



# Application of west java water sustainability index to three water catchments in west java, Indonesia



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## ABSTRACT

This study presents a comparative application of the West Java Water Sustainability Index to Citarum, Ciliwung and Citanduy catchments in West Java, Indonesia. A two-fold comparison is presented, firstly, that of the overall condition of water resources using the final index value and secondly, that of specific water sustainability issues using the comparison of the sub-index values of the indicators. The overall comparison ranks the condition of water resources of Citanduy catchment is slightly better, whereas sub-index values of *Education*, *Health Impact*, *Water Demand*, and *Poverty* show important differences among catchments. Based on the performance of the catchments identified in this study, priority of actions has been recommended to the authorities.

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## 1. Introduction

The importance of water to living creatures is all too evident. Therefore, it is of utmost importance to maintain the sustainability of water resources, so that these resources can be utilised by humans and others, now and also in the future. In one of the most densely populated provinces of Indonesia, West Java, the conditions of water resources are poor. The increase in population in the province has resulted in the increased demand for clean water. To fulfil the demand, both surface and groundwater resources in West Java are utilised. Both resources are dependent on rainfall. The availability of these water resources is abundant, due to high rainfall in most areas of West Java. However, this abundance of water is not properly managed, and has resulted in water shortages in some areas of the province (Rahmat and Wangsaatmadja, 2007). In terms of their quality, most surface and groundwater resources in West Java are polluted by domestic, agricultural and industrial activities.

In the last decade, the provincial government of West Java has implemented various programs to improve the condition of water resources. However, these programs have not been successful. It is therefore important to obtain a comprehensive understanding of the current status of the condition of water resources in West Java. Once this information has been obtained, relevant programs can be designed to improve the quality of the water resources.

A water sustainability index is a useful tool that can be used to obtain information on the condition of water resources. It is a single dimensionless number that expresses the condition of water resources in a simple form and hence can be easily understood by both water professionals as well as laypersons. Such an index comprises of indicators related to the sustainability of water resources, which are aggregated to form the final index. It offers the following benefits:

1. It can be used to identify all factors contributing to the condition of water resources (Chaves and Alipaz, 2007; Policy Research Initiative, 2007; Sullivan, 2002), so that the resources can be efficiently used to fulfil present and future needs.
2. It can be used to assist decision makers to prioritise issues and programs related to water resource management.
3. It can be used to communicate the current status of existing water resources to the wider community (Policy Research Initiative, 2007).

In the recent past, several indices related to water resource sustainability have been developed, namely Water Poverty Index-WPI (Lawrence et al., 2003), Canadian Water Sustainability Index-CWSI (Policy Research Initiative, 2007) and Watershed Sustainability Index-WSI (Chaves and Alipaz, 2007). The Water Poverty Index (WPI) was developed to assess the link between poverty and water availability (Sullivan, 2002). Even though there have been some successful experiences with the implementation of these sus-

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**Table 1**  
Final Framework of WJWSI.

Component	Indicator	Sub-indicator	Unit	Threshold values	
				Max	Min
Conservation	Water Availability		m <sup>3</sup> /cap/yr	1700 <sup>a</sup>	500 <sup>b</sup>
	Land Use Changes		%	100 <sup>a</sup>	0 <sup>b</sup>
	Water Quality		–	12:00 AM	–31 <sup>b</sup>
Water Use	Water Demand		%	40 <sup>b</sup>	10:00 AM
	Water Service Provision	Coverage	%	80 <sup>a</sup>	0 <sup>b</sup>
		Water Loss	%	30 <sup>b</sup>	15 <sup>a</sup>
Policy and Governance	Information Disclosure		–	100 <sup>a</sup>	0 <sup>b</sup>
	Governance Structure		–	100 <sup>a</sup>	0 <sup>b</sup>
	Public Participation	Education	%	100 <sup>a</sup>	0 <sup>b</sup>
		Poverty	%	20 <sup>b</sup>	12:00 AM
		Health Impact	(cases/1000 population)	2 <sup>b</sup>	12:00 AM
		Sanitation	%	100 <sup>a</sup>	0 <sup>b</sup>
		Law Enforcement			100 <sup>a</sup>

<sup>a</sup> preferable.

<sup>b</sup> not preferable.

tainability indices, as they have been developed for use in specific regions or countries, they are not fully applicable in other areas.

Therefore, a new water sustainability index called the West Java Water Sustainability Index (WJWSI) was recently developed to help improve the water resources management in West Java (Juwana et al., 2010a,b). The WJWSI was specifically developed with the involvement of local water stakeholders and was based on the natural and socio-economic characteristics of West Java.

The final structure of the WJWSI is shown in Table 1. Further justification for the components, indicators, sub-indicators and their threshold values can be found in Juwana et al. (2010a).

This index will be able to not only obtain information on the condition of water resources in West Java, but also to prioritise water issues for better management of water resources within the province. The prioritization of water issues is especially important since such prioritization was not found in existing documents related to water resource management in West Java.

This paper presents the application of WJWSI to three different catchments in West Java (namely Citarum, Ciliwung and Citanduy catchments) with the purpose of obtaining information on the condition of water resources in those catchments. This comparative analysis is used to provide information on the general condition of water resources in each catchment, as well as their specific needs. Each application commenced with collecting the required data and information related to the WJWSI indicators and sub-indicators. Data were collected from past studies, institutional databases and other relevant sources. These data were used to compute the sub-index values of each WJWSI indicator and sub-indicator. These sub-index values were then aggregated to produce the final WJWSI value. The sub-index values and the final WJWSI value of these applications were used to analyse the performance of the catchments, and to provide recommendations to the respective catchment authorities to improve the management of water resources in these catchments.

## 2. West java and the selected catchments

### 2.1. West java

The West Java Province is one of the most highly populated provinces, which is adjacent to the Jakarta Province. Due to its location, the Jakarta Province relies heavily on the West Java Province for various needs such as labour, raw materials for industries and daily household needs. The natural resources in West Java have been utilised by various sectors and stakeholders in Indonesia, which have resulted in the degradation of environmental resources, including water resources (Rahmat and Wangsaatmadja,

2007). The average annual rainfall in the mountain areas of West Java Province is between 3000 and 5000 mm/year, whereas in other areas it is about 2000 mm/year.

The population in West Java has increased progressively from year to year. In 2006, for example, the population was 40.74 million, and in 2009, it was 43.02 million (18.11% of the national population). The increased population in West Java has made significant impacts on the existing land use. Apart from the need for housing for people in West Java due to the increased population, the demand from industries in the Jakarta Province has also led to changes in adjacent provinces, namely the West Java and the Banten (Bappeda Team, 2004). As a result, forestry and agricultural areas in these provinces have significantly changed.

The West Java Province has 40 catchments. Of these catchments, the main rivers in 22 catchments flow into the northern parts of the province and the main rivers in the other 18 catchments flow into the southern parts of the province. A study by Hasibuan (2005) reported that 18 West Java catchments were in a critical condition, based on various factors including the water quality of major rivers, land use and soil saturation.

In general, the condition of water resources in the West Java catchments, both in terms of quality and quantity, are far from satisfactory. In terms of water quality, five main rivers in West Java catchments including Citarum, Ciliwung, Citanduy, Cileungsi and Cimanuk Rivers are considered critical, based on the water quality that these rivers did not meet thenational standards for water quality during 2005–2009 (Tarigan, 2009). The main contributors to the low water quality of these rivers are the industries polluting the rivers, as well as domestic and agricultural discharge. The Environmental Protection Agency (EPA) of West Java (2008) stated that as many as 542 industries were polluting rivers in West Java. The rivers also suffered from the improper discharge of 79.8 ha of agricultural waste and domestic waste of 8.6 million people. In terms of water quantity, in the last two decades, many areas in West Java have suffered from drought and floods (Wangsaatmadja, 2004). Of the 40 catchments in West Java, the three catchments of Citarum, Ciliwung and Citanduy (presented in Fig. 1) are considered highly important for various reasons. The following sub-sections describe these reasons and also provide a brief description of the status of water resources in these three catchments.

### 2.2. Citarum catchment

The Citarum catchment occupies an area of approximately 7400 km<sup>2</sup>. As illustrated in Fig. 1, three reservoirs (Saguling, Cirata and Jatiluhur) have been built within the catchment, which are used to supply water for various purposes, such as domestic, agricul-

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