CHAPTER VI
SUMMARY AND CONCLUSIONS


The stretch of the Godavari river within the Nanded district is selected for the present study. The Godavari river enters Nanded district of Rahatı and at Basar it enters Nizamabad district of Andra Pradesh.

Eighteen sampling locations were selected from the stretch of Godavari river in Nanded. District i.e from Parbhani-Nanded district Border to Nanded-Nizamabad district Border. Eighteen parameters viz. Temperature, pH, Turbidity, Electrical Conductivity, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Sodium, Potassium, Chloride, Alkalinity, Sulphate, Phosphate, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand and most probable Number (MPN) have been determined from Godavari river water.

Godavari river water quality

In summer season temperature varies from 30°C to 35.2°C. In rainy season temperature varies from 29 to 32.1°C. In winter season temperature varies from 17.1°C to 22.4°C.
The average of temperature was calculated for three seasons. It is seen that the minimum temperature was recorded in the winter season while maximum temperature was recorded in the summer season. The minimum temperature in winter season and the maximum temperature in the summer season which is due to seasonal change.

In summer season pH varies from 6.50 to 9.55. In rainy season pH varies from 6.40 to 8.49. In winter season pH varies from 7.99 to 9.60.

When the average of pH was calculated for three seasons it is seen that the pH in rainy season remain low and it gradually increased during the summer and winter season.

In the present study it is observed that the pH is less alkaline in rainy season which becomes slightly more alkaline in summer season and becomes more alkaline in winter season the higher value of pH in winter season can be attributed to high algal growth which utilizing CO2 through photosynthetic activity and decomposition of organic matter. It is also seen that all samples of winter season show pH content above maximum desirable limit.

In summer season turbidity varies from 6.50 to 9.55. In rainy season Turbidity varies from 6.40 to 8.49. In winter season turbidity varies from 7.99 to 9.60.

When the average of turbidity was taken for there seasons it is seen that in the summer season more turbidity is observed at location 1 to 3 indicating lifting of water for irrigation purpose. In the rainy season the more fluctuation in the turbidity is observed which indicates lifting of water at location 1 to 3 and solid waste interaction at locations 6,8 and 16 while at location 11 high turbidity values can be attributed to the discharge of sewage water into Godavari river and at location 18 the high turbidity values can be attributed to algal bloom.
In summer season electrical conductivity varies from 738.61 to 2433.08 μs/cm. In rainy season electrical conductivity varies from 890.68 to 1716.19 μs/cm. In winter season electrical conductivity varies from 521.37 to 2281.02 μs/cm.

When the average of the electrical conductivity was taken for three seasons it is seen that the low EC is observed during the winter and summer season at locations 1 to 4 and high EC values are observed at locations 5 to 12. In the rainy season the EC values remain high and more or less constant except few exceptions. This increase in EC can be attributed to the presence of salts and contamination of Godavari river water.

In summer season total dissolved solids varies from 472.71 to 1557.17 mg/l. In rainy season total dissolved solids varies from 542.23 to 1098.36 mg/l. In winter season total dissolved solids varies from 333.68 to 1459.85 mg/l. It is also seen that the total dissolved solids content of all the water samples are below maximum permissible limit.

In summer season total hardness varies from 111 to 334 mg/l. In rainy season total hardness varies from 40 to 338 mg/l. In winter season total hardness varies from 56 to 292 mg/l. When the average of total hardness was taken for three season it is seen that the total hardness is low during the rainy season which slightly increases during the winter season and it is more in the summer season indicating the low water level and high evaporation resulting in accumulation of the salts. It is also seen that the total hardness content of all the water samples is below maximum permissible limit.

In summer season calcium varies from 17.63 to 16.15 mg/l. In rainy season calcium varies from 8.02 to 76.15 mg/l. In winter season calcium
varies from 12.02 to 69.73 mg/l. When the average of calcium was taken for three seasons it is seen that the Ca content are increasing from rainy season to winter season and to summer season with few exceptions indicating the accumulation of Ca during summer. It is also seen that the calcium content of all the water samples is below maximum permissible limit.

In summer season magnesium varies from 80.12 to 309.16 mg/l. In rainy season magnesium varies from 23.97 to 296.32 mg/l. In winter season magnesium varies from 25.05 to 25.16 mg/l. When the average of magnesium was taken for three seasons it is seen that the contents of Mg increases from winter season to rainy season and to summer season except few locations. It is also seen that the magnesium content of all the water samples is below maximum permissible limit.

In summer season sodium varies from 5 to 119 mg/l. In rainy season sodium varies from 5 to 116 mg/l. In winter season sodium varies from 9 to 114. When the average of Na contents was taken for three seasons it is seen that during the rainy and winter season the contents of Na remaining more or less same while during the summer season its contents are higher. It is also seen that at locations 14 to 18 the fluctuation is minimum during all the seasons. The high content of Na from location 5 to 13 indicates discharge of domestic sewage, into the Godavari river.

In summer season potassium varies from 9 to 65 mg/l. In rainy season potassium varies from 1 to 33 mg/l. In winter season potassium varies from 9 to 40 mg/l. When the average of K contents was taken for three seasons it is seen that during rainy and winter season the contents of K are slightly low as compare to its contents during the summer season. The higher values of K at locations 4, 9, 11, indicate that the disposal of
waste water and at locations 14 and 15 indicates the interaction of rocks with river water.

In summer season chloride varies from 15.62 to 225.78 mg/l. In rainy season chloride varies from 35.50 to 284 mg/l. In winter season chloride varies from 29.82 to 170.40. When the average of chloride taken for three seasons it is seen that the chloride contents at locations 5 to 12 are increasing from winter season to rainy and to summer season, while chloride at other locations do not show much variations. The increase in contents of chloride during summer season can be attributed to the reduced flow of Godavari river and discharge of domestic sewage and human animal excreta in the river. Chloride content of samples is within the maximum permissible limit.

In summer season alkalinity varies from 105 to 490 mg/l. In rainy season alkalinity varies from 100 to 780 mg/l. In winter season alkalinity varies from 110 to 345 mg/l. When the average of alkalinity was taken for three season it is seen that the contents of alkalinity during all the three season at locations 1 to 4 and 13 to 18 are low while at locations 5 to 12 its contents are high during all the three seasons and they are increasing from winter to rainy and to summer season. High content of alkalinity at locations 5 to 12 indicates the discharge of sewage water into the Godavari river.

In summer season sulphate varies from 1.97 to 120.58 mg/l. In rainy season sulphate varies from 1.26 to 61.75 mg/l. In winter season sulphate varies from 9.02 to 105 mg/l. When the average of sulphate contents was taken for three seasons it is seen that the contents of sulphate during the rainy and winter season remains more or less same. While the contents of sulphate during the summer season are high as compare to other seasons and its contents are increasing gradually towards the downstream direction.
The increase in SO$_4$ during summer season indicates organic pollution and reduced water flow in the Godavari river. Sulphate content is well within the permissible limit.

In summer season phosphate varies from 0.40 to 14.83 mg/l. In rainy season phosphate varies from 0.01 to 9.99. In winter season phosphate varies from 0.02 to 7.45 mg/l. When the average of phosphate was taken for three seasons it is seen that the phosphate contents during the summer season are high as compare to its contents in other seasons. It is also observed that the phosphate contents at locations 5-12 are high as compare its contents at other locations indicating the discharge sewage water into the Godavari River. The highest phosphate values at Govardhan ghat (Sample no.5) also indicates that the addition of ash of dead bodies.

In summer season dissolved oxygen varies from 3.04 to 13.47 mg/l. In rainy season dissolved oxygen varies from 2.22 to 9.72 mg/l. In winter season dissolved oxygen varies from 5.27 to 13.40 mg/l. When the average of DO was taken for three seasons it is seen that the contents of DO during rainy season are low, during the summer season are intermediate while during the winter season it is high. The minimum DO in rainy season indicate the utilization of DO in decomposition of organic matter while in summer season it shows intermediate range which can be attributed to higher temperature and low solubility of oxygen in water.

In summer season biological oxygen demand varies from 14.10 to 36.60 mg/l. In rainy season biological oxygen demand varies from 12.20 to 35.80 mg/l. In winter season biological oxygen demand varies from 12.20 to 36.10 mg/l. When the average of BOD was taken for three seasons it is seen that the contents of BOD during the winter season are low as compare to its contents during the summer season. It is also seen that the BOD
contents from the location 1 show increasing trend up to the location 12 and further it shows decreasing trend.

The high BOD trend from location no. 5 to 11 indicates the high pollution load. At these locations river Godavari receives maximum amount of domestic waste. It is also seen that at locations 1 to 4 sufficient oxygen is present which is reflected in the healthy vigorous life in the river. As soon as river enters the Nanded city at location 5 the content of BOD increases while the content of DO decreases. This indicates that high pollution load. This trend continues up to the location 12 in this stretch of Godavari river species that tolerate high organic content and low DO are present. This part of Godavari river is a pollution zone and active decomposition zone. The decomposition of maximum amount of organic material is carried out in this zone. After location 12 i.e. from the location 13 the content of DO increases while the content of BOD decreases. This indicates that it is a recovery zone and river is maintaining the high quality stream environment (Bootkin and Keller, 1997). This is the natural process where the self purification of river water is carried out.

In summer season chemical oxygen demand varies from 128 to 748 mg/l. In rainy season chemical oxygen demand varies from 280 to 1180 mg/l. In winter season chemical oxygen demand varies from 72 to 368 mg/l. When the average of COD was taken for three seasons it is seen that the contents of COD during winter season are low and during the rainy season its contents are high while during the summer season the content of COD show intermediate range indicates discharge of waste into the river.

When the data have been plotted on the Pipers trilinear diagram it is seen that all the samples represent Ca+Mg>Na+K (alkaline earths exceed alkalies) hydrochemical facies except few samples (2, 6, 12 and 13) from rainy season and (2, 7 and 13) from winter season which
represents \( \text{Na}^+\text{K} > \text{Ca}^+\text{Mg} \) (alkalies exceeds alkaline earths) hydrochemical facies.

It is seen that 6 samples (42.85%) of February, 7 samples (38.88%) of April and May, 2 samples (11.11%) of June, 3 samples (16.66%) of July, 5 samples (27.77%) of August, October, December and January and 5 samples (27.77%) of September and November month represents \( \text{Cl}^+\text{SO}_4 > \text{HCO}_3^+\text{CO}_3 \) (strong acid exceeds weak acid) hydrochemical facies. While 12 samples (66.66%) of February, 17 samples (94.44%) of March, 11 samples (61.11%) of April and May, 16 samples (88.88%) of June, 15 samples (83.33%) of July, 13 samples (72.22%) of August, October, December and January and 14 samples (77.77%) of September and November month represent \( \text{CO}_3^+\text{HCO}_3 > \text{Cl}^+\text{SO}_4 \) (weak acid exceeds strong acid) hydrochemical facies. It is also observed that maximum samples (61 to 94%) represent \( \text{CO}_3^+\text{HCO}_3 > \text{Cl}^+\text{SO}_4 \) hydrochemical facies.

When the data have been plotted on the piper's U.S. Salinity diagram it is seen from that 2 sample (11.11%) of February, 7 samples (38.88%) of October, 4 samples (22.22%) of November, 3 samples (16.66%) of December and 1 sample (5.55%) of January month fall in C2-S1 field. While 7 samples (38.88%) of February, 18 samples (100%) of March, April, May, June, July, August, and September, 11 samples (61.11%) of October 13 samples (72.22%) of November, 14 samples (77.77%) of December and 15 samples (83.33%) of January fall in C3-S1 field. Very few samples 4 samples (22.22%) of February, 1 sample (5.55%) of November and December and 2 samples (11.11%) of January fall in C4-S1 field. It is also observed that all the samples from March 2004 to September 2004 and maximum samples of other months fall in C3-S1 field. This suggests that the Godavari river water is of excellent quality for irrigation purpose.
The SAR values of Godavari river water are less than 10 indicating excellent quality for irrigation purpose.

The KR values for Godavari river water are more than 1 indicate the unsuitable quality for irrigation purpose.

The SSP values for Grodavari river water of study area are more than 50 indicate unsuitable water for irrigation purpose.

The RSC values for the Godavari river water of the study area are less than 1.25 indicate that the water is safe for irrigation purpose.

**Biomonitoring**

Biomonitoring has provided a valuable and convenient basis for determining river water quality due to increased awareness of the requirement for information on river water quality.

In summer season most probable number varies from 2400 to 110 MPN/100 ml. In rainy season most probable number varies from 2400 to 63 MPN/100 ml. In winter season most probable number varies from 2322 to 63 MPN/100 ml. When the average of MPN was taken for three seasons it is seen that the contents of MPN are low during winter season and gradually increases during summer while its contents are high during rainy season. It is also observed that the contents of MPN are high at locations 5 to 12 indicating the discharge of municipal sewage into the Godavari river. It is also seen that all samples show most probable number (MPN) content above maximum permissible limit.

In the present investigation *Bosmina*, *Amoeba*, *Euglina* and *Paramecium* species were found in the Godavari river water. At locations 5 to 12 except *Bosmina* all the species of Zooplankton were found. All these species are pollution tolerant but the population of the most pollution tolerant species *Euglina* was found at locations 7, 9, 11 and 12 indicating the high degree of pollution as compared to other locations. On the other hand at
locations 1 to 4 only one species i.e. *Bosmina* was found which generally present in a deep water conditions. The species *Bosmina* generally appears on water surface in the morning period and in other times it remains at bottom. Since the water level at location 13 to 16 was very shallow none of the species were found. Fish species were found at locations 1 to 4 and 13 to 18 while at location 5 to 12 none of the fish species like Labio Rohita, Catla Catla, were found. This also correlates with the amount of DO and BOD present in the Godavari river water at there locations. At locations 5 to 12 the content of DO was less and content of BOD was more as compare to other locations.

In the present investigation Spirogyra, Entromorpha, Chlorella Phytoplankton and diatom species were found and potamegoton water weeds are also found.

The algal species which are the pollution indicating species found in large quantities at locations 5 to 12 and 18. At location 4, and 13 to 18 spirogyra species was found indicates less pollution of Godavari river while locations 5 to 12 Spirogyra, Entromorpha, Chlorella and diatoms, were found indicating polluted water of Godavari river. At locations 11, 12, 17 and 18 algal bloom and aquatic weeds were present indicates eutrophic conditions.

**Recommendation and Suggestions**

1) The Domestic waste water should not be discharged into the Godavari river.

2) The sewage waste should be treated properly before discharging into the Godavari river.

3) Anthropogenic activities should be prohibited along the Godavari river.
4) Dumping of solid waste along the bank of Godavari river should be prohibited and proper disposal method for solid waste should be adopted.

5) The fish species like Gappi fish should be cultivated in the Godavari river specifically at locations from 5 to 12 where high pollution load is observed.

6) Awareness campaign should be arranged in the Nanded city.

7) Clean Godavari river plan should be taken by municipal corporations with the help of common peoples.

8) Immersion of Ganpati and putting Holliestic waste in the river should be strictly prohibited.

9) Industrial effluent discharges should be avoided into river water.

10) Washing of animals should be banned in the river water.

11) River water quality should be assessed after interval of three months or season wise continuously.

12) Exploration of sand from the river bed should be restricted.

13) Over fishing should be avoided.

14) Eutrophication level should be maintained after every summer season.

15) Soil erosion should be stopped along the bank of the river.