Assessment of Water Quality in Downstream Watershed for The Realization of Integrated Coastal Zone Management

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ABSTRACT

Watersheds, especially downstream areas, are very important areas for the life of aquatic ecosystems. This downstream area is a coastal area which is a transitional area between land and ocean ecosystems. Several previous studies have shown that this area is polluted from industrial waste and domestic waste. Research sampling was conducted in the downstream watershed, Semarang Indonesia. Garang watershed is located in Semarang Regency as the upstream area and Semarang City as the downstream area. Sampling was carried out according to the regulation of the Governor of Central Java Indonesia 156/2010. This sampling was carried out in segment 7. Segment 7 according to their designation of Garang watershed which are settlements, estuaries, fisheries and loading and unloading ports. Water sampling in the downstream watershed. Samples for water quality analysis were taken in the downstream area of the river which is a coastal area. The results of the water quality analysis are compared with Government Regulation 82/2001. The results showed that the concentration of TDS, Copper and Chromium exceeded the quality standard. One of the analyzes used in the implementation of the ICZM is water quality, this is used for the maintenance of the downstream watershed area.

Keywords: *water quality, watershed, downstream*

1. INTRODUCTION

ICZM is a sustainable system designed for sustainable management of the coastal zone. ICZM thematic policy areas are control of coastal water pollution by land use in catchment areas such as agro-environmental policy, industrial waste management, household waste treatment, sectoral analysis: integration of environmental principles per sector of land use, environmental responsibility to users [1]. The ICZM process requires the participation of all stakeholders. Planning, review of decisions, plans and strategies for coastal and marine management is essential in this process. [2].

Watershed is an area that is very important to be preserved because it is very beneficial for the life of aquatic organisms. The watershed is a very complex area because it covers the upstream area in the mountainous area, the middle area is an urban area, and the downstream area is a coastal area, furthermore, the downstream area in this watershed needs to be managed using the ICZM process. The ecosystem in this coastal area must be maintained because it is very important for the stability of the water area, furthermore that the management of this coastal area requires coordination, collaboration, integration, synchronisation and synergy by various management institutions [3].

ICZM aims to maintain sustainable biodiversity and protect vital habitats. The ICZM method has been considered for use in various countries to solve problems of biodiversity, managing the marine environment, and natural resources. In ICZM, the stages of monitoring and conservation of biodiversity are carried out, for example monitoring of water quality in the downstream watershed area which is a coastal area [4]. The aim of this study is for analyzing the implementation of water quality monitoring to realize the management of coastal areas which are downstream of the watershed.

2. METHODS

2.1. Types of Research

This research was conducted with a quantitative descriptive method which aims to describe the condition of water quality in the Garang watershed, Semarang, Indonesia and its effects due to domestic and industrial waste.

2.2. Sampling Locations

Water sampling was carried out in the Garang watershed downstream (Fig 1). Garang watershed is divided into 7 segments based on their designation. This downstream area is a coastal area of the Java Sea. About 25% of the human population lives in the world's coastal zones [7]. Coastal areas are important areas for human survival and socio-economic development. Furthermore, it is very important to evaluate the ecological condition and environmental carrying capacity in the coastal zone [8]. Utilization of the downstream area of the Garang watershed is an estuary area, aquaculture, ports and settlements. Waste in this area comes from domestic waste, industrial waste that affects the water quality [5]. The water quality parameters studied in the ICZM analysis were Salinity, pH, DO, COD, and heavy metals [4].

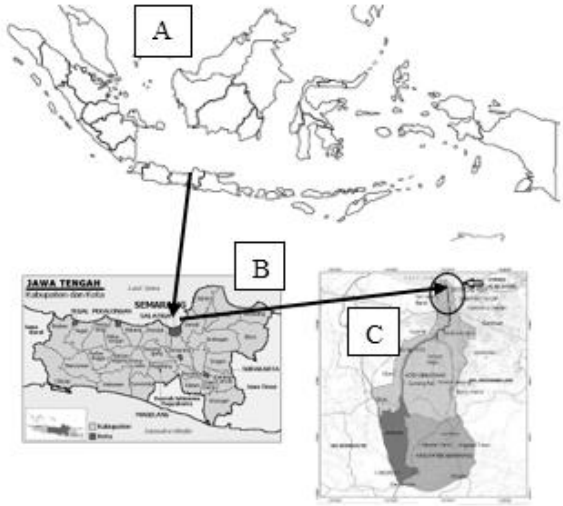

Figure 1. Study area: the map of the Indonesia (A), Central Java Province (B), Sampling Location: Downstream Area of Garang Watershed, Semarang, Indonesia (C)

2.3. Water Quality Analysis

Analysis of water quality in this research: water temperature using DO Meter Lutron 5510. Total TDS and TSS using Conductivity Meter 3210. DO using SNI 06-6989.14-2004 method. BOD using SNI 6989.72:2009 method. COD using SNI 06-6989.15-2004 method, Nitrates, Chromium (Cr), Copper (Cu), and Manganese (Mn) using Spektrofotometer DR 2800. The obtained water quality data is compared with Government Regulation 82/2001.

3. RESULTS AND DISCUSSION

3.1. Land Use

The largest land use at this location is a residential area of 179.962 Ha. Urban land use can affect flow regimes, water quality, and change river channels. Variations in river gradients (channel slopes) affect the response of fish assemblages to land use [9]. Land use can be used by the government to plan sustainable development in an area [10]. River water quality, socio-economic conditions of the community and variations in land use influence each other. The expansion of this city causes structural damage and degradation of the function of river channels in this urban area. Some activities from urban areas that cause water pollution are industry, agriculture, aquaculture, and runoff. The existence of pollution that exceeds the carrying capacity of the river water environment can cause a decrease in water quality and a reduction in aquatic biodiversity. Pollution of urban rivers can affect sustainable economic and social development and threaten human health [11]. Land use and infrastructure parameters are used to provide a measure of anthropogenic changes that have an impact on river conditions and biota. Land use and infrastructure activities affect river health [16].

3.2. Water Quality

The water temperature at the research site is between 27.6-30°C. Phytoplankton growth in waters 20°C – 30°C [37]. The role of temperature for fishery biota is affecting its growth and life [12]. In addition to temperature, which affects the growth and survival of fishery biota is sunlight, this affects the biodiversity of other living things in the watershed [13]. Another effect of temperature is on the ecological system, DO, chemical, physical and biological processes [21].

Total dissolved solids (TDS) ranged from 183-4110 mg/l. TSS concentration in coastal sampling point, exceeds quality standards of 1000 mg/l. TDS includes all salts present in water and nonionic components. Dissolved organic compounds affect the TDS and can be measured by the total dissolved carbon content (TDC). The TDS content was taken by filtering the water sample, evaporating the filtrate, and measuring the dry weight of the remaining main solute. The total TDS content is used by geomorphologists interested in determining the effects of chemical erosion in different areas [14]. The high TDS is thought to be due to the influence of soil erosion and agricultural runoff [15]. High levels of TSS downstream of the river may come from high surfactant particles ranging from detergents, cleaners, cleaning agents, and emulsifiers [16]. Total Suspended Solids (TSS), ranged from 89 – 217 mg/l. The status of aquatic waste and its ecological system can be seen by the concentration of

TSS [21]. Clogged gills and blocked airway surfaces are the effects of TSS deposition in the watershed [24].

Biochemical oxygen demand (BOD), ranged from 17- 25 mg/l. High BOD concentration indicates low DO in the water, furthermore that it can cause death in fish due to low of oxygen. High BOD concentration can reduce fish populations in the waters [35]. BOD is dissolved oxygen needed by aquatic organisms. The breakdown of organic components in water samples at a certain temperature over a certain period is a function of BOD. The amount of oxygen needed by aquatic organisms can be affected by the BOD content. This is to oxidize organic matter with the final result of a stable organic form [17]. Chemical oxygen demand (COD), ranged from 18.9-43.9 mg/l, and Dissolved Oxygen (DO), ranged from 5.6-12.2 mg/l, COD and DO represent the oxygen depletion parameter. Both of these parameters are important because oxygen is very important for the life of aquatic organisms. During the process of decomposition of organic matter and oxidation of inorganic chemicals, COD is required. Good and stable river water quality is indicated by the presence of good COD, BOD and DO [21]. The need for clean water in various countries continues to increase, but industry, agriculture, and increasingly intensive urbanization cause an increase in the amount of waste that causes pollution of the aquatic environment which causes a decrease in water quality, especially DO concentrations. This happens because the waste is discharged into the waters without sewage treatment [18].

Nitrification and denitrification are affected by nitrate. The nitrogen cycle is influenced by nitrate as an important element. Watershed pollution sourced from agricultural waste, one of which is because the nitrate content is in agricultural fertilizers. The location in the middle of the river is a large area of agriculture and plantations, so it can be polluted by fertilizers. Water runoff, sewage disposal and nitrogen fixation are some of the factors that affect the amount of nitrate in the watershed [22]. The amount of runoff of agricultural fertilizers in the catchment area during the rainy season in this agricultural area can be shown by nitrate [18]. The condition of ammonia that continues to rise is very dangerous for aquatic biota. Ammonia is present in water in the form of ionized (NH_4^+) and ionized (NH_3) The content of ammonia that is safe for aquatic life is less than 0.1 mg/l to below 1.0 mg/l [23]. The increasing phosphate concentration will affect the eutrophication of waters [19]. Eutrophication in rivers occurs due to the presence of nutrients. The growth of algae and plankton increases (algal bloom) resulting in a reduction in oxygen in aquatic biota [20], the reduction in the intensity of sunlight entering the water body will experience a reduction, if the water is covered by algae. The use of water by the community must be controlled so that there is no closure of water bodies, for example, waste management is carried out in the watershed.

Chromium (Cr) concentration ranged from 0.024-0.025 mg/l. Cr is a heavy metal that can be harmful to humans even in small amounts [25]. The Cr content: 0.025 exceeds the Cr content that should exist in river waters: 0.0017 mg/l [26], furthermore that the Cr content in the coastal area is considered dangerous for aquatic biota. The negative impact caused by chromium for the aquatic environment, which can pollute waters, dissolve in water, settle to the bottom of the water, is corrosive, and toxic. Cr compounds are often found in polluted waters and have been known to be toxic, mutagenic, and have carcinogenic effects on biological systems even though Cr is an important element in the body [36].

Copper (Cu) concentration ranged from 0.11-0.15 mg/l. Cu concentration in coastal sampling point, exceeds quality standards of 0.02 mg/l. These heavy metals have harmful effects on human health when exposed to them [27]. Concentrations of Cu, Nitrate, and phosphate will contaminate surface water because it can have a negative impact on water supplies and ecosystems [28]. Manganese (Mn) concentration ranged from 0.248-0.562 mg/l. Mn can cause skeletal abnormalities and severe abnormalities in the reproductive system in fish [30]. Manganese in nature is found in surface and groundwater sources [31].

3.3. Integrated Coastal Zone Management (ICZM)

ICZM is an integrated, planned, coordinated and comprehensive effort. The purpose of this ICZM is to provide environmental protection and sustainability of coastal areas. The suitability of the area in the place, is the basis for the development of the right area. After that, what needs to be done is the management of the area, and controlling the area from environmental damage. The community can be involved in the maintenance of coastal areas, by participating in environmental education and area conservation activities. The addition of infrastructure and improvement from the economic side is the next alternative strategy [32]. Various problems in the environment, namely watershed deforestation, ecosystem degradation, sanitation, waste disposal and water quality require the realization of ICZM [33].

Steps for the realization of ICZM in coastal areas [34]: 1) Integrated waste management, management of aquatic resources, environmentally and sustainable regional development. 2) Protection from pollution of coastal and marine areas and their economy. 3) Protection of the environmental carrying capacity of coastal and marine areas, sustainable use and economic growth

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