Landscape and sociodemographic factors affecting urban floods

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Abstract: Floods are major social and environmental concerns in many urban areas. We investigated how changes in land cover, sociodemographic conditions, and landscape factors affect flood damage in major urban areas of South Korea. Using historical maps and GIS analysis, we showed flood damages increased in those areas where rapid urbanization happened. Human modifications of natural area further exacerbated flood risks during the development stage and subsequent periods. This study underscores the importance of understanding the historical geographical conditions, and how humans either increased or reduced flood damage through social and technical interventions.

Keywords: Floods, urbanization, GIS, old maps, South Korea

1. Introduction

Floods are major concerns in many urban areas in the globe as floods are the most damaging natural hazards in the world. Globally, flood damage is estimated to be more than $40 billion (OECD, 2016). In South Korea, the frequency and intensity of floods have increased in recent years with the rapid conversion of natural areas to urban and other industrial areas. However, the spatial pattern of flood damage and the various factors affecting flood damage at a finer spatial scale have not been thoroughly examined. Thus, we seek to investigate what landscape and sociodemographic factors affect flood damage at the district level in South Korea using GIS and spatial analysis.

2. Data and Methods

2.1. Data

Flood damage at a district level data was obtained from the Korean water resources management information system and summarized by each decade. To avoid different size and population of each district, we derived flood damage per area and flood damage per person. The explanatory variables include land cover data for both old and (1910) and later (2010) years obtained from Korea Ministry of Environment. Topographic variables include mean elevation, slope, and standard deviation of slope. Sociodemographic variables include road density and housing density as well as fiscal self-ratio.

2.2. Methods

ArcGIS 10.6 was used to derive % land cover and other landscape variables as well as map the response variables. We also used correlation coefficient and multiple regression to identify statistically significant factors that affect flood damage in the study area, following a previous study (Bae and Chang 2019).

3. Results and discussion

Flood damage per area is not randomly distributed over space. The higher damage per area include a portion of Seoul, some northeastern Gun in Gangwon province, and other coastal areas in the South. Flood damage per person shows somewhat different spatial patterns. The hotspots are found in relatively low populated areas of Gangwon province and southwestern coastal areas, while the coldspots are shown in mostly populated Seoul metropolitan areas and inner Gyongsanbukdo.

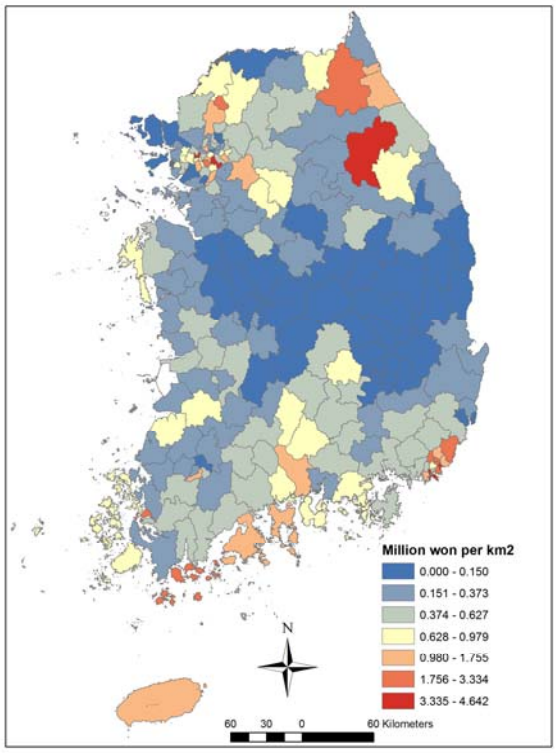

Figure 1. Mean annual flood damage per area, 2010

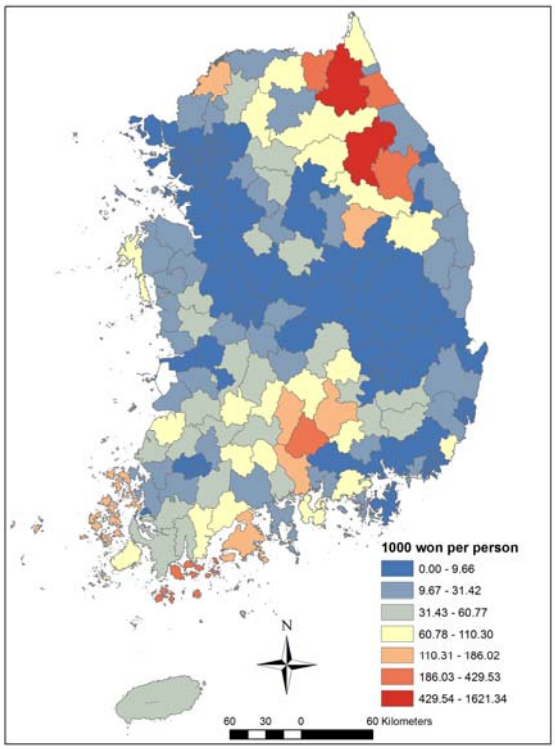

Figure 2. Mean annual flood damage per person, 2010

The most statistically significant factor for flood damage per area is % agricultural land in the 1910 map, followed by percent water in the 1910 map, house density in 2010. Statistically significant factors affecting flood damage per person are mean elevation, percent forest in riparian areas in 1910, and percent forest area in riparian areas in 2000. These findings suggest that conversion of natural forested areas to urban areas has increased flood damage in South Korea.

4.Conclusions

We examined what sociodemographic and landscape factors affect flood damage using two response variables. While specific factors are different for the two different response variables, our results suggest that including historical land cover conditions offer some useful insights for understanding flood damage in South Korea. With the potential increases in floods in coming decades as a result of projected climate change, flood managers could use the findings of this research to better manage land areas.

Acknowledgement

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