
Hazen A.J. Russell & Andy F. Bajc
Where to Find us!

Groundwater Information Network


Workshop presentation and program will be available on GIN
Collaboration

Ontario

Ministry of Agriculture, Food and Rural Affairs
Ministry of Environment and Climate Change
Ministry of Municipal Affairs and Housing
Ministry of Natural Resources and Forestry
Ontario Geological Survey
Government Structure

Canada

Federal
- Natural Resources
- Environment
- Agriculture
- Earth Science
  - Geological Survey
    - Canadian Centre for Earth Mapping and Observation
  - Canadian Centre Remote Sensing

Provincial
- Provincial Agencies
- Regional Municipalities
- Conservation Authorities

This Senate report made substantial recommendations to government.

Recommendation 1: The Government of Canada should take the necessary steps to ensure that all of Canada’s major aquifers are mapped by 2010. This data should be made available in the national groundwater database and supported by a summary document assessing the risks to groundwater quality and quantity.
Key Canadian Aquifer Studies

Completed Projects
1- Gulf Islands
2- Nanaimo Lowlands
3- Fraser Lowlands
4- Okanagan Valley
5- Paskapoo
7- Buried Valleys
9- Milk River
14- Basal Clastic Unit
16- Sandlands
18- Oak Ridges Moraine
21- Waterloo Moraine
23- Annapolis Valley
24- Carboniferous Basin
25- AFSDQ- Mirabel
26- Châteauguay
27- Richelieu
28- Chaudière
29- St-Maurice
30- Portneuf
31- Prince Edward Island
32- Esker St-Mathieu
33- South Nation River
34- Lake St. Martin

Future Projects
5- Shuswap Highlands
8- Upper Cretaceous Sands
10- Judith River
11- Eastend-Ravenscrag
12- Intertill Aquifers
13- Carbonate Rocks
15- Odanah Shale
17- Assiniboine Delta
19- Grand River Basin
20- Credit River Basin
22- Upper-Thames Basin

Legend
- Aquifer
- River
- Lake
Hydrogeological Region
- Appalachian Mountains
- Canadian Shield
- Cordillera
- Hudson Bay Lowlands
- Carboniferous Basin
- Permafrost
- Southern Ontario Lowlands
- St. Lawrence Platform
- Western Canada Sedimentary Basin

N = 11

Canada’s Natural Resources – Now and for the Future
Study Area

Source Water Protection
• 10 years
• 250 million
• Conservation – Watershed based
Framing Documents / Agencies

- Interprovincial Geoscience Accord
  - Ontario Geological Survey
- IJC (Great Lakes water quality)
- Ontario / Canada Agreement
  - Contribution of groundwater – surface water
- Clean Water Act
  - Source Water Protection
- Place to Grow Act
Issues: Southern Ontario

- Drought
- Growth
- Source Protection
- Sustainable Water Supply
- Multiple Land Use
- Great Lakes Water Quality
- Ecological Function
High Level Framework

1. Framework for Sustainable Groundwater Use

2. Supporting Great Lakes water accord

3. Methods Development for regional groundwater studies

4. Case Studies

5. Science & Technology Exchange
Aquifer Studies: Methodologies / Workflows

- Basin Analysis
  - Data collection to understand the geological history of the basin
  - Predictive Framework
  - Requires high quality data

- Baseflow – Low-flow
- Sediment coding

Sharpe et al. 2002
1. Framework for Sustainable Groundwater Use

1. How is data managed over the long term?
2. Baseline data to understand groundwater flow, quality, etc.
   1. Stratigraphic database etc.
   2. Attribute datasets to framework
3. Geological Framework 3D model for:
   1. sediment
   2. Bedrock
4. Portal for data access
Highlights value of a Southern Ontario Framework for
Storage of data
Classification of data
Accessibility to data
Delivery of data
How is data managed over the long term?

- **Workshop November 24th 2015**
  1. Data management and dissemination
  2. Stakeholder access to data and model results
  3. Regional groundwater model platform for southern Ontario and Great Lakes basin

- **Outcome**
  - White paper
How is data managed over the long term?

- Provincial
  - MOECC, MNRF, OGS, OMFRA, MMAH
- Conservation Ontario, GRCA and CAMC
- Association Municipalities of Ontario
- Academia
- Federal (GSC, AAFC, ECCC)
How is data managed over the long term - progress

- **Low Water Response Network**
- **Groundwater Information Network**
- Enhanced OGS Data serving
- Enabling OGS borehole data
Geological 3D Model Surficial

1: Waterloo Moraine
2: Barrie-Oro Moraine
3: Brantford-Woodstock
4: Orangeville Moraine - Fergus
5: South Simcoe County
6: Niagara Peninsula
7: Central Simcoe County

Elevation (m asl)

- 3-D Mapping Studies
- Green Belt

Lake Erie
Lake Huron
Lake Ontario
Georgian Bay
2. Supporting Great Lakes Water Quality Accord

- Classification of surface water/groundwater interaction
- Studies to map out discharge and base flow
  - Initiated winter 2016
    - Universities Waterloo and Western Ontario
    - Literature review
    - Proof of concept
    - Piggyback on MOECC funding for Lake Simcoe and GRCA Grand River work
3. Methods Development for Regional Groundwater Studies

1. 3-component seismic acquisition and processing
2. Passive Seismic
3. Down-hole geophysics methods
4. Petrophysics studies - aquitards
5. pXRF geochemistry - chemostratigraphy
6. Soil Moisture Radar Studies
7. RadarSat interferometry
3-Component Seismic

Source: Minvib I, vibrating in-line horizontally. 6 m shot spacing, up to 6 km of profile per day
Production: 6 km per day

Source: Microvibe
Downhole Geophysics

(65 BH’s)

LEGEND
- Recent sediments
- Organics
- Moraine
- Basin sand
- Basin mud
- Mud till
- Glaciofluvial sediment
- Sandy silt till
- Bedrock

- Boreholes with geophysical logs
- GSC 'Golden Spike' Boreholes

Map showing locations of boreholes and geological features.
Aquitard Petrophysical Studies

Petrophysical Studies

- Geochemistry
- Mineralogy
- Grain shape and packing
- Porosity
- Permeability (?)
- Connect to K

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1. Strata characterization, baseline dataset
2. Data on glacial process and sediment provenance.
3. Cost effective.

- OGS collaboration / University of Guelph
pXRF Chemostratigraphy

GTA pilot

OGS- Borehole transects

18-20 boreholes

2000 samples
Mapping/modelling water and water-related data layers at various scales

Data Layers:
- Land Surface Evapotranspiration (ET) and Lake Evaporation
- Soil Moisture and Freeze/Thaw
- Surface Runoff
- Groundwater Recharge
- Water Storage
- Water Budget
- Surface Water Body
- Landcover and Leaf Area Index
- Surface Deformation

Spatial Scales:
- Local Watershed/Aquifer
- Large Drainage Basin
- Canada National

Temporal Scales:
- Depending on parameters, from hourly to 30 years

Methods:
- Optical and microwave satellite observations
- EALCO model

Total water storage (mm H$_2$O) (Wang et al., 2015, J. Hydro. Wang and Li, 2016, Can J Rem Sen.)

ET at various scales (Wang et al., 2013, HESS. Wang et al., 2015, J. Hydromet.)
Stochastic Hydrostratigraphic Characterisation and Uncertainty

Ph.D thesis:
Nicolas Benoit, Polytechnique Montreal,

General objective: Develop a stochastic approach that adequately characterizes the effect of hydrostratigraphic heterogeneity uncertainty on groundwater flow.

Specific objectives:
- Improve hydrofacies geostatistical simulations
- Develop a regionalization approach for hydraulic conductivity tensor including the connectivity concept (extreme values).
- Provide an approach for uncertainty assessment associated with the effects of hydrostratigraphic heterogeneity on the regional groundwater flow.
Hydrogeophysics

- Under development
- Increased parameter extraction from geophysics data
- Seismic reflection
- Electrical methods
- Downhole geophysics
- Insitu hydraulic testing
4. Case Studies

- Regional Geochemistry
- Data Collection Wasaga and Niagara Study areas OGS
- Analysis with Collaborators
  - Laurentian Valley (OGS)
  - Yonge St Aquifer (CAMC)
  - Paris Moraine
Southern Ontario Geochemical Survey

- direct link between sediment chemistry and Paleozoic bedrock
- Higher values in limestone terrain south of Shield
GTA-ORM Geochemical Survey

Soil-sediment geochemical survey (1994, 1995)

- paired A / C soil horizon samples (682)
- regional landscape geochemistry (~1 site /30 km²)
- nested sample design: site, target-cell, lab duplicates; reference standards
- linked till samples (~340)
- analyzed elements (33) (INAA, AAS, ICP-MS; XRF)
Seismic Acquisition with OGS

Canada’s Natural Resources – Now and for the Future

Wasaga Beach

Niagara
Seismic Acquisition with OGS
5. Science & Technology Exchange

- CJES special volume
  - Submissions in progress
- Workshops and information transfer
  - November 24th, March 10th
- Field Trips
  - GAC 2017, Kingston (GSC 175th anniversary)
- Summary of Fieldwork articles
  - OGS
- Groundwater Information Network
Summary

- Pan Southern Ontario Project
- Advance methods for regional hydrogeology
- Develop an integrated regional groundwater data framework
- Framework for Sustainable Groundwater Management
  - E.g., Climate Change, Cumulative Effects
Where to Find us!

Welcome to GIN

The Groundwater Information Network is developed to improve knowledge of groundwater systems, and enhance groundwater management, through increased access to groundwater information. GIN connects a variety of groundwater information from authoritative sources, such as water well databases, water monitoring data, aquifer and geology maps, and related publications. Provincial and territorial collaborators include British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, Nova Scotia, and Yukon; international collaborators include the USGS and others.