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Characterizing the dominant conditioning factors of urban waterlogging in highly urbanized coastal cities

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Under the background of global climate change and rapid urbanization, the low-lying coastal cities are vulnerable to urban waterlogging events, which seriously interrupt the sustainable development of society and economy. Urban waterlogging is a stagnant water disaster, which process affected by natural conditions and human activities. Previous studies had explored the effect of land-use type on waterlogging in relatively small watersheds. Few, however, have comprehensively revealed the relative contributions of the natural and anthropogenic factors to urban waterlogging concerning analysis scale variations. What is less known, are the dominant factors and the best analysis scale. The natural and anthropogenic factors such as topography, land cover characteristics (composition and spatial configuration), drainage density, and urban morphology are not comprehensively considered, which leads to some biases. To overcome this limitation, this study aims to investigate the complex mechanism of urban waterlogging by identifying the relative contribution of each influencing factor and the stability linking waterlogging to influencing factors at multiple analysis scales (i.e. 1 km, 2 km, 3 km, 4 km, and 5 km). We consider waterlogging events in the central urban districts of Guangzhou (PR China) from 2009 to 2015 as a case study. A novel method that integrates the stepwise regression model with hierarchical partitioning analysis is presented to quantify the complex relationship between urban waterlogging and influencing factors. Results show that the spatial distribution of waterlogging events in the central urban area presents a strong agglomeration pattern. The waterlogging hotspots are mostly concentrated in the historical area of Guangzhou (Liwan district, Yuexiu district, the northern part of Haizhu district and western part of Tianhe district). Under all analysis scales, urban waterlogging is confirmed to mainly affect by both land cover characteristics (the percent cover of urban green spaces and residential area) and urban topography (slope.std). However, the dominant factor of waterlogging varied noticeably among different analysis scales, which presents a strong scale effect. At a small analysis scale (1km), the urban topography factors (slope.std and relative elevation) are the dominant conditioning factors of urban waterlogging

events; however, with the increase of analysis scale, the contribution of topographic factors gradually declines, while the relative contributions of land cover composition (greenspace, residence area, grassland) and land cover spatial configuration (LPI, AI, Cohesion index) are much higher than other factors. These results also reveal that both of the land cover composition and spatial configuration can significantly affect the magnitude of waterlogging, which indicates that even if the proportion of land cover remains constant, changing the spatial distribution pattern of land cover will also affect the magnitude of waterlogging. This finding improves our understanding that urban waterlogging can be alleviated by balancing the composition of land cover as well as by optimizing the land cover spatial pattern. This study extended our scientific understanding of the complex mechanisms of waterlogging in the highly urbanized coastal city with respect to a multi-scale analysis perspective, providing useful support for the prevention and management of urban waterlogging.