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# Spatial Methodologies for the Analysis of Vulnerability in Urban Areas - A Case Study for Terrorism in Tokyo, Japan

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The geographic analysis of crime risk, criminogenic factors and their spatial influence has gained legitimate interest in the past, most notably by the increased popularity in the Risk Terrain Modeling (RTM) methodology by Caplan & Kennedy. Our research is an attempt to apply this concept to the analysis of vulnerability to terrorism in urban areas. In the course of this effort we developed a generic Spatial Urban Vulnerability Analysis (SUVA) framework. The aim is to analyze the distribution of vulnerability in space based on the attributes of the objects defining that space (such as people, buildings and infrastructures).

This paper is a case study of an application of the SUVA framework in a central area in Tokyo, Japan. First we outline the underlying vulnerability concept, which consists of two factors: susceptibility and disutility. Then we explain the general SUVA framework and analysis methodologies. In the next part we briefly introduce the study area, present the selected vulnerability factors for this case study, and explain their selection process. This is followed by a detailed description of the operationalization of the vulnerability factors using spatial and non-spatial methodologies. We move on to the object-based vulnerability maps and the calculation and visualization of the vulnerability factors' spatial influence. Lastly we combine the single factor maps to a comprehensive vulnerability map of the study area. We conclude the paper with an evaluation of possible target audiences and the overall usefulness of the presented methodology.

Keywords: GIS, spatial analysis, vulnerability, urban, terrorism, Tokyo