E121

Evaluation of the Impact of Flood Risk on Population Movement in Kyoto-city

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Introduction

In recent years, extreme flood events in Japan showed an increasing frequency. Besides the natural drivers such as precipitation and global warming, social constructs and population structure shaped the impact that varied temporarily and spatially (Takahashi, 1971). Population in Japan declined for the first time in 2015 according to the national census, and the trend will persist in the decades to come. Depopulation and aging put more stress on disaster prevention and reduction, compelling the government to leverage risk information and innovative urban planning to improve resistance and resilience. In 2002, Japan Government started providing Flood Maps to inform the public of the inundation depth had a flooding event occurred; however, how people responded to the information remained unclear.

Research Objective

Answering this question entails several challenges. First, many factors may co-influence the population, confounding the impact from risk exposure had it been in place. Previous studies on the geographical distribution of people suggested that risk exposure and migration were correlated (Qiang, 2019), yet the evidence did not prove a causal relationship. Second, people of different age groups may respond differently to the same risk. Sampling the population before and after the flooding in flooded regions, Murai et al. (2019) found that the flood event influenced the residential choices of people aged 25 to 44 but showed no significant impact on the elderly, who were in general reluctant to relocate. In this study, we will investigate whether there is a causal link between exposure to flooding risks and movement of population at different age groups. Kyoto-city published its first flood map in 2004 (fig. 1), and thereafter neither major flood events nor revision on the flood map took place, making it a suitable candidate for our case study.

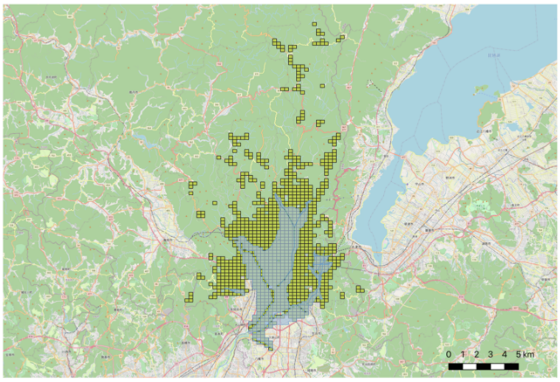

Figure 1: Flood Map and Population Mesh in Kyoto-city

Research Method

To identify migration caused by the risk exposure, we need evidence of the counterfactual— what would have happened had the information on flood risks not been released. The net change in migration failed to provide such evidence. Thus, we use difference-in-difference (DID) method with matching, one of the most popular ways to estimate the effect of a policy change.

Collection of Data: 500 m mesh data of the National Census before and after the issuance of the Flood Map is used to calculate the change in population distribution. To address the heterogeneity of the impact on different age groups, we partition the population by age. We superimpose the Flood Map with the population mesh in QGIS and identify a mesh as a flood-prone unit if its overlap with Flood Map spans more than half the unit. We collect the spatial information that may have an impact on the population (Table.1) and transform them into covariates in our model.

Table 1: List and Source of Data

Data of Collection	Source
Population	ゼンリン会社
Schools	国土数値情報
Railway Stations	
Medical Services	
Parks	
Welfare Institutes	
Shopping Centers/Convenient stores/Supermarkets	
Slope/Elevation	

Causal Models: We aggregate the units exposed to the risk of flooding in the treated group. And we obtain the effect of the treatment, risk exposure in our context, by differencing the difference between the treated group and the control group. The latter is constructed by matching – finding units in the flood-free area with attributes similar to the former. We assume the migration in the two groups would have experienced a parallel trend with time if the risk exposure had not been disclosed (fig.2), and any shocks that affected one group were likely to affect both.

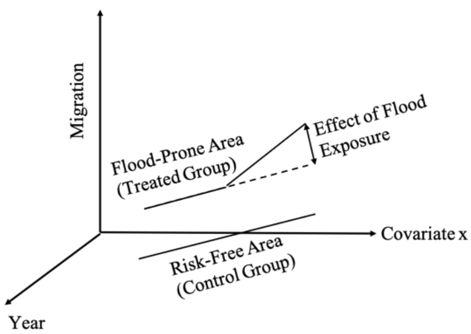

Figure 2: Difference-in-Difference Method

We build three models, all derived from DID concepts but with increasing complexity, and compare their results.

Basic form (two-period and multiple periods):

$$Y_{it} = \alpha + \beta_1 T_t + \beta_2 Risk_i + \beta_3 T_t \times Risk_i$$

Generalized form with control on covariates:

$$Y_{it} = \alpha + \beta_1 T_t + \beta_2 Risk_i + \beta_3 T_t \times Risk_i + \sum_k \gamma_{jit} x_{jit}$$

Risk exposure is included as a dummy and the coefficient of its interaction term, which represents the average impact of flood exposure on migration in the treatment group, estimated by a two-way panel data regression.

Research Significance

Targeting Kyoto-city, this study evaluates the impact of flood exposure on migration. Knowledge in the sensitivity of different age groups to flood risks will facilitate decision-making in spatial planning and disaster reduction. The approach and model comparison in this study can be applied in the analysis of other disaster-related policies.

Reference:

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3. 村井智也・渡部哲史・山田真史・知花武佳：人口予測に基づく水害による人口減少の特徴の把握，水文・水資源学会研究発表会要旨集，32 巻，pp.262-,2019.