Technical Note NT-101

Acquisition of georeferenced control points for comparative purposes with acquired airborne laser

Catherine Pomares and Jean-François Cantin

September 2001

For reference:

Pomares, C. and J.-F. Cantin (2001). Acquisition of georeferenced control points for comparative purposes with acquired airborne laser. Technical Note MSC Québec – Hydrology Section NT-101, Environment Canada, Sainte-Foy. 13 pages.

RESEARCH TEAM

Environment Canada - Meteorological Service of Canada - Hydrology

Design and composition	Catherine Pomares
Supervision	Jean-François Cantin
Technical support	Patrice Fortin
Translation	André Bouchard André Plante
Revision	Jean-Philippe Côté

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

This work was performed within the framework of a project that has for main goal the evaluation of impacts of water level fluctuations on the riverine ecosystem in the Saint-Lawrence River. The parties involved are the Meteorological Service of Canada – Québec Region (MSC-Québec), Hydrology Section and the International Joint Commission (IJC).

In an effort to accurately estimate the water level variations and flow patterns, the exact topography of the Saint-Lawrence River flood plain is required. These fluctuations impact many sectors directly, in both the public and private domains, which depend on appropriate water levels to conduct their activities such as navigation and water provisioning. More specifically, the topography will permit the development of environmental models to predict and quantify bank erosion, flood risks, impacts of low water levels and water quality.

The technology retained for acquiring the desired topographic data was the airborne laser. This technique consists of sweeping the ground surface with a laser coupled to a GPS receiver and an inertial system which will produce a Digital Terrain Model (DTM). The study area stretches from Cornwall to Trois-Rivières and includes the Ottawa River downstream of the Carillon Dam as well as the Mille-îles and Prairies Rivers. In that sector, the area to cover is limited by the low water line and by the line defined by the 100-year return period in terms of high water levels for the Saint-Lawrence River.

The goal of this work is to compare and therefore validate the acquired information through the airborne laser with known georeferenced control points. To achieve this goal, control points within the study area were obtained from several organizations and inventoried.

2. Methodology

2.1 Maps of the areas to be covered

Based on bathymetric data acquired in the field or obtained from numerous organizations such as the Canadian Hydrographic Service, and topographic maps at the 1: 20 000 scale, an estimate of the area to be covered (in blue) was determined (Figure 1). This zone is limited by chart datum on the low-water side and by the high-water mark defined by the 100 year return period.

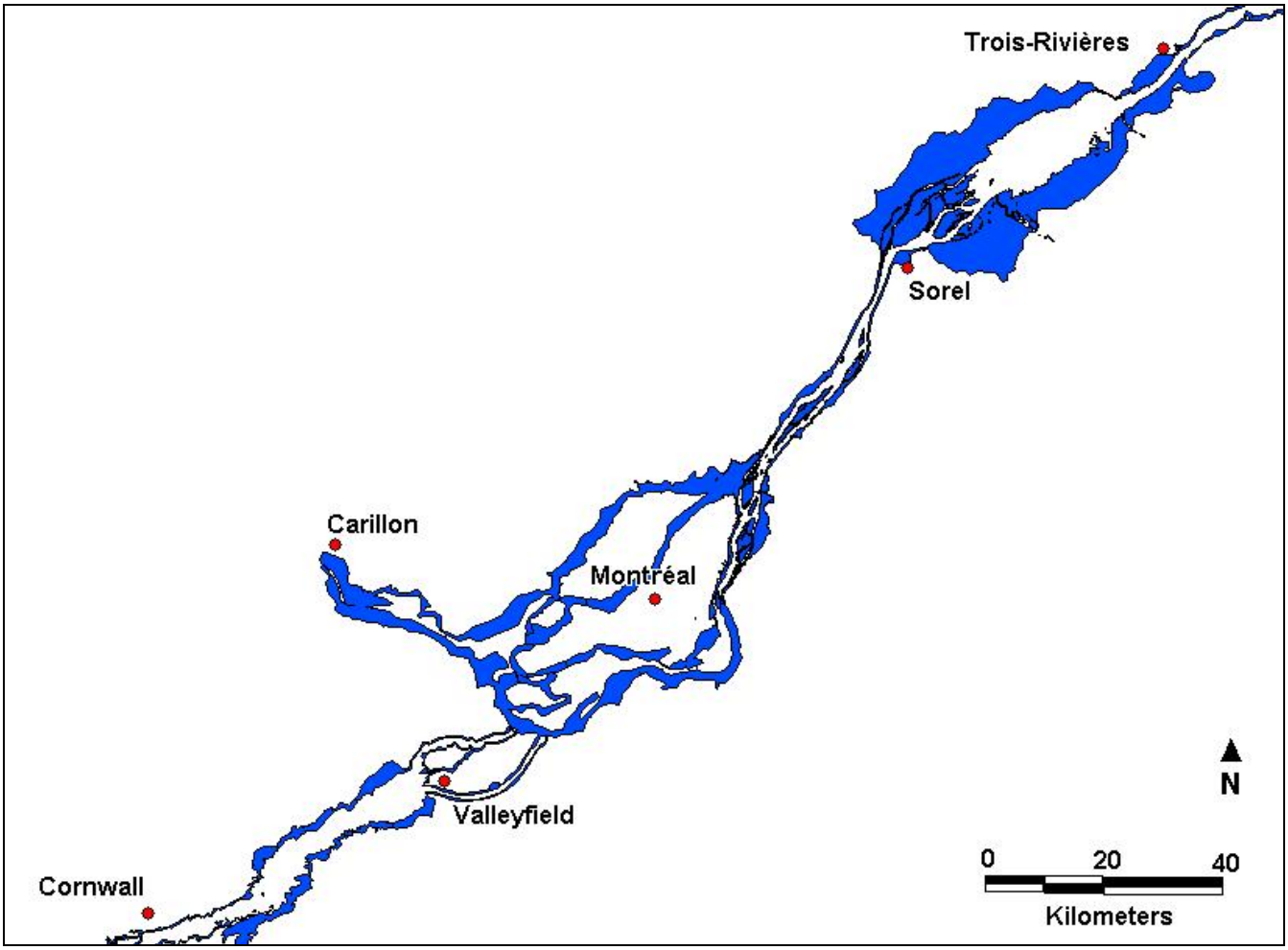

Figure 1 : Area to be covered based on the hundred-year flood return period.

Three areas where defined as having a priority status as far as obtaining numerical data. These three areas are: R7 – Lakes of the Montréal archipelago (Lake des Deux-Montagnes, Lake Saint-Louis, Bassin LaPrairie), R9 – Port of Montréal to Sorel and R10 – Sorel to Trois-Rivières. All of the islands situated within these zones are completely covered as well. However, the Mille-Îles and des Prairies Rivers are not included in the present mandate. An estimate of the areas to be covered is included in Figure 2.

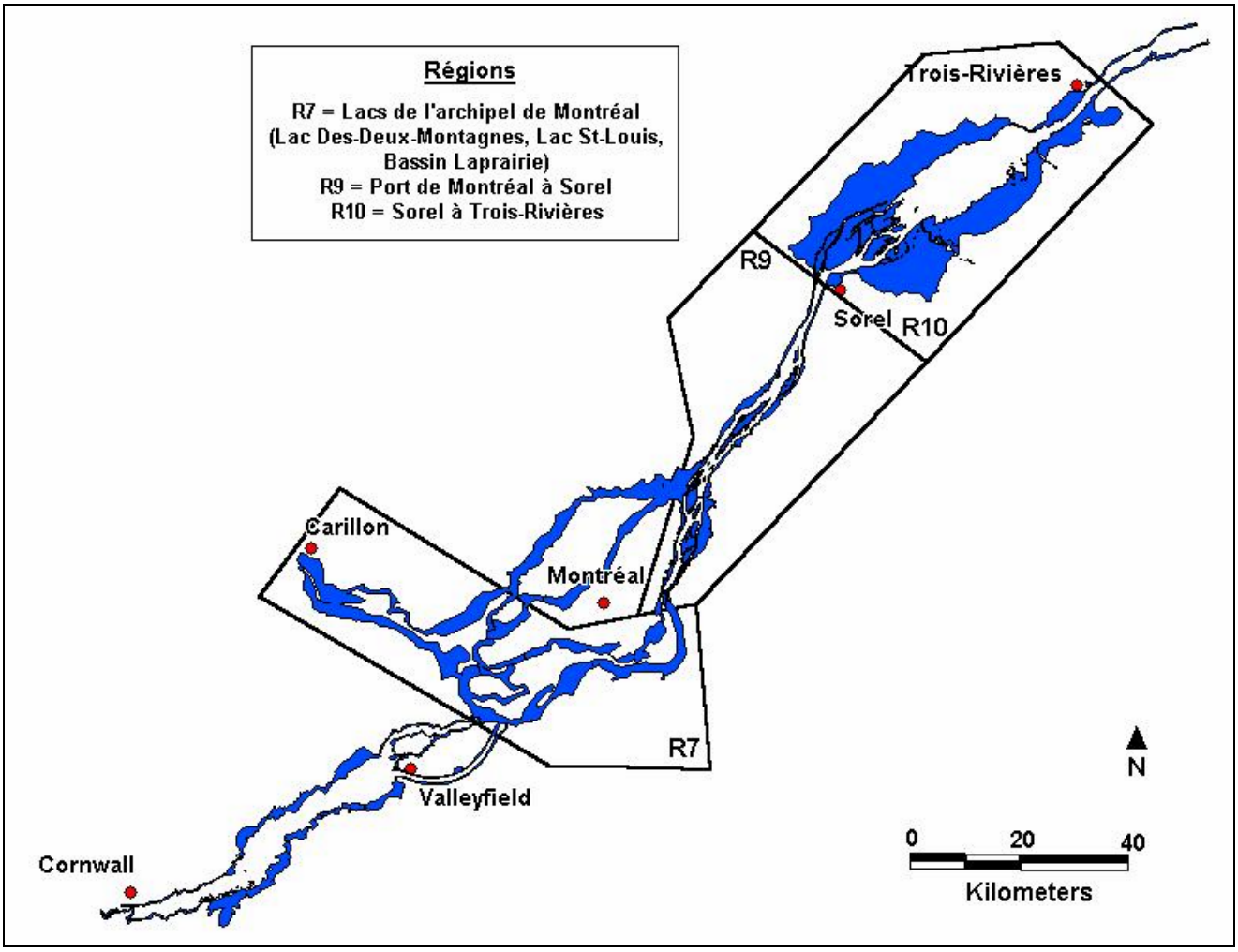

Figure 2 : Map of the three areas to be covered.

2.2 Data providers and favored approaches

A search for organizations possessing the required information was carried out. This, followed by various meetings, led to an inventory of georeferenced points available at five government institutions: Canadian Coast Guard, Department of National Defense, Québec Transport Ministry, Québec Cartographic Services and the Québec Geodetic Service. Since no common data management structure existed between organizations, the method of transfer, as well as the format and processing of the information varies depending on the source. A first step was thus to process the information to make sure it could meet our requirements. As well, depending on the organization, the georeferenced points were available in different projections (Table 1).

Table 1 : Georeference point projections.

Government institutions	Point projections
Canadian Coast Guard	Latitude-Longitude
Department of National Defense	Universal Transverse Mercator (UTM) (area 18)
Québec Transport Ministry	Quebec Modified Transverse Mercator (MTM) (area 8)
Québec Cartographic Services	Quebec Modified Transverse Mercator (MTM) (area 8)
Québec Geodesic Services	Universal Transverse Mercator (UTM) (area 18)

Data from the original files were grouped in a single table which summarizes the informations under a single format thus ensuring compatibility between data from different organizations. A common projection was also given to all the georeferenced points to permit the visualization of all the points on a single map. This will also allow for a quick comparison between these points and those obtained from the DTM. The chosen projection was the Quebec Modified Transverse Mercator; NAD83; area 8.

A number of methods were developed in order to allow the visualization of the georeferenced points identified in the study area. For all the files that were created, it is possible to access the informations directly from the table corresponding to the map or by selecting a given point from the map itself. As well, all the files can be associated with a topographic map permitting the exact location of the control points that were inventoried.

When possible, in an effort to respect the airborne laser precision, the points that were retained had to show a minimal precision of +/- 15cm in the X, Y and Z components. For all of the involved government institutions, this constraint was respected. However, some of the data held by the Québec Cartographic Services for less documented areas was accepted even if it had less precision.

3. Presentation of Results

The Figure 3 illustrates the positioning, the source and the precision of the obtained data.

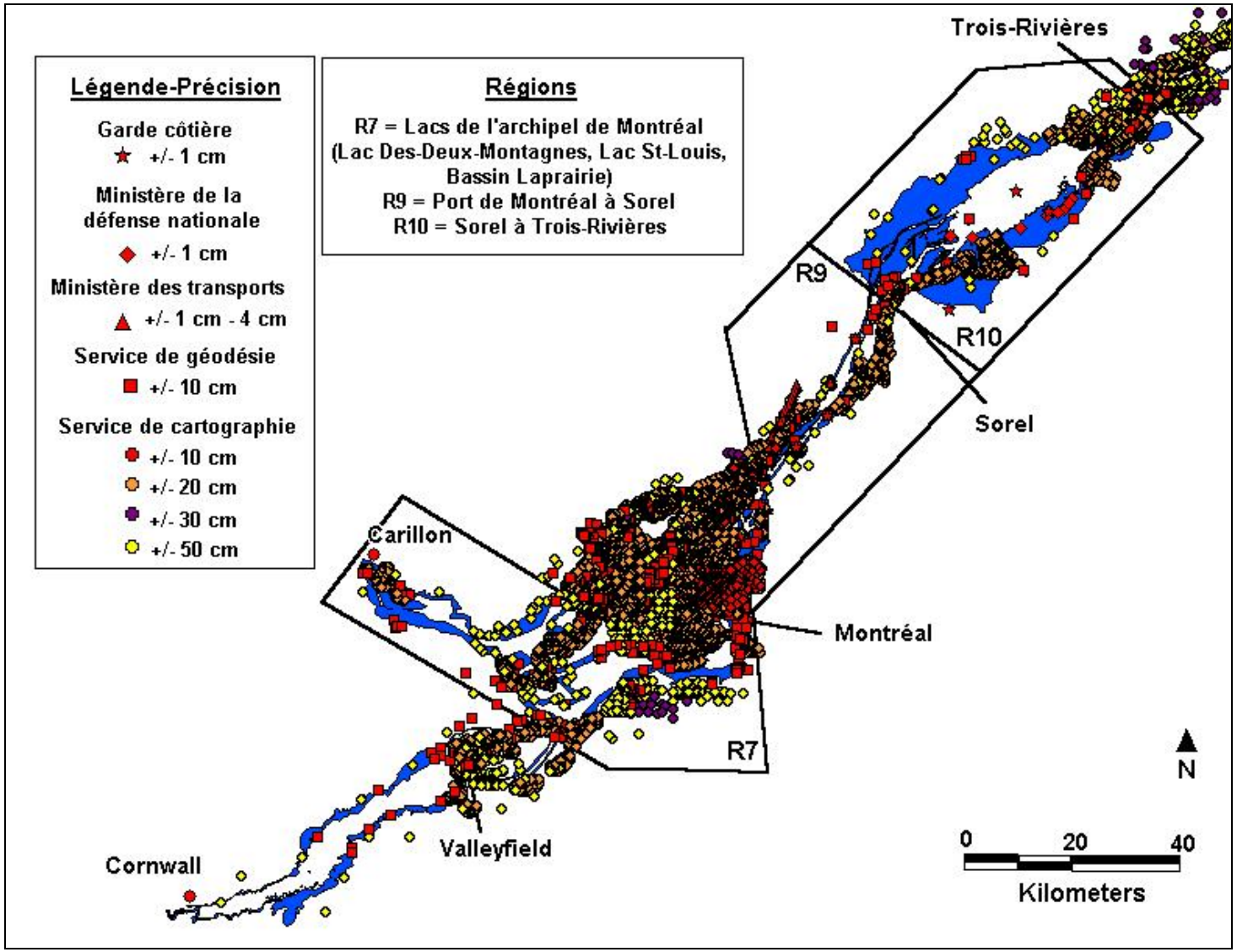

Figure 3: Positioning of georeferenced points from Cornwall to Trois-Rivières.

All the points that respect the initial condition of a precision of +/- 15 cm are shown in red. A total of 6580 points respect this criterion. The points originating from de Québec Cartographic Service that did not respect this criterion are easily identified by their color which varies depending on their level of precision. They can also be identified from the table as the precision of each point is annotated. The Table 2 shows the number of available data points based on the government institution from which they were obtained and, if required, from their degree of precision.

Table 2 : Number of inventoried georeferenced points.

Government institutions	Number of points	Precision	MapInfo map symbol
Canadian Coast Guard	16	+/- 1 cm	☆ = red
Department of National Defense	27	+/- 1 cm	◇ = red
Québec Ministry of Transport Laurentide-Lanaudière Laval-Milles-Iles Est-de-la-Montérégie	 1333 99 8	 +/- 1 cm +/- 4 cm +/- 1 cm	 △ = red △ = red △ = red
Québec Geodesic Services	597	+/- 10 cm	□ = red
Québec Cartographic Services	4500 21364 388 2120	+/- 10 cm +/- 20 cm +/- 30 cm +/- 50 cm	○ = red ○ = orange ○ = purple ○ = yellow

The next three figures show the positioning of the georeferenced points based on the three areas that were attributed a priority status for the gathering of airborne laser data (Figures 4, 5 and 6).

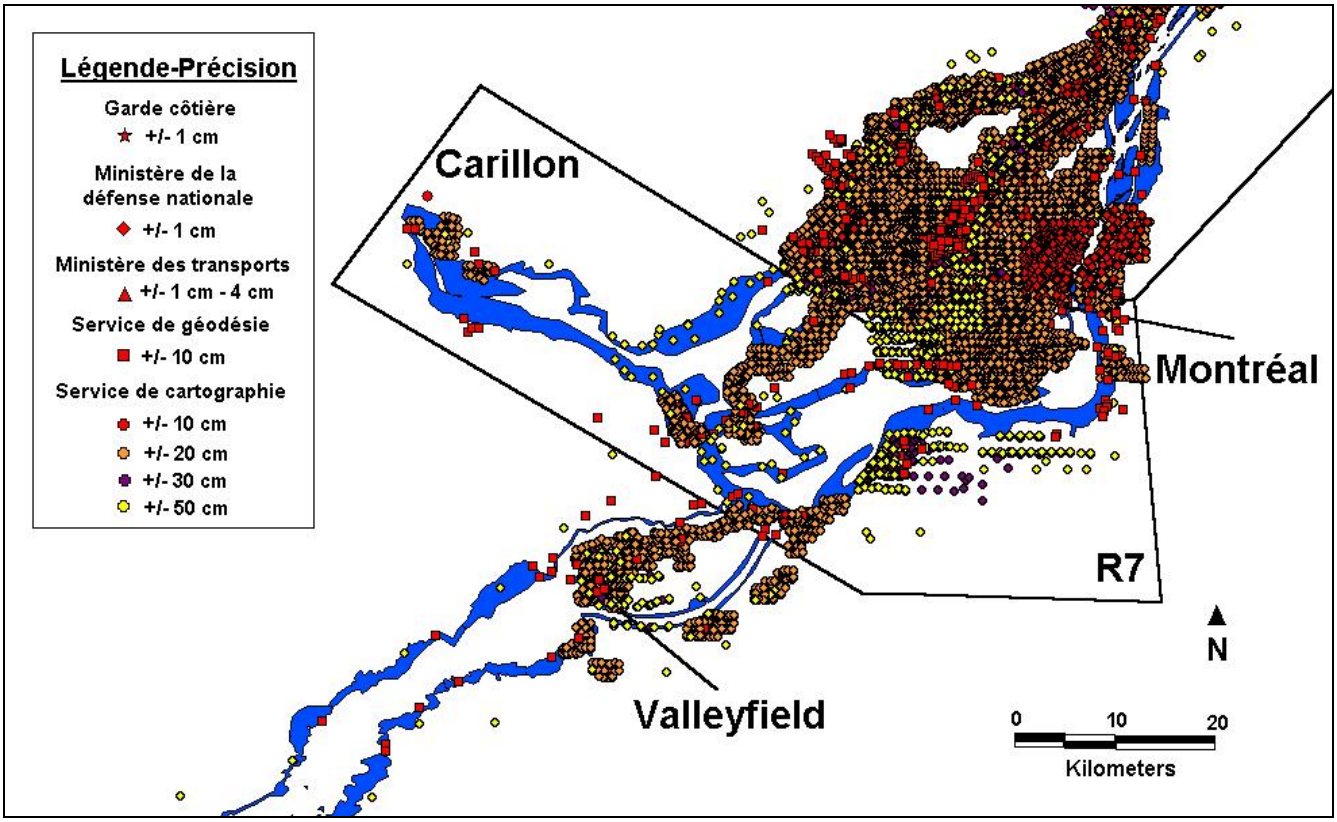

Figure 4 : Positioning of the georeferenced points for area R7: Lakes of the Montréal archipelago (Lake Des-Deux-Montagnes, Lake Saint-Louis and Bassin LaPrairie).

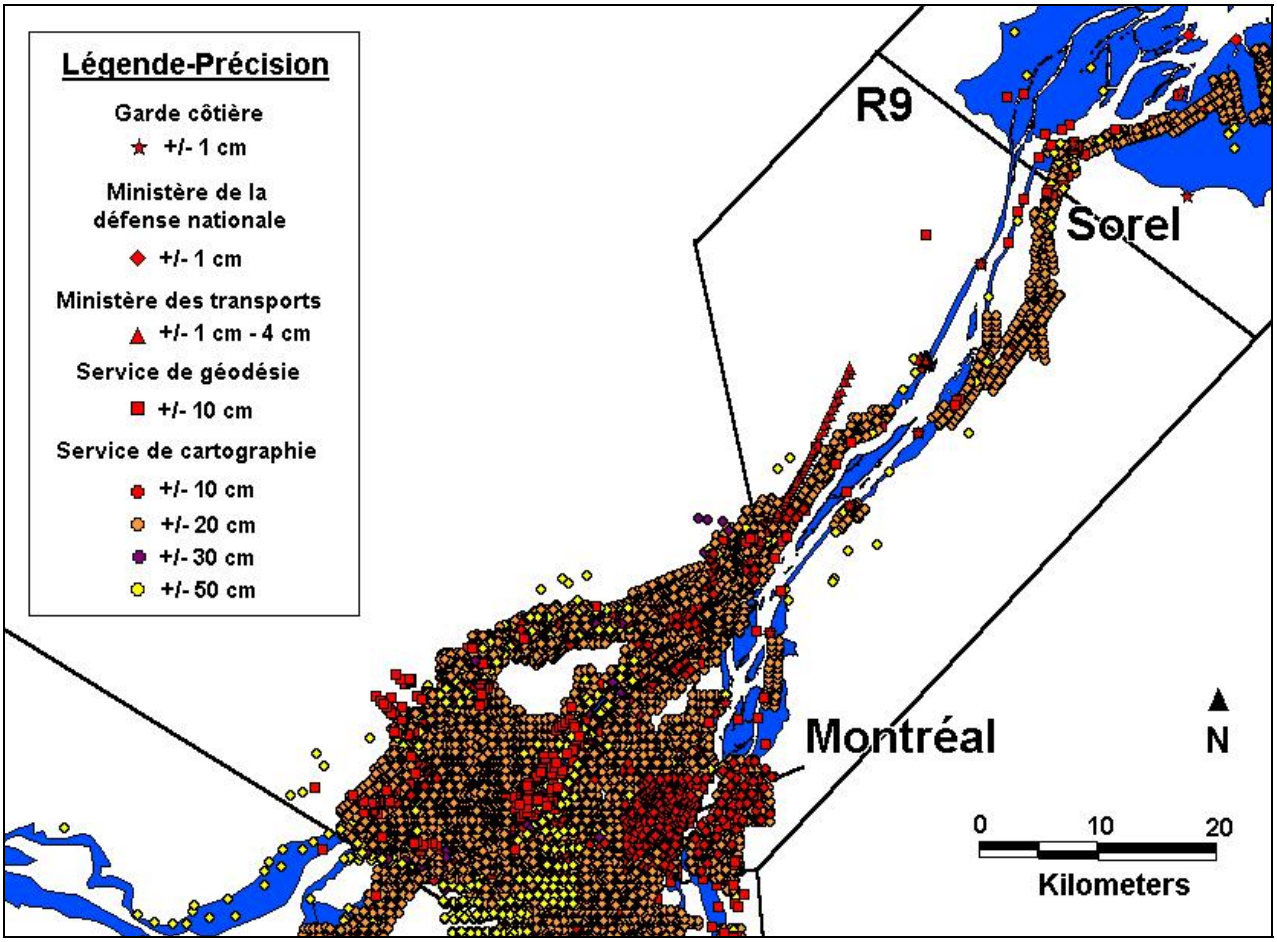

Figure 5 : Positioning of the georeferenced points for area R9: Port of Montréal to Sorel.

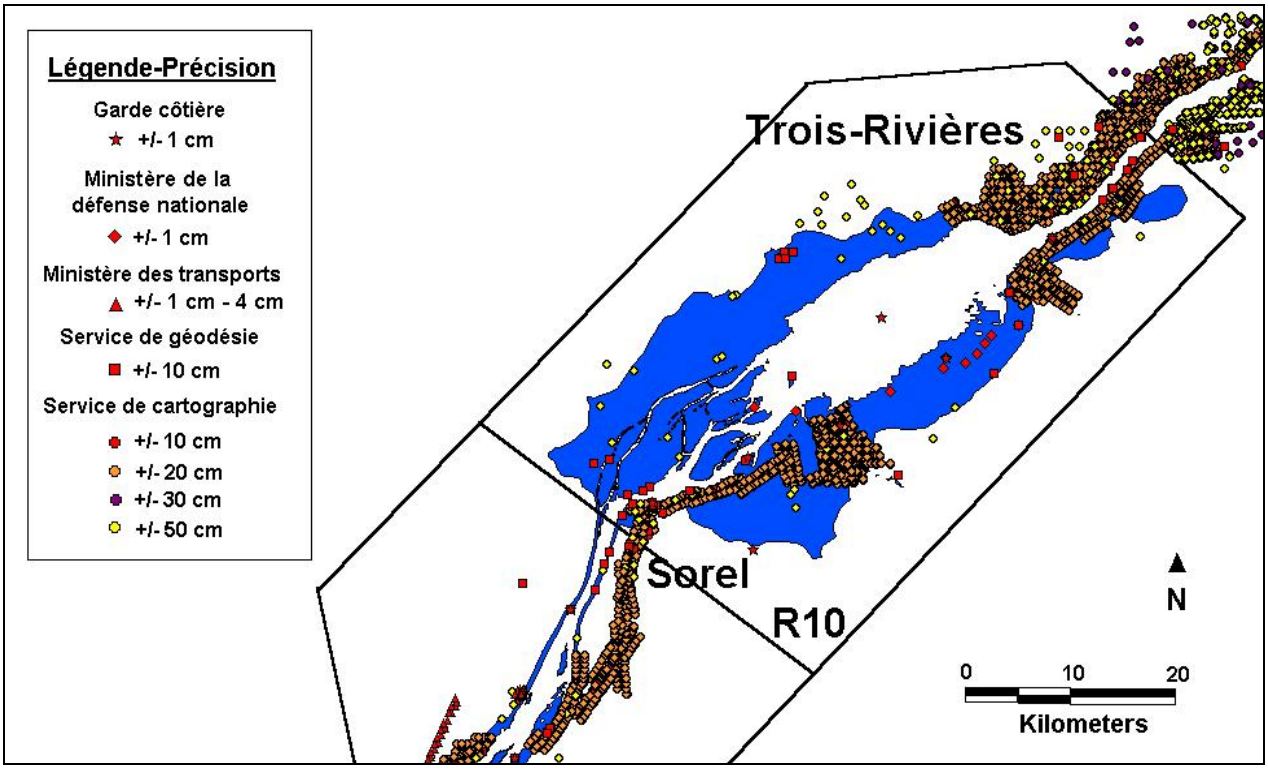

Figure 6 : Positioning of the georeferenced points for area R10: Sorel to Trois-Rivières.

An estimate of the number of available data points for each area was done and is reported in Table 3. It can be noticed that some areas only show a small number of catalogued data points, namely the area including Lake Saint-Pierre. As well, areas in Lake Des Deux-Montagnes and in Lake St-François are sparsely documented. This situation could be explained by the fact that these areas are less populated and have fewer infrastructures compared to other areas.

Table 3 : Estimate of the number of inventoried georeferenced data points within each area to be covered.

Area	Number of points
R7 : Lakes the Montréal archipelgo	5399
R9 : Port of Montréal to Sorel	5646
R10 : Sorel to Trois-Rivières	2921

4. Conclusion

The works perform permitted the inventory of known georeferenced control points covering the area from Cornwall to Trois-Rivières that are positioned within the hundred-year flood plain of the Saint-Lawrence River. It will therefore be possible to compare these values to the Digital Elevation Model produced with the data acquired by airborne laser. Such a comparison is essential to validate acquired data with the objective of ensuring the best possible quality for the resulting DTM.

From the work to find these points, it was found that the results are positive in term of the quantity of data found, its precision and its quality. However, certain regions that are very important in terms of the impacts of water level fluctuations remain sparsely documented.

5. References

Duchaine, D., Bouchard, A., Fortin, P. et J.-F. Cantin (1999). Évaluation de la superficie de territoire à survoler lors de relevés au laser aux fins de la construction d'un modèle de terrain du fleuve Saint-Laurent couvrant le secteur de Cornwall jusqu'à Trois-Rivières. Document interne. Service Météorologique du Canada – Hydrologie, Environnement Canada, Sainte-Foy.