Performance Indicator Summary

Performance indicator: Cost of the damage due to flooding of residential buildings

Technical Workgroup: Coastal TWG – Lower river

Research by: Environment Canada, Meteorological Service of Canada – Hydrology (Bernard Doyon *et al.*)

Modeled by: B. Doyon (in the Flood Damage Assessment System), and also B. Werick (in the STELLA Shared Vision Model)

Activity represented by this indicator: This Performance Indicator allows the assessment of the damage due to flooding of the properties located within the St. Lawrence River 100-year return floodplain. The assessment is done at the municipal level and the costs include the damage to the structure of the residences and their content.

Link to water levels: The damage due to flooding of a single residence is closely linked to the water depth inside the house. However, for practical reasons, the damage assessed at the municipal level is related to the water level recorded at the nearest hydrometric station (from which the flood peak is read). Such regional stage-damage curves are constructed by aggregating the results from the large scale application of local flood depth-damage curves.

Importance: As far as inundations are concerned, this indicator is the most important one because it allows the assessment of the most significant source of economic loss in the study area. It is also the only indicator that assesses the damage in terms of dollars. Moreover, the indicator covers the bulk of the potential damage, 89% of the buildings constructed within the St. Lawrence 100-year floodplain being residences.

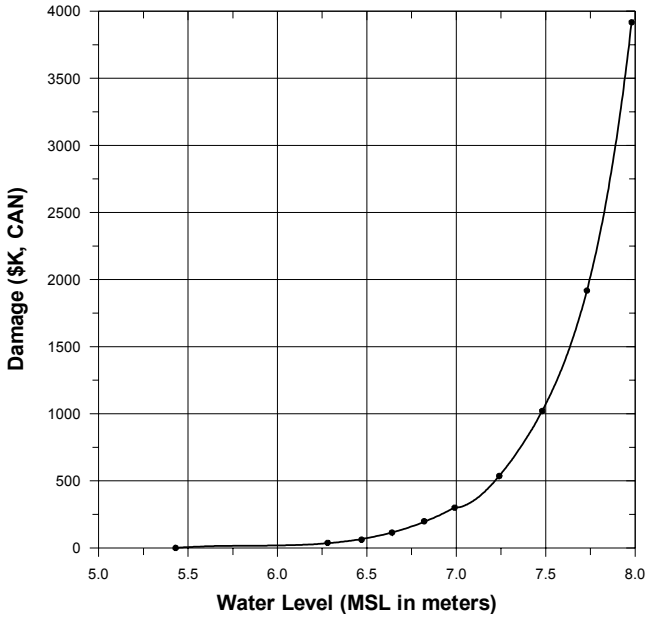
Performance Indicator Metrics: American dollars (of 2003).

Temporal validity: The useful life of a stage-damage curve is usually around 15 to 20 years. However, the curves are not valid for ice-covered conditions of the river and they are not applicable for the damages resulting from the obstruction of the flow by an ice jam.

Spatial validity: One regional stage-damage curve has been developed for every municipality where at least one building lies within the 100-year return floodplain. From Cornwall to Trois-Rivières, there are 41 municipalities in that situation (note: Montréal

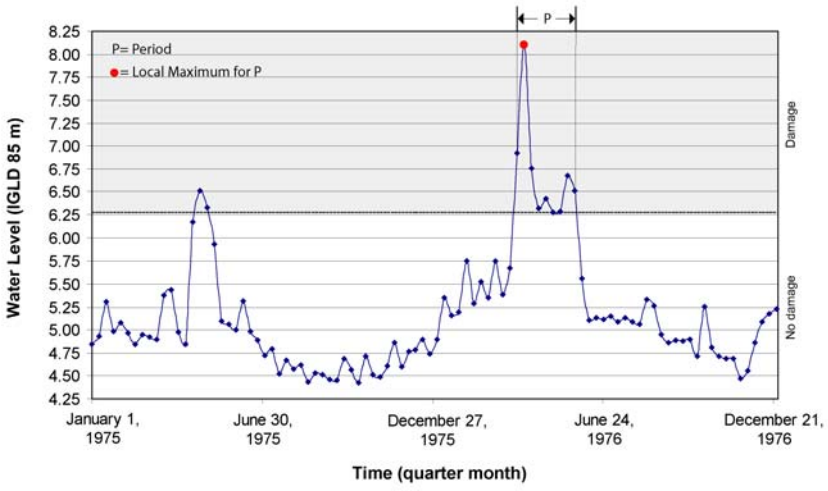
has been divided into two areas). Each regional stage-damage curve is geo-referenced and associated with a specific hydrometric station. The stage-damage curves are not interchangeable.

Links with hydrology used to create the PI algorithm: Each regional stage-damage curve is constructed by aggregating the potential damage attributable to different water levels on every residence of a given municipality. The regional curve is then used to assess the damage at the municipal level by reading on the chart the damage corresponding to the water level recorded at the associated hydrometric station.



The water level used to assess the damage is the highest one recorded during the flood event. For this reason, the search for a peak on the hydrograph is done using a variable search period because there is no limitation on how long the flood lasts. The beginning of the search period is placed at the point where damage begins. The search period is as long as the curve stays in the damage zone on the hydrograph. When the search for the maximum is completed, only one peak is kept even though numerous local maximums can be observed on the hydrograph. The highest peak value is used to assess the damage *via* the regional stage-damage curve.

As explained throughout this document, each regional stage-damage curve is site-specific, *i.e.* it allows the assessment of flood damage for a given municipality. The stage-damage curve must be solved at the location of its corresponding hydrometric station. In other words, the damage is assessed using the proper stage-damage curve and the water level computed at a specific location.



The Algorithm: The procedure consists of verifying, for every municipality, at every time step of the simulation, if the water level at the corresponding hydrometric station exceeds a threshold value – which is different for every municipality. When the threshold value is exceeded for a municipality, damage begins to occur and it is time to search for the maximum flood peak. At the same time step, other municipalities may not be affected by the flooding yet – in fact they may not be affected at all. The total damage, *i.e.* the damage for the entire study area, is obtained by summation of all municipal damage for the entire duration of the simulation.

Validation: The damage assessed with the help of the regional stage-damage curves compared favourably with the total damage recorded during the last major flood event of 1998. The water levels used for the validation were based on an interview survey of riparian owners who experienced the 1998 spring flood. The results were compared to the damage incurred by the owners whose property was flooded. The curves gave satisfying results, with a slight overestimation of the damage of less than 4%.

Documentation and References:

Doyon, B., Côté, J.-P., Bonnifait, L., Roy, N., Morin, A. and É. Dallaire (2004). Crues du fleuve Saint-Laurent: construction de courbes d'endommagement par submersion applicables aux résidences installées dans la plaine inondable. Technical Report MSC Quebec Region – Hydrology RT-132, Environment Canada, Ste-Foy, 51 pages (in French).

Doyon, B., Dallaire, É., Roy, N., Morin, A. and J.-P. Côté (2004). Estimation des dommages résidentiels consécutifs aux crues du fleuve Saint-Laurent. Technical Report MSC Quebec Region – Hydrology RT-133, Environment Canada, Ste-Foy, 41 pages (in French).

Doyon, B., Morin, A., Roy, N., Dallaire, É. and J.-P. Côté (2004). Assessment of Flood Damage: Impact Functions for the Lower St. Lawrence. Technical Report MSC Quebec Region – Hydrology RT-128, Environment Canada, Ste-Foy, 27 pages + Appendix.

Risk and uncertainty assessment: Some regional stage-damage curves are currently being reviewed. Once these curves are fully validated, we are confident that, together, they will accurately predict the flood damage for residential buildings constructed within the 100-year floodplain. However, it must be emphasized here that the precision of the results improves with the number of flooded houses – the larger the number of flooded residences, the smaller the error on the damage assessment. Finally, the curves cannot be used to assess the damage resulting from flooding due to the presence of an ice jam.