generation times, evidence suggests some phytoplankton can adapt to changes in pH induced by increased carbon dioxide on rapid time-scales. Phytoplankton serves as the base of the aquatic food web, providing an essential ecological function for all aquatic life. Under future conditions of anthropogenic warming and ocean acidification, changes in phytoplankton mortality may be significant (Steinacher *et al.,* 2010; Lohbeck *et al.,* 2012; Collins *et al.,* 2013).

Phytoplanktons are a key food item in both aquaculture and mariculture. Both utilize phytoplankton as food for the animals being farmed. In aquaculture and mariculture, the phytoplankton is naturally occurring and is introduced into enclosures with the normal circulation of seawater. In aquaculture, phytoplankton must be obtained and introduced directly. The plankton can either be collected from a body of water or cultured, though the former method is seldom used. Phytoplankton is used as a foodstock for the production of rotifers, which are in turn used to feed other organisms. Phytoplankton is also used to feed many varieties of aquacultured molluscs, including pearl oysters and giant clams. A 2018 study estimated the nutritional value of natural phytoplankton in terms of carbohydrate, protein and lipid across the world ocean using ocean-colour data from satellites, and found the calorific value of phytoplankton to vary considerably across different oceanic regions and between different time of the year (Boyce *et al.,* 2010; Mousavi *et al.,* 2014; Brahim *et al.,* 2015; Hanife, 2016).

The abundance of phytoplankton is mainly influenced by the presence of pollutant in water. The first problem of pollution in the freshwater systems in our country is mainly because of anthropogenic activities (Haniffa *et al.,* 1993). The consequence of urbanization and industrialization leads to spoilage of water. During the last decades it was observed that the groundwater gets polluted drastically because of increased anthropogenic activities (Abdul, 1998).

Moreover, natural aquatic ecosystems are being used as disposal sites for a wide variety of wastes (Sarojini, 1996). The toxic chemicals; human wastes and sewage by affected on all the species interactions them. Direct human activities in the form of washing, bathing are important factors causing the pollution in water bodies. The increasing human influences in recent years in and around our aquatic systems and their catchment areas, have led to the deterioration of water quality and eutrophication (Bhatt *et al.,* 1999).

A high temporal and geographical variability of rainfall in this country a reservoir operation occupies an important place in the utilization of water resources. Water quality becomes an important parameter for the assessment and management of surface water. Accurate information on the condition and trends of water resources quantity and quality is required as a basis for economic and social development and for the development and maintenance of environmental quality. The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to pollute water quality and depletion of aquatic biota. It is therefore necessary that the quality of drinking water should be checked at regular time of interval, because due to use of contaminated drinking water human population suffers from varieties of water borne diseases.

The second problem is eutrophication which is global phenomena associated with nutrient enrichment of aquatic ecosystem. Eutrophication means not only an increase in higher tropic levels, changes of the community structure and simultaneously changes in main paths of energy flow within the aquatic ecosystems (Wetzel, 2001). In natural course, it is slow process of lake ageing with ultimately lead to successions. However, man is responsible for accelerating the process of succession many folds endangering the very survival of water bodies all over the worlds by using nutrients like nitrates, phosphates, sulphates, and chloride are contributed to the process of eutrophication. The abundance of organic compounds, radionuclide's, toxic chemicals, nitrates and nitrites in water may cause unfavorable condition for aquatic biota. Nutrient enrichment directly affects the water quality and lead to number of consequences indicative of imbalance in the freshwater ecosystem.

The water bodies consist of organic as well as inorganic dissolved solids. The inorganic solids are anions like magnesium, sodium, potassium, etc. The ionic composition of water plays an important role in the metabolism of various aquatic organisms and which is the index of productivity. The concentration of calcium, inorganic carbon and sulphates are influenced by microbial metabolism. The presence of bicarbonates of calcium and potassium increases the hardness of water. Sahai and Sinha, (1969) and Munawar (1970) showed that the presence of blue green algae is found to be in water having high concentration of calcium. The presence of chloride in water is not harmful but above 250 mg/lit gives a peculiar taste to water. The main sources of chlorides are dissolution of salt deposits, discharges of effluents from chemical industries, sewage, drainage and irrigation. The assessment of water resource quality from any region is an important aspect for the developmental activities of that region. It is due to negligence of man many ground water and surface water sources get contaminated. Ultimately the contamination of water lead to hazardous situations and many times it becomes harmful to the community at large. The contaminated water is dangerous to aquatic fauna and flora.

Most of the small water bodies are located in the vicinity of temples and mosque like religious places. Most of the fairs are celebrated near these lakes. The day-to-day maintenance of these reservoirs is neglected. Many of our religious activities cause pollution of these holy water bodies. In normal lake, the amount of dissolved oxygen varies little with depth. In Eutropic Lake oxygen count varies from sufficient at the surface to very low at the bottom. The population pressure and activities near lake like bathing and cloth washing results in reduction of the oxygen level of lakes.

The nature of threats to fresh water resources is almost uniform across the state, though some of them may be site specific. The major threats identified in the state vary in character and intensity. The main causes being change in land use, catchment degradation, irrational use of water, ground water depletion, domestic and industrial pollution, Eutrophication, intrusion of exotic weeds, local biodiversity loss, crossing of carrying capacity of wetland, climate change, droughts, floods, disaster, social economic regional disparities and issues, and local and trans boundary conflicts. Most of these cause negative and cumulative environmental impacts and are incremental with time having long-term effect. The changing attitude of the people for modern lifestyles and the dilemma between Growth V/s Developments are some of the common factors in aggravating the threat perception in rapidly industrializing state of Maharashtra. According Samant (2012), in the last few decades it is increasingly realized that there is exponential increase in the environmental problems in the state, just as in the whole country. The Maharashtra being a leading industrialized and urbanized state in India, the gravity and extent of these problems has become more severe.

This degradation in ecology is correlated to depletion in the basic natural resources in quality as well as in quantity. Freshwater, a basic life supporting system is one of the main natural resources is on decline. In the recent years this situation is aggravated by the impacts of climate change as a result of global warming. Depletion and degradation in the natural and manmade water resources directly influences life in mosaic of ecosystems and habitats, natural cycles and ultimately the biodiversity, including man. There is general agreement among scientists, technocrats, planners that water shortage in the state is serious challenge faced by millions, particularly under privileged, Maharashtra, despite its position in the country as a largely water sufficient state, is increasingly witnessing serious water shortages in the past decades. This is badly influences on agriculture, and indirectly socioeconomic development. Therefore, water conservation and its management has become a priority area for everybody.

World's most productive environments are wetlands. They provide tremendous economic benefits to mankind through fishery production, by maintaining water table for agriculture water storage and the reduction of natural hazards like floods and draughts. But what is grossly ignored today is that wetlands provide critical habitats for many species of fauna and flora. Countless mammal, bird, reptile, amphibian, fish and invertebrate species, quite often threatened with extinction, depend on these habitats for their survival. Their value is further evidenced by the fact that wetlands can produce up to eight times as much plant matter as wheat fields.

The basic need for the wetlands conservation as portrayed by most in the development scenario is the water supply to the growing human demands as wants and not the basic needs.

Also, the nature of these demands is rapidly changing from needs in the rural areas to semi urban and urban areas with modern life styles with ever increasing consumption patterns. The problem of sustained water supply is further aggravated by population increase and immigration in Maharashtra.

The quality of water may be described according to their physicochemical and biological characteristics. An understanding of water chemistry is the basis of the knowledge of the multi-dimensional aspect of aquatic environmental chemistry, which involves the source, composition, reaction and the transportation of water. The water bodies of rivers, lakes and dams or reservoirs are continuing subject to a dynamic state of change with respect to the geological age and geo-chemical characteristics. This is demonstrated by continuous circulation, transformation of energy and matter through the medium of living and their activities. Water flows plays a vital role in nutrient dynamics and aquatic productivity through transport of nutrients to organism (Barik *et al.*, 2010).

The fresh water resources not only support the live-hood but also cover the rich biological diversity. The biological diversity of the earth and its origins has long been a source of amazement and curiosity. Current interest in diversity centers both on why there are so many species and on how diversity impacts population and ecosystem processes. However, the accelerating effects of human activities on biodiversity and the possibility that the loss of biodiversity might impact ecosystem functioning renewed interest in the effects of diversity on ecosystem processes and on ecosystem services essential to society (Joshi *et al.*, 2016).

Variety of biotic factors can be seen in Lake Ecosystem. Bacteria are present in all regions of lentic waters. Free-living forms are associated with decomposing organic material, biofilm on the surfaces of rocks and plants, suspended in the water column, and in the sediments of the benthic and profundal zones. Other forms are also associated with the guts of lentic animals as parasites or in communal relationships. Bacteria play an important role in system metabolism through nutrient recycling, which is discussed in the Trophic Relationships section (Brönmark and Hansson, 2005)

Algae, including both phytoplankton and periphyton are the principle photo-synthesizers in ponds and lakes. Phytoplanktons are found drifting in the water column of the pelagic zone. Many species have a higher density than water which should make them sink and end up in the benthos. To combat this, phytoplankton have developed density changing mechanisms, by forming vacuoles and gas vesicles or by changing their shapes to induce drag, slowing their descent. A very sophisticated adaptation utilized by a small number of species is a tail-like flagellum that can adjust vertical position and allow movement in any direction.

Phytoplankton can also maintain their presence in the water column by being circulated in Langmuir rotations. Periphytic algae, on the other hand, are attached to a substrate. In lakes and ponds, they can cover all benthic surfaces. Both types of plankton are important as food sources and as oxygen providers (Keddy, 2010).

Aquatic plants live in both the benthic and pelagic zones and can be grouped according to their manner of growth: 1) emergent = rooted in the substrate but with leaves and flowers extending into the air, 2) floating-leaved = rooted in the substrate but with floating leaves, 3) submerged = growing beneath the surface and 4) free-floating macrophytes = not rooted in the substrate and floating on the surface. These various forms of macrophytes generally occur in different areas of the benthic zone, with emergent vegetation nearest the shoreline, then floating-leaved macrophytes, followed by submersed vegetation. Free-floating macrophytes can occur anywhere on the system's surface (Brown, 1987).

Aquatic plants are more buoyant than their terrestrial counterparts because freshwater has a higher density than air. This makes structural rigidity unimportant in lakes and ponds (except in the aerial stems and leaves). Thus, the leaves and stems of most aquatic plants use less energy to construct and maintain woody tissue, investing that energy into fast growth instead. In order to contend with stresses induced by wind and waves, plants must be both flexible and tough. Light, water depth and substrate types are the most important factors controlling the distribution of submerged aquatic plants. Macrophytes are sources of food, oxygen, and habitat structure in the benthic zone, but cannot penetrate the depths of the euphotic zone and hence are not found there (Moss, 1998).

Zooplankton is tiny animals suspended in the water column. Like phytoplankton, these species have developed mechanisms that keep them from sinking to deeper waters, including drag-inducing body forms and the active flicking of appendages such as antennae or spines. Remaining in the water column may have its advantages in terms of feeding, but this zone's lack of refugia leaves zooplankton vulnerable to predation. In response, some species, especially Daphnia sp., make daily vertical migrations in the water column by passively sinking to the darker lower depths during the day and actively moving towards the surface during the night. Also, because conditions in a lentic system can be quite variable across seasons, zooplankton have the ability to switch from laying regular eggs to resting eggs when there is a lack of food, temperatures fall below 2 °C, or if predator abundance is high. These resting eggs have a diapauses, or dormancy period that should allow the zooplankton to encounter conditions that are more favorable to survival when they finally hatch (Brönmark and Hansson, 2005).

The invertebrates that inhabit the benthic zone are numerically dominated by small species and are species rich compared to the zooplankton of the open water. They include Crustaceans, molluscs, and numerous types of insects. These organisms are mostly found in the areas of macrophyte growth, where the richest resources, highly oxygenated water, and warmest portion of the ecosystem are found. The structurally diverse macrophyte beds are important sites for the accumulation of organic matter, and provide an ideal area for colonization. The sediments and plants also offer a great deal of protection from predatory fishes. Very few invertebrates are able to inhabit the cold, dark, and oxygen poor profundal zone. Those that can are often red in color due to the presence of large amounts of hemoglobin, which greatly increases the amount of oxygen carried to cells. Because the concentration of oxygen within this zone is low, most species construct tunnels or borrows in which they can hide and make the minimum movements necessary to circulate water through, drawing oxygen to them without expending much energy (O'Sullivan and Reynolds, 2005).

Fish have a range of physiological tolerances that are dependent upon which species they belong to. They have different lethal temperatures, dissolved oxygen requirements, and spawning needs that are based on their activity levels and behaviors. Because fish are highly mobile, they are able to deal with unsuitable abiotic factors in one zone by simply moving to another. A detrital feeder in the profundal zone, for example, that finds the oxygen concentration has dropped too low may feed closer to the benthic zone. A fish might also alter its residence during different parts of its life history: hatching in a sediment nest, then moving to the weedy benthic zone to develop in a protected environment with food resources, and finally into the pelagic zone as an adult. Other vertebrate taxa inhabit lentic systems as well. These include amphibians, reptiles, and a large number of waterfowl species. Most of these vertebrates spend part of their time in terrestrial habitats and thus are not directly affected by abiotic factors in the lake or pond. Many fish species are important as consumers and as prey species to the larger vertebrates mentioned above.

The biodiversity of a lentic system increases with the surface area of the lake or pond. This is attributable to the higher possibility of partly terrestrial species of finding a larger system. Also, because larger systems typically have larger populations, the chance of extinction is decreased. Additional factors, including temperature regime, pH, nutrient availability, habitat complexity, speciation rates, competition, and predation, have been linked to the number of species present within systems (Browne, 1981).

The plankton communities in lake systems undergo seasonal succession in relation to nutrient availability, predation, and competition. Sommer *et al.* (1986) described these patterns as part of the Plankton Ecology Group (PEG) model, with 24 statements constructed from the analysis of numerous systems.

In winter, it increased nutrient and light availability result in rapid phytoplankton growth towards the end of winter. The dominant species, such as diatoms, are small and have quick growth capabilities. These planktons are consumed by zooplankton, which become the dominant plankton taxa. In spring, a clear water phase occurs, as phytoplankton populations become depleted due to increased predation by growing numbers of zooplankton. In summer, plankton abundance declines as a result of decreased phytoplankton prey and increased predation by juvenile fishes. With increased nutrient availability and decreased predation from zooplankton, a diverse phytoplankton community develops (Hillebrand 2004).

As the summer continues, nutrients become depleted in a predictable order: phosphorus, silica, and then nitrogen. The abundance of various phytoplankton species varies in relation to their biological need for these nutrients. Small-sized plankton becomes the dominant type of plankton because they are less vulnerable to fish predation. In fall season, predation by fishes is reduced due to lower temperatures and zooplankton of all sizes increase in number. Again, winter represented with cold temperatures and decreased light availability result in lower rates of primary production and decreased phytoplankton populations. Reproduction in plankton decreases due to lower temperatures and less prey. The PEG model presents an idealized version of this succession pattern, while natural systems are known for their variation (Hillebrand and Azovsky, 2001).

Beside this, increasing water pollution continuously threats this important biota. Water is unique component of nature and play an important role in the life from unicellular animals to man. The quality of water is described by its physical, chemical, and biological characteristics. Numerous manmade activities like addition of kitchen, bathrooms and toilet waste, industrial waste water, excess use of chemical fertilizers and pesticides has polluted environment of both surface and ground water. Increases in urbanization, industrialization, agriculture activity are harmful for fresh water resources in the nature. The pollution alters the water quality and makes it unsuitable for fish to survive.

Sulfur dioxide and nitrogen oxides are naturally released from volcanoes, organic compounds in the soil, wetlands, and marine systems, but the majority of these compounds come from the combustion of coal, oil, gasoline, and the smelting of ores containing sulfur. These substances dissolve in atmospheric moisture and enter lentic systems as acid rain. Lakes and ponds that contain bedrock that is rich in carbonates have a natural buffer, resulting in no alteration of pH. Systems without this bedrock, however, are very sensitive to acid inputs because they have a low neutralizing capacity, resulting in pH declines even with only small inputs of acid. At a pH of 5–6 algal species diversity and biomass decrease considerably, leading to an increase in water transparency is a characteristic feature of acidified lakes. As the pH continues lower, all fauna becomes less diverse. The most significant feature is the disruption of fish reproduction. Thus, the population is eventually composed of few, old individuals that eventually die and leave the systems without fishes. Acid rain has also been especially harmful to lakes (Giller and Malmqvist, 1998).

Eutrophic systems contain a high concentration of phosphorus nitrogen, or both. Phosphorus enters lentic waters from sewage treatment effluent, discharge from raw sewage, or from runoff of farmland. Nitrogen mostly comes from agricultural fertilizers from runoff or leaching and subsequent groundwater flow. This increase in nutrients required for primary producers results in a massive increase of phytoplankton growth, termed a plankton bloom. This bloom decreases water transparency, leading to the loss of submerged plants. The resultant reduction in habitat structure has negative impacts on the species that utilize it for spawning, maturation and general survival. Additionally, the large numbers of short-lived phytoplankton result in a massive amount of dead biomass settling into the sediment. Bacteria need large amounts of oxygen to decompose this material, reducing the oxygen concentration of the water. This is especially pronounced in stratified lakes when the thermocline prevents oxygen rich water from the surface to mix with lower levels. Low or anoxic conditions preclude the existence of many taxa that are not physiologically tolerant of these conditions (Moss, 1998).

Invasive species have been introduced to lentic systems through both purposeful events as well as unintentional events. These organisms can affect natives via competition for prey or habitat, predation, habitat alteration, hybridization, or the introduction of harmful diseases and parasites. With regard to native species, invaders may cause changes in size and age structure, distribution, density, population growth, and may even drive populations to extinction (Keddy, 2010).

The water quality is mostly analyzed by its physicochemical properties. Wetzel (2001) suggest that physical properties of aquatic ecosystems are determined by a combination of heat, currents, waves and other seasonal distributions of environmental conditions. The morphometric of a body of water depends on the type of water body such as a lake, river, stream, wetland, estuary etc. and the structure of the earth surrounding the body of water. Lakes, for instance, are classified by their formation, and zones of lakes are defined by water depth. River and stream system morphometric is driven by underlying geology of the area as well as the general velocity of the water. Another type of aquatic system which falls within the study of limnology is estuaries. Estuaries are bodies of water classified by the interaction of a river and the ocean or sea. Wetlands vary in size, shape, and pattern however the most common types, marshes, bogs and swamps, often fluctuate between containing shallow, freshwater and being dry depending on the time of year.

The light zonation is the concept of how the amount of sunlight penetration into water influences the structure of a body of water. These zones define various levels of productivity within aquatic ecosystems such as a lake. For instance, the depth of the water column which sunlight is able to penetrate and where most plant life is able to grow is known as the photic or euphotic zone. The rest of the water column which is deeper and does not receive sufficient amounts of sunlight for plant growth is known as the aphotic zone. The portion of the electromagnetic spectrum which is reflected when sunlight hits the surface of the water is known as albedo.

Similar to light zonation, thermal stratification or thermal zonation is a way of grouping parts of the water body within an aquatic system based on how each layer has different temperature variations. The less turbid the water, the more light is able to penetrate, and thus heating a thicker depth of water. Heating declines exponentially with depth in the water column, so the water will be warmest near the surface but progressively cooler as moving downwards. There are three main sections which define thermal stratification in a lake. The first is the epilimnion which is closest to the surface and experiences primarily wind circulation although the water is generally uniformly warm because of the close proximity to the surface. The layer below is often called the thermocline and is an area within the water column which tends to experience a rapid decrease in temperature. Finally, the layer which is the bottom-most within the body of water is the hypolimnion which has uniformly cold water because of its depth which restricts sunlight from reaching it. In temperate lakes, fall-season cooling of surface water to 4 °C results in turnover of the water column.

According to *Boyd* (2015), the chemical composition of water in a natural environment is influenced mainly by precipitation, type of soil and bedrock in the watershed, erosion, evaporation and sedimentation. All bodies of water have a certain composition of both organic and inorganic elements and compounds. There are hundreds of variables which are considered to play a role in water quality however a few have been determined to be of greater interest regarding the role they play in aquatic ecosystem health. While certain biological activities have an impact on dissolved gas concentrations, nutrients, etc. human activity is one of the strongest influences on water quality.

Dissolved oxygen is an element which is necessary for a number of biological and chemical reactions which are critical to the proper functioning of the ecosystem. Some of the biological processes which alter the concentrations of dissolved oxygen include photosynthesis and aquatic organism respiration. Due to the role that photosynthesis plays in dissolved oxygen concentrations in a body of water. Oxygen profiles are affected by photosynthesis, wind mixing of surface waters, and respiration or organic matter, such that oxygen declines similar to the temperature profile. These profiles are based on similar principles as thermal stratification and light penetration. Since dissolved oxygen concentrations are driven primarily by photosynthesis, the amount of sunlight is a limiting factor in terms of how much photosynthesis can occur within the different levels of the water column where light is readily available. This means that dissolved oxygen levels are generally lower as you move deeper into the body of water because of the lower availability of light in those parts of the water.

Dissolve oxygen and dissolved carbon dioxide are often discussed together due the role they both play in aquatic organism respiration. These organisms absorb dissolved oxygen from the water to use in respiration and expel carbon dioxide as a byproduct of this process. Carbon dioxide tends to have an inverse diurnal relationship with oxygen. Nitrogen and phosphorus are ecologically significant nutrients in aquatic systems. Nitrogen is generally present as a gas in aquatic ecosystems however most water quality studies tend to focus on nitrate, nitrite and ammonia levels. Most of these dissolved nitrogen compounds follow a seasonal pattern with greater concentrations in the fall and winter months compared to the spring and summer. Phosphorus has a different role in aquatic ecosystems as it is a limiting factor in the growth of phytoplankton because of generally low concentrations in the water. Dissolved phosphorus is also crucial to all living things, is often very limiting to primary productivity in freshwater, and has its own distinctive ecosystem cycling.

The availability of different nutrients in the water enhances the eutrophication that increases the growth of aquatic weeds. The aquatic weeds are plants that have adapted to living in aquatic environments. They are also referred to as macrophytes. A macrophyte is an aquatic plant that grows in or near water and is emergent, submergent or floating. They provide cover for aquatic animals like fish and substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife. Aquatic plants require special adaptations for living submerged in water, or at the water's surface. The most common adaptation is aerenchyma, but floating leaves and finely dissected leaves are also common. Aquatic plants can only grow in water or in soil that is permanently saturated with water. They are therefore a common component of wetlands (Keddy 2010)

The Macrophytes thrive in all the water bodies in India and pose a risk to the water body choking in long run. In water bodies large number of macrophytes of different types resides throughout the year. Depending on the type of nutrient loading the macrophytes colonize different types of freshwater bodies in India. The aquatic weeds are classified into free floating, rooted floating, submerged and emergent type. Based on nutrient input into a lake from the catchment area and anthropogenic activities, the process of succession converts the pond ecosystem into a dry land and the pond ecosystem will be not be usable for benefit of human being (Kiran *et al.* 2006).

The limnology classifies lakes or other bodies of water according to the trophic state index. An oligotrophic lake is characterized by relatively low levels of primary production and low levels of nutrients. A eutrophic lake has high levels of primary productivity due to very high nutrient levels. Eutrophication of a lake can lead to algal blooms. Dystrophic lakes have high levels of humic matter and have typically yellow-brown, tea-coloured waters. These categories do not have rigid specifications; the classification system can be seen as more of a spectrum encompassing the various levels of aquatic productivity. Hence, these physicochemical properties directly relate the biodiversity in concern water body. As Communities of organisms that are dependent on each other and on their environment live in aquatic ecosystems (Keddy, 2010).

PROBLEM STATEMENT:

The problem of water pollution in India is very critical. Several states in the country facing problems of surface water pollution and exploitation of ground water resources in excess. Its manifestations are declining per capita water availability, falling water tables and deterioration of water quality. These increasing imbalances and anomalies shed doubt on the long availability of water resources. Generally, influence of above factors varies in magnitude depending upon geographical location of the water body. The water quality in ponds, rivers and streams may vary depending on the geological morphology vegetation and land use modified by human activities such as agricultural, in the catchment, industries and urban settlements produce nutrients and toxic substances such as organic and inorganic pollutants and other chemicals including heavy metals. Water pollution occurs when these substances enter the water and alter their natural function (Water and River Commission, 1997). In this concern, the study was conducted during February 2016 to January 2019 to analyze the phytoplankton diversity of Adan reservoir of Washim district of Maharashtra (India) with reference to physicochemical status.

SCOPE OF THE STUDY:

Adan reservoir is an earthfill and rockfill dam on Adan River near Karanja, Washim district in state of Maharashtra (India). During monsoon reservoir gets enough water but in post monsoon period particularly March and April water level is very much reduced. The reservoir is surrounded by red laterite soil and black cotton soil. The inland reservoir is fed by seasonal drainage to its periphery and nearby local streams and springs. The concern water body is represented with rich phytoplankton diversity, but now days this rich diversity is continuously affected by many activities leading to contamination of water. Hence the present study is an attempt to analyze the phytoplankton diversity of Adan reservoir of Washim district with reference to physicochemical status.

AIMS AND OBJECTIVES:

The nutrient rich physicochemical conditions of the water body help to increase the productivity of phytoplankton. In this concern, the present investigation was aimed to achieve the following objectives…...

- ✓ To study the present status of phytoplankton in reservoir.
- ✓ To analyse the physicochemical properties of Adan reservoir.
- ✓ To correlate the physicochemical properties and plankton diversity.
- ✓ To study macrophytes and evaluate the eutophication status of reservoir.
- ✓ To suggest appropriate conservation and management strategies for reservoir.

REVIEW OF LITERATURE:

A Literature review is a text of a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources, and do not report new or original experimental work. Most often associated with academic-oriented literature, such reviews are found in academic journals. Literature reviews are a basis for research in nearly every academic field.

In the era of globalization, global warming and climate change are matter of concern to all, whether they are animals, plants or even micro-organisms. Conservation is the only way that presently exists to save the biodiversity. The phytoplankton diversity in the aquatic ecosystem is in no way exceptional from the current impact of altered physicochemical status. Some of the most important recent publication concerns to present research are reviewed below.

Cunqi *et al.* (2010) studies the seasonal variations in the structure and dynamics of phytoplankton community of the lake Baiyangdian in China, quantitative samples were collected in each season. A total of one hundred fifty-two taxa of phytoplankton were identified. The highest phytoplankton abundance was observed in spring and the lowest in autumn. Cyanophyta, Euglenophyta and Cryptophyta were the most important groups in terms of abundance and biomass. The preponderant and sub-preponderant species changed in accordance with the seasons. Canonical Correspondence Analysis was used to investigate the relationship between environmental factors and phytoplankton community. The results indicated that nutrient gradient had a positive correlation with first axis in spring, summer and autumn. But in winter, the nutrient gradient had a positive correlation with second axis. The varieties of environmental factors affected the structure of phytoplankton community in each season. Analysis showed a slight, but significant method to understand the spatial distribution of phytoplankton community in lake systems.

Esmaeili *et al.* (2010) quoted that Urmia Lake of Iran is one of the two large hypersaline lakes in the world which have *Artemia*. It is located in northwest of Iran. Due to a decrease in water inflow and volume, the salinity of Urmia Lake had increased. The increased salinity has greatly influenced biological aspects of the lake, and caused the lake undergoes at critical conduction. This study investigated the distribution fluctuations of phytoplanktons and selected physicochemical factors in relation to *Artemia* distribution in Urmia Lake. Statistical analysis of mean values of different physicochemical parameters and phytoplankton abundance indicated significant differences among sampling months. The fourteen phytoplankton genera included Bacillariophyceae with ten genera, Chlorophyceae with two genera and Cyanophyceae with two genera were identified during sampling period. The lowest average density of phytoplankton was observed in December and the greatest average density August. *Dunaliella* sp. composed the maximum of the lake's phytoplankton. Statistical analysis of phytoplankton fluctuations showed a significant difference among different months.

Jafari and Alavi (2010) studied the community structure of plankton in relation to physicochemical characteristics of the river Talar of Iran polluted by industrial effluents and domestic sewage. In addition, seasonal changes in phytoplankton and zooplankton populations and species abundance were also determinate. The dominant phytoplanktonic algae determined were *Oscillatoria*, *Anabaena*, *Nostoc*, *Spirogyra*, *Pediastrum*, *Navicula* and *Nitzschia*. The dominant zooplanktonic organisms determined were *Paramecium*, *Daphnia*, *Cypris*, *Keratalla* and *Arachinous*. The present study on ecology and the surface water of this fresh water river covered a number of aspects, beginning from abiotic and biotic parameters to pollution assessment and thereby revealed a true picture of the water quality of the river.

Rajagopal *et al.* (2010) studied the diversity of phytoplankton in relation to physicochemical parameters with respect to pollution status of two perennial ponds of Sattur area, Tamil Nadu. Fifty species were identified belonging to Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. High value of physicochemical parameters and low phytoplankton diversity were recorded in the Chinnapperkovil pond, whereas low value of physicochemical parameters and high phytoplankton diversity were recorded in the Nallanchettipatti pond. Class Chlorophyceae qualitatively and quantitatively dominated in both the habitats when compared to other taxa. This study revealed that phytoplankton species richness was comparatively higher in Nallancheettipatti pond. The species diversity was high in Nallanchettipatti pond compared to Chinnapperkovil pond. Abundance of different specific taxa in these ponds suggested that these taxa can be considered as pollution indicators. Phytoplankton species diversity and physicochemical parameter profiles indicated the Chinnapperkovil pond to be mesoeutrophic whereas the Nallanchettipatti pond as oligoeutrophic.

Ali *et al.* (2011) examined the relationship between phytoplankton population and some important physicochemical variables in the Bukan Dam Reservoir. The sampling was performed monthly from eight sampling sites. Phytoplankton counts were made by inverted microscope. Total fifty-five phytoplankton taxa were identified that included Chlorophyta, Bacillariophyta, Dinophyta, Cyanobacteria, Euglenophyta, Chrysophyta and Cryptophyta. Correlations between some important physicochemical factors and total phytoplankton number were calculated. Results indicated that phytoplankton total number positively correlated with nitrates and negatively correlated with Secchi disc depth.

Mathias *et al.* (2011) studied the green algal species and their association with physicochemical parameters in some manmade ponds in Zaria, Nigeria. Phytoplankton and water samples were collected preserved and analyzed using standard methods. A total of 27 green algal species divided into sixteen families were recorded. The *Closterium* sp. and *Rhizoclonium hookeri* were positively associated with the concentration of iron, however they were negatively correlated to alkalinity, total dissolved solids and electrical conductivity. *Stichococcus bacillaris*, *Staurastrum rotula* and *Sphaeroplea* sp. had significant positive relationship with biochemical oxygen demand, manganese levels in the water. *Pseudouvella americana* and *Scenedesmus quadricauda* showed a close positive association with alkalinity but were sensitive to iron, BOD, manganese. The observed species showed closed association with physicochemical factors in these ponds.

Patil *et al.* (2012) studied the physicochemical properties of Shivaji University lakes of Kolhapur city and its impact on phytoplankton population. In study, physical parameters included the temperature, turbidity and chemical parameters included the pH, temperature, alkalinity, dissolved oxygen, total hardness and nitrate, phosphate and sulphate. A total nineteen species were observed during the study period. There were nine species from Chlorophyceae, four species of the class Cynophyceae, three of the class Bacillariophyceae, three of the class Euglenophyceae. Maximum species of the class chlorophyceae were observed during study period. The *Microcystis* species was observed in Rajaram lake indicateed the signs of eutrophication of lake, while species like *Desmidium* observed from Music Department Lake was the indicator of better water quality. The physicochemical parameters such as nitrates, phosphate, temperature and alkalinity are favorable for the growth of phytoplankton.

Devi and Antal (2013) studied the diversity of phytoplankton in relation to physicochemical parameters with respect to water quality status of a subtropical pond, '*Datte da Talab*' in Jammu and Kashimr. The physicochemical parameters showed well marked seasonal variations. A total of twenty-one genera belonging to three different groups namely Bacillariophyceae, Chlorophyceae and Cyanophyceae were recorded during the study period with maximum in winter season and minimum in summer season. Qualitatively and quantitatively Bacillariophyceae dominated all other classes followed by Chlorophyceae and Cyanophyceae. No apparent differences were found in phytoplankton composition at all the sampling sites. The distribution and density of phytoplankton species was influenced by physical and chemical factors of the pond environment. Phytoplankton showed significant correlation with certain abiotic parameters such as water and air temperature, phosphates, carbonates and chlorides.

Jagadeeshappa and Vijaya (2013) quoted that the increasing human activities in addition to natural causes affected the wetland ecosystem. Amongst the various water bodies, wetlands also play an important role in the biodiversity of this region. Their study documented the distribution of phytoplankton and their correlation with physicochemical conditions of water of four wetlands of Tumkur District from Karnataka. All the selected wetlands were surrounded by coconut garden and having a direct connection with the Hemavathi River channel. The result revealed the presence of one hundred fourteen species of phytoplankton from the wetlands. Among these, Chlorophyceae was the most dominant class in phytoplankton, followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae. In all these wetlands, the diversity of phytoplankton was more in pre monsoon compared to post monsoon and monsoon season. The results showed a seasonal fluctuation in the physicochemical characters of the water. That may due to entry of rain water and also due to change in the temperature, pH, turbidity, chloride, transparency, total dissolved solids, alkalinity, dissolved oxygen etc.

Narasimha and Benarjee (2013) studied the physicochemical characteristics and plankton diversity of a suburban perennial water body, located in Nagaram village in Warangal district of Andhra Pradesh. The results of the study revealed that Transparency, Total solids, Total dissolved solids, and Turbidity was maximum during rainy months. The pH, conductivity, hardness, dissolved oxygen and biological oxygen demand was higher during summer months. The chloride concentration was higher in the month of January. Phytoplankton was represented with thirty-one species belonging to four groups of which Chlorophyceae was dominant followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae. Their study helped in better understanding to the management of the Nagaram tank for intensive fish culture.

Elayaraj and Selvaraju (2014) studied the physicochemical parameters and cyanophycean members of two pond water quality of Chidambaram from Tamil Nadu. The study revealed that the relationship between phytoplankton density in general and that of the specific groups are highly complex and often controlled by interactions of different factors. In both pond water, the cyanophycean members positively correlated with temperature, pH, carbon dioxide, alkalinity, hardness, nitrate, biological oxygen demand and chemical oxygen demand; where as it was negatively correlated with acidity and dissolved oxygen. The study concluded that the cyanophycean members were highly tolerant organisms. They prefered to grow at higher temperature and in highly alkaline, biological oxygen demand and chemical oxygen demand containing water. Hence, they could stand with high levels of contaminated waters of Thillai Kali Kovil Pond, when compared to Ilamiyakkinar Kovil pond.

Elżbieta (2014) determined the response of planktonic cyanobacteria and periphyton assemblages to lamella separator treated storm waters in urban Lake Jeziorak Mały. The basic factors favored the cyanobacterial growth were water temperature and iron, while high chloride concentration limited their development. Cyanobacterial abundance recorded at the separators was half that of the pelagic zone because of a lower water temperature and higher chlorine concentration, indicating high algal sensitivity to the considerable velocity and disturbances caused by storm water effluents. Higher silicon and calcium concentrations at the separators and orthophosphates at sites with stones and gravel showed connection with the growth of various diatoms. The species richness was related with the water temperature, conductivity, pH, etc. Similarities in the periphyton dynamics in separator pipes and epilithon suggested the significant influence of separator treated storm water on these assemblages, in contrast to epiphyton and phytoplankton in the pelagial zone, where these waters had limited influence.

Ferdous and Nusrat (2014) mentioned that *'Marjad Baor'* is the largest oxbow lake of Bangladesh. Physicochemical characteristics and phytoplankton diversity were studied to determine the water quality of lake. Important physical and chemical parameters prevailing in the study area such air temperature, water temperature, transparency, Electrical Conductivity, Total Dissolved Solids, Hydrogen Ion Concentration, Dissolved Oxygen, Biological Oxygen Demand, free carbon dioxide, carbonate and bicarbonate alkalinity, calcium and magnesium hardness, total hardness, chloride content, nitrate and phosphate were analyzed. Seasonal variation in these parameters was observed. Total phytoplankton abundance was high in January and low in March that showing the trend of frequent phytoplankton growth. *Oscillatoria sp.* was the dominant in the water which is known as the main contributor to eutrophication.

Jyotsna *et al.* (2014) investigated some hydrographical and chemical properties of Karagam lake near Narasannapeta of Srikakulam District from Andhra Pradesh. In their investigation, seasonal changes in the growth and distribution of phytoplankton along with physicochemical parameters were studied. The average values of pH, turbidity, conductivity, dissolved oxygen, biological oxygen demand, carbonate, bicarbonate, dissolved solids, chloride, fluoride, ammonia, nitrate, phosphate, silicate were showed the monthly fluctuation. The dominant members belong to Chlorophyceae with twenty-six genera followed by Bacillariophyceae with eighteeen genera, Cyanophyceae seventeen genera and Euglenophyceae with three genera. During the two years of investigation, maximum algal forms present in this lake were Chlorophyceae and Bacillariophyceae, moderate was Cyanophyceae while Euglenophyceae contributed the lowest forms.

Pandey *et al.* (2014) studied the phytoplankton diversity of Harda swamp from Purnia in relation to certain physicochemical factors. A total of 27 genera of phytoplankton belonging to four groups namely Chlorophyceae, Myxophyceae, Bacillariophycae and Euglenophyceae were found in the swamp. The most abundant group was Chlorophyceae followed by Myxophyceae, Bacillariophycae while least was Euglenophyceae. The phytoplankton density was higher in summer, moderate in winter while lowest in monsoon. The species diversity of phytoplankton was found to be maximum in monsoon followed by winter and summer. The species belonging to Chlorophyceae were most dominant. Pollution tolerant species found in swamps were stagnation of waters for the most of the period and limited water recharge. The swamp harbours many allergenic algae such as *Chlorella ulgaris, Anabaena sp., Microcystis sp., Nostoc sp.* and *Oscillatoria sp*. The swamps harbour many pollutions tolerant species like *Cyclotella, Fragilaria* and *Navicula*. Phytoplanktons showed negative correlation with pH, dissolved oxygen and bicarbonate. On the basis of observations, the swamp water was polluted**.**

Sitre *et al.*, (2014) studied the aquatic weed of Chora village of Bhadrawati tehsil of Chandrapur district. The investigation revealed sixteen macrophyte species in the catchment area of the reservoir. Out of these macrophytes from the study area, four species belong to free floating, five rooted floating and four submerged types whereas three species belong to emergent type. The people residing nearby this reservoir use this reservoir for washing and bathing activities and for open defecation practices in the bank add anthropogenic source of pollution leading to enriching its nutrient contents thereby subsequently degrading the water quality and copious growth of aquatic weeds. This pond is a closed type of ecosystem having embankments on all the sides and the sediments of this lake are constantly getting polluted due to human activities present near the basin and anthropogenic interference by dumping sewage and drainage from the nearby localities.

Abubakarm *et al.* (2015) assessed the phytoplankton and physicochemical parameters of Kazaure dam of Nigeria. The study determined the weekly variation of some of the physicochemical parameters. Temperature, pH, dissolved oxygen, biological oxygen demand, nitrate, phosphate and transparency and phytoplankton occurrence in water samples of Kazaure dam were analyzed. The analyzed physicochemical parameters showed significant weekly variations in the sampling points. A total of 28 species of the phytoplankton were observed in this study, belonging to three classes, Bacillariophyta, Chlorophyta and Cyanophyta. The Bacillariophyta were found to be the most diverse class with fifteen species followed by Chlorophyta with eight species and Cyanophyta with five species.

Alhassan and Hazel (2015) mentioned that temporary fresh water pools support invertebrate communities especially planktons. The high variability in environmental condition connected with relatively unpredicted flooding regime limit for specialized species with high tolerance to stress and specific feature for surviving the dry phase. The physicochemical parameters like temperature, dissolved oxygen and pH are vital to the survival of many temporary water species as it provides essential indications that regulate the timing of life cycles, flight periodicities and colonization dynamics. Freshwater ecosystem served as an important asset for man and habitation for an extraordinary rich, endemic and sensitive species. Increase in human demand on these ecosystems results to large and rising threats to biodiversity and for that recording diminishes of biodiversity, identifying their causes, and finding solutions have become necessity in freshwater ecosystem.

Asha *et al.* (2015) studied the plankton diversity of 36 selected ponds in Nedumangad Block Panchayat. It was crucial to observe the physicochemical features of a water body for different term investigations as the survival and activity of organisms depends on the environmental characteristics of those water bodies. Plankton analysis showed the presence of phytoplankton belonging to the class Cyanophyceae, Chlorophyceae, Bacillariophyceae and zooplanktons found are *Zoea* larvae and *Mysis* larvae of prawn. Moreover, phytoplankton reflects the water environmental condition at the time of growing and sampling. Phytoplanktons were greatly affected by ecological conditions like salt stress, temperature, pH, biological oxygen demand and other environmental factors. The plankton abundance was depending on the temperature variations and levels of dissolved oxygen as they were positively correlated while abundance does not have any interdependence on both the conductivity and pH as they were negatively correlated. Results of investigation clearly showed that the water was not good for human consumption and also struggling for own existence. Algal analysis thus showed that water quality of the pond had reached at threshold level and therefore, it needed some corrective measures to maintain the water quality of the pond and that would help the society to get an awareness of the quality of the water they were using for daily consumption and thereby rectify the present condition.

Kather *et al.* (2015) studies the plankton diversity and water quality of Ambattur lake. The lake is situated in Ambattur of Thiruvallur District of the Indian state Tamil Nadu. It is one of the biggest lake acts as reservoir in Chennai, located in Thirumullaivayil of Tamil Nadu. During their study, the surface water samples were collected from five different locations at regular interval. Physicochemical parameters and biological parameters were investigated. A total of twenty-two species of plankton were recorded and fluctuations among physicochemical parameters during the investigation were also noticed during the study.

Sunder (2015) studied the plankton diversity and density with physicochemical parameters of open pond in Town Deeg from Bhratpur of Rajasthan. The planktons were counted by using Sedgwick 4 Rafter Counting Cell method. Pond water samples were collected for physicochemical parameters. The studied physicochemical parameters like temperature, transparency, pH, total dissolved solids, conductivity, salinity, dissolved oxygen, and alkalinity showed the monthly fluctuation. During study, thirty-six taxa of phytoplankton consisted of five families namely Cyanophyceae, Chlorophyceae, Euglenophyceae, Bacillariophyceae and Dinophyceae were encountered. The presence of species such as *Microcystis, Phacus, Oscillatoria, Surirella Closterium, Aphanocapsa*, *Anabeana* and *Euglena* showed that the pond was likely to be polluted. The study provided an important basis to assess the fish production potentialities and to formulate sustainable aquaculture practices in man-made habitats and fishery management policies in concerned aquatic ecosystems.

Dhanam *et al.* (2016) carried out a study in the Ousteri lake of Puducherry. The samples were analyzed for various physicochemical parameters like water temperature, pH, Free carbon dioxide, dissolved oxygen, turbidity, electrical conductivity, total dissolved solids, total alkalinity, chloride, phosphate, nitrate, biological oxygen demand and chemical oxygen demand were analyzed. Results showed an increased concentration in physicochemical parameters that was more in summer as compared to other seasons. The plankton studies were noticed that a total of twenty-four species belonging to twenty-six genera under the four classes. Among these, Cyanophyceae comprised of fifteen species followed by Chlorophyceae with nine species, Bacillariophyceae with seven species and Euglenophyceae with three species were recorded. The Cyanophyceae algal growth was dominated over Chlorophyceae, Bacillariophyceae and Euglenophyceae.

Idhole *et al.*, (2016) observed the eight microphyte species belonging to seven families from the wetlands of the Washim region of Maharashtra. The present study shows that Hydrilla, duckweed, vallisneria were found most abundant at Ekburgii dam, Narayan Baba Talav. The dense vegetation of Nymphaea was also observed at Ekburgii dam. Their study concludes that further studies may be done to develop biodiversity of Aquatic plants are essential components of healthy aquatic systems. All plants whether in or around water play the important role in photosynthesis. They use sunlight, carbon dioxide, and water to grow and produce new plant tissue. They also produce oxygen through this process. It has been assured that aquatic weed has assumed greater awareness of the pollution in Aquatic ecosystem. The study of aquatic weeds is important in environmental monitoring as possible indicator of physiological and chemical changes in environmental ecosystem. This diversity of Aquatic weeds is useful biomarker for environment ecosystem.

Kemal and Sevindik (2016) studied the phytoplankton diversity and physicochemical status of Çaygören reservoir of Turkey. Their study revealed the presence of one hundred ninety-two taxa in nine divisions. The Bacillariophyta, Chlorophyta, Cryptophyta, Cyanobacteria were dominated phytoplankton at least for one season during the observation period. Species of Cryptophyta dominated phytoplankton during the winter, while Chlorophyta and Streptophyta species were dominant in the fall. Bacillariophyta species dominated phytoplankton in the spring and Cyanobacteria were dominant in the summer. The maximum phytoplankton biomass and abundance were recorded in summer and the minimum biomass and abundance were recorded in winter. The correlation results showed that water temperature, transparency, phosphate, oxidation-reduction potential and water discharge had significant effects on the dynamics of dominant phytoplankton of the reservoir.

Sudhakaran *et al.* (2017) determined the influence of physicochemical properties of water on phytoplankton population of two lake ecosystem namely Kirumambakkam and Korkadu from Pondicherry region of India. The sulphate, organic carbon, phosphate, sodium, potassium, dissolved oxygen, salinity and total dissolved solids were higher in Kirumamabakkam lake water samples. The ammonia, nitrate and biological oxygen demand were higher in Korkadu lake water samples. During study period, total thirteen species of phytoplankton were represented by diverse groups Chlorococcales with four species, Volvocales with three species, Oscillatoriales with two species while Euglenales, Nostocales and Pennales with single species each. Population density of phytoplankton of Kirumamabakkam and Korkadu lakes were observed to be well influenced by physicochemical properties of water.

Chunne and Nasare (2018) reported results of comparative analysis of phytoplankton diversity assessment between Nandgaon and Arwat lake of Chandrapur district of Indian state Maharashtra. Both the lakes have different entity from each other with respect to inflow source, depth, vegetation and surroundings. Result showed that both the lake had floristic similarities and differences. Total seventy-four species of phytoplankton were recorded during study period. The Nandgaon lake revealed the fourty three species of phytoplankton while Arwat Lake represented thirty-one species of phytoplankton. Chlorophyceae was found to be dominant group during study seasons. The phytoplankton assemblage of studied lakes showed the significant relation with their physicochemical status.

Rawat and Trivedi (2018) assessed the phytoplankton species diversity in reference to physicochemical parameters of fresh water Khedi Kalan station of Dholawad dam of Madhya Pradesh. Their work was useful to explore Phytoplankton species, their composition along with relation with physicochemical parameters of concern water body. The phytoplankton could be used as the indicator of physicochemical status of any water body. Physicochemical parameters play significant role for algal growth. A total of five groups Chlorophyceae, Bascillariophyceae, Cynophyceae, Dinophyceae and Euglenophyceae of phytoplankton were identified during the study period. These groups showed the significant relation with physicochemical status of dam.

Sharma and Tiwari (2018) performed the assessment of physicochemical parameters and phytoplankton diversity of Nachiketa Tal from Himalaya. Study revealed the presence of seventy-one taxa of phytoplankton belonging to 57 genera. Phytoplankton in the lake was represented by six major families namely Bacillariophyceae, Chlorophyceae, Cyanophyceae, Xanthopyceae, Dinophyceae and Euglenophyceae. The overall phytoplankton density was found to be abundant in winter season, declined in monsoon season. But the population of Cyanophyceae and Euglenophyceae was found to be high in summer season. Results showed the increases in turbidity, total dissolved solids in monsoon season were the driving factors for decreasing the phytoplankton density in the lake. The distribution of phytoplankton in the lake was dependent on the variability of physicochemical factors.

Sivalingam (2018) examined the water quality of Manchiryal town lake of Adilabad district from Andhra Pradesh. The water quality analysis helped him to know the suitability of water for different purpose like agriculture, industrial and domestic uses etc. The physicochemical parameters were used to indication of water quality. In the study period thirteen parameters were analysed to water quality of lake used by stranded method. They were atmosphere temperature, water temperature, pH, transparence, turbidity, total dissolved solids, total hardness, dissolved oxygen, biological oxygen demand, chemical oxygen demand, chorine, phosphate and sulphate. The lake surrounding devotional activities was main cause to pollution of water quality. The main cause to pollution of this lake urbanization, industrialization, domestic uses, devotional activities and people interact with lake surroundings. Because domestic activities and sewage consult to the rainy season are main causes to the pollution of lake water.

Prajapati and Patel (2019) **s**tudied the diversity of phytoplankton in relation to physicochemical parameters with respect to pollution status of two perennial ponds of Mehsana from Gujarat. The study was conducted in the month of February. The sixteen species were identified that belonging to cyanophyceae, bacillarophyceae and chlorophyceae. The high value of physicochemical parameters and low phytoplankton diversity were recorded in the Chhatiyarda pond. The low value of physicochemical parameters and high phytoplankton diversity were recorded in the Panchot Pond. The identified species *Oscillatoria, Gleocapsa, Spirulena, Nostoc* belongs to Cyanophyceae; species such as *Navicula, Synedra, cymbella, Nitzschia, Amphiplura* were belongs to Bacillariophyceae, while *Closterium, Spirogyra, Zygnema, Oedogonium* and *Ulothirx* were of chlorophyceae. It was remarkable that the chlorophyceae population were found as the most abundant group in both the ponds.

The above literature clearly indicated that many researchers made the attempts to study the phytoplankton diversity from different fresh water ecosystem of India. In same concern the present was conducted during February 2016 to January 2019 to analyze the phytoplankton diversity of Adan reservoir of Washim district with reference to physicochemical condition.

MATERIALS AND METHODS:

The study was conducted during February 2016 to January 2019 to analyze the phytoplankton diversity of Adan reservoir of Washim district with reference to physicochemical status. The effective protocol was adopted during study. The applied methods were as mentioned below-

STUDY AREA

India: The Land of Geographical Diversity

India is vast country and is considered as a sub-continent for its vastness. This Sub-continent extending from the Himalayas to the sea is called the land of Bharat. India is situated at north of the equator, between 800.40” to 370.60” North latitude and 680.70” to 970.25” East longitude. Geographically India can be divided into four regions. The first is the cold regimes of Himalayan region or the Northern Mountain wall that extends from Kashmir in the west to Assam in the East. The second region is the great and big Northern plains which are provided with water by the rivers like Indus, Ganges, Brahmaputra and their tributaries. Due to this region is most fertile and productive. The third region comprised of the Plateau of the Central India and the Deccan. The rain forest of Western Ghats and Eastern Ghats are stretched on the two sides of the Deccan which meets at the Nilgaris. The Coromandal cost stands between the Eastern Ghats and the Bay of Bengal. In addition, India is situated at the tri junction of African, Eurasian and Oriental biota.

The Deccan Plateau

The Deccan Plateau is a large plateau in India which covers most of the Southern part of the country. It is between three mountain ranges and extends over eight Indian states: particularly the state of Telangana, Maharashtra, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu are on this plateau. The plateau covers 422,000 square Kilometers and that of 43 % of India’s landmass. The plateau is extremely large and there are many habitats; different ecosystems with different sorts of vegetation, climate, geology and animals. The forests on the plateau are older than the Himalayan Mountains. On the west of the plateau are the Western Ghats. These mountain ranges rise from their nearby coastal plains and nearly meet at the southern tip of India. The mountains make the Southward pointing vertex of a triangle. The northern boundary of the triangle is made up by the Satpura Range and Vindya Range. The northern range separates the plateau from the heavily populated riverine plains of northern India.

Figure 1: Map of India with Vidarbha highlighted in red

Vidarbha Region of Maharashtra

Vidarbha is the eastern region of the Indian state of Maharashtra comprising Nagpur and Amravati division. Geographically Vidarbha lays northern part of Deccan plateau. The total geographical area of Vidarbha is 97,321 square kilometer. This is diverse part of the country with thick dry deciduous forest in the eastern most part and semi arid, agriculture dominated area in the west. Large basaltic rock formations exist throughout Vidarbha, part of the 66 million year old volcanic Deccan traps.

Washim District

Washim district is located in the eastern region of Vidharbha. It is situated in Amravati division of Maharashtra state in Western India. Geographically Washim district lies in between longitude 16.61-21.16 N and latitudes 76.7-77.4 E. Akola present to its north, Amravati lies to its north-east, Hingoli lies to its south, Buldhana lies to its west, Yavatmal lies to its east. The district is characterized by numerous rivers and water bodies. These water resources support the live hood of the area. There are hilly ranges extending from through the tehsils of Malegaon, Washim, Mangrul Pir and Manora. There is plain region in the basins of River Penganga in the Risod Tehsil (Washim Gazetteer, 2018).

Figure 2: Map of Adan Dam representing the location of sampling sites

Morphometry of Adan Reservoir

Adan reservoir is an earthfill and rockfill dam on Adan river near Karanja, Washim district in state of Maharashtra in India. During monsoon reservoir gets enough water but in post monsoon period particularly March and April water level is very much reduced. The reservoir is surrounded by red laterite soil and black cotton soil. The inland reservoir is fed by seasonal drainage to its periphery and nearby local streams and springs. After detailed survey of the reservoir, 04 convenient stations were fixed for study.

Adan Reservoir at a Glance:

Feature	Details
Coordinates	20°25′17.55″N 77°33′47.07″E
Type of dam	Earthfill
Impounds/ Source	Adan river
Height	30.13 m (98.9 ft)
Length	755 m (2477 ft)
Dam volume	1428 km^3(343 cu mi)
Total capacity	67,250 km^3(16,130 cu mi)
Surface area	10,520 km^2(4,060 sq mi)

CLIMATE AND ENVIRONMENTAL CHARACTERISTICS

Climate: The winter season is from December to about the middle of February followed by hot summer season which last up to May. June to September is the south-west monsoon, whereas October and November constitute the post-monsoon season.

Temperature: Area experiences extreme variations in temperature with very hot summers and very cold winters. The mean minimum temperature is 14.4^0C and means maximum temperature is 45.8^0C at town in the district. The summers are extremely hot while the winters are dry and very cold the temperature may drop to 5 °C.

Rainfall: The rainfall analysis for reveals that the normal annual rainfall over the district varies from 750 to 950 mm from south west monsoon during June to September (Falling Rain genomics, 2018).

Humidity: Except during the southwest monsoon season when the humidity ranges between 60 to 80 % the air is generally dry over the area. The summer months are the driest when the relative humidity is even less than 20% in afternoon on many days.

Cloudiness: The skies are heavily clouded to overcast during southwest monsoon season in the latter half of the summer season and the post monsoon season there is moderate cloudiness particularly in the afternoons. In the rest of the year, clear or lightly clouded skies generally prevail.

Wind: Winds are generally light with some strengthening in speed in the latter part of the hot season and in the early part of the monsoon season. The winds are mostly from the northeast or east during the post monsoon and yearly cold weather season. With February, wind become westerly to north western and continued to be so until June. In southwest monsoon season wind direction between southwest and northwest are most common. Hailstorms are common during February to April and also during the post monsoon period from November to January.

FIELD VISIT AND SAMPLE COLLECTIONS:

Field Stations

For convenient monitoring, systematic field study and regular sampling stations were fixed at the reservoirs, after detailed survey of the reservoir four stations were fixed. The outlets, inlets, morphometric features were the important factors considered during selection of the sampling stations. These stations were designated as A, B, C and D.

- Station A: Inlet area – West Side
- Station B: Storage Area – North Side
- Station C: Storage Area - South Side
- Station D: Outlet Area – East Side

Water Sample Collections

Water samples were collected separately from the reservoir during early morning from 07.00 a.m. to 08.30 a.m. in the first week of each month. Samples for physicochemical analysis were collected manually from two different depths. Samples were collected from surface (1-2 cm) and bottom (maximum 10 meters) regions of the reservoir. Variations occurred in sampling according to the variations in water level of the reservoir. Samples were collected directly from the surface of water with the help of 2 liters acid cleaned bottles and samples were transferred to the acid cleaned 2 liters polythene bottles using a plastic tube. All possible precautions were taken to avoid air bubbles. These water samples were kept in darkness packed in an ice box at 4^0C till the samples reached laboratory for analysis. All the analysis was carried out as per procedures suggested by Trivedy and Goel (1986) and APHA (1998).

Water samples were collected for the study of all the phytoplankton. The phytoplanktons were collected with the help of filtering net. The known quantity (1000 liter) of water filtered from sampling site through zooplankton net which is made up of fine mesh and phytoplankton collected in to 100 ml bottle which is attached at the bottom of net. The samples were preserved in 4% formaldehyde solution and studied for diversity by using standard key literature.

LABORATORY ANALYSIS

Temperature

The water temperature was measured at the sampling sites during early in the morning between 07.00 to 08.30 a.m. by mercury thermometer of range 0^0C to 50^0C and with 0.2^0C least count. The water sample was taken in measuring cylinder and its temperature was recorded immediately by immersing the thermometer up to the level of mercury in capillary column in water for sufficient time so as to get a constant level of reading. The temperature was recorded in degree Celsius (^{0}C)

pH

The pH is negative log 10 of hydrogen ion concentration. A neutral solution has a pH of 07 while less than 07 render it acidic and pH more than 07 is alkaline. The values measured in the field with the help of portable digital pH meter. Standard buffer solutions were used for calibration.

Transparency

Transparency or light penetration in a body of water is one of the most important characteristics of water quality. Transparency of water largely depends on the optical properties which are influenced by particular impurities present in it. It is commonly determined by using Secchi disc of metal. Secchi disc is a circular disc of 20 cm in diameter, painted on the Upper surface alternately white and black in a radial fashion. For lowering, it is tied with the help of nylon wire. The Secchi disc was dipped in water with the help of rope till it disappeared from the view and then uplifted till it reappeared. Disappeared and reappeared readings were measured with the help of scale in cm. The average readings of these two depths were considered the limit of visibility. The transparency calculated by following formula as below

$$\text{Secchi disc transparency (cm)} = \frac{A\text{-}B}{2}$$

Where,

A- Depth at which Secchi disc disappears (cm)

B- Depth at which Secchi disc reappears (cm)

Transparency is dependent on turbidity which directly proportional to the amount of suspended matter.

Total Dissolved Solids

A total dissolved solid constitutes mainly the various kinds of minerals present in water. The total dissolved solids were estimated by gravimetric method in mg/liter. A suitable sized, dried evaporating beaker was taken and weighed. Then 100 ml sample was filtered through Whatman filter paper No.42. Filterd sample was collected into pre weighed beaker and kept on a water bath for evaporation. After evaporation beaker was kept in an oven at 103 ^{0}C for one hour. After cooling the final weight (A) of beaker was taken. Amount of total dissolved solids (TDS) was calculated by using following formula-

$$\text{TDS (mg/lit)} = \frac{(A\text{-}B) \times 1000 \times 1000}{V}$$

Where,

A - Final weight of beaker in gm, B – Initial weight of beaker in gm.

V- Volume of sample evaporated in ml.

Total hardness

Total hardness was determined with titration method by using EDTA (Ethylene di amine tetra acetic acid disodium salt). For determining hardness 50 ml of water sample was taken in a conical flask. To this 01 ml of ammonia buffer solution and a pinch of erichrome black T indicator was added and titrated against 0.01 M EDTA titrant till color changed from the wine-red color to sky blue. The amount of total hardness was calculated using the following formula.

$$\text{Total hardness (mg/lit)} = \frac{\text{ml of titrant} \times 1000}{\text{Volume of sample}}$$

Total alkalinity

Two drops of methyl orange indicator were added to the solution in which phenolphthalein alkalinity was already determined. That was titrated with 0.1 N HCL up to color changed from yellow to pink. It was calculated by following formula

$$\text{Total alkalinity as } CaCo_3 \text{ (mg/lit)} = \frac{\text{ml of titrant x N x 1000 x 50}}{\text{Volume of sample}}$$

Where, N-Normality of HCL

Dissolve oxygen

Dissolved oxygen present in natural waters depends on physico-chemical and biological activities in the water body. Its solubility is related to pressure and temperature. Dissolved oxygen was determined by modified Winkler's method. During the sampling, the water samples were collected in 300 ml of BOD bottles without bubbling and by taking all necessary precautions. After collection 1 ml of $MnSO_4$ and alkaline KI was added in water sample by using separate pipettes. It was thoroughly mixed and brown precipitate was allowed to settle. After returning to the laboratory 1 ml of Concentrated H_2SO_4 was added through the side of bottle to dissolve the brown precipitate. After 100 ml of this solution was taken into conical flask and titrated against 0.025 N Sodium thiosulphate ($Na_2S_20_3$) up to color changes blue to colorless by using 1% as an indicator (Trivedy and Goel, 1984). The dissolved oxygen content was calculated by using following formula –

$$\text{Dissolved oxygen (mg/lit)} = \frac{\text{Ml of titrant x N x 8 x 1000}}{V_2 \{V1\text{-}V/V1\}}$$

Where,

N - Normality of titrated Sodium thiosulphate

V2 - Volume of sample used for titration (100 ml)

V1 - Volume of BOD bottle (300 ml)

V - Volume of MnSo4 and Alkaline KI used (1 ml)

Chlorides

Chloride was estimated by taking 50 ml of water sample in a conical flask. 02 ml of 5% potassium chromate (K_2CrO_4) was added in to it. Then it was titrated with 0.02 N Silver nitrate until a persistent radish brown tinge appeared. Chloride was calculated by using the following formula –

$$\text{Chloride (mg/lit)} = \frac{\text{Ml of titrant x N x 1000 x 35.5}}{\text{Volume of sample}}$$

Where, N = Normality of $AgNO_3$

Sulphate

Sulphate is widely distributed in nature and may be present in natural water in concentrations ranging from a few to several thousand milligrams/litre. It is one of the major anions occurring in natural waters. Sulphates in water are generally bound to alkali and alkaline earth metals and are readily soluble. Sulphates were estimated spectrophotometrically at 420 nm against a standard curve. For estimation, 50 ml of sample was filtered through Whatman filter paper No.1. About 10 ml of NaCl-HCl and 10 ml of glycerol-ethanol solutions were added one after the other. Then 0.15 gm of barium chloride was added to it and mixed it for 30 minutes with the help of magnetic stirrer, absorbance was measured against a distilled water blank at 420 nm. The observed absorbance is expressed in mg/L.

Nitrates

The values of nitrate were estimated by spectrophotometrically at 410 nm. First 25 ml of sample was evaporated to dryness on water bath. To the residue 0.5 ml phenol di- sulphonic acid solution was added to dissolve solid. Later on, 5 ml distilled water and 1.5 ml concentrated liquid ammonia was added and stirred. A yellow color was developed. Readings were taken on spectrophotometer at 410 nm against distilled water blank. The values of nitrate were calculated with calibration cure. Results were expressed as mg/lit.

Phosphates

Phosphates were estimated by spectrophotometrically. At first 50 ml sample was taken in a conical flask. To it, 2 ml of molybdate and 5 drops of stannous chloride were added, blue color appears indicates the presence of phosphates. Reading was taken on spectrophotometer at 690 nm after five minutes. The conc. of phosphates was found out with help of standard curve and results expressed as mg/lit.

Phytoplankton

Each of the 1 lit sample collected was centrifuged to concentrate the plankton organisms. These samples were made up 100 ml after removing the surface water in the centrifuge tube. Phytoplankton was studied for quantitative and qualitative details. Counting was made using a stereomicroscope with 40x magnification using drop method (Trivedy, and Goel 1986) and thus the phytoplankton of the concentrate was calculated. The actual count/liter was calculated from this by dividing it with the concentrations factor 10. Colonial and filamentous forms counted as single units. The phytoplankton was identified using the standard keys provided by Reynolds (1980). The micro-photographs of representative sample were taken using a digital camera.

Aquatic weeds

Aquatic weeds were collected by field visits and visual observations. The survey was conducted to collect information regarding floating, emergent, marginal and submerged type of vegetation. The macrophytes were collected by hand picking and brought to the laboratory and were identified using Kamble and Pradhan (1988); Cook (1996) and other standard literature.

STATISTICAL ANALYSIS:

Results were recorded as Mean ± Standard Deviation (SD). Data were collected, organized and analyzed with using of the Microsoft Excel Program (Joshi *et al.*, 2015). Diversity and correlation were quantified with the help of PAST Version 1.60 software (Hammer *et al.* 2001). The *p value* <0.05 was considered to be statistically significant.

OBSERVATIONS AND RESULTS:

PHYSICOCHEMICAL ANALYSIS

Water Temperature

During study, itwas ranges from 20.43 to 28.51^{0}C. It was minimum during the months of winter and maximum in months of summer.

Table 1: Water Temperature (^{0}C) at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	26.42	26.17	26.96	27.92	26.87	0.775
2	March	27.52	27.47	28.06	28.42	27.87	0.455
3	April	27.62	27.67	28.16	28.62	28.02	0.470
4	May	26.32	26.27	26.86	25.12	26.14	0.732
5	June	25.82	26.97	26.36	25.12	26.07	0.787
6	July	24.12	26.07	24.66	24.02	24.72	0.944
7	August	23.12	24.87	23.66	23.92	23.89	0.732
8	September	23.12	24.47	23.66	23.22	23.62	0.615
9	October	21.12	21.67	21.66	21.42	21.47	0.259
10	November	20.52	19.97	21.06	20.92	20.62	0.489
11	December	21.32	21.47	21.86	20.72	21.34	0.473
12	January	22.12	22.27	22.66	21.92	22.24	0.313

Table 2: Water Temperature (^{0}C) at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	26.92	26.67	26.77	27.92	27.07	0.576
2	March	27.62	27.37	27.67	28.22	27.72	0.358
3	April	27.52	27.27	27.47	28.52	27.70	0.561
4	May	26.12	25.87	26.37	25.52	25.97	0.363
5	June	27.12	26.87	26.27	26.02	26.57	0.512
6	July	26.72	26.47	27.07	25.82	26.52	0.528
7	August	24.22	23.97	24.17	23.42	23.95	0.366
8	September	24.52	24.27	23.97	23.72	24.12	0.349
9	October	22.12	21.87	21.57	21.82	21.85	0.225
10	November	21.12	20.87	21.07	20.82	20.97	0.147
11	December	21.42	21.17	21.67	20.82	21.27	0.363
12	January	22.12	21.87	22.57	21.32	21.97	0.521

Table 3: Water Temperature (^{0}C) at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	27.27	27.42	27.47	27.96	27.53	0.299
2	March	28.27	28.32	28.57	28.86	28.51	0.271
3	April	28.47	28.42	27.77	28.96	28.41	0.488
4	May	25.17	24.72	24.67	25.26	24.96	0.303
5	June	24.77	24.62	25.27	25.16	24.96	0.310
6	July	23.97	24.32	23.57	24.86	24.18	0.547
7	August	21.57	21.72	21.37	22.26	21.73	0.381
8	September	20.97	21.42	21.57	21.96	21.48	0.409
9	October	21.37	21.22	21.17	21.76	21.38	0.267
10	November	20.87	20.42	20.47	20.96	20.68	0.275
11	December	20.17	20.62	20.57	20.36	20.43	0.207
12	January	21.47	21.82	21.47	22.16	21.73	0.331

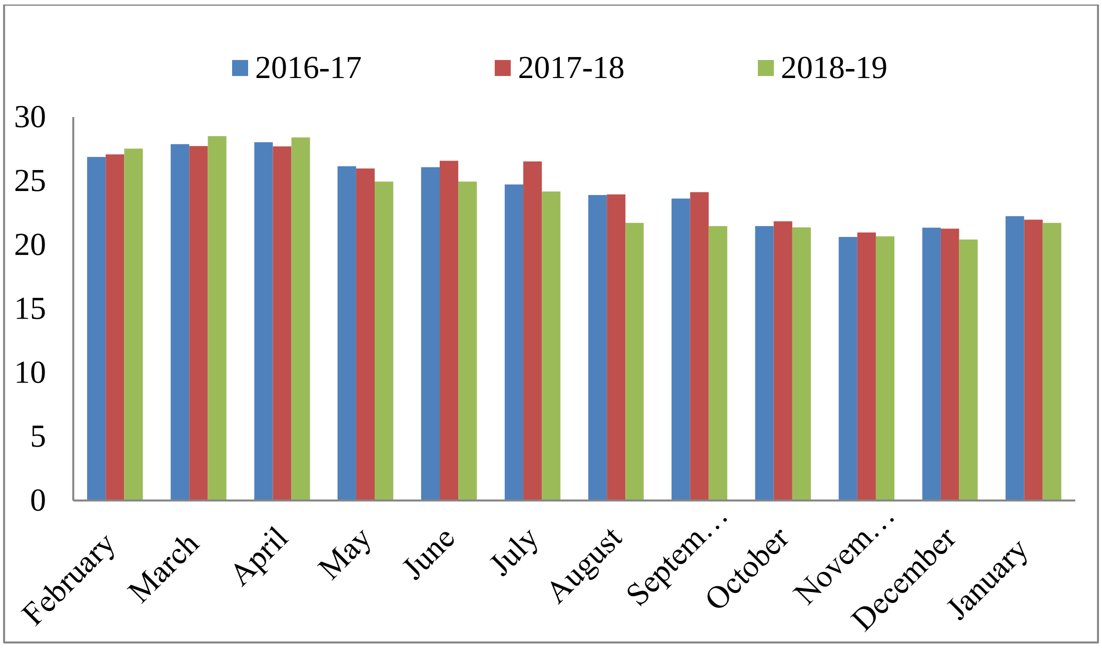


Figure 1: Water Temperature (^{0}C) at different station of Adan Reservoir

Water pH:

During study, itwas ranges from 7.47 to 8.79. It was minimum during the months of winter and maximum in months of late summer to early monsoon

Table 4: Water pH at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	8.39	8.53	8.39	8.36	8.43	0.272
2	March	8.49	8.53	8.39	8.61	8.51	0.091
3	April	8.19	8.43	8.79	8.71	8.53	0.274
4	May	8.21	8.83	8.79	8.91	8.69	0.321
5	June	8.39	8.83	8.49	8.91	8.66	0.254
6	July	8.49	8.93	8.09	8.61	8.53	0.347
7	August	8.19	8.53	8.29	8.61	8.41	0.198
8	September	8.39	8.53	8.19	8.81	8.48	0.261
9	October	7.39	7.43	7.59	7.61	7.51	0.111
10	November	7.39	7.63	7.49	7.71	7.56	0.143
11	December	7.59	7.93	7.79	7.91	7.81	0.156
12	January	8.19	8.16	8.19	8.25	8.20	0.038

Table 5: Water pH at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	**A**	**B**	**C**	**D**	**Mean**	**± SD**
2	March	8.63	8.71	8.33	8.49	8.54	0.167
3	April	8.33	8.71	8.43	8.29	8.44	0.189
4	May	8.43	8.61	8.53	8.29	8.47	0.138
5	June	8.33	9.01	8.93	8.59	8.72	0.315
6	July	8.53	9.01	8.73	8.89	8.79	0.208
7	August	8.73	9.11	8.43	8.79	8.77	0.279
8	September	8.23	8.71	8.23	8.09	8.32	0.271
9	October	8.63	8.71	8.53	8.29	8.54	0.182
10	November	7.33	7.61	8.03	7.29	7.57	0.341
11	December	7.63	7.81	7.63	7.79	7.72	0.098
12	January	7.73	8.11	7.73	7.79	7.84	0.182

Table 6: Water pH at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	8.53	8.61	8.59	8.43	8.54	0.081
2	March	8.42	8.51	8.47	8.52	8.48	0.045
3	April	8.93	8.61	8.39	8.93	8.72	0.264
4	May	8.93	8.51	8.59	8.93	8.74	0.222
5	June	8.93	8.71	8.59	8.63	8.72	0.152
6	July	8.73	8.91	8.29	8.23	8.54	0.332
7	August	8.43	8.41	8.29	8.43	8.39	0.067
8	September	8.63	8.81	8.49	8.33	8.57	0.204
9	October	7.33	7.51	7.29	7.73	7.47	0.201
10	November	7.43	7.81	7.39	7.63	7.57	0.194
11	December	7.93	7.91	7.59	7.93	7.84	0.167
12	January	8.43	8.51	8.19	8.33	8.37	0.138

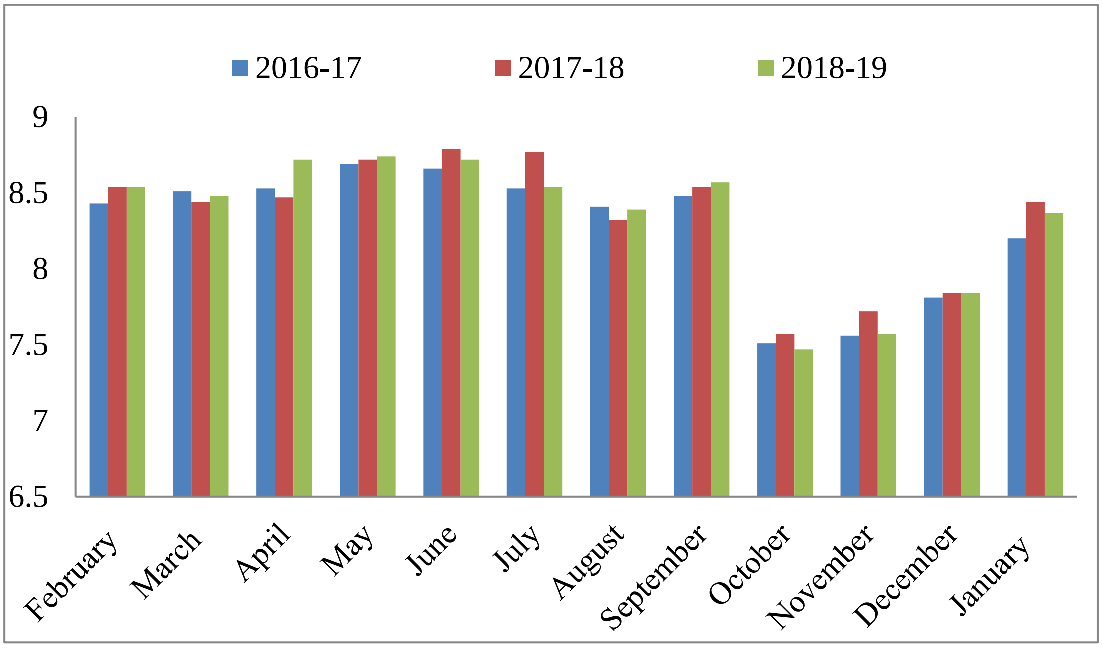


Figure 2: Water pH at different station of Adan Reservoir

Water Transparency:

During study, it was ranges from 30 cm to 107 cm. It was minimum during the moths of monsoon while increased during winter to summer.

Table 7: Water Transparency at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	78	71	74	68	72.75	4.272
2	March	63	70	68	67	67.00	2.944
3	April	55	54	56	51	54.00	2.160
4	May	50	52	52	49	50.75	1.500
5	June	47	46	46	43	45.50	1.732
6	July	28	32	31	29	30.00	1.826
7	August	38	38	42	35	38.25	2.872
8	September	45	51	46	48	47.50	2.646
9	October	66	71	76	68	70.25	4.349
10	November	95	96	106	93	97.50	5.802
11	December	98	111	105	108	105.50	5.568
12	January	108	103	109	104	106.00	2.944

Table 8: Water Transparency at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	88	68	71	78	76.25	8.884
2	March	65	67	70	66	67.00	2.160
3	April	50	51	54	51	51.50	1.732
4	May	47	49	52	48	49.00	2.160
5	June	45	43	46	44	44.50	1.291
6	July	30	29	32	30	30.25	1.258
7	August	40	35	38	38	37.75	2.062
8	September	44	48	51	46	47.25	2.986
9	October	70	68	71	69	69.50	1.291
10	November	95	93	96	94	94.50	1.291
11	December	103	108	111	106	107.00	3.367
12	January	102	100	103	103	102.00	1.414

Table 9: Water Transparency at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	81	91	90	86	87.75	3.304
2	March	65	68	65	68	66.50	1.732
3	April	52	53	53	55	53.25	1.258
4	May	48	50	49	52	49.75	1.708
5	June	44	48	43	47	45.50	2.380
6	July	28	33	28	32	30.25	2.630
7	August	38	43	39	39	39.75	2.217
8	September	45	47	43	49	46.00	2.582
9	October	69	73	73	70	71.25	2.062
10	November	96	98	103	97	98.50	3.109
11	December	102	106	102	107	104.25	2.630
12	January	104	105	106	105	105.00	0.816

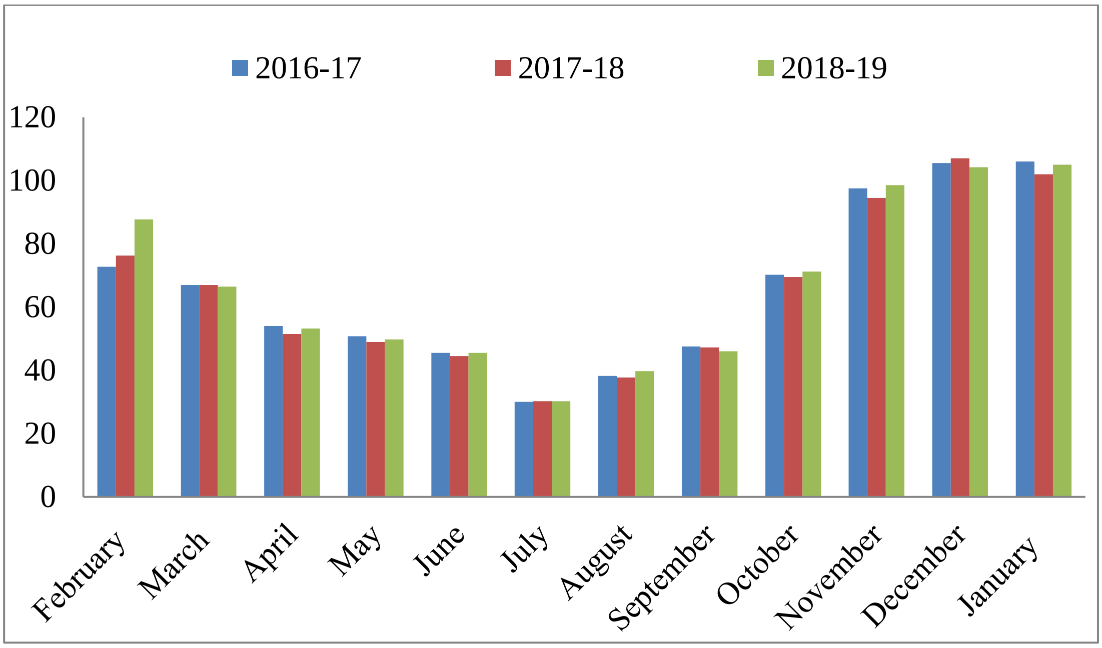


Figure 3: Water transparency at different station of Adan Reservoir

Total Dissolve Solids:

During study, it was ranges from 142.13 to 348.03 mg/l. It was maximum during the monsoon while decreased during winter to summer.

Table 10: Water TDS at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	233.1	237.4	223.6	239.6	233.43	7.084
2	March	189.9	204.4	190.7	207.2	198.05	9.028
3	April	168.3	185.2	171.3	182.8	176.90	8.347
4	May	130.3	147.5	138.3	152.4	142.13	9.814
5	June	233.1	247.7	247.8	241.5	242.53	6.940
6	July	346.3	357.6	343.6	344.6	348.03	6.480
7	August	323.5	337.7	332.9	342.4	334.13	8.076
8	September	325.3	328.6	332.8	335.6	330.58	4.543
9	October	262.8	277.6	269.4	278.5	272.08	7.416
10	November	273.1	276.8	262.9	277.6	272.60	6.757
11	December	233.2	237.2	223.3	245.2	234.73	9.105
12	January	228.4	242.6	228.6	233.2	233.20	6.647

Table 11: Water TDS at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	249.3	262.4	255.45	245.2	253.09	7.502
2	March	191.5	200.3	204.55	197.8	198.54	5.457
3	April	176.1	185.4	187.05	182.2	182.69	4.831
4	May	140.2	144.5	154.55	145.4	146.16	6.035
5	June	173.1	192.1	195.05	183.6	185.96	9.854
6	July	297.8	307.7	319.55	313.2	309.56	9.216
7	August	326.3	340.6	349.05	332.6	337.14	9.865
8	September	333.3	337.1	326.55	328.1	331.26	4.846
9	October	271.4	287.4	282.05	277.6	279.61	6.784
10	November	267.8	277.2	276.95	277.2	274.79	4.660
11	December	232.8	245.1	244.55	243.6	241.51	5.841
12	January	226.1	235.7	244.85	232.6	234.81	7.796

Table 12: Water TDS at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	255.8	246.85	241.7	243.05	246.85	6.353
2	March	205.1	203.65	190.8	205.25	201.20	6.971
3	April	187.6	182.05	173.3	179.85	180.70	5.914
4	May	155.1	144.05	140.8	143.95	145.98	6.268
5	June	195.6	206.85	191.3	186.85	195.15	8.579
6	July	319.1	330.05	312.8	311.55	318.38	8.456
7	August	352.6	337.05	338.3	337.05	341.25	7.590
8	September	327.1	337.05	312.8	327.05	326.00	9.978
9	October	282.6	276.55	268.3	275.15	275.65	5.870
10	November	277.5	286.85	273.2	281.55	279.78	5.820
11	December	245.1	246.95	230.8	246.55	242.35	7.741
12	January	245.4	246.55	231.1	226.85	237.48	9.978

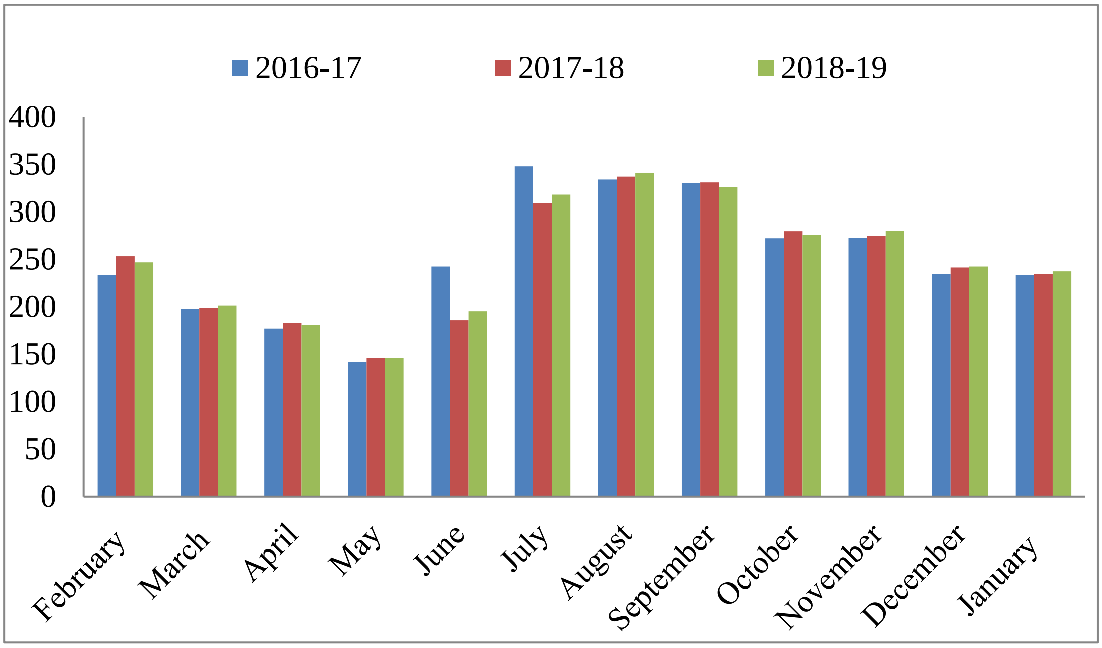


Figure 4: Water TDS at different station of Adan Reservoir

Total Hardness:

During study, it was ranges from 111.31 to 153.67 mg/l. It was maximum during the summer while decreased during monsoon to winter.

Table 13: Total Hardness at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	131.81	127.47	118.14	127.98	126.35	5.806
2	March	140.65	138.77	129.54	139.29	137.06	5.077
3	April	148.42	147.57	138.34	148.12	145.61	4.861
4	May	153.46	154.77	146.14	155.77	152.54	4.367
5	June	135.43	137.18	127.94	132.49	133.26	4.040
6	July	128.86	129.17	120.54	130.33	127.23	4.501
7	August	125.64	123.77	114.54	124.16	122.03	5.056
8	September	125.73	126.57	117.34	127.02	124.17	4.581
9	October	125.64	124.57	115.34	124.81	122.59	4.855
10	November	117.51	121.97	112.74	122.35	118.64	4.507
11	December	119.76	123.17	113.94	123.83	120.18	4.523
12	January	117.65	118.97	109.34	119.01	116.24	4.645

Table 14: Total Hardness at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	130.62	130.09	123.65	128.5	128.22	3.174
2	March	134.92	137.04	139.13	141.65	138.19	2.879
3	April	143.82	145.16	149.14	151.86	147.50	3.684
4	May	149.25	153.18	154.14	158.12	153.67	3.642
5	June	141.55	138.1	137.06	139.15	138.97	1.923
6	July	133.42	131.54	130.78	129.15	131.22	1.772
7	August	125.81	124.43	125.72	123.09	124.76	1.281
8	September	124.45	125.34	126.15	127.95	125.97	1.490
9	October	123.15	124.28	123.19	126.16	124.20	1.411
10	November	121.68	121.61	126.25	125.24	123.70	2.403
11	December	123.13	120.73	128.16	125.84	124.47	3.229
12	January	116.31	117.5	121.09	123.68	119.65	3.371

Table 15: Total Hardness at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	125.53	128.2	126.42	121.54	125.42	2.816
2	March	127.75	132.42	129.47	127.74	129.35	2.205
3	April	136.62	142.22	144.69	137.54	140.27	3.835
4	May	142.66	151.2	146.16	144.74	146.19	3.636
5	June	131.12	139.19	138.39	139.14	136.96	3.910
6	July	125.06	131.24	131.15	122.54	127.50	4.392
7	August	120.93	123.23	126.43	122.14	123.18	2.360
8	September	123.22	125.12	127.38	126.14	125.47	1.759
9	October	124.41	122.98	126.24	125.54	124.79	1.424
10	November	117.82	119.09	126.26	121.74	121.23	3.731
11	December	114.58	122.53	117.73	120.74	118.90	3.493
12	January	107.73	113.51	114.06	109.94	111.31	3.005

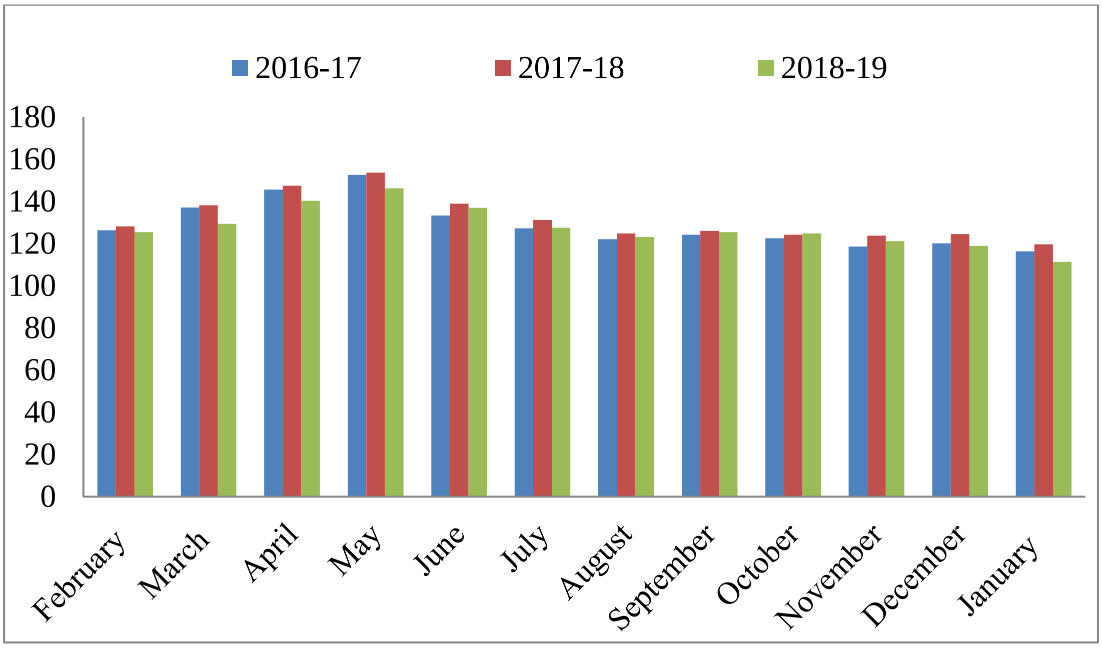


Figure 5: Total Hardness at different station of Adan Reservoir

Total Alkalinity:

During study, it was ranges from 169.38to 249.85 mg/l. It was maximum during the summer while decreased during monsoon to early winter.

Table 16: Total Alkalinity at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	229.15	210.59	212.82	214.33	216.72	8.426
2	March	221.42	209.86	215.42	221.43	217.03	5.557
3	April	243.67	244.36	237.58	249.71	243.83	4.965
4	May	257.51	239.05	249.73	253.12	249.85	7.874
5	June	248.11	233.06	241.76	242.68	241.40	6.228
6	July	236.48	232.46	232.2	239.43	235.14	3.465
7	August	226.85	223.65	222.39	230.18	225.77	3.490
8	September	209.61	205.24	211.16	219.02	211.26	5.750
9	October	187.32	175.67	185.53	186.41	183.73	5.424
10	November	169.61	168.62	168.68	176.61	170.88	3.847
11	December	198.32	189.62	191.06	197.56	194.14	4.438
12	January	197.45	191.91	192.33	199.04	195.18	3.599

Table 17: Total Alkalinity at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	220.89	211.38	205.02	212.78	212.52	6.524
2	March	215.86	223.73	212.14	221.98	218.43	5.381
3	April	237.36	251.78	238.83	244.59	243.14	6.551
4	May	246.05	255.06	240.68	250.12	247.98	6.102
5	June	234.06	244.6	236.31	248.75	240.93	6.908
6	July	230.46	241.53	227.65	239.2	234.71	6.698
7	August	219.65	232.24	221.01	228.43	225.33	6.008
8	September	210.24	221.45	202.78	217.36	212.96	8.215
9	October	185.73	194.4	172.49	192.53	186.29	9.924
10	November	167.62	178.58	168.78	175.25	172.56	5.233
11	December	188.62	199.66	187.49	198.04	193.45	6.284
12	January	192.91	201.05	188.62	199.38	195.49	5.771

Table 18: Total Alkalinity at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	226.08	204.85	214.43	213.02	214.60	8.744
2	March	226.09	209.42	214.78	216.14	216.61	6.955
3	April	248.61	238.66	242.83	237.83	241.98	4.930
4	May	260.08	244.51	246.05	245.68	249.08	7.363
5	June	252.76	239.11	235.58	233.32	240.19	8.711
6	July	243.23	231.48	232.65	229.65	234.25	6.111
7	August	233.09	221.85	223.24	219.01	224.30	6.120
8	September	222.65	201.61	211.99	210.78	211.76	8.614
9	October	196.63	182.32	185.43	188.49	188.22	6.148
10	November	179.45	162.61	169.62	165.84	169.38	7.299
11	December	202.05	189.32	190.58	187.49	192.36	6.583
12	January	203.39	192.45	192.09	192.62	195.14	5.506

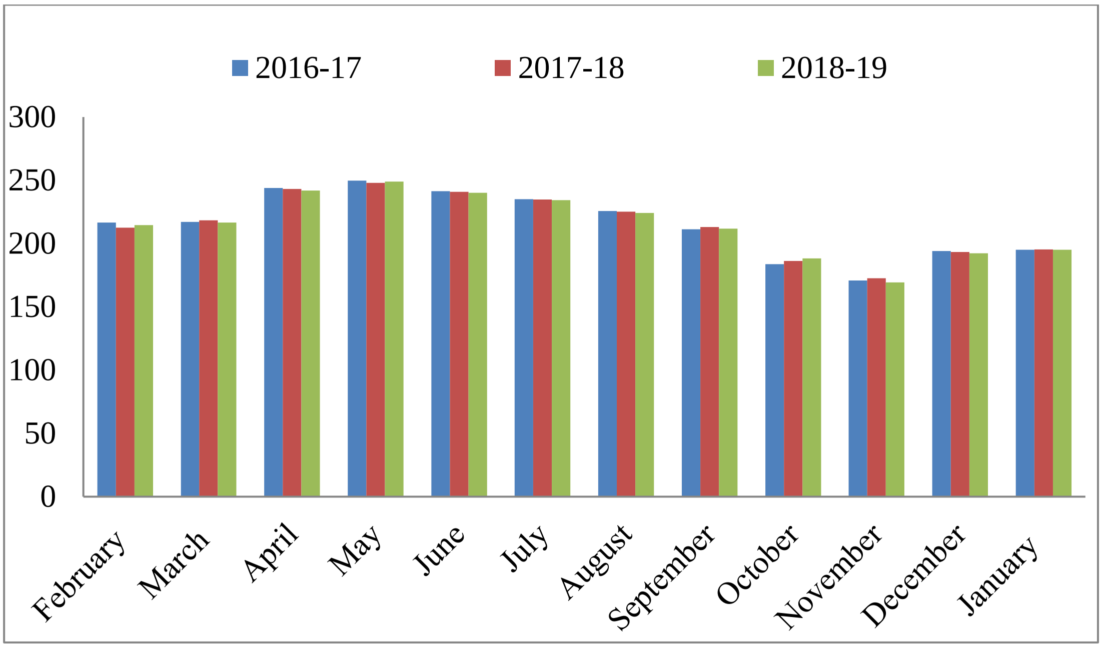


Figure 6: Total Alkalinity at different station of Adan Reservoir

Dissolved Oxygen:

During study, it was ranges from 5.79 to 12.01 mg/l. It was maximum during the winter while decreased during monsoon.

Table 19: Dissolved Oxygen at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	7.8	8.1	8.0	8.2	7.99	0.17
2	March	6.9	7.3	7.3	7.4	7.20	0.20
3	April	6.7	7.4	7.2	7.1	7.06	0.29
4	May	7.2	7.4	7.1	7.6	7.29	0.22
5	June	6.8	6.9	6.8	7.2	6.89	0.19
6	July	6.0	6.4	5.7	6.5	6.12	0.36
7	August	5.7	6.2	5.9	6.2	5.97	0.23
8	September	8.0	8.6	7.5	8.4	8.09	0.49
9	October	7.8	9.8	9.8	8.3	8.90	1.01
10	November	10.0	11.9	11.0	10.4	10.79	0.83
11	December	12.0	12.3	11.5	12.4	12.01	0.40
12	January	10.4	10.5	10.5	10.3	10.40	0.10

Table 20: Dissolved Oxygen at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	7.4	8.4	8.2	8.2	8.01	0.44
2	March	6.6	7.7	7.2	7.9	7.31	0.58
3	April	6.3	7.4	7.3	8.3	7.29	0.82
4	May	6.8	7.4	7.3	7.2	7.14	0.26
5	June	6.4	7.2	7.4	7.3	7.04	0.46
6	July	5.7	6.1	6.6	6.5	6.19	0.41
7	August	5.4	6.3	6.2	6.4	6.04	0.46
8	September	7.6	7.8	8.4	7.7	7.85	0.36
9	October	7.5	10.2	8.4	10.2	9.04	1.35
10	November	9.6	11.4	11.4	11.3	10.90	0.89
11	December	11.6	11.9	12.3	11.9	11.89	0.29
12	January	10.9	10.6	10.4	10.7	10.60	0.30

Table 21: Dissolved Oxygen at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	7.8	7.5	7.9	8.1	7.79	0.25
2	March	6.9	6.5	6.8	7.2	6.81	0.29
3	April	6.8	6.7	7.1	7.1	6.90	0.20
4	May	7.1	6.8	6.8	7.3	6.97	0.23
5	June	6.9	6.5	7.0	7.5	6.96	0.41
6	July	6.2	5.7	6.0	6.4	6.04	0.30
7	August	5.8	5.5	5.8	6.2	5.79	0.29
8	September	7.9	8.0	7.8	8.3	7.99	0.19
9	October	7.9	9.5	7.9	8.4	8.41	0.73
10	November	10.9	10.8	10.8	11.2	10.90	0.19
11	December	11.9	11.4	12.0	12.4	11.89	0.41
12	January	10.2	10.2	10.4	10.3	10.30	0.10

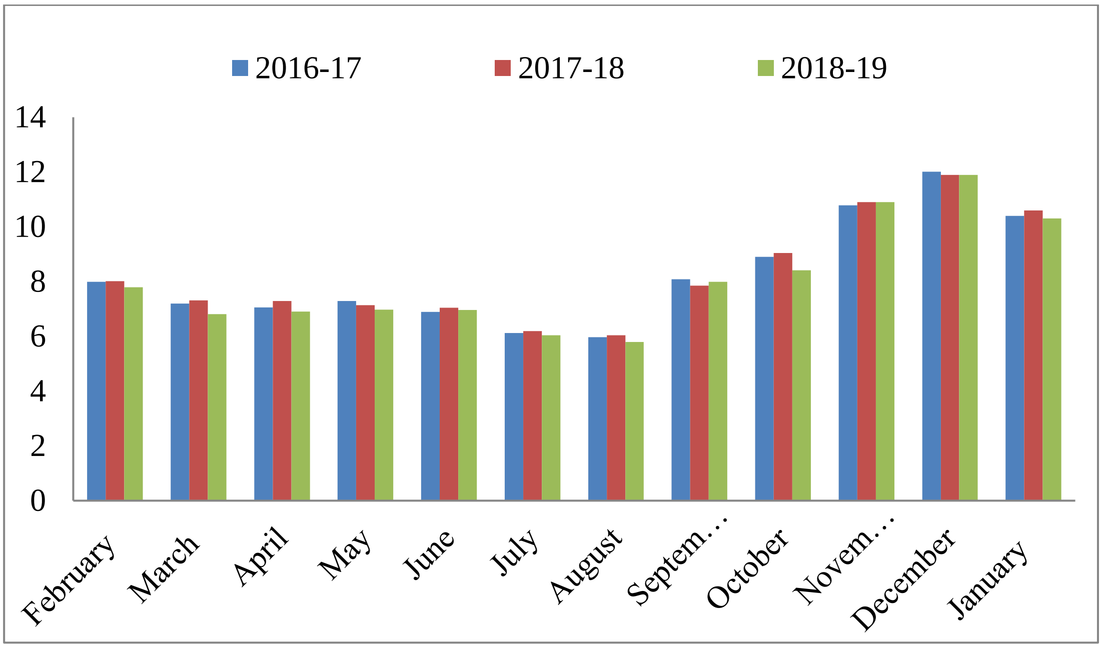


Figure 7: Dissolved Oxygen at different station of Adan Reservoir

Chlorides:

During study, it was ranges from 8.15 to 13.01 mg/l. It was maximum during the months of summer while decreased from monsoon to winter.

Table 22: Chlorides at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	11.52	10.83	10.82	10.74	10.98	0.364
2	March	11.59	11.53	11.89	12.5	11.88	0.444
3	April	12.62	11.93	12.42	12.64	12.40	0.330
4	May	12.97	12.33	13.07	13.68	13.01	0.553
5	June	12.32	11.83	11.22	11.72	11.77	0.451
6	July	11.51	11.03	11.51	11.68	11.43	0.280
7	August	11.65	10.83	11.35	11.72	11.39	0.405
8	September	10.45	10.13	10.65	10.82	10.51	0.296
9	October	9.51	8.63	9.41	9.54	9.27	0.432
10	November	8.61	8.13	8.41	8.74	8.47	0.266
11	December	8.09	7.83	8.79	8.82	8.38	0.499
12	January	8.75	8.03	8.45	8.7	8.48	0.329

Table 23: Chlorides at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	10.81	11.45	11.49	11.68	11.36	0.379
2	March	11.57	12.41	12.36	12.44	12.20	0.418
3	April	11.71	12.65	12.19	12.88	12.36	0.518
4	May	12.75	13.01	12.64	13.24	12.91	0.269
5	June	10.79	12.37	11.29	12.4	11.71	0.803
6	July	10.75	11.57	11.78	12	11.53	0.546
7	August	10.79	11.53	11.42	11.76	11.38	0.415
8	September	9.89	10.55	10.32	10.78	10.39	0.380
9	October	8.61	9.41	8.98	9.64	9.16	0.457
10	November	7.81	8.67	8.48	8.9	8.47	0.469
11	December	7.89	8.29	8.26	8.52	8.24	0.261
12	January	7.77	8.69	8.62	8.92	8.50	0.503

Table 24: Chlorides at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	10.29	10.75	11.29	10.51	10.71	0.430
2	March	12.16	11.51	11.36	12.27	11.83	0.457
3	April	12.09	11.95	12.39	12.41	12.21	0.227
4	May	13.14	12.31	12.74	13.45	12.91	0.494
5	June	10.99	11.47	12.09	11.49	11.51	0.450
6	July	11.18	11.07	11.28	11.45	11.25	0.161
7	August	11.02	10.83	11.42	11.49	11.19	0.317
8	September	10.22	9.85	10.22	10.59	10.22	0.302
9	October	9.18	8.71	9.28	9.31	9.12	0.279
10	November	8.38	7.97	8.38	8.51	8.31	0.235
11	December	8.56	7.59	7.86	8.59	8.15	0.503
12	January	8.32	7.99	8.52	8.47	8.33	0.239

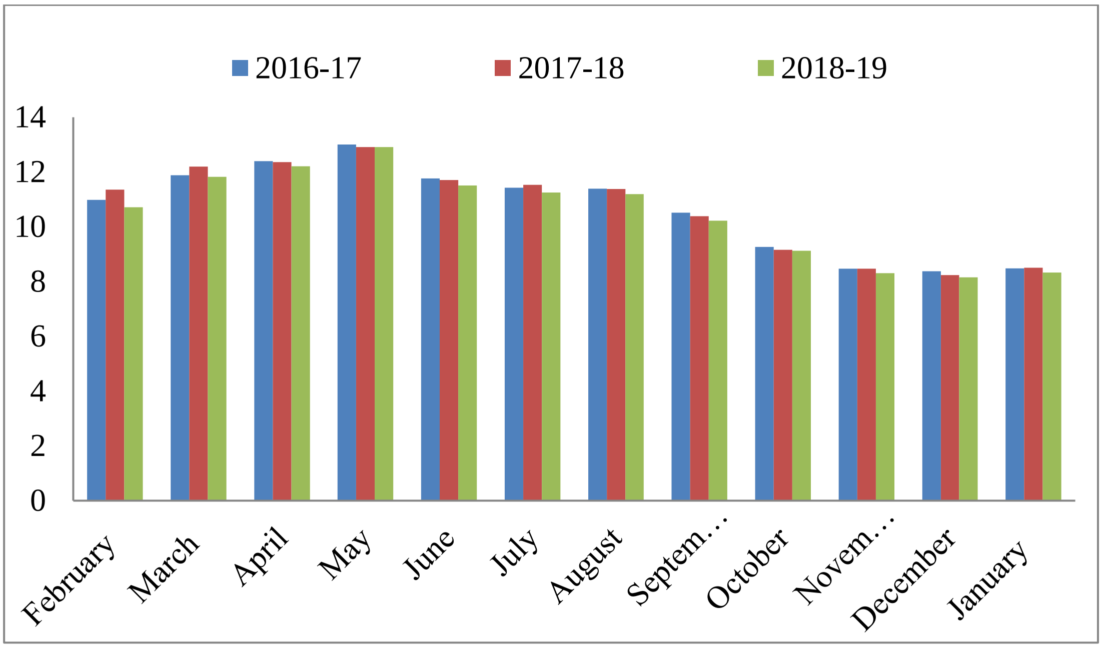


Figure 8: Chlorides at different station of Adan Reservoir

Sulphate:

During study, it was ranges from 7.84 to 12.62 mg/l. It was maximum during the months of monsoon while decreased from winter to summer.

Table 25: Sulphate at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	8.0	8.6	8.1	8.2	8.27	0.26
2	March	9.0	9.1	8.7	8.9	8.97	0.17
3	April	8.5	8.5	9.5	9.9	9.14	0.71
4	May	10.3	10.8	10.7	10.7	10.67	0.22
5	June	10.5	10.6	10.8	10.9	10.74	0.18
6	July	11.5	11.9	11.0	10.8	11.34	0.50
7	August	12.2	12.1	12.0	11.8	12.07	0.17
8	September	12.3	12.0	11.8	12.3	12.14	0.24
9	October	12.0	11.9	12.0	12.0	12.02	0.05
10	November	11.3	10.8	11.2	11.1	11.14	0.22
11	December	8.7	8.5	8.5	8.6	8.62	0.10
12	January	8.0	7.8	8.0	7.5	7.87	0.24

Table 26: Sulphate at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	8.5	8.2	8.0	8.2	8.27	0.21
2	March	8.8	8.6	8.9	8.8	8.82	0.13
3	April	8.5	9.3	9.8	9.7	9.37	0.59
4	May	10.7	10.6	10.6	10.5	10.64	0.08
5	June	10.4	10.3	10.8	11.0	10.67	0.33
6	July	11.6	11.1	10.9	10.8	11.14	0.36
7	August	12.1	11.9	12.0	11.6	11.94	0.22
8	September	12.2	12.3	12.1	12.1	12.22	0.10
9	October	11.7	11.8	11.5	11.7	11.72	0.13
10	November	10.5	10.6	10.8	10.9	10.74	0.18
11	December	8.6	8.7	8.4	8.5	8.59	0.13
12	January	8.0	7.7	7.7	7.8	7.84	0.14

Table 27: Sulphate at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	8.5	8.1	8.6	8.3	8.42	0.22
2	March	9.5	9.6	9.2	9.4	9.47	0.17
3	April	9.0	9.0	10.0	10.0	9.54	0.58
4	May	10.8	11.3	11.2	11.1	11.14	0.22
5	June	11.0	11.1	11.3	11.4	11.24	0.18
6	July	12.0	12.4	11.5	12.0	12.02	0.37
7	August	12.7	12.6	12.5	12.5	12.62	0.10
8	September	12.8	12.5	12.3	12.5	12.57	0.21
9	October	12.5	12.4	12.5	11.8	12.34	0.34
10	November	11.5	11.9	11.0	10.8	11.34	0.50
11	December	9.2	9.0	9.0	9.1	9.12	0.10
12	January	8.5	8.3	8.5	8.1	8.39	0.19

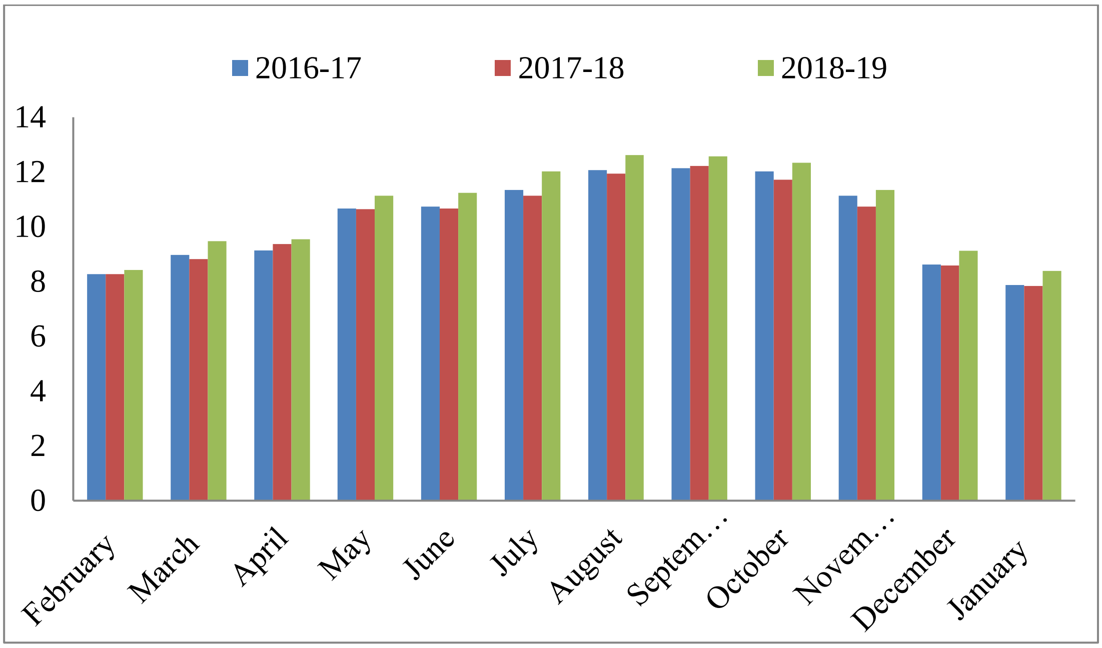


Figure 9: Sulphate at different station of Adan Reservoir

Nitrates:

During study, it was ranges from 0.51 to 0.79 mg/l. It was maximum during the months of summermonsoon while decreased from monsoon to winter.

Table 28: Nitrates at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	0.59	0.63	0.63	0.59	0.61	0.023
2	March	0.67	0.66	0.68	0.67	0.67	0.008
3	April	0.71	0.68	0.67	0.70	0.69	0.018
4	May	0.77	0.78	0.8	0.79	0.79	0.013
5	June	0.79	0.77	0.81	0.79	0.79	0.016
6	July	0.68	0.69	0.71	0.69	0.69	0.013
7	August	0.73	0.71	0.71	0.71	0.72	0.010
8	September	0.63	0.63	0.66	0.63	0.64	0.015
9	October	0.59	0.58	0.57	0.58	0.58	0.008
10	November	0.59	0.61	0.61	0.61	0.61	0.010
11	December	0.61	0.59	0.58	0.59	0.59	0.013
12	January	0.59	0.61	0.61	0.58	0.60	0.015

Table 29: Nitrates at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	0.59	0.60	0.60	0.59	0.60	0.006
2	March	0.63	0.63	0.64	0.64	0.64	0.006
3	April	0.71	0.63	0.65	0.66	0.66	0.034
4	May	0.79	0.77	0.76	0.77	0.77	0.013
5	June	0.75	0.77	0.79	0.76	0.77	0.017
6	July	0.66	0.66	0.65	0.65	0.66	0.006
7	August	0.69	0.66	0.63	0.66	0.66	0.024
8	September	0.55	0.57	0.61	0.57	0.58	0.025
9	October	0.54	0.53	0.54	0.54	0.54	0.005
10	November	0.55	0.53	0.56	0.54	0.55	0.013
11	December	0.56	0.59	0.55	0.57	0.57	0.017
12	January	0.54	0.53	0.55	0.54	0.54	0.008

Table 30: Nitrates at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	0.54	0.57	0.56	0.55	0.56	0.015
2	March	0.62	0.60	0.61	0.61	0.61	0.008
3	April	0.63	0.6	0.62	0.63	0.62	0.014
4	May	0.73	0.74	0.73	0.74	0.74	0.006
5	June	0.73	0.74	0.76	0.73	0.74	0.014
6	July	0.61	0.63	0.62	0.62	0.62	0.008
7	August	0.64	0.63	0.62	0.63	0.63	0.008
8	September	0.55	0.54	0.58	0.54	0.55	0.019
9	October	0.49	0.51	0.51	0.52	0.51	0.013
10	November	0.51	0.52	0.53	0.51	0.52	0.010
11	December	0.54	0.56	0.52	0.54	0.54	0.016
12	January	0.54	0.56	0.57	0.55	0.56	0.015

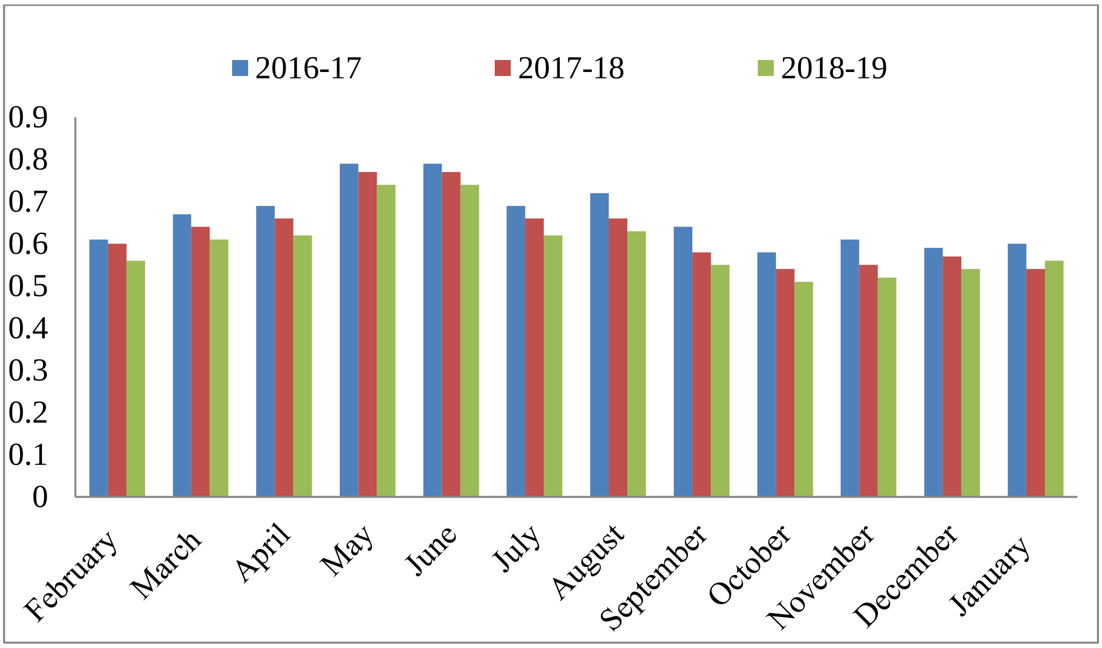


Figure 10: Nitrates at different station of Adan Reservoir

Phosphates:

During study, it was ranges from 1.40 to 4.96 mg/l. It was maximum during the months of monsoon while decreased from winter to summer.

Table 31: Phosphates at different stations during year 2016-17

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	1.69	1.67	1.79	1.82	1.74	0.074
2	March	2.18	2.24	2.2	2.19	2.20	0.026
3	April	2.5	2.27	2.37	2.52	2.42	0.117
4	May	3.17	3.08	3.43	3.19	3.22	0.150
5	June	3.27	3.07	3.02	3.2	3.14	0.115
6	July	4.17	4.27	3.77	3.82	4.01	0.250
7	August	4.07	4.98	4.87	4.91	4.96	0.090
8	September	3.47	3.48	3.54	3.68	3.54	0.097
9	October	2.67	2.77	2.82	2.75	2.75	0.062
10	November	1.77	1.68	1.73	1.69	1.72	0.041
11	December	1.67	1.82	1.78	1.8	1.77	0.067
12	January	1.27	1.57	1.37	1.37	1.40	0.126

Table 32: Phosphates at different stations during year 2017-18

Sr. No.	Months	A	B	C	D	Mean	± SD
1	February	1.68	1.69	1.77	1.81	1.74	0.063
2	March	2.19	2.21	2.25	2.22	2.22	0.025
3	April	2.51	2.37	2.52	2.54	2.49	0.078
4	May	2.54	3.12	3.19	3.20	3.01	0.317
5	June	3.28	3.25	3.06	3.17	3.19	0.098
6	July	4.12	4.19	3.97	3.92	4.05	0.126
7	August	4.97	4.89	4.91	4.92	4.92	0.034
8	September	3.47	3.51	3.50	3.67	3.54	0.090
9	October	2.77	2.72	2.79	2.73	2.76	0.033
10	November	1.79	1.7	2.2	1.74	1.86	0.231
11	December	1.74	1.7	1.75	1.76	1.74	0.026
12	January	1.29	1.47	1.52	1.55	1.46	0.116

Table 33: Phosphates at different stations during year 2018-19

Sr. No.	Months	A	B	C	D	Mean	+ SD
1	February	1.52	1.6	1.64	1.56	1.58	0.052
2	March	2.04	2.08	2.05	2.04	2.05	0.019
3	April	2.21	2.35	2.37	2.38	2.33	0.079
4	May	2.95	3.02	3.03	3.03	3.01	0.039
5	June	3.08	2.89	3.01	3.02	3.00	0.080
6	July	4.02	3.79	3.75	3.77	3.83	0.126
7	August	4.72	4.74	4.75	4.85	4.77	0.058
8	September	3.34	3.33	3.5	3.02	3.55	0.324
9	October	2.55	2.62	2.56	2.58	2.58	0.031
10	November	1.53	2.03	1.57	1.55	1.67	0.241
11	December	1.53	1.58	1.59	1.62	1.58	0.037
12	January	1.52	1.62	1.64	1.56	1.59	0.055

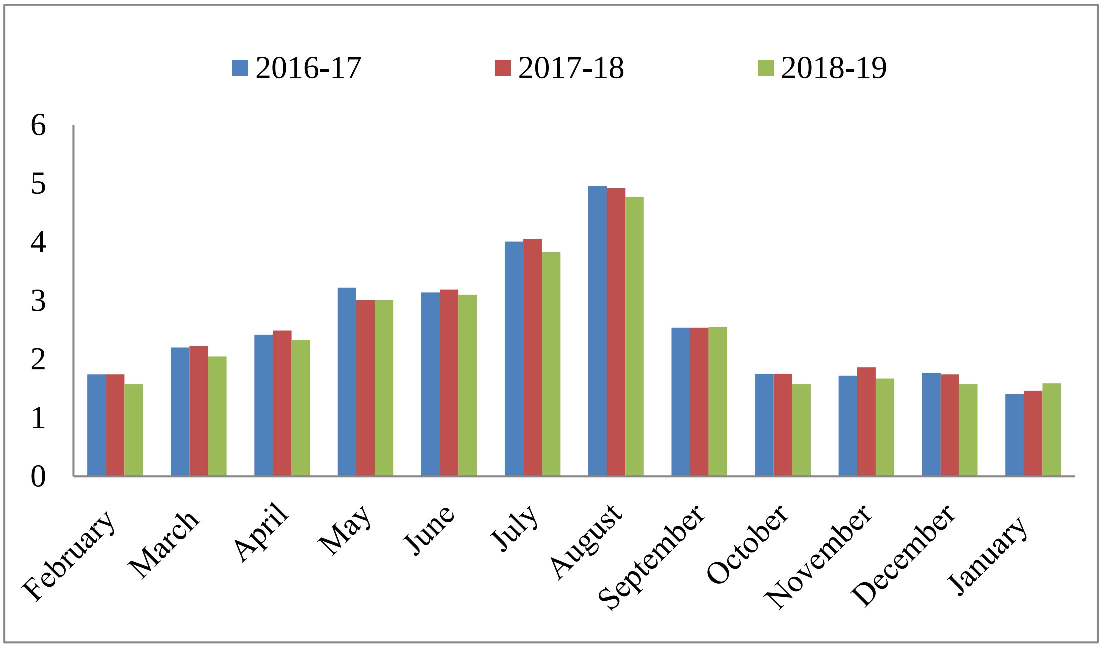


Figure 11: Phosphates at different station of Adan Reservoir

PHYTOPLANKTON ESTIMATION

During the period of investigation, total fifty species belonging to four groups were identified. The maximum number of individuals and diversity was observed during winter and lower by summer and monsoon. The Chlorophyceae were represented with in twenty five species; Bacillariophyceae with fourteen; Cyanophyceae with ninespecies while Euglenophyceae was represented with only two species. The Chlorophyceae were obtained in maximum quantity; Bacillariophyceae and Cyanophyceae showed moderate while Euglenophyceae observed with minimum population (Table 4.1).

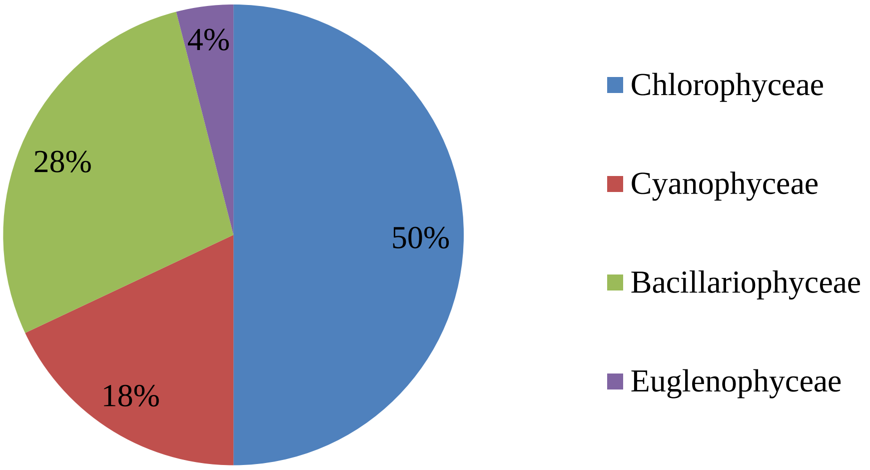


Figure 12: Phytoplankton composition

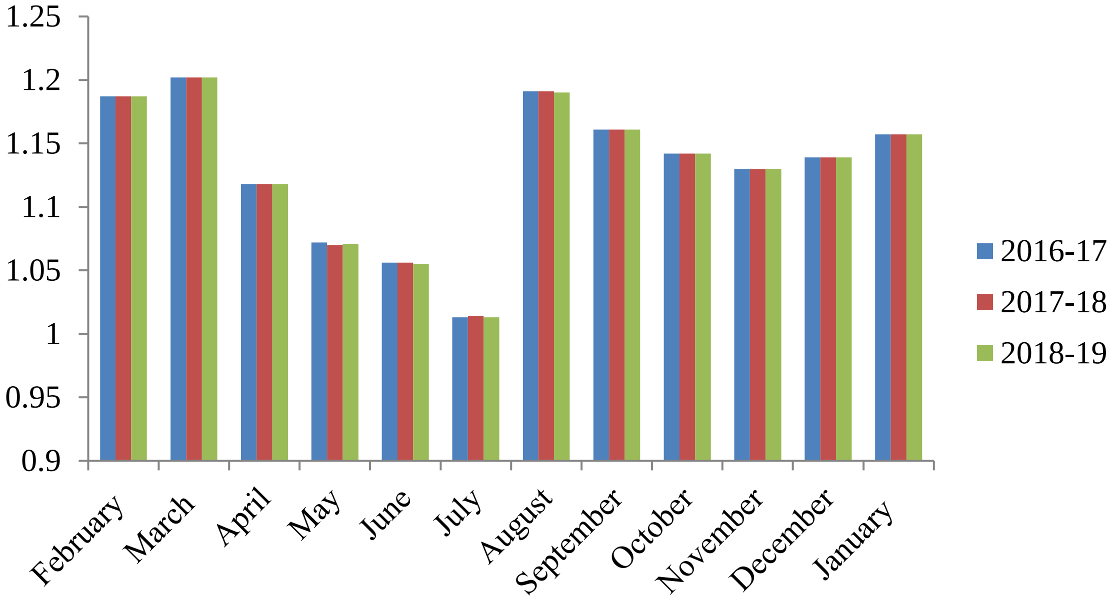


Figure 13: Shannon diversity of phytoplankton during year 2016 to 2019

Table 34: The phytoplankton (Plank/L) diversity assessment during 2016-17

A	Chlorophyceae	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1.	*Ankistrodesmus counvolutus*	81	105	65	32	38	57	140	154	207	246	64	82
2.	*Characium sp.*	58	71	72	0	0	22	98	130	225	280	59	90
3.	*Chlamydomonas cingulata*	346	418	193	31	47	29	79	106	184	242	127	276
4.	*Chlorella vulgaris*	312	209	148	75	59	28	75	125	172	246	95	245
5.	*Coelastrum acerosum*	124	214	231	171	96	37	86	106	194	230	34	72
6.	*Coelastrum lanceolatum*	193	0	14	0	0	10	63	106	171	175	118	126
7.	*Cosmarium grannatum*	187	113	27	13	11	34	93	126	194	232	236	206
8.	*Cosmarium monomazum*	84	0	10	0	0	10	86	145	185	153	32	45
9.	*Euastrum didelta*	41	22	14	11	11	18	70	139	206	166	21	48
10.	*Golenkinia sp.*	91	119	127	49	50	61	134	202	268	311	22	70
11.	*Gonium duplex*	35	14	0	0	0	0	38	68	100	166	14	36
12.	*Hydrodictyon reticulatum*	732	826	253	10	0	50	172	222	270	308	296	628
13.	*Mesotaenium sp.*	58	45	14	0	0	34	81	147	259	201	16	56
14.	*Oedogonium sp.*	127	174	43	0	0	18	63	159	199	150	68	78
15.	*Pediastrum simplex*	160	187	53	55	177	22	48	154	197	266	128	161
16.	*Scenedesmus dimorphus*	75	102	22	0	0	0	119	175	221	225	31	56
17.	*Scenedesmus quardricauda*	64	42	0	0	0	0	79	99	53	59	20	42
18.	*Selenastrum gracile*	80	70	26	22	59	93	142	186	122	145	99	86
19.	*Sphaerocystis schroeteri*	539	615	328	63	115	0	42	89	150	211	167	326
20.	*Sphaerozosma sp.*	6	0	0	0	13	29	140	208	274	142	6	52
21.	*Spirogyra sp.*	995	182	39	8	0	38	82	185	337	179	461	774
22.	*Stigeoclonium sp.*	36	0	11	0	0	58	161	246	185	200	5	26
23.	*Ullothrix sp.*	60	18	8	0	0	0	139	227	262	274	20	60

24.	*Volvox aureus*	817	718	214	161	0	16	16	162	206	311	403	434
25.	*Zygnema sp.*	31	0	0	0	0	13	81	142	230	205	116	84
	Total	5332	4264	1912	701	676	677	2327	3808	5071	5323	2658	4159

B	**Bacillariophyceae**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
1.	*Achnanthes lancelolata*	98	146	26	22	39	39	148	205	184	148	20	50
2.	*Amphora ovalis*	162	96	22	0	14	42	132	230	201	205	98	137
3.	*Asterionella farmosa*	40	40	34	0	78	127	258	308	286	242	86	37
4.	*Cymbella affinis*	92	26	22	18	34	14	22	103	187	233	70	79
5.	*Diatoma vulgaris*	33	30	22	38	72	58	199	247	308	410	42	128
6.	*Fragelaria capuncia*	238	219	10	11	0	0	26	145	79	198	64	147
7.	*Frustulia rhomboides*	306	58	18	0	0	21	175	220	183	97	93	166
8.	*Gomphonema gracile*	981	642	143	22	0	37	91	138	139	179	624	711
9.	*Melosira granulata*	0	0	10	0	78	110	192	242	222	250	5	6
10.	*Naviculla radiosa*	179	220	170	143	35	58	141	249	290	156	47	90
11.	*Pinnularia nobilis*	1176	1125	484	68	34	121	306	351	359	318	1544	2398
12.	*Surrinela striatula*	19	0	39	38	12	36	0	78	99	178	8	16
13.	*Synedra ulna*	846	450	235	62	74	43	93	139	192	196	1620	2493
14.	*Tabellaria genestrata*	13	0	30	38	0	0	60	96	154	217	27	59
	Total	4183	3052	1265	460	470	706	1843	2751	2883	3027	4348	6517

C	Cyanophyceae	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1.	*Anabaena spiroides*	506	109	26	0	0	0	92	150	253	258	101	326
2.	*Cylindrospermum sp.*	56	0	0	0	0	0	87	154	200	200	22	24
3.	*Gloeocapsa sp.*	99	145	46	25	41	0	99	186	254	342	63	104
4.	*Gloeotrichia sp.*	306	185	112	30	0	0	69	129	160	110	230	282
5.	*Microcystis aeruginosa*	3528	2657	159	0	64	87	265	305	340	341	1721	3714
6.	*Nostoc pruniforme*	523	326	18	10	0	36	141	247	335	236	187	347
7.	*Phormidium sp.*	6	22	0	0	0	0	115	156	74	194	12	22
8.	*Rivularia sp.*	159	102	46	18	0	103	182	227	282	282	98	156
9.	*Lyngbya sp.*	90	0	0	0	0	21	73	68	124	150	24	58
	Total	5273	3546	407	83	105	247	1123	1622	2022	2113	2458	5033

D	Euglenophyceae	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1.	*Euglena acus*	282	285	195	54	0	0	137	188	244	241	110	259
2.	*Phacus pyrum*	126	103	30	46	62	0	104	118	118	84	76	54
	Total	408	388	225	100	62	0	241	306	362	325	186	313

	Phytoplankton group	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
1.	**Chlorophyceae**	5332	4264	1912	701	676	677	2327	3808	5071	5323	2658	4159	36908
2.	**Bacillariophyceae**	4183	3052	1265	460	470	706	1843	2751	2883	3027	4348	6517	31505
3.	**Cyanophyceae**	5273	3546	407	83	105	247	1123	1622	2022	2113	2458	5033	24032
4.	**Euglenophyceae**	408	388	225	100	62	0	241	306	362	325	186	313	2916
	Total	15196	11250	3809	1344	1313	1630	5534	8487	10338	10788	9650	16022	95361
	Shannon Diversity	1.187	1.202	1.118	1.072	1.056	1.013	1.191	1.161	1.142	1.13	1.139	1.157	*****

Table 35: Quantitative phytoplankton (Plank/L) assessment during 2017-18

A	Chlorophyceae	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1.	*Ankistrodesmus counvolutus*	66	85	53	26	31	46	114	125	168	200	52	67
2.	*Characium sp.*	47	58	59	0	0	18	80	106	183	228	48	73
3.	*Chlamydomonas cingulata*	281	339	157	25	38	23	64	86	150	196	103	224
4.	*Chlorella vulgaris*	254	170	120	61	48	23	61	101	140	200	77	199
5.	*Coelastrum acerosum*	101	150	188	139	78	30	70	86	157	187	27	59
6.	*Coelastrum lanceolatum*	157	24	12	0	0	8	51	86	139	142	96	102
7.	*Cosmarium grannatum*	152	82	22	10	9	28	75	103	158	189	192	167
8.	*Cosmarium monomazum*	68	12	8	0	0	8	70	118	150	124	26	36
9.	*Euastrum didelta*	33	18	11	9	9	14	57	113	168	135	17	39
10.	*Golenkinia sp.*	74	97	103	40	41	49	109	164	218	253	18	57
11.	*Gonium duplex*	29	12	0	0	0	0	31	55	81	135	12	29
12.	*Hydrodictyon reticulatum*	595	671	205	8	0	40	140	181	220	250	241	510
13.	*Mesotaenium sp.*	47	36	12	0	0	28	66	120	211	163	13	46
14.	*Oedogonium sp.*	103	142	35	0	0	14	51	129	162	122	55	63
15.	*Pediastrum simplex*	130	152	43	45	144	18	39	125	160	216	104	131
16.	*Scenedesmus dimorphus*	61	83	18	0	0	0	97	142	179	183	25	46
17.	*Scenedesmus quardricauda*	52	34	0	0	0	0	64	81	43	48	16	34
18.	*Selenastrum gracile*	65	57	21	18	48	75	116	151	99	118	81	70
19.	*Sphaerocystis schroeteri*	438	497	267	51	94	0	34	72	122	172	136	265
20.	*Sphaerozosma sp.*	5	3	0	0	10	23	114	169	222	116	5	42
21.	*Spirogyra sp.*	809	138	32	7	0	31	67	150	274	146	374	629
22.	*Stigeoclonium sp.*	29	10	9	0	0	47	131	200	150	163	4	21
23.	*Ullothrix sp.*	49	14	7	0	0	0	113	185	213	223	16	49

24.	*Volvox aureus*	664	573	174	131	0	13	13	131	168	253	328	353
25.	*Zygnema sp.*	25	10	0	0	0	10	66	115	187	166	94	68
	Total	4334	3465	1556	570	550	546	1893	3094	4122	4328	2160	3379

B	**Bacillariophyceae**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
1.	*Achnanthes lancelolata*	79	118	21	18	32	32	120	166	150	120	16	40
2.	*Amphora ovalis*	132	78	18	0	11	34	107	187	163	166	79	111
3.	*Asterionella farmosa*	33	33	28	0	63	103	210	250	233	197	70	30
4.	*Cymbella affinis*	75	21	18	14	27	12	18	84	152	189	57	64
5.	*Diatoma vulgaris*	27	24	18	31	59	47	162	201	250	333	34	104
6.	*Fragelaria capuncia*	193	178	8	9	0	0	21	118	64	161	52	120
7.	*Frustulia rhomboides*	249	47	14	0	0	17	142	179	149	79	75	135
8.	*Gomphonema gracile*	797	522	116	18	0	30	74	112	113	146	507	578
9.	*Melosira granulata*	0	0	8	0	64	90	156	197	181	203	4	5
10.	*Naviculla radiosa*	146	179	138	116	29	47	114	202	236	127	38	73
11.	*Pinnularia nobilis*	956	909	393	55	28	98	248	285	292	258	1255	1949
12.	*Surrinela striatula*	16	5	32	31	10	29	0	63	81	145	7	13
13.	*Synedra ulna*	688	361	191	51	60	35	75	113	156	159	1316	2025
14.	*Tabellaria genestrata*	10	4	25	31	0	0	49	78	125	176	22	48
	Total	3401	2479	1028	374	383	574	1496	2235	2345	2459	3532	5295

C	**Cyanophyceae**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
1.	*Anabaena spiroides*	411	78	21	0	0	0	75	122	205	210	82	265
2.	*Cylindrospermum sp.*	46	10	0	0	0	0	71	125	163	163	18	20
3.	*Gloeocapsa sp.*	81	118	37	20	33	0	81	151	207	278	51	85
4.	*Gloeotrichia sp.*	249	150	91	24	0	0	56	105	130	89	187	229
5.	*Microcystis aeruginosa*	2867	2159	129	0	52	71	215	248	276	277	1398	3018
6.	*Nostoc pruniforme*	425	265	15	8	0	29	114	201	272	192	152	282
7.	*Phormidium sp.*	5	18	0	0	0	0	94	127	60	157	10	18
8.	*Rivularia sp.*	129	63	37	14	0	84	148	185	229	229	80	127
9.	*Lyngbya sp.*	73	10	0	0	0	17	59	55	101	122	20	47
	Total	4286	2881	330	66	85	201	913	1319	1643	1717	1998	4091

D	**Euglenophyceae**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
1.	*Euglena acus*	229	231	159	44	0	0	111	153	198	196	90	211
2.	*Phacus pyrum*	103	84	25	38	51	0	85	96	96	68	62	44
	Total	332	315	184	82	51	0	196	249	294	264	152	255

	Phytoplankton group	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Total**
1	**Chlorophyceae**	4334	3465	1556	570	550	546	1893	3094	4122	4328	2160	3379	29997
2	**Bacillariophyceae**	3401	2479	1028	374	383	574	1496	2235	2345	2459	3532	5295	25601
3	**Cyanophyceae**	4286	2881	330	66	85	201	913	1319	1643	1717	1998	4091	19530
4	**Euglenophyceae**	332	315	184	82	51	0	196	249	294	264	152	255	2374
	Total	12353	9140	3098	1092	1069	1321	4498	6897	8404	8768	7842	13020	77502
	Shannon Diversity	1.187	1.202	1.118	1.07	1.056	1.014	1.191	1.161	1.142	1.13	1.139	1.157	****

Table 36: Quantitative phytoplankton (Plank/L) assessment during 2018-19

A	Chlorophyceae	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1.	*Ankistrodesmus counvolutus*	91	118	73	36	43	64	158	173	233	276	72	93
2.	*Characium sp.*	65	80	81	0	0	25	111	147	253	315	67	101
3.	*Chlamydomonas cingulata*	389	470	217	35	53	32	89	120	207	272	143	311
4.	*Chlorella vulgaris*	351	235	167	85	67	32	85	140	194	276	107	275
5.	*Coelastrum acerosum*	140	201	260	193	108	41	97	119	218	258	38	81
6.	*Coelastrum lanceolatum*	217	40	16	0	0	11	71	120	193	197	132	141
7.	*Cosmarium grannatum*	211	107	31	14	13	39	104	142	219	261	266	231
8.	*Cosmarium monomazum*	95	20	11	0	0	11	96	163	208	172	36	50
9.	*Euastrum didelta*	46	25	15	13	13	20	79	157	232	186	23	54
10.	*Golenkinia sp.*	103	134	143	55	57	68	151	227	302	350	25	79
11.	*Gonium duplex*	40	16	0	0	0	0	43	77	113	187	16	41
12.	*Hydrodictyon reticulatum*	824	929	284	11	0	56	194	250	304	347	333	707
13.	*Mesotaenium sp.*	65	50	16	0	0	39	91	166	292	226	18	63
14.	*Oedogonium sp.*	143	196	49	0	0	20	71	179	224	168	77	87
15.	*Pediastrum simplex*	180	211	59	62	199	25	54	174	221	299	144	181
16.	*Scenedesmus dimorphus*	85	114	25	0	0	0	134	197	248	253	35	63
17.	*Scenedesmus quardricauda*	72	48	0	0	0	0	89	112	59	67	23	47
18.	*Selenastrum gracile*	90	79	29	25	67	104	160	210	137	163	112	97
19.	*Sphaerocystis schroeteri*	607	690	369	71	130	0	48	100	169	238	188	367
20.	*Sphaerozosma sp.*	7	2	0	0	14	32	158	234	308	160	6	59
21.	*Spirogyra sp.*	1120	194	44	9	0	43	93	208	379	202	518	871
22.	*Stigeoclonium sp.*	41	10	13	0	0	65	181	277	208	225	5	30
23.	*Ullothrix sp.*	68	20	9	0	0	0	157	256	294	309	23	68

24.	*Volvox aureus*	919	790	240	181	0	18	18	182	232	350	454	489
25.	*Zygnema sp.*	35	17	0	0	0	14	91	159	259	230	131	95
	Total	6004	4796	2151	790	764	759	2623	4289	5706	5987	2992	4681

B	**Bacillariophyceae**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
1.	*Achnanthes lancelolata*	110	164	29	24	44	44	167	230	207	167	23	56
2.	*Amphora ovalis*	183	108	24	0	15	48	149	259	226	230	110	154
3.	*Asterionella farmosa*	45	45	39	0	87	143	291	347	322	273	97	41
4.	*Cymbella affinis*	104	29	25	20	38	16	25	116	211	262	78	89
5.	*Diatoma vulgaris*	37	33	25	42	81	66	224	278	347	462	47	144
6.	*Fragelaria capuncia*	267	247	12	13	0	0	30	163	89	223	72	166
7.	*Frustulia rhomboides*	345	66	20	0	0	23	197	248	206	109	104	187
8.	*Gomphonema gracile*	1103	723	161	25	0	41	103	155	157	202	702	800
9.	*Melosira granulata*	0	0	11	0	88	124	216	273	250	281	5	6
10.	*Naviculla radiosa*	202	248	191	161	40	66	158	280	327	176	53	102
11.	*Pinnularia nobilis*	1323	1265	545	77	39	136	344	395	404	357	1737	2698
12.	*Surrinela striatula*	22	0	44	42	14	41	0	87	112	201	9	18
13.	*Synedra ulna*	952	501	265	70	83	49	104	157	216	221	1823	2804
14.	*Tabellaria genestrata*	14	5	34	42	0	0	68	108	174	244	31	67
	Total	4707	3434	1425	516	529	797	2076	3096	3248	3408	4891	7332

C	Cyanophyceae	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1.	*Anabaena spiroides*	570	112	29	0	0	0	104	169	284	291	113	367
2.	*Cylindrospermum sp.*	63	10	0	0	0	0	98	174	225	225	24	27
3.	*Gloeocapsa sp.*	112	163	51	28	46	0	112	210	286	384	71	117
4.	*Gloeotrichia sp.*	345	208	126	33	0	0	77	145	180	123	259	317
5.	*Microcystis aeruginosa*	3969	2989	179	0	72	98	298	343	383	383	1936	4179
6.	*Nostoc pruniforme*	589	367	21	12	0	41	158	278	377	266	211	391
7.	*Phormidium sp.*	7	25	0	0	0	0	130	176	84	218	14	25
8.	*Rivularia sp.*	179	94	51	20	0	116	204	256	317	317	111	176
9.	*Lyngbya sp.*	101	20	0	0	0	23	82	77	140	168	27	65
	Total	5935	3988	457	93	118	278	1263	1828	2276	2375	2766	5664

D	Euglenophyceae	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1.	*Euglena acus*	317	320	220	61	0	0	154	212	275	271	124	292
2.	*Phacus pyrum*	142	116	34	52	70	0	117	133	133	95	86	61
	Total	459	436	254	113	70	0	271	345	408	366	210	353

	Phytoplankton group	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
1	**Chlorophyceae**	6004	4796	2151	790	764	759	2623	4289	5706	5987	2992	4681	41542
2	**Bacillariophyceae**	4707	3434	1425	516	529	797	2076	3096	3248	3408	4891	7332	35459
3	**Cyanophyceae**	5935	3988	457	93	118	278	1263	1828	2276	2375	2766	5664	27041
4	**Euglenophyceae**	459	436	254	113	70	0	271	345	408	366	210	353	3285
	Total	17105	12654	4287	1512	1481	1834	6233	9558	11638	12136	10859	18030	107327
	Shannon Diversity	1.187	1.202	1.118	1.071	1.055	1.013	1.19	1.161	1.142	1.13	1.139	1.157	****

Table 37: Monthly Variation in Physicochemical parameters and plankton of Adan reservoir From Feb 2016 to Jan 2017

Month	**Water Temp**	**pH**	**Transparency**	**TDS**	**T. hardness**	**T. Alkalinity**	**DO**	**Chlorides**	**Sulphate**	**Nitrates**	**Phosphate**	**Phytoplankton**
Unit	^{0}C	-	cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Shannon
Feb	26.87	8.43	72.75	233.43	126.35	216.72	7.99	10.98	8.27	0.61	1.74	1.187
Mar	27.87	8.51	67.00	198.05	137.06	217.03	7.20	11.88	8.97	0.67	2.20	1.202
Apr	28.02	8.53	54.00	176.90	145.61	243.83	7.06	12.40	9.14	0.69	2.42	1.118
May	26.14	8.69	50.75	142.13	152.54	249.85	7.29	13.01	10.67	0.79	3.22	1.072
Jun	26.07	8.66	45.50	242.53	133.26	241.40	6.89	11.77	10.74	0.79	3.14	1.056
Jul	24.72	8.53	30.00	348.03	127.23	235.14	6.12	11.43	11.34	0.69	4.01	1.013
Aug	23.89	8.41	38.25	334.13	122.03	225.77	5.97	11.39	12.07	0.72	4.96	1.191
Sep	23.62	8.48	47.50	330.58	124.17	211.26	8.09	10.51	12.14	0.64	3.54	1.161
Oct	21.47	7.51	70.25	272.08	122.59	183.73	8.90	9.27	12.02	0.58	2.75	1.142
Nov	20.62	7.56	97.50	272.60	118.64	170.88	10.79	8.47	11.14	0.61	1.72	1.130
Dec	21.34	7.81	105.50	234.73	120.18	194.14	12.01	8.38	8.62	0.59	1.77	1.139
Jan	22.24	8.20	106.00	233.20	116.24	195.18	10.40	8.48	7.87	0.60	1.40	1.157

Note- Monthly values are the average of four selected stations.

Table 38: Monthly Variation in Physicochemical parameters and plankton of Adan reservoirFrom Feb 2017 to Jan 2018

Month	Water Temp	pH	Transparency	TDS	T. hardness	T. Alkalinity	DO	Chlorides	Sulphate	Nitrates	Phosphate	Phytoplankton
Unit	^{0}C	-	cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Shannon
Feb	27.07	8.54	76.25	253.09	128.22	212.52	8.01	11.36	8.27	0.60	1.74	1.187
Mar	27.72	8.44	67.00	198.54	138.19	218.43	7.31	12.20	8.82	0.64	2.22	1.202
Apr	27.70	8.47	51.50	182.69	147.50	243.14	7.29	12.36	9.37	0.66	2.49	1.118
May	25.97	8.72	49.00	146.16	153.67	247.98	7.14	12.91	10.64	0.77	3.01	1.070
Jun	26.57	8.79	44.50	185.96	138.97	240.93	7.04	11.71	10.67	0.77	3.19	1.056
Jul	26.52	8.77	30.25	309.56	131.22	234.71	6.19	11.53	11.14	0.66	4.05	1.014
Aug	23.95	8.32	37.75	337.14	124.76	225.33	6.04	11.38	11.94	0.66	4.92	1.191
Sep	24.12	8.54	47.25	331.26	125.97	212.96	7.85	10.39	12.22	0.58	3.54	1.161
Oct	21.85	7.57	69.50	279.61	124.20	186.29	9.04	9.16	11.72	0.54	2.76	1.142
Nov	20.97	7.72	94.50	274.79	123.70	172.56	10.90	8.47	10.74	0.55	1.86	1.130
Dec	21.27	7.84	107.00	241.51	124.47	193.45	11.89	8.24	8.59	0.57	1.74	1.139
Jan	21.97	8.44	102.00	234.81	119.65	195.49	10.60	8.50	7.84	0.54	1.46	1.157

Note- Monthly values are the average of four selected stations.

Table 39: Monthly Variation in Physicochemical parameters and plankton of Adan reservoirFrom Feb 2018 to Jan 2019

Month	Water Temp	pH	Transparency	TDS	T. hardness	T. Alkalinity	DO	Chlorides	Sulphate	Nitrates	Phosphate	Phytoplankton
Unit	^{0}C	-	cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Shannon
Feb	27.53	8.54	87.75	246.85	125.42	214.60	7.79	10.71	8.42	0.56	1.58	1.187
Mar	28.51	8.48	66.50	201.20	129.35	216.61	6.81	11.83	9.47	0.61	2.05	1.202
Apr	28.41	8.72	53.25	180.70	140.27	241.98	6.90	12.21	9.54	0.62	2.33	1.118
May	24.96	8.74	49.75	145.98	146.19	249.08	6.97	12.91	11.14	0.74	3.01	1.071
Jun	24.96	8.72	45.50	195.15	136.96	240.19	6.96	11.51	11.24	0.74	3.00	1.055
Jul	24.18	8.54	30.25	318.38	127.50	234.25	6.04	11.25	12.02	0.62	3.83	1.013
Aug	21.73	8.39	39.75	341.25	123.18	224.30	5.79	11.19	12.62	0.63	4.77	1.190
Sep	21.48	8.57	46.00	326.00	125.47	211.76	7.99	10.22	12.57	0.55	3.55	1.161
Oct	21.38	7.47	71.25	275.65	124.79	188.22	8.41	9.12	12.34	0.51	2.58	1.142
Nov	20.68	7.57	98.50	279.78	121.23	169.38	10.90	8.31	11.34	0.52	1.67	1.130
Dec	20.43	7.84	104.25	242.35	118.90	192.36	11.89	8.15	9.12	0.54	1.58	1.139
Jan	21.73	8.37	105.00	237.48	111.31	195.14	10.30	8.33	8.39	0.56	1.59	1.157

Note- Monthly values are the average of four selected stations.

CORRELATION ASSESSMENT

Table 40: Matrix showing the correlation coefficient and significance level of different parameters (2016-17)

*	Water Temp	pH	Transparency	TDS	T. hardness	T. Alkalinity	DO	Chlorides	Sulphate	Nitrates	Phosphate	Phytoplankton
Water Temp	-											
pH	0.82523	-										
Transparency	-0.54422	-0.67112	-									
TDS	-0.45231	-0.18120*	-0.29122*	-								
T. hardness	0.77287	0.62501	-0.47521	-0.67820	-							
T. Alkalinity	0.81154	0.90783	-0.76079	-0.26299	0.77753	-						
DO	-0.71634	-0.75062	0.93497	-0.12992*	-0.53326	-0.79642	-					
Chlorides	0.88275	0.84392	-0.80233	-0.29915	0.85435	0.92477	-0.87570	-				
Sulphate	-0.27031*	-0.09253*	-0.58980	0.60223	-0.05687*	0.02412*	-0.37320	0.13348*	-			
Nitrates	0.58090	0.74853	-0.70350	-0.22173	0.70373	0.85280	-0.70898	0.81994	0.27093*	-		
Phosphate	0.14045*	0.41582	-0.86226	0.53477	0.15479*	0.51175	-0.73749	0.51155	0.76038	0.57893	-	
Phytoplankton	-0.05491*	-0.22855*	0.39006	-0.02904*	-0.32508	-0.43500	0.23314*	-0.26990*	-0.26643*	-0.50070	-0.26693*	-

**Statistically not significant at $p<0.05$*

Table 41: Matrix showing the correlation coefficient and significance level of different parameters (2017-18)

*	Water Temp	pH	Transparency	TDS	T. hardness	T. Alkalinity	DO	Chlorides	Sulphate	Nitrates	Phosphate	Phytoplankton
Water Temp	-											
pH	0.77314	-										
Transparency	-0.63540	-0.61274	-									
TDS	-0.40612	-0.27475	-0.12267*	-								
T. hardness	0.71495	0.53027	-0.48362	-0.75689	-							
T. Alkalinity	0.82674	0.83780	-0.78249	-0.40464	0.79593	-						
DO	-0.78344	-0.68963	0.94504	-0.01521*	-0.52294	-0.81819	-					
Chlorides	0.92145	0.74340	-0.77576	-0.39274	0.81845	0.90915	-0.88486	-				
Sulphate	-0.11421*	-0.05976*	-0.64613	0.50918	-0.01131*	0.12276*	-0.43261	0.13073*	-			
Nitrates	0.67449	0.70260	-0.67597	-0.52451	0.81094	0.88933	-0.69307	0.82063	0.18832*	-		
Phosphate	0.23106*	0.33582	-0.86435	0.45573	0.11880*	0.51207	-0.75477	0.45133	0.79738	0.45806	-	
Phytoplankton	-0.18843*	-0.36204*	0.40828	0.23178*	-0.41550	-0.44625	0.23316*	-0.23112*	-0.26937*	-0.53334	-0.26739*	-

**Statistically not significant at $p<0.05$*

Table 42: Matrix showing the correlation coefficient and significance level of different parameters (2018-19)

*	Water Temp	pH	Transparency	TDS	T. hardness	T. Alkalinity	DO	Chlorides	Sulphate	Nitrates	Phosphate	Phytoplankton
Water Temp	-											
pH	0.64573	-										
Transparency	-0.28773	-0.5759	-									
TDS	-0.57948	-0.33852	-0.1353*	-								
T. hardness	0.60793	0.55169	-0.61648	-0.61087	-							
T. Alkalinity	0.63123	0.87499	-0.77045	-0.39439	0.79185	-						
DO	-0.57896	-0.66108	0.88813	0.001205*	-0.60357	-0.80211	--					
Chlorides	0.74941	0.78498	-0.76931	-0.40827	0.8587	0.92204	-0.87583	-				
Sulphate	-0.41388*	-0.1389*	-0.65996	0.53557	0.18514*	0.096153*	-0.39049	0.15021*	-			
Nitrates	0.44108	0.72227	-0.61102	-0.52833	0.76187	0.85951	-0.61144	0.79038	0.12665*	-		
Phosphate	-0.12927*	0.33801	-0.86918	0.473	0.26326*	0.50981	-0.71081	0.47105	0.79813	0.41574	-	
Phytoplankton	-0.00778*	-0.21934*	0.43587	0.18198*	-0.46089	-0.4444	0.20165*	-0.2698*	-0.30208*	-0.51852	-0.25752*	-

**Statistically not significant at $p<0.05$*

Table 43: Matrix showing the overall correlation coefficient and significance level of different parameters (2016-19)

*	Water Temp	pH	Transparency	TDS	T. hardness	T. Alkalinity	DO	Chlorides	Sulphate	Nitrates	Phosphate	Phytoplankton
Water Temp	-											
pH	0.73163	-										
Transparency	-0.47531	-0.61675	-									
TDS	-0.4788	-0.26631*	-0.18384*	-								
T. hardness	0.69601	0.56335	-0.5174	-0.67535	-							
T. Alkalinity	0.74304	0.87066	-0.77083	-0.35172	0.77631	-						
DO	-0.67196	-0.69655	0.9192	-0.04868*	-0.5342	-0.80374	-					
Chlorides	0.84276	0.78536	-0.78206	-0.36526	0.83572	0.91734	-0.87323	-				
Sulphate	-0.2898*	-0.0961*	-0.62042	0.5435	0.011533*	0.077449*	-0.40048	0.12762*	-			
Nitrates	0.54856	0.65889	-0.62775	-0.39518	0.71459	0.81818	-0.61802	0.77609	0.14277*	-		
Phosphate	0.077185*	0.36048	-0.86481	0.48812	0.1794*	0.51099	-0.72949	0.47955	0.76654	0.46798	-	
Phytoplankton	-0.07857*	-0.26766*	0.41136	0.12634*	-0.39036	-0.44171	0.22226*	-0.25618*	-0.27658*	-0.48629	-0.26348*	-

**Statistically not significant at p<0.05*

Table 44: Average occurrence of the macrophytes observed at Adan Reservoir during February 2016 to January 2019

Sr.	Family	Sr.	Species	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1	*Chlorophyceae*	**1.**	*Chara vulgaris L.*	+++	+++	++	+	+	-	+	+	++	++	+++	+++
		2.	*Nitella sp. L.*	+++	++	++	+	-	-	+	+	+	++	+++	+++
2	*Marsileaceae*	**3.**	*Marsilea quadrifolia L.*	-	-	-	-	-	+	++	+++	+++	+++	++	++
3	Typhaceae	**4.**	*Typha sp.,*	+++	+++	+++	++	-	-	-	+	+	+	+++	+++
4	*Mimisaceae*	**5.**	*Acacia nilotica L.*	+	+	+	+	+	+	+	+	+	+	+	+
5	*Ithraceae*	**6.**	*Ammannia baccifera L.*	-	-	-	-	-	-	+	+	++	++	+	+
6	*Asteraceae*	**7.**	*Aageratum conyzoids L*	+++	+	-	-	-	-	-	-	-	-	+	++
		8.	*Caesulia axllaris R.*	+++	++	+	-	-	-	-	-	-	+	+++	+++
		9.	*Eclipto alba L.*	-	-	-	-	-	-	-	+	++	+	+	-
		10.	*Gnaphalium pulvinatum D.*	++	+	+	+	-	-	-	-	-	-	+	++
		11.	*Grangea maderaspatana L.*	+	++	+	-	-	-	-	-	-	-	+	+
7	*Gentianaceae*	**12.**	*Centaurium centauroides R.*	+	+	+	-	-	-	-	-	-	-	+	+
8	*Menyanthaceae*	**13.**	*Nymphoides indica L*	+++	++	++	+	+	-	-	+	++	++	+++	+++
9	*Borgianaceae*	**14.**	*Heliotropium supinum L.*	+	+	-	-	-	-	-	+	++	+++	++	+
10	*Convolvulaceae*	**15.**	*Ipomea aquatica F.*	+++	+++	+++	++	+	-	-	+	++	+++	+++	+++
		16.	*Ipomoeo fistulosa M.*	++	++	+	+	+	+	+	++	+++	+++	+++	+++
		17.	*Merremia aegyptia L.*	-	-	-	-	-	-	-	+	+	+	++	+
11	*Scrophulariaceae*	**18.**	*Bacopa monnieri L.*	++	+	+	-	-	-	-	-	-	+	+	+
		19.	*Stemodia viscosa R.*	-	-	-	-	-	-	+	+	++	+++	+++	+
		20.	*Sutera dissecta D.*	++	++	+	-	-	-	-	-	-	-	+	++

		21.	*Verbascum chinensis L.*	++	++	+	-	-	-	-	-	-	-	+	++
12	*Acanthaceae*	**22.**	*Hygrophila spinosa T.*	+++	++	+	+	+	+	+	++	++	++	+++	+++
13	*Verbenaceae*	**23.**	*Phyla nodiflora L.*	++	+	+	+	-	-	-	+	+	++	++	+++
14	*Euphorbiaceae*	**24.**	*Chrozophora prostrata D.*	++	++	++	+	-	-	-	-	-	+	+	++
15	*Hydrocharitaceae*	**25.**	*Hydrilla verticillata L.*	+++	+++	+++	+++	+	+	++	++	++	+++	+++	+++
		26.	*Ottelia alismodes L.*	++	++	++	+	+	-	-	-	++	+++	+++	+++
		27.	*Valisneria spiralis L.*	+++	+++	++	+	-	-	-	+	++	+++	+++	+++
16	*Commelinaceae*	**28.**	*Commelina benghalensis L.*	-	-	-	-	-	-	+	+	+	++	++	++
17	*Najadaceae*	**29.**	*Najas minor A.*	+++	+++	++	+	-	-	++	++	++	++	+++	+++
18	*Potamogetonaceae*	**30.**	*Potamogeton nodosus P.*	++	+	+	-	-	-	+	+	++	+++	+++	++
		31.	*Potamogeton pectinatus L*	+++	+++	+	-	-	-	-	-	-	+	++	+++
19	*Cyperaceae*	**32.**	*Cuperus rotundua L.*	+++	+++	+++	++	-	-	-	+	++	+++	+++	+++
		33.	*Cyperus scariosus R.*	+++	++	++	+	-	-	-	-	+	++	+++	+++
		34.	*Eleocharis capitata R.*	++	+++	+++	+	-	-	-	-	-	-	+	+
		35.	*Scirpus articulatus L.*	+	+	-	-	-	-	+	++	++	+++	+++	+++
		36.	*Scirpus lateriforus G.*	+	+	-	-	-	-	-	+	+	++	+++	++
		37.	*Scirpus roylei P.*	++	+	+	+	-	-	-	+	++	+++	+++	+++
20	*Poaceae*	**38.**	*Cynodon dacttylon L*	++	++	+	+	+	+	+	+	++	+++	+++	+++
# Occurrence: - Absent; + Low; ++ Moderate; +++ High															

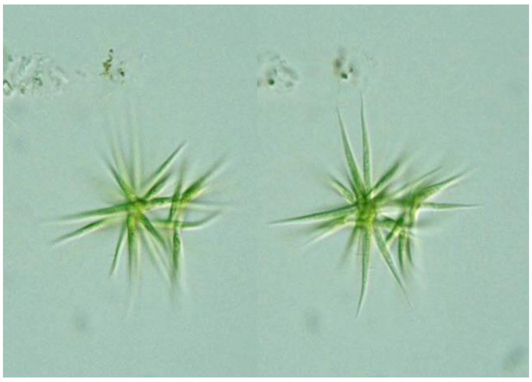
The study revealed the rich phytoplankton diversity. The observed status of phytoplankton diversity was mostly related to the studied physicochemical parameters. The observed results were correlated and significantly different at $p<0.05$. The results shows the significant correlation relation between all the studied physicochemical parameters with observed phytoplankton ($p<0.05$). Among studied relations, only the relations between Water Temperature-Sulphate, Water Temperature-Phosphate, Water Temperature-Phytoplankton, Water Temperature-Macrophytes, pH- TDS, pH-Sulphates, pH-Phytoplankton, Transparency-TDS, TDS-DO, TDS- Phytoplankton, Total Hardness-Sulphates, Total Hardness- Phytoplankton, Total Alkalinity-Sulphates, DO-Phytoplankton, Chlorides-Sulphates, Chlorides-Phytoplankton, Sulphate-Nitrate, Phytoplankton and Phosphates- Phytoplankton were not significantly correlated ($p<0.05$).

MACROPHYTES INVENTORY

The present study was conducted during February 2016 to January 2019 to observe the aquatic macrophytes of Adan reservoir of Washim district of Maharashtra (India). The aquatic macrophytes exhibited a heterogeneous assemblage of numerous species in the Adan Reservoir. Total 38 species belonging to twenty families of macrophytes were recorded. From these species, 21 were belonging to Dicotyledons; fourteen to Monocotyledons while three species to Cryptogams. These species comprised of aquatic, sub-aquatic and terrestrial habitat. The Cyperaceae represented by six, Asteraceae with five, Scrophlariceae with four species while Hydrocharitaceae and Convolvuaceae with three species each. The aquatic species like *Hydrilla, Najas* and *Chara* as well as marginal species *Cynodon* and *Ipomea;* including terrestrial *Acacia* species were dominant during the period of investigation. The other recorded species were *Marsilea, Typha. Nymphoides, Verbascum, Phyla, Chrozophora, Ottelia, Vallisneria, Potamogeton, Cyperus, Scirpus* were moderately present during study. The species like *Ammania, Eclipta, Grangea, Centaurium, Helitropium, Merremia, Stemodia, Sutera* were observed sparsely. The dense population of *Acacia* was notice at the bank of the reservoir. During the study period, maximum macrophytes were recorded during winter and pre-summer while minimum was recorded during rainy season.

PHYTOPLANKTON AND AQUATIC WEEDS ADAN RESERVOIR

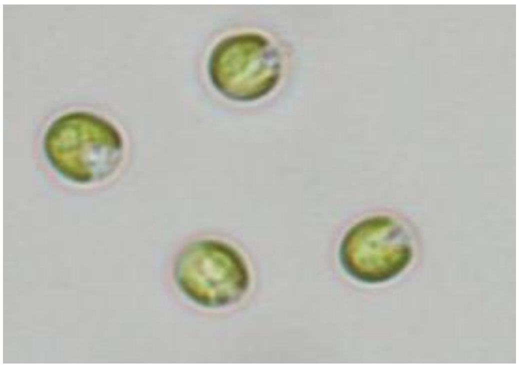
PLATE 1



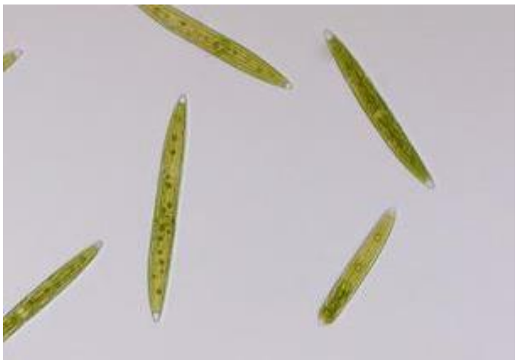
Ankistrodesmus counvolutus

Characium sp.

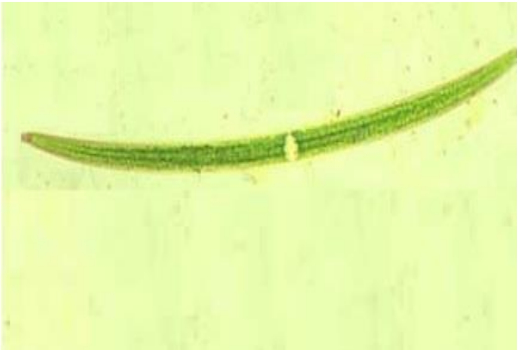
Chlamydomonas cingulata



Chlorella vulgaris

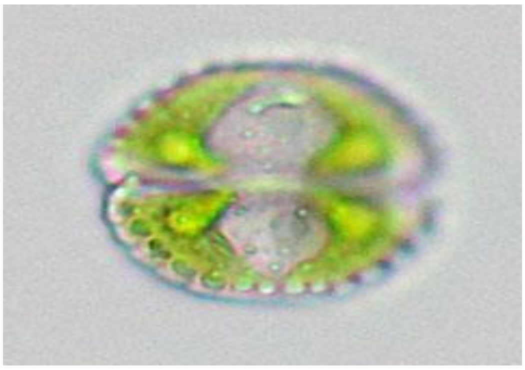


Coelastrum acerosum



Coelastrum lanceolatum

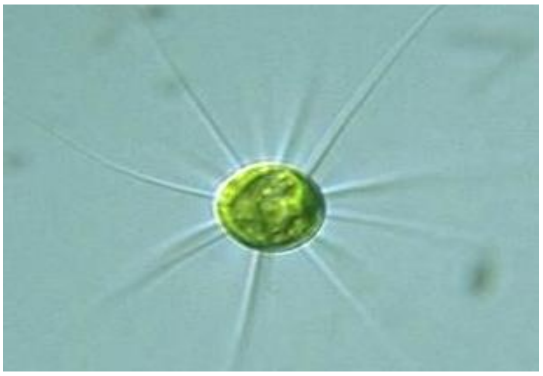
Cosmarium grannatum



Cosmarium monomazum

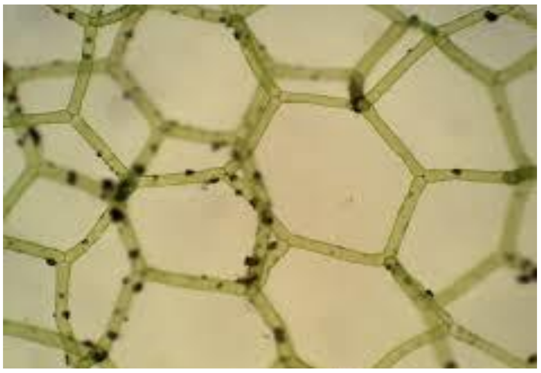
PLATE 2

Euastrum didelta



Golenkinia sp.

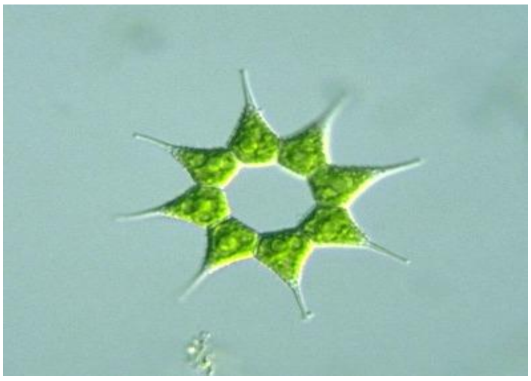
Gonium duplex



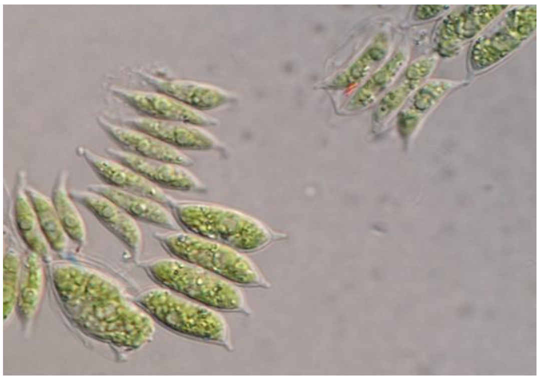
Hydrodictyon reticulatum

Mesotaenium sp.

Oedogonium sp.



Pediastrum simplex



Scenedesmus dimorphus

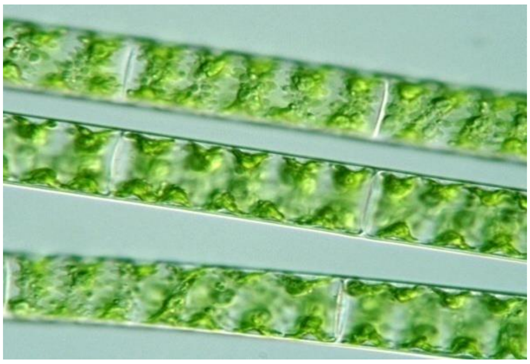
PLATE 3

Scenedesmus quardricauda

Selenastrum gracile

Sphaerocystis schroeteri

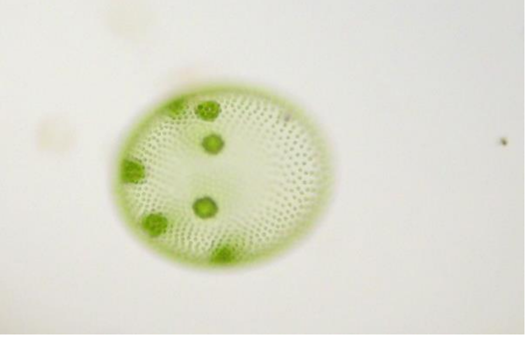
Sphaerozosma sp.



Spirogyra sp.

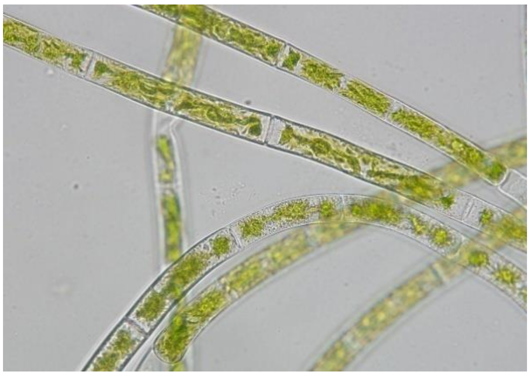
Stigeoclonium sp.

Ullothrix sp.



Volvox aureus

PLATE 4



Zygnema sp.

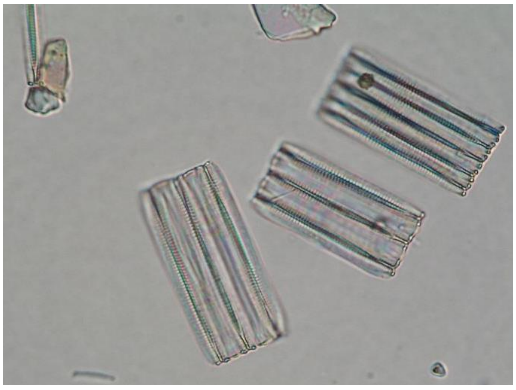
Achnanthes lancelolata

Amphora ovalis

Asterionella farmosa

Cymbella affinis

Diatoma vulgaris

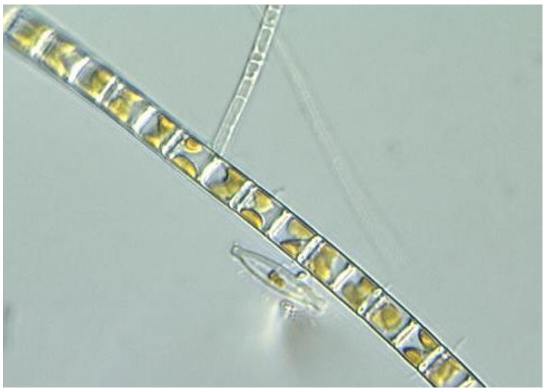


Fragelaria capuncia

Frustulia rhomboids

PLATE 5

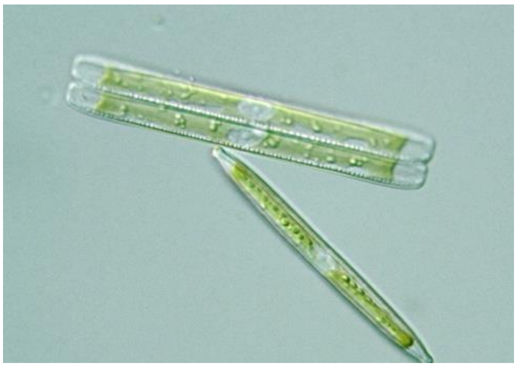
Gomphonema gracile



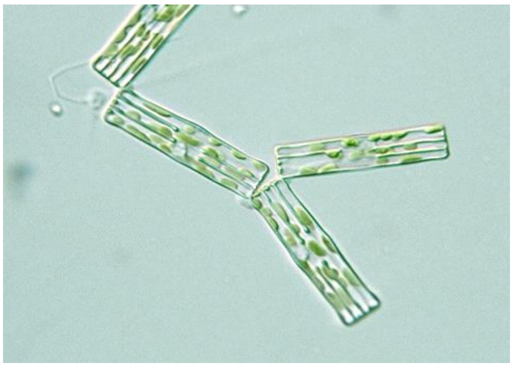
Melosira granulate

Naviculla radiosa

Pinnularia nobilis

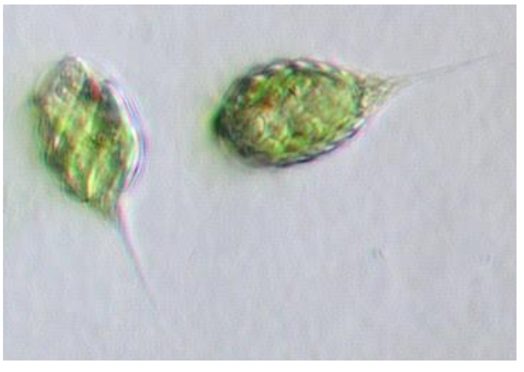


Synedra ulna



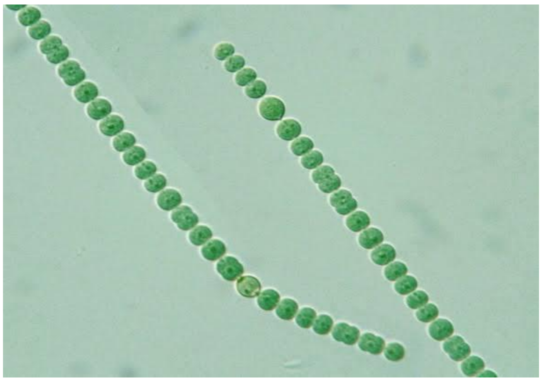
Tabellaria genestrata

Euglena acus

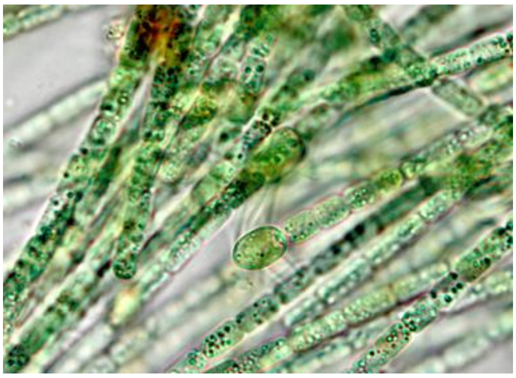


Phacus pyrum

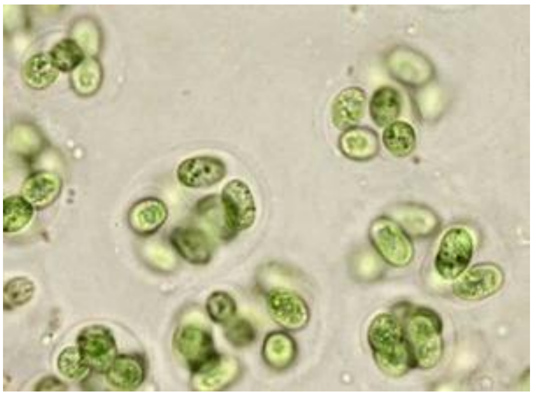
PLATE 6



Anabaena spiroides

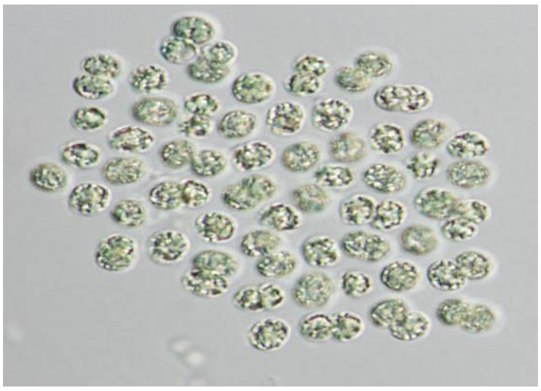


Cylindrospermum sp.

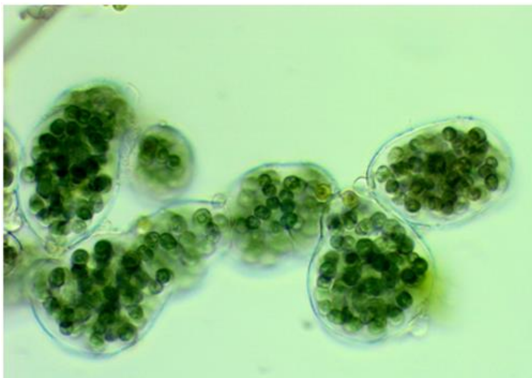


Gloeocapsa sp.

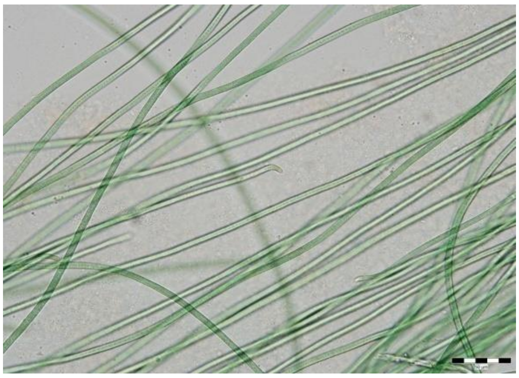
Gloeotrichia sp.



Microcystis aeruginosa



Nostoc pruniforme

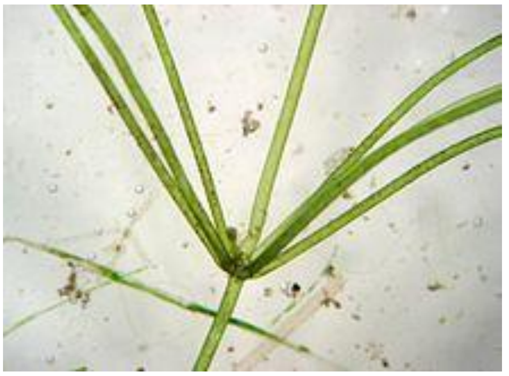


Phormidium sp.

Lyngbya sp.

PLATE 7

Chara vulgaris L.



Nitella sp. L.

Marsilea quadrifolia L.

Typha sp.,

Acacia nilotica L.

Ammannia baccifera L.

Aageratum conyzoids L

Caesulia axllaris R.

PLATE 8

Eclipto alba L.

Gnaphalium pulvinatum D.

Grangea maderaspatana L.

Centaurium centauroides R.

Nymphoides indica L

Heliotropium supinum L.

Ipomea aquatica F

Ipomoeo fistulosa M.

PLATE 9

Merremia aegyptia L.

Bacopa monnieri L.

Stemodia viscosa R.

Sutera dissecta D.

Verbascum chenensis L.

Hygrophila spinosa T.

Phyla nodiflora L.

Chrozophora prostrata D.

PLATE 10

Hydrilla verticillata L.

Ottelia alismodes L.

Valisneria spiralis L.

Commelina benghalensis L.

Najas minor A.

Potamogeton nodosus P.

Potamogeton pectinatus L

Cuperus rotundua L.

PLATE 11

Cyperus scariosus R..

Eleocharis capitata R.

Scirpus articulatus L.

Scirpus lateriforus G.

Scirpus roylei P.

Cynodon dacttylon L

DISCUSSION:

The freshwater ecosystems include rivers, streams, lakes, ponds and springs and the total water content of these systems is called terrestrial waters. The main source of terrestrial water is rainfall, although thermal spring beneath the earth's surface also contributes to the freshwater systems. The amount of freshwater on earth is insignificant as compared to that of the world ocean; yet the freshwater ecosystems; the rivers are important geo-chemically because they are responsible for the most of the weathering erosion of landmasses. A large proportion of the fresh water is stored as ice and snow at higher altitudes and around the poles or ground water as and less than 0.5 % is available for use by organisms, including for human civilization. However, increasing human populations have resulted accelerating demands on water supplies for drinking, industrial, hygiene and agricultural process.

Wetlands are the most productive ecosystems of the world. They are unique and many wetlands are as old as or older than rivers. These are the transitional zones where the flow of water, the cycling of nutrients and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soil and vegetation. The water reservoirs play a major role in agricultural, fishery and electricity production along with the use of water for drinking purposes. Several factors which determine the water quality of a reservoir includes seasonal climatic changes seasonal precipitation, wind action, geologic origin of the catchment basin and pattern of hydrological cycle prevalent in the reservoir (Barik *et al.*, 2010). Several limnological parameters such as conductivity, total dissolved solids, and phytoplankton and reservoir morphometry have been used in estimating potential biomass from reservoirs.

The several physicochemical or biological factors, in suitable range, help in increased activities and growth for aquatic animals. On the other hand, some factors exert stress and adversely affect growth and reproduction of different animals. Studies on water quality mostly centre on fish production and aquatic biotic integrity. Therefore, protection of water quality is very important issue so it should be kept within acceptable range (Quyang *et al.*, 2006). The water is probably the only natural resource to touch all aspects of human civilization from agricultural and industrial development and having the cultural and religious values. Water is a necessity for all living beings, without it; there would be no life. Life originated in water and ultimate basis of it, the protoplasm is a colloidal solution of complex organic molecules in a watery medium. Water is essential at all levels of life, cellular to ecosystem. It is essential for the circulation of body fluids in the plants, animals and it stands as the key substance for the existence and continuity of life through reproduction and different cyclic processes in nature.

Water plays the central role in mediating global scale ecosystem processes, linking atmosphere, lithosphere and biosphere, by moving substances among them, and enabling chemical reactions to occur. Humans depend on these resources for all their needs of existence and survival. Understanding such aquatic life requires a sound knowledge not just of organisms themselves but also of these external influences of media that affects them. In this concern, the study was conducted during 2016 to 2018 to analyse the physicochemical status of Adan reservoir.

Water temperature is an important factor which influences the chemical, biochemical and biological characteristics of river water. The temperature is a physical quantity that expresses the subjective perceptions of hot and cold. Temperature is measured with a thermometer, historically calibrated in various temperature scales and units of measurement. Phytoplankton required moderate temperature to survive. The average water temperature was ranges from 20.43 to 28.51 ^{0}C. It was minimum during the months of winter and maximum in summer. Water Temperature was significantly correlated ($p<0.05$) with pH (r=0.73163), Transparency (r=-0.47531), Total dissolved solids (r=-0.4788), Total hardness (r=0.69601), Total Alkalinity (r=0.74304), Dissolved oxygen (r=-0.67196), Chlorides (r=0.84276), and Nitrates (r=0.54856).

The pH is one of another most important factors in measuring water quality. The pH is a numeric scale used to specify the acidity or alkalinity of an aqueous solution. It is approximately the negative of the base 10 logarithm of the molar concentration, measured in units of moles per liter, of hydrogen ions. More precisely it is the negative of the base 10 logarithm of the activity of the hydrogen ion. Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. Pure water is neutral, at pH 7, being neither an acid nor a base. Contrary to popular belief, the pH value can be less than 0 or greater than 14 for very strong acids and bases respectively. Present investigation shows the water pH was ranges from 7.47 to 8.79. It was minimum during the months of winter and maximum in months of late summer to early monsoon. The pH was significantly correlated ($p<0.05$) with Water Temperature (r=0.73163), Transparency (r=-0.61675), Total hardness (r=0.56335), Total Alkalinity (r=0.87066), Dissolved oxygen (r=-0.69655), Chlorides (r=0.78536), Nitrates (r=0.65889) and Phosphate (r=0.36048).

Transparency is clarity of water which inversely proportional to turbidity. The turbidity is the cloudiness or haziness of water caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality. Water can contain suspended solid matter consisting of particles of many different sizes. While some suspended material will be large enough and heavy enough to settle rapidly to the bottom of the container if a liquid sample is left to stand, very small particles will settle only very slowly or not at all if the sample is regularly agitated or the particles are colloidal. These small solid particles cause the liquid to appear turbid. The average water transparency was ranges from 30 cm to 107 cm. The minimum values were recorded during the monsoon while water transparency increased during winter to summer. Transparency was significantly correlated ($p<0.05$) with Water Temperature (r=-0.47531), pH (r=0.73163), Total hardness (r=-0.5174), Total Alkalinity (r=-0.77083), Dissolved oxygen (r=0.9192), Chlorides (r=-0.78206), Sulphate (r=-0.62042), Nitrates (r=-0.62775), Phosphate (r=-0.86481), Chlorophyll-a (r=0.60353) and Phytoplankton (r=0.41136).

Total dissolved solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form. Generally, the operational definition is that the solids must be small enough to survive filtration through a filter with two-micrometer pores. Total dissolved solids are normally discussed only for freshwater systems, as salinity includes some of the ions constituting the definition of TDS. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is not generally considered a primary pollutant. It is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants. During the period of investigation, average total dissolved solids in the water were ranges from 142.03 to 348.13 mg/l. It was maximum during the monsoon while decreased during winter to summer. Total dissolved solids, was significantly correlated ($p<0.05$) with Water Temperature (r=-0.4788), Total hardness(r=-0.67535), Total Alkalinity (r=-0.35172), Chlorides (r=-0.36526), Sulphate (r=0.5435), Nitrates (r=-0.39518) and Phosphate (r=0.48812).

Hard water is water that has high mineral content. Hard water is formed when water percolates through deposits of limestone and chalk which are largely made up of calcium and magnesium carbonates. Hard drinking water may have moderate health benefits, but can pose serious problems in industrial settings, where water hardness is monitored to avoid costly breakdowns in boilers, cooling towers, and other equipment that handles water. In domestic settings, hard water is often indicated by a lack of foam formation when soap is agitated in water, and by the formation of limescale in kettles and water heaters. Wherever water hardness is a concern, water softening is commonly used to reduce hard water's adverse effects. Total hardness was ranges from 111.31 to 153.67 mg/l. In this study, the maximum values were recorded during the summer while it was decreased during monsoon to winter. Total hardness was significantly correlated ($p<0.05$) with Water Temperature (r=0.69601), pH (r=0.56335), Transparency (r=-0.5174), Total dissolved solids (r=-0.67535), Total Alkalinity (r=0.77631), Dissolved oxygen (r=-0.5342), Chlorides (r=0.83572), Nitrates (r=0.71459), Chlorophyll-a (r=-0.62399) and Phytoplankton (r=-0.39036).

Total alkalinity refers to the ability of the pool water to resist a change in pH. The key purpose total alkalinity serves is to help control the pH in the pool. It is the name given to the quantitative capacity of an aqueous solution to neutralize an acid. Measuring alkalinity is important in determining a stream's ability to neutralize acidic pollution from rainfall or wastewater. It is one of the best measures of the sensitivity of the stream to acid inputs. There can be long-term changes in the alkalinity of streams and rivers in response to human disturbances. During the period of investigation, the average of total alkalinity was ranged between from 149.85 to 169.38 mg/l. The maximum values of total alkalinity were recorded during the summer while decreased during monsoon to early winter. Total Alkalinity was significantly correlated ($p<0.05$) with Water Temperature (r=0.74304), pH (r=0.87066), Transparency (r=-0.77083), Total dissolved solids (r=-0.35172), Total hardness (r=0.77631), Dissolved oxygen (r=-0.80374), Chlorides (r=0.91734), Nitrates (r=0.81818), Phosphate (r=0.51099), Chlorophyll-a (r=-0.73542) and Phytoplankton (r=-0.44171).

In aquatic environments, oxygen saturation is a ratio of the concentration of dissolved oxygen (O_2) in the water to the maximum amount of oxygen will dissolve in the water at that temperature and pressure under stable equilibrium. Well-aerated water such as a fast-moving stream is without oxygen producers or consumer is 100% saturated. It is possible for stagnant water to become somewhat supersaturated with oxygen either because of the presence of photosynthetic aquatic oxygen producers or because of a slow equilibration after a change of atmospheric conditions. Stagnant water in the presence of decaying matter will typically have an oxygen concentration much less than 100%. It was observed that the value of dissolved oxygen fluctuates from 5.79 to 12.01 mg/l. During study, the maximum values were recorded during winter and minimum during monsoon. Dissolved oxygen was significantly correlated ($p<0.05$) with Water Temperature (r=-0.67196), pH (r=-0.69655), Transparency (r=0.9192), Total hardness (r=-0.5342), Total Alkalinity (r=-0.80374), Chlorides (r=-0.87323), Sulphate (r=-0.40048), Nitrates (r=-0.61802) and Phosphate (r=-0.72949).

The chloride ion is formed when the element chlorine gains an electron or when a compound such as hydrogen chloride is dissolved in water or other polar solvents. Chloride salts such as sodium chloride are often very soluble in water. Chloride is also a useful and reliable chemical indicator of aquatic fecal contamination, as chloride is a non-reactive solute and ubiquitous to sewage and potable water. During the period of investigation, average Chlorides in the water was ranged between 8.15 to 13.01 mg/l. It was maximum during the months of summer while decreased from monsoon to winter. The Chlorides content was significantly correlated ($p<0.05$) with Water Temperature(r=0.84276), pH (r=0.78536), Transparency (r=-0.78206), Total dissolved solids (r=-0.36526), Total hardness (r=0.83572), Total Alkalinity (r=0.91734), Dissolved oxygen (r=-0.87323), Nitrates (r=0.77609) and Phosphate (r=0.47955).

Sulphate occurs widely in everyday life. Sulphates are salts of sulfuric acid and many are prepared from that acid. Sulphate found as microscopic particles like aerosols that resulting from biomass combustion and by decomposition. They increase the acidity of the atmosphere and form acid rain. The anaerobic sulphate-reducing bacteria can remove the black sulphate crust that often tarnishes buildings. During the period of investigation, average sulphate in the water was ranged between 7.84 to 12.62 mg/l. It was maximum during the months of monsoon while decreased from winter to summer. Sulphate was significantly correlated ($p<0.05$) with Transparency(r=-0.62042), Total dissolved solids (r=0.5435), Dissolved oxygen (r=-0.40048) and Phosphate (r=0.76654)

Almost all inorganic nitrate salts are soluble in water at standard temperature and pressure. A common example of an inorganic nitrate salt is potassium nitrate. Nitrate salts are found naturally on earth as large deposits, particularly of nitratine, a major source of sodium nitrate. Nitrites are produced by a number of species of nitrifying bacteria by various fermentation processes using urine and dung. In freshwater systems close to land, nitrate can reach high levels that can potentially cause the death of aquatic organism. The nitrate in the water was ranges from 0.51 to 0.79 mg/l. During the period of investigation, it was maximum during the months of summer monsoon while decreased from monsoon to winter was detected. Nitrate content was significantly correlated ($p<0.05$) with Water Temperature (r=0.54856), pH (r=0.65889), Transparency (r=-0.62775), Total dissolved solids (r=-0.39518), Total hardness (r=0.71459), Total Alkalinity (r=0.81818), Dissolved oxygen (r=-0.61802), Chlorides (r=0.77609), Phosphate (r=0.46798), Chlorophyll-a (r=-0.70504) and Phytoplankton (r=-0.48629).

A phosphate is an inorganic chemical and a salt-forming anion of phosphoric acid. In ecological terms, because of its important role in biological systems, phosphate is a highly sought after resource. Once used, it is often a limiting nutrient in environments, and its availability may govern the rate of growth of organisms. Addition of high levels of phosphate to environments and to micro-environments in which it is typically rare can have significant ecological consequences. The blooms in the populations of some organisms at the expense of others, and the collapse of populations deprived of resources such as oxygen can occur. In the context of pollution, phosphates are one component of total dissolved solids, a major indicator of water quality, but not all phosphorus is in a molecular form which algae can break down and consume. During the study, phosphate in the water was ranges from 1.40 to 4.96 mg/l. The maximum values of phosphate were recorded during the months of monsoon while decreased from winter to summer. Phosphate content was significantly correlated ($p<0.05$) with pH($r=0.36048$), Transparency ($r=-0.8648$), Total dissolved solids ($r=0.48812$), Total Alkalinity ($r=0.51099$), Dissolved oxygen ($r=-0.72949$), Chlorides($r=0.47955$), Sulphate ($r=0.76654$) and Nitrates($r=0.46798$).

These observations clear the seasonal fluctuations in water properties. While comparing with BIS drinking water standard, the water of these sites is not much suitable for drinking purpose but can be use for drinking after proper treatment. But water of Adan reservoir is suitable for irrigation and fish culture. These suggestions are in will agreement with previous studies of Halwe (2004), Dahegaonkar (2008), Nasare *et al.* (2009), Telkhade *et al.* (2009), Thirumala *et al.,* (2011), Shaikh and Bhosle (2012), Singh and Sharma (2012), Summarwar (2012), Bakawale and Kanhere (2013), Saxena and Saxena (2014), Belkhode and Sitre (2016), Chavhan and Lanjekar (2016), Lalhningliani and Lalrinpuia (2017), Chunne and Nasare (2018), Jain *et al.* (2018), Rawat and Trivedi (2018), Prajapati and Patel (2019) and a name a few.

The most wonderful mystery of the life may well be the means by which it created so much diversity from so little physical matter. Diversity is a cornerstone of life whose pattern changes from place to place with time to time of the day and the season of year (Joshi *et al.*, 2013). The Adan reservoir of Washim district of Maharashtra represented the rich aquatic organism diversity. A biodiversity generally refers to the variety and variability of life on Earth. Biodiversity typically measures variation at the genetic, the species, and the ecosystem level. Terrestrial biodiversity tends to be greater near the equator, which seems to be the result of the warm climate and high primary productivity. Biodiversity is not evenly distributed; rather it varies greatly across the globe as well as within regions. Among other factors, the diversity of all living organisms depends on temperature, precipitation, altitude, soils, geography and the presence of other species.

Among these, the aquatic biodiversity can be defined as the variety of life and the ecosystems that make up the freshwater, tidal, and marine regions of the world and their interactions. Aquatic biodiversity encompasses freshwater ecosystems, including lakes, ponds, reservoirs, rivers, streams, groundwater, and wetlands. As an important part of this, the phytoplanktons are very diverse and can be categorised in many ways.

Phytoplanktons are the autotrophic components of the plankton community and a key part of aquatic ecosystems. Most phytoplanktons are too small to be individually seen with the unaided eye. However, when present in high enough numbers, some varieties may be noticeable as colored patches on the water surface due to the presence of chlorophyll within their cells and accessory in some species. During the period of investigation, total fifty species belonging to four groups were identified. The maximum number of individuals and diversity was observed during winter and lower by summer and monsoon which was observed to be related with physicochemical status. The Chlorophyceae were represented with in twenty five species; Bacillariophyceae with fourteen; Cyanophyceae with nine species while Euglenophyceae was represented with only two species. The Chlorophyceae were obtained in maximum quantity; Bacillariophyceae and Cyanophyceae showed moderate while Euglenophyceae observed with minimum population. Phytoplankton diversity was significantly correlated ($p<0.05$) with Transparency, Total hardness, Total Alkalinity, Nitrates, Chlorophyll-a, and Macrophytes. The similar type species composition was previously observed by Dahegaonkar (2008), Nasare *et al.* (2009), Telkhade *et al.* (2009), Thirumala *et al.,* (2011), Halwe (2012), Shaikh and Bhosle (2012), Singh and Sharma (2012), Summarwar (2012), Bakawale and Kanhere (2013), Saxena and Saxena (2014), Belkhode and Sitre (2016), Chavhan and Lanjekar (2016), Odelu (2016), Lalhningliani and Lalrinpuia (2017), Chunne and Nasare (2018), Rawat and Trivedi (2018), Prajapati and Patel (2019) and a name a few

The Chlorophyceae was represented with twenty five species. It is one of the classes of green algae, distinguished mainly on the basis of ultrastructural morphology. They are usually green due to the dominance of pigments chlorophyll a and chlorophyll b. The chloroplast may be discoid, plate-like, reticulate, cup-shaped, spiral or ribbon shaped with flagella in different species. Most of the members have one or more storage bodies called pyrenoids located in the chloroplast. Pyrenoids contain protein besides starch. Some algae may store food in the form of oil droplets. Green algae usually have a rigid cell wall made up of an inner layer of cellulose and outer layer of pectose (Guiry and Guiry, 2007).

Bacillariophyceae were represented with fourteen species. It mainly includes the diatoms which are unicellular: they occur either as solitary cells or in colonies, which can take the shape of ribbons, fans, zigzags, or stars. Individual cells range in size from 2 to 200 micrometers. In the presence of adequate nutrients and sunlight, an assemblage of living diatoms doubles approximately every 24 hours by asexual binary fission; the maximum life span of individual cells is about six days.Diatoms have two distinct shapes: a few (*centric diatoms*) are *radially* symmetric, while most (*pennate diatoms*) are broadly bilaterally symmetric. A unique feature of diatom anatomy is that they are surrounded by a cell wall made of silica (hydrated silicon dioxide), called a frustule. These frustules have structural coloration due to their photonic nanostructure, prompting them to be described as "jewels of the sea" and "living opals". Movement in diatoms primarily occurs passively as a result of both water currents and wind-induced water turbulence; however, male gametes of centric diatoms have flagella, permitting active movement for seeking female gametes. Similar to plants, diatoms convert light energy to chemical energy by photosynthesis, although this shared autotrophy evolved independently in both lineages. Unusually for autotrophic organisms, diatoms possess a urea cycle, a feature that they share with animals, although this cycle is used to different metabolic ends in diatoms (Wehr *et al.*, 2007).

Cyanophyceae was represented with presence of nine species. It is a primitive group of algae, commonly known as blue green algae. The name blue green algae are given because of the presence of a dominant pigment c-phycocyanin, the blue green pigment. In addition, other pigments like chlorophyll a (green), c-phycoerythrin (red), β-carotene and different xanthophylls are also present. The members of this class are the simplest living autotrophic prokaryotes. Some of them are nitrogen-fixing, that lives in a wide variety of moist soils and water either freely or in a symbiotic relationship with plants or lichen-forming fungi. They range from unicellular to filamentous and include colonial species. Colonies may form filaments, sheets, or even hollow spheres. Some filamentous species can differentiate into several different cell types: vegetative cells are the normal, photosynthetic cells that are formed under favorable growing conditions; akinetes are climate-resistant spores that may form when environmental conditions become harsh; thick walled heterocysts that contain the enzyme nitrogenase, vital for nitrogen fixation in an anaerobic environment due to its sensitivity to oxygen (Rodríguez-Ezpeleta *et al.*, 2005).

Euglenophyceae covered only two species in this study. They are one of the best-known groups of flagellates, which are excavate eukaryotes of the phylum Euglenophyta and their cell structure is typical of that group. They are commonly found in freshwater, especially when it is rich in organic materials, with a few marine and endosymbiotic members. Most euglenids are unicellular. Many euglenids have chloroplasts and produce their own food through photosynthesis, but others feed by phagocytosis, or strictly by diffusion. This group is known to contain the carbohydrate paramylon. Euglenoids are distinguished mainly by the presence of a type of cell covering called a pellicle. Within its taxon, the pellicle is one of the euglenoids' most diverse features from a morphological standpoint. The pellicle is composed of proteinaceous strips underneath the cell membrane, supported by dorsal and ventral microtubules. This varies from rigid to flexible, and gives the cell its shape, often giving it distinctive striations. In many euglenids the strips can slide past one another, causing an inching motion called metaboly. Otherwise they move using their flagella (Ciugulea *et al.*, 2004).

The study revealed the rich phytoplankton diversity. The observed status of phytoplankton diversity was mostly related to the studied physicochemical parameters. The phytoplankton diversity abundance was significantly correlated ($p<0.05$) with Transparency ($r=0.41136$), Total hardness ($r=-0.39036$), Total Alkalinity ($r=-0.44171$), Nitrates ($r=-0.48629$), Chlorophyll-a ($r=0.53771$) and Macrophytes ($r=0.58577$). The observed results were correlated and significantly different at $p<0.05$. The result shows the significant correlation relation between the studied physicochemical parameters observed phytoplankton and macrophytes occurrence. Only the relations between Water Temperature-Sulphate, Water Temperature-Phosphate, Water Temperature-Phytoplankton, Water Temperature-Macrophytes, pH- TDS, pH-Sulphates, pH-Phytoplankton, Transparency-TDS, TDS-DO, TDS- Phytoplankton, Total Hardness-Sulphates, Total Hardness- Phytoplankton, Total Alkalinity-Sulphates, DO-Phytoplankton, Chlorides-Sulphates, Chlorides-Phytoplankton, Sulphate-Nitrate, Phytoplankton and Phosphates- Phytoplankton were not significantly correlated ($p<0.05$). These recent studies mainly included Nasare *et al.*, (2009), Telkhade *et al.* (2009), Shaikh and Bhosle (2012), Singh and Sharma (2012), Summarwar (2012), Sunder (2015), Belkhode and Sitre (2016), Chavhan and Lanjekar (2016), Ghule and Halwe (2016), Lalhningliani and Lalrinpuia (2017), Rawat and Trivedi (2018), Sharma and Tiwari (2018), Sivalingam (2018), Prajapati and Patel (2019) and name a few.

During study, the macrophytes were collected by hand picking and brought to the laboratory and were identified using Cook (1996) and other standard literature. During study, total 38 species belonging to twenty families of macrophytes were recorded. From these species, 21 were belonging to Dicotyledons; fourteen to Monocotyledons while three species to Cryptogams. These species comprised of aquatic, sub-aquatic and terrestrial habitat. The Cyperaceae represented by six, Asteraceae with five, Scrophlariceae with four species while Hydrocharitaceae and Convolvuaceae with three species each. The aquatic species like *Hydrilla*, *Najas* and *Chara* as well as marginal species *Cynodon* and *Ipomea;* including terrestrial *Acacia* species were dominant during the period of investigation. The other recorded species were *Marsilea, Typha. Nymphoides, Verbascum, Phyla, Chrozophora, Ottelia, Vallisneria, Potamogeton, Cyperus, Scirpus* were moderately present during study. The species like *Ammania, Eclipta, Grangea, Centaurium, Helitropium, Merremia, Stemodia, Sutera* were observed sparsely. The dense population of *Acacia* was notice at the bank of the reservoir.

During the study, maximum macrophytes were recorded during winter and pre-summer while minimum was recorded during rainy season.

The study confirms the presence of numerous different species of weeds in the water body which can harm the pond in long run by adding its nutrient content. The open defecation practices prevalent on the banks of this pond coupled with enriched sediments and garbage disposal were daily increasing its organic loading thus providing a rich base for continuous growth of aquatic and emergent macrophytes in the basin. If this prolific growth of aquatic weeds is not curtailed and due attention is not given then this beautiful pond will become a dumping ground of pollutants which will be lost forever from the history thus subsequently losing a good recreation place. The results showed that the lake basin was rich with a diverse range of aquatic weeds which were posing a grave threat of silting and losing its aesthetic value due to prolific growth of aquatic weeds. These views are in well agreement with Sitre *et al.* (2014) and Idhole *et al.* (2016).

Though the concern water body is represented with rich phytoplankton diversity, but now days this rich diversity is continuously affected by many activities leading to contamination of water. Government of India brought out a comprehensive legislation that provides protection the water bodies and concern biodiversity. These legislations of Indian Government are to emphasize the responsibility and obligations to protect and save our country's national heritage for us and generations to come. But beyond the laws, it is necessary to design an advanced framework for conservation of the biodiversity (Singhar, 2014).

It is clear that people's role is very important in for conservation of biodiversity. Hence before implementing any strategies for their conservation, it is necessary to aware the peoples about them, their role in environment. There is need to control clearing of forests and poaching of land that raise for agriculture and civilization purposes because these water bodies are home to innumerable several different species, hence aforestation, plantation must be encouraged. Some further considerations of relevance to developing conservation strategy such as-

- **Social Acceptability:** Revitalization of community-based system of sustainable resource use and conservation of biodiversity will have wide social acceptance.
- **Cultural Diversity:** Incorporate the system of culturally define key stone system into resource management which support in conservation of biodiversity.
- **Aesthetic Appeal:** Appeal to civics for conservation of environment and biodiversity.

According to phytoplankton diversity and physicochemical status, the Adan reservoir seems to be productive but moderately polluted due to agricultural run-off and domestic sewage which is indirectly suggests the beginning of eutophication. But comparing with BIS drinking water standard, the water of these sites is not that much suitable for drinking purpose but can be used for drinking after proper processing. But water of Adan reservoir is suitable for irrigation and fish culture. The present study also provides an insight into distribution, abundance diversity and ecology of phytoplankton in reservoir. The investigation generated some important baseline data on the water quality and plankton community structure of the reservoir. These data would be helpful in planning for future policy decisions on using the reservoir as drinking water source as well as in the better conservation and management of the precious wildlife in the world-famous sanctuary. Though the water body under investigation is not severely polluted but requires careful monitoring in the future to maintain quality of water by proper means. Supervision of experts and remedial measures are essential for rehabilitation and conservation of reservoir for the possible long duration.

SUMMARY AND CONCLUSION:

The present study was conducted during February 2016 to January 2019 to analyze the phytoplankton diversity of Adan reservoir of Washim district of Maharashtra (India) with reference to physicochemical status.

During the period of investigation, temperature influences the properties of dam water. Average water temperature was ranges from 20.43 to 28.51 ^{0}C. It was minimum during the months of winter and maximum in months of summer.

The pH indicates the concentration of hydrogen ions. Present investigation shows the water pH was ranges from 7.47 to 8.79. It was minimum during the months of winter and maximum in months of late summer to early monsoon.

During the period of investigation, average water transparency was ranges from 30 cm to 107 cm. The minimum values were recorded during the months of monsoon while water transparency increased during winter to summer.

During the period of investigation, average total dissolved solids in the water were ranges from 142.13 to 348.03 mg/l. It was maximum during the monsoon while decreased during winter to summer.

Total hardness was ranges from 111.31 to 153.67 mg/l. In this study, the maximum values were recorded during the summer while total hardness was decreased during monsoon to winter.

During the period of investigation, the average of total alkalinity was ranged between from 169.38 to 249.85 mg/l. The maximum values of total alkalinity were recorded during the summer while decreased during monsoon to early winter.

It was observed that the value of dissolved oxygen fluctuates from 5.79 to 12.01 mg/l. During study, the maximum values were recorded during winter and minimum during monsoon.

During the period of investigation, average chloride in the water was ranges from 8.15 to 13.01 mg/l. It was maximum during the months of summer while decreased from monsoon to winter.

During the period of investigation, average sulphate in the water was ranged between 7.84 to 12.62 mg/l. It was maximum during the months of monsoon while decreased from winter to summer.

The nitrate in the water was ranges from 0.51 to 0.79 mg/l. During the period of investigation, it was maximum during the months of summer to monsoon while decreased from monsoon to winter.

During the study, phosphate in the water was ranges from 1.40 to 4.96 mg/l. The maximum values of phosphate were recorded during the months of monsoon while decreased from winter to summer.

During the period of investigation, sixty species belonging to four groups were identified. The maximum number of individuals and diversity was observed during winter and lower by summer and monsoon. The Chlorophyceae were represented with in twenty five species; Bacillariophyceae represented with fourteen; Cyanophyceae represented with ninespecies while Euglenophyceae was represented with only two species. The Chlorophyceae were obtained in maximum quantity; Bacillariophyceae and Cyanophyceae showed the moderate while Euglenophyceae observed with low population.

The aquatic weeds were collected by hand picking. They carried to the laboratory and identified by using the available standard literature. The study confirmed the presence of thirty eight different species of aquatic weeds in the Adan reservoir which can harm the water body in long run by adding its nutrient content.

During study, the observed status of phytoplankton diversity was mostly related to the studied physicochemical parameters. The observed results were correlated and significantly different at $p<0.05$. The results showed the significant correlation relation between all the studied physicochemical parameters with observed phytoplankton diversity($p<0.05$). Only the relations between Water Temperature-Sulphate, Water Temperature-Phosphate, Water Temperature-Phytoplankton, Water Temperature-Macrophytes, pH- TDS, pH-Sulphates, pH-Phytoplankton, Transparency-TDS, TDS-DO, TDS- Phytoplankton, Total Hardness-Sulphates, Total Hardness- Phytoplankton, Total Alkalinity-Sulphates, DO-Phytoplankton, Chlorides-Sulphates, Chlorides- Phytoplankton, Sulphate-Nitrate, Phytoplankton and Phosphates-Phytoplankton were not significantly correlated ($p<0.05$).

Table 45: Average Monthly Variation in Physicochemical parameters and plankton of Adan reservoirFrom Feb 2016 to Jan 2019

Month	Water Temp	pH	Transparency	TDS	T. hardness	T. Alkalinity	DO	chlorides	Sulphate	Nitrates	Phosphate	Chlorophyll-a	Phytoplankton
Unit	^{0}C	Unit	cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/m^3	Shannon Diversity
Feb	27.16	8.50	78.92	244.46	126.66	214.61	7.93	11.02	8.32	0.59	1.69	70.58	1.187
Mar	28.03	8.48	66.83	199.26	134.87	217.36	7.11	11.97	9.09	0.64	2.16	67.86	1.202
Apr	28.04	8.57	52.92	180.10	144.46	242.98	7.08	12.32	9.35	0.66	2.41	43.23	1.118
May	25.69	8.72	49.83	144.76	150.80	248.97	7.13	12.94	10.82	0.77	3.08	17.09	1.071
Jun	25.87	8.72	45.17	207.88	136.40	240.84	6.96	11.66	10.88	0.77	3.11	16.98	1.056
Jul	25.14	8.61	30.17	325.32	128.65	234.70	6.12	11.40	11.50	0.66	3.96	38.40	1.013
Aug	23.19	8.37	38.58	337.51	123.32	225.13	5.93	11.32	12.21	0.67	4.88	64.98	1.191
Sep	23.07	8.53	46.92	329.28	125.20	211.99	7.98	10.37	12.31	0.59	3.54	70.36	1.161
Oct	21.57	7.52	70.33	275.78	123.86	186.08	8.78	9.18	12.03	0.54	2.70	55.90	1.142
Nov	20.76	7.62	96.83	275.72	121.19	170.94	10.86	8.42	11.07	0.56	1.75	102.69	1.130
Dec	21.01	7.83	105.58	239.53	121.18	193.32	11.93	8.26	8.78	0.57	1.70	108.36	1.139
Jan	21.98	8.34	104.33	235.16	115.73	195.27	10.43	8.44	8.03	0.57	1.48	49.50	1.157
Min	20.76	7.52	30.17	144.76	115.73	170.94	5.93	8.26	8.03	0.54	1.48	16.98	1.013
Max	28.04	8.72	105.58	337.51	150.80	248.97	11.93	12.94	12.31	0.77	4.88	108.36	1.202
Observed range													
Min	20.43	7.47	030	142.03	111.31	169.38	05.79	08.15	07.84	0.51	1.40	013.03	1.013
Max	28.51	8.79	107	348.13	153.67	249.85	12.01	13.01	12.62	0.79	4.69	111.76	1.202

In brief concluding the present study, as indicated by physicochemical and biological status of Adan dam of Washim district from Indian state Maharashtra, the water body is seems to be productive but moderately polluted due to agricultural run-off and domestic sewage which is indirectly suggests the beginning of eutophication. The comparison with BIS drinking water standard, the water of these sites is not that much suitable for drinking purpose but can be used for drinking after proper processing. But water of Adan reservoir is suitable for irrigation activities and fish culture. The present study also provides an insight into distribution, abundance diversity and ecology of phytoplankton in reservoir.

The investigation generated some important baseline data on the water quality and phytoplankton community structure of the reservoir. These data would be helpful in planning for future policy decisions on using the reservoir as drinking water source as well as in the better conservation and management of the diversity related to the concern water body. Though the water body under investigation is not severely polluted but requires careful monitoring in the future to maintain quality of water by proper means. Supervision of experts and remedial measures are essential for rehabilitation and conservation of reservoir for long duration.

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Designation:

- Founder of Sarthi Coaching Classes
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- Member of Pinkathon (Womens Marathon League)
- A member of Muktangan English School

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- Masters from Amaravati University, Bachelor of Education B. Ed. (Science)
- M. Phil. From Algappa University
- Ph. D. from Amaravati University
- She is a founder of "Sarathi" Science Coaching Institute

- She is also a founder of "Aaple Kutumb Foundation"
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- Member of Muktangan English School which is completely devoted for the betterment of economically backword adiwasi students education and let them be a part of modern society since last 12 years.
- Her hunger of learning never extinguished, and she always seek excellence in her life. In order to extend her learning curves, she is helping the youths, children, parents with her motivational and inspirational speeches,
- Writing blogs, coaching them, giving career counselling, training them as a fitness trainer, spreading knowledge via YouTube and contributing for social causes.
- She is reachable through her blogs, articles, editorials, columns.
- Apart from all, she is contributing with her training on Abacus, Conducting Training for students for their upliftment in Science through field visits and practical based teaching
- At present, she is deeply involved and very passionate about Focussing on teaching science to her students by activity.

Project/Research Experience:

- Assessment of phytoplankton diversity of Adan Reservior, Washim District in relation of Physico-Chemical status
- Bidegredation of agro-wastes through cultivation of *Pleurotus sajor* caju*, P. florida, P. cous, P. flabellatus*.
- Present state and prospects of pollution by polythene and its reutilization to conserve nature

Participation:

- Zee Marathi Sankrant Queen 2020 National Conference held by Vidyabharti Mahavidyalaya.

- UGC and DST Sponsored international Conferance held by S.S.S.K.R.I. Mahavidyalaya, Karanja (Lad) 2018. National conference at Shirpur (Jain) held by late Pundalikrao Gawali
- Arts And Science Mahavidyalaya (RAOBS 2017). CM Chashak 2018-2019 held at Nagpur University Nagpur.
- Zee 24 Taas Chala Kheluya Mangalagaur 2018
- Zee Marathi Sankrant Queen 2018.
- National Conference of Traditional Community Health Practitioners on Conservation of Lokswastha Parampara held by Rashtrasant Tukdoji Maharaj Nagpur University.
- One day Workshop on Patent and It's Global Perspectives held by Vidyabharti Mahavidyalaya Amravati 2017.
- International Conference held by S.G.B. Amravati University 2005.
- S.G.B. Amravati University inter- collegiate Table-Tennis Tournament 2003-2004,
- Inter University West Zone Table-Tennis Tournament 2005-06 held at Gujarat University, Ahmadabad.
- S.G.B. Amravati University N.S.S. (National Service Scheme) rendered 240 hours of social service during 2002-2003 and attended a special camp held at Zodga- National Children's Science congress.
- Karyashala of Mahila Janivjagruti and vikas 2002 organized by S.G.B. Amravati • University, Amravati.
- Participation in Folk Dance competition organized by S.G.B. Amravati University, at R. A. College, Washim 2001-02.

Awards:

- 3rd prize in Best Seminar Competition 2004-05 organized by V.M.V. Amravati
- Placement in S.G.B. Amravati University Table Tennis Teamand awarded colour.
- Achieved 1st rank in seminar competition organized by S.S.K.R.I college, Karanja (Lad) in 2003.
- 1st rank in Folk dance competition organized by R.A. College Washim2002.
- 1st rank in General knowledge examination organized by Saptahik "Perishram
- Falashruti Kranja (Lad).

- 1st prize in Table-Tennis competition organized by the Washim District Table Tennis Association from2000 up to 2005.
- 3rd rank in "Ekpatri Abhinay" Organised by Sanskar Bharti Vidarbha Prant Washim.
- 1st prize in Ekpatri Prayog (one act play) held by Rajyastariya Sakhi Mohotsav 2017
- 1st prize in Dance Compitition held by Lokmat Sakhi Manch.
- 1st rank in Hammer throwin 43thMaharashtraMasters Atheletics Championship 2022 (State Meet)
- 1st rank in Discuss throwin 43rd Maharashtra Masters Atheletics Championship 2022 (State Meet)
- 3rd rank in Relay Fast Walking in 43rd Maharashtra Masters Atheletics Championship 2022 (State Meet)
- Participation in Khasdar Krida Mohotsav "Khelo India Khelo"2022.
- Presented a paper on Giloy Fair National Conferance for Socioeconomic Empowerment. 2022
- Paper Presentation on phytoplankon diversity at Emerging Trends in Science, National Conference.
- Paper Presentation on physicochemical characteristics of Adan Reservoir, Washim district in international conference as Recent Trends in Science and Technology. 2018

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Dr. Ghude participated in so many co-curricular and extra-curricular activities such as Zee Marathi Sankrant Queen 2020, Zee 24 Tass Chala Kheluya Mangalagaur 2018, Zee Marathi Sankrant Queen 2018, S.G.B. Amravati University Inter- Collegiate Table-Tennis Tournament 2003-2004, Inter University West Zone Table-Tennis Tournament 2005-06 held at Gujarat University, Ahmadabad, S.G.B. Amravati University N.S.S. (National Service Scheme) rendered 240 hours of social service during 2002-2003, National Children's Science congress, Karyashala of Mahila Janivjagruti and Vikas 2002, Folk Dance competition. Recently, she was awarded with "Bharatiy Shiksha Padmabhushan Award 2023" by IDYM Foundation, India.

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