The characteristics and evaluation of water pollution in Ganjiang Tail River

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Abstract. The water quality in Ganjiang River has an important impact on the ecological environment of Poyang Lake, because Ganjiang River is an important water supply of Poyang Lake. In this paper, the electrical conductivity (ED), turbidity (NTU), suspended solids (SS), total phosphorus (NP), total nitrogen (NT), ammonia nitrogen (NH4-N), nitrate nitrogen (NO3-N), and chemical oxygen demand quantity (COD) have been considered as indicators of water quality while performing an assessment of water in Ganjiang River. We evaluated and analyzed comprehensively the quality of surface and underground water by using the Water Quality Identification Index Method. The sample water was retrieved every 50 days from eight monitoring points located in three sections of downstream Ganjiang River in Nanchang city; the study was conducted from September 10, 2015 to June 1, 2016. The results indicate that the pollution index of northern, central, and southern tributaries in Ganjiang River downstream are 3.807, 3.567, and 3.795, respectively; these results were obtained by performing the primary pollutants quality identification index method (PP-WQI); the pollution index for the same tributaries was found to be 3.8077, 3.5003, 3.7465, respectively when we performed comprehensive water quality identification index method (CWQI). The water pollution grades are between level 3 and level 4. The main pollutants are COD, TN, and SS; moreover, there is a linear relationship between the pollution index in groundwater and surface water. The water quality is the best in the central branch, and worst in the south; the water quality is moderate in the north. Furthermore, the water of upstream is better than that of downstream. Finally, the water quality is worst in summer but best in winter.

1. Introduction
There are many evaluation methods to comprehensively assess the quality of river water in our country; water quality assessment methods can be classified into two types: a single factor evaluation method and synthetic evaluation method. Because of their "one-vote veto system", a single factor method can hardly reflect water quality pollution; therefore, it is rarely used by researchers. Water quality is preferably determined using a comprehensive evaluation method [1]. With this method, we can accurately estimate the overall pollution in water that declines its quality. Nemero index method is most frequently used statistical techniques [2], and it based on the combination of weights; this method is integrated with the conventional methods, such as water quality evaluation method [3], comprehensive water quality index method [4] and evaluation based on factor analysis method [5],
water quality identification index [6], and other evaluation methods. Among the various evaluation methods used to determine water quality, the most effective one is the water quality identification index method [7, 8]; this method has numerous advantages, such as water quality category, quantitative pollution, water (environmental) functional zone standard, water (environmental) management information; all these parameters can be optimized both qualitatively and quantitatively in order to make a reasonable assessment of water quality. Therefore, the water quality identification index method has been widely used to evaluate the quality of river water [8, 9-11]. Water quality identification index and single-factor identification index method [7], comprehensive water quality identification index method [12, 13], and major pollutants identification index method [14].

In recent years, agricultural and industrial emissions have been increasing with the development of industry and agriculture in Nanchang, resulting in varying degrees of pollution that declines the water quality of Ganjiang River; it is important to note that Ganjiang River of Poyang Lake is an important source of water. It is bound to have a greater impact on the ecology of lower reaches of Poyang Lake. It is important to monitor the changes in Ganjiang River with respect to time and season; with Xu Z X [15] integrated the pollution index for analyzing and evaluating the water quality in Ganjiang Jian River. Then, Hu C [16] combined analytical hierarchy process with comprehensive index method to perform a critical evaluation of Ganjiang River health in Nanchang city of China. Furthermore, Li A P [17] used artificial neural network forecasting method to obtain a better prediction of water quality in Nanchang section of Ganjiang River in China.

In research studies that focus on improving the various prediction methods of water quality, there have been numerous advancements. For example, the grey correlation method is based on the following technologies: computer artificial intelligence [18], analytic hierarchy process [19], artificial neural network method [1], fuzzy mathematics method [20], regression support vector machine, projection pursuit regression method [21], principal component analysis method [13, 15], fuzzy identification method [16], and indicator probability density method [22] All these methods were successfully applied as forecasting methods to predict water quality. Because of this innovative strategy, we can offer ecological protection to Poyang Lake. To analyze the effects of recent changes in Ganjiang River, we used the method of water quality identification index; thus, we analyzed Ganjiang River’s water in terms of space and time scales. The results of these analyses helped us compile a scientific report on water quality evolvement and regional ecological management of Poyang Lake.

2. Material and methods

2.1. Regional overview

The Ganjiang River is high in the west and low in the north; it flows northwards when exposed to a mild climate and abundant rainfall; the river flows through a region that can be included in a subtropical monsoon climate zone. Spring and summer are affected by the subtropical monsoon winds, so the air is warm and humid. The air flows in the basin in the South, whereas the Northern cold air often flows over the valley; it is long-lasting current that precipitates as frontal rain over a wide range. In the Ganjiang River basin, precipitation mostly occurs for four consecutive months; however, the monsoon season lasts for about 3–6 months, which is a long period of concentrated rainfall. The average runoff has been constant at 684.2 m³ since many years (outside the continent mentioned above), whereas the depth of average runoff has been 845.2 mm. Ganjiang Tail river is located in the north of Jiangxi Province and in the southwestern bank of Poyang Lake. This region receives high rainfall in the range 1400–1600 mm, and the average annual runoff is 11.74 billion m³; however, the average runoff is 941.3 mm. The region is rich in water and soil resources. Besides, it offers excellent services to its citizens, including convenient transportation, strong industrial base, excellent conditions for agricultural production, and an industrial agglomeration degree of significance. The Ganjiang River extends from the south to the north of Nanchang city in the northeast of Nanchang, and it is divided into three branches (North Branch, Middle Branch, and South Branch) that merge
with the Poyang Lake to form an excellent network of water resources in the region; therefore, this region is developed in terms of industrial agriculture.

2.2. Sampling program
The surface water quality monitoring and the sampling principle were combined with the actual situation in the North Branch, in the branch, South branch points; thus, a total of 8 sampling points were set up in the section (figure 1). The sampling period extended from September 10, 2015 to June 1, 2016. During this period, five samplings were collected every 50 days. Using a polyethylene bottle, we collected samples from the surface, and the middle and bottom part of fracture surface. Finally, the test was conducted and the weighted average was achieved; the values of test results have been provided in the section of indicator values. In accordance with The Surface Water Environmental Quality Standards (GB3838-2002), we included the following parameters in the index: pH values, conductivity (EC), turbidity, suspended solids (SS), total phosphorus (TP) and total nitrogen (TN), ammonia nitrogen (NH₄–N), nitrate-nitrogen (NO₃–N), and chemical oxygen demand (COD).

![Figure 1. The sample points in the Ganjiang Tail River.](image)

Notes: G1 is North Port station; G-2 is North branch in Tankou village power stations; G-3 is North Hezhou electric power stations of irrigation and drainage; G 4 is Middle branch of Xialou village; G-5 is Middle branch of the South Village; G-6 is Middle of the bridge before the bridge; and G-7 is South Branch of Chubei bridge; G-8 is South Branch of Beiwang bridge.

2.3. Measured values of water quality objectives
The average value of water quality indexes and specific test statistics are shown in table 1: it displays 8 monitoring points and 5 monitoring water quality indicators; both types of points are measured with respect to time and space.
Table 1. The measured value for water quality monitoring data.

|    | ED  | NTU  | SS   | TP   | TN   | NH₄-N | NO₃-N | COD   |
|----|-----|------|------|------|------|-------|-------|-------|
| T1 | 124.34 | 23.16 | 41.83 | 0.058 | 0.058 | 0.709 | 7.44  | 103.48 |
| T2 | 132.78 | 28.47 | 47.58 | 0.302 | 1.457 | 1.626 | 14.90 | 80.38 |
| T3 | 108.93 | 29.22 | 43.89 | 0.339 | 1.599 | 1.485 | 15.87 | 64.29 |
| T4 | 83.59  | 27.08 | 48.90 | 0.294 | 0.818 | 0.972 | 16.17 | 61.20 |
| T5 | 114.89 | 24.12 | 67.82 | 0.375 | 1.695 | 1.790 | 17.92 | 89.15 |
| G1 | 99.42  | 19.90 | 51.33 | 0.303 | 1.019 | 1.031 | 13.12 | 88.58 |
| G2 | 102.17 | 30.18 | 49.67 | 0.252 | 0.989 | 1.032 | 13.96 | 89.92 |
| G3 | 135.83 | 42.16 | 67.25 | 0.278 | 0.919 | 0.859 | 9.13  | 112.67 |
| G4 | 97.67  | 26.89 | 39.67 | 0.252 | 0.993 | 1.240 | 13.30 | 70.42 |
| G5 | 97.50  | 24.46 | 36.42 | 0.173 | 0.898 | 1.343 | 13.43 | 67.75 |
| G6 | 97.92  | 26.53 | 41.92 | 0.221 | 0.900 | 1.038 | 11.75 | 68.42 |
| G7 | 116.67 | 32.86 | 54.17 | 0.250 | 0.910 | 1.689 | 13.92 | 77.17 |
| G8 | 125.00 | 28.97 | 50.00 | 0.299 | 0.926 | 1.312 | 13.83 | 64.50 |
| G9 | 142.88 | 8.88  | 16.25 | 0.200 | 1.331 | 1.243 | 20.72 | 54.00 |

Note: G9 is average value of groundwater index of 8 monitoring points. Tables in addition to NTU index is dimensionless units, ED units (μS/cm), but the remaining indicators are in (mg/L). T1 for October 30, 2015, T2 for December 4, 2015, T3 for January 12, 2016, T4 for March 10, 2016, T5 for May 31, 2016.

3. Evaluation methods

According to the method of water quality identification index (WQI) [7], we expressed water quality as a decimal with algebraic properties; they provide a quantitative estimate of water quality at any given point of time. In this method, we first determined the strength of the water monitoring data with respect to all the participating factors using a single-factor water quality identification index. Secondly, we considered the Surface Water Environment Quality Standard (GB3838-2002) and the classification of water quality standards, Water Function Zone Division Standard (GB/T50594-2010) to develop a functional classification standard of water; then, we calculated water quality identification index.

3.1. Single factor water quality identification index method

The method of single-factor water quality identification index (SWQI) [7] reflects the following parameters: water quality categories (X₁), water quality category of interval (X₂), and the relationship between individual indicators and water (environmental) function areas (X₃). Three digits, including an integer, two or three digits after the decimal point could be shown as follows:

\[ P_i = X_1 X_2 X_3 \]  

Where \( P_i \) is the identification index of water quality indicators; \( X_i \) is the purpose of water quality indices of water quality categories; \( X_2 \) is the monitoring data of \( X_1 \) (Water quality changes in the position, according to the rounding principle); and \( X_3 \) is the comparison with ribbon category for the water category.

3.2. Primary pollutant-water quality identification index

Primary Pollutant-Water Quality Identification Index (PP-WQI) [14] is a modification of SWQI, and it reflects the major classes of pollutants defined by water quality parameter \( X_4 \).

\[ PP - WQI = X_1 X_2 X_3 (F) \]  

wherein, \( PP - WQI \) is the monitoring data that represents the water quality with respect to main
pollutants in the index of water body identification; \( X_1 \) and \( X_2 \) are the parameters that have been described above in the single-factor water quality identification index; the difference is \( X_1 \), and it is used to provide an overall assessment of water quality indicators, below the number of categories of water quality standards and water quality indicators; For \( F = \) the monitoring data of main pollutants in water \( (P_i = X_1 X_2) \) Maximum water quality indicators).

3.3. Comprehensive water quality identification index method

Comprehensive water quality identification indexes (CWQI) [16] are defined as follows: the average of the total representative of water quality and zoning comparison; the participation is inferior to the Ribbon among the overall indicators of water quality, which are identified by the evaluation standard number of water quality objectives.

\[
CWQI = X_1 X_2 X_3 X_4 \quad (3)
\]

\[
X_1 X_2 = \frac{1}{n} \sum_{i=1}^{n} X_i X_{j} \quad (4)
\]

\( CWQI \) represents all participants in the evaluation system of comprehensive results in \( X_1, X_2 \).

With the above equations (3) and (4), we obtained different results after \( X_1 X_2 \) calculation as compared to those obtained with single factor water quality identification index; this is because the evaluation method of \( X_1 X_2 \) is different in this case. On an average, \( X_1 \) refers to the participants in the comprehensive evaluation of water quality indicators, so it is inferior to the single index number of targets in the Ribbon of water environment; \( X_4 \) refers to the comprehensive water quality categories defined after comparing the results of the water of the Ribbon category; the participation emphasizes on the single factor identification index \( P_i \) in \( X_3 \) Not for 0 To determine the number.

4. Results and discussion

According to Surface Water Environment Quality Standard (GB3838-2002) and the Water Function Zone Division Standard (GB/T 50594-2010), we defined the classification standard of water quality. As per the grading standards, we defined the classification standard values of water quality index in table 2.

| Water type | quality | I   | II  | III | IV  | V   | Bad | V   |
|------------|---------|-----|-----|-----|-----|-----|-----|-----|
| ED         |         | 400 | 1000| 1500| 2000| 3000| 3500|
| NTU        |         | 15  | 20  | 25  | 35  | 50  | 80  |
| SS         |         | 20  | 25  | 30  | 60  | 150 | 200 |
| NP         |         | 0.02| 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| NT         |         | 0.2 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 |
| NH4-N      |         | 0.15| 0.5 | 1.0 | 1.5 | 2.0 | 4.0 |
| NO3-N      |         | 10  | 15  | 20  | 25  | 35  | 50  |
| COD        |         | 15  | 15  | 20  | 30  | 40  | 80  |

Table 3 shows that all monitoring points of ED meet class requirements; moreover, NO3-N is somewhat greater than lever III of water quality standards. In addition, NH4-N and TN class III meet water quality standards. It is important to note that TP and TN represent light pollution, whereas NTU and SS indicate more serious pollution, while mean COD is an indicator of worst pollution.
Table 3. The water quality of the monitored data of the corresponding category.

|     | ED | NTU | SS | TP | TN | NH$_4$-N | NO$_3$-N | COD |
|-----|----|-----|----|----|----|----------|----------|-----|
| T1  | I  | IV  | IV | II | I  | I        | I        | Bad |
| T2  | I  | IV  | IV | IV | IV | II       | II       | V   |
| T3  | I  | IV  | IV | V  | III| III      | II       | IV  |
| T4  | I  | IV  | IV | III| II | III      | IV       |     |
| T5  | I  | IV  | V  | V  | III| III      | IV       |     |
| G1  | I  | III | IV | IV | III| II       | V        |     |
| G2  | I  | IV  | IV | III| III| II       | V        |     |
| G3  | I  | IV  | V  | III| II | II       | Bad      |     |
| G4  | I  | IV  | IV | III| III| II       | V        |     |
| G5  | I  | IV  | IV | III| III| II       | IV       |     |
| G6  | I  | IV  | IV | III| III| II       | IV       |     |
| G7  | I  | IV  | IV | III| IV | II       | V        |     |
| G8  | I  | IV  | IV | III| III| II       | IV       |     |

4.1. Single factor water quality identification method for evaluating results

According to sections 2.1–2.3, we combined water quality identification index calculation method and the results of monitoring data to provide an evaluation of water quality. Table 4 presents a complete evaluation of results by single factor water quality index method.

Table 4. Single factor water quality identification index method for evaluating results.

|     | ED | NTU | SS  | TP  | TN | NH$_4$-N | NO$_3$-N | COD | WQI | PP-WQI | CWQI |
|-----|----|-----|-----|-----|----|----------|----------|-----|-----|--------|------|
| T1  | 1.30| 4.11| 4.41| 2.50| 1.30| 2.40     | 1.90      | 6.13| 3.17| 3.03(COD)| 3.030|
| T2  | 1.30| 4.31| 4.61| 4.51| 4.91| 4.31     | 3.00      | 5.42| 4.06| 4.06(COD)| 4.063|
| T3  | 1.30| 4.41| 4.51| 4.91| 5.12| 4.00     | 3.10      | 4.31| 3.93| 4.05(TN) | 3.952|
| T4  | 1.20| 4.31| 4.61| 4.41| 3.60| 2.90     | 3.10      | 4.11| 3.58| 3.54(SS) | 3.541|
| T5  | 1.30| 4.11| 5.12| 5.22| 5.22| 3.30     | 3.60      | 6.04| 4.15| 4.25(COD) | 4.252|
| G1  | 1.20| 3.60| 4.71| 4.51| 4.02| 3.10     | 2.70      | 5.92| 3.77| 3.74(COD) | 3.741|
| G2  | 1.30| 4.41| 4.71| 4.02| 4.00| 3.10     | 2.90      | 6.02| 3.85| 3.84(COD) | 3.841|
| G3  | 1.30| 5.01| 5.12| 4.31| 3.80| 2.70     | 2.20      | 6.33| 3.86| 3.84(COD) | 3.841|
| G4  | 1.20| 4.31| 4.31| 4.02| 4.00| 3.50     | 2.80      | 4.71| 3.67| 3.64(COD) | 3.641|
| G5  | 1.20| 4.11| 4.21| 3.50| 3.80| 3.70     | 2.80      | 4.51| 3.57| 3.53(COD) | 3.430|
| G6  | 1.20| 4.21| 4.41| 3.80| 3.80| 3.10     | 2.50      | 4.61| 3.54| 3.53(COD) | 3.430|
| G7  | 1.30| 4.51| 4.81| 4.02| 3.80| 4.41     | 2.80      | 5.12| 3.88| 3.85(COD) | 3.852|
| G8  | 1.30| 4.41| 4.71| 4.51| 3.90| 3.60     | 2.80      | 4.31| 3.73| 3.74(SS) | 3.641|

4.2. Comparison of different methods for the evaluation of water quality

To determine how different evaluation methods affected the evaluation of the water quality of Ganjiang River, we applied the method of weighted average pollution index on water (environmental) functional area (Pollution Index method, PIM) [1]. We compared the results obtained by PMI method with those obtained using the following methods: single factor index method (SFCI) [1], Nemero index method (NI) [2], major pollutant index method (MPI) [16], single factor water quality identification index (WQI), main pollutants water quality identification index method (PP-WQI), and comprehensive water quality identification index method (CWQI). As shown in table 5, there are
seven ways to evaluate the water quality of Ganjiang River. The relationship between groundwater and surface water pollution index is shown in table 5.

Table 5. Assessment of different methods on the water quality of Ganjiang River.

| Sampling points | PIM | SFCI | NI | MPI | WQI | PP-WQI | CWQI |
|----------------|-----|------|----|-----|-----|--------|------|
| T1             | 0.94| 1.72 | 1.39| 4.00| 3.17| 3.03(COD)| 3.0300|
| T2             | 1.08| 1.59 | 1.36| 5.38| 4.06| 4.06(COD)  | 4.0630|
| T3             | 1.06| 1.60 | 1.36| 5.27| 3.93| 4.05(TN)   | 3.9520|
| T4             | 0.92| 1.63 | 1.32| 4.70| 3.58| 3.54(SS)   | 3.5410|
| T5             | 1.17| 2.26 | 1.81| 5.63| 4.15| 4.25(COD)  | 4.2520|
| G1             | 1.02| 1.71 | 1.41| 4.95| 3.77| 3.74(COD)  | 3.7410|
| G2             | 1.04| 1.66 | 1.38| 5.07| 3.85| 3.84(COD)  | 3.8410|
| G3             | 1.17| 2.24 | 1.79| 5.12| 3.86| 3.84(COD)  | 3.8410|
| G4             | 0.97| 1.33 | 1.16| 4.80| 3.67| 3.64(COD)  | 3.6410|
| G5             | 0.91| 1.29 | 1.11| 4.63| 3.57| 3.53(COD)  | 3.5300|
| G6             | 0.92| 1.40 | 1.18| 4.60| 3.54| 3.53(COD)  | 3.5300|
| G7             | 1.10| 1.81 | 1.50| 5.12| 3.88| 3.85(COD)  | 3.8520|
| G8             | 1.03| 1.67 | 1.38| 4.92| 3.73| 3.74(SS)   | 3.6410|
| North Branch average | 1.08| 1.87 | 1.53| 5.04| 3.83| 3.807      | 3.8077|
| In the average  | 0.93| 1.34 | 1.15| 4.68| 3.59| 3.576      | 3.5003|
| South Branch average | 1.07| 1.74 | 1.44| 5.02| 3.80| 3.795      | 3.7465|

As shown in table 5, the results of seven evaluation methods of water quality are as follows: three-section North Branch (G1, G2, G3), Medium (G4, G5, G6), and South (G7, G8). Using the weighted average pollution index method (PIM), we obtained various results for class III water and good quality water. In the single-factor category index method (SFCI), the worst water quality indicators define the water quality class according to the evaluation criteria of class III water and moderately polluted water; the results are statistically analyzed by nemero index method (NI). According to these criteria, the river water sample belongs to class III water and is slightly polluted; dyeing index method of main pollutants (MPI) analyzed water of grade IV according to their criteria. In addition, there are three water quality identification index (WQI, PP-WQI, CWQI). The evaluation results are close to each other, because all samples are identified as class III water and the deviation is minor ($X^2 = 0.7$); the samples are very similar to water of grade IV, based on the main pollutants water quality identification index method (PP-WQI). To indicate the main pollutants in water, we first consider COD and then TN and SS. G9 shows that groundwater belonged to class II water quality as it included only pollutants of TN.

The method of single factor water quality identification index was used to evaluate various categories of water quality, because it can also reflect the gap between water quality categories and targets of the Ribbon. Integrated water identifies index evaluation method can fully quantify the integrated water information. Furthermore, PP-WQI method is based on water quality identification index method, and it is introduced to reflect the parameters of main pollutants in river water. Thus, it reflects integrated pollution degree of water, and it also reflects the causes of water pollution with its main pollution index. Thus, both it can provide both qualitative and quantitative evaluations. Moreover, it comprehensively reflects the pollution status in water; therefore, we recommend PP-WQI method as the preferred method of water quality evaluation.

Based on time analysis, we present various evaluation methods in table 5: T5 (2016-5-31 in summer) is the period with the highest pollution, followed by T2 and T3 (12-4 and 1-12 in winter) as the second highest pollution periods, T4 (3-10 III) has moderate pollution levels, and T1 (10-30 autumn) has the least pollution. This is because in the summer season, the rainfall is much greater in Ganjiang River of Nanchang city; with a continuous increase in rainfall, various rainwater streams...
meet into Ganjiang River. The rainwater brings a lot of pollutants into the river. As the relative concentration of pollutants increases sharply, the water quality becomes poor. Consequently, the pollution index increases tremendously. In contrast, the rainfall is less in autumn; with a steady decline in rainfall, the volume of runoff in Ganjiang River also reduces. Moreover, as the rainwater streams reduce into the Ganjiang River, the pollution content reduces very sharply. Thus, as the relative concentration of pollutants decreases, the pollution index also becomes smaller.

Based on space analysis, we consider WQI method as an example: the North Branch G1 Monitoring pollution indexes (Port) 3.77 are less than the two branches and raw materials. Moreover, G2 (Tankou village power station) and G3 (Hezhou electric power stations of irrigation and drainage) monitoring pollution index is 3.85 and 3.86, respectively; G6 Monitoring points (Bridge before the bridge) Pollution index of 3.54 is less than G4 Monitoring points (Xialou village) Pollution index of 3.67. Furthermore, South Branch G8 Monitoring points (Beiwang Bridge) Pollution index of 3.73 is less than G7 Monitoring points (Chubei Bridge) Pollution index of 3.88. The water quality declines from upstream to downstream in space: North-the best, worst is South Center. Further analysis has shown more dredges and raw materials. Some farmers on the coast breed pension ducks, and usually these ducks move into the river for food. Thus, the water quality becomes poor when these ducks thrive into the river.

5. Conclusions
The main conclusions of this study are as follows:
- Water pollution occurs at different time-periods of the year: pollution is highest in summer, but moderate in winter; however, autumn is the season that experiences minimum pollution; the pollution levels increase from upstream to downstream in space: North is the best with least pollution; central region has moderate pollutions, and South Center has the worst pollution.
- The weighted average results of evaluation were obtained by the pollution index method (PIM); the results of main pollutants dye index (MPI) were poor.
- In the Ganjiang River, the main pollutants that decline water quality in the Lake were accounted by COD; the remaining pollutants were accounted by TN and SS.
- Under the influence of surface water, the pollution index of groundwater and surface water is linear.

Recommendation: By comparing seven methods of water quality assessment, we developed an identification index of major pollutants that precisely reflect the comprehensive water pollution levels and the causes of water pollution, which are also known as the major pollution indicators. Both qualitative and quantitative evaluations can comprehensively reflect the pollution of water provided we perform an integrated assessment of water quality in rivers; PP-WQI method was found to be the preferred method of water quality assessment. The main pollutants of Ganjiang Tail River are quantified by COD and TN. This indicates that the river water contains higher levels of organic matter; therefore, the Government should invest more resources in eliminating these sources of organic pollution: pesticide should be sprayed judiciously and there should strict supervision to control the effluents released by chemical plants in the region.

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