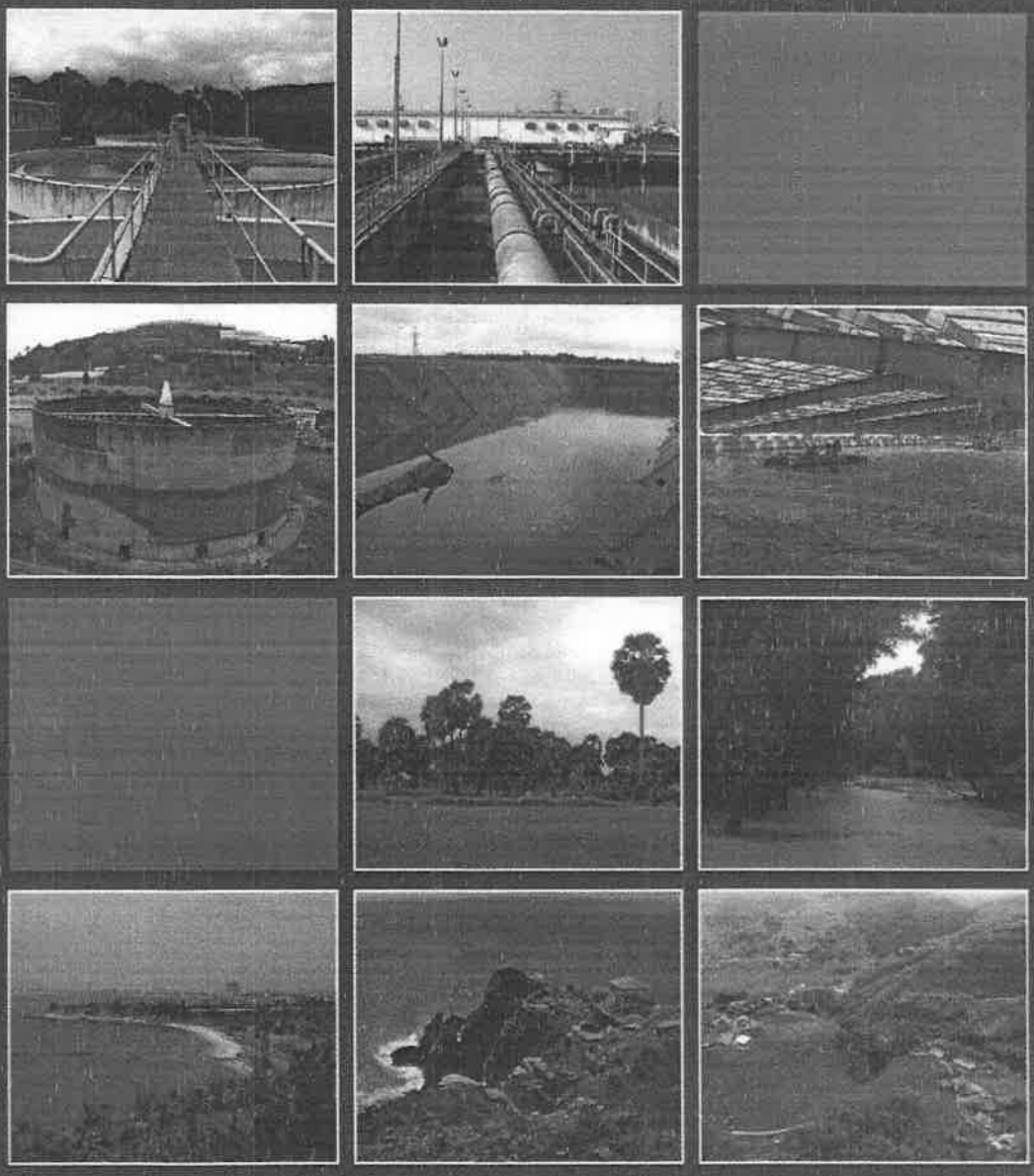
The 12th International Symposium on Southeast Asian Water Environment

PROCEEDING

28th - 30th Nov, 2016
Hanoi, Vietnam



NHÀ XUẤT BẢN XÂY DỰNG

Proceedings

of

The 12th International Symposium on Southeast Asian Water Environment

(SEAWE 12)

28 - 30 November 2016
Meliá Hotel, Hanoi, Vietnam

Organized by

National University of Civil Engineering (NUCE, Vietnam)
Research Center for Water Environment Technology (UT, Japan)
Southeast Asian Center for Water Environment Technology (AIT, Thailand)

Co-organized by

United Nations University – Institute for the Advanced Study of Sustainability (UNU-IAS, Japan)
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Industrial Activities and Its Effects to River Water Quality (Case Study Citarum, Bengawan Solo and Brantas), an Evaluation for Java Island as An Economic Corridor in Master Plan o...

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The 12th International Symposium on Southeast Asian Water Environment (SEAWE2016)
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INDUSTRIAL ACTIVITIES AND ITS EFFECTS TO RIVER WATER QUALITY (CASE STUDY CITARUM, BENGAWAN SOLO AND BRANTAS), AN EVALUATION FOR JAVA ISLAND AS AN ECONOMIC CORRIDOR IN MASTER PLAN OF ACCELERATION AND EXPANSION OF INDONESIA ECONOMIC DEVELOPMENT (MP3EI) 2011-2025

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Abstract

Java economic corridor, outlined in Masterplan of Acceleration and Expansion of Indonesia Economic Development 2011-2025 (MP3EI), is aiming for Indonesian economic growth through industry development. Being implemented in action, impacts on water resources sustainability needs to be reviewed. Carrying capacity of water resources was reviewed by analyzing river water quality, regulatory policies and its implementation in Provincial/Regency/City level. Research method was conducted by collecting secondary data, industry amount analysis, and FGD with relevant institutions. This study selected three largest watersheds in Java island, namely Citarum, Bengawan Solo and Brantas. Data shows the dominating industry in Upper Citarum is 75% textile industry and the rest varied from electroplates, chemicals, and others in smaller percentage. Discharge of wastewater has exceeded 4 times to allowable discharge. Dominating industry around Bengawan Solo are textiles 42%, food and beverages 16% and others. Brantas River has variety of industries with uniform percentage. Results showed the policies, regulation and methods of monitoring in district and city level were still inadequate so that almost the entire receiving river quality is very low. Resource and capacity of Provincial and Regency/City Level EPA, as leading institution of river water quality management, still needs significant improvement managing water quality environment.

Keywords: Citarum, Bengawan Solo, Brantas, MP3EI, river, industry

INTRODUCTION

In implementing the concept of sustainable development on national scale economic growth targets, environmental assessment from industrial activities should be included as their role as main player in economic sector. Otherwise it will increase the risk of negative implications on the disturbance of carrying capacity of the environment.

Indonesian government regulation, which is documented on Master Plan Percepatan dan Perluasan Pengembangan Ekonomi Indonesia 2011 – 2025 (MP3EI; Master Plan of Acceleration and Expansion of Indonesia Economic Development 2011 – 2025) is aiming ambitiously to place Indonesia in the global economic map as a developing country. This aims Indonesia's GDP to reach U$D 14,250 – 15,500. To achieve the objectives, economic growth is intended to accelerate to 6.4 – 7.5% with lower inflation rate in 3% by the end of 2014. One of the three mission in the document states the increasing and expantion of value chain in industrial production, and also increase efficiency of distribution chain. This target can be achieved by creating local economic activity, which implicates on the increasing regional economy, either provincial or district[1].

Preconditions and best practices basic concept of MP3EI is on food security, water resource sustainability, and energy regulation sectors. It mentions prerequisites of water resource sustainability is not only focusing on infrastructure development, but also actions such as:

1. Government ensures accessibility and existence of clean water to all groups and public.
2. Regulating clean water by water resource monitoring to ensure continuity
3. Regulating the forest in order to sustain water catchment area.
4. Local government (province and district) should put a role to allocate forest area in certain percentage of the total area.

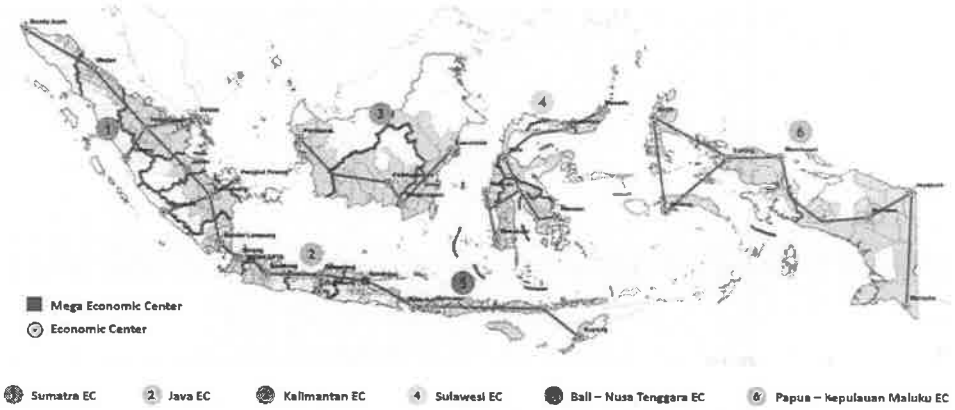


Figure 1. Economic corridor segmentation in MP3EI document
(Source: Coordinating Ministry of Economic Affairs, 2011)

The development themes of each corridor in the acceleration and expansion of economic development are segmented regionally (**Figure 1**), as Java Economic Corridor is themed as a "Driver for National Industry and Service Provision" with 2 Mega Economic Center in it. In reviewing MP3EI concept, implementation, and implication on carrying capacity of the environment, the challenge is on several problems as follows:

- Unintegrated actions on economic activities to water and environment conservation.
- Regulation on environmental sector has not yet included in the document
- Not all the stakeholders have been stated and coordinated explicitly in the document

Environment and heavy metal pollution is one of the risks in economic and infrastructure development. This will implicate on significant environmental disturbance permanently in water body system, which takes effect on the environmental quality and ecology degradation (Roosmini, 2011, 2013). Having high amount of heavy metals in the riverbed and watershed, this phenomenon may turn public water utility from drinkable clean water to having high risk on public health non-useable water. Heavy metal is not only dangerous pollutants regarding its persistency, bioaccumulation, bio-concentration, and degradability, but also it will create complex compounds with organics and inorganics though adsorbtion and other processes [2][3][4].

Having its ability harming the environment and the ecosystem in general, river pollution is a very serious problem to be addressed. Efforts from industry sector and related agencies to reduce pollution caused by waste from industrial activities is targeted to improve performance of their Wastewater Treatment Plant (WWTP) and to reduce/eliminate expected pollutant concentrations. The declining quality of surface water (rivers and reservoirs) have been perceived by the industry along with the development and the number of industry discharging wastewater into the river[5]

MATERIALS AND METHOD

In this research, the three largest watershed were chosen to represent three biggest provinces in Java Island, namely Citarum, Bengawan Solo, and Brantas, which flows in the west, center, and east part of the island. Citarum flows from the upstream area in the district of Bandung to the Bekasi District in the area of West Java. Bengawan Solo river basin flow across two provinces from Central Java and the downstream in the area of East Java, while Brantas flows in the administrative region of East Java Province. Correlation between Java Economic Corridor and watershed area maps is displayed in **Figure 2**, which includes several industrial activities.

The research method was to collect secondary data and number of industries representing three largest provinces in Java, an inventory of laws and policies and FGD to relevant institutions. In this study, selected three largest watershed/river in Java Island, namely Citarum representing West Java, Bengawan Solo representing Central Java and Brantas for East Java.

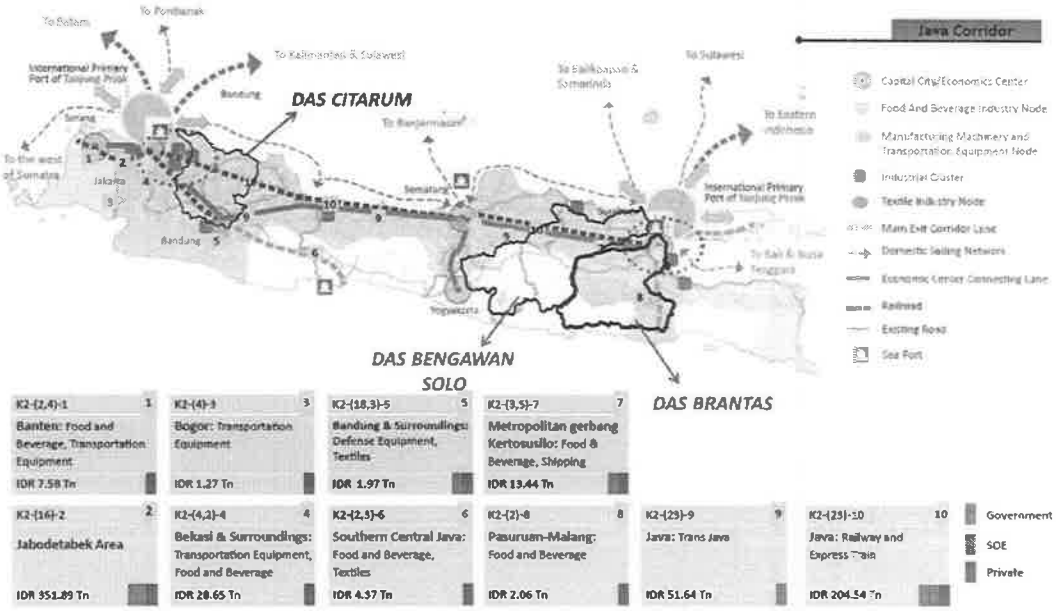


Figure 2. Overlayed watershed and Java Economic Corridor map.
(Analyzed from Coordinating Ministry of Economic Affairs and Provincial State EPA, 2011)

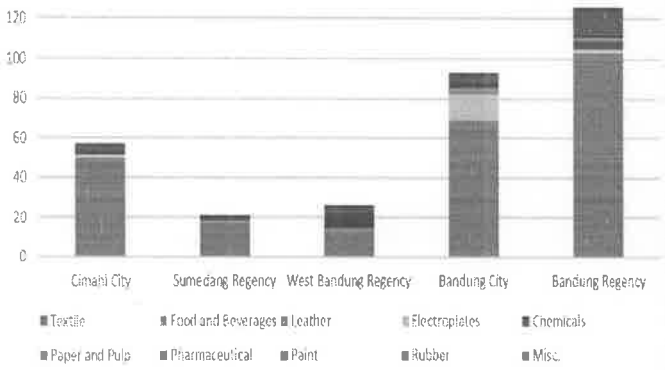
RESULTS AND DISCUSSION

Citarum River

Citarum river flows from Wayang Mountain, southern area of Bandung City, and the estuary is to the Java Sea. Having the length of 297 kms, Citarum riverbank is the longest and biggest watershed in West Java area. Citarum riverbank has a very important role for public's social and economy, especially for communities in West Java and Jakarta. Water from the river is widely used as water source, irrigation, agriculture, fisheries, industry, and water-based energy production for Java and Bali Island. However, Citarum River has been declared as the most polluted rivers in the world. Industrial sector uncontrolled development increases the risk of industrial sewage discharged into the river, especially in the Upper Citarum River segment. Several activities around Upper Citarum River implied producing waste containing heavy metals, such as the textile industry, iron, steel, pharmaceutical, and paper, which production process involves cadmium, chromium, copper, zinc and other heavy metal[6]. In 2001, there are

approximately 400 industries discharges waste water into the Citarum River. Industrial activity along the Upper Citarum River **(Table 1)** area affecting water quality that is not in accordance with relevant regulation, creating a possible condition that even if the entire industrial effluent meets quality standards, the concentration of those heavy metals in several locations will remain exceeding the standard. Industrial areas in the Majalaya District is one of the main pollution cause to downstream section [7][8].

Table 1 Industry type discharging waste water into Citarum River



Industry Type	Total	Percentage
Textile	238	74%
Food and Beverages	13	4%
Leather	3	1%
Electroplates	16	5%
Chemicals	5	2%
Paper and Pulp	5	2%
Pharmaceutical	7	2%
Paint	4	1%
Rubber	2	1%
Misc.	30	9%

(Source: West Java EPA, 2014)

Industrial waste water will affect the environmental quality of the Citarum River as receiving waterbody. Water quality changes that occur in the Citarum River is monitored at several monitoring stations. One sampling site monitored by West Java EPA (*BPLHD Provinsi Jawa Barat*), Koyod Bridge (**Table 2**), located in Rancakusumba Village, Bandung Regency. The location in affected by activities in Wangisagara, Paseh, Ibun and Majalaya District, where there are 3 geothermal industry and lots of activities in agriculture, animal husbandry, and textile industries.

Table 2 Average water quality in Koyod Monitoring Point in 2011 – 2014

PARAMETERS	Unit	Standard	Avg (2011 - 2014)	PARAMETERS	Unit	Standard	Avg (2011 - 2014)
Physical				Oil and Grease	mg/L	1000	2382
Conducticity	umhos/cm		549.39	Nitrate (NO3-N)	µg/L	10	11.0785
Temperature	C		26.59	Nitrite (NO2-N)	mg/L	0.06	0.1456
TDS	mg/L	1000	591.1525	DO	mg/L	4	3.341
TSS	mg/L	50	117.5515	pH	-	6 - 9	8.1575
Chemical				Zinc (Zn)	mg/L	0.05	0.109
Ammonia (NH3-N)	mg/L	-	5.104875	Mercury (Hg)	mg/L	0.002	0.00001
Iron (Fe)	mg/L	-	1.503	Sulphate (SO4)	mg/L	-	73.249
Surfactant (MBAS)	µg/L	200	311.508	Copper (Cu)	mg/L	0.02	0.024
Phenol	µg/L	1	20.91	Lead (Pb)	mg/L	0.03	0.079
Total Phosphate (PO4)	mg/L	0.2	0.3815	Arsenic (Ar)	mg/L	1	0.00079
Cadmium (Cd)	mg/L	0.01	0.0144	Cyanide (CN)	mg/L	0.02	0.0315
BOD	mg/L	3	58.417	Chlorin (Cl2)	mg/L	0.03	0.0925
COD	mg/L	25	166.167	Sulfide (H2S)	mg/L	0.002	0.18345
Chromium VI (Cr6+)	mg/L	0.05	0.107	**Biological**			
Manganese (Mn)	mg/L	-	0.274	Fecal coli	/100 mL	1000	624948
				Total Coli	/100 mL	5000	27794325

(Source: West Java EPA, 2011 – 2014)

Average measurements in **Table 2** shows that 17 of the 30 parameters exceeded the quality standard (shown in yellow) are listed on the water quality of class B; C; D West Java Regional Regulation No. 39 Year 2000 and Government Regulation No. 82 Year 2001. Several exceeding parameters in the tables are heavy metal that can harm the environment and quality of Citarum

River, such as zinc, mercury, copper, lead, cyanide, hexavalent chromium, and cadmium.

Bengawan Solo River

Several regular monitoring points in Bengawan Solo River is spotted in 5 locations as follows:

1. Waduk Gajah Mungkur Outlet Bridge, Wonogiri (Point BS-1)
2. Taman Jurug Bridge, Solo (Point BS-2)
3. Ngringgo Palur Village Road, Kabupaten Karanganyar (Point BS-3)
4. Kiwonan Bridge, Dusun Pilang, Kecamatan Masaran, Kabupaten Sragen (Point BS-4)
5. Gawan Village Bridge, Kecamatan Tanon, Kabupaten Sragen (Point BS-5)

Based on Central Java EPA, type of industry (**Figure 3**) at the most is the textile industry, as much as 41.5%. The textile industry in this area there are several types, such as the garment industry, activities of dyeing, spinning fabric and batik industry.

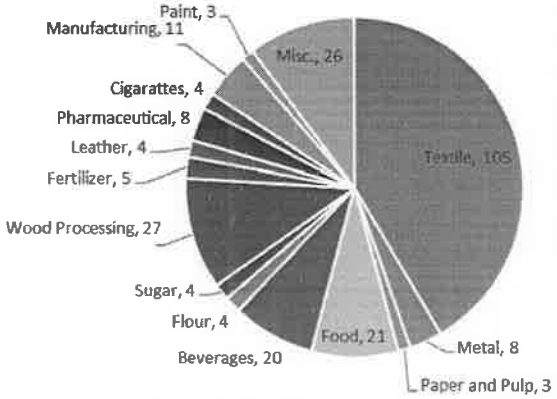


Figure 3 East Java EPA monitoring points in Bengawan Solo and surrounding industry type (Source: Center Java EPA, 2014)

Central Java EPA monitoring data showed that during 2009 - 2015 BOD & COD were always exceeded water quality standard Class II on Government Regulation No. 82 in 2001. In **Figure 4** it can be seen that the comparison fluctuating value between BOD and COD in river water. The high value of BOD / COD ratio showed high content of biodegradable chemical substances which may be caused by organic matter from floating fishnet cages and domestic activities. The figure shows in dry season non-biodegradable substances are higher than the biodegradeables.

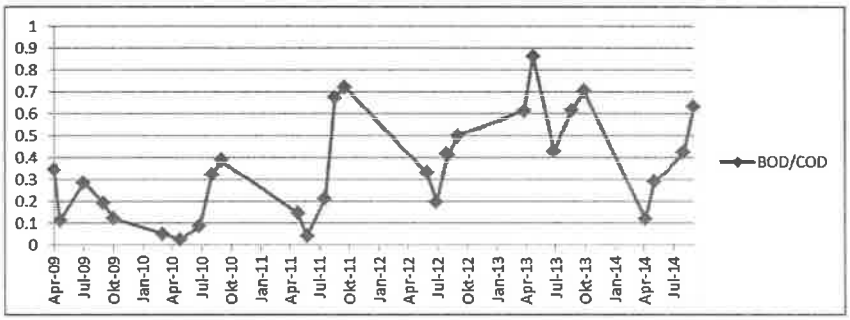


Figure 4 BOD/COD value on Gajah Mungkur Dam Outlet (Analyzed from Central Java EPA Data)

Chromium is measured by monitoring activities at the point of BS-3 (**Figure 5**) shows the content of which is still under water quality class II, which is 0.05 mg / L. Based on data from BLH Central Java province, dominating industry type (**Figure 3**) is textile industry with percentage of 41.5%. Textile industries in this area, such as the garment industry, activities of dyeing, spinning fabric and batik industry.

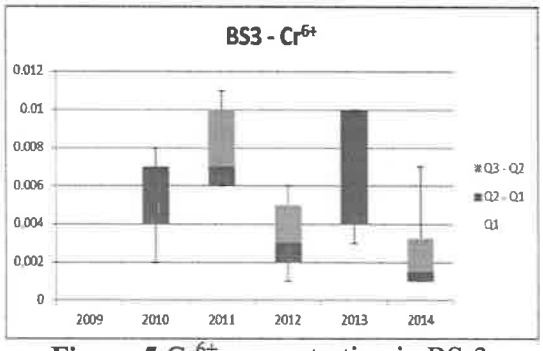


Figure 5 Cr^{6+} concentration in BS-3
(Analyzed from Central Java EPA)

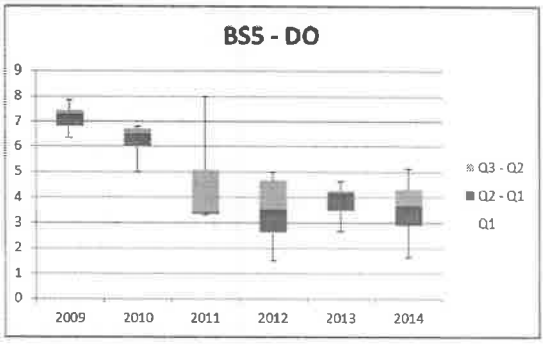


Figure 6. DO concentration in BS-5
(Analyzed from Central Java EPA)

As shown in **Figure 6,** DO at BS-5 has decreasing trend. BS-5 is the point of the last observation prior to the segment Bengawal Solo River in Central Java province. The decreasing water quality must be considered as it would involve the work of the two institutions, Central and East Java EPA. Management of the river in terms of water quality between the two provinces work area should be well regulated in order to maintain quality of the River.

Bengawan Solo River has an important role as water source for industries, but based on the data BLH Central Java province, only 10 of 295 industries Bengawan Solo River basin that have permits to acquire water from the river Bengawan Solo. In 2014, water uptake is higher than wastewater discharged (shown in **Table 3**) in Bengawan Solo River with the difference in value of 71664.5 m3 / day. This suggests high amount of industrial water requirement from Bengawan Solo River. Based on available data, the highest requirement was in Sukoharjo and the least was zero requirement in Sragen, Wonogiri, and Surakarta, due to unavailability of data. Moreover, accessible complete data Central Java EPA data was only on specific industries, especially after listed as National or Regional PROPER industry.

Table 3 Water uptake & wastewater industry permit in Bengawan Solo, Central Java segment

Regency/City	Water Uptake Permit (m^3/day)	Wastewater Discharge Permit (m^3/day)	Actual Discharge (m^3/day)
Boyolali Regency	2007.587	350	1905.31
Karanganyar Reg.	1100	0	9400.45
Klaten Regency	5000	0	19446
Sragen Regency	0	0	360
Sukoharjo Regency	76990.9	13084	9190.7
Wonogiri Regency	0	0	0
Surakarta City	0	0	396.92
TOTAL	85098.5	13434	40699.4

(Analyzed from Central Java EPA, 2015)

Regarding wastewater quality, WWTP ownership data was not available in all the industries. Industrial WWTP was only operated in 67 industries out of 207. The other 88 did not have operating treatment plant and another 140 was not yet known their WWTP ownership.

Brantas River

Brantas Watershed was discharged by 293 industries in East Java. It is shown that most industries are in Blitar with the number of 95 industries, while the least were in Nganjuk as only two industries listed. However, according to Regency/City EPA, the least number of industry did not decrease pollution load. Brantas River water quality is still influenced by the agricultural and livestock sector. Determination of the parameters were carried out during the analysis of industrial waste water sampling performed by the institution procedure, type of industry, and Regulations available. Regulations for Brantas watershed area is East Java Governmental Regulation No. 72 in 2013, which additional points in Governor Regulation No. 52 in 2013 as is it the same as effluent standards issued by Ministry of Environment. From the monitoring data from East Java Province EPA, compliance with effluent standards by industries also vary from each region (**Table 6**).

Having a focused group discussion of all the Regional/City Level EPA, the exceeding effluent quality exceeding prior to the standards caused by several factors, including the limited funds of the industry to manage wastewater, high operational costs for the procurement and operation of the WWTP, the limited resource of technicians to manage operational WWTP, and also lack of supervision conducted to the industry by the government.

Table 6 Waste water quality compliance to effluent standards by industries in Brantas Watershed

Regency/City	Wastewater quality discharge VS standard regulation parameter		
	Meet the standard		Exceeded
	Checklist	Percentage	
Mojokerto City			√
Lamongan Reg.	√	90%	
Kediri Reg.			√
Kediri City			√
Blitar Reg.			√
Blitar City			√
Malang Reg.	√	50%	
Batu City			√
Gresik Reg.			√
Nganjuk Reg.			√
Jombang Reg.	√	90%	
Surabaya City	√	70%	
Sidoarjo	√	25 - 50%	
Mojokerto			√

(Source: FGD Result)

CONCLUSION

Being stated as the polluted river in the world, Citarum river water quality was still had bad water quality, indicated by several parameters exceeding effluent standard, namely nitrite, nitrate, BOD, COD, cyanide, chlorine, sulfides, and *E. coli*. Many heavy metals were also discovered high in segments of the river, namely cadmium, chromium hexavalent, zinc, mercury, lead, and copper. Bengawan Solo River have relatively low content of heavy metals, chromium, compared to effluent standards. However, BOD and COD were found always exceeding the effluent

standard. Dissolved oxygen was also found with a downward trend. Based on the results of Focus Group Discussion, Regency/City Level EPA in East Java suggested that more than 50% of the industry did not meet regulated effluent standard.

Indonesia's ambition on economic target requires integrated coordination by several stakeholders, including environmental institution, such as Ministry of Environment (currently Ministry of Environment and Forestry), Province Level EPA, Regency/City Level EPA, National Development Agency (BAPPENAS), Management Board of River Area (BBWS), and also other organization/institution supporting and managing the main industrial activity and regulating the unwanted byproducts. As main players of the economic growth, should be managed. Sustainable development goals require integrated targets and actions including not only economic and development aspect, but also environmental aspect. Based on the data from several Province and Regency/City Level EPA in Java Economic Corridor, the exceeding effluent standard and decreasing river water qualities in rivers in Java Island monitoring points indicates that the environmental aspect has not been considered enough compared to economic aspect.

ACKNOWLEDGEMENT

This research was funded by Indonesian Ministry of Research, Technology, and Higher Education.

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