User Task Scenarios for Map-Based Decision Support in Community Health Planning

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INTRODUCTION

Health outcomes are affected by the socio-demographic and physical-environmental characteristics of the places where people live. Therefore, epidemiologists have been interested in the use of maps to explore spatial patterns of disease for a long time. Geographic Information Systems (GIS) are not only useful when visualizing complex spatial datasets but also when mapping the results of analytical processes. One such process is multi-criteria evaluation (MCE), which can be used to generate composite measures of public health based on individual, medical and non-medical factors.

The objective of this study was to determine if geovisual MCE can be an effective tool in community health planning. We provided highly interactive thematic maps coupled with MCE tools to planners at a community health centre and evaluated their use for community health planning and decision-making. User task scenarios were designed in a way to compare the usefulness of different representation methods for a number of tasks.

The pilot user test with two expert participants included interviews, questionnaires, and user task scenarios with think-aloud audio and screen video recording. We assessed the easiness of completing the tasks using completion rates and times and could identify a number of specific usability issues with the tool at hand.

RESEARCH CONTEXT

Geographic visualization describes the approach to explore geospatial phenomena through visual thinking (MacEachren 1994, Jiang 1996, MacEachren and Kraak 2001). More recently, the integration of analytical methods within geovisualization has been termed geovisual analytics (Kraak 2007). A multi-disciplinary approach involving geovisualization, decision science, data mining, and human-computer interaction was suggested by Andrienko et al. (2007). Examples of multi-criteria analysis linked with geovisualization tools were given by Jankowski et al. (2001), Andrienko and Andrienko (2002), Rinner and Malczewski (2002), and Rinner (2007). Few case studies used exploratory map-centred multi-criteria evaluation in public health planning (Jankowski et al. 2001; Rinner and Taranu 2006).

The development of geovisualization tools has largely been technology driven but recently, there was a shift towards user-centred design (Fuhrmann et al. 2005). Different evaluation methods can be selected to yield quantitative performance measures or qualitative user feedback. Ideally, a number of evaluation techniques should be employed to thoroughly assess a tool's effectiveness (Sweeney et al. 1993; Tobon 2005).

A study conducted by Koua, et al. (2006) measured the ability of a visualization-computational system to meet user requirements. The tasks in their study were categorized based on taxonomies suggested by Keller and Keller (1992), Wehrend and Lewis (2000), and Zhou and Feiner (1998). The categories were created based on real world visualization issues and included operations such as identify, query, cluster, rank, compare and correlate.

CASE STUDY AND METHODS

Socio-demographic variables from the 2001 Canadian Census and from a community health centre were pre-processed for 140 neighbourhoods within the City of Toronto. The *CommonGIS* software (Andrienko and Andrienko 1999) including its analytic hierarchy process (AHP) extension (Rinner and Taranu 2006) were set up to represent composite measures of healthcare needs with the ability to adjust weightings and include or exclude variables to quickly run decision-making scenarios.

The participants in this pilot study were two research staff members of a community health centre who are experts in neighbourhood health data analysis. However, they had limited experience with GIS software and would be classified as novice users with respect to geovisualization tools. There were 15 usability tasks which were completed in linear order using eleven components of the software. These components included choropleth maps, utility bar maps, parallel coordinate plots, and the AHP (see Figure 1).

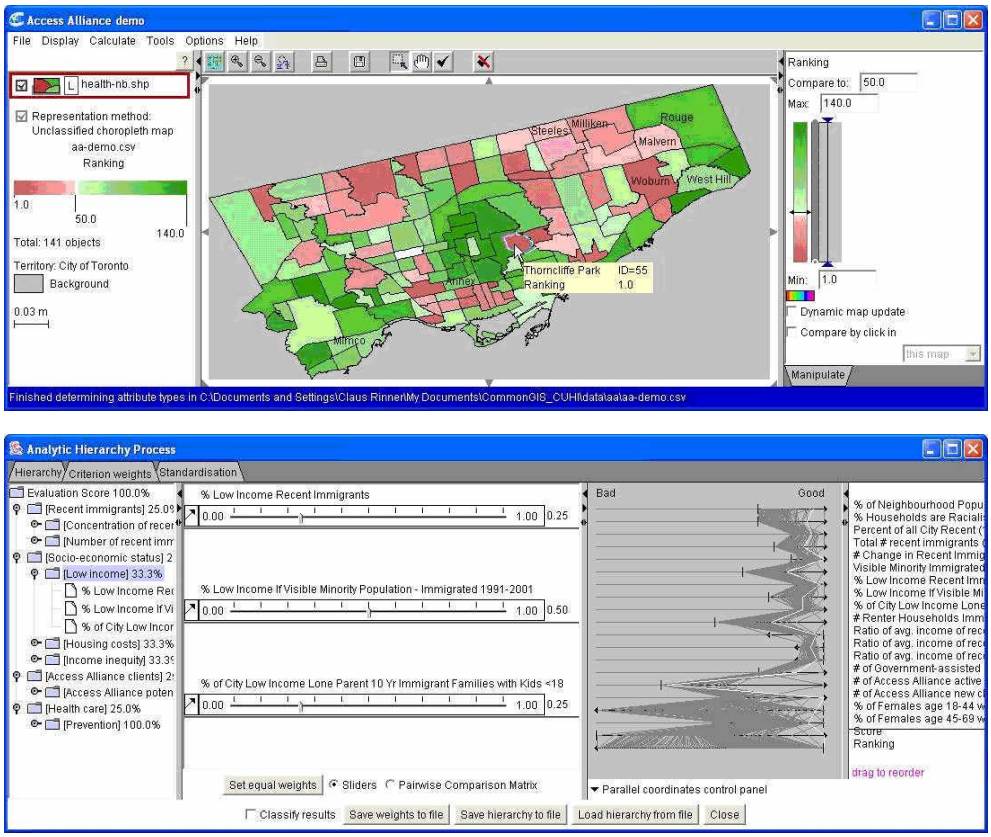

Figure 1: CommonGIS user interface showing an unclassified choropleth map of ranks of Toronto neighbourhoods by their need for health services (top – red indicates high need) as well as the multi-criteria evaluation tool with a hierarchy of community health indicators (bottom left), indicator weighting (bottom centre), and a parallel coordinate plot (bottom right). All displays and calculation functions are dynamically linked to support interactive, map-based decision support.
(Data source: Statistics Canada, Census 2001, and Access Alliance Multicultural Health and Community Services).

The user test employed a combination of formative and summative methods. These included tutorials, interviews, user task scenarios with the think-aloud protocol as well as the use of standard performance measures. The recording of the participants' on-screen activity was assisted by *Camtasia Studio 4.0.1* and a microphone. Furthermore, records of testing and the development of usability graphs were supported by the Microsoft Excel-based *Usability Datalogger 4.2*.

RESULTS AND DISCUSSION

Effectiveness is illustrated in Table 1 through task completion rates. Although no task was labeled as hard, and no task was considered as failed, both participants required assistance with tasks in the Query, Identify, Classify, Distribution, and Locate categories (grey cells).

Task	Representation Method	Easy	Medium	Hard	Assistance	Fail
Compare	Cross-classification map	x			x	
	Utility bars	x	x			
	Parallel coordinate plot		x, x			
Rank	Unclassified choropleth	x, x				
	Attribute table sort	x			x	
Query	Dynamic query				x, x	
Identify	Cursor over map	x, x				
	Select features in legend		x, x			
	Index of objects				x, x	
Classify	Classified choropleth				x, x	
Distribution	Unclassified choropleth				x, x	
	Unclassified choropleth	x			x	
	Unclassified choropleth	x	x			
	Utility bars		x		x	
Locate	Analytic Hierarchy Process				x,x	
Total		9	7	0	14	0

Table 1: User task scenarios, representation methods, and task completion (effectiveness).

The same tasks also emerged as requiring the longest time to be completed by participants, representing efficiency. The delays for the tasks highlighted in Table 1 (with the exception of the identify task) ranged from roughly three to eight times the completion time of the remaining tasks.

Usability issues were identified by the participants during the test. Generally, there were three reasons why participants required assistance with tasks: The interpretation of the representation method was not intuitive, the corresponding functionality was cumbersome to use, or locating the function was difficult.

The average rating in the post-test questionnaire for perceived usefulness was 6.25 out of 7 and for perceived ease of use 4.9 out of 7. These values indicate that the participants felt that CommonGIS was a useful geovisualization tool and that they were willing to use it. However, the overall system usability only received a score of approximately 60 out of 100, which indicated that CommonGIS was not assessed as user-friendly.

Acknowledgements

We would like to thank Access Alliance Multicultural Health and Community Services for their support of this research. The contribution of the participants in the case study is gratefully

acknowledged. Partial funding was provided by the Natural Sciences and Engineering Research Council of Canada (NSERC) and the GEOIDE Network of Centres of Excellence in Geomatics.

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