Analysis of water quality parameters of Tadakaleru stream from Anantapuramu City to Singanamala Tank – A case study

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Abstract. Water is an important component of human life. His existence and growth are inextricably connected to water. Water is utilised for human necessities such as drinking, washing, bathing, cooking, and so on. Irrigation and industry both require water for the production of food and other necessities. Sewage and waste industrial effluents are being mixed with fresh water streams in many areas throughout the world, affecting humans, animals, and plants. Anantapuramu is a significant city in the Rayalaseema area of Andhra Pradesh. It has a population of about 5 lakh people. Singanamala is a village in Anantapur district with a population of 10,000 people. Untreated sewage from Anantapuramu runs for 12 kilometres in the Tadakaleru stream before arriving to Singanamala Tank. People in Singanamala village utilise the water stored in the Singanamala tank for irrigation and drinking. In other words, Anantapuramu's sewage provides fresh water to the inhabitants of Singanamala. By sampling at regular intervals, the current study intends to analyse the water quality characteristics of the Tadakaleru stream from the site of confluence of sewage from Anantapuramu to Singanamala tank. The ability of the Tadakaleru stream to purify itself will be tested. The quality of the groundwater is also examined. At present the sewage of Anantapur is being self-purified in Tadakaleru stream. In mere future, for increased population sewage treatment plant is necessary to treat the sewage of Anantapur town.

Key words: Tadakaleru stream, Singanamala tank, Water quality analysis, Self-purification.

1. Introduction

The hydrosphere contains 0.3 percent of the world's fresh water and is easily accessible via lakes, reservoirs, and river systems, is an important aspect of the ecosystem [1]. Many living organisms' basic functions require water, and river water is a crucial natural resource for people. Many human activities, like as agriculture, industry, tourism, and domestic life, rely on the river. Rivers have a lot of potential for economic development [2]. A range of human activities linked to economic expansion contribute to the degradation of water quality. Rivers can clean a certain amount of toxins released into them within their capacity, but if the pollution discharge surpasses that capacity, water quality deteriorates [3].

Water from lakes, rivers, and beaches have bad odours and have an awful flavour. Unchecked growth of aquatic weeds and decrease in fish population are water pollution indicators. To describe chemical processes occurring in water bodies, generic water quality standards such as pH, DO, BOD, and TDS are utilised. The hydrogen ion concentration (H⁺ ions) in natural water containing in water is measured by pH. HCO₃⁻, CO₃²⁻, and OH⁻ ions are also the most important factors that affect water
pH. Natural water has a pH ranging from 3 to 10. In total dissolved solids, inorganic salts (primarily calcium, potassium, magnesium, sodium, chlorides, bicarbonates, chlorides, and sulphates) and organic molecules are present. TDS levels in water are influenced by natural sources, sewage, urban run-off, industrial waste water, and chemicals employed in the water treatment process. [4][5]. TDS fluctuation indicates contamination in water. Another important parameter is dissolved oxygen (DO), which is a measurement of how much oxygen is dissolved in water. DO provide information regarding water quality. Bacteria in the water consume oxygen as organic stuff decomposes. In rivers, too much organic waste can generate eutrophic conditions, which are marked by a lack of oxygen and can cause a water body to "die." Many other markers, such as BOD and Fecal coli, can be used to identify how dirty a body of water is. All of them are combined in WQI [6][10][11].

In India, the Rayalaseema region of Andhra Pradesh’s Anantapur district is located in a roughly semi-arid zone, second only to Rajasthan. Anantapur is the state of Andhra Pradesh’s driest district. This region misses out on the full benefits of both monsoons due to its remote location from the east and west coasts, resulting in recurrent droughts. It has the lowest average rainfall of around 450 mm, compared to Andhra Pradesh’s state average of around 900-1100 mm. Drought affects around 85% of the population in this district during monsoon seasons due to low rainfall, high temperatures, and strong dry winds. Anantapur district is located between 13°40’ and 15°15’ north latitude and 76°50’ and 78°30’ east longitude. The districts of Kadapa and Chittoor border the district on the east, and the district of Kurnool borders it on the north. The state of Karnataka borders the district on the south and west. The total geographical area of the district is 19,125 square kilometers [7].

![Figure 1.Study Area](image-url)
Singanamala Tank (Sri Rangarayalu Cheruvu) is located in Singanamala, Andhra Pradesh's Anantapuramu District. Singanamala village is 3 kilometres away, while Anantapuramu Town is 20 kilometres away. It is the district's largest tank and is situated at 14° 48' 00” N latitude and 77° 43’ 00” E longitude. This tank is 287 metres (944 feet) above sea level, with a catchment area of 3436 acres and an existing ayakut of around 5000 acres. This tank has a storage capacity of 0.5 TMC and a depth of 5-9 feet. Rainfall is the primary source of water for this reservoir, which gets surface runoff from Tadakaleruvagu, Erravanka, Vadiyampeta canal, and Narasapuramvanka in monsoon.

2. Materials and Methods

Water samples were taken to analyse physico-chemical parameters from 12 sampling points along the Tadakaleru stream, which runs from Anantapur Town to Singanamala Tank. Figure 1 depicts the study region. Water was collected in 1 litre bottles, which were then analysed for physicochemical properties using standard methods. The samples were tested for pH, EC, total hardness (using the ethylene-diamine-tetra-acetic [EDTA] titration technique), total alkalinity, chloride, sulphate, nitrate, BOD, DO, and other parameters. All of the tests were done within 24 hours of collecting the sample. Ground water samples were taken near the Tadakaleru stream and analysed. The Methods used for analysis of quality parameter of water samples are given in Table.2. The ground water sampling points are given in Table.3.

2.1 pH. pH scale is used to determine the amount of H+ ions in water. A pH metre (Elico) is used to measure all surface and ground water samples.

2.2 EC. The EC is a measurement of total ionised material concentration in water. It is measured in micro S cm⁻¹. An EC metre is used to evaluate the samples (Elico).

2.3 TDS. TDS (total dissolved solids) is a measurement of the total quantity of dissolved solid concentration in water. It is measured in parts per million (ppm). The TDS metre is used to measure it.

2.4 Hardness. The ability of water to precipitate soap is referred to as hardness. Dissolved calcium and magnesium ions are the main sources of water hardness. These ions produce insoluble precipitates when they come into contact with soap. The presence of bicarbonates of Ca and Mg ions in the water causes temporary hardness. The presence of chlorides and sulphates of Ca and Mg ions causes permanent hardness. The hardness was determined using the EDTA method. The EDTA method uses di-sodium salt to ethylene Di amine Tetra acetic acid as a permanent complexing agent with calcium and magnesium ions in hard water. At pH 9-10, the Eriochrome Black T indicator forms an unstable wine red complex. After titration, the Na salt of EDTA forms a stable complex, with the unstable complex being replaced by water containing Ca²⁺ and Mg²⁺ ions. The Eriochrome Black T indicator produces a blue when the pH is between 9 and 10, indicating that the formation of complex.

2.5 Chloride. Water contains chloride ions in the forms of NaCl, MgCl₂, and CaCl₂. The chloride ions were determined using the argentometric method. Titrating against a standard AgNO₃ solution with K₂CrO₄ as an indicator determines the chloride ions in the water sample.
2.6. Alkalinity. Alkalinity can be classified into two types based on titration against a standard acid with phenolphthalein or methyl orange indicator. To determine caustic alkalinity, phenolphthalein is used (carbonate). To determine bicarbonate alkalinity, use the methyl orange indicator. The methyl orange endpoint appears only after the phenolphthalein endpoint. 2–3 drops of phenolphthalein indicator are pipetted into a clean flask with 100 mL of water. To fill the burette, N/50 H2SO4 is used. The end point is determined after titrating with acid against a water sample. It is the goal to get rid of pink. The titration should then be continued after adding 2 or 3 drops of methyl orange.

2.7. Dissolved Oxygen. The amount of dissolved oxygen (D.O.) in natural and wastewaters is influenced by the physical, chemical, and biological activities that present in a water body. Water pollution control and waste treatment process control both need D.O. analysis. The Winkler (or iodometric) test is still the most precise and reliable titrimetric method for D.O. analysis, having been enhanced by a variety of procedures and equipment, as well as instruments. A divalent manganese solution is added to a water sample in a glass-stoppered bottle, then a strong alkali is added. D.O. in the sample oxidises fast to divalent manganous hydroxide in an equal amount. In the presence of iodide ions and after acidification, oxidised manganese reverts to the divalent state, with iodine liberation matching to the original D.O. concentration in the sample. A hypo standard solution is used to titrate the iodine.

2.8 Biochemical Oxygen Demand. The amount of oxygen needed for the biological breakdown of dissolved organic matter to occur under aerobic environment and at the specified time and temperature is identified as the Biochemical Oxygen Demand (B.O.D.). The time is usually 5 days long, with a temperature of 20°C (the WHO standard). One of the most important procedures in sanitary analysis is the B.O.D. test, which is used to assess the polluting power, or strength, of sewage, industrial wastes, or polluted water. It is a measurement of the amount of clean diluting water needed for successful sewage dilution disposal.

Table 1. Methods used for analysis of quality parameter of water samples [8][9]

| Parameter                | Determination                      | Reference Code     |
|--------------------------|------------------------------------|--------------------|
| Colour                   | Cobalt scale                       | IS3025(part4)      |
| Electroconductivity      | EC meter works on potentiometric method | IS1070(1992)    |
| Total Hardness           | Titration against EDTA             | IS3025(Part-21)   |
| Temporary Hardness       | Titration against EDTA             | IS3025(Part-21)   |
| Acidity                  | Titration against NaOH             | IS3025(Part-22)   |
| Alkalinity               | Titration against HCL              | IS3025(Part-23)   |
| Bio-Chemical Oxygen Demand(BOD) | Incubation method                  | IS3025(Part-44)   |
| Dissolved Oxygen(DO)     | Titration Method                   | IS3025(Part-38)   |
| Total Dissolved Solids(TDS) | TDS Meter works on back-    | IS3025(Part-16&17) |
| Total Suspended solids(TSS)| Filtration method               | IS3025(Part-16&17) |
| Total Volatile Solids(TVS)| Evaporation before boiling       | IS3025(Part-16&17) |
Table 2. Sampling points for surface water

| Sample No. | Location                                      | Sources                                                                 |
|------------|-----------------------------------------------|-------------------------------------------------------------------------|
|            | **Samples in the Drain of Anantapur**         |                                                                         |
| 1          | Sangamesh Functionhall                       | Munnanagar, Saradanagar etc.                                            |
| 2          | Iron bridge                                  | Vidyuthnagar, Aravindanager, Ashoknagar, Sainagar, etc.                  |
| 3          | Near Ananthapuram, RTC bus stand             | Gandhi bajar, Old Town, Venugopal Nagar                                 |
|            | **Samples in Nadimivanka**                   |                                                                         |
| 4          | Near Rudrampeta                              | Kattakindapalli, Rudrampeta etc.                                       |
| 5          | Nadimivanka road crossing near Police Training College (PTC). | Ram nagar, Marutinagar, Kovurnagar etc.                                |
| 6          | Nadimivanka at Somanathnagar                 | Indiragandhinagar, Somanath Nagar, Shanthinagar, RK nagar etc.          |
| 7          | Nadimivanka near HLC Aqueduct                | Revenuecolony, Ramachandranagar,                                       |
|            | **Samples in Tadakaleru after the confluence of Nadimivanka & drainage from the Town** |                                                                         |
| 8          | Thadakaleru near ISKCON Temple               | Drainage from Nadimivanka and from Anantapuramu town (Samples 1 to 8)   |
| 9          | Near Podaralla(v)                            | No addition of contaminants                                            |
| 10         | Near Jantalur(v)                             | No addition of contaminants                                            |
| 11         | Joining point at Singanamalatank             | No addition of contaminants                                            |
| 12         | In Singanamala Tank                          | Provide storage for the water of Tadakaleru stream.                    |

Table 3. Ground water sampling points.

| Sample No. | Location                                      |
|------------|-----------------------------------------------|
| 1          | Anantapur Town 5th Road                       |
| 2          | Anantapur Town at RTC bus stand               |
| 3          | At ISKCON Temple                              |
| 4          | At Govindampalli                              |
| 5          | At Podaralla                                  |
| 6          | At Jantalur                                   |
| 7          | At Singanamala- Tadakaleru Confluence         |
| 8          | At Singanamala Tank                           |

3. Result and Discussion

Tables 4 and 5 provide the surface water quality characteristics of 12 samples taken from the Anantapur and Tadakaleru streams from Anantapur Town to Singanamala Tank. Water quality is also determined in ground water samples near the Tadakaleru stream and in table 6 the results are reported.
Table 4. Surface water quality parameters for different samples (1 to 8)

| Sample | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |
|--------|----|----|----|----|----|----|----|----|
| Temperature (°C) | 30 | 31 | 31 | 31 | 33 | 33 | 33 | 33 |
| Colour | Black | Black | Black | Black | Black | Black | Black | Brown |
| Turbidity (NTU) | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 |
| EC (µs/cm) | 760 | 680 | 630 | 530 | 455 | 402 | 375 | 345 |
| pH | 6.1 | 6.55 | 6.8 | 6.81 | 7.2 | 7.45 | 7.9 | 7.2 |
| TDS (ppm) | 970 | 845 | 734 | 728 | 685 | 645 | 573 | 478 |
| Acidity (ppm) | 1100 | 855 | 830 | 729 | 650 | 606 | 525 | 435 |
| Alkalinity (ppm) | 300 | 330 | 365 | 405 | 435 | 453 | 466 | 546 |
| Hardness (ppm) | 250 | 242 | 237 | 235 | 225 | 219 | 213 | 215 |
| Total solids (ppm) | 3000 | 2800 | 2700 | 2600 | 2500 | 2000 | 1800 | 1400 |
| Fixed (ppm) | 500 | 500 | 200 | 600 | 500 | 500 | 400 | 400 |
| Volatile (ppm) | 2500 | 2300 | 2500 | 2000 | 2000 | 1500 | 1400 | 1000 |
| TDS-TSS (ppm) | 2030 | 1955 | 1966 | 1872 | 1815 | 1355 | 1227 | 925 |
| DO (ppm) | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 |
| BOD (ppm) | 100 | 94 | 85 | 76 | 65 | 60 | 53 | 45 |
| Chlorides (ppm) | 320 | 315 | 309 | 303 | 298 | 292 | 285 | 280 |
| Sulphates (ppm) | 400 | 380 | 175 | 364 | 353 | 349 | 315 | 300 |

Table 5. Surface water quality parameters for different samples (8 to 12)

| Sample | 9 | 10 | 11 | 12 |
|--------|---|----|----|----|
| Temperature (°C) | 34 | 34 | 35 | 35 |
| Colour | Brown | Brown | Brown | Colourless |
| Turbidity (NTU) | 3 | 3 | 3 | 2 |
| EC (µs/cm) | 290 | 250 | 190 | 175 |
| pH | 7.8 | 7.9 | 8.0 | 8.18 |
| TDS (ppm) | 379 | 235 | 190 | 175 |
| Acidity (ppm) | 376 | 285 | 206 | 195 |
| Alkalinity (ppm) | 565 | 570 | 585 | 600 |
The variation in surface water quality parameters is mentioned in tables 4 and 5. The surface water sampling locations are mentioned in table-2. The colour of the surface water samples is black to brown, as indicated in tables 4 and 5, due to sewage water pollution of streams in the Anantapur Town area. The pH value in Anantapur town is 6.1, while it reached to 8.18 at Singanamala tank sample-12 from table 4& 5 and from figure 2. pH levels between 6.5 and 8.5 are acceptable. The low pH value in Anantapur Town implies that the water is sewage.

In Anantapur town, the turbidity value is 6 NTU, while it drops to 2 NTU in Singanamala from figure-3. Dilution in the stream causes the turbidity measurement to drop. The water at Anantapur is murky owing to sewage solids. The turbidity in the Singanamala tank, on the other hand, is caused by suspended soil particles. The temperature of waste water is usually between 25 and 35 degrees Celsius from figure-4. Because conductivity is a measurement for water's potential to flow electrical charge, it is directly connected to the ionic concentration in the water, the EC value steadily declines from 750 μs/cm to 175 μs/cm as shown in figure -5. The TDS value for Anantapur town was 970 ppm, however it was reduced to 175 ppm due to a drop in dissolved solid concentration in solution. The acidity level in Anantapur is 1100 ppm, however it has dropped to 195 ppm as shown in table-4. The town of Anantapur has an alkalinity of 300 parts per million, which has recently been raised to 600 parts per million. This implies geological or leachate pollution in ground water due to agriculture. The hardness of the anantapur town sample is 250 ppm, and it drops to 200 ppm at the singanamala tank from table-4. This hardness is within the 500ppm acceptable range. After minor softening, this water may be utilised for irrigation and even drinking.

The total solids value for Anantapur town was formerly 3000 ppm, but has now been reduced to 500 ppm as mentioned in tables 4 & 5. This denotes stream’s ability to purify itself. The amount of...
dissolved oxygen in the air is steadily increasing from 2ppm in Anantapur to 6ppm in Singanamala. Self-purification is also indicated by the steady increase in DO value. Aquatic life may be able to thrive in the Singanamala tank. Similarly, BOD levels in Anantapur Town were decreased from 100 to 15 ppm as shown in tables 4 & 5. Self-purification is also shown by the continuous decrease in BOD levels.

The chloride ion concentration at sampling site 1 is 689 ppm, however it drops to 237 ppm in Singanamala tank as shown in tables 4 & 5 and figure7. This is below the maximum chloride ion concentration that may be tolerated. The sulphates ions concentration in the Anatapurtown is 400 ppm, while it drops to 200 ppm in the Singanamala tank as shown in figure6. Because natural sulphate ions have been eliminated by reduction throughout the flow. Table 6 shows ground water samples that
demonstrate pollution near Anantapur Town. This is due to pollutants seeping from sewage water running through the streams. The ground water quality near Singanamala tank has improved. Also, the variation of total solids and DO are depicted in Figure 8 and Figure 9.

Figure 6. Variation of Sulphates

Figure 7. Variation of Chlorides

Figure 8. Variation of Total Solids

Figure 9. Variation of DO
Table 6. Ground water parameters for different samples

| Tests         | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 6 | Sample 7 | Sample 8 |
|---------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Temperature (C) | 20       | 21       | 22       | 23       | 23       | 24       | 24       | 25       |
| Turbidity (NTU) | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1        |
| Conductivity (μs/cm) | 1732     | 1635     | 1430     | 1123     | 1036     | 953      | 854      | 768      |
| TDS (ppm)     | 715      | 632      | 568      | 495      | 510      | 422      | 375      | 355      |
| pH            | 5.8      | 6.2      | 6.4      | 6.6      | 7.2      | 7.5      | 7.8      | 8.0      |
| Hardness (ppm) | 635      | 652      | 553      | 569      | 603      | 634      | 615      | 609      |
| DO(ppm)       | 2.5      | 2.8      | 2.6      | 3.2      | 3.5      | 3.9      | 4.8      | 5.1      |
| Cl^- (ppm)    | 257      | 283      | 223      | 150      | 165      | 170      | 190      | 200      |
| SO_4^{2-} (ppm) | 355     | 326      | 310      | 315      | 290      | 235      | 226      | 282      |
| Alkalinity (ppm) | 528    | 516      | 486      | 530      | 453      | 435      | 392      | 356      |
| Acidity (ppm) | 302      | 344      | 363      | 326      | 259      | 210      | 194      | 150      |

The variation in ground water quality parameters is mentioned in Table 6. The ground water samples are collected from 8 locations as mentioned in Table 3. In this the temperature value is between 20 degrees Celsius and 25 degrees Celsius. Turbidity value is around 1 NTU for all 8 samples. Conductivity value is high near Anantapur town i.e. 1732 μs/cm and decreased to 768 μs/cm near Singanamala tank. TDS values vary from 715 ppm to 355 ppm over the flow. At Anantapur town, ground water samples possess pH of 5.8. over the flow it got increased to 8.0. Hardness values are within the range of 600 to 660 ppm over the flow. DO value at Anantapur town is 2.5ppm and at singanamala tank it is 5.1 ppm. Chloride ion concentration is within the range of 165 to 260 ppm. Sulphate ion concentration follows a decreasing trend from Anantapur town to Singanamala tank. Its value is between 355ppm and 282ppm. Alkalinity value follows a decreasing trend from Anantapur town to Singanamala tank. Acidity value also follows a decreasing trend from Anantapur town to singanamala tank. Its value is between 302ppm and 150ppm.

4. Conclusion

The sewage of Anantapur town is mainly of domestic origin. The presence of industrial effluents in sewage is very less. This domestic sewage can be mitigated easily through the natural process of self-purification within the carrying capacity of the Tadikaleru stream. On observing tables 4 and 5, the
values also indicate a decreasing trend of contaminants over the flow indicating the presence of self-purification. Without treatment, self-purification of streams is adequate to cleanse the sewage pollution of Anantapur in today's population. However, if the population grows, a sewage treatment facility will be required since the stream may not be able to self-purify the contaminants in greater amounts.

Water treatment plants are also required at the Singanamala tank to purify the water, which is utilised for a variety of reasons including drinking and washing. The water from Singanamala tank is appropriate for irrigation since the hardness or EC is below permitted limits. In between the Anantapur town and Singanamala tank via Tadakaleru stream irrigation can be possible with this sewage water. But the crops that can grow in these ranges can only be chosen. There is also a chance of decrease in the fertiliser application since sewage water is used for farming and it could be a perennial source. Over all further investigations are required to formulate the policies for the reuse of sewage of Anantapur town for irrigation, establishment of sewage treatment plant for Anantapur town.

5. References

1. World Water Resources: a New Appraisal and Assessment for 21st century (Report) using water quality index (WQI) method and GIS in Aksu River (SW-Turkey). UNESCO (1998), Sci Total Environ 584:131–144.
2. Patil S, Ghorade IB, (2013), Assessment of physico-chemical characteristics of Godavari river water at Trimbakeshwar and Kopargaon, Maharashtra. Indian J Appl Res 3(3):149–152.
3. Zhaoshi W, Zhang D, Cai Y, Xiaolong W, Lu Z, Yuwei C (2017) Water quality assessment based on the water quality index method in Lake Poyang: the largest freshwater lake in China. Sci Rep 7:17999
4. Patel SV, Chavda P, Tyagi S, (2019), carrying out assessment of groundwater quality of villages of Bhavnagar district of Gujarat, India. Environ Claims J 31(1):79–92
5. Tyagi S, Sharma B, Singh P, Dobhal R, (2013), Water quality assessment in terms of water quality index. Water Res 1(3):34-43.
6. Popovic NZ, Duknic JA, Atlagic JZ, Rakovic MJ, Marinkovic NS, Tubic BP, Paunovic MM (2016), Application of the water pollution index in the assessment of the ecological status of rivers: a case study of the Sava River, Serbia. ActaZoologicaBulgarica 68(1):97–102.
7. Reddy R, Gopal K R, Narasimhulu K., Reddy L S S and KumarK (2007). Aerosol Size Distribution Variation in Anantapur (14.62°N, 77.65°E) Semi Arid Zone and its Impact on Aerosol Effective Radius. Aerosol Air Qual. Res. 7: 550-562. https://doi.org/10.4209/aaqr.2007.01.0004
8. Methods of sampling and test (physical and chemical) for water and wastewater, IS 3025-1987(Part-1)
9. Bureau of Indian Standards, (1998 & 2012) Indian Standard Drinking Water, ICS 13.060.20. IS:10500, 2nd Revision. New Delhi, India: Bureau of Indian Standards.
10. A. Kaushik, H.R. Sharma, S. Jain, J. Dawra, C.P. Kaushik, (2010) Pesticide pollution of river Ghaggar in Haryana, India, Environ. Monit. Assess. 160 (1–4) 61–69.
11. Y. Martinus, W. Astono, D. Hendrawan, (2018) Water quality study of Sunter River in Jakarta, Indonesia, IOP Conference Series: Earth and Environmental Science, vol. 106.