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Socio-Economic Vulnerability assessment and validation in Seoul, South Korea

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Vulnerability is regarded as a crucial element in disaster risk reduction, garnering increasing attention from researchers. However, these assessments typically conclude with the spatial representation and analysis of vulnerability index values, with very few attempts made on vulnerability validation. This study has employed Principal Component Analysis (PCA) algorithm for the entire 38 selected socio-economic features, resulting in 9 principal components (or factors) to estimate Socio-Economic Vulnerability Index (SEVI). The results reveal consistent vulnerability levels in over half of the dong (administrative units), compared with SEVI estimated from a subjective weighting scheme based on expert experience. Meanwhile, the remaining dong exhibit a change in only one level of vulnerability. SEVI values and ranks from PCA were subsequently internally validated through global uncertainty and sensitivity analyses using Monte Carlo method. The vulnerability scores of all input features were randomly generated based on their fitted probability distribution functions, serving as input parameters for 39,936 Monte Carlo simulations. The median statistic was employed to evaluate the vulnerability uncertainty based on both bias of estimated SEVI values and ranks in comparison with simulated data. The findings from this analysis revealed that medium-low and medium vulnerability levels tend to be underestimated, while medium-high and high levels primarily witness an overestimation tendency. The bias in SEVI ranks was further employed to assess the vulnerability uncertainty. In the sensitivity test, a tornado diagram was created to illustrate the explanation of each feature to the overall SEVI variability. The results indicate that the feature with highest explanation of SEVI variability is the number of families with only children and a mother, accounting for more than 5%. The methodology employed in this study is applicable to areas with limited social and economic data sources. Based on our findings, we suggest that the areas with low bias on SEVI values or ranks are reliable for developing disaster risk mitigation strategies, while other areas require further consideration. Additionally, the results from the sensitivity test provide valuable support for future research when selecting input features for socio-economic vulnerability assessment.

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