Groundwater Geoscience Program
Yves Michaud, Program Manager

NANAIMO WATER DAY,
March 21st, 2014
Place of GSC in the federal Government Structure in Canada

Federal Government Of Canada

Department of Natural Resources

Department of Environment

Etc....20 other

Earth Science Sector

Geological Survey of Canada

Canadian Centre Remote Sensing

Mapping information Branch

Canadian Centre for Mapping and Earth Observation
The Role of GSC in a Canadian Context

- Canada’s federal geoscience agency since 1842
- Provides Canada with a comprehensive geoscience knowledge base contributing to **economic development, public safety**, and **environmental protection**
- Operates collaboratively with multiple provincial and territorial agencies
- Plays a primary role in areas of federal jurisdiction (e.g. Transboundary issues, Federal lands)
- Acquires, interprets, and disseminates geoscience information
- Maintains national databases, standards and policies
- Provides coordination with international geoscience agencies
- **Not to forget**... **Natural resources responsibility is with provinces**
## Research context at NRCan

### Strategic priorities of ESS

<table>
<thead>
<tr>
<th>To support the competitiveness of natural resources sectors</th>
<th>To promote the sustainable development of the North</th>
<th>To promote resources development while respecting the environment</th>
<th>Sound scientific and technological databases for land management, including security and stewardship</th>
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</thead>
<tbody>
<tr>
<td>• Targeted geoscience initiative 4 (TGI-4)</td>
<td>• Canada legal boundaries</td>
<td>• Groundwater geoscience program</td>
<td>• Natural hazards and public safety</td>
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<td>• New energy sources</td>
<td>• Geomapping for energy and minerals</td>
<td>• Environmental studies and evaluations</td>
<td>• Essential geographic data</td>
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<td>• Innovation in geomatic</td>
<td>• Adaptation to climate changes</td>
<td>• Teledetection aimed at strengthening regulations for oil sands sector</td>
<td>• CHIS and emergency geomatic services</td>
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<td>• Polar continental shelf program</td>
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To promote the sustainable development of the North:

- Canada legal boundaries
- Geomapping for energy and minerals
- Adaptation to climate changes
- Polar continental shelf program

To promote resources development while respecting the environment:

- Groundwater geoscience program
- Environmental studies and evaluations
- Teledetection aimed at strengthening regulations for oil sands sector

Sound scientific and technological databases for land management, including security and stewardship:

- Natural hazards and public safety
- Essential geographic data
- CHIS and emergency geomatic services
Freshwater in Canada

- Canadian’s river discharge is about 105,000 m³/sec annually
- 7% of world’s renewable surface water
- About 60% of surface water is flowing north, while 85% of the population are settled in the south
- Groundwater is more abundant than surface water
Groundwater use in Canada

- About 10 M people rely on groundwater as drinking water
- 80% of rural population

Source: Statistiques Canada
ESS’s Groundwater Geoscience Program

To provide scientific knowledge on GW resources for water management and protection

- Develop a Framework for collaboration
- Identify 30 key regional-scale aquifers (>1000 km2)
- Initiate aquifers mapping and assessment projects
- Initiate a Groundwater Information Network
- Initiate a National Aquifer Evaluation & Assessment projects
ESS’s Groundwater Geoscience Program

Objectives:
- Understand the dynamics of archetypical Canadian aquifers, and develop methodologies for their assessment
- Make data available through the Groundwater Information Network using internationally accepted, web-enabled methods and standards

Outcomes:
- Canada has a comprehensive defensible scientific base of aquifer knowledge when resolving transboundary water issues
- Canadians are able to manage GW resources responsively

Outputs:
- Maps and assessment of 30 key Canadian aquifers
- Fully operational and web–accessible Groundwater Information Network
Phase III - 2009-2014:

1) Aquifers mapping and assessment (7)
2) Groundwater Information Network & Dissemination
3) National Aquifer Evaluation & Assessment

Aquifers to be assessed 2009-2014:

- Nanaimo (B.C.)
- Milk River (Alta)
- Buried Valleys (Prairies)
- Waterloo Moraine (ON)
- Richelieu-Lake Champlain (QC)
- Chaudière (QC)
- St Maurice (QC)
Steps to Understanding

- Database Development
  - e.g. compilation of archival data; new data collection and integration

- Geological Models
  - e.g. conceptual models
  - landform and terrain models
  - stratigraphic, architectural and depositional models

- Hydrostratigraphic Models
  - e.g. conceptual models
  - definition and characterization of aquifers and aquitards

- Groundwater Flow Models
  - e.g. flow characterization
  - quantitative analysis (e.g. water balance)
  - numerical flow modelling

- Quantitative Understanding of groundwater flow system

Sharpe et al. 2002
Steps to Understanding

1) Compilation de l'information existante
   
   **Sources des données**
   - **MEF**
   - **MTQ**
   - **MRN**
   - **RNC**
   - **Fichier privé**
   - **Hydro-Q**

   **Types de données**
   - **Rapports**
   - **Cartes**

2) Travaux de terrain
   - Échantillonnage et analyse granulométrique des sédiments
   - Forage
   - Piézomètre
   - Leves géophysiques
   - Architecture et stratigraphie
   - Échantillonnage et analyses géochimiques de l'eau

3) Intégration et analyse des données géoscientifiques
   - Base de données relationnelle

4) Interprétation et production de cartes hydrogéologiques
   - Contextes hydrogéologiques
   - Coupes hydrostratigraphiques
   - Piézométrie
   - Hydrogéochimie
   - Isopaque

Michaud et al. (2002)
Steps to Understanding Basin analysis

- Data collection to understand the geological history of the basin
- Predictive Framework
- Requires high quality data
Aquifer mapping and assessment “the approach”

1) Aquifer characterization
   - Delineate aquifer systems (unconfined, semi and confined)
   - Geological model
   - Define hydrostratigraphic facies
   - Test aquifer properties
   - Characterize the GW quantity
   - Delineate recharge zones
   - Characterize the GW quality (Water types)
   - Assess the vulnerability (e.g. DRASTIC)

2) GW flow dynamics
   - Define GW flow rates and regime
   - Calculate GW storage and GW use

3) Resource assessment
   - 3D hydrodynamic model
   - Calculate the sustainable yield
Aquifer mapping and assessment container and content

Geological context

GW quantity

Canada’s Natural Resources – Now and for the Future
Aquifer Mapping and assessment content

- 155 GW samples (56 parameters)
- 2 dominant water types
  - Ca-HCO₃: recent recharge (low mineralization)
  - Na-HCO₃: confined flow conditions (cations exchange)
Aquifer Mapping and assessment
GW flow dynamics

Water Budget and use

Piezometric map
Field methods development
Geophysical surveys
Airborne Electro-magnetic survey
Three dimensional mapping

Apparent Conductivity Map
3D Modelling methods
SVM Processing

Input Data Set

SVM

Volumetric SVM Model
Remote sensing methods
ET, Leaf Area Index & GW recharge

Evapotranspiration (ET) (left) and groundwater recharge (right) obtained by the EALCO model (mm H₂O/year, 1979-2008 average). EALCO is a physically-based numerical model developed in ESS to simulate the hydrological and ecological processes of terrestrial ecosystems using EO.
Remote sensing methods
Satellite GRACE

Trend:
- 14 mm/yr
- 12 mm/yr
- 20 mm/yr
Welcome to GIN

The Groundwater Information Network aims to improve knowledge of groundwater systems and enhance groundwater management through increased access to groundwater information. GIN connects water well databases from British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, and Yukon, and provides some key aquifer information from Natural Resources Canada.

Explore Maps
Explore aquifers and related groundwater information, as well as view and download water well and monitoring site information:
- Basic map viewer
- Google-like map viewer

Find Information
Search for groundwater information:
- Find water wells or monitoring sites
- Find key Canadian aquifers
- Find other groundwater information

News
Stay informed through our news feed and tweets:
- New “Canada’s Groundwater Resources” book now available!
- Canada’s Groundwater Resources’ book compiled and edited by Alfonso Rivera now available on Amazon.ca.
- New presentation at the World Water Week held on September 2nd 2013 in Stockholm, Sweden.
- Brodaric, B. and Booth, N presented a talk on “Interoperable Groundwater Data Exchange Network emerging in North America” during the “Groundwater

Under the Hood
Re-usable GIN tools that can be incorporated into your website or application:
- Well-log viewer
- Time-series viewer
- Gazetteer
- OGC WMS, WFS and SOS services

Partners
The success of the GIN network is result of active collaboration of provincial and federal stakeholders.
- Yukon
- British Columbia
- Alberta
- Saskatchewan
- Manitoba
- Ontario
- Quebec
- Nova Scotia
- Canada

Contact Us
Please complete the online form for general enquiries or technical issues.
- Online form

http://gw-info.net/
Groundwater Information Network
ESS Aquifer Mapping Data

Groundwater Standard Data Products

[Map of Canada showing groundwater information network]
Groundwater Information Network
ESS Aquifer Mapping Data

Objectives

- Provide a coherent national view, and online access, for information on the 30 key aquifers and related groundwater data.

- Move towards common layers of information following standard data structure (GWML)

Common Data Products

1. Hydrogeological Units (Aquifers, ...)
2. Bedrock Geologic Units
3. Surficial Geologic Units
4. Recharge Rate
5. Groundwater Level
6. Groundwater Samples
7. Groundwater Composition (Quality)
8. Groundwater Flow
9. Aquifer Vulnerability
10. Aquifer Confinement
11. Water Wells
12. Hydraulic Properties
13. Groundwater Usage
Groundwater Information Network
Connecting to partner’s databases

Water Wells and Monitoring Sites
Groundwater Information Network
Connecting to partner’s databases
## Conclusion

**Defining the right products**

<table>
<thead>
<tr>
<th>Possible use</th>
<th>Level of information</th>
<th>Low (Scarce and heterogeneous data from various sources)</th>
<th>Advanced (systematic investigation)</th>
<th>High (hydrogeological system and groundwater models)</th>
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<tbody>
<tr>
<td>Reconnaissance and Exploration</td>
<td>general hydrogeological map (aquifer)</td>
<td>hydrogeological parameter maps</td>
<td>regional groundwater systems maps (conceptual model)</td>
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</tr>
<tr>
<td>Planning and Development</td>
<td>map of groundwater resource potential</td>
<td>specialized hydrogeological parameter maps (planning maps)</td>
<td>graphic representation derived from GIS (sections, 3D diagrams, scenarios)</td>
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<tr>
<td>Management and Protection</td>
<td>map of groundwater vulnerability</td>
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<td></td>
</tr>
<tr>
<td>Possible use</td>
<td>Level of information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>static</td>
<td>time-dependence</td>
<td>dynamic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>reliability</td>
<td>high</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>cost</td>
<td>high</td>
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<td></td>
</tr>
<tr>
<td>large</td>
<td>area represented</td>
<td>small</td>
<td></td>
<td></td>
</tr>
<tr>
<td>small</td>
<td>scale</td>
<td>large</td>
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Conclusion

Informed, sustainable action requires understanding

- Water is an essential component of economic development
- Need an integrated understanding of both geological and hydrogeological frameworks for sustainable water management
- High quality data collection is required to advance knowledge