RESEARCH ON DRIVING FACTORS OF LAND SUBSIDENCE WITH REMOTE SENSING TECHNOLOGY

Zhu Lin[1,2] , Gong Huili[1,2] , Li Xiaojuan[1,2] , Su Yaoming[1,2], Jing Lingling [1,2]

(1. College of Resource Environment and Tourism, Capital Normal University, Beijing 100048, China;
2. 3D Information Acquisition and Application Key Laboratory of Education Ministry; Capital Normal University, Beijing 100048, China)

Abstract: In many areas of northern China, groundwater is the main source of water supply. In recent years, as the city's expansion and development, excessive long-term exploitation of groundwater has induced land subsidence and threatened the safety of people's lives and property. As China's political and cultural center, Beijing has already built five water sources to meet large demand for urban water supply. Related geological disasters are induced under the impaction of large-scale, high-intensity exploitation concentratively. In Shunyi district, one main region in Beijing, where Capital International Airport located, geological disasters such as land subsidence and ground fissure have become increasingly prominent. In order to keep sustainable social-economic development, this article utilizes Principal Components Analysis (PCA) method to analyze the driving factors of land subsidence in Shun Yi district combining with remote sensing technology.

Based on multi-scale resolution remote sensing images, urban expansion, which is represented by the changes of build-up area, was interpreted by using Landsat TM images (1990 and 2000), SPOT4 (2006) images. By using of spatial analysis function of GIS, build-up area increased 56.67Km^2 from 1990 to 2000. And the built-up area grew about 43.53Km^2 from 2000 to 2006. At the same time, data of rainfall, unconfined groundwater exploitation, confined and unconfined groundwater level are also collected from 1990 to 2006. Comparison is made between intensity change of accumulative land subsidence and natural-human activities coupled factors. Correlation coefficients between exploitation amounts of shallow groundwater and ground subsidence, between precipitation and land subsidence, between shallow groundwater level depth and accumulative ground subsidence, and between confined water level depth and accumulative ground subsidence, are 0.975, 0.4776, 0.9616 and 0.9996, respectively. Built-up area sizes in 1990-2006 are linear correlated with corresponding accumulative ground subsidence, with a correlation coefficient of 0.9915.

According to the analysis above, seven factors including the property of unsaturated zone, distribution of faults, precipitation, bedrock burying depth, build-up area, groundwater annual exploitation intensity and groundwater level, are extracted to describe natural-human coupled factors inducing land subsidence. Principal Component Analysis (PCA) is used to analyze the contribution of these factors to surface subsidence. The result indicates that the first principal component is mainly composited of the influence of unsaturated zone and the annual exploitation rate. If unsaturated zone is difficult to be infiltrated, the amount of recharge to groundwater becomes smaller. Then under the same exploitation condition, the groundwater level would decline sharply. At the same time, annual exploitation rate, reflecting over-exploitation of groundwater, is another mainly factor intensifying surface subsidence disaster. The property of unsaturated zone and annual exploitation rate factors have positive relationships with the amount of accumulated land subsidence. The second principal component mainly reflects the effects of bedrock burying depth and groundwater level. With bedrock burying depth growing, which means the compressible thickness of strata pulsing increasing, the possibility of stratum compression will be added. Groundwater level shows negative correlation with surface land subsidence, with groundwater level descending sharply, amount of accumulative land subsidence increasing. The third principal component is mainly composed of precipitation and build-up area. Precipitation, the primary recharge to groundwater,

shares negative correlation with the amount of accumulated land subsidence. Besides the build-up area would aggravate land subsidence. Generally, land subsidence is more serious in dense build-up area. Therefore rational planning and layout should be taken into account in future. The fourth principal component mainly reflects the influence of fault belts, which can control the distribution of land subsidence to some extent. Being close to fault zones, strata would be more vulnerable to suffer tectonic activity.

Key words: multi-scale resolution remote sensing data; land subsidence; driving factors; Principal Component Analysis