

Title:

Social-ecological vulnerability assessment of the Cologne Urban area to heat waves

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Abstract:

At present more than 50% percent of the world population is living in urban areas. This proportion is going to increase in the coming decades and more and more people will settle in hazard-prone locations. In particular, urbanization increases the exposure and vulnerability of people to heat waves as temperatures in urban areas are generally higher than in their surroundings because of the Urban Heat Island effect. In parallel, the capacity of ecosystems in urban areas to provide specific services such as climate regulation and air quality purification is often altered and reduced.

The objective of the research is to assess the ecological vulnerability of the Cologne urban areas to heat waves. We based our analysis on the generic framework developed by the MOVE (Methods for the improvement of vulnerability assessment in Europe) European funded project and defined ecological indicators to quantify this vulnerability. In particular, the identification of the relevant

ecosystem services which influence the vulnerability of the population in urban areas were identified and indicators to measure the role of different land cover types for climate regulation and air quality mitigation potential were developed. The methodology makes use of GIS applications to spatially assess the vulnerability, described as the result of exposure, susceptibility and lack of resilience, of different districts to heat waves.

The Population Distribution was multiplied by the mean surface temperature per district in Cologne to calculate the exposure indicator to heat waves. The population distribution was computed for all the 85 districts. Susceptibility indicators measure the predisposition of society and ecosystems to suffer harm resulting from the levels of susceptibilities or fragilities of settlements and disadvantageous conditions as well relative weaknesses related to heat waves. This component was calculated by finding the ratio between the sealed areas and unsealed areas (greenery and water bodies). The Lack of Resilience indicator measures the limitations in access and mobilization of resources in the system, and the incapacity to respond in absorbing the impact. This component, was computed using the formula $(1 - (\text{percentage of green and water areas per district} * \text{coefficient of cooling effect of each land cover type}))$. Finally a vulnerability map was produced as a result of the values of the three components described above. According to the presence, state and characteristics of the ecosystem services the districts considered different degrees of vulnerability. In particular, districts at the centre of the urban areas, with fewer green and blue spaces, represent the higher ecological component of vulnerability to heat waves.