

Groundwater Program Newsletter



Groundwater News

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Editor's Message

"The greater danger for most of us is not that our aim is too high and we miss it, but that it is too low and we reach it." Michelangelo.

When I took this job with the Geological Survey of Canada more than six years ago, I had a vision, a mission, a purpose, a concept and a plan; you may call it a dream. So, yes, I had aimed too high, but I can see now that it is paying. I think I was right to aim high, the message has passed, it has been heard; the trends and initiatives we see and read across the country every day relative to groundwater are clear evidence of this.

I dreamed that we generated sufficient knowledge in order to develop, protect and take informed decisions in the management of this precious resource. I dreamed that Canada as a whole, and in particular the provincial, municipal, agricultural and other users of groundwater will, one day, manage the groundwater resources in conjunction with surface water in an integrated manner. I dreamed that data and information on groundwater would be produced following state-of-the-art methods and technologies and, most importantly, that data and information would be easily accessible to Canadians through the now very popular World Wide Web.

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My dream included a management framework where monitoring, data and models would be closely interrelated and would be used as integrated tools to manage the groundwater resource. I dreamed...

So, with these *nouages* in my head, I decided to continue on taking this challenge and I applied for program manager of the Groundwater Program for another 3-year period. I wanted to continue fighting my cause, given that now senior management seems to be listening. So far I've won my cause, and now we have a new phase of the program for 3 more years, from 2006 to 2009.

In this issue, I present a brief summary of the projects completed last March as a wrap-up of the first phase of the program, 2003-2006. And I also provide a synopsis and the structure of the program as it was designed and approved for its second phase. So we have a new phase, new projects and a new team. You will see that it is essentially the same vision with some modifications on the areas of study and enhanced emphasis on data and information with open and user-friendly easy access to the data and information products; as well as a synthesis of knowledge to be presented in a book format on the groundwater resources in Canada. Groundwater studies require long-term commitment, so don't be surprised if the new phase is a *déjà vu*; it is important for governments and OGDs, as well as for public at large, to know that we are here to stay and that we will continue seeking cooperation and collaboration from them.

So even if I still haven't fully reached my aim, I know we are on the right track to reach it in a not-so-distant future. I refuse to aim low and to listen to the voices trying to slow me down. I consider my job not just a simple job, a way to put food on the table and a roof over my head; to me this job is a passion, for given the linkages with policy an society at large, hydrogeology is both a science and an art. I like this job and I love doing it!



Alfonso Rivera
Chief Hydrogeologist and Groundwater
Program Manager



Summary of the first phase of the groundwater program (2003-2006)

National Groundwater Database (Project leader: Éric Boisvert)

The national groundwater database project (NGWD) concentrated primarily on two aspects: a) Determining a database exchange standard based on international OGC standards (Open Geospatial consortium), and b) implementing the architecture that allows the dynamic conversion of data from a local format distributed in a number of databases towards a common standard. The database was also used as a repository of hydrogeological data gathered from all NRCan aquifer characterization and mapping projects.

The data exchange standard, called H2O, is a GML (Geographic Markup Language) application; the work for H2O was carried out by the technical team and is based on the IUGS (International Union of Geological Sciences) exchange of data that was published in an early version of GeoSciML (GeoScience Markup Language). H2O also builds on another OGC standard being prepared on observations and measurements (Observation and Measurements) for determining a standard on water quality in cooperation with Environment Canada.

The data conversion architecture was developed in an Open Source XML environment called Cocoon (Apache Cocoon). This architecture permits delivery of data from a number of heterogeneous sources to standards supported by the department (derived from GML, as are GeoSciML and H2O). The protocols used for exchanging data are also derived from OGC standards, i.e., WMS (Web Mapping Service), WFS (Web Feature Service), WCS (Web Coverage Service), SOS (Sensor Observations Service) and WMC (Web Mapping Context).

The NGWD prototype is located at

<http://ntserv.gis.nrcan.gc.ca/gwp/ngwd/exploration>

In the second phase of the project, integration of the NGWD into the Phoenix portal (<http://www.decisiontools.ca>) is planned, as well as the elimination of portal duplication. Work is expected to continue on the standards, and the cooperation with the international partners working on standard products similar to H2O will be extended.

Waterscape Web Site and Posters (Project Leader: Bob Turner)

The Waterscape project offers a new series of posters illustrating the issues related to water for various communities across Canada. Complete content of the posters is available at: http://geoscape.nrcan.gc.ca/h2o/index_f.php.

At this time, two waterscapes have been completed and are available on the website: the Gulf Islands and the Bow River Basin. Soon, the Bowen Island and Okanagan Valley waterscapes will also be accessible. Contact Bob Turner for more details (bturner@nrcan.gc.ca).

Marketing of the ESS Groundwater Program (Responsible: Alfonso Rivera)

The overall purpose of the marketing and communication plan was to raise awareness, interest, commitment and action amongst the potential stakeholders of the ESS Groundwater Program.

The marketing and communication plan of the program was the culmination of a development process that began in 2000, before the

program was launched, as an outcome of two national workshops which identified issues linked to Canada's groundwater resources and explored various means to address those issues.

The marketing and communication plan was designed to achieve the following objectives set at the two national workshops:

- To promote the awareness and understanding of the national document "Canadian Framework for Collaboration in Groundwater across Canada."
- To promote the establishment of the Canadian Groundwater Advisory Council.
- To draft a plan for communication and outreach.
- To draft a plan for funding the establishment of the Canadian Groundwater Advisory Council and its activities.

Specific objectives of a marketing and communication plan were defined as:

- To promote awareness of the "Canadian Framework for Collaboration in Groundwater" across Canada.
- To promote understanding of and commitment to support initiatives contained within the Framework to specific target segment.

During its first phase (2003-2006), the ESS Groundwater Program succeeded in promoting, communicating and marketing the Framework with some provinces and OGDs. However, it has been less successful in creating the mechanisms to establish the Canadian GW Advisory Council and its activities other than chairing a National Ad-hoc Committee on Groundwater for a period of two years. It is intended to continue the marketing of the ESS Groundwater Program and to enhance the collaboration across Canada during the second phase of the program. ESS is currently in talks with EC to jointly develop the ideas and concepts described in the Framework.

Monitoring Network (Project Manager: Alfonso Rivera)

Discussions are in full swing on the groundwater monitoring network project in Canada. A meeting took place in Vancouver in March 2006, bringing together participants from the Department of Natural Resources and Environment Canada, Alfonso Rivera and Yves Michaud, and from USGS (US Geological Survey), for the purpose of developing an agreement for collaboration and for strengthening the partners' relationships. The major points of this collaboration agreement involve the sharing of monitoring methodologies applied, data gathered and knowledge acquired. For more information, please contact Ted Yuzik at Meteorological Service, Environment Canada.

Assessment of Regional Aquifers: Towards a National Inventory (Alfonso Rivera)

A national inventory of the groundwater resources of Canada is part of the ESS Groundwater Program – A key Canadian Resource. The first phase of this inventory was scheduled from 2003 to 2006, followed by a second phase from 2006 to 2009. The national inventory is a combination of geological mapping, regional hydrogeological assessments and groundwater modelling. It is a project based on geological mapping, quantitative hydrogeology and groundwater resources research.

The Groundwater Program's approach was to initiate a series of regional aquifer assessments as a road towards a national inventory of the groundwater resources of Canada; including the collection, analysis and synthesis of data, and the building of conceptual models of key regional aquifer systems. It was recognized from the start that

such an endeavor would take many years to complete and could only be done with a strong cooperation with the provinces and OGDs. The program would build a vision and would provide some characterization and full assessments of selected key regional aquifers that would initiate the inventory.

A national inventory of Canada's groundwater resources is needed for Canada's federal, provincial and municipal governments to plan, promote, and regulate population growth, agricultural activities, and industrial development; to adapt to climate change; and to implement environmental conservation and protection programs. Planning, promotion, and regulation require accessible, local knowledge of groundwater quantity, its chemical quality, and its vulnerability to sources of contamination. Such knowledge would reside in a **National Groundwater Inventory**.

A National Groundwater Inventory would serve various purposes as defined in the Canadian Framework for Collaboration on Groundwater (Rivera et al, 2003). The ESS Groundwater Program has adopted those concepts.

18 points criteria was considered to select "key" regional-scale aquifers in Canada: scientific, geographic, socio-economic and technical-scientific. 30 aquifers were identified as "key" Canadian aquifers following the GSC criteria. The first phase of the program (2003-2006) would assess 20% of them (6/30) these were: the Okanagan basin (BC); the Paskapoo formation (Alta); the Greater Toronto area (ON); the Southern Ontario GLB (ON); the Châteauguay transboundary aquifer (QC); and the Annapolis-Cornwallis aquifer system (NS). In addition to those six aquifers, the GW Program benefited from 3 other key aquifers which had been already assessed before 2003: the Gulf Islands (BC); the Mirabel aquifer (QC); and the Carboniferous basin (NB), making a total of 9 aquifers mapped with a varying degree of assessments.

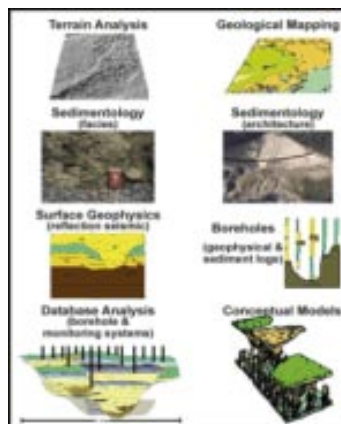
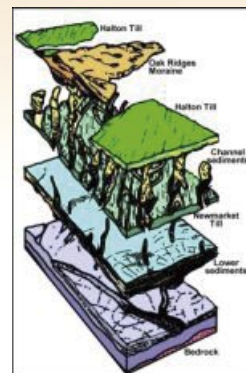
The following sections present a brief summary of the results of those assessments performed during the first phase of the program.

Greater Toronto Groundwater study (Responsible: David Sharpe)

The Oak Ridges Moraine project in the Greater Toronto Area started in 1993 with co-funding from NATMAP (National Mapping Program) and the Hydrogeological Program of the Geological Survey of Canada (GSC), and it finished as one year Greater Toronto wrap-up in March 2004. The project was a collaborative exercise between the GSC and Ontario provincial agencies (Ontario Geological Survey, Ministry of Natural Resources, Ministry of Environment, Municipal Affairs) and a number of regional municipalities (York, Durham). This project was initially conceived as a joint surficial mapping and groundwater project to develop a regional geological framework for more site-specific hydrogeological studies (e.g. Interim Waste Authority, municipal studies). This objective was achieved through a basin analysis approach focused on data collection that would enable the geological history of the basin to be understood, and consequently permit the development of predictive geological models. The project set new standards in Ontario for the collection of a variety of geological and hydrogeological datasets for regional hydrogeological studies, including: i) low-flow stream gauging, ii) waterwell analysis, iii) seismic reflection data collection, iv) the collection and analysis of continuous cored boreholes, v) Digital Elevation Model development, vi) GIS based stratigraphic model development, vii) geostatistical approaches to mapping aquitards and piezometric surfaces, and viii) web delivery of publications and data.

A complete listing of published results (peer reviewed papers, Open Files, extended abstracts) for the project is available through the project website (http://gsc.nrcan.gc.ca/hydrogeo/orm/index_e.php) publication page. Links are available to PDF or other file formats for download

Geological model of the Oak Ridges Moraine. The units are the following, from the oldest to the most recent: i) bedrock, ii) lower sediments, iii) Newmarket Till, iv) Channel sediments, v) Oak Ridges Moraine sediments, and vi) Halton Till



The three-dimensional hydrostratigraphic methods applied on a regional scale highlight the role of geology, geophysics and data integration in improving understanding of the hydrogeological context

Great Lakes Basin, Southern Ontario regional groundwater characterization (Responsible: David Sharpe)

An initial assessment of groundwater in the Great Lakes Basin (2004-2006) provided groundwater research information and advice in Southern Ontario on Source Water Protection to governments and related partner agencies. Field work for the study included hydrogeological characterization of key buried valleys and stratified moraine aquifers. This included the assembly of high-quality datasets (e.g. reflection seismic profiles, borehole geophysics, sedimentology, and physical hydrogeology) to characterize selected aquifer systems. This included the development of conceptual geological, geophysical models for the Laurentian valley, and sedimentological models of Waterloo moraine. The project advanced regional methods for developing 3D hydrostratigraphic and hydrogeological models of buried valleys and stratified moraines; as well as state-of-the-art manuals on low-flow, baseflow surveys and 3D mapping/modeling. Efforts resulted in selected geological and hydrogeological maps, posters and reports for provincial and Conservation Authority Moraine Coalition. Results also reached a wide audience via: i) web reporting of publications; ii) organizing and running workshops on 3D mapping and groundwater science in the southern portion of the Great Lakes basin, and iii) public lectures on the importance of groundwater mapping to water resource management. In addition, selected project data were linked to the National Groundwater database. Gaps and opportunities for groundwater science in the Great Lakes region were identified for new progress (Groundwater Mapping Phase II).

Groundwater Assessment in the Okanagan Basin (GAOB) (Responsible: Steve Grasby)

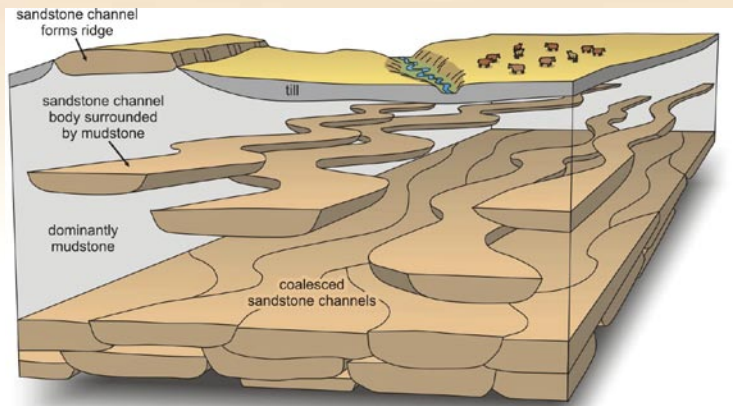
In 2004, the Geological Survey of Canada (GSC) in collaboration with the Ministry of Water, Land and Air Protection (WLAP) (Ministry of Environment, since 2005) launched the groundwater assessment in the Okanagan Basin (GAOB, 8 200 km²). The major objectives were to: describe the geological architecture of the Okanagan Basin and major aquifer units, estimate the vulnerability of the groundwater resource, assess the sustainable yield of aquifers in the basin, characterize the regional water budget, assess hydraulic properties of both surficial deposits and bedrock aquifers, identify groundwater recharge areas, and to review potential impacts of climate change. The principal goal of the project was to increase current groundwater knowledge in populated regions to assist with sustainable groundwater management and protection. Data collected was integrated to the National Groundwater database.

The work completed by the GSC in the project was only carried out during one year. In the second phase of the program (2006-2009), more substantial participation of the GSC is planned for this project.

The Paskapoo groundwater study (Responsible: Steve Grasby)

The Paskapoo Formation in Alberta was the focus of a key 3-year study in the western sedimentary basin. The main objective was to provide enhanced understanding of the regional hydrogeological properties of this aquifer system. The project enhanced the Alberta Water well database as a searchable system. Historic well data were used for regional mapping, characterising trends in transmissivity, and water chemistry. To supplement this, over 100 new water samples were collected for detailed geochemical analyses, including a broad suite of elements and stable isotopes. The project also made use of abundant petroleum wells in the region. Petroleum well logs allow regional mapping of net sand content and porosity analyses of the Paskapoo aquifer. Aquifer properties of 3 deep cores (~100 m each) provided more detailed of the Paskapoo aquifer. These were collected with partners from the University of Calgary (Hayashi, Bently, Ryan) and through financial support of Alberta Environment. These cores provided essential stratigraphic information and permeability and porosity characteristics of aquifer sands. In addition, detailed thin section petrography provided better understand mineralogical and diagenetic controls on porosity and permeability.

Several presentations on results have been made at scientific and stakeholder meetings. A series of Open File reports are being released providing key results and principal findings. Technical papers are currently being prepared. The figure below (Grasby et al, in preparation) depicts the current conceptual model of the Paskapoo aquifers system. The model indicates that the formation is not a single aquifer but a heterogeneous aquifer system. Local flow cells develop with groundwater recharge occurring in the uplands, and groundwater discharge occurring in the valley bottoms.



The Paskapoo aquifers system.

Châteauguay River Watershed – Regional Hydrogeological Assessment Project (Project Manager: Miroslav Nastev)

The regional hydrogeological assessment of the Châteauguay River watershed, directed by Miroslav Nastev at GSC, is now completed. The research carried out in the framework of this project and the results obtained allowed, among other things, the development of Atlas of the Châteauguay River watershed. The atlas is the product of 4 years of combined efforts by the Quebec Ministère du Développement Durable, Environnement et les Parcs, Geological Survey of Canada – Department of Natural Resources Canada and the Quebec Institut National de la Recherche Scientifique – Eau, Terre et Environnement. We can state that this cooperation has been a success and we are proud of having participated in it. This atlas will enable the territory's managers and users to perfect their knowledge of the watershed with a view to improving management of groundwater resources. The data in the atlas are presented using thematic and interpretative maps accompanied by a brief explanatory text; they are grouped into three main themes: the territory, groundwater, and management.

The complete Atlas reference is: Coté, M.-J., Lachance, Y., Lamontagne, C., Nastev, M., Plamondon, R., Roy, N., **Atlas du bassin versant de la rivière Châteauguay** – Territoire, Eau souterraine, Aménagement. Ministère du Développement Durable, de l'Environnement et des Parcs, Québec, 57 p. Please contact M. Nastev to obtain a copy of the Atlas.



Annapolis-Cornwallis Valley Aquifer Study (Leader: Christine Rivard)

The Annapolis Valley project, a regional hydrogeological study focusing on major aquifer units of the most important agricultural area of Nova Scotia, is near completion. The results of this regional hydrogeological study are expected to be valuable to the agricultural industry and to all residents of the Valley by providing baseline information to select, manage and protect long-term water supplies. This study has allowed the development of large databases, including hydrologic, hydrogeologic and geochemical data, and has advanced our understanding of aquifers of the Annapolis Valley by providing recharge rate values, characteristics of fractures and hydraulic properties for each geological formation, vulnerability maps and a Quaternary geology map at the 1: 100 000 scale, bringing a new interpretation and vision of the glacial-deglacial history of the region.

This project was a fruitful collaboration between many stakeholders, including the Nova Scotia Environment and Labour (NSEL), Agriculture and Agri-Food Canada (AAFC), the Clean Annapolis River Project (CARP), Acadia University, INRS-Eau, Terre et Environnement (INRS-ETE), Université du Québec à Montréal (UQAM), the Centre of Geographic Sciences (COGS), Environment Canada, National Defence, the Nova Scotia Department of Natural Resources (NSDNR), the United States Geological Survey (USGS), the Nova Scotia Agricultural College (NSAC), and local hydrogeologists.

Three Master's degree theses have been or are being conducted on: 1) the aquifer vulnerability, 2) surface water / groundwater interactions, and 3) modeling of the nitrate migration in a sub-watershed. A final report presenting the current state of understanding of this regional hydrogeological system, along with the methodology used, data and results to characterize geological formations or groups of the Annapolis Valley was written and is currently being reviewed by co-authors. An Atlas containing thematic maps and summarizing key information on the Valley aquifers is presently being finalized and will be available by the end of this fiscal year. In all, 8 conferences have been presented, and 3 proceedings and 2 GSC Open Files have been published or submitted so far within the framework of this project. Two scientific papers are in preparation.

Thematic Research on Groundwater

The Groundwater Program also included some projects dealing with a few selected thematic researches. The Thematic Groundwater Research Project tried to address emerging groundwater issues affecting Canadians through focused scientific investigations in type localities. These investigations would yield new basic knowledge of sub-surface physical and chemical processes and new aquifer characterization and mapping methods that will be applied nationwide in similar settings. Three studies were developed under this project: a) Groundwater flow and chemistry in bedrock aquifers of the Lake Saint-Martin area of Manitoba; b) Prince Edward Island nitrogen cycle of aquifers at risk; and c) the Study of groundwater flow dynamics in an esker, Abitibi region. The sections below provide a brief summary of those studies.

Prince Edward Island Nitrogen Cycle of Aquifers at Risk (Leader: Martine Savard)

The recent work in the context of the thematic project – the nitrogen cycle “PEI-N Cycle” project directed by Martine Savard, has found that the chemical species in the nitrogen cycle in farmland are continually nitrified and leached towards the groundwater (saturated zone). From this observation, the nitrogen transfer cycle towards the

groundwater may be deduced by using oxygen isotopes in the nitrate which bear a signature of the seasonal precipitation present in the ground. These recent discoveries are creating a great deal of interest. Martine Savard was recently invited to present the results of the “PEI-N Cycle” project at two conferences below.

Environment Canada–St. Lawrence Centre (Montréal). Savard M.M. (2006). La nitrification hivernale dans le contexte des sols agricoles - une contribution possible aux excès en nitrates dans les eaux souterraines telle que suggérée par l'étude des isotopes stables des nitrates [translation : Winter nitrification in the context of farmland – a possible contribution to excess nitrates in groundwater as suggested by the study of stable nitrate isotopes] - 28 April, 2006.

Agriculture & Agri-Food Canada, Québec, Savard, M.M. (2006). Échanges Pédosphère-Hydrosphère - L'exemple du suivi des nitrates sur l'Île du Prince Edouard [translation : Pedosphere-hydrosphere exchanges– The example of monitoring nitrates on Prince Edward Island] – 26 January, 2006.

The research was conducted in cooperation with PEI-Forests, Environment & Energy and Agrifood Canada; in addition to Martine Savard, members that contributed to this discovery are: Daniel Paradis, Anna Smirnof, Shawna Liao (of GSC) and George Somers, Yefang Jiang, Eric van Bochove and Georges Thériault, scientists from the two main project partners, and an intern researcher, Isabelle Destroismaisons.

Study of Groundwater Flow Dynamics in an Esker, Abitibi Region (Leader: Serge Paradis)

The Esker-Abitibi project, led by Serge Paradis, is about to be completed. The work was primarily conducted as part of Marie-Noëlle Riverin's master's degree on the characterization and modelling of flow dynamics in the St-Mathieu/Berry, Quebec esker aquifer system. An acquisition-integration tool for semi-automated stratigraphic reconstitution of cross sections and volumes was also developed. A scientific article summarizing this work will be submitted in the fall, 2006 (Smirnof et al). A 3D geological model of the esker has also now been published (Bolduc et al., 2006).

As a result of the Ester-Abitibi project, two technology transfers were made. The first is the transfer of instrumented piezometers to the municipality of Amos. The second is the delivery of the Esker/Abitibi database to the Université du Québec in Abitibi-Témiscamingue (UQAT). The municipality of Amos and UQAT will be responsible for the equipment and data management. Future data will be integrated into the National Groundwater Database.

In the last year, the Esker/Abitibi research group attended the Réseau Environnement symposium (30 participants) and co-organized the 2nd Groundwater symposium in Abitibi-Témiscamingue (125 participants). Attending these symposiums has allowed the knowledge derived from the Esker/Abitibi project to be passed on to various local and regional participants coming from municipalities, the provincial government, the private sector and the general public. The Esker/Abitibi project has received 2 letters of support from the municipalities of Amos and Saint-Mathieu-d'Harricana expressing their satisfaction regarding the research carried out and the sharing of knowledge gained.

Remote sensing in support of groundwater monitoring and vulnerability assessment (Responsible: Richard Fernandes)

A fourth project completed the first phase of the GW program: the project “Remote sensing in support of groundwater monitoring and vulnerability assessment” directed by Richard Fernandes and

completed in March 2006. This project links both historical and current surface and climate processes to groundwater dynamics over key regional aquifers. Guidelines for remote sensing-based survey of aquifer surface properties were developed and provided to provincial agencies resulting in an enhancement of their ability to monitor and manage current groundwater resources. The project targeted the Oak Ridges Moraine, near Toronto, the Chateauguay Aquifer south of Montreal and the Annapolis Valley Aquifer, in Nova Scotia. The Oak Ridges Moraine supplies drinking water to a region with the largest population density in Canada. The major question here was to quantify the impact of land development on the sustainability of the aquifer. The latter sites correspond to a predominantly rural area experiencing climate related water shortages. This Annapolis site is the subject of a joint climate change impacts study between all levels of government, universities and local groups. The major question here was to quantify the impact of historical and projected climate variability on water availability from the aquifer. Through working with partners at these sites, this project developed best-practice guidelines for remote sensing applications to groundwater assessments.

Planned outcomes for the project were to: produce surface parameter maps over 2 regional aquifers, produce guidelines for further mapping provided to provincial agencies, and to improve assessments of water resources in future conditions by using existing groundwater models with recharge estimates from a hydrological model.

Phase II of the groundwater program (2006-2009)

The new phase of the program includes 4 new projects and 14 sub-projects. We also have a new team with most of the researchers coming from the previous phase of the program; some borrowed from other programs in the Earth Sciences Sector, and a few totally new researchers in our institution. The new phase of the program is composed of four main projects:

- 1- Groundwater inventory: aquifer systems in Canada (P-1)
- 2- Groundwater Pathways, Database, Information Transfer (P-2)
- 3- Groundwater Earth Observation and Thematic Research (P-3)
- 4- Synthesis of GW Knowledge, Program Management and Leadership (P-4)

The choice of the projects in the second phase was done following the overall long-term goal of the program, namely to inventory the groundwater resources of Canada, to generate hydrogeological knowledge and to make that knowledge readily available and easily accessible. In addition, it is planned that the program attracts investment, generates jobs, and influences research in this area of keen national interest, as already demonstrated in the first phase of the program (2003-2006). In this second phase, there will be enhanced emphasis on capacity building and awareness.

Projects are planned in a manner to be strongly interlinked through the national groundwater database now being part of the Groundwater Pathways, database, and information transfer project (P-2). The projects are planned and organized to deliver, by 2009, an advanced National Groundwater Inventory (NGWI), to the point where decision-makers will have access to sound science advice in the form of a robust information base comprising:

- 1- A synthesis of Canada's groundwater resource knowledge (book under P-4);
- 2- A first order assessment of the location, volume and vulnerability of groundwater present in Canada's key national aquifers (P-4, P1);

- 3- Detailed groundwater resource assessments of nine key national aquifers (three more than in 2006, bringing the NGWI to 30% of the key national aquifers; P-1).

The NGWI will enhance Canada's capacity for informed groundwater resource decision-making to reduce risks and costs by:

- a) Building capacity to use Groundwater geoscience through development of HQP with partners (P-2);
- b) Conducting partnered projects and joint activity planning (P-2, P-3);
- c) Reporting and communicating progress and knowledge (P-2); and
- d) Providing key expertise on-demand (P1, P-2, P-3 and P-4).

The table below presents all projects and sub-projects with their respective project leaders. These projects will be further described in future Newsletters and their development and results will be discussed in the program's website: http://ess.nrcan.gc.ca/2002_2006/gwp/ (please be aware that this web site will change later in the year to accommodate for new ESS structure. I will inform you when the time comes, AR.)

Project	Sub-projects	Sub-PL
GW Knowledge synthesis and Program Management PL: A. Rivera	Book on the GW Resources in Canada and Program Management	A. Rivera
GW Inventory: aquifer systems in Canada PL: D. Sharpe	Great Lakes Basin, Southern Ontario	D. Sharpe
	Sandilands and Southern Manitoba	M. Hinton
	Paskapoo, AB	S. Grasby
GW Pathways, Database, Information Transfer PL: B. Brodaric	Okanagan, GAOB	S. Grasby
	Groundwater PATHWAYS: Sustainability Planning with Groundwater Information	B. Brodaric
	Mapping Variability of Groundwater Resources over Major Canadian Water Basins from GRACE Data (version 2)	C. Klatt
	Enhancing Canada's Capacity to Integrate Geoscience Information into Decision-Making Process	D. Mate
GW Earth Observation and Thematic Research PL: S. Chalfoux	Atlas Maps of Groundwater Issues	P. Paul
	Assessment of Regional Groundwater Recharge through Integrated Earth Observation (EO)	S. Chalfoux
	Nitrates sources and climate change on groundwater quality in agriculture areas	M. Savard
	Impacts of anthropogenic activities and climate change on GW levels and aquifer recharge across Canada	C. Rivard
	Groundwater resources of the Lake Saint-Martin area, Manitoba	A. Desbarats
	Methodology development and hydrogeological characterizations in support of groundwater resources mapping	D. Paradis
Improved models for surface water – groundwater interaction at the watershed scale – Chateauguay River Basin, southwestern Québec	M. Nastev	



Advances in groundwater research

Book on groundwater resources in Canada

A second workshop for preparing the book on groundwater resources in Canada took place in Quebec City on 17, 18 and 19 January 2006. This workshop proved to be very productive. The first day was devoted to presenting the objectives of writing the book and a discussion of the book's content and style. Roundtable discussions were held on the second day of the workshop to determine the presentation standards of information contained in the book, including the structure of the chapters dealing with hydrogeological regions and a list of Canadian classification of aquifers and aquitards. Presentations on the sustainability of groundwater resources in Canada were made on the third day of the workshop by Alfonso Rivera and Garth van der Kamp (EC).

At the end of this workshop, a detailed plan for the book was prepared. This plan includes the chapters and their authors, drafts of chapters, design of the book and the names of two potential publishers. The authors shall submit the first complete version of their chapters in December 2006. Systematic updates on this project will be provided in the Newsletter subsequent issues and in the program's web site.

Detailed minutes of the workshop are available upon request.

IV World Water Forum

The IV World Water Forum was held in Mexico City from 16 to 23 of March, 2006.

These Forums are organized every three years by the World Water Council since 1997, and have become the most important events for promoting sustainable water management policies world wide. Alfonso Rivera has participated in the III (Japan in 2003) and in the IV Forums (Mexico City). Alfonso's participation was as a scientific voice for Canada in groundwater-related issues; it provided an opportunity to influence and guide groundwater initiatives under the context of the World Water Forums, regarding the issue of transboundary groundwater, a current key issue of the government of Canada. This participation is directly linked to two of the outcomes of the Groundwater Program.

Alfonso participated in 2 sessions, one with the OAE's report on the Transboundary aquifers of the Americas; and the other one with the IAH-WHYMAP consortium presenting for the first time the World Hydrogeological map; in both cases information and data from Canada were included as developed by the Groundwater Program and partners from the provinces. Copies of the IAH-WHYMAP map (GW Resources of the World map at 1:50 000 000) are available upon request.

Rosenberg Workshop to review the «Water for life» Strategy Alberta (A. Rivera)

A workshop was conducted under the auspices of the Rosenberg International Forum on Water Policy. The Rosenberg Forum is an activity of the University of California created through an endowment gift from the Bank of America to the University in honour of Richard Rosenberg on the occasion of his retirement as President of the Bank. The Rosenberg Forum meets every two years at different locations around the world. In addition, they also conduct regional workshops that focus on problems that are local or regional in nature.

At the request of Alberta Ministry of Environmental, the Rosenberg Forum conducted a workshop on June 7-9, 2006 in Calgary. The purposes of the workshop were: 1) to review and offer comments

and recommendations on «Water for Life,» the Alberta water strategy and 2) to assess the capacity of groundwater to support current and anticipated growth in the Calgary-Edmonton urban axis and make recommendations on the gathering and maintenance of groundwater data and a groundwater management plan for the region.

I was invited to participate to the formal review of the Alberta Water for Life strategy during the Rosenberg Forum. Members of the Ministry of Alberta Environment (DM and ADM level) were there and I learned things and elements of the strategy that I was not aware of, I must say that I was impressed with the structure and issues.

Our Canadian Framework has been fully recognized in the GW action plan and in some cases applied with some small modifications. The Rosenberg Foundation invited very distinguished groundwater scholars in the world (USA, Australia, Israel) as well as two Canadians (Ben Rostrom and I). I was glad to hear one of the Rosenberg member's recommendations to AENV to (quote) "Alberta's GW Action Plan should be closely coordinated with the Groundwater Program and plans of Natural Resources Canada" (end of quote).

It seems that we do have a role to play in this very rich and exciting water strategy of one of the most important provinces considered to be a semi-arid region.

People in the News

Éric Boisvert received on November 28, 2005 in Ottawa an award of sectorial recognition for its implication in the development and the management of the national groundwater database of Canada. The award recognizes the leadership of Éric Boisvert for its innovative practice in the installation of a dynamic data-processing support allowing the management of the hydrogeologic data of Canada and information of the groundwater Program in the ESS. The database is a tool designed for decision-making within a framework of management and protection of groundwater. Éric has created several services, of which Internet communication and data sharing, from now available on the portal of the database.



Éric succeeded in linking NRCAN to groundwater stakeholders in Canada and other international key stakeholders. He created a powerful tool to explore the groundwater data and information of Canada, including decision-support systems. Éric's achievement is outstanding, for not only he was very creative and innovative in developing his project, but he also developed mechanisms for collaboration and partnership amongst a myriad of stakeholders with very different vision and approaches in the handling of groundwater data and information. Bravo Éric!

Suggested Reading

In this issue, the list of suggested readings is a partial compilation of the most relevant publications with the results of the first phase of the program. If you are interested in obtaining copies of some of these references, please contact Isabelle Martineau, at (418) 654-2677 or Email to: Isabelle.martineau@nrcan.gc.ca.

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Bolduc, A., Paradis, S.J., Riverin, M-N., Lefebvre, R., Michaud, Y., 2006, A 3D Esker Geomodel For Groundwater Research: The Case Of The Saint-Mathieu - Berry Esker, Abitibi, Québec, Canada in Russel, H., Berg, R.C., and Thorleifson, L.H., eds., 4th **Three-dimensional geological mapping for groundwater applications workshop**; Salt Lake City, Utah; US; 15 October 2005, Dossier public, 5048, Commission géologique du Canada, 17-20

Bolduc, A., Paradis, S.J., Riverin, M-N., Lefebvre, R., Michaud, Y., 2005, **Development of a 3D geomodel for eskers: the case of the Saint-Mathieu - Berry Esker, Abitibi**, Québec, Canada, Geological Society of America Annual Meeting, Salt Lake City, UTAH, Octobre in: Program with abstracts

Bolduc, A., Paradis, S.J., 2005, **Modélisation 3D de l'esker Saint-Mathieu - Berry (32 D/08 et 32 D/09) à l'aide du logiciel Gocad**, Québec Exploration 2005, Québec, Novembre dans: Résumés des conférences et des photoprésentations, p. 131.

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Paradis, S.J., Bolduc, A., and Stea, R., 2005, **Surficial geology, Annapolis Valley, Nova Scotia**; Geological Survey of Canada, Open File 5276, scale 1:100 000.

Paradis, S.J., Bolduc, A., Riverin, M-N., Lefebvre, R., 2005, **Historique du projet Esker/Abitibi, 2e Colloque sur l'Eau souterraine en Abitibi-Témiscamingue**, Amos, Québec, Novembre

Rivard, C., Ross, M., Michaud, Y., Hamblin, T., Drage, J., Blackmore, A., Webster, T., Paniconi, C. and Deblonde, C., 2004. **Preliminary hydrogeological characterization of the Annapolis Valley, Nova Scotia, proceedings**, in: 57th Canadian Geotechnical Conference – 5th Joint CGS/IAH-CNC Conference, pp. 5-12

Rivard, C., Michaud, Y., Liao, S., Bolduc, A., Paradis, S., Paradis, D., Castonguay, S., Deblonde, C., Hamblin, T., Drage, J., Paniconi, C., Webster, T., Spooner, I., 2005, **Characterization of the Annapolis Valley aquifers, Nova Scotia – A work in progress**, in: 6th Joint CGS/IAH-CNC Conference, Saskatoon, September 2005, Technical session #8 (#585).

Rivard, C., Paradis, D., Paradis, S., Bolduc, A., Morin, R.H., Liao, S., Pullan, S., Gauthier, M.-J. Trépanier, S., Blackmore, S., Spooner, I., Deblonde, C., Fernandes, R., Castonguay, S., Hamblin, T., Michaud, Y., Drage, J., Paniconi, C., 2006, **Canadian groundwater inventory: Regional hydrogeological characterization of the Annapolis-Cornwallis Valley aquifers**, final report, 170 p. and Appendix.

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