

A Regional Initiative for the Efficient Transfer of Groundwater Knowledge Between Experts and Stakeholders

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Abstract

Recent hydrogeological mapping throughout the Saguenay-Lac-Saint-Jean region in Quebec, Canada, has yielded a very comprehensive geodatabase (GDB) on groundwater and aquifer systems, designed to fulfil the requirements of groundwater management at the regional level. The high density of observed hydrogeological data points also makes the GDB useful for many local or sub-regional applications. Recently acquired data from continuing geotechnical or groundwater-related activities must be integrated into the GDB in order to maintain its relevance for a variety of problems concerning groundwater quality, its management and its protection. When

it is consistently updated, such a hydrogeological (HG) GDB also stands as a critical and constantly evolving link between the scientific community, government agencies, regional and municipal authorities, and ultimately the population who draw upon the groundwater resource. The HG-GDB represents a central hub of effective collaboration between scientists and data users, and the intent is that it may lead to more appropriate decision-making when faced with different issues and/or when taking actions that may include applied groundwater research projects. Groundwater data transfer becomes an information exchange process, an essential tool facilitating the sustainable management of groundwater resources.

Keywords

Regional hydrogeology

Knowledge transfer

Land-use management

1. Introduction

The transfer of scientific knowledge to large user communities has long been recognized as a necessity in the health sciences (e.g. Lemire et al. 2009), but it is also applicable to all disciplines of science. The transfer of knowledge to stakeholders is particularly important for groundwater, as this underground component of the water cycle, although ubiquitous, remains invisible. Hydrogeologists must decipher for the benefit of stakeholders a number of phenomena affecting groundwater, many of which are based on a geological description of the subsurface; such knowledge is essentially based on interpretation.

The efficient use of groundwater knowledge is hampered by numerous obstacles in many states and provinces in North America (Lavoie et al., 2013, 2014). Pelchat (2015) has identified important barriers to the implementation of groundwater protection measures, including poor groundwater knowledge by land managers and the lack of resources to implement the required measures.

In Quebec, great advancements have been made since 2008 in groundwater and aquifer characterization, thanks to regional and provincial initiatives. Recent hydrogeological knowledge acquisition projects have produced

extensive hydrogeological geodatabases (HG-GDB) that are made available to public and private users. This short paper presents an overview of an ongoing project for the transfer of groundwater knowledge contained in a regional HG-GDB to potential users in the Saguenay-Lac-Saint-Jean (SLSJ) region (275,000 inhabitants), particularly to land-use planners.

2. Regional Context Regarding Hydrogeological Knowledge and Land-Use Planning

Over the last three decades, researchers in hydrogeology at the *Université du Québec à Chicoutimi* (UQAC) have carried out numerous research projects in the SLSJ region, mostly in collaboration with municipalities and industries. These projects made use of available data on the subsurface that had been acquired by public or private organizations, particularly for geotechnical, environmental or hydrogeological purposes. Although extremely useful, these data were owned and hosted by a diversity of data owners and presented a variety of formats and quality levels. Gathering and integrating these existing data required much time and effort.

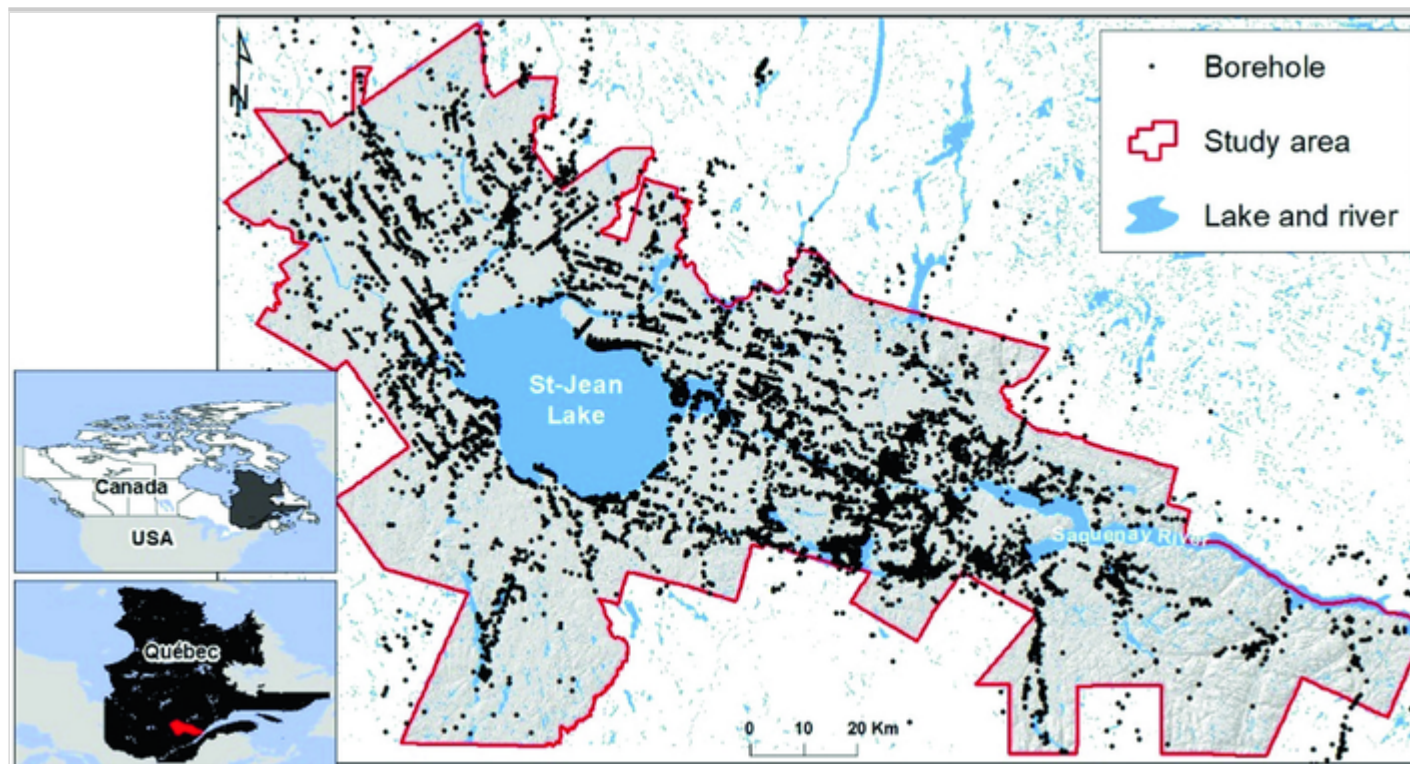
In 2008, UQAC entered into an agreement with several administrative entities in the SLSJ region, including the City of Saguenay, the Mashteuiatsh First Nations Community, the four regional county municipalities (*Municipalités régionales de comté*; MRC), and the regional offices of four government ministries: municipal affairs, natural resources, agriculture, and health and social services. The objective was to integrate all available data related to groundwater into a single, comprehensive HG-GDB.

This agreement was followed by a major program launched in 2009 by the Quebec Government: the Groundwater Knowledge Acquisition Program (*Programme d'acquisition de connaissances sur les eaux souterraines*; PACES; <https://www.environnement.gouv.qc.ca/eau/souterraines/programmes/acquisition-connaissance.htm>). Managed by the Ministry of Environment, this province-wide program was given the objective of mapping the hydrogeological resources of the “municipalized” southern and more densely populated portion of the province of Quebec. The PACES program is subdivided into several regional projects, each managed by an expert team including hydrogeologists and GIS experts operating out of one of several universities in Quebec. These PACES projects involve three main steps: the integration of available data on the subsurface into a geodatabase, the acquisition of new groundwater data, and a general description of regional hydrogeological systems.

One of these regional PACES projects was conducted from 2009 to 2013 across the municipalized territory (13.210 km²) of the SLSJ region (Fig. 1). It required the partnership of all the municipal entities in the region as well as the Mashteuiatsh First Nations Community. The overall results of the PACES-SLSJ project are based on more than 12,000 data points covering a variety of information types, including: stratigraphic logs from boreholes, descriptions of rock outcrops, groundwater geochemistry analyses, hydraulic properties of aquifers, grain size distributions of superficial deposits, piezometry data, and surface and borehole geophysical data (Fig. 1; CERM-PACES 2013; Walter et al. 2018). These data were used to develop the PACES project deliverables, including approximately 30 maps on a 1/225 000 scale and a regional geodatabase (Chesnaux et al., 2011) integrating all of the collected data. The results were delivered to the Quebec Ministry of Environment and to all regional partners in the PACES-SLSJ project. The scientific value of these deliverables has been leveraged and enhanced by numerous research projects conducted by professors and graduate students at UQAC.

Fig. 1

Municipal territory of the Saguenay-Lac-Saint-Jean region in Quebec, showing locations of the boreholes providing data to the hydrogeological geodatabase



2.1. A Pilot Project on Hydrogeological Knowledge Transfer to Stakeholders

In 2015, a series of one-day workshops were organized by the Quebec Groundwater Network (*Réseau québécois sur les eaux souterraines*; RQES) in all regions covered by the PACES projects completed at that date. The purpose of these workshops was to teach land planners how to access and use the regional geodatabases developed by PACES project scientists (Ruiz et al. 2015, 2016). Although these workshops were well organized and useful, they had several important limitations: (1) they were limited over time to one day; (2) the level of groundwater knowledge remains limited for most workshop participants, who probably face multiple issues other than groundwater in their day-to-day functions; (3) the number of workshop spaces is limited, so an entire organization is usually represented by a single participant; (4) a participant may not be anymore the actual person in charge when his/her organization is later on facing problems related to groundwater.

Meanwhile, an informal post-PACES work committee was created in SLSJ, with the aim of developing a more efficient use of the new, comprehensive HG-GDB; the committee brought together researchers in hydrogeology from UQAC as well as representatives of the MRCs and the Mashteuiatsh First Nations Community. The meetings of this committee gave rise in 2017 to a new pilot project called RISUp, to respond to the needs of municipalities in relation to groundwater, through research (R), implementation of the HG-GDB in every MRC (I), support (S), and updating (Up) of PACES-SLSJ hydrogeological data. The RISUp project has been self-funded by the partners over the last three years; it pays the salaries of two part-time research associates at UQAC. Specifically, the main objectives of this pilot project constitute a circular data exchange process (Fig. 2) involving: (1) the acquisition of hydrogeological knowledge and data by experts and researchers, (2) updating the HG-GDB and adapting it to the needs of every MRC, (3) the transfer of this knowledge to regional stakeholders, (4) providing ad hoc scientific and technical support to users on groundwater-related issues; (5) helping to define actions to be taken to address identified groundwater-related problems. These actions may involve hydrogeological researchers or consultants, or both; they often result in new data being gathered and entered the regional HG-GDB in order to keep the circle turning.

Fig. 2

Circular transfer of groundwater knowledge resulting from the RISUp project



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used for a much wider variety of purposes than what had been initially planned during their acquisition; as a geoethics result, data produced is more likely to be used than wasted.

The projects with a research component are mostly carried out by students under the supervision of professors. The issues to be addressed by these projects are first identified by RISUp partners, then translated into research problems by researchers or professors. The resulting research projects are then assigned to students, or in rare cases, directly managed by UQAC researchers and professors. The integrated training aspect of RISUp makes it a very valuable initiative in geoethics for the entire region. In addition to responding to specific regional issues, RISUp will support the training of the next generation of scientists in accordance with the realities of the municipal environment. These newly formed experts become highly qualified professionals able to work in the community, for instance, within private engineering and environmental consulting, for which the municipal sector represents a large market share in Quebec.

Another important aspect of RISUp is that it can provide local support to those in charge of map production and database management in municipal organizations. This support takes the form of individual visits by RISUp professionals, directly to the offices of partner organizations. During these visits, various exercises (mapping, SQL queries, etc.) are carried out using the data contained in the regional HG-GDB. As a contribution in geoethics, these activities ensure an efficient transfer of knowledge using specific tools developed for RISUp partners.

However, in some cases, the university can be seen as a direct competitor to hydrogeological consulting firms. Indeed, university researchers accompany regional decision-makers in groundwater-related projects, as some consultants would do. This competition, at least in appearance, raises the fundamental question of the role of the university in a region that comprises private, governmental, and municipal entities.

Meetings of the RISUp partners are scheduled at least twice a year. Their purpose is (1) to communicate key results to partners, (2) to present future projects, and (3) to define priorities for action. Representatives from the two watershed organizations active in the SLSJ region are invited to participate in the RISUp management meetings.

4. Concluding Remarks

Effective collaboration between scientists and data users gives rise to the development of applied groundwater research projects that are based on actual problems. The resulting groundwater information exchange process facilitates the sustainable management of groundwater as a resource and a component of ecosystems.

A significant change has occurred over the last ten years among regional decision-makers in the SLSJ region. Although relatively new to the specialized field of groundwater, regional stakeholders now understand the general hydraulic and chemical aspects of groundwater dynamics. Some partners now see a potential for economic development (water supply in remote areas, water bottling, etc.), and all the partners are now well-informed concerning the fragility of the groundwater resource. All stakeholders now fully understand the importance of adequately protecting groundwater and also have a better understanding of the importance of continuing research and developing knowledge for a more sustainable management of the groundwater resource over the territory. Discussions among the RISUp partners are underway to pursue the project for an additional three years.

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