

Spatial Analysis of Urban and Regional Environments for the Mitigation of Disasters Caused by Acts of Arson

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Introduction

The most common fires are still incendiary fires, although the number of fires has decreased in the past 10 years in Japan. The rate of incendiary fires, particularly, tends to be higher in urban cities. In this study, we investigated the urban environmental spatial information, as well as the spatial information concerning the fires caused by arson. Accordingly, we analyzed the effects of the surrounding environments on the incendiary fire while referring to the principles of “Safer Places”: (1) Access and Movement, (2) Surveillance, (3) Ownership, (4) Activity, (5) Management and Maintenance, and (6) Structure, which are closely related to the principles of Crime Prevention Through Environmental Design (CPTED)—for instance, Surveillance, Access Control, and Territorial Reinforcement.

Analysis

In this study, first, population survey data, land use data, building inventory data, road data, and railway station data were gathered as urban environmental spatial information by using a geographic information system (GIS) in Osaka City, Japan. (Osaka has approximately 2.7 million people in a 223-km² area; the incendiary fire represents one quarter of all fires in Osaka.) Figure 1 shows the density of incendiary fire incidents per area—determined by kernel density estimation—that displays hot spots for 12 years between 2000 and 2011 in Osaka City. Second, we conducted a multivariate analysis to clarify the characteristics of the sites where the incendiary fires occurred. The number of incendiary fires per unit area was used as a response variable, and the aforementioned urban environmental spatial information was used as an explanatory variable. In this study, the city was divided into approx-

imately 1,000 grids (grid size: 500 m) and divided into approximately 4,000 grids (grid size: 250 m). On the other hand, the city is divided into 332 activity areas by the neighborhood association alliance (Fig. 1), that can be called the “local community area” because its boundary is similar to the elementary school district’s. We conducted the analysis in 500-m grids, 250-m grids, and local community areas, and then we compared these results in order to clarify a suitable evaluation unit for the mitigation of a disaster caused by an act of arson.

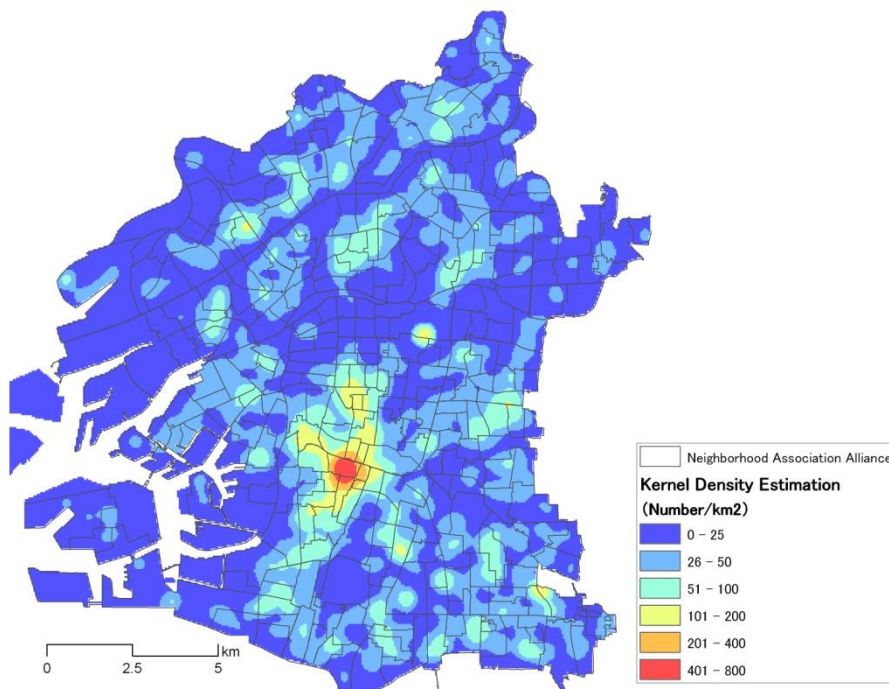


Figure 1: Kernel density map of incendiary fire incidents for 12 years in Osaka City.

Conclusion

It was found that the areas with a high rate of families living in small spaces, a high rate of narrow roads, high populations, and a high number of elderly households tend to have more incendiary fires. The areas near the railway station tend to have more incendiary fires as well. Narrow roads, for example, limit “Access and Movement” or “Surveillance.” It must be difficult that many and various residents have “Ownership” in the limited area. It must be also difficult that the residents have “Ownership” around the station where an unspecified large number of people visit. Moreover, There is a possibility that the high number of elderly households means lower levels of “Activity” or “Management and Maintenance” in those are-

as. Further, the results of the multivariate analysis in the local community area showed a higher coefficient of determination (R^2) value than that in the grid, although the sample size was smaller. This may indicate that the local community area is a suitable evaluation unit for understanding the effects of the surrounding environments on the incendiary fire. Therefore, we suggest that community boundaries based on geography, history, and urban activity are selected as units of urban social spatial analysis (e.g., crime mapping and prevention). The results of the community-based spatial analysis will be helpful in the mitigation of disaster and development of safe communities.

Acknowledgements

We thank an anonymous reviewer for carefully reading our manuscript and for giving useful comments. We would also like to express our gratitude to the Osaka City Fire Department for their cooperation in this study. Moreover, we thank Mr. Ryo Fukutani for his help in this study. Finally, we would like to thank the Fire and Disaster Management Agency of Japan for a grant that made it possible to complete this study.

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