Heat Vulnerability Index (HVI) Mapping in Extreme Heat Days Coupled with Air Pollution Using Principal Component Analysis (PCA) Technique: A Case Study of Amiens, France

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Abstract : Extreme heat events are emerging human environmental health concerns in dense urban areas due to anthropogenic activities. High spatial and temporal resolution heat maps are important for urban heat adaptation and mitigation, helping to indicate hotspots that are required for the attention of city planners. The Heat Vulnerability Index (HVI) is the important approach used by decision-makers and urban planners to identify heat-vulnerable communities and areas that require heat stress mitigation strategies. Amiens is a medium-sized French city, where the average temperature has been increasing since the year 2000 by +1°C. Extreme heat events are recorded in the month of July for the last three consecutive years, 2018, 2019 and 2020. Poor air quality, especially ground-level ozone, has been observed mainly during the same hot period. In this study, we evaluated the HVI in Amiens during extreme heat days recorded last three years (2018,2019,2020). The Principal Component Analysis (PCA) technique is used for fine-scale vulnerability mapping. The main data we considered for this study to develop the HVI model are (a) socio-economic and demographic data; (b) Air pollution; (c) Land use and cover; (d) Elderly heat-illness; (e) socially vulnerable; (f) Remote sensing data (Land surface temperature (LST), mean elevation, NDVI and NDWI). The output maps identified the hot zones through comprehensive GIS analysis. The resultant map shows that high HVI exists in three typical areas: (1) where the population density is quite high and the vegetation cover is small (2) the artificial surfaces (built-in areas) (3) industrial zones that release thermal energy and ground-level ozone while those with low HVI are located in natural landscapes such as rivers and grasslands. The study also illustrates the system theory with a causal diagram after data analysis where anthropogenic activities and air pollution appear in correspondence with extreme heat events in the city. Our suggested index can be a useful tool to guide urban planners and municipalities, decision-makers and public health professionals in targeting areas at high risk of extreme heat and air pollution for future interventions adaptation and mitigation measures.