

RESEARCH ARTICLE

WATER POLLUTION LOAD CAPACITY OF ISTN LAKE IN JAGAKARSA SOUTH JAKARTA

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ABSTRACT

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ISTN Lake is located in a campus environment and has an important ecological role as a water source, local conservation area, and natural laboratory for academic research. However, increasing pollution pressure from domestic activities around the lake can cause a decline in water quality and disrupt its ecological function. Therefore, a scientific study is needed to assess the lake's water quality, identify pollution sources, and formulate waste management strategies that support the sustainability of the lake ecosystem and its use as a natural laboratory. This study uses a quantitative descriptive approach, with measurements of physicochemical parameters (pH, DO, BOD, COD, TSS, TN, TP), and water quality index (IKA) analysis to assess the level of pollution. The results of the study showed that most observation points had water quality status in the "MODERATE" category (IKA: 67.76 - 73.89), with one point reaching the "GOOD" category (IKA: 77.63). The main factors affecting water quality come from high organic loads due to domestic waste and nutrient runoff from the surrounding environment. The analysis shows that a better waste management system is needed, restoration of riverbank vegetation, and regular water quality monitoring are needed to maintain the sustainability of the lake. ISTN lake management can adopt an integrated and sustainable approach, including pollution control, ecosystem restoration, and utilization of the lake as an ecological laboratory. By implementing an effective waste management system, technology-based water quality monitoring, and environmental education for the academic community, the lake can continue to function as a healthy water resource and support the campus ecosystem.

KEYWORDS

water quality, setu, water quality index (IKA), environmental management, water conservation.

1. INTRODUCTION

Setu or situ is a natural or artificial freshwater body located in the Jabodetabek area. The functions of the situ ecosystem include as a rainwater reservoir, flood control, and habitat for aquatic flora and fauna (Astuti et al., 2022). Situ ISTN is one of the situ spread across the Jakarta, Bogor, Depok, Tangerang, and Bekasi (Jabodetabek) areas. Situ ISTN plays an important role in rainwater management and supports environmental sustainability through flood control and providing green open spaces. This system not only helps conserve air, but also improves the quality of the urban environment by providing various ecosystem benefits (Rifyal, and Akbar, 2023). The effective implementation and management of this system can increase the city's resilience to climate change and support long-term desires (Komala, et al., 2024). However, air quality in many locations in this area has decreased due to various factors. The situation in DKI Jakarta is categorized as poor water quality, due to lack of maintenance and low public and government awareness in maintaining clean waters.

The main factors affecting the decline in water quality of Setu in Jabodetabek include domestic waste, industrial waste, and sedimentation. Domestic waste from densely populated settlements is often discharged directly into water bodies without going through a treatment process, thus increasing the levels of organic matter and nutrients such as nitrogen and phosphorus. This contributes to the eutrophication process characterized

by an explosion of algae populations and a decrease in dissolved oxygen (DO) levels, which have a negative impact on aquatic biota. In addition, industrial waste containing heavy metals and hazardous chemical compounds worsens the toxicity of the water, and can even cause long-term damage to the aquatic ecosystem.

Various studies have shown that many lakes and ponds in Indonesia have experienced a decline in water quality due to various factors, including eutrophication, industrial and domestic pollution, and sedimentation due to land erosion around the lake area. Lakes experience eutrophication which causes a decline in water quality due to increased organic matter and excessive algae growth. Research has been conducted on dragonfly diversity in several locations in South Tangerang and it was found that water pollution affects the distribution and number of dragonfly species that can survive. Research has been conducted on water quality in Setu Rawa Badak, Danau Sunter, and Situ Cilodong using chemical parameters such as pH, dissolved oxygen, and phosphate content. This study shows that there is domestic waste pollution that excessively increases water fertility.

The status of water quality will greatly affect the policies that will be taken regarding the management of Situ. Water quality assessment is not sufficient to be carried out based on individual parameters such as pH, BOD, or TSS, because each parameter is interrelated and does not stand

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alone. Therefore, an integrative method is needed such as the Water Quality Index (IKA/INA) which is able to summarize various parameters into one representative value. This approach facilitates the delivery of information to policy makers and the community, as well as being the basis for decision making based on scientific data. In determining water quality, these parameters do not stand alone but can be transformed into one representative value, namely the Water Quality Index. The purpose of calculating the Water Quality Index is to simplify information so that information on the quality of a water body is presented in a single value.

Situ ISTN is located on the ISTN Campus which is administratively located in Jagarkarsa District, South Jakarta City. Situ ISTN is one of the natural laboratories owned by ISTN. In order to formulate a sustainable management policy for Situ ISTN based on scientific data, a comprehensive study of the water quality conditions is needed. This study aims to evaluate the water quality of Situ ISTN through the calculation of the Water Quality Index using the IKA/INA method. This study focuses on three main targets, namely: (a) assessing the feasibility of using the lake water, whether it still meets the requirements for various purposes such as fisheries, recreation, or as a source of raw water; (b) identifying the main sources of pollution, both from domestic waste, surface runoff, and other activities around the lake; and (c) providing strategic recommendations for pollution control, water quality restoration, and utilization of the lake as an environmental education center and living laboratory that supports the tridharma of higher education.

2. THEORETICAL FRAMEWORKS

Research shows that the quality of water in setu or situ in Jabodetabek has become a major concern given its role in water management, aquatic ecosystems, and the provision of water resources for urban communities. In addition to the eutrophication factor, water quality in several setu in Jabodetabek is also influenced by aquaculture activities and urbanisation. Indicated that several lakes and reservoirs in Indonesia, including in the Jabodetabek area, experienced eutrophication with Trophic State Index (TSI) levels showing eutrophic to hyper-eutrophic conditions (Juwana, et al., 2022). This study found that Situ Lido in Bogor has a TSI index ranging from 58.37 to 61.51, signalling an excessive increase in nutrient content in the water, often caused by anthropogenic activities such as domestic and agricultural waste.

Aquaculture has an impact on water quality fluctuations in tropical waters. Parameters such as dissolved oxygen (DO), ammonia content, and total suspended solids (TSS) have increased in areas with high aquaculture activity (Widyawati, et al., 2022).

Meanwhile, research conducted in the Citarum River also indicated that the rapid pace of urbanisation without a good waste management system contributed greatly to the decline in the water quality of the surrounding setu and situ (Ismaya, and Iriana, 2023). The use of the Water Quality Index (WQI) in this study shows that the majority of waters in Jabodetabek have experienced a significant decline in quality in the last decade.

Situ ecosystem management based on ecology and natural restoration has an important value to maintain water quality in urban areas (Mohamad Faudzi, et al., 2023). BOD and COD parameters tend to exceed the established water quality standards, indicating the high content of organic matter that pollutes the waters. In line with this, showed that the decline in water quality is more dominantly caused by untreated household waste and increased sedimentation due to land use change. Thus, a more comprehensive and ecosystem-based approach is needed to maintain the sustainability of water quality in situ.

3. METHODOLOGY

The research method used a quantitative descriptive methodology approach that aims to provide an objective picture of the condition of water quality in the Setu ecosystem based on the results of measurements and analysis of numerical data. The following are details of the stages and methods used:

3.1 Research Design

The type of research used is quantitative descriptive, namely research that aims to describe the condition of water quality in the setu ecosystem based on numerical data obtained from direct observation and measurement. The methods used in this study include field experiments and laboratory analysis, in order to obtain objective physical, chemical, and biological data on the waters.

The approaches used in this study include:

- Field observation: Conducted to identify the physical characteristics of the setu, the surrounding environmental conditions, and anthropogenic activities that have the potential to affect water quality.
- Laboratory experiments: Water samples taken from the research location are analyzed in the laboratory to measure water quality parameters, referring to the established quality standards.
- Water Quality Index (IKA) Analysis: Used to assess the level of water pollution quantitatively based on laboratory measurement results. This method provides a classification of water quality at each observation point, which is useful as a basis for evaluating water conditions and formulating management strategies.

This design was chosen to produce a comprehensive picture of the condition of the setu ecosystem scientifically and based on data, and to support decision-making in conservation efforts and sustainable management.

- Location and Determination of Sampling Points

Location and determination of sampling points using purposive random sampling method based on the condition of the area and shape of the surface of the setu which is under environmental pressure due to domestic waste, and other anthropogenic activities. Samples were taken from several strategic points that represent the condition of the setu, namely:

- Inlet (upstream) zone: The area where water enters from the main source, such as a river or drainage.
- Centre zone: The central part of the setu that reflects the general water condition.
- Outlet zone (downstream): The area where water leaves the setu, showing the impact of pollution on the next river flow.
- High-activity zone Near residential or recreational areas that are at risk of high pollution.
- Water Sample Collection and Analysis

Sampling is carried out using the Grab Sampling Method, which is direct water collection at a predetermined location. The water parameters analysed are Physical Parameters, Chemical and Biological Parameters. Physical parameters include TDS, TSS, Temperature and Water Clarity. Chemical parameters include: pH, BOD, COD, DO, NH3-N, Nitrate, while for biological parameters using Fecal Coli.

Analyses were conducted based on APHA (2017) - Standard Methods for the Examination of Water and Wastewater.

This data is important for assessing the impact of pollution on aquatic ecosystems.

- Data Analysis
 - Calculation of Water Quality Index

To determine the condition of water pollution, the IKA/INA calculation method was used.

- Statistical Analysis

Pearson Correlation Analysis to determine the relationship between water quality parameters. Data were processed using Minitab and Microsoft Excel software for statistical analysis and graphical visualisation.

- Utilisation of Remote Sensing and GIS

GIS is utilized to map the spatial conditions of water quality at each sampling point. Spatial data is combined with laboratory analysis results to produce a visualization of the distribution of water quality in the lake ecosystem. The use of GIS provides an effective location-based approach to support targeted water resource management planning.

3.2 Interpretation of Results and Discussion

The data obtained is compared with the water quality standards stipulated in Government Regulation Number 22 of 2021. The results of the analysis can be used to:

- Assess the feasibility of using lake water, whether it still meets the requirements for various purposes such as fisheries, recreation, or as a source of raw water.
- Identify the main sources of pollution, both from domestic waste, surface runoff, and other activities around the lake.
- Provide strategic recommendations in efforts to control pollution, restore water quality, and utilize the lake as an education center and environmental laboratory.

4. RESULTS AND DISCUSSIONS

4.1 Physical Condition of ISTN's Situ

Setu ISTN is administratively located in the Kelurahan, kecamatan city of South Jakarta. Geographically located between coordinates 106048'44.072' East longitude; 6021'19.38' South latitude and 106048'49.19' East longitude; 6021'14.483' South latitude. South latitude.



Figure 1: Site plan Setu and ISTN

ISTN Setu water body occupies a valley area approximately in the middle area of the ISTN campus. The ISTN campus building that surrounds the Setu water body, limits the direct interaction of community activities around the campus with the Setu water body. However, the ISTN Campus, which has a population of approximately 1328 academicians, has the potential to contribute wastewater to the lake water body. In addition, open areas in the form of parking lots, sports facilities and grass vegetation have the potential to contribute wastewater through surface flow when it rains. The condition of land cover around the Setu water body can be seen on the Drone Photo Map of the results of near crew aerial photography on 11 December 2024 presented in Figure 2.

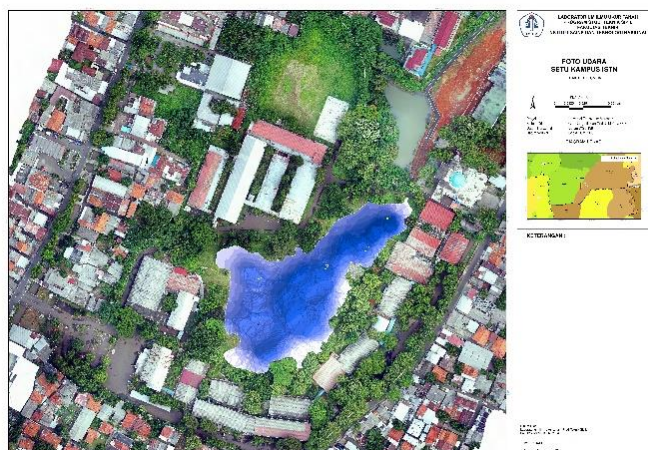


Figure 2: ISTN Setu Water Depth Map

4.2 Water Quality Parameters

Water quality parameters analysed:

- Total Dissolved Solids (TDS), this parameter indicates the amount of dissolved solids in water, which can come from minerals, salts, and organic matter.
- Total Suspended Solids (TSS), this parameter measures the amount of suspended particles in water that can affect turbidity.
- Temperature can affect the rate of chemical reactions and biological activity in aquatic ecosystems.
- Clarity, a parameter that indicates the condition of clarity at a certain water depth that may be related to the optical quality of the water, such as transparency or particulate content.
- pH, a parameter that indicates the acidity or basicity of water that affects chemical processes in waters.
- Biochemical Oxygen Demand (BOD5), is a parameter that measures the amount of oxygen needed by microorganisms to break down organic matter in water for 5 days.
- Chemical Oxygen Demand (COD) is a parameter that shows the amount of oxygen needed to oxidise organic and inorganic materials in water.
- Dissolved Oxygen (DO) is a parameter that shows the condition of oxygen dissolved in water, which affects the survival of aquatic organisms.
- Ammonia (NH₃) is a parameter in water that can be sourced from domestic waste, agriculture, or decomposition of organic matter.

Based on the results of Pearson correlation analyses conducted on various water quality parameters (TDS, TSS, temperature, pH, BOD5, COD, DO, NH₃, and clarity), several significant relationships were found that can provide insight into the main factors affecting water quality. A strong negative correlation was found between temperature and pH ($r = -0.981$, $p = 0.003$), indicating that an increase in temperature is inversely proportional to the acidity of the water. This can be attributed to biological and chemical processes in water, where an increase in temperature can increase the decomposition rate of organic matter and decrease pH due to the release of carbon dioxide from microbial activity. In addition, NH₃ (Ammonia) had a very strong negative correlation with TDS ($r = -0.932$, $p = 0.021$), indicating that ammonia concentration tends to increase when the amount of dissolved solids in water decreases.

In addition to statistically significant relationships, some parameters showed strong but insignificant relationships based on p-values higher than 0.05. For example, the correlation between TSS and temperature ($r = 0.814$, $p = 0.094$) showed that the higher the temperature, the higher the amount of suspended particles in the water, although this relationship was not statistically significant. Similarly, the relationship between COD and temperature ($r = 0.760$, $p = 0.136$) showed an increasing trend of organic pollutant load as temperature increased. This relationship indicates that the decomposition process of organic matter is faster at higher temperatures, but still needs to be tested with a larger number of samples to make the results more valid.

In general, the analysis results showed that the relationship between water quality parameters was complex, with several factors influencing each other directly or indirectly. The dissolved oxygen (DO) parameter did not show a significant relationship with most of the other parameters, but had a negative correlation with COD ($r = -0.416$, $p = 0.486$), which may indicate that an increase in organic pollution is inversely proportional to the availability of oxygen in the water. This is consistent with the theory that organic contaminants increase oxygen demand for decomposition, thereby reducing dissolved oxygen levels in the water. However, due to the relatively small number of samples used ($n=5$), further research with a wider range of data is needed to confirm this correlation pattern more accurately.

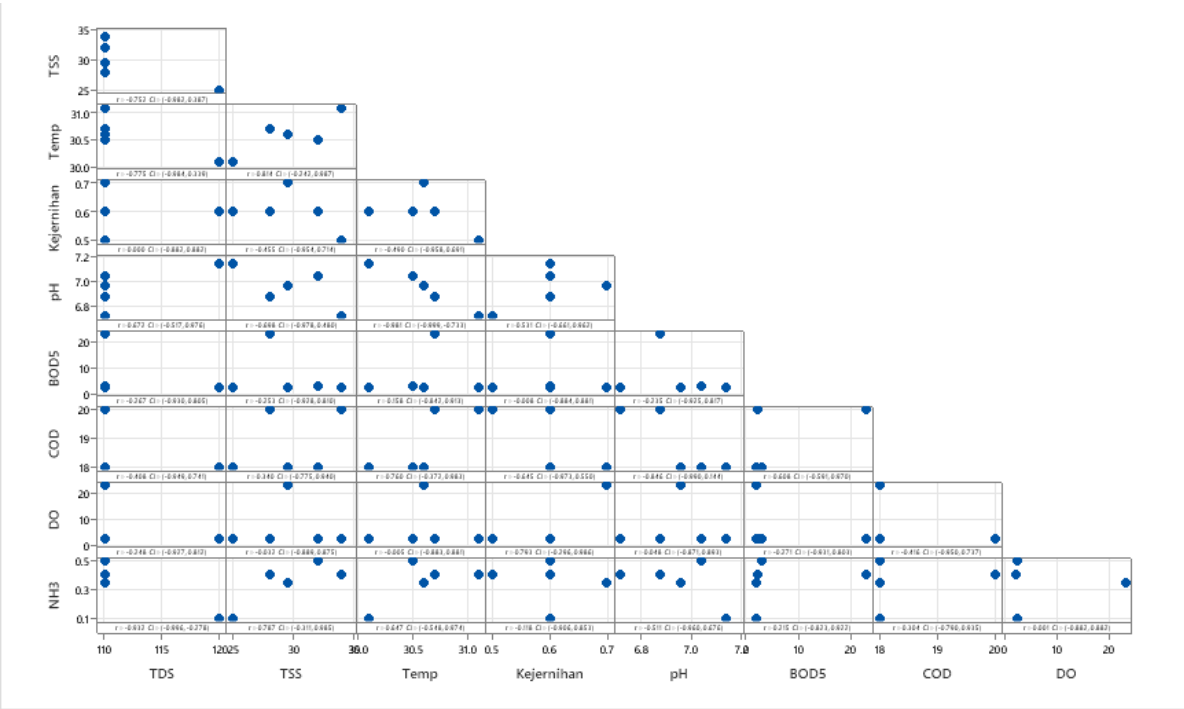


Figure 3: Matric Plot between Water Quality Parameters

Table 1: Correlation matrix between water quality parameters								
	TDS	TSS	Temp	KEJERNIHAN	pH	BODS	COD	DO
TSS	-0.752							
TEMP	-0.775	0.814						
KEJERNIHAN	0.000	-0.455	-0.459					
pH	0.672	-0.698	-0.981	0.531				
BODS	-0.267	-0.253	0.158	-0.008	-0.235			
COD	-0.408	0.34	0.760	-0.645	-0.846	0.608		
DO	-0.248	-0.032	-0.005	0.793	0.048	-0.0271	-0.416	
Nh3	-0.932	0.787	0.647	-0.118	-0.511	0.215	0.034	0.001

Source: Analysis, 2024

4.3 Water Quality Index

Based on the calculation of the Water Quality Index (WQI) at the five observation points, it is known that the majority of points have a water quality status of 'MEDIUM', with WQI values ranging from 67.76 to 73.89. The highest value was found at point 4 (77.63), which is categorised as 'GOOD', while the point with the lowest value was point 2 (67.76). The 'MEDIUM' category indicates that the water quality at this location can still be used for certain purposes, but has been degraded due to pollution. The main factor influencing the IKA value is most likely from the increase in organic and inorganic loads, such as BOD, COD, TSS, and nutrients (Nitrogen and Phosphate) entering the water body.

The highest IKA value at point 4 (77.63, 'GOOD' status) indicates that the water conditions at this point are relatively cleaner than other points. This could be due to better water circulation, the lack of direct sources of pollution, or the natural recovery process through the activities of aquatic biota and phytoremediation. In contrast, other points with lower IKA values (category 'MEDIUM') indicate greater pollution pressure, possibly due to human activities such as domestic sewage, light industrial or agricultural effluents flowing into the water body without adequate treatment.

Overall, the results of this IKA calculation indicate that water quality is still reasonably usable, but mitigation efforts are needed to prevent further degradation. Water quality degradation in the 'MEDIUM' category can lead to worse conditions if not managed properly. Some measures that can be taken to improve water quality include the implementation of better sewage treatment systems, restoration of aquatic ecosystems, as well as conservation efforts with an ecosystem-based approach (Smith et al., 1999). In the absence of appropriate interventions, the risk of

eutrophication and water quality degradation may increase, impacting aquatic ecosystems and the utilisation of water resources by surrounding communities. Data The results of the IKA calculation and the status of the water quality of the ISTN setu are presented in the attached table.

Table 2: IKA Value and Water Quality Status of Setu		
Point	Water Quality Index	Water Quality Status
1	73.89	MEDIUM
2	67.76	MEDIUM
3	68.50	MEDIUM
4	77.63	GOOD
5	68.01	MEDIUM

Source: Analysis, 2024

The distribution of water quality distribution was obtained based on spatial analysis with Kriging of IKA values at 5 monitoring point locations. Based on the distribution of locations, it shows the relevance of the presence of pollutant sources to the IKA value. In the West-North location or Point 4 shows an IKA value of 77.63 or good water quality status, while the other 4 points show IKA values at point 1 (73.89), point 2 (67.76), point 3 (68.50) and Point 5 (68.01) or moderately polluted status. This value distribution is in accordance with the observation that around point 4 no drainage channel input was found, it is likely that water input is obtained from surface flow that occurs on the land above it. this condition is different from the area around points 1, 2, 3, and 5 where there are several drainage channel outfalls from the land above it. the distribution of water quality is presented in Figure 4.

4.4 Setu Management

Based on the status of the water quality of the setu, which is already moderately polluted, the management of the setu within the campus must consider the conservation of aquatic ecosystems, sustainable use, as well as education and research for students and the academic community. The following are some strategies that can be implemented:

4.4.1 Water Quality Management and Pollution Control with the following activities:

- Implementation of a good sewage treatment system, to ensure that domestic waste from dormitories, canteens, and laboratories does not directly enter the setu, but goes through a wastewater treatment plant (IPAL) first.
- Creation of riparian vegetation zones by planting natural filter plants such as water hyacinth, vetiver, and bamboo around the setu to absorb excess nutrients that can cause eutrophication.
- Periodic monitoring of water quality, by measuring parameters such as pH, DO, BOD, COD, TSS, and nutrients using automatic sensors or manual sampling to determine water quality trends over time.

4.4.2 Utilisation of Setu for Education and Research

- Opening research programmes and student projects for various Faculties such as Engineering and Pharmacy, in order to conduct research on aquatic ecosystems, bioremediation, and biodiversity conservation in the ISTN setu.
- Development of field laboratory facilities, namely Setu, so that it can be used as a natural laboratory for student practicum in studying limnology, biodiversity, and water treatment technology.
- Education and conservation activities through routine programmes such as environmental campaigns, water management innovation competitions, and aquatic ecosystem conservation training for students and communities around the campus.

4.4.3 Ecosystem Conservation and Sustainable Utilisation

- Rehabilitation of the setu ecosystem, through rearrangement of aquatic habitat by planting native vegetation and reducing invasive species such as water hyacinth that can cause siltation.
- Management of fish and aquatic biota populations to maintain ecosystem balance by introducing appropriate fish species, such as plankton-eating fish to control eutrophication, and ensuring no overfishing occurs.
- Utilisation of the setu for sustainable recreation, allowing it to be used as an educational tourism area with eco-friendly boats, walking paths around the setu, and green zones for academic and recreational activities.

5. CONCLUSIONS

- The results of the study show that most observation points have water quality status in the "MODERN" category (IKA: 67.76 - 73.89), with one point reaching the "GOOD" category (IKA: 77.63) indicating ongoing pollution pressure due to anthropogenic activities such as domestic waste and fertilization, so that sustainable management is needed to prevent further decline in quality.
- The main source of pollution affecting the decline in water quality of Situ ISTN comes from high organic loads, which are dominated by domestic waste and nutrient runoff from the surrounding environment, such as residential areas, campus activities, and unmanaged vegetation. The presence of these organic compounds causes an increase in BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), and nutrients such as nitrogen and phosphate, which contribute to the eutrophication process and a decrease in dissolved oxygen in the water. This condition indicates the need for more integrated mitigation and waste management measures to prevent degradation of the quality of the water ecosystem in the future.
- Pollution management efforts need to be carried out immediately to

prevent a decline in water quality towards the "Poor" category, especially due to increased BOD, COD, TSS, and nutrients. An ecosystem-based approach through waste processing, riparian vegetation restoration, and environmental education is key to maintaining and improving the quality of aquatic ecosystems.

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