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Risk assessment of groundwater abstraction vulnerability using spatial analysis: Case study at Salatiga Groundwater Basin, Indonesia

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Abstract

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Abstract

Salatiga Groundwater Basin (SGB) is located in Java Island, Indonesia. Administratively, it covers Semarang Regency, Salatiga City, and Boyolali Regency. Industry and community use groundwater to fulfil their daily need. Increasing number of deep wells that extract groundwater will cause some environmental problems, such as lowering groundwater level and subsidence at SGB. Thus, there is a need to assess the adverse impacts of groundwater abstraction. Risk assessment of groundwater

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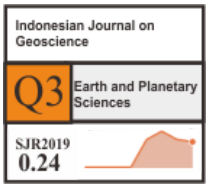

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Risk Assessment of Groundwater Abstraction Vulnerability Using Spatial Analysis: Case Study at Salatiga Groundwater Basin, Indonesia

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approved: January, 23, 2020; available online: July, 16, 2020

Abstract - Salatiga Groundwater Basin (SGB) is located in Java Island, Indonesia. Administratively, it covers Semarang Regency, Salatiga City, and Boyolali Regency. Industry and community use groundwater to fulfil their daily need. Increasing number of deep wells that extract groundwater will cause some environmental problems, such as lowering groundwater level and subsidence at SGB. Thus, there is a need to assess the adverse impacts of groundwater abstraction. Risk assessment of groundwater vulnerability due to abstraction is the goal of this study. The research method was taking account of weighting of geological parameters, such as response characteristics of the aquifers, characteristics of aquifer storage, aquifer thickness, piezometric depth, and distance from the shoreline to conduct the groundwater vulnerability mapping. It was then overlaid on a map of regional spatial plan to develop the map of vulnerability risk due to abstraction. The groundwater vulnerability due to abstraction is categorized in the medium level. After being overlaid by the land use map, the risk of groundwater vulnerability due to abstraction is classified into three kinds, which are low, medium, and high. Regions with a low class can be neglected. Areas with moderate risk require an exhaustive review of technical requirements of the use of borewell. Areas with high-risk need a comprehensive consideration to use artesian wells by monitoring wells with drill licenses, tightening the permit to add new production wells, and conducting periodic review of groundwater monitoring.

Keywords: risk assessment, groundwater, vulnerability, abstraction, aquifer, Salatiga Groundwater Basin

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Introduction

The term of groundwater vulnerability was introduced by a French hydrogeologist, Margat, in 1968, and the first vulnerability map was constructed in France by Albined in 1970. Since the early 1980s, more complex methods of groundwater vulnerability assessment have been developed, and a considerable number of vulnerability maps of various scales and objectives have been produced throughout the world (Witkowski *et al*., 2007). The risk assessment of groundwater vulnerability due to abstraction is developed by aggregating some major vulnerability parameters to one vulnerability index, involving various steps of selection, transforming some parameters into raster data, rating, and weighting. In this research, groundwater vulnerability is mainly formulated as an intrinsic property of the aquifer system that relies on the sensitivity of the system to human and/or natural impact.

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Temporal Variations of Petrological Characteristics of Tangkil and Rajabasa Volcanic Rocks, Indonesia

Reza Firmansyah Hasibuan[1], Tsukasa Ohba[1], Mirzam Abdurrachman[2], and Takashi Hoshide[1]

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Abstract - Tangkil and Rajabasa Volcanoes are neighbouring subduction-zone volcanoes located on the southeast tip of Sumatra Island (Sunda Strait, Indonesia). Stratigraphic correlation of lavas in Tangkil-Rajabasa volcanic area was established from field observations, morphological analysis, and K-Ar dating analysis. Detailed petrography and geochemical data of two and eleven lava units from Tangkil and Rajabasa, respectively, were then integrated with the stratigraphy to show the temporal variations. Early stage (> 4.3 Ma) effusives of Tangkil Volcano are dacitic to rhyolitic (67-71 wt. % SiO_2; Tklf), whereas the later (*c.* 4.3 Ma) rocks are basalt to basaltic andesite (*c.* 52 wt. % SiO_2; Tklm). Tangkil shows bimodal magmatism, of which the felsic endmember is > 71 wt. % SiO_2 and < 0.1 wt. % MgO. Lavas of Rajabasa Volcano are comparatively younger (*c.* 0.3 to 0.1 Ma) with compositions ranging from basalt to andesite (51-62 wt. % SiO_2; Rbs). Chemical variations of Rajabasa accounts for the interactions of at least three endmembers: Mg-rich medium-K basalt magma, low-Mg medium-K basalt magma, and high-K andesitic magma. During the long evolution of Rbs magma system, the temporal chemistry shows rising-falling variation in SiO_2 and MgO indicating the three magmas were active. The felsic endmember magma of Rajabasa is fixed in composition (at ~62 wt. % SiO_2; ~2.2 wt. % MgO). The rocks from the last Tklf and Rbs indicate open system processes by containing plagioclase and pyroxene phenocrysts that show resorption of evolved core and overgrowth of less evolved mantle. The multiple zones of dissolution-overgrowth in plagioclase crystals and the fluctuating trend in temporal whole-rock variation suggest that the changes of magmatic condition in temperature, H_2O, or chemical composition were repetitive.

Keywords: temporal variation, evolution, magma recharge, Rajabasa, Tangkil, Sunda Strait

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Introduction

Temporal chemical variations of volcanic rocks from subduction-related volcanoes have been documented in the past decades (*e.g.* Newhall, 1979; Tsukui, 1985; Camus *et al.*, 1987; Prosser and Carr, 1987; Gertisser and Keller, 2000, 2003; Amma-Miyasaka and Nakagawa, 2003; Wibowo, 2017) by integrating the stratigraphy, isotopic dating, and whole-rock chemistry to understand the magmatic evolution. The temporal variations are detected at various time scales, ranging from inhomogeneous volcanic products by a single eruption in minutes or hours to variations during a series of eruptions in thousands of years; or even the entire lifetimes of a volcano or volcanic field, up to tens of million years. The variations in many calc-alkaline volcanic rocks