

MONITORING KUALITAS AIR SECARA *ON-LINE*: STUDI KASUS SUNGAI BRANTAS

ON-LINE WATER QUALITY MONITORING: A CASE STUDY ON BRANTAS RIVER

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Abstrak

Sebanyak 23 monitoring kualitas air secara *on-line* telah terpasang di sepanjang sungai Brantas di Jawa Timur. Konstruksi stasiun *on-line* ini telah diarahkan secara akurat, *realtime*, terprogram, dan data yang berkelanjutan atas mutu dari air sungai Brantas, seperti tingkat polusi air dapat dideteksi tepat waktu. Penempatan 23 stasiun tersebut, seperti halnya jenis parameter yang dideteksi oleh sensor di dalam stasiun, telah didasarkan pada karakteristik air sungai pada masing-masing penempatan. Dengan ini, sumber polusi air dapat dideteksi dengan lebih akurat. Parameter yang terukur meliputi pH, temperatur, konduktivitas, oksigen terlarut, kekeruhan, orthophosphate, dan amoniak.

Kata kunci : kualitas air, *on-line* monitoring, polusi air, sensor

Abstract

Twenty three on-line water quality monitoring stations have been built along Brantas river in East Java. The construction of these on-line stations has been aimed at providing accurate, real-time, programmed, and continuous data on the quality of the Brantas river water, such that the occurrence of a certain level of water pollution can be detected on time. The placement of these twenty three stations, as well as the types of parameters detected by the sensors inside the stations, has been based on the characteristics of the river water at each location. With this, the source of water pollution can be detected more accurately. The measured parameters include pH, temperature, conductivity, dissolved oxygen, turbidity, orthophosphate, and ammonia.

Keywords : on-line monitoring, sensor, water pollution, water quality

1. INTRODUCTION

The Brantas River with its tributaries is the largest river in the province of East Java with a length of 320 km. The main stream of the Brantas River flows most of the way around the Butak-Arjuno Massif located in the centre of the basin. It is joined by a number of larger tributaries, e.g. the Lesti River, the Ngrowo River, the Konto River and the Widas River. The catchment area is about 11,800 km² and 16 million people live within the catchment. The city of Malang (1,5 million) is situated in the upper catchment, whereas other large urban industrialized regencies of Sidoarjo, Mojokerto, Gresik and Surabaya (total population about 6 million) lie in the lower catchment.

The Long-term Development Phase II PJT 1994 - 2019 and Master Plan IV PJT (1997) emphasized

on the conservation and preservation of water resource as well as on the optimization of the use of water resources. Within this framework, the Indonesian Institute of Sciences (LIPI) has had a collaborative work with Verbundplan GmbH to extend the existing Water Quantity Monitoring and Flood Forecasting and Warning System (FFWS). This extension concerns with the implementation of a Water Quality Monitoring Network along Brantas River and some of its tributaries. The On-line Water Quality Monitoring Stations have been implemented as part of Brantas river water quality and pollution management on Brantas River East Java – Indonesia.

For water management and water resources development, water quality and quantity monitoring is an important issue. Water quality monitoring is required to ensure the standards and criteria set by

the government or regulatory agency for river water, with respect to specific use (e.g. drinking, industrial, irrigation etc.). A well planned and managed water quantity and quality measuring network can serve as a valuable tool for predicting shifts or trends. The objectives of the On-line Water Quality Monitoring have been defined in accordance to water use, obtaining baseline data and inventories, regulation and guideline for development, law enforcement, water quality and quantity modeling, and basis for water discharge permit development.

Furthermore, the integration of this water quality monitoring network into the existing system including collection, documentation and interpretation of relevant data is one of the main objectives of the project. Modelling of hydrological events combined with a Hydrological Information System and a Decision Support System will strengthen the development of the overall water management tasks in the Brantas River Basin. It acts as a model for the conservation of the Indonesian river basins, especially in Java. To cover the monitoring area along Brantas River, 23 On-line Water Quality Monitoring Station have been constructed. They consist of 3 different types based on the measured parameters type I (11 stations): pH, temperature, conductivity, dissolved oxygen (DO), and turbidity. Type II (7 stations): pH, temperature, conductivity, dissolved oxygen (DO) and nutrients (ammonia and orthophosphate) and type III (5 stations): pH, temperature, conductivity, dissolved oxygen (DO), turbidity, and nutrient (ammonia and orthophosphate).

The pH is a measure of the acidity or alkalinity of a sample. It functions as an indicator for chemical and biological reactions in an aquatic environment. Temperature is an influencing factor for chemical and biological reactions. Dissolved oxygen is an indicator for the river metabolism. It can be used to monitor organic as well as nutrient pollutants. The actual oxygen concentration depends on a number of factors, such as temperature, air pressure, oxygen consumption by microorganisms in a biodegradation process, oxygen production by algae, etc. The conductivity is a cumulative parameter for the ionic concentration of a solution. The higher the salt, acid or alkali contents in a solution, the greater its conductivity. It indicates the amount of dissolved material in the water column. Turbidity is an indicator for the amount of suspended solids in river water. Nutrients, ammonia and orthophosphate, are monitored to ensure the monitoring of

pollution and hydrological effects as well as eutrophication. Changes in nutrient supply for autotrophic organisms are monitored. In addition, some of the stations are equipped with pressure sensor to measure the water level.

Based on the extensive studies of the Brantas River and its tributaries, the evaluation of available historical and current data (both flow and water quality). The criterion for selection of sites has been based on the reduction of pollution load, improvement of water quality and uses the on-line data for river basin management. In view of this, the location of stations should be close to problem areas, viz. population centers and industrial zones. Most stations are located around city centers like Surabaya, Kediri or Malang where the river is burdened with both untreated domestic and industrial waste load. Ideal locations for the stations are close to point sources (with the intention of controlling emissions), metropolitan areas (public health priority) and drinking water intake points. List of the stations can be seen on the Table 1.

Table 1. Locations On-line Monitoring Station

No.	Location	Coord.	Coord.	Type	Frequ.
WQ 1	Upstream Pendem Bridge	07° 54,099'	112°34,544'	1 a	daily
WQ 2	Downstream Kendalpayak Bridge	08° 03,316'	112°37,697'	2	daily
WQ 3	Sengguruh Dam	08°10,970'	112°33,061'	3	hourly
WQ 4	Sutami Dam	08° 09,422'	112° 27,062'	2	daily
WQ 5	Selorejo Dam	07° 52,288'	112°21,322'	2	daily
WQ 6	Wlingi Dam	08° 08,533'	112° 14,905'	1	daily
WQ 7	Lodoyo Dam	08° 08,975'	112° 11,466'	1	daily
WQ 8	Downstream Tambangan Pakel	08° 03,637'	111° 58,735'	1a	daily
WQ 9	Downstream Ngujang Bridge	08°00,987'	111°55,456'	3	hourly
WQ10	Upstream Mrican Barrage	07° 45,899'	112°01,490'	1	daily
WQ 11	Downstream Cheil Jedang	07° 26,739'	112°15,429'	3	daily
WQ 12	Downstream Ajinomoto	07° 26,957'	112°26,888'	3	daily
WQ 13	Upstream Tambangan Cangu	07° 26,162'	112° 27,593'	1	daily
WQ 14	Downstream Jrebeng Bridge	07° 23,229'	112° 34,650'	2	daily
WQ 15	PDAM Krikilan	07°22,315'	112°35,590'	2	15 min.
WQ 16	Karanglo	07°22,080'	112°37,723'	1 a	hourly
WQ 17	Upstream Karangpilang Intake	07°20,902'	112°40,888'	3 a	15 min
WQ 18	PDAM Kayoon	07° 16,059'	112° 44,965'	2 a	15 min
WQ 19	PDAM Ngagel	07° 18,029'	112° 44,480'	2	15 min
WQ 20	Downstream Mangetan Gate	07° 26,601'	112° 28,103'	1	hourly
WQ 21	Upstream Kertosono Old Bridge	07°36,000'	112°06,580'	1	hourly
WQ 22	Upstream Dam Porong Canal	07° 27,165'	112° 29,014'	1	Hourly
WQ 23	Upstream Lesti Bridge	08° 13,836'	112° 41,080'	1	Hourly

As shown in Figure 1, after being stored locally in the monitoring stations the data are sent to a central remote control unit located at the Master Station Malang by means of a telemetric system. The remote control central unit is used to communicate with the monitoring stations, the data management, data storage and evaluation. From there the data are queried periodically by means of SQL commands and are transferred to the central

database (ORACLE database) located at the Master Station Malang. This is meant for a more efficient evaluation and analysis of the data as well as in connection to the data monitoring of the existing system to allow more flexibility and reliability for decision makers. The online water quality monitoring system is controlled from the Remote Control Central Unit (RCCU) located at the Master Station Malang.

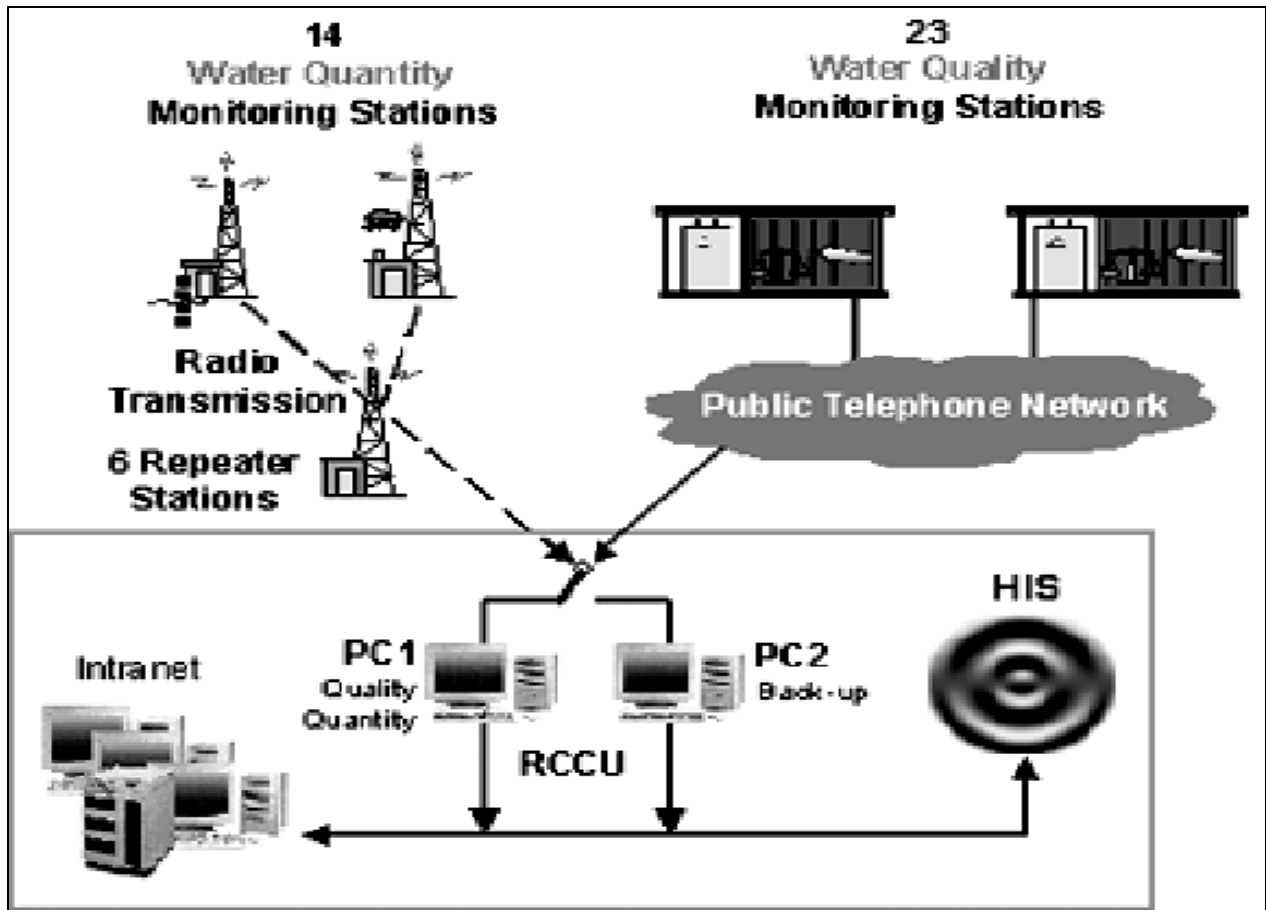


Figure 1. On-line Water Quality monitoring concept

2. DESCRIPTION OF ON-LINE WATER QUALITY MONITORING STATION

The station is equipped with the steel shelter and the adjoining building. The water quality monitoring instruments are placed in the steel shelter and all other supplementary facilities e.g. power supply, electrical cabinet and telephone modem are in the adjoining building. Personnel safety requirements and appropriate ventilation systems are included. Equipment and personal safety are given by a front door access control, a security control system and a fire detection system inside the shelter as well as in the front room. According to

the specific site conditions, an external submersible pump is installed within the river bed. A pipe connects the sample water intake with the water pipes within the shelter. The main instrumentation is an assembly of sensors to measure pH value, temperature, conductivity and dissolved oxygen concentrations of river water which are installed in a continuous flow - trough cell. A turbidity meter is mounted on the wall. A refrigerated automatic sampler is installed for reference samples in all three types. The photographs of the instrumentation can be seen in Figure 2.

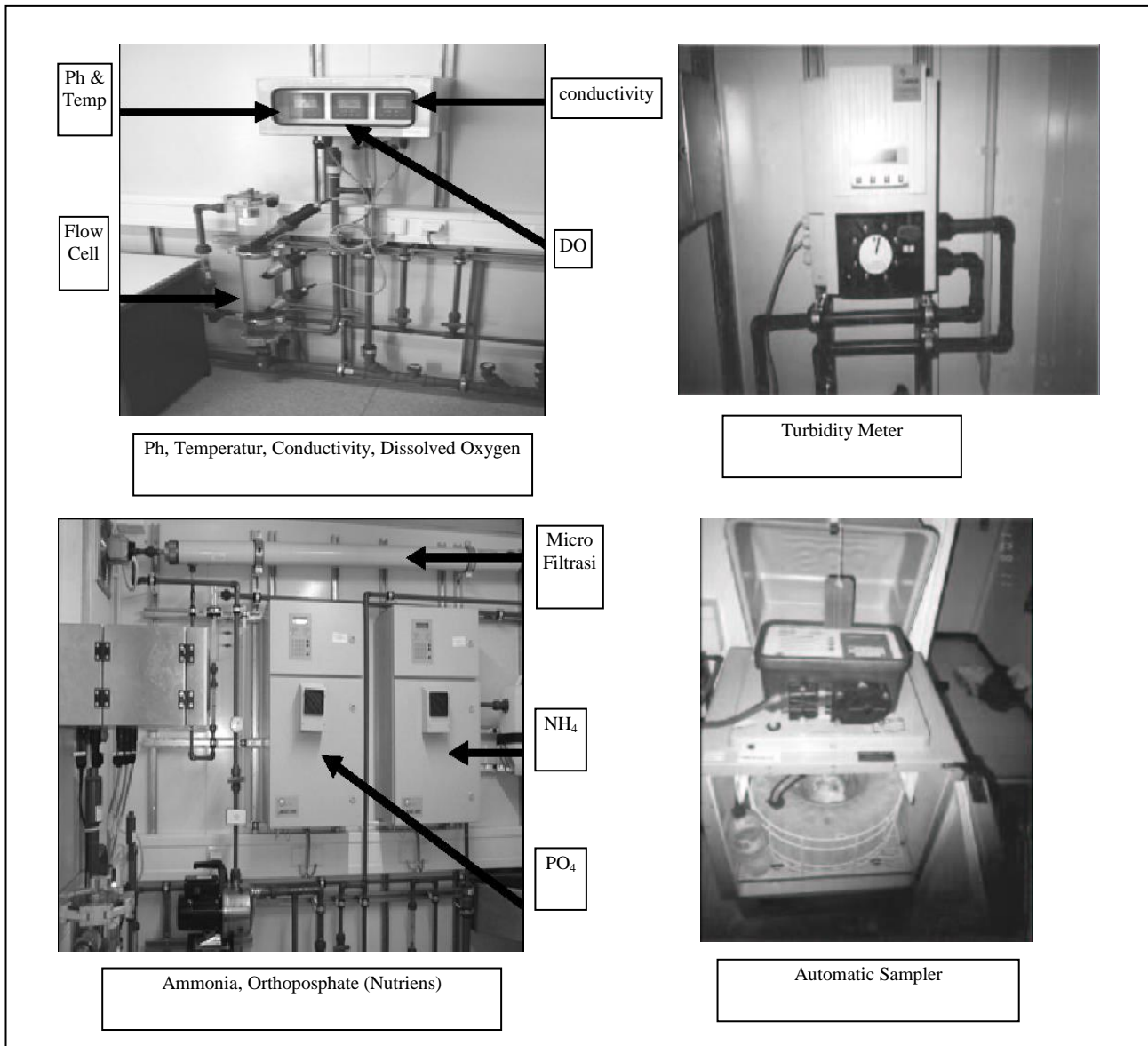


Figure 2. Monitoring Instrument inside the Station

The external submersible pump pumps the sample water directly from the river into the water pipes installed inside the shelter. The sample water supply is controlled via the control unit CU300. After the prefilter there is a by-pass to the continuous flow cell. Within the continuous flow cell the water passes through the pH, temperature, dissolved oxygen and conductivity sensors. These sensors monitor the water quality permanently. A bypass after the continuous flow cell supplies the turbidity meter with sample water. The turbidity meter measures the turbidity permanently.

Another bypass supplies the pump for microfiltration unit which maintains a constant flow rate

through the microfiltration unit. The filtered water is used to analyse the nutrients ammonia and orthophosphate at pre-set intervals. The rest of the micro-filtered water is stored in a water tank.

At the very end of the sample water pipe in the shelter the automatic sample unit takes reference samples of the pre-filtered but not micro-filtrated water. The amount and frequency of the samples can be pre-set by the operator. The water is drained out of the shelter after passing the equipment as described above. A schematic overview of the water flow in the station is shown in Figure 3.

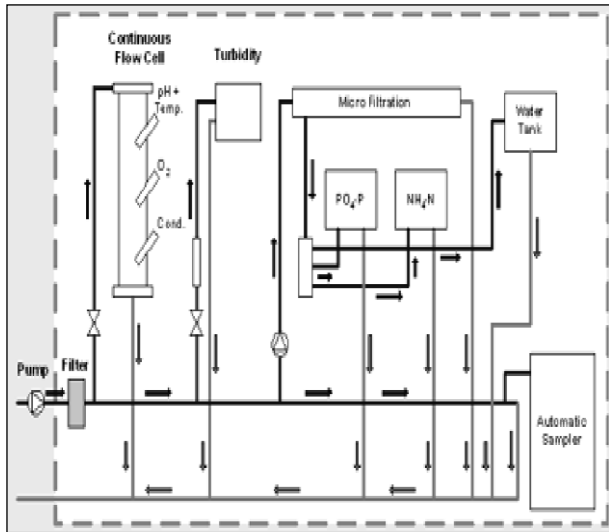


Figure 3. Schematic Overview of the Sample Water Flow in a Type 3 Station

3. DISCUSSION

Since the beginning of the operation of the 23 stations, some river water pollution cases were detected. There are two interesting cases, the first one is a molasses accident from sugar cane factory in the Brantas river on August 2001 and the second case is Brantas river phenomenon during Idul Fitri Holiday on December 2002.

As shown in Figure 4 and 5, the nearest (WQ 10 Mrican) detected the decrease of Dissolved Oxygen and the increase of Conductivity in the location significantly. Moreover, the molasses propagation can be detected clearly in the 2 next downstream stations WQ 21 Kertosono (about 20 Km from location) and WQ 13 Tambangan Canggung (about 40 Km from location).

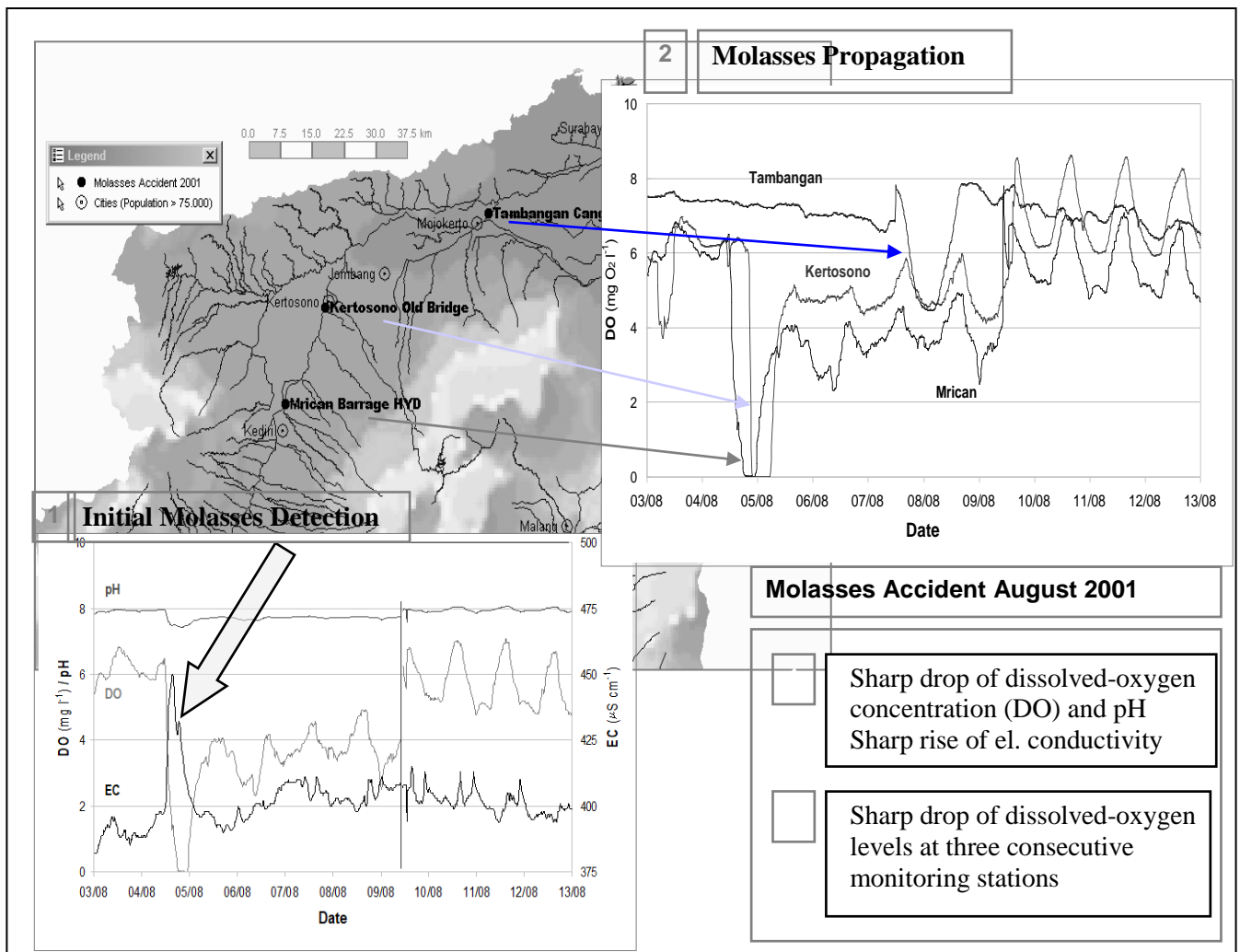


Figure 4. Monitoring Result of Molasses Accident in August 2001

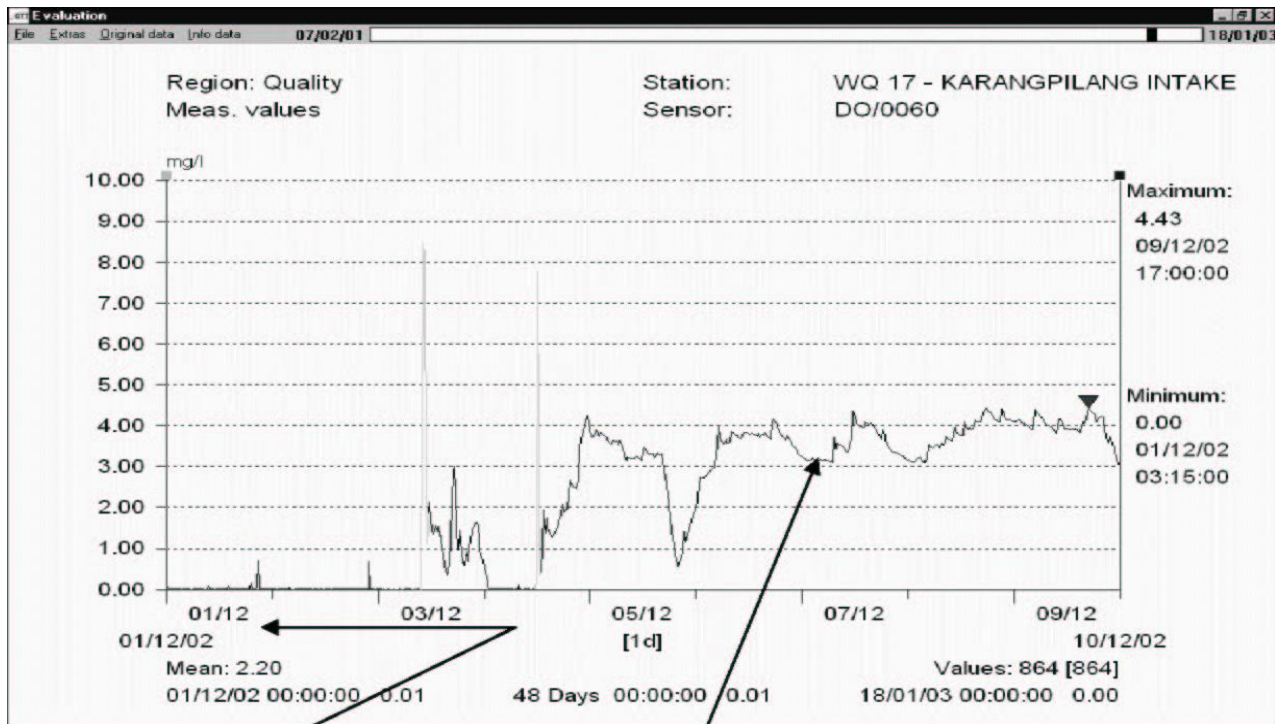


Figure 5. DO Measurement in Station WQ17 Karang Pilang During Idul Fitri Holiday in, Desember 2002

In general, high population and industry activity along Brantas River have caused the river water quality becomes bad as indicated by the low value of Dissolved Oxygen concentration and high turbidity value. However, this condition improved during the Idul Fitri Holiday in December 2002. As shown in Figure 5, it is indicated by the increase in DO concentration, which was monitored by the Station WQ16 Karang Lo, WQ17 Karang Pilang, and WQ19 PDAM Ngagel in the beginning of December 2002. A simple explanation to this phenomenon is that the industry stopped the production and people activity was decreased during the Idul Fitri holiday, therefore the waste water resulted by industry and people activity is decreased significantly.

4. CONCLUSION

In this paper, the concept of on-line water quality monitoring system on Brantas River has been des-

cribed. The monitoring network of water quality and water quantity stations for the entire Brantas River System provides the data which is needed to establish an effective decision tool for the management of the river basin. Continuous monitoring allows immediate action in case of emergency. Furthermore, long-term evaluation of the data quality results in improves in predictive capabilities based on modeling techniques and thus providing important support for decision makers.

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