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The Potential of Spatial Data and Models in Health Research

The greatest potential of geospatial data and modeling in health research, in my opinion, lies in the *integration of disparate datasets* from within and outside the health realm, as well as in the *visual power of maps*. The ability of geographic information systems (GIS) to integrate data through their geographic references, and the persuasiveness of the graphical presentation of research results to decision-makers have been documented extensively in the GIScience literature. The exponential increase of open-access base maps, online mapping APIs, and interactive geovisualization tools has opened the door to ever more users and uses of geospatial data and modeling.

An additional potential, which is less commonplace than the above, is the use of normative spatial models. Modeling is often descriptive, predictive, and/or explanatory, representing processes and behaviours, attempting to forecast them, and ultimately explain them. In decision analysis, however, modeling is often normative or prescriptive, representing how actors *should* behave instead of how they are behaving or will behave, or why they act in the ways they are. Normative models such as multi-criteria decision-making have been integrated in GIS concepts and tools, and have a great potential of informing health service planning and public health policy decisions.

Besides the *potential* of geospatial tools for health research, I do also see significant *risks* associated with their use in the health domain. There is strong pressure by researchers and other interest groups in government and industries (e.g., insurance) to gain access to individual health data. But this is probably the most sensitive information one can attain about a person. Other risks include excessive expectations for the utility of GIS tools in handling individual-level and small-area health data, and for the ability of GIS to explain health outcomes at higher levels of aggregation.

While health research can benefit from geospatial data and models, the relationship also holds the other way around: I believe that the further development of geographic information theories, methods, and tools will benefit tremendously from health research. Health applications exacerbate normal expectations on data and model accuracy, privacy protection, visualization capabilities, analytical performance and precision, and support for the interpretation of results, which impose significant challenges on GIScience research and GIS development.

Personal Research Context

As a GIScience researcher, I have been involved in public health applications of GIS since nearly ten years, starting with invited presentations in 2004/05 on interactive and online mapping for decision support at the Ontario Tobacco Research Unit within the Centre for Addiction and Mental Health, Toronto, and at the Inner City Health Research Unit and Injury Prevention Research Office within St. Michael's Hospital, Toronto. Articles subsequently published in GIScience journals focused on conceptual issues of combining exploratory geovisualization of social determinants of health with spatial multi-criteria decision analysis, and designing effective online mapping tools for public health planning and policy support (Rinner & Taranu 2006; Cinnamon et al. 2009a,b; Rinner et al. 2011). Although addiction and mental health, inner-city health issues, and injury prevention continue to be of interest, I find that a project on developing a spatially explicit heat vulnerability assessment for the City of Toronto addresses this Vespucci Institute's theme "synthesizing population, health and place" most comprehensively.

Extreme hot weather is becoming an increasing threat to human health in urban areas across the globe. Vulnerability to heat-related illness is not equally distributed among the population, and places of residence, work, and leisure activity play an important role in heat exposure and heat sensitivity. In Toronto, heat waves cause an average of 120 premature deaths each year, and the number of extremely hot days is expected to increase significantly with climate change. In collaboration with Toronto Public Health, we developed a heat vulnerability assessment approach to complement the existing heat alert system and guide hot weather response and community outreach within the City. Heat vulnerability indices for the general population and for seniors were created for small-area geography as a weighted combination of 30 socio-economic, health, and environmental variables using multi-criteria decision analysis. The indices along with the exposure and sensitivity indicators were mapped in a report and online. Currently, the indices are undergoing statistical validation.

The heat vulnerability assessment project has provided me with a broad range of experiences in research, teaching, and community service. The project represents a real-world application of spatial multi-criteria decision analysis and cartographic design concepts that were otherwise limited to student projects and classroom exercises. It also allowed me to develop a conceptual model of map-based decision support. Preliminary results were published in Rinner et al. (2010), while two project reports were made publicly available at http://www.toronto.ca/health/hphe/air_quality/report_climate.htm along with City-internal reports. The project also motivated a series of 1st-year cartography lab assignments, which required students to manipulate raster and vector data to create a mini-atlas of heat vulnerability in Toronto, and it spawned senior undergraduate and graduate student projects on the relationship between land-use and surface temperature (Rinner & Hussain 2011), on crowd-sourcing of heat information from Twitter (under review), and on spatially explicit variants of composite indices (in progress).

Expectations for the Institute

The Institute will take place towards the end of my one-year sabbatical. While I have used the fall to complete unfinished manuscripts, and plan to use the winter to write several chapters of a monograph in one of my main fields of interest, spatial multi-criteria decision analysis, I would like to conclude the sabbatical by exploring new research directions and new contacts with academics and practitioners. The Vespucci Institute and the subsequent AAG conference will provide an excellent starting point for this. Areas of particular interest in the Institute include crowd-sourcing and "volunteering" of health information; health data management and masking of individual records; immersive geovisualization techniques; as well as environmental health and global health applications of geospatial analysis.

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