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MATHEMATICAL MODEL OF TIME-LAPSE VERTICAL GRADIENT MICROGRAVITY MEASUREMENT AND ITS APPLICATION FOR SUBSURFACE MASS CHANGE AND VERTICAL GROUND MOVEMENT (SUBSIDENCE) IDENTIFICATION, CASE STUDY: SEMARANG ALLUVIAL PLAIN, CENTRAL JAVA, INDONESIA

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Abstract

Application of microgravity survey by measuring gravity change in time had been used extensively in many fields. The major causes of gravity change are mass change in reservoir including ground water level change (subsurface) and vertical ground movement (subsidence). While the observed gravity change, called as time-lapse microgravity anomaly, is as superposition of all the causes, hence how to identify each source is very important one because some of causes could have similar response. As example is increase in subsurface density shows similar gravimetric response with that of ground subsidence. In order to distinguish this similarity, time-lapse microgravity along with its vertical gradient analysis is effective. Theoretical background of this analysis is that vertical gradient microgravity value at the surface would be constant if there is only subsidence (no subsurface mass change). Therefore, response of its time-lapse vertical gradient microgravity for subsidence will be zero. In contrast, subsurface density change is identified as anomaly in both time-lapse microgravity and its vertical gradient, and the value of anomaly is proportional to the amount of subsurface density contrast (change). To demonstrate this technique, microgravity and vertical gradient microgravity measurement were repeatedly conducted in Semarang alluvial plain area where 2 to 17 cm/year subsidence rate and 1 to 5 m/year ground water level change occurred. Their time-lapse microgravity and vertical gradient anomalies indicate existence of ground water decrease, subsidence, and combination between subsidence and tidal flood. These results were confirmed with elevation change measurement and ground water level change from well data.

Keywords and phrases: time-lapse, vertical gradient, microgravity, subsurface mass change, subsidence.

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