Utilization of Elevation and Borehole Data of Hanoi City, Vietnam

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In Hanoi, the capital of Vietnam, environmental problems (land subsidence, flood, groundwater pollution and so on) have been increasing in recent years. The main reason is rapid urbanization and water control. In the rainy season, flooding occurs by heavy rain. Because the discharging water system is very old. Sometimes, buildings are sinking under the ground slowly because of the subsidence. The reason is excessive pumping of groundwater. Hanoi city is depend on the groundwater for the daily life water. These problems are related to the geography and subsurface structure of Hanoi city.
In this study, we collected the elevation data and borehole data through Hanoi University of Mining and Geology. Firstly, we need to generate the DEM (Digital Elevation Model) using the elevation data. DEM is a digital representation of ground surface topography and the most important element of topographic analysis. Secondly, we analyzed the borehole data for well construction of Hanoi city. We input it the developed borehole database for share with Vietnamese researcher. Finally, we constructed the 3D geological model of Hanoi city and visualized it using GRASS GIS.
Research area is the center part of Hanoi city, Vietnam and covers a range of lat. 21°00′00″ to 21° 04′22.5″ and long. 105°47′30″ to 105°51′52.5″. The coordinate system is VN2000. Hanoi is located on Red River Delta, this area is underlain by the Pleistocene and the Holocene sedimentary rocks. The Pleistocene rocks are divided into the Lechi Formation, Hanoi Formation and Vinh Phuc Formation. The Holocene rocks are divided into the Hai Hung Formation and Thai Binh Formation.
49 maps of an elevation survey points were collected through Hanoi University of Mining and Geology. The scale of this map is 1:2,000. The research area is 8km x 8km, and the number of survey points is 16,745. We generated a DEM based on the surface estimation method, we call it BS-Horizon (Nonogaki et al., 2008). The very subtle elevation gaps are significantly recognizable on it.
160 borehole data of Hanoi city was collected through Hanoi University of Mining and Geology. Each borehole data is a non-core drill data for the well construction. We picked up some information from the borehole data. The well name and drilling point can be found from the borehole data. The drilling point was described as the EPSG Geodetic Parameter Dataset (28418, Datum; Pulkovo 1942, Projection; Gauss-Kruger zone 18). Each thickness and lithofacies can be found from the borehole data. However, the description of lithofacies were not standardized. Therefore we unificated the geological description by Japanese standard, JASIC (Japan Construction Information Center Foundation) description. We classified 30 types of descriptions.
We outputted each geological boundary surface data from the borehole data and estimated DEMs of the geological boundary surfaces for 3D geological modeling using the same method of the topographic DEM.
The spatial distribution and the relation of geological units are expressed in the logical model based on the fundamental field data and the knowledge. The 3D geological model is composed the DEMs of the geological boundary surfaces and the logical model. We visualized the 3D geological model using GRASS GIS.
In this study, we constructed the 3D geological model using the borehole data of Hanoi city. This

is useful not only for the elucidation of geological structure of Hanoi city but also for the provision of the basis data to various fields. It is important to consider the urban sustainability of Hanoi city as in improvement of urban infrastructure and disaster prevention. Future works of this study are to develop the accessible 3D geological modeling system using Web-GIS.
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Keywords: DEM, Borehole data, 3-D geological model

