



## Determination of pH-BOD-COD and degradation in batang arau watersheds at Padang city

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### ABSTRACT

*This research aims to determine the pH, BOD and COD in river basin region and its relation to the occurrence of damage to the environment. The study was conducted by sampling at six locations representing the upstream region, the central region and the region downstream/estuary for four years, from 2011 until 2014. The sampling locations in the watershed Batang Arau at Padang city, include Lubuk Paraku (section 1), Banyan Lubuk Kilangan (section 2), the center, Bridges Lubeg by pass (section 3), Bridge Aur Duri / Pulau Aia (section 4), downstream, Bridges Aru Padang (section 5) and Muaro Bridge Siti Nurbaya (section 6). In the Upstream, for the parameters pH, BOD and COD in 2011 to 2014 received a range of changes in pH of 6-9, unless the parameters BOD in 2012 of about 4.35 mg/L. In the central region (middlestream), namely BOD content of 4.35 mg/L (2011), 4.54 mg/L (2012), 3.36 mg/L (2013) and 2.56 mg/L (2014), approaching the quality standards was set at 3 mg/L. While the pH and COD are below the quality standards every year. In the downstream, the results of BOD of 17.21 mg/L (2011), 21.25 mg/L (2012), 5.04 mg/L (2013) and 3.42 mg/L (2014). Meanwhile, COD 47.5 mg/L (2011), 57.76 mg/L (2012), 11.17 mg/L (2013) and 20, 5 mg/L (2014), while the quality standards for COD by 25 mg/L, and pH parameters within normal limits. From this research, we reported that watersheds degradation has been in downstream area (section 5 and 6), but in upstream and middlestream was still normally and not degraded.*

**Keywords :** BOD, COD, pH, Degradation, Watersheds, Padang City

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### INTRODUCTION

The quality of life is directly related to availability and quality of water consumed. Population growth, industrial development and disordered land occupation has contributed to the worsening of the contamination and consequently the lack of preservation of surface and groundwater sources(1).

Ecosystem in which it occurs in a process of interaction between the factors biotic, abiotic and human. DAS (Daerah Aliran Sungai, Watersheds) is limited by natural barriers, such as ridges or mountains, and artificial boundaries, such as roads or embankments, where the rain water that fell in the region contributes to the flow control point (outlet). As an ecosystem, then every inputs (input) into the watershed, and ongoing processes that occur therein can be evaluated based on the output (output) of these ecosystems. Component input in the watershed ecosystem is rainfall, while the output component consists of water discharge and sediment load. DAS components in the form of vegetation, soil and canal/river in this case acts as a processor.

The relationship between land use and changes in water courses may be influenced by organic, physical, chemical and bacteriological pollution caused by urban and industrial supply, discharge of sewage and industrial effluents, and runoff in urban areas. In rural areas, these changes can result from the consumptive use of water for crop irrigation, use of pesticides and fertilizers, animal waste, deforestation, fires, and inappropriate use of techniques and procedures for management that cause soil erosion, and drainage water from rural roads(1).

Various previous research on Watershed focuses on the agronomy, irrigation, forest, water use efficiency, environmental management, human activity(2). Geographically, between urban and rural areas will have an impact on water quality of the water flow in the watershed(3). This is because the population density factor will have an impact on the environment. Similarly, the influence of patterns of agriculture also poses a risk to damage the flow of the river(4). Types of crops grown, will give a different impact on the chemical content of contaminants such as insecticides. This is due, insecticides and use of chemical substances in agriculture, is closely related to the type of crop on the farm.

In this research, the monitoring of the quality of the Watershed in Sungai Batang Arau, Padang City, for four years chemically. Monitoring is aimed to obtain information about the damage to the environment, particularly water quality within the parameters of the degree of acidity (pH), chemical oxygen demand (COD) and biochemical oxygen demand (BOD) in the Watershed along the Batang Arau.

Watersheds (DAS) Padang city has an area of 17364.22 hectares. Districts that passed is the District Lubuk Kilangan (upstream), District Lubuk Begalung (centerstream) as well as the District of South Padang and Padang District West (downstream). According BAPPEDA (Environmental Government Agencies) city of Padang, the use land in sub DAS Batang Arau is the upstream part of the protected forest and forest conversion, such as Bung Hatta Forest Park. In addition to the forest, other land use is a field/moor, abandoned land, mines and settlements.

Description of NAB (a threshold value according to government regulations PP number 82/2001) is threshold value(5). Raw threshold value is the value of the minimum allowable standards for the environment. If the number is exceeded, the NAB categorized polluted environment. Each city has a set NAB to demonstrate the level of quality of the environment, including water quality in rivers and air quality in the region. In the city of Padang, the city government under the coordination of the Environment Agency of Padang decide these standards in the form of government regulations contained in Regulation no 82/2001.

Development activities in the Batang Arau watershed areas as very intensive with high population growth as a result of the high dynamics of Padang city development. Micro economic activity, agriculture, industry, small scale industries to large industrial and mining is the backbone of the economy of the Padang city. But increasing development and economy of the desert city is estimated to have a negative effect on the environment that the increasing pollution load exposed and decline in water quality in Sungai Batang Arau from year to year.

## EXPERIMENTAL SECTION

The data used in this study is obtained from the performance results of a water sampling some rivers at Batang Arau watersheds over a period of 4 (four) years spread from 2011 to 2014. In this research we use pH meter tools and Winkler modified Method for determination BOD. Determination of COD by using Dichromate Kalium Method. This research was continuously measured at Laboratory of Environmental Government Agency, Padang city, during 2011 till 2014 (for 4 years) as shown in fig.1.



Fig. 1. Padang City map from Government of West Sumatera (a) and map of Indonesia (b)

## Materials

Water samples are collected from different location (at Padang City, as shown figure 2) in 6 (six) section of river according to Bridge (Bridge 1 location at Lubuk Paraku, Bridge 2 at Beringin, Bridge 3 at Lubug Begalung/Lubeg, Bridge 4 at Aur Duri, Bridge 5 at Seberang Padang and Bridge 6 at Siti Nurbaya). Section 1 and 2 is up stream/upper river, section 3 and 4 is middle stream section, and section 5 and 6 is downstream/lower river. pH

meter, Multimeter, stirred tank reactors, beakers different in size and capacity, digital type of balance, spatula, filter paper, oven, BOD incubator and COD reactor are used to perform this research work. Analytical grade BOD and COD reagent, and different indicator are also used for analysis.

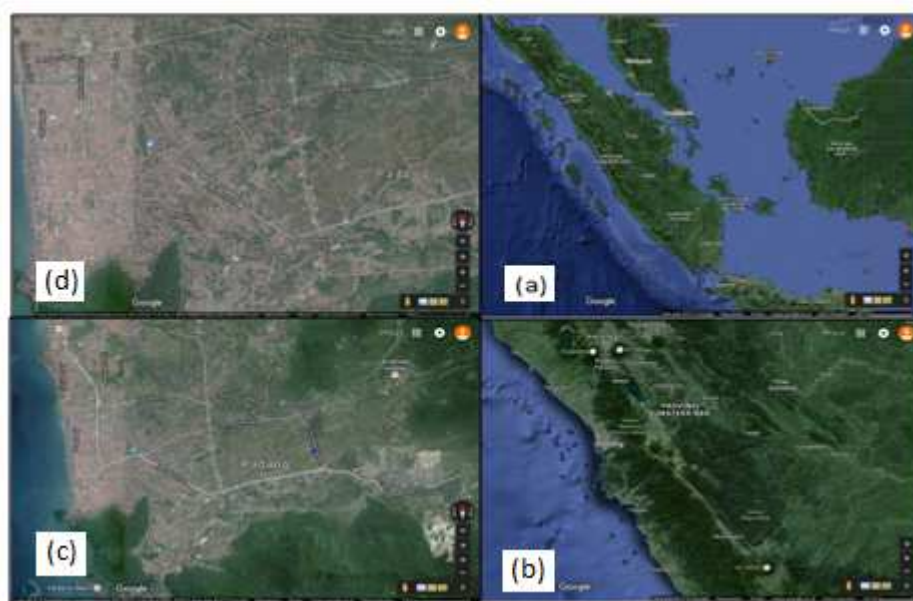


Fig. 2. Sumatera Island map from Google Earth (a), West Sumatera province from Google Earth (b), Padang City Watersheds from Google Earth (c) and (d)

## Method

### Analytical Method

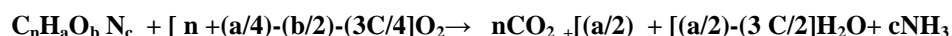
The measured parameters of water during the experiments are chemical oxygen demand (COD), biological oxygen demand (BOD), and pH. This experiment is conducted accordingly with standard methods for water analysis(1; 6; 7).

### Power Hidrogen (pH) Measurement

Most of the water having a neutral pH is average 7. pH scale measure the acidity or basicity of a solution . pH measurement is carried out by using pH meter.

### BOD and COD Measurement

Chemical oxygen demand (COD) measurement is carried out according to a given standard methods for the analysis of water. Chemical oxygen demand (COD) concentration is calculated using the following formula:



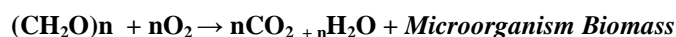
### Standard Potassium Dichromate (0.25 N)

Dissolve 12.35 g  $K_2Cr_2O_7$  at  $103^\circ C$  for 24 hour in distilled water and dilute to 1000 mL, add about 120 mg of sulphuric acid

### BOD Determination

This method consists filling an airtight BOD bottle with water completely by overflowing the sample and sealed with Para film polymer. Incubating this sealed BOD bottle in BOD incubator at specific temperature ( $20^\circ C$ ) for 5 day period. Five days biological oxygen demand (BOD) measurement is carried out according to a standard method for analysis of water, 5-days BOD test.

The process of determining through the oxidation of organic compounds by  $K_2CrO_4$  to reach 95-100 %, aerobic microorganisms in water that serves as decomposer organic material can only perform its function if there is sufficient oxygen. When the available oxygen lacking or insufficient in number, then the degradation process becomes blocked or simply to fouling because oxygen functions as a food for the organism.



The more oxygen is consumed from the waters of oxygen levels in the surrounding environment of diminishing thereby disrupting life in aquatic organisms(1; 6; 7).

## RESULTS AND DISCUSSION

### Analysis of Impaired Watersheds and Degradation Factor

Disruption to the process Watershed includes the increasingly rapid growth of settlements along the river, including the establishment of industry industry that causes water pollution. Another factor that comes from the activity in the urban population in the form of household waste and rubbish bins were swept out of the ditch water to the streams also cause disruption to the flow of rivers in urban areas.(2) This is what causes damage to watersheds in the Padang city, so the decline of the quality of their water in the parameters studied.

### Monitoring of pH, BOD and COD

By measuring the degree of acidity (pH), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) as shown in Table 1, 2, 3 and 4, visible deterioration in water quality Watershed in Batang Arau, which is marked by the decline acidity. This can be seen the degree of acidity in Section 1 and 2 representing the area Middlestream, in 2011 (6,80 and 7,80), 2012 (7.80 and 7.07), 2013 (7.18 and 7.07) and 2014 (6.50 and 6.71). While the Downstream area (section 3 and 4), also experienced a decrease in pH. Significant decline seen in section 5 and 6, in the Upstream area.

**Table 1. Batang Arau River water quality in 2011**

Watersheds sections	pH	BOD (mg/L)	COD (mg/L)	Location
Section 1	6,80	1,90	5,60	Lb.Paraku Bridge
Section 2	7,80	2,20	15,50	Beringin Bridge
Section 3	7,52	3,30	18,00	Lubeg Bridge
Section 4	7,20	5,40	20,00	Aur Duri Bridge
Section 5	8,10	14,92	45,00	Seberang Padang Bridge
Section 6	8,30	19,52	50,00	Siti Nurbaya Bridge
NAB	7-9	3	25	

*Description of NAB (a threshold value according to government regulations PP number 82/2001)*

**Table 2. Batang Arau River quality in 2012**

Watersheds sections	pH	BOD (mg/L)	COD (mg/L)	Location
Section 1	7,80	1,69	5,76	Lb.Paraku Bridge
Section 2	7,07	2,01	7,20	Beringin Bridge
Section 3	7,02	6,11	20,8	Lubeg Bridge
Section 4	6,99	2,97	7,28	Aur Duri Bridge
Section 5	6,83	15,8	40,48	Seberang Padang Bridge
Section 6	6,83	27,85	75,04	Siti Nurbaya Bridge
NAB	6-9	3	25	

*Description of NAB (a threshold value according to government regulations PP number 82/2001)*

This decrease is due on the one hand the changes in vegetation along streams, as happened in the watershed are located in the East Sahelian, West Africa. In Sahel extends east-west across Africa between the Sahara desert to the north and the humid savanna to the south. It is one of the world's largest water-limited environments (WLE). The region is often considered to be particularly vulnerable to climate change and human activities(8). At Batang Arau, population growth and community activities along the river has increased water pollution, reducing the acidity of the water.

**Table 3. Batang Arau River quality in 2013**

Watersheds sections	pH	BOD (mg/L)	COD (mg/L)	Location
Section 1	7,18	1,78	5,7	Lb.Paraku Bridge
Section 2	7,07	2,20	6,80	Beringin Bridge
Section 3	7,60	2,86	7,80	Lubeg Bridge
Section 4	7,60	3,46	8,9	Aur Duri Bridge
Section 5	7,53	3,88	10,4	Seberang Padang Bridge
Section 6	7,13	6,3	11,95	Siti Nurbaya Bridge
NAB	6-9	3	7	

*Description of NAB (a threshold value according to government regulations PP number 82/2001)(5)*

In the COD and BOD measurement, as shown in Table 1,2,3 and 4, a decrease in water quality occurs significantly in downstream areas (Downstream). This is due to increased activity of urban residents along the river and water pollution that leads to downstream watersheds.

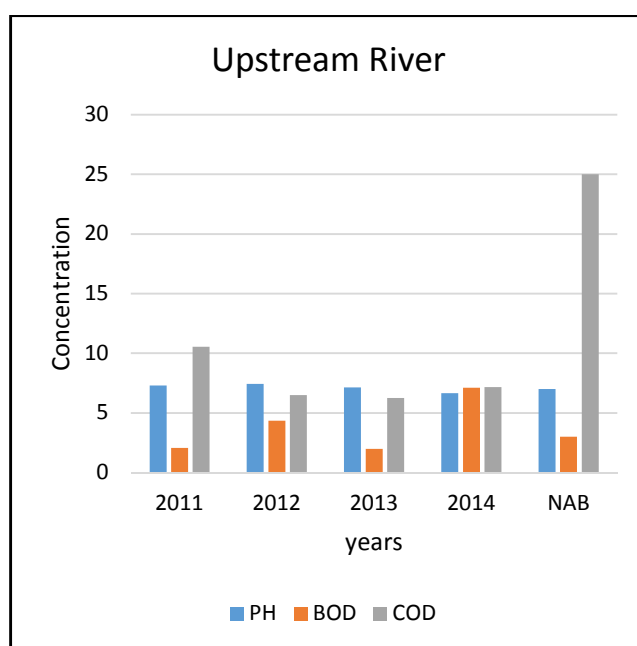
**Table 4. Batang Arau River quality in 2014**

Watersheds sections	pH	BOD (mg/L)	COD (mg/L)	Location
Section 1	6,50	< MDL	< MDL	Lb.Paraku Bridge
Section 2	6,71	< MDL	< MDL	Beringin Bridge
Section 3	7,13	2,52	4,5	Lubeg Bridge
Section 4	6,91	2,00	7,3	Aur Duri Bridge
Section 5	7,15	2,19	17,00	Seberang Padang Bridge
Section 6	7,10	4,65	24,00	Siti Nurbaya Bridge
NAB	6-9	3	25	

Description of NAB (a threshold value according to government regulations PP number 82/2001)

### River Water Quality Degradation of Batang Arau Analysis in Upstream of Watersheds

From Fig. 3, sampling points in the Upstream, in Lubuk Paraku Bridge and Banyan Bridge, for the parameters pH, BOD and COD in the local sections 1 and 2 on the upstream side respectively in the year 2011 to 2014 received a range of changes in the pH of 6- 9, while for the parameters BOD in 2012 of about 4.35 mg/L is above the water quality standard designation in accordance with PP.82/2001. As for the other years besides BOD in 2012 for the parameters BOD, COD and pH meet the quality of the river according to the criteria of the standard quality designation.



**Fig 3. Quality Degradation of Batang Arau River in the Up Stream ( section point 1 & 2 )**

The high BOD value is due to the economic activity in the agricultural sector, in the form of rice fields directly adjacent to the river Batang Arau and the frequent use of water bodies for bathing, washing and defecation, and restaurant waste products. Based on these results can be explained that the river rod arau on the upstream side has not been relegated towards polluted

### Analysis in Middlestream of Watersheds

Figure 4 the central part (sample points Lubeg Bridge and Bridge Aur Duri) river flow was also seen for the content of BOD and COD compared pH is above the quality standards which have been established in accordance with PP.No.82(5) PP / 2001 on the designation of water quality standards that year 2011 at 4.35 mg / L, 2012 of 4.54 mg / L, 2013 by 3.36 mg / L while in 2014 amounted to 2.56 mg / L, approaching the quality standards set at 3 mg / L, while the pH and COD are below the quality standards every year.

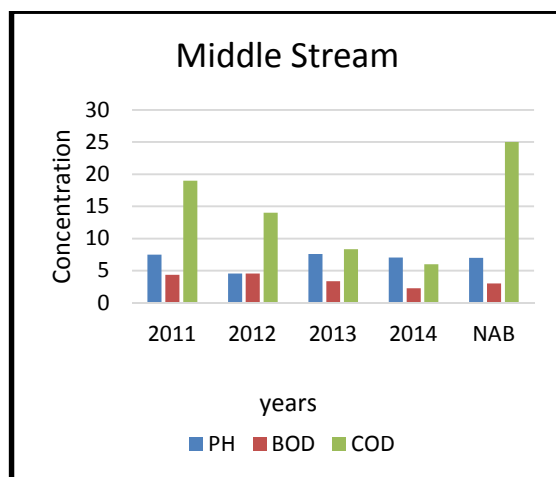


Fig 4. Quality Degradation of Batang Arau River in the Middle Stream ( section point 3 & 4 )

This is due to economic activity in the river Batang Arau and frequently used water bodies for bathing, washing and defecation, and the waste products of restaurants and activities such as leather tanning industry, rubber and liquid waste disposal housing. Based on these results can be explained that the river Batang Arau at the center began relegated towards polluted.

#### Analysis in Downstream of Watersheds

In Figure 5. The downstream (point Siti Nurbaya and Seberang Padang Bridges) Batang Arau river quality in the lower reaches of the river Batang Arau accounted quality under Regulation 82/2001 can not be used as raw material for drinking water, which in 2011 amounted to 17, 21 mg / L, 2012 amounted to 21.25 mg / L, the year 2013 was 5.04 mg / L and 2014 of 3.42 mg / L for BOD with quality standards sebesar 3 mg / L. As for COD in 2011 amounted to 47.5 mg / L, in 2012 by 57,76mg / L, in 2013 amounted to 11.17 mg / L and 2014 amounted to 20, 5 mg / L, while the quality standards for COD by 25 mg / L

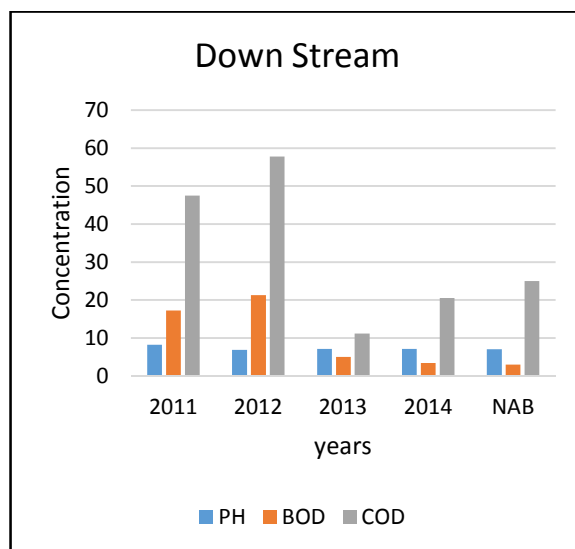


Fig 5. Quality Degradation of Batang Arau River in the Down Stream ( section point 5 & 6 )

Results of this study when compared to some relevant research results can be seen that the Batang Arau river city of Padang for COD parameter is influenced by the presence of liquid waste disposal at the company / industry, and other community activities. According to research Zul Adri (2011), the increased number of COD in river Batang Kuranji because in this area there are incoming sources of pollution such as waste workshops, residential waste and sewage hotel.(9) COD value increase caused by the disposal of waste originating from the region awoke, residential and agricultural areas are located around the river.(10)



## CONCLUSION

Observations during the four years from 2011 to 2014 against the Batang Arau Watersheds, changes in environmental quality in chemical terms, ie, pH, BOD and COD. Parameter pH, BOD and COD in the points 1 and 2 (Upper River) in 2011, 2012, 2013 and 2014 have not been subject to degradation unless parameter BOD in 2012 amounted to 4.35 mg / L exceeds the quality set at 3 mg / L according to PP 82/2001 on the designation of the river water quality.

The quality of the river in the middle for the parameters pH, BOD and COD in 2011 amounted to 4.35 mg / L, 2012 of 4.54 mg / L, 2013 by 3.36 mg / L while in 2014 amounted to 2.56 mg / L, approaching the quality standard limits set at 3 mg / L. The quality of the river downstream, in 2011 was 17.21 mg / L, 2012 is 21.25 mg / L, the year 2013 was 5.04 mg / L and 2014 was 3.42 mg / L for BOD with quality standards is 3 mg / L. As for COD in 2011 was 47.5 mg / L, the year 2012 is 57,76mg / L, the year 2013 was 11.17 mg / L and 2014 was 20, 5 mg / L, while the quality standards for COD is 25 mg / L passes through drinking water quality standard in PP / 82/2001. Based on this research, the degradation of watersheds Batang Arau occur in areas downstream, not upstream and midstream.

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