Integration of real-time weather data and Geographic Information System (GIS) for use in transportation

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Description du projet

The objective of the proposed research is to integrate real-time weather data from radars and numerical models with GIS (Geographic Information System), with applications to the transportation industry. Weather can greatly affect the cost of transportation. Extreme weather events such as blizzards and floods can damage transportation infrastructure. Conversely, inaccurate warnings of adverse weather conditions can also increase transportation costs. Operational decision making thus requires timely and accurate dissemination of weather data, including both knowledge of current weather and a forecast of future weather, that is tailored specifically to the needs of the transportation industry.

GIS is a powerful software which works with complex spatially distributed data, so that patterns and geographic relationships can be visualized, characterized and extracted. Such a system can be applied to decision making in different areas. An example is the use of GIS to help public officials in planning evacuation of populated areas based on their proximity to a fire. The data in this case are meteorological (wind speed, humidity, precipitation and temperature), demographic (population distribution in a city) and the physical characteristics of the area in question (topography, burning capacity). GIS would integrate these data and analyze them to provide estimates of zones most vulnerable to fire damage; the results are then displayed in a user-friendly manner.

We propose to develop a GIS-based prototype weather advisory system for road transportation in Montreal, that integrates weather information from the McGill radar and high resolution regional weather prediction models. The meteorological data would include precipitation of different types, winds and temperature. This information will be integrated with the road network of the city through GIS to provide weather-related decision support for transportation.

The principal investigator (C. Lin) has extensive experience with high resolution regional numerical weather prediction models, and has worked with radar data as well. Examples of recent research of his group includes the comparison of precipitation retrieved from the McGill radar with values simulated by models, and the coupling of meteorological and hydrological

models for flood forecasting. Through hydrological modelling, his group also has acquired GIS expertise using the Arcview system. The co-investigator (A. Langevin) is an expert in operations research, and has extensive experience with the application of routing algorithms for winter road maintenance for the city of Montreal. The team thus has the necessary experience to carry out the proposed research.

C. Lin and A. Langevin are already working together in a separate project funded by RCM2 on Nowcasting and Decision Making. The current proposal builds upon this collaboration; it is yet distinct from the Nowcasting project, as GIS plays no role in the Nowcasting project. The proposed research is another example of how meteorological and decision making expertise can be combined for real world problems, transportation in this case. This combination of expertise is a direct result of collaboration between traditionally distinct mathematical modelling communities, and is made possible through RCM2.

We have initiated, but have not completed, contacts with two industrial sectors. They are the GIS software company ESRI Canada, and the transportation authorities of the city of Montreal. GIS software which incorporates weather radar data has been developed in the U.S. by ESRI and the weather private sector; however, no Canadian weather data are included. This is a result of two factors. In the U.S., there is already a functioning nation-wide network of weather radars (NEXRAD) provided by the U.S. National Weather Service. In Canada, Environment Canada is in the early stages of a 5-year project that will provide a radar network covering the major population centres. The McGill radar is part of this network. The second factor is the lack of a significant weather private sector in Canada. There is thus a window of opportunity in Canada. Our proposal takes advantage of this opportunity, to do the research and development needed to integrate Canadian weather data with GIS. Initial contact with ESRI Quebec is positive; they are very much interested in the research and development proposed here to integrate weather data with GIS for the city of Montreal (see the attached letter).

The research program consists of three sub-projects. The first is the preparation of weather data from the McGill radar and high resolution numerical models in a format that is appropriate for integration with GIS. The second is the integration process itself. This involves the visualization and analysis of the weather data in the Montreal area using GIS, focusing on the road transportation network. The third sub-project consists of scenario studies using selected cases of extreme weather events which has affected the transportation network of the city, such as the summer flooding of 1987 and the 1998 January ice storm. This involves the issuing of timely and reliable warnings of adverse weather conditions in relevant geographic areas, based on the integrated system.

Our research will result in a prototype weather advisory system for the Montreal road transportation system, which fully integrates weather information from the McGill radar and Canadian high resolution models with GIS. Such a system issues proactive alerts for decision makers, in the “push data” rather than “pull data” mode. The prototype will also be applicable to other urban centres in Canada.