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Procedia Earth and Planetary Science 12 (2015) 47 – 62

Procedia
Earth and Planetary Science

ISEDM 2013

3rd International Symposium on Earthquake and Disaster Mitigation

Land subsidence in Bandung Basin and its possible caused factors

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Abstract

Bandung basin which located in West Java, Indonesia is a large intra-montane basin surrounded by volcanic highlands. The basin is a highly urbanized area whose population has been rapidly increasing since few decades ago. It is widely believed that the increase of population, as well as industrial activities, will increase the degree of groundwater extraction and will eventually lead to land subsidence over the area of Bandung basin. According to results of ten champaign of GPS (Global Positioning System) surveys, which were conducted within the period of 2000 to 2012 it was found that several locations in Bandung basin experienced land subsidence, with an average subsidence rate of about –8 cm/year and it can reach to about –16.9 cm/year in a certain location and time period. The large subsidences occur in Cimahi, Gedebage, Dayeuhkolot, Rancaekek, Majalaya, and Katapang districts. Similar results are also achieved from InSAR (Interferometry Synthetic Aperture Radar) data. During the period of 1999 to 2010, maximum rate of land subsidence in the Bandung basin reached 2 meters that occurred in industrial areas such as in Cimahi, Katapang, Dayeuhkolot, Gedebage, and Rancaekek. It is indicated that there is a strong correlation between the land subsidence and groundwater extraction in Cimahi, Dayeuhkolot, Majalaya, and Rancaekek. Furthermore, there could also be possible existence of other causes due to natural compaction in almost all subsidence areas and tectonic processes in Dayeuhkolot, Gedebage, Cimahi, dan Majalaya.

Peer-review under responsibility of the Scientific Committee of ISEDM 2013

Key Words: Bandung; subsidence; groundwater extraction; natural compaction; tectonic

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doi:10.1016/j.proeps.2015.03.026

1. Introduction

The Bandung Basin is a large intra-montane basin surrounded by volcanic highlands, located in West Java province, Indonesia (Fig.1). The central part of the basin has an altitude of about 665 m and is surrounded by up to 2400-m- high Late Tertiary and Quaternary volcanic terrain[1]. The catchment area of the basin and surrounding mountains cover approximately 2300 km^2, and the Citarum River with its tributaries forms the main drainage system of the basin catchment. This main drainage is one of the largest watershed on the island of Java, and provides water for drinking, agriculture and fisheries, as well as the main supply for three reservoirs (hydroelectric dams), with a total volume of about 6147 million cubic meters [2]. Mean annual temperature in the basin is about 23.7°C and mean annual precipitation amounts is about 1700 mm [3]. Deposits in the basin comprise of coarse volcaniclastics, fluvial sediments and notably a thick series of lacustrine deposits.

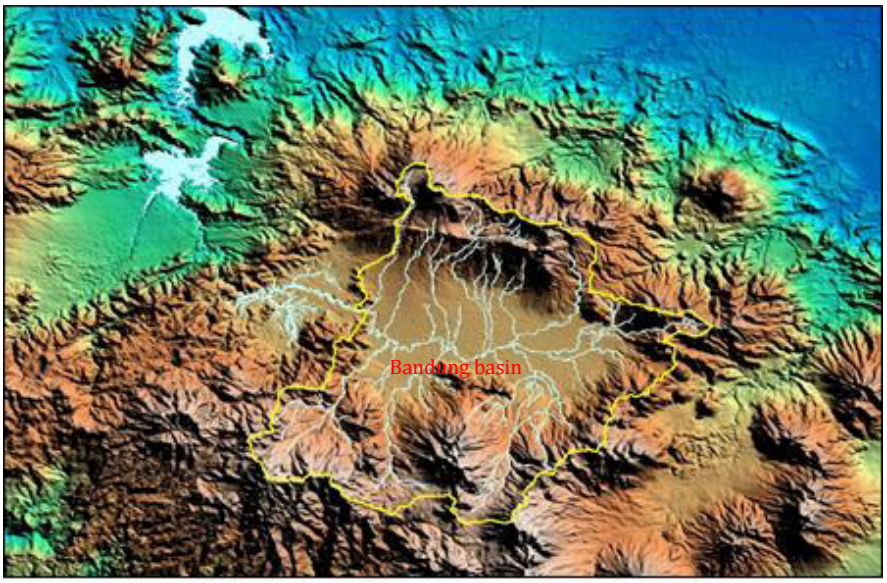

Fig 1. Topography of Bandung Basin located in West Java, Indonesia

On the basis of its hydraulic characteristics and its depth, the multi-layer aquifer configuration of the Bandung basin may be simplified into two systems[4]: shallow aquifer (a few meters to around 40 m below the surface) and deep aquifer (more than 40 to 250 m below the surface). These aquifers are composed of volcanic products from the volcanic complexes that bordered this basin, and lake sediments that were deposited when the central part of the basin was a lake. The lake was fully formed about 50.000 years ago, and was drained away about 16.000 years ago[1].

The population of the Bandung municipality increased from less than 40,000 in 1906 to nearly one million in 1961, and had grown to about two and half million by 1995. The population over the Bandung basin was about