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A spatial meta-indicator for identifying and evaluating hotspots of climate-related drivers for conflict and migration in the Sahel

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The countries of the Sahel are among the countries currently most affected by global climate and/or environmental change. The combination of multiple stresses, such as endemic poverty, population pressure due to high population growth rates, prevailing dominance of the primary sector, complex governance, political instability, population displacement due to natural or man-made disasters, highly degraded environments, etc. and the resulting weak adaptive capacity make the Sahel one of the most vulnerable regions to the projected effects of climate change. Against this background, based on a request from UNEP-PCDMB (Disasters and Conflicts), a comprehensive study focusing on the implications of climate change on conflict dynamics and migration patterns in the nine Sahelian countries which are forming the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS) was conducted by the Centre for Geoinformatics (Z_GIS) at Salzburg University.

Within this context a mapping task was carried out highlighting observed changes for the past 20 to 30 years (depending on data availability) concerning a set of four climate-change induced drivers as well as migration and conflict patterns for the nine CILSS member states and their neighbouring countries based on time-series of freely available global datasets. The four climate-related drivers were: (1) erratic temperature and rainfall patterns, (2) drought occurrences, (3) major flood events, and (4) sea level rise.

In addition to solely using these singular indicators to deliver information on specific components of the complex and manifold nexus of climate change, as well as migration and conflict, a spatial meta-indicator was developed for highlighting and assessing hotspots of the climate-related drivers, and the migration and conflict patterns in the target area. The developed meta-indicator was composed by integrating and weighting the singular indicators in a multi-dimensional feature space, making use of normalization (for this study an 8 bit value range had been applied as new value range to each of the integrated drivers) and regionalization techniques (Kienberger et al., 2009). The resulting conceptual spatial entities, instances of geons (Lang et al., 2008) are homogenous in terms of their response to the climate-related spatial phenomena under concern. The applied concept is a method for delineating units where similar spatial conditions apply with respect to a set of defined spatial indicators. Consequently, for each delineated unit a hotspot intensity (HI) value was calculated considering the six integrated layers ($v_1, v_2, \ldots, v_6$) in a six dimensional feature space trough the vector product:

$|HI| = (v_1^2 + v_2^2 + v_3^2 + v_4^2 + v_5^2 + v_6^2)^{0.5}$

In order to ease the subsequent interpretation of the results, values were standardized within a new range from zero to one [0, …, 1], where zero reflects a very low and one a very high hotspot intensity. Building on that, all units with significant hotspot intensity (> 0.75) were defined as the actual hotspots. Next to the location and estimated size of the delineated hotspots, the specific composition of the hotpots was visualized by means of a pie chart for each of them, showing the relative proportion of the contributing drivers or indicators. Consequently, not only the approximated size and location, but also the quality of the respective hotspot was determined and mapped, indicating to policy makers or stakeholders where further fine-scaled studies could be conducted and at the same time highlighting which domains should be addressed in particular.

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