Spatial assessment of land use impacts on bio-physico-chemical parameter gradients along Blanakan River, Subang, West Java

N. D. Takarina

Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Depok, Indonesia
E-mail: noverita.dian@sci.ui.ac.id

Abstract. Blanakan River is one of the prominent river in West Java. However, the river is subject to the bio-physico-chemical parameter changes caused by surrounding land uses. Correspondingly, this study aims to develop spatial assessment of bio-physico-chemical parameter gradients along Blanakan River. In this study, bio-physico-chemical parameters including biota (fish), dissolved oxygen, pH, salinity, temperature and turbidity have been collected from 9 stations. Those stations were spatially located along river gradients from upstream, middle to downstream areas. Generally, the spatial assessment and data analysis showed a gradient in the values of the turbidity, salinity and biota. Moreover, the result confirms the significant of turbidity gradients in the river (p<0.05, F=13.95301). The mean value of turbidity is higher in the upstream (x=190.93 NTU) and lower in the downstream areas (x=90.66 NTU). Furthermore, the middle followed by downstream areas has high number of fish species from 4 family including Cichlidae, Tetraodontidae Leiognathidae and Mugilidae. The high turbidity in the upstream level is influenced by surrounding land uses, which is dominated by residential. Meanwhile, land uses in downstream are dominated by fish ponds. To conclude, the land uses gradients along Blanakan River have affected the bio-physico-chemical parameter gradients as well.

1. Introduction
For the living organisms, especially aquatic organisms, water is considered to be the vital requirements. However, growth in population and industrialization, has caused pressures to freshwater system especially river. Due to the waste discharged from the human and industrial activities, the quality of bio-physic-chemical parameters in river water has been deteriorated which affects human as well as aquatic life. For example, the dissolved oxygen in the river bodies in Tamil Nadu that receive domestic waste water can be low as 3.6 mg/l [1]. Furthermore, the turbidity of the river water near the settlements in Madhya Pradesh can be high as 178.25 NTU [2].

Besides has an effect on physico and chemical parameters, the land use also has deteriorated effect on river organism. For example, the fish collected from the polluted Gangga River showing pollutant-induced oxidative stress [3]. River pollution in Indonesia, especially in Java Island has been reported intensively. For example, rivers that flows in Jakarta city. The land uses surrounding the rivers in Jakarta city are dominated by anthropogenic activities, for instance industry and housing. As a consequence, the river systems receive numerous influx, including heavy metals [4]. Respectively, the Cr, Cu, Pb and Zn in Angke, Ciliwung, Sunter, Cakung and Bekasi rivers have exceeded the Canadian Standard for Contaminated Sediments [5].
Blanakan River in Subang city, West Java is an important river. This river provides water for every requirement. Ranging from water supply for the communities (drinking and washing), water for irrigation and fishery as well. However, the Blanakan River is also receiving growing threats, mainly from the land uses surrounding the river. Considering the vital roles of Blanakan River, hence there is an urgent need to study the land use impacts on whole bio-physico-chemical parameter gradients along the river.

2. Materials and Method
The samples were collected from 9 stations that located along Blanakan River. The sample collection activities were conducted in April 2019. The samples that collected and measured directly from the river were dissolved oxygen (DO), pH, salinity, temperature and turbidity [6]. Moreover, the fishes were collected and identified. Rainfall data are secondary data which collected from government database.

2.1. Study site
The Blanakan River is located in Subang district, West Java province. The station geocoordinates were from upstream at lat: -6.277444, long: 107.6599 (station 1) to downstream (river mouth) lat: -6.240083, long: 107.667472 (station 9) (Figure 1). The width of Blanakan River is varied from 60 m near the river mouth to 11 m in the upstream

![Figure 1. The locations of 9 stations across Blanakan River](image)

2.2. Physico-chemical parameters
The parameters including dissolved oxygen (DO), pH, salinity, temperature and turbidity were measured directly in the field. DO and temperature were measured by using DO meter, pH with pH meter, salinity with refractometer and turbidity with turbidity meter.

2.3. Biota parameters
The biota parameters were collected directly from the rivers. Those parameters were collected by using fish nets and then identified.

2.4. Spatial mapping
All the coordinates of bio-physico-chemical parameters were recorded by using GPS. GIS software was used to map the bio-physico-chemical parameters in the Blanakan River. The map of bio-physico-chemical parameters then overlayed with the Blanakan river and land use layers.
2.5. Statistical and factorial analysis
ANOVA comparison test and factorial analysis were used to analyze the differences of vio-physical-chemical parameters influenced by land uses.

3. Result and Discussion
The land uses surrounding the Blanakan River were consisted of 3 types [7]. In the downstream near the river mouth and sea (Station 7, 8, 9), the land uses were dominated by fish ponds that revegetated with mangrove. The middle parts (Station 4, 5, 6) were a transition land use from fish ponds to settlements. In the upstream, the land uses were mostly dominated by settlements and paddy fields (Station 1, 2, 3) (Figure 2).

![Figure 2. The types of land uses in Blanakan River](image)

| Family       | Species                  | Station |
|--------------|--------------------------|---------|
| Cichlidae    | Oreochromis mossambicus  | √       |
| Tetraodontidae| Arothron sp.             |         |
| Leiognathidae| Leiognathus splendens    | √       |
| Mugilidae    | Mugil dussumieri         |         |
| Synbranchidae| Monopterus albus         |         |

Table 1. The biota parameters (fish species) in Blanakan River

| Family       | Species                  | Station |
|--------------|--------------------------|---------|
| Cichlidae    | Oreochromis mossambicus  | √       |
| Tetraodontidae| Arothron sp.             |         |
| Leiognathidae| Leiognathus splendens    | √       |
| Mugilidae    | Mugil dussumieri         |         |
| Synbranchidae| Monopterus albus         |         |

: present, s: settlement/paddy field (upstream), t: transition, f: fish pond (downstream/rivermouth)

There are 5 fish species from 5 families identified in Blanakan River. Stations 4 and 6 were locations that have more fish species compared to other locations. Those stations were located at the land use transitions from fish ponds to settlements. There are several species that adapt to living in the habitat influenced by settlements. For example, Oreochromis mossambicus, which is recognized as a highly successful invader of aquatic ecosystems due to its adaptation and ability to tolerate unfavourable environmental conditions affected by anthropogenic influences [7]. Other species that living in transition habitat were Leiognathus splendens and Mugil dussumieri. Those species were marine fishes and frequently visit river [8,9]. In downstream near rivermouth, there are Monopterus albus and Arothron sp. The M. albus has habitat ranging from river to paddy field and fish pond [10], which is a common land use in downstream of Blanakan River. Meanwhile, Arothron sp. was known as a marine fish.
Figure 3 below depicts spatial model of distribution of dissolved oxygen (DO), pH, salinity, temperature and turbidity. The turbidity shows a distribution pattern that follows the patterns of landuse. The type of land uses has affected the turbidity (ANOVA test: p<0.05, F=13.95301). The high turbidity with value up to 190.93 NTU was observed in the upstream that the land uses were dominated by the settlements (Station 1, 2, 3). The reduced turbidity with value up to 90.66 NTU was observed in the downstream (Stations 7, 8, 9) near river mouth surrounded by fish ponds.

High value of salinity in the downstream was observed because the stations were located near river mouth that bordered directly with Java Sea. Conversely, the salinity in the upstream was very low because of the influence of freshwater from the land. The temperature was higher in the river mouth. This condition happens because the water in river mouth mixed with water offshore that receive constant heat from the sun.

The Figure 3 shows that DO was high near settlements which is contrast to the current literatures [11,12]. This condition may be related to the temperature parameter. The water temperature near settlements tends to be colder. Hence, the cooler water tends to bond more oxygen. The DO was also observed high near river mouth. Respectively, the river mouth has high salinity. The increase in salinity will reduce the presence of microorganism [13]. Hence, the absence of microorganism due to salinity will reduce the oxygen consumption by microorganism and raise the DO level.

The Table 2 shows the result of significant physico-chemical parameters of Blanakan River analyzed in 2dimension (factor 1 and factor 2). The significant parameters in factor 1 are pH and turbidity. Meanwhile, the significant parameters in factor 2 are salinity and temperature.

In Figure 4, it is clear that stations 1, 2 and 3 are closer to the factor 1. It means that the stations 1, 2 and 3 are influenced significantly by the turbidity and pH. The station 1-3 are located near the settlements. Hence, the settlements have contributed to the turbidity (Figure 3).
The station 4-9 are closer to the factor 2. The salinity is the significant parameters in the factor 2. This is related to the observation that locations of station 4-9 are near the river mouth that more saline (Figure 3).

### Table 2. The factor analysis of physico-chemical parameters

| Physico-chemical parameters | Factor 1 | Factor 2 |
|-----------------------------|----------|----------|
| Salinity                    | -0.547   | 0.694    |
| pH                          | 0.917    | -0.078   |
| Temp.                       | -0.09    | 0.926    |
| DO                          | 0.777    | -0.203   |
| Turbidity                   | 0.793    | -0.331   |

**Figure 4.** The model of factor analysis of land use (settlement, fish pond+mangrove, transition) impact on physico-chemical parameters in 9 stations (Sta.1,2,3,4,5,6,7,8,9) in Blanakan river. Axis x (factor 1) represents turbidity, pH and DO parameters and axis y (factor 2) represents salinity and temperature parameters.

### 4. Conclusions

This research has confirmed that the land uses can influence the bio-physico-chemical parameters. Based on the spatial model and factor analysis, this research shows that the stations located near settlements have higher turbidity values. Meanwhile, the stations located near fish pond and mangrove and transition land uses as well were less affected by settlements.

### 5. References

[1] Raja P, Amarnath A M, Elangovan R and Palanivel M 2008 *J. Environ. Biol.* 29 pp765
[2] Gupta N, Pandey P and Hussain J 2017 *Water Science* 31 pp 11
[3] Vaseem H and Banerjee T K 2016 *Environ. Monit. Assess.* 188 pp 444
[4] Takarina N D, Yasman, Sunardi and Reza A 2008 *Jurnal Kimia Lingkungan* 9 pp 153
[5] Takarina N D and Adiwibowo A 2011 *J. Coast. Dev.* 14 pp 168
[6] Takarina N D, Nurliansyah W and Wardhana W 2019 *Biodiversitas* 20 pp 171
[7] Ganie M A, Bhat M D, Khan M I, Parveen M and Balkhi M H 2013 *J. Ecol. Nat. Environ.* 5 pp 310
[8] Mote N 2017 AL-KAUNIYAH *Journal of Biology* 10 pp 26
[9] Prihatiningsih, Ratnawati P and Taufik M 2014 *Bawal* 6 pp 1
[10] Sow A Y, Ismail A, Zulkifli S Z, Azmai M N A and Hambali K 2018
    *Malayan Nature Journal* **70** pp 47
[11] Cooper S D, Lake P S, Sabater S, Melack J M and Sabo J L 2013 *Hydrobiologia* **719** pp 383
[12] Ding J, Jiang Y, Fu L, Liu Q, Peng Q and Kang M 2015 *Water* **7** pp 4427
[13] Tang X, Xie G, Shao K, Sai-Bayartu, Chen Y and Gao G 2012 *Applied and Environmental Microbiology* **78** pp 4748

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