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Analysis of Composite Health Risk Indicators Built at a Regional Scale and Fine Resolution to Detect Hotspot Areas

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Abstract : Analyzing the relationship between environment and health has become a major preoccupation for public health as evidenced by the emergence of the French national plans for health and environment. These plans have identified the following two priorities: (1) to identify and manage geographic areas, where hotspot exposures are suspected to generate a potential hazard to human health; (2) to reduce exposure inequalities. At a regional scale and fine resolution of exposure outcome prerequisite, environmental monitoring networks are not sufficient to characterize the multidimensionality of the exposure concept. In an attempt to increase representativeness of spatial exposure assessment approaches, risk composite indicators could be built using additional available databases and theoretical framework approaches to combine factor risks. To achieve those objectives, combining data process and transfer modeling with a spatial approach is a fundamental prerequisite that implies the need to first overcome different scientific limitations: to define interest variables and indicators that could be built to associate and describe the global source-effect chain; to link and process data from different sources and different spatial supports; to develop adapted methods in order to improve spatial data representativeness and resolution. A GIS-based modeling platform for quantifying human exposure to chemical substances (PLAINE: environmental inequalities analysis platform) was used to build health risk indicators within the Lorraine region (France). Those indicators combined chemical substances (in soil, air and water) and noise risk factors. Tools have been developed using modeling, spatial analysis and geostatistic methods to build and discretize interest variables from different supports and resolutions on a 1 km2 regular grid within the Lorraine region. By example, surface soil concentrations have been estimated by developing a Kriging method able to integrate surface and point spatial supports. Then, an exposure model developed by INERIS was used to assess the transfer from soil to individual exposure through ingestion pathways. We used distance from polluted soil site to build a proxy for contaminated site. Air indicator combined modeled concentrations and estimated emissions to take in account 30 polluants in the analysis. For water, drinking water concentrations were compared to drinking water standards to build a score spatialized using a distribution unit serve map. The Lden (day-evening-night) indicator was used to map noise around road infrastructures. Aggregation of the different factor risks was made using different methodologies to discuss weighting and aggregation procedures impact on the effectiveness of risk maps to take decisions for safeguarding citizen health. Results permit to identify pollutant sources, determinants of exposure, and potential hotspots areas. A diagnostic tool was developed for stakeholders to visualize and analyze the composite indicators in an operational and accurate manner. The designed support system will be used in many applications and contexts: (1) mapping environmental disparities throughout the Lorraine region; (2) identifying vulnerable population and determinants of exposure to set priorities and target for pollution prevention, regulation and remediation; (3) providing exposure database to quantify relationships between environmental indicators and cancer mortality data provided by French Regional Health Observatories.

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