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MUNICIPAL RISK ASSESSMENT TOOL (MRAT)

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ABSTRACT

MRAT is a made-in-Canada tool that overlays municipal data sets and insurance claims data onto an interactive map. The tool allows infrastructure managers to accurately identify areas with frequent insurance claims and easily identify where a more in-depth assessment should occur. The tool facilitates an understanding of risk factors to potentially impacted areas allowing owners to start to diagnose problems and generate solutions before flooding occurs. The process began with an original objective that would identify areas where there are an increased number of insurance claims. Early in its development, it became obvious that it could be a valuable tool for infrastructure managers. The team included three pilot municipalities from across the country that provided knowledge, data and feedback on the tool. As the power of the tool was developed and validated for municipalities and insurers, meteorologists were engaged to supplement the tool's decision making capacity in developing future climate scenarios. On the surface, the tool is innovative because it a represents a marriage of datasets that do not naturally come together. With the unprecedented challenges of climate change and aging infrastructure, our standard practices and relationships need to be innovated. The tool provides objective proof that sharing information amongst stakeholders is valuable and benefit all parties including the public. Engineering is increasingly multi-disciplinary and there are exciting opportunities to facilitate continuous improvement by stretching traditional engineering paradigms. Prior to this tool, municipalities did not have access to claims information unless citizens took the initiative to report their claims.

Keywords: extreme weather events, climate change, flooding, risk assessment, stormwater infrastructure, statistical discrimination,

1. EXECUTIVE SUMMARY

"Extreme weather events" caused by climate change are occurring with increasing intensity, duration and frequency. They are also revealing vulnerabilities in existing municipal infrastructure. The Municipal Risk Assessment Tool (MRAT) was developed to answer the following questions posed by Insurance Bureau of Canada (IBC):

- What is the current risk of sewer back-ups on existing climate conditions across Canada?
- What is the potential future risk of sewer back-ups based on current climate change projections?
- Is existing infrastructure adequate to address current and future climate conditions?

MRAT's map-based web portal provides a visual representation of basement sewer back-up risk zones within a municipality based on the existing sewer system parameters and present / future climatic factors unique to that municipality. Risk assessments are developed using statistical discrimination analysis which has various benefits as a statistical tool.

MRAT identifies which infrastructure investments should be prioritized, area's of similar characteristics, access to updated rainfall return statistics and information on climate patterns. Coquitlam, BC was one of three Canadian municipalities where MRAT was piloted.

1.1 The Problem

IBC members are concerned about the effects climate change plays on insurable assets. Examples include:

- Insured losses from natural disasters in 2013 – including Alberta and Toronto floods – are close to $3 billion, highest in Canadian history
- Replacement cost for Canada's sewer and stormwater infrastructure is $55 billion, according to the Federation of Canadian Municipalities
- Single largest contributor to claims for property owners since 2010 is sewer back-ups, historically it was fire

2. PROJECT OBJECTIVES, SOLUTIONS AND ACHIEVEMENTS

Dillon developed MRAT to answer the following for IBC:

- What are the current risks of sewer-backup claims based on existing infrastructure and climatic conditions?
- What are the future risks of sewer-backup claims based on existing infrastructure and future climatic conditions?
- Are current infrastructures performing at acceptable levels?
- Are there vulnerabilities in current infrastructure that require mitigation?

MRAT's verifiable approach uses municipal data, insurance claims historic data, advanced data analytics and web-based tools. Its three primary components are:

- Data acquisition (includes municipal information, claims history and climate)
- Processing, modelling and advanced analytics
- Interpretation and utilization of maps

The process incorporates four main variables so that hazard, exposure and vulnerability of sewer back-up within a selected study area are addressed. In addition, the risk formula of MRAT uses two kinds of climate information to assess risks under different climate change scenarios. The climate information used is:

- Historic information based on existing climate data using Intensity Duration Frequency (IDF) curves which graphically represent the probability of average rainfall intensity
- Range of possible risk, due to changing climate as projected by climate change modelling and downscaling

"Extreme weather events that used to occur infrequently are now happening once every few years. Climate change is giving us more extreme storms and more extreme rainfall events. We are proud to have partnered in the development of the MRAT tool which is the most advanced analytical tool of its kind for predicting vulnerabilities in our infrastructure" said Dana Soong, Manager Utility Programs and MRAT technical expert for the City of Coquitlam.

MRAT's web portal provides a visual representation of basement sewer back-up risk zones within a municipality based on the existing sewer system parameters and present and future climatic factors unique to that municipality. The tool benefits municipalities in the following ways:

- Identifying areas which infrastructure investment should be prioritized
- Identifying areas of similar characteristics that can benefit from improved planning and design requirements as urban development occurs
- Offering access to updated rainfall return period statistics
- Providing information about future climate patterns

Encouraging both public and private entities to work collaboratively in partnership to develop the MRAT predictive tool has been challenging. All parties, including IBC, its member firms and municipal experts, are concerned with changing weather patterns. The MRAT tool has shown potential to allow alternate strategies for mitigation plans for municipalities to minimize the risk associated with expected climate change.

Many municipal engineers have developed their own risk assessment processes based on local history of sewer back up and overland flooding. Building municipal support for a common methodology that complements their local experience has been the key to develop and validate the MRAT.

3. TECHNICAL EXCELLENCE AND INNOVATION

Historically most municipal infrastructure has been designed on the premise that climate is stationary and historical climate data can effectively be used to predict future design needs. A consequence of climate change is an increase in vulnerability to existing infrastructure and thus a challenge to current and future planning initiatives.

The ability to quantify risks under different climate change scenarios can help municipal infrastructure asset management authorities explore the implications of a changing climate on infrastructure. Specifically, it looks to update design standards for infrastructure projects to account for climate changes.

Dillon collaborated with Tesera Systems Inc. from Calgary, AB to develop the model and work through the analytics component of the project. Advanced geomatics and risk analytics were critical in developing MRAT as a usable tool for predicting environmental outcomes and creating a business solution that worked for IBC and the municipalities.

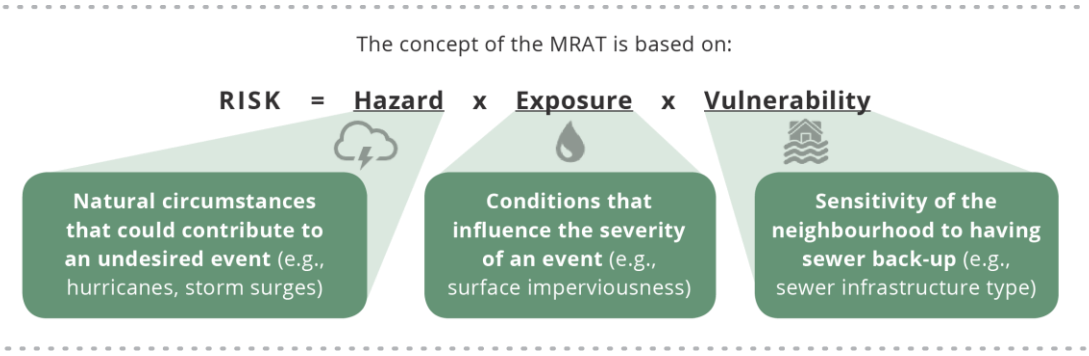

Figure 1: Concept of MRAT

Risk assessments are developed using statistical discrimination analysis which has various benefits as a statistical tool. For MRAT, it is used to determine which predictor variables are related to the dependent variables to assign data. As variables differ for each municipality, every risk assessment is unique.

Combining data from multiple sources to deliver a concise map became a challenge due to the different types of data that were available. Consistent data are necessary in order to develop a predictive tool. By combining the various data sources, the core team has developed data standards that ensure a standard level of output, and added additional data alternatives to enhance the analysis, and to ensure accuracy.

There are a multitude of input variables that affect the risk, vulnerability and exposure of a neighbourhood to sewer back-up risks due to climatic events including:

- Climatic
- Infrastructure
- Operational
- Physical variables

The web-based tool combines data to estimate the risk of sewer backflows today and in the future as the climate changes. MRAT compiles the following information to develop results:

- Municipal infrastructure and land use
- Climate history and climate modelling of the future
- Insurance claims history

This innovative visual representation of storm and sanitary sewer back-flow risk zones within a municipality based on the existing sewer system parameters and present and future climatic factors provides municipalities with verifiable data modelling that will aide in the determination of updating infrastructure assessments. The ability to calculate costs and benefits of infrastructure investments more accurately, access to updated rainfall return period statistics and providing information about future climate patterns ensures municipalities have the information they need to make informed decisions.

4. ENVIRONMENTAL, ECONOMIC, AND SOCIAL SUSTAINABILITY AND AESTHETICS

MRAT will be used by city engineers to help them identify infrastructure problems, not just now but in the future as our weather gets more extreme. It allows municipalities to build on their traditional risk management approaches using the MRAT innovations that leverage data and advanced technology. Coquitlam, BC, Fredericton, NB, and Hamilton, ON piloted MRAT and partnered with IBC on a major national launch. Six other Canadian cities (London, ON, Winnipeg, MB, St. John's, NL, Moncton, NB, Halifax, NS and Bathurst, NB) have shared their infrastructure data with IBC and are moving forward on the planning process.

MRAT will help enable municipalities to better forecast, prepare for and adapt to future extreme weather events, leverage limited infrastructure dollars, and determine where best to focus capital infrastructure investment to lower the future risk of flooded basements and reduce the number of sewer back-up claims and related insurance claims.

The tool shows that through the use of advanced modelling, municipalities can better predict potential future infrastructure issues. This proactive approach illustrates how advanced engineering can make the places in which we work, live and play safer and less susceptible to the severe effects of our changing climate.

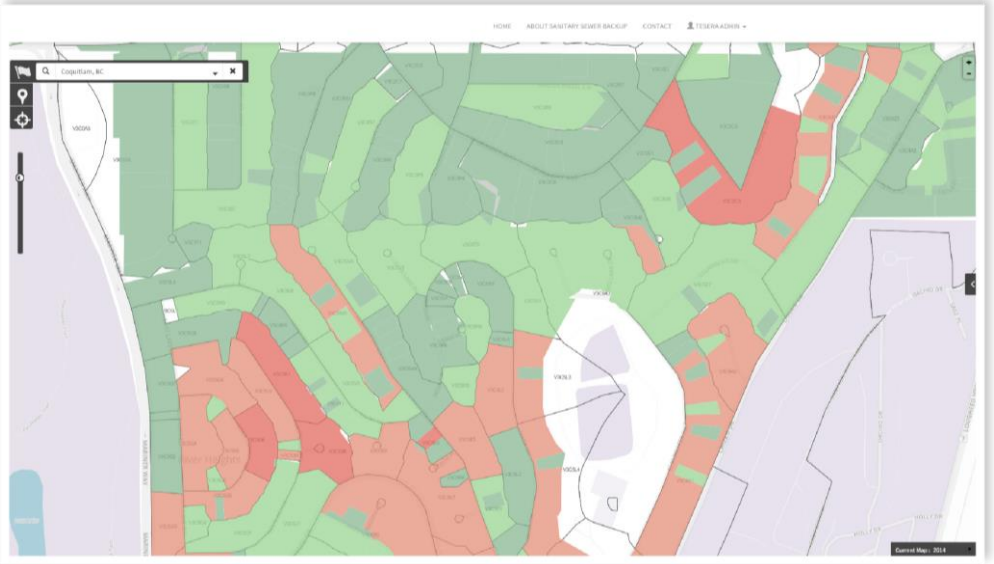

Figure 2: Sample View of Flood Risk Map of Coquitlam

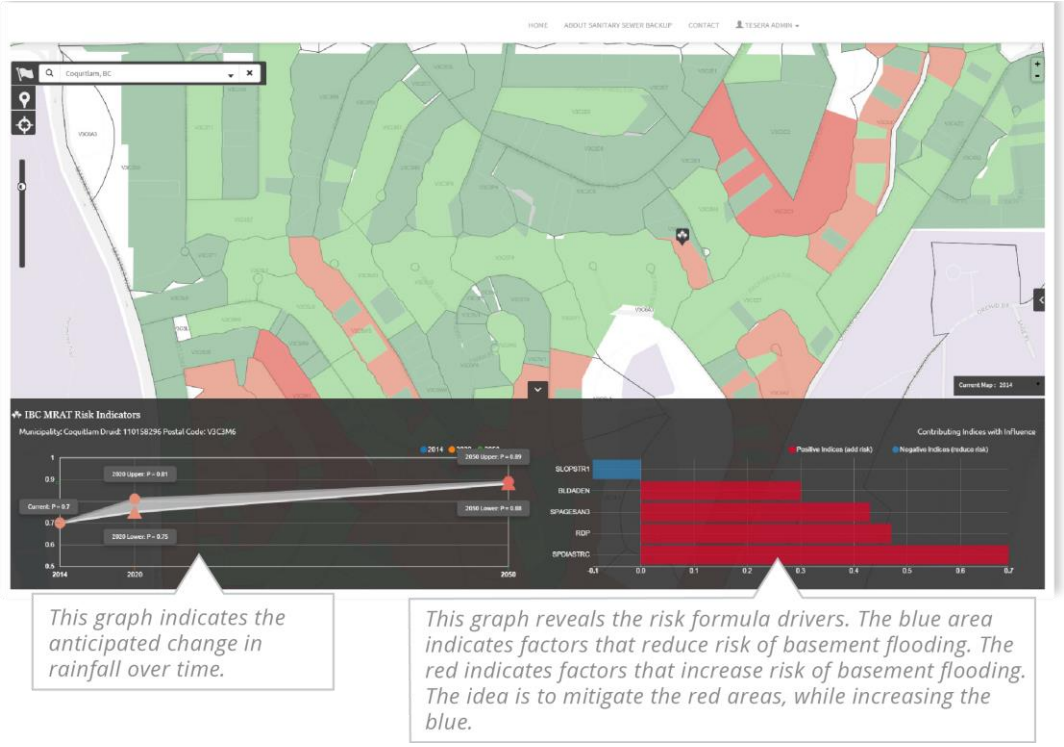

Figure 3: Sample View of FLood Risk Map of Coquitlam, With Information Graphs at Bottom

Figure 4: Sample View of Split Screen Ability to Better Showcase Specific Risk Information on the Flood Risk Map