Chapter IV

1.1 Summary

In present study sewage water was analyzed for study of various physic-chemical parameter, heavy metal analysis and study of effect of sewage water on histopathology of freshwater fish Tilapia mossambica were collected from Penur tank near Mohol; district Solapur. For assessment of physicochemical parameters and some heavy metals four sampling stations were selected. Sampling station S1 is located out of Solapur city near Juna Poona naka where all sewage from city drained and nala become wide. The sampling station S2 is located at Dongaon village located 7.4 km from Solapur city. The sampling station S3 Degaon located at the distance of 17 km from Solapur city. The sampling station S4 is near Telgaon, about to 20 km from Solapur city. Where sewage is poured into the Sina river.

The sewage water samples collected from the marginal areas at 1 to 1.5 m depth. The water samples in dried plastic cans of 5 Lt. Capacity were collected and analyzed in to the laboratory immediately. The sample collection was made during the morning hours between 8.15 to 10.45 am. The samples were collected during three seasons viz Monsoon season (June to September), winter season (October to January) and summer season (February to May) for the period of 2 years. Collected sewage from Solapur nala was collected and analyzed with seasonal intervals for following physic-chemical parameters and heavy metal analysis.

In present study higher temperature was recorded during summer season in all sampling stations as compare with monsoon and winter season respectively. Maximum temperature was recorded at station S4 during all three seasons followed by station S2, S3 and S1. Minimum temperature was recorded at station S2 during all three seasons. Mean temperature recorded during three seasons was 25.0 °C 19.5 25.0 °C and 28.5 25.0 °C respectively. From observations it was cleared that maximum temperature was recorded during summer season and minimum during winter season.

pH recorded during three seasons showed slight variations from all sampling stations. Maximum pH was recorded during monsoon season and minimum pH was
recorded during summer seasons. Sampling station S1 and S3 showed decreasing trends in pH level from all three seasons. Station S2 and S4 showed variation in trends of pH level. During monsoon and summer station pH level was found to be decreased and during winter pH was increased more as compare to summer and monsoon seasons. Mean pH level during monsoon season was much high and it was 7.7. During winter pH was 7.5 and during summer season it was 7.2. From observations it was cleared that maximum pH value were recorded during monsoon season followed by winter followed by summer season.

Turbidity recorded during all three seasons showed variation in levels turbidity from all sampling stations. Minimum turbidity was recorded at station S2 and maximum turbidity recorded at station S4. Turbidity recorded at station S2 showed increasing trends seasonally. At station turbidity recorded during monsoon was high as compare to winter and summer. At station S4 minimum turbidity was recorded during winter season as compare to the monsoon and summer season. Mean turbidity recorded during all three season showed high level of turbidity during monsoon season and it was 279.42 followed by winter it was 276.56 and during summer 275.62 during summer season. It clears from observations that maximum turbidity was recorded during monsoon season followed by winter and summer season, respectively.

Oxygen content from sewage water Solapur city sewage nala recorded from all stations was very low. Maximum oxygen content was recorded during monsoon season as compare to the winter and summer. Maximum oxygen content was recorded at initial station S1 during all three seasons followed by S2, S3 and S4 stations, respectively. The mean oxygen level recorded during monsoon, winter and summer seasons was 2.8 ml/l, 2.4 ml/l and 1.7 ml/l respectively higher level of dissolved oxygen recorded during monsoon followed by winter and monsoon, respectively. It was also noticed that level of dissolved oxygen decreased progressively from all sampling stations down streams during all three seasons.

CO$_2$ content recorded during three seasons showed overall increase from all sampling stations downstream. Maximum CO2 was recorded during summer season and minimum CO$_2$ was recorded during winter seasons. CO$_2$ content recorded at
sampling station S3 was much higher during all three seasons. During monsoon and winter CO$_2$ level was found to be decreased. Mean CO$_2$ content during summer season was much high and it was 137.3 mg/l, during monsoon CO$_2$ level was 94.17 mg/l. And during winter mean CO$_2$ content was recorded from all sampling station and it was 85.4 mg/l. From observations it was clear that maximum CO$_2$ was recorded during summer season followed by monsoon season followed by winter.

Alkalinity recorded from all sampling station was much higher ranged between 250 µhos/cm to 510 µhos/cm. Maximum alkalinity was recorded during monsoon season and minimum alkalinity was recorded during summer from all sampling station followed by winter season. The range of alkalinity during monsoon was 470 µhos/cm. To 510 µhos/cm. During winter range of alkalinity was 410 µhos/cm. to 270 µhos/cm. And during summer the range of alkalinity lies between 250 µhos/cm. to 400 µhos/cm. maximum alkalinity was recorded at sampling station S1 and S4 respectively. Alkalinity recorded from sampling stations S1, S2 and S4 showed increasing trends downstream. At sampling station S2 alkalinity was decreased during summer season. Mean level of alkalinity during monsoon season was 491 µhos/cm, during winter 352 µhos/cm. and during summer it was 300 µhos/cm. it clearly indicate that maximum alkalinity was recorded during monsoon season as compare to winter and summer season the alkalinity value were 352 µhos/cm. and 300 µhos/cm respectively.

Maximum calcium content was recorded during monsoon season as compare to the winter and summer. at sampling station S2 maximum calcium content was recorded during all three seasons followed by S1, S3 and S4 stations, respectively. The mean calcium content recorded during monsoon, winter and summer seasons was 140 mg/l, 71.05 mg/l. and 22.83 mg/l, respectively. High level of calcium was recorded during monsoon followed by winter and summer. It was also noticed that calcium content of sewage water showed increasing trends from all sampling stations downstream during all three seasons.

Sodium content recorded during three seasons showed overall increase from all sampling stations downstream. Maximum sodium content was recorded during summer season and minimum content of sodium was recorded during monsoon and winter
At sampling station S3 sodium content was comparatively higher than that of other sampling stations during all three seasons.

During monsoon season sodium content was found to be minimum. Mean sodium content recorded during summer season was much high and it was 388.8 mg/l., during monsoon was 242.7 mg/l. And during winter mean sodium content recorded was 346.4 mg/lit. From observations it was clear that maximum sodium content was recorded during summer season followed by winter and monsoon season. Overall increase in sodium content from all sampling station was noticed with downstream.

Assessment of total dissolved solids (TDS) from sewage water Solapur city sewage nala was analyzed seasonally. TDS recorded during study period was much higher. TDS level was found to be increased progressively from initial sampling station S1 to downstream S2, S3 and S4 sampling station respectively during summer season. Moderate level of TDS was recorded during winter at station S2 and it was 2218 mg/lit. During seasonal assessment it was also noticed that TDS was increased progressively from monsoon to summer season. Maximum TDS was recorded during summer season from sampling station S3 and S4 during summer seasons. And minimum during monsoon and winter season. Mean TDS was recorded higher during summer season followed by winter and monsoon where TDS was 1959.2 mg/lit and 1865.2 mg/lit., respectively.

Overall increases in chloride content was noticed at station S1 and S2 while at sampling station S3 and S4 chloride content was found decreased during winter season. Chloride content of monsoon season compared with summer season showed higher level of chloride content during summer season. The mean chloride content was recorded very high during summer season followed by winter and monsoon season. The mean chloride content recorded during monsoon season was 429.5 mg/lit. During winter it was 411.7 mg/lit. and in summer chloride content from sewage water was 657.5 mg/lit. From above data it is clear that chloride content recorded during summer season was much higher that monsoon and summer season. It was also noticed that chloride content was found to be increased progressively, downstream from all sampling stations seasonally.
BOD and COD value recorded from sewage water seasonally showed increasing trends downstream. BOD and COD value during monsoon season were minimum as compared to winter and summer. It was also noticed that BOD and COD value were increased progressively seasonally. The mean BOD value recorded during all three season was 94.5 mg/lit, 100.00 mg/lit and 149.00 mg/lit, respectively. Whereas COD value recorded seasonally were 490.5 mg/lit, 500.2 mg/lit and 595.00 mg/lit for monsoon, winter and summer season, respectively. It was noticed that BOD and COD value recorded higher during summer season and minimum value recorded during monsoon. It was also noticed that BOD and COD value were progressively increased with downstream station viz.

During physicochemical analysis of sewage water from Solapur city sewage nala Value of Total Solids (TS) recorded were much higher as compare to other physicochemical parameters. In present study TS were increased progressively downstream and seasonally. The maximum TS were recorded during Summer season followed by winter and monsoon respectively. Mean TS recorded during Monsoon was 7502.2 mg/lit, 8892.7 mg/lit and 10753.0 mg/lit respectively. From above data it is clear that maximum TS was recorded during Summer season.

Wotton (1992), pollution of river water is caused due to toxic pollutants such as pesticides, insecticides, petrochemicals, heavy metals, phenols etc. These pollutants have direct effect on biotic environment of water ecosystem. Globally large volume of water in selected area of Maysour district, Karnataka recorded the residues of urea in surface water and ground water. They further concluded that the presence of nitrate in water sample was related with in urea indicating contamination of surface water and ground water due to the nitrogenous fertilizers. In similar study they have recorded high level of phosphate in sewage water from Solapur sewage nala which is also correlated with use of phosphate contain fertilizers.

In present study phosphate content recorded during all three showed decreasing trends from all sampling stations. Maximum level of phosphate was recorded at sampling station S4 and minimum level of phosphate was recorded at initial sampling station S1. It was also noticed that phosphate content was increased downstream from
sampling station S1 up to last sampling station S4 located near Telgaon where sewage from Solapur city is poured into Sina river. Mean phosphate level recorded during monsoon was 13.9 mg/lit, in winter 10.5 mg/lit and in summer it was 9.0 mg/lit. From above data it indicate that minimum phosphate content was recorded during summer season from all sampling stations and maximum phosphate content was recorded during monsoon season.

Seasonal assessment of bicarbonate was carried out, seasonally showed variations in content from sewage water. Maximum bicarbonate was recorded during monsoon from sampling station S1, S2 and S3. In summer maximum bicarbonate content was recorded at sampling station S4. Decreasing trends were noticed in content of bicarbonate from initial three sampling station while station S4 showed increasing trend. It was also noticed that decrease in bicarbonate during winter from all sampling station. Mean value of bicarbonate content recorded during three seasons were 290.0 mg/lit, 233.7 mg/lit and 303.7 mg/lit respectively. Minimum bicarbonate content was recorded during winter season whereas maximum content was observed during summer season followed by monsoon season.

Potassium content recorded during all three season from all sampling stations showed increasing trends downstream. The Mean content of potassium recorded seasonally showed high level during summer season followed by monsoon and winter, respectively. Slight decrease in mean potassium content was noticed during winter season and it was 19.00 mg/lit as compare to the monsoon it was 19.8 mg/lit. Maximum variation in potassium content was observed during summer and it was 29.2 mg/lit.

Magnesium content recorded during study showed increasing trends downstream seasonally. Minimum magnesium level was observed during monsoon season. Mean level of magnesium content during all three seasons showed increasing trends. The minimum magnesium content was recorded during monsoon season and it increased progressively from winter to summer season. The mean magnesium content recorded was 54.00 mg/lit, 78.2 mg/lit and 87.00 mg/lit respectively. Zinc is the heavy metal used in alloy production, batteries, and plastics and in galvanization process etc. some toxic metals occurs in runoff from motar fuel, break lining and due to the tier
were. In urban areas heavy transport is the largest source of lead pollution. In majority of cities the municipal waste channel system and industrial effluents treatment are not sufficient and are always inadequate because of poor maintenance. The uncontrolled discharge of untreated sewage and effluent to any water bodies results in high level of water quality deterioration. The sewage and effluents responsible for contain heavy metals, disease producing pathogens and organic compounds.

Heavy metal zinc (Zn) was analyzed from Solapur city sewage nala showed moderate variation in content from all sampling stations. At initial sampling station S1 level of Zn was observed high as compared to all sampling stations. During winter season overall decrease in Zn was noticed downstream. Mean level of Zn was noticed during monsoon, winter and summer are 0.30 mg/lit, 0.27 mg/lit and 0.29 mg/lit respectively. It is clear from above value that maximum Zn was recorded during monsoon season followed by summer and winter, respectively.

Similar trends were noticed in case of heavy metal boron (B) and Iron (Fe). Maximum level of boron and iron was recorded at sampling station S4 and minimum at initial sampling station S1. Seasonally, both the heavy metals were showed higher level of content into the sewage water during summer season and minimum during winter season.

Sankar, et. al. (2010), studied variation in physicochemical parameters and heavy metals in water and sediment from Uppanar estuary Nagapattinam seasonally observed high level of heavy metals such as copper, zinc, cadmium and mercury. Further they noticed that high level of cadmium and mercury recorded during summer and post monsoon season. They concluded that the level of copper during monsoon season was low and it could be due to the adsorption of copper to the particulate matter and sedimentation at the bottom.

Sulphate content was analyzed from sewage water from four sampling station observed overall increase in sulphate content downstream during all three seasons. The mean sulphate value recorded seasonally was 1020.00 mg/lit, 1084.75 mg/lit and 1140.00 mg/lit. Respectively for monsoon winter and summer seasons. The maximum
sulphate content was recorded during summer season followed by winter and monsoon. In present study similar trends of increases have been observed during all three seasons.

Copper (Cu) content recorded during all three seasons showed increasing trends downstream from all sampling stations except sampling station S3 where increase in copper content was noticed high during summer season. Seasonal Increase in copper content was also noticed during study period. The mean values recorded were 21.5 gm/lit, 24.7 mg/lit and 27.5 mg/lit, respectively.

Manganese (Mn) content from sewage water Solapur sewage nala showed decreasing trends downstream from all sampling stations. Maximum level of manganese was recorded as sampling station s1 and minimum during summer season. Maximum content was recorded during summer followed by monsoon and winter. The mean Mn level recorded during three seasons was 9.65 mg/lit, 9.47 mg/lit and 10.4 mg/lit respectively. It clearly indicate that maximum Mn content was noticed during summer and minimum during winter season.

Effect of sewage treatment of histopathology was studied at different concentrations viz 25 %, 50 %, 75%, and 100%. Mortality of fishes occurred with increasing concentrations. Severity of damage to the different vital organs such liver, and gill showed very high with increased concentrations of sewage water.
1.2 Conclusion

Water is one of the most important resources on the earth and is significant component of life of biotic components on the earth. Because of increased demand of water now a day exerted a heavy pressure on aquatic ecosystem, the quality and conditions water for human and animal use is limited, it indicates the there is an urgent and strong need for comprehensive water management all over the world WHO, (1992). Therefore such type of research should be carried out for the study of impact of different types of pollutants on various life forms which inhabitants of aquatic ecosystem and assessment of effluents generated from various industries which pollute the water sources. This type of study gives us information about our limits in nature.
Study of environmental pollution gaining much importance, as it is related with biotic components of various ecosystems including human being. Due to urbanization, industrialization and increased agricultural activities leads to alterations in quality of environmental conditions. Avery anthropogenic activity is responsible for pollution problem in our surrounding. Growing population needs provision of basic requirements includes air, water, food and shelter. To fulfill increased demand of goods improvement in technology was achieved worldwide. With increased technology pollution problem is created and affected life of plants and animals including human being. Increased pollution created health related hazards by acute as well as chronic exposure.

The living water communities and their active relationships, chemical environment, productivity and physical environment are all distributed in aquatic environment. Limnology is the study of all aquatic environments such as rivers, ponds, lakes, streams, different types of wetlands and large as well as small water reservoirs. Supply of freshwater becomes insufficient continuously worldwide due to increased use for various purpose and addition of different type of pollution. It has been observed that different types of pollutants which generated by anthropogenic activities are threatened to biodiversity of aquatic ecosystems like river, ponds and lakes, etc. The growing concern for problems and implementation of environment, development in new administrations, new environmental strategies and international agreements are major steps towards the changes which should improve the existing water resources and yet undiscovered threats in these environmental systems.

Presently due to the lack of awareness, legislative and protective management towards the tropical water conservation, uncontrolled trends of environmental pollution created human health related disorders. So there is need of qualitative and quantitative maintenance of various kinds of water sources. The aquatic environment supports variety of life form, pollution of water environment would refuse the utility for water supply, recreation and production of commercially useful species because of sensitivity to biotic components of water habitat.

Present study is an attempt to study various physicochemical parameters and heavy metals from Solapur city sewage nala. The temperature of sewage water
recorded was always lower than that of air during the period of study. In summer mean temperature of sewage water was 29°C. This was higher than in monsoon (25.7°C.) and in winter (19.5°C). The temperature of sewage was higher as compared to that in winter. A rise in temperature of the water leads to the spread up of the chemical reaction in water which reduces the solubility of gases like O₂, CO₂. Body, which also exhibited a correlation with atmospheric temperature.

Trivedy, Goel (1988) during study of physcio-chemical parameters reported that the temperature was higher in March and lower in November few water bodies from Satara District. Kiran (2010) reported similar observations from Bhadra project form Karnataka. Yadav (2011) recorded the range of temperature between 16.5°C to 35.9°C. Similar observation has observed in present study. In present study it was also noticed that, decrease in temperature was occurred with downstream.

The temperature of sewage water recorded was always lower than that of air during the period of study. In summer mean temperature of sewage water was 29°C. This was higher than in monsoon (25.7°C.) and in winter (19.5°C). The temperature of sewage was higher as compared to that in winter. A rise in temperature of the water leads to the spread up of the chemical reaction in water which reduces the solubility of gases like O₂, CO₂. BOD, COD, etc which also exhibited a correlation with atmospheric temperature.

Most important parameter for water quality is pH. It is not direct affect on consumers; it is not direct affect on consumers. Value of pH above 7 indicates the hardness of water it means water contains calcium and magnesium and low value of pH means below 7 is affected the growth of bacteria. In the present study, sewage was observed to be deep colored liquid effluents flowing through nala all along its length. Many authors contributed the study in this regard includes. The pH of sewage water ranged between 7.1 and 7.9. It is observed that sewage water was alkaline during all the three seasons and showed minor seasonal variations. Similar trends of temperature were reported by Kumar and Sharma The pH variation is caused by different kinds of chemicals used in textile industries. In present study value showed slight fluctuations and it was slightly alkaline in nature during all three seasons.
The transparency values were low indicating high tropic status of the lake. The present transparency values were declining in the rainy season due to sewage contamination from rain water. Turbidity values were high in monsoon due to the addition of silt load with the influx of monsoon run off. Total dissolved solid values were very high during summer season as compare to winter and rainy season that may be due to the gradual disturbances in sedimentation of solids and scarcity of water in city during summer. Electric conductivity values were high in rainy; this may be due to contamination of water by sewage, domestic waste, and high built of salts. To maintain the balance of different populations and make the healthy water body the chemical parameter that is dissolved solids is very important. High amount of suspended solids effect on aquatic flora and fauna and diversity of aquatic life system is reducing and promotes the oxygen level depletion.

In present study the mean dissolved oxygen was recorded from all four sampling stations during monsoon were 2.8 ml/lit. During winter the mean dissolved oxygen was 2.4 and in summer 1.7. The High dissolved oxygen was recorded during monsoon than in winter and summer. The dissolved oxygen value was high during rainy season as compared to winter and summer. The low values of dissolved oxygen might be also because of decomposition of organic matter. Similar, results were obtained by Chavan and Dhulap (2012). The dissolved oxygen and transparency can be used all over for continuous monitoring of sewage water. Decreases in oxygen level might be due to additional pollutants and heavy load of bacteria from fecal matter mixed with effluents. Abrah, (2014). The another reason of decrease in oxygen content during summer followed by winter season was might be due to addition of more oxygen demanding substances and less availability of water for domestic use during summer season to Solapur city, as it come under drought prone area of Maharashtra.

In present investigation the free CO$_2$ the absence of the free CO$_2$ may be due to its complete utilization in photosynthetic activity.

Total alkalinity values were higher in winter. The presence of total alkalinity indicates that the lake seems to be productive. Thus present water of lake seems to be moderately polluted due to domestic sewage and agricultural runoff, which indirectly
suggest the beginning of eutrophication. Maximum level of chlorides was recorded during rainy season, which may be attributed to the addition of considerable amount of domestic sewage. Lower level of chloride content was recorded in summer and it was might be due to their deposition in the soil and evaporative loss of water.

Hardness has no adverse effect on health there is evidence that hard water plays a role in heart disease, Masood Alam, et.al. (2002). Total hardness was ranged between 117 mg/l and 167 mg/l and it seemed that the water of the present wetland was suitable for the growth of organisms.

In present study Sulphates content was ranged between 30 to 60 mg/l. An increase in sulphates was observed from January, February and March. The higher values of sulphates during summer can be attributed to the deposition in the soil of water. Causes of eutrophication are due to the large amount of organic matter in water. To determine the pollution strength of the sewage water or waste water the parameter is important that is biological oxygen demand (BOD). High level of biological oxygen demand shows the available of oxygen which is useful to the living organism in water, it consumed by bacteria leading to the inability of fish and other aquatic organisms to survive in the water, Waziri (2010).

The value of biological oxygen demand was observed above permissible limit to discharge in to the river water. As sewage nala joins to Sina river disposes it’s all content with high biological oxygen demand is neither used for agricultural purpose nor can it discharged in to the river.

To measure domestic and industrial waste in water the test used that is chemical oxygen demand (COD). Chemical oxygen demand means the organic matter required the amount of oxygen for its oxidation. The waste is measure in terms of equality of oxygen required for oxidation of organic matter to produce carbon dioxide and water, Sagar, (2012). Chemical oxygen demand recorded from sewage nala during all three season was much higher, that is above permissible limit of ISI (1995), which is not suitable discharged in to Sina river, neighter can be used for agricultural, domestic and other use.
High level of chemical oxygen demand indicates the toxicity and the presence of organic substances in waste water. Chemical oxygen demand is amount of oxygen which is required for decomposition of chemical waste coming from the many types of industries. High value of chemical oxygen demand indicates high level of accumulation of organic waste in water. It can estimate the carbonaceous factor of organic matter and it can measure the pollution in water or in aquatic ecosystem.

Biological oxygen demand is used to measure the required amount of oxygen by bacteria which is used to break down simpler substance in decomposable organic matter which is present in waste water. Concentration of organic matter from water is measured by biological oxygen demand; if the decomposable matter is in large amount then the demand of oxygen is also in large amount hence the biological oxygen demand is also greater.

Low value of biological oxygen demand is due to less quantity of solids, suspended solids in water also in quantitative number of microbial population, Avasan and Rao, (2001). High value of biological oxygen demand is indicating the strength of pollution of the waste water it also indicate the level of available oxygen which is used by living organisms in waste water. Biological oxygen demand can measure requirement of oxygen by microbes to degrade the organic matter in aerobic condition high biological oxygen demand in a critical condition delete the oxygen level thus indicate pollution in water high level biological demand shows to refuse in dissolved oxygen because the available oxygen consumed by bacteria and it is affected on fish and aquatic organism.

Biological oxygen demand and chemical oxygen demand values of the lake were higher in summer due to high rate of organic decomposition from domestic waste water. The biological oxygen demand values during monsoon and in winter may be due to decrease in the temperature of water, which in turn retards the microbial activity.

To determine quality of water the electrical conductivity is important parameter. It is used to measure the carrying capacity of electrical current; it is directly related to the concentration of ionized substance in water, Jayalaksmi, et.al. (2011). other parameters
like sulphate, phosphate, nitrate etc. show the high concentration in samples. High concentration of phosphate and nitrate shows the quick growth or death of plants, algae etc.

Due to heavy metal degradation of the cells of liver occurs. Liver made up hepatocytes not oriented into distinct lobules but arranged in branched laminae two thick cells separated by sinusoids it is polygonal cells with spherical nucleus situated centrally.

In animal body liver is the largest digestive gland involved in metabolic processes. Liver plays very important role in emulsification and excretion of hazardous substances. Figueireda-Fernandes, et.al. (2007) noticed histopathological alterations in liver of fish *Tilapia mossambica* for 96 hrs to sewage water. Severity of histopathological alteration was observed was very high with higher concentrations in the liver of freshwater fish *Tilapia mossambica* than in low concentration of sewage treatment. In present study liver showed dilated sinusoids appeared irregular and it showed disconnection in between cells and hemorrhage severity of vacuoles varied in necrotic cells. Around the central vein the infiltration of mononuclear lymphocyte was noticed.

In nature there are some kinds of minerals which are very useful for plants and animals including human in trace amount beyond which these minerals could responsible for hazardous and toxic effect in organism. Generally they are called as heavy metals such as Zn, Cu, Fe, B, etc. Heavy metal Zn is essential for every animals and plants in trace amount. Heavy doses of 165mg Zn causes renal failure, vomiting and cramps. Absence of Cu in diet or as ingredient of food may inhibit growth and affect circulatory system. 100 mg of mercury for human may cause headache, diarrhea, effect of nervous system, destruction of circulatory system, damage to kidney tissues, imperative, loss of teeth, inflammation of gum etc. in present study high level of heavy metal recording during three seasons at all stations. Maximum level of heavy metals recorded during summer season when compared with the value of monsoon and wither. It was also noted that increase in level of heavy metals in sewage water with downstream. As the level of these heavy metals in sewage water from Solapur city nala very high will responsible for various disease in human and animals. The sewage water
from Solapur city nala were dumped in to the Sina river which pass from various areas of Solapur district and meet with Bhima river. Water from Sina and Bhima river is made available for agriculture, for growing cattle feed, and for drinking purpose. The heavy metal contaminated water will create health related problems to the peoples inhabitant on the bank of these rivers in near future.

Water from Sina River is not used for drinking and domestic purpose but Bhima are Sina river basin is used for disposal of municipal sewage and industrial effluents from Solapur city. Sina river meet with Bhima river at Degaon 20 km from Solapur city and pour all its effluent in to Bhima. The water from Bhima river is used for agricultural practices, and by industries and peoples from nearby village for the various purpose. Hence the heavy load of effluent having high oxygen demanding substances and heavy metals entering in to the body of human and animals too.

Physicochemical and heavy metal analysis study of sewage water from Solapur nala reflected the pollution status of the water body and it is necessary to conduct further experimentations before coming to the final remarks and the aspect related to histopathology needs to be undertaken from different seasons in future.

Water is essential and renewable resource in the nature. Due to the population explosion, increased urbanization, heavy industrialization, untreated effluents generated from industries and sewage from municipal wastes etc. all natural resource are under stress and it happens due to continuous use of insecticides, herbicides, and pesticides. Such plastic, petrochemical substances, nonbidegradable chemical fertilizers etc cause water pollution up to 70% of available water make water unsafe for drinking and use in other purposes like agriculture and fishery. Many water borne human being related diseases such as dysentery, cholera, typhoid etc. are transmitted by contaminated drinking water. Quality of water is related to health directly and it is important to determine the utility of water.

Determination of the quality of water is difficult factor for evaluation of the level of water pollution.
In sewage water different types of pollutants observed which are coming from industrial waste, domestic waste etc. and are causing health problems, some time they create serious health problems and found to be fatal to death of an organism.

The water of Sina river becoming seriously contaminated various type of pollutants and toxic metals that is heavy metals. These heavy metals and pollutants affect the surface water and making it polluted and not suitable for drinking and irrigation. Discharge of industrial waste in sewage nala and discharge of sewage nala into water bodies of Sina river in Solapur city results in high level of concentration of pollutants in water of Sina river which may be toxic to various types of organisms. The sewage effluents can be negatively affected on water quality of Sina River which is not good not only for human use but also not good for animals and irrigation.

Discharge of sewage water had serious effect on quality of water in terms of fecal coli form which indicates the level of bacteria. Due to the presence of fecal coli form in sewage water it is also mix with river water and causes potential risk to all animals as well as human being. Comparative study of sewage water samples at four different stations for three seasons that is rainy season, monsoon season and summer season carried out by using some important parameters such as Temperature, pH, Turbidity, Dissolved Oxygen, CO₂ Electrical Conductivity, Alkalinity, Calcium. Sodium, Total Dissolved Solids, Chloride, Biological Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Hardness, Sulphate, Phosphate, Bicarbonate, Potassium, Magnesium, Zinc, Boron, Iron, Copper, Manganese showing analysis of physico -chemical parameters of sewage effluents are above permissible limit and it can affect the water quality of Sina river.

In many cities industrial waste water and municipal sewage water discharged directly in to the water bodies. It is difficult to government to control the pollution due to the limited financial resource. In many cities municipal sewage incomplete coverage, inadequate results to increase systems, failure in operation and maintaince results to increase in waste effluents in water.
Due to the organic waste enter in to water bodies batteries are highly produced and uses the entire oxygen supply from water it lead in to the death of many fishes and organisms. To control the water pollution health agencies must try to establish indicator of quality of water. For the department of petroleum biological treatment plants making compulsory. For the municipal sewage waste water treatment plants operated on sewage water before discharging sewage water in to water bodies. The antifouling paints used during fishing season in post monsoon season are responsible for release of cupreous oxide in water which enhances the content of copper in water. Ananthan (2006). Aknsorotin, et. al. (2013), noticed abnormal behaviors due to the acute toxicity of glyphosate herbicides such as jumping and gulping of air, equilibrium loss, restlessness and increased opercular activities similar might be the case. similar patterns of behavior were recorded in present study due to sub lethal treatment of sewage water for 96 hrs to different concentrations.

Histopathological study showed severs damage to the important organs like gills and liver of freshwater fish *Tilapia mossambica*. During treatment of sewage to fishes for 96 hrs in 25% concentration showed 30 % death of fishes. At 50% concentration 60% death of fishes was observed. After 72 hrs in 75% sewage treatment 90% death of fishes was observed and after 96 hrs of exposure to sewage treatment. In 100% concentration of sewage, 100% death was recorded , indicating that the concentrations of sewage water used for treatment were able to cause the severe damages that were harmful to fish physiology and showed various visible disturbance in their normal behavior. Excessive mucus on the body surface and on gills was also observed. Other behavioral changes seen during 96 hr exposure to fishes showed unsteady jerking movements, and trying to jump out from tub up to 24 hr. After 96 hr organs such as gills and liver were considered for histopathology. In histology of gills a typical structural organization of lamellae in untreated fish, Hadi and Alwan (2012). Heavy metals, pesticides, fertilizers, sewage are directly affected and damage the gills.

Gills are directly exposed to poisons due to environmental pollution and cause pathogencity in water animals like fish. The irritant materials which are dissolved in
water due to pollution can damage the gills because the gills are the unguarded structures of fish due to its location and direct contact with water. Main function of the chloride cell is osmoregulation but the pathological changes in chloride cells show the osmoregulation dysfunction,

Virtanen, (1986). Due to the sewerage water treatment of 25%, 50%, 75% and 100% for 96 hrs showed severe damage to epithelial lining of lamellae and created shrinkage of lamella, degeneracy of epithelium it also followed by rupture of brachial artery and subsequently leads to extreme reduction in the activity rate and swimming.

According to WHO report (1996) maximum allowed limit of iron in drinking water is 1.0 mg/L. It was found that the value of iron in all water samples are 50% below, 23% optimum and 27% higher than present study the Iron content was found to be much higher and it ranged between 0.35 mg/lit to 2.2 mg/lit. Maximum level of Iron was recorded during summer season and minimum during monsoon season. At station S4 maximum iron content was recorded during all three seasons. Station S4 was near last station where all sewage disposed in to the Sina river. As sewage contains high level of Iron, make water unfit for domestic and agricultural use. High level of Iron in water imparts a bitter taste and causing staining in cloths. Excess amount of iron in water cause coagulation of blood in blood vessels, increase in pulse rate, hypertension etc.

According to the WHO (1996) presence of maximum permissible concentration of copper in drinking water is 1.0 ppm. The value recorded during study period from Solapur sewage nala was much higher than permissible level Copper accumulates in liver and brain. Copper toxicity is a fundamental cause of Wilson’s disease.

Today main problem is not that heavy metals are toxic or nontoxic. We know that heavy metals are toxic but problem is that in what concentrations levels of heavy metals are safe in water, which are not harmful to uses of water like agriculture, domestic, humans etc.also not harmful to fishes and aquatic organism. Pollution of river is great problem not in India but all over in world. Many industries not using any waste water treatment plant for their discharging effluent even on sewage water there is absence of water treatment plant and many cities discharged their sewage water directly in rivers or
water bodies which are present near city. It resulted in increase in level of heavy metals and increase in physical and chemical parameters.

Present study will contain various types of viruses and pathogenic bacteria which will create hazards to human health. Due to this population around Sina river might be affected from water borne diseases like amoebic dysentery, typhoid, hepatitis, skin diseases, etc. in present study water from station S1, S2, S3 and S4 were containing high levels of all chemicals like chlorides, phosphates, sulphates, etc. heavy metals like zinc, boron, iron, magnesium, nitrates, manganese etc are found above the permissible limit. It containing all municipals waste, industrial waste and agricultural waste, these all contaminated sewage pored directly into Sina River, which is very harmful and dangerous to human beings as well as aquatic organism. Every type of pollution in aquatic environment impacts on development, growth of fish, reproduction in aquatic ecosystem, physiology affect food chain. Fishes which consume pollutants, accumulation of pollutants, heavy metals in different tissues of organism may result in chronic damage and potential illness of population.

In present where the sources of pollutants in sewage water from Solapur sewage nala are through runoffs from the municipal sewage canal, municipal dump sites and could also the attributed due to indiscriminate defecation and disposal of untreated industrial effluents which had contributed to increase levels of the various pollutants. Pretreatment of all kinds of waste water prior to disposal into the environment is necessary so as to avoid environmental pollution. According to Ajayi and Adeleye, (1977), large quantity of sewage and untreated solids are discharged indiscriminately in to the water systems such as streams and river flowing through cities, towns and villages.

From the present study it clearly observed that the sewage water from Solapur city nala contains various sub-pollutants which were adversely affected all physico-chemical parameters which were not in permissible limit and not fit for any use. This sewage water disposed in to the Sina river with high level of physic-chemical parameters and heavy metals in it. Thus the water from Sina river neighter can be used for crop field, irrigation, vegetables, for neither cattles nor domestic use. Therefore there
is urgent need for regular monitoring of water quality of Sina river and proper pretreatment on sewage and industrial effluents is needed. We here strongly suggest that disposal of sewage water without any proper treatment should not be discharged in any water bodies.

The sewage water from Solapur city is drained into the Sina River. The Sina river joins to the holly river Bhima (Chandrabhaga) and pollutes river water. So there is urgent need to monitor and analyses of the different physico chemical parameters from sewage water. Physicochemical and heavy metal analysis study of sewage water from Solapur nala reflected the pollution status of the water body. It is necessary to conduct further experimentations before coming to the final remarks and the aspect related to histopathology needs to be undertaken from different seasons in future.
4.2 Recommendation

Solapur is a metropolitan city responsible for the addition of large quantities of sewage and effluent disposal, leading to a heavy load on the sewage system. The direct addition of untreated waste in the sewage nala creates an alarming situation for surface water and underground water. Therefore, we strongly recommend that the sewage be treated before disposal in the sewage canal, and there is a need for more sewage treatment plants as per need, hence it is concluded that sewage treatment plants make sewage water and effluent safe for disposal, but it is necessary to maintain sewage treatment plants regularly. It is very necessary to use advanced treatment technology for the treatment of waste water. On the other hand, it is very necessary to make people aware of the safe use of water for drinking and agricultural use.

Data available during the study showed that some industries still produce high quantities of effluents containing various pollutants, which can be responsible for aquatic toxicity. In Solapur city, the textile industry is one of the largest and imported sectors. The climatic condition of Solapur is suitable for the textile process. There are about 8000 power looms and 15000 hand looms in the city. In M.I.D.C. area, there are about 70% textile units. These industries discharge the large amount of effluents directly to the public drain and open place. Due to a lack of awareness, the negative impact of these industries on Sina River is significant, as it does not have any sewage treatment facilities, and the release of sewage into the river can pollute the river water. Even Solapur city also releases its waste into Sina River directly without any proper treatment. The diseases include typhoid, infective hepatitis, cholera, and dysentery and gastroenteritis. Apart from pollution from animal waste, the industries also release waste either directly into streams or
in to drains, which join the streams resulting in degradation of water quality of Sina river. With our observations and study it has been suggested that biological oxygen demand of effluent or sewage should not be higher than 20 mg/lit (Govt. of India 1985). Before discharged in to river, for irrigation biological oxygen demand value should not be above 50 mg/lit. The permissible limit for vegetable and crop irrigation should not be higher than 100 mg/lit (ISI 1982). In present study biological oxygen demand values recorded were above permissible limit and is unfit for irrigation and other purposes. Therefore there is prior need of proper treatment on sewage before discharge into the river system. For reduce the sewage effluents and agricultural impact there is need to management plan and conservation. River receives organic waste in large quantity for that sewage treatment plan is necessary. We strongly recommend that drainage systems as well as industrial waste prohibited for the discharge their waste directly in to river. There is urgent need of proper infrastructure of adequate sanitation together must be provided with help of education. For the disposal of sewage water we can use Dry sanitation method. Participation of people towards recycling, awareness, sharing experience, sanitary systems in own houses, open defecation must be avoided etc. using these thing pollution of river can be controlled if we consider some aspects such as by providing the collection system of garbage and sewage treatment plant on river bank, to environment and on public health, on animals etc. are resulted. Water is put no numerous uses by man, cities situated along the banks improve the water supply system and sanitation system in rural and urban areas also improves the drainage and irrigation. The sewage water demands regular monitoring and control and proper pre-treatment before being disposed in the environment. Municipal corporation of Solapur city should provide strict rules and regulations directed by EC (EPA, 1996).
Future scope of Study:

1. The findings of present study will potentially significant implications for policy, programs, and research related to water pollution in the Solapur city and other fields of pollution study.

2. Data and information collected during research will help to develop strategies, policy and programs related to water pollution in Solapur city.

3. Study will help to Solapur Municipal Corporation for town planning, development of industrial area. Settlement and sewage disposal etc.

4. Study will help about pollution status of sewage water, and industrial effluents discharged in to the sewage nala.

5. Study will help to make awareness about health, environmental protection and conservation among the peoples of Solpaur city about.

6. Data collected during study will develop guideline and model for the researchers in the field of pollution study.
Limitations of the study:

1. As Solapur city comes under semi-arid region of Maharashtra, hence quantity and quality of rain fall is not certain. This will reflect change in various physicochemical parameters from Solapur sewage nala.

2. Amount of sewage disposed in sewage nala from Solapur city may vary with season to season, that it will responsible for variations in various physico-chemical parameters.

3. Quantity and quality of effluents generated from textile industries from Solapur city may vary with operation process and types of precaution during certain period of year.

4. Diurnal fluctuations may occur in volume generated from domestic use. It will also reflect the quantity and quality of various parameters from sewage water.

5. During period of scarcity of water supply for domestic purpose to Solapur city, less water is made available by cutting time and duration in water supply by Solapur Municipal Corporation during summer, it will also reflect the amount and volume of various parameters in sewage water from Solapur city.