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Selected Measurement Parameters of Water Quality: Comparative Insight of India and Indonesia

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ABSTRACT

A number of rivers in India and Indonesia are usually used by the people to fulfill their daily needs. To ensure the quality of river water is in reasonable limit, it is important to monitor water quality regularly. The objective of this study was to review and compare the selection of water quality monitoring parameters in India and Indonesia. The used method was descriptive analyses. The results of the study showed several findings: *first*, in terms of regulation, India was lesser than that of Indonesia; *second*, India used the water quality index to assess the state of water quality, while Indonesia used the STORET method or the water pollution index; *third*, India had legally stipulated the main parameters in considering the status of water quality, whereas Indonesia had yet to stipulate it; and *forth*, there were 10 water quality parameters that were often used in both India and Indonesia, namely pH, BOD, COD, DO, nitrate, phosphate, temperature, TDS, TSS, and total coliform. Therefore, these parameters should be selected as the key parameters to monitor water quality.

KEYWORDS

Parameter
Water Quality
India
Indonesia
Water Pollution

1. Introduction

Population growth and economic development can lead to an increasing natural resource use, especially water, and increasing human waste (Vuuren & Bouwman, 2005; Miller & Spoolman, 2018). This also occurs in India as developing country with the second largest population in the world (Ahmad *et al*., 2020). River in India, especially the Ganga River, has a very important role as water resource to meet human daily needs and become the center of Hindu culture so that many religious activities are carried out on the river (Kesari et al., 2021). On the contrary, that river faces serious water pollution due to the waste of human activities such as domestic, industry and agriculture that are directly discarded into river without treatment (Siddiqui and Pandey, 2019;Dixit *et al*., 2017).

Similar condition also happens in Indonesia in which most waste from human activities is directly dumped into rivers, causing river pollution. This can be seen of the water pollution in Bengawan Solo River (Lusiana *et al*., 2022) because of population growth, economic activity and industrial activities (Setyaningrum & Agustina, 2020). Furthermore, in few parts of Bengawan Solo river bank were occupied by people for house, garden, ricefield and factory (Santoso, Sudargono & Rahmawati, 2020). On the other hand, that river is usually used by the local people as drinking water resource, industry, agriculture and filling wells in the watershed (Kusumastuti *et al.*, 2021). To ensure the river water is safe and does not treaten human health, it is necessary to monitor water quality regularly and continuously using parameters that have been determined by each country.

The selection of correct parameters will determine the state of the water quality being measured whether it is in accordance with reality or not. With the variety of parameters available to measure water quality, a critical review is needed to discuss the selection of water quality parameters in terms of accuracy, costs, and practicality in photographing water quality.

The purpose of this paper is to review and compare the selected measurement parameters of water quality carried out by India and Indonesia in order to conclude which parameters the most

appropriate are. In addition, the analysis of the selection of water quality parameters could be the recommendation for the Indonesian government in determining the appropriate parameters in terms of socio-economic and environmental aspects. The main reasons for selecting India and Indonesia as the case studies in this article are: 1) both are developing countries with large populations and using river as water resource to meet their needs; 2) both countries have the same tropical climate so that river ecosystem has similarity; and 3) India and Indonesia have the similar primary cause of river pollution such as domestic, industry and agriculture.

2. Method

This study is a descriptive study using secondary data. It will use comparative approach to analyse this research by comparing the parameters of water quality monitoring carried out in India and in Indonesia.

There are several systematic steps that will be used to produce the appropriate recommendation in the selection of water quality parameters, namely: 1) finding the latest articles that meet the criteria for the research topic; 2) conducting a critical review of the article to find out the new things that may have an important role in the development of science; 3) discussing the results of the journal reviews by comparing cases in India and Indonesia with an emphasis on the water quality monitoring parameter variables selected by each country, the used method to conclude the state of water quality, the minimum parameters in calculating the water quality index. These variables will be analyzed in terms of the accuracy and practically in use, and the costs incurred; and 4) concluding the best parameters that will be likely opted in water quality monitoring.

3. Results

3. 1. Types of water quality monitoring parameters in India

The physico-chemical and biological parameters in India are regulated by the Central Pollution Control Board (CPCB) which stipulates 32 main physico-chemical parameters and 1 biological parameter that can be used to measure water quality. 32 physico-chemical parameters such as conductivity, TDS (total dissolved solids), ammonia (NH3), arsenic, barium, odor, iron, BOD (biochemical oxygen demand), boron, calcium hardness, detergent, DO (dissolved oxygen), phenol, fluoride, cadmium, total hardness, chloride, chromium, magnesium hardness, manganese, mercury, nitrate, pH, taste, salenium, zinc, cyanide, sodium, sulfate, copper, lead, color. Meanwhile, the used biological parameter is total coliform. The results of water quality monitoring are used to determine the water usage.

According to the standard of CPCB, the designation of water usage in India is classified into 5 classes, namely: 1) class A for drinking water resources without conventional treatment, but after disinfected; 2) class B for bathing outside; 3) class C for drinking water sources with treatment and disinfectant; 4) class D for animal husbandry and fishery; and 5) class E for irrigation, industrial refrigeration and controlled waste disposal. There are 4 primary parameters that must be used in determining the class of water use such as BOD, DO, pH, and total coliforms.

Practically, the implementation of water quality monitoring in India mostly uses physico-chemical parameters, but to ensure that the monitored water is safe for human health and other living things, the calculation of toxic microcystisns (MC) that produce cyanobacteria is used as a bioindicator approach (Kesari *et al*., 2021). Furthermore, previous studies have proven that cyanobacteria can be used as a major bioindicator of water pollution worldwide (Casero *et al*., 2019; Mateo *et al*., 2015); Therefore, the presence of MC in river water can be applied to predict the trophic status of river water.

Fig. 1. A Landscape of Ganga River from Prayagraj to Varanasi (Uttar Pardesh), India
Source: Kesari *et al*., 2021

In terms of water quality monitoring in Ganga River conducted by Kesari et al. (2021), 15 physico-chemical parameters and 7 biological parameters were selected. Those physico-chemical parameters include temperature, pH, conductivity, TSS, TDS, hardness, alkaline, iron, nitrate, COD, phosphate, sulfate, chlorine, DO and BOD. While the 7 biological parameters are transparency, algal cell concentration, algal cell density, total coliform, fecal coliform, chlorophyll-a, productivity (air community structure: gross productivity/GP and net primary productivity/NPP). The allowable value of each parameter to be consumed in India is based on the guidelines for drinking water safety standards of CPCB. The results of measuring the water quality of Ganga River in the Prayagraj in 2017 and 2018 are illustrated in Table 1 below.

Table 1. Results of water quality monitoring in river Ganga

Parameters	2017	2018	Allowable value of CPCB
Physico-chemistry			
Temperature (^{o}C)	28-30	25-27	-
pH	7,3-7,8	7,5-7,9	6,5-8,5
Conductivity (mho/cm)	293-402	191-375	300
TSS (mg/L)	62-142	78-167	-
TDS (mg/L)	257-309	209-294	-
hardness (mg/L)	194-313	192-290	600
Alkaline (mg/L)	128-197	122-184	120
Iron (mg/L)	0,152-0,218	0,130-0,215	1,0

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Parameters	2017	2018	Allowable value of CPCB
NO_3_N (mg/L)	2,84-4,56	2,52-3,25	-
COD (mg/L)	32,8-54,3	30,7-42,5	-
Phosphate (mg/L)	1,21-1,78	0,92-1,47	-
Sulfate (mg/L)	37,4-49,0	32,3-46,0	400
chlorine (mg/L)	65-104	32,3-46	1000
DO (mg/L)	6,7-8,0	7,2-8,2	>4
BOD (mg/L)	3,9-4,9	3,2-4,0	-
Biology			
Transparenc (m)	0,35-0,48	0,42-0,62	-
Algal cell concentration (cells/mL)x10^3	8,1-10,7	3,1-9,2	-
Algal cell density (mg/L)	20,6-28,4	12,3-19,2	-
Total coliform (MPN/100mL) x10^3	8,2-11,3	5,3-8,4	-
Fecal coliform (MPN/100mL) x10^3	4,0-7,2	3,1-4,4	-
Chlorophyll-a (mg/L)x10^{-2}	1,30-1,74	0,84-1,21	-
Productivity (mgO_2/m^2/24h)	GP: 19,3-30,8 NPP: 9,5-12,7	GP: 18,5-29,3 NPP: 9,7-16,9	-

Source: Kesari *et al.*, 2021,

Giving illustration the state of water quality in Ganga River, the water quality index (WQI) is selected as a method of drawing conclusions based on the standards of the National Sanitation Foundation WQI (NSFWQI) (Kamboj & Kamboj, 2019). 8 parameters were used in determining WQI along with the value of each factor as shown in Table 2.2 below.

Tabel 2. Parameters and value factors in determining WQI

Parameters	Factor Value
DO	0,18
Fecal coliform	0,17
pH	0,12
BOD	0,12
Temperature	0,11
NO3_N	0,11
Phosphate	0,11
TDS	0,08

Source: Kesari *et al.*, 2021,

WQI is calculated of each parameter with the formula (1) below:

$$WQI_{NFS} = \sum_{k=1}^{n} WkQk \quad (1)$$

n = water quality parameters; Qk = k value of water quality parameters; Wi = k factor value of water quality parameters.

Calculations of each parameter are summed to obtain the total WQI. The WQI value can describe water quality with the following classifications: 1) very good: 90-100; 2) good: 70-90; 3) medium/medium: 50-70; 4) bad: 25-50; and 4) very bad: 0-25.

The results of the WQI calculation of Ganga River conducted by Kesari, *et al*., (2021) in Prayagraj showed that in 2017 the river water quality was in the poor category with a WQI score of 46.31, and in 2018 the river water quality was classified as medium with a WQI score. 50.66. This means that water is in the bad category and medium for drinking or bathing purposes so that the poor or medium class is suitable for transportation and irrigation activities.

In the study of MC as a bioindicator of water pollution in Ganga River, it was shown that MC production was sensitive to several physico-chemical parameters, including light intensity, temperature, rainfall, pH, iron, nitrogen, and phosphate (Kaebernick and Neilan 2001; Wagner *et al*., (2019). Other studies have also revealed that physico-chemical factors directly or indirectly affect cell growth and MC generation in water bodies (Bouaicha *et al*., 2019). The findings in water

quality monitoring of the Ganges show that MC is toxic so that the presence of MC in the water can be used as a new parameter in WQI calculations and to plan a strategy for restoration of the Ganges River (Kesari *et al.*, 2021).

3. 2. Types of water quality monitoring parameters in Indonesia

The parameters stipulated in water quality monitoring in Indonesia are regulated by Governmental Regulation (PP) Number 82 of 2001 concerning Water Quality Management and Water Pollution Control. There are 42 physico-chemical parameters, namely: temperature, TDS, TSS, pH, BOD, COD, DO, , nitrate, total phosphate as PNH3_N, arsenic, cobalt, boron, barium, cadmium, selenium, chromium, lead, iron, copper, manganese, mercury, chloride, zinc, fluoride, cyanide, nitrite as N, sulfate, free chlorine, sulfur as H2S, oils and fats, detergents as MBAS, phenolic compounds, BHC, aldrin/dieldrin, chlordane, DDT, heptachlor, lindane, methoxyctor, endrin and toxaphan. While, the selected biological parameters are fecal coliform and total coliform. Moreover, Indonesia also selects radioactivity parameters such as gross-A and gross-B.

The results of water quality measuring using those parameters are presented as basic data in determining water quality standards in Indonesia. There are 4 water criteria set by the Indonesian government, namely: 1) class 1 for drinking water; 2) class 2 for water recreation facilities and infrastructure; 3) class 3 for freshwater aquaculture and animal husbandry; and 4) class 4 for irrigation.

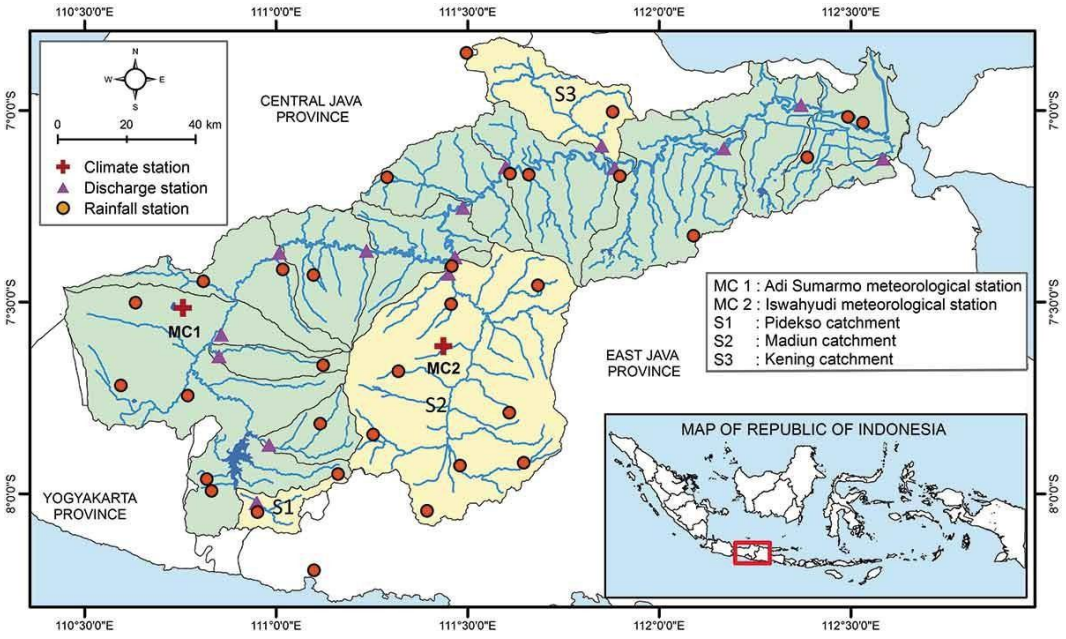

Fig. 2. A Landscape of Bengawan Solo River, Indonesia
Source: Marhaento, Booij & Ahmed (2021)

The implementation of the regulation of water quality monitoring in Indonesia has yet to fully apply all the parameters stipulated by government. This can be seen through the research conducted by Lusiana *et al*. (2022) in water quality monitoring in Bengawan Solo River that only prefers 11 physico-chemical parameters and 1 biological parameter as shown in Table 3. The data was taken from 2016-2020 by the Bengawan Solo River Basin Center (BBWS). Based on PP 82 of 2001, the allowable value of each parameter is based on the water quality standard according to the function of the river water which is determined by the central government for rivers/lakes located in 2 or more provinces, the provincial government for rivers/lakes situated in 2 or more cities/regencies, and regency/city government for rivers/lakes located in one regency/city. In the case of river that has yet to have water quality standars such as Bengawan Solo River, that water quality standar is in class 2.

Table 3. The results of water quality monitoring in Bengawan Solo River from 2016 to 2020

Parameters	Min	Max	Mean	Std.dev	Allowable value of class 2 (PP 82/2001)
Physico-chemistry					
Temperatur (^{O}C)	23,12	32	27,29	1,604	Max deviasi 3
pH	0	8,89	7,374	0,787	6-9
TDS (mg/L)	35	840	225,66	114,55	<1000
TSS (mg/L)	1	1130	83,11	146,38	<100
DO (mg/L)	0	9,74	5,833	1,839	>3
Nitrate (mg/L)	0,001	13,44	2,725	2,472	<20
Nitrite (mg/L)	0	3,8	0,254	0,421	<0,06
Ammonia (mg/L)	0	7,026	0,273	0,568	<0,50
Phosphate (mg/L)	0	2,66	0,269	0,346	<1
COD (mg/L)	4,3	441,7	21,319	28,439	<40
BOD (mg/L)	0,3	103	6,789	6,37	<6
Biology					
Total coliform ((MPN/100mL) x10^3	0	24000	553,496	2630,259	<10

Source: BBWS Bengawan Solo (2021) dalam Lusiana *et al*. (2022)

4. Discussion

4. 1. Comparison of the selection of water quality monitoring parameters in India and Indonesia

The comparison of the selection of water quality monitoring parameters in India and Indonesia is grouped into few parts. The first part contains the types of water quality measurement parameters stipulated in governmental regulations both in India and Indonesia. The second part will discuss the implementation of river water quality measurement in India and Indonesia. The third section would discuss the methods for determining the status of water quality in India and Indonesia.

4.1.1. Comparison the types of water quality parameters based on national regulation

To guarantee the consumed water meets safety standards, India and Indonesia have different approaches in determining the water quality monitoring parameters. Indonesia has regulated more water quality parameters than India. Indonesia has 46 parameters which is classified into 3 physical parameters, 39 chemical parameters, 2 biological parameters and 2 radioactivation parameters. Meanwhile, India only regulates 33 parameters including 2 physical parameters, 30 chemical parameters and 1 biological parameters.

Table 4. Comparison of water quality monitoring parameters in India and Indonesia

India (CPCB)	Indonesia (PP 82 Tahun 2001)
Physics	
TDS conductivity	*TDS* temperature, TSS
Chemistry	
ammonia (NH3), arsenic, barium, iron, boron, BOD (Biochemical Oxygen demand), detergent, DO (Dissolved Oxygen), phenol, fluoride, cadmium, chloride, chromium, manganese, mercury, nitrate, pH, salenium, zinc, cyanide, sulfate, copper, lead. odor, calcium hardness, hardness/total hardness, magnesium hardness, taste, sodium absorption ratio, color,	*ammonia (NH3), arsenic, barium, iron, boron, BOD (Biochemical Oxygen demand), detergent, DO (Dissolved Oxygen), phenol, fluoride, cadmium, chloride, chromium, manganese, mercury, nitrate, pH, salenium, zinc, cyanide, sulfate, copper, lead.* aldrin/dieldrin, sulfur as H2S, BHC, chlordane, COD, DDT, endrin, heptachlor, free chlorine, cobalt, lindane, methoxyctor, oils and fats, nitrite as N, total phosphate as P, toxaphan.

India (CPCB)	Indonesia (PP 82 Tahun 2001)
Biology	
total coliform	*total coliform* fecal coliform
Radioactivation	
–	gross-A, gross-B

Source: CPCB & PP 82 Tahun 2001

In the comparison of the selection of water quality parameters in India and Indonesia as shown in Table 4, it is clear that 2 physical parameters used by India such as TDS and conductivity, while in Indonesia uses 3 parameters, namely TDS, temperature and TSS. The most interesting points of this difference are: 1) TDS is the only physical parameter regulated in both countries; 2) conductivity may only be used in India; 3) temperature and TSS are not selected in India, but in the implementation of the water quality measurement in Ganga River by Kesari *et al.* (2021), the parameter of temperature and TSS were also selected.

Chemical parameters are the water quality parameters that have many types. However, there are differences in the number and composition of parameters used by India and Indonesia, namely: 1) 23 parameters used by the two countries such as ammonia (NH3), arsenic, barium, iron, boron, BOD, detergent, DO, phenol, fluoride, cadmium. , chloride, chromium, manganese, mercury, nitrate, pH, salenium, zinc, cyanide, sulfate, copper, lead; 2) the attracting parameter selection in India is that smell, taste and color are regulated in legistation, although human senses are only tools to measure these parameters. In Indonesia, these parameters are not mentioned in the regulations because they are general in nature and do not require artificial tools to measure them; 3) total hardness and magnesium hardness are included in the regulations in India, but it is not implemented in Indonesia. According to the research from WHO (2011), the correlation of water hardness to human health is not yet known. Although, some evidence has shown that water hardness could have an impact on human health, especially on the kidneys and liver (Mitra, Pal, & Das, 2018); and 4) 6 chemical parameters are only used in Indonesia such as aldrin/dieldrin, sulfur as H2S, BHC, chlordane, COD, DDT, endrin, heptachlor, free chlorine, cobalt, lindane, methoxyctor, oils and fats, nitrite as N, total phosphate as P, toxaphan. This evidence shows that the Indonesian government has serious attention to the impact of the use of pesticides so that the DDT parameter is recommended to be measured in monitoring water quality. In addition, oil and fat are also selected as water quality monitoring parameters because they have likely become the basic needs of Indonesia people.

The biological parameters could be the key parts that indicate the state of water quality because the presence of organisms in the water may be correlated with the aquatic ecosystem. However, the regulations in both countries, biological parameters have the least number of selected parameters in which India only adopts total coliform and Indonesia chooses 2 parameters such as total coliform and fecal coliform. With the discovery of new science, India uses cyanobacteria as bioindicators (Kesari *et al*., 2021). This finding is very important because toxic cyanobacteria can be used to increase the accuracy of quality monitoring.

In terms of the monitoring of radioactivity in the water, Indonesia is slightly more sopisticated because of including radioactivity as water quality parameters with 2 types such as gross-A and gross-B. However, the implementation of that parameter is still rarely done.

4.1.2. Comparison the implementation of water quality monitoring in India and Indonesia

In the case of measuring river water quality in India and Indonesia, there is two similarities, namely: 1) fewer parameters are selected than they should be. For example, to measure the water in Ganga River in India selected only 15 physico-chemical parameters and 7 biological parameters (Kesari *et al.*, 2021). The interesting thing of this finding is that 7 types of biological parameters are applied such as water transparency, algal cell concentration, algal cells density, total coliform,

fecal coliform, chlorophyll-a, productivity. In addition, during measuring the water quality in Ganga River, cyanobacteria were found as toxic substance. However, Indian regulations only stipulate one biological parameter, namely total coliform. This shows that the elimination of some physico-chemical parameters is replaced by the addition of new biological parameters. Almost the same as the case in Indonesia in measuring the water quality in Bengawan Solo river in which only 11 physico-chemical parameters were used of 42 parameters, while only single biological parameter was used, namely total coliform from 2 parameters recommended by the government (Lusiana *et al*., 2022). The same study was also conducted by Novianti, Zaman, & Sarminingsih (2022) in measuring the water quality in Cidurian River in West Java Province using only 11 physico-chemical parameters and 1 biological parameter. However, in other part Indonesian people use parameter of salinity to assess water quality (Ningrum & Utomo, 2020).

The difference in the implementation of water quality monitoring in both coutries that is: 1) the used parameters in India are almost twice as many as in Indonesia. This can be seen from the measurement of the water quality in Ganga River conducted by Kesari *et al.* (2021) that selected 22 parameters, while the used parameters to measure the Bengawan Solo River and Cidurian River were only 12 parameters; and 2) although the parameters chosen by the Indian are less than those recommended by the government, there are some parameters that have not been set by the government in the regulations. For example temperature, phosphate, TSS, algal cell concentration, algal cell density, chlorophyll-a, productivity and cyanobacteria. On the other hand, all parameters selected by the Indonesian are listed in governmental regulation. This shows that the Indian is probably more creative for choosing water quality parameters than Indonesia.

4.1.3. Comparison the calculation of the state of water quality

India and Indonesia have different approaches in calculating the status of water quality. India prefers the water quality index to determine the status of water quality. Based on the standard parameters of the CPCB (1992) the main parameters are selected according to the water designation. Table 5 shows that for water quality in classes A, B and C, the selected parameters are pH, DO, BOD and total coliform. Water quality in class D uses pH, DO and ammonia as primary parameters. For class E, the used parameters are slightly different from the previous classes such as using pH, conductivity, sodium absorption ratio and boron.

Table 5. Criteria of water quality parameter in India

Water Quality	Class	Criteria
Drinking water resources without conventional treatment, but after disinfection	A	1. Total coliform (mpn/100ml) ≤50 2. pH 6,5-8,5 3. DO ≥6 mg/L 4. BOD (5days 20^{O}C) ≤2 mg/L
Recreation/bathing in nature	B	1. Total coliform (mpn/100ml) ≤500 2. pH 6,5-8,5 3. DO ≥5 mg/L 4. BOD (5days 20OC) ≤3 mg/L
Sumber air minum Drinking water resources with treatment and disinfection	C	1. Total coliform (mpn/100ml) ≤5000 2. pH 6-9 3. DO ≥4 mg/L 4. BOD (5days 20OC) ≤3 mg/L
Animal husbandry and fishery	D	1. pH 6,5-8,5 2. DO ≥4 mg/L 3. Free ammonia ≤1,2 mg/L
Irrigation, industrial refrigeration, controlled sewage	E	1. pH 6,0-8,5 2. Conductivity in 25C micro mhos/cm max 2250 3. Sodium absorption ratio max 26 4. Boron max 2 mg/L
	Below E	Not meet criteria A, B, C, D dan E

Source: CPCB (2019)

Indonesia has different approach in determining the state of water quality. In the Decree of the Minister of Environment Number 115 of 2003, there are two approaches in determining the status of water quality. The first approach is the STORET method in which comparing the existing water quality data with the stipulated water quality standards. That method classifies the water quality into 4 classes, namely: class 1 (very good), class 2 (lightly polluted), class 3 (moderately polluted) and class 4 (severely polluted). The second approach is the water pollution index, namely the level of pollution relative to the allowable water quality parameters. In Indonesian regulations, no provision of what water quality parameters should be choosen so that researchers are free to select the used parameters. Although, the results of water quality monitoring are classified into 4 classes as mentioned above based on the minimum/maximum values of the measured parameters.

In the implementation of water quality assessment in Ganga River, 8 water quality parameters are selected such as DO, BOD, fecal coliform, phosphate, nitrate, pH, temperature, and TDS (Kesari *et al.*, 2021). These parameters are the main components in calculating the water quality index in Ganga River. The interesting thing about the selection of these parameters is that fecal coliform, phosphorus and temperature are parameters that have not been stipulated in Indian regulation (CPCB). In addition, in the context of assessing the river water quality as the primary source of drinking water, DO, BOD and PH are only used as parameters. Whereas, the total coliform parameter was not opted. This shows that in assessing the water quality in Ganga River, it is less compliant with applicable regulations, even though more parameters are used.

In the water quality monitoring in Indonesia, especially in Bengawan Solo River, 12 parameters are selected such as pH, TDS,temperature, ammonia, TSS, DO, nitrite, nitrate, phosphate, COD, BOD and total coliform (Lusiana *et al.*, (2022). All of these parameters are listed in the national regulations, although for the calculation of the state of water quality has not been stipulated the type of parameters should be. In case of water quality monitoring in Cidurian River conducted by Novianti, Badrus & Sarminingsih (2022) has slightly different comparing to Bengawan Solo River that is 12 paremeters are selected such as TDS, TSS, debit, pH, BOD, COD, DO, phosphate, nitrate, ammonia,detergent and fecal coliform. There are 9 similar parameters which are selected in water quality monitoring both in Bengawan Solo and Cidurian, namely: pH, TDS, TSS, BOD, COD, BO, nitrate, ammonia and phosphate. This confirms that these 9 parameters have a significant role in determining the state of water quality.

4. 2. Implementation of water quality monitoring

Ideally, all kinds of water quality monitoring parameters are implemented to obtain more accurate results in assessing the water quality. However, due to limited cost, time and effort, all parameters recommended by the government cannot be used. Therefore, it is necessary to prioritize the use of parameters without reducing the quality of result of water quality monitoring. To determine the priority, it will consider the accuracy, cost and practicality.

To measure the accuracy of each water quality parameter is not easy. However, this study will use a comparative study of the selection of used parameters by India and Indonesia. According to the comparative discussion of the selection of water quality parameters in India and Indonesia in the previous section, it can be concluded that 10 water quality parameters are often used by two countries, such as physical parameters (TDS, TSS, temperature), chemical parameters (COD, pH, BOD, DO, nitrate, phosphate), and biological parameter (total coliform). Furthermore, there are several reasons for selecting this parameter, namely: 1) these parameters are representative of 3 types of parameters such as physics, chemistry and biology: 2) BOD, DO, pH and total coliform parameters are the key parameters that apply in India in determining water quality status, especially for drinking water (CPCB, 2019); 3) nitrate and phosphate parameters are the dominant parameters that affect the trophic status of water. The results of the study show that the main sources of nitrate and phosphate come from agricultural fertilizers and untreated wastewater which causes eutrophication and the emergence of aquatic weeds (Velusamy, et al., 2021). This shows that nitrate and phosphate can be an indication of water quality; 4) changing in temperature can affect

the chemical, physical and biological processes in the water (Lai & Dzombak, 2021); and 5) COD, TDS and TSS are commonly found in wastewater and can affect water turbidity and underwater life. The importance of these parameters can be seen from the study of Maharani, Nailufhar & Sugiarti (2019) which uses COD, TSS, TDS and pH parameters in determining the wastewater quality before and after treatment.

In terms of budget of the selected water quality monitoring, in will refer to the PP Number 44 of 2014 concerning Types and Tariffs for Types of Non-Tax State Revenues (PNBP) for the Ministry of Environment and Forestry. In calculating the cost of monitoring water quality with 10 parameters requires a total cost of Rp. 867,000, -. The total coliform parameter is the most expensive parameter with the price of Rp. 210,000,-, while the cheapest parameter is the measurement of temperature and pH with each sample rate of Rp. 10,000, -. In the aspect of the location of measuring water quality parameters, some of the parameters are tested in the laboratory, while the others that can be directly tested at the location of water sampling are temperature, pH and DO. The cost per parameter and sample measurement method can be seen in Table 6.

Tabel 6. The cost of selected parameter dan method of water quality monitoring

Parameters	Cost per sample (Rp)	Method
Physics		
Suhu	10.000	In situ
TDS	58.000	Laboratorium
TSS	75.000	Laboratorium
Chemistry		
pH	10.000	In situ
BOD	170.000	Laboratorium
COD	84.000	Laboratorium
DO	42.000	In situ
Nitrate	120.000	Laboratorium
Phosphate	84.000	Laboratorium
Biology		
Total coliform	210.000	Laboratorium

Sumber: : PP Nomor 44 Tahun 2014, rewritten

5. Conclusion

The decision to select the appropriate water quality parameters based on the needs and accuracy was not easy decision. This was caused by the consideration of cost, energy and time. Both India and Indonesia had legally stipulated the types of water quality parameters which could be used. Moreover, Indonesia had more water quality parameters than that of India. Two countries had also regulated the method that could be prefered to evaluate the state of water quality as basic data of water usage.

India had legally set up the minimum types of water quality parameters in determining the status of water quality such as BOD, DO, pH and total coliform, while Indonesia had not regulated it. Two countries had similar implementation of using water quality parameters in which they used fewer parameters than the stipulated parameters by government. The paramaters that were often selected by two countries were pH, BOD, COD, DO, nitrate, phosphate, temperature, TDS, TSS, and total coliform. Therefore, these parameters could be taken into consideration in determining the minimum parameters of water quality monitoring in Indonesia so that the result of water quality was more accurate, inexpensive and easy to do.

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