



Integrating Numerical Modelling into the Groundwater Policy Assurance Process

Dan Palombi, Alberta Geological Survey

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Outline

- Project regions and current initiatives
- > Modelling results
- D Towards integrating numerical modelling into a regulatory framework





AGS Groundwater Program

Overview

- Study, map and quantify Alberta's groundwater and brine resources
- Focused on regional saline and non-saline aquifers exploited by energy development
- Regional geological and hydrogeological mapping, groundwater flow modelling, and evaluation of management tools

3 Phases of the Program

- I. Characterize the natural system
- II. Understand dynamics of groundwater system under development
- III. Develop decision support tools for resource management, regulation, and policy development



Council of Canadian Academics, 2009







Regional Project Areas

- Phased approach to study area characterization
- Future study areas will focus in regions with intense energy development







Phase II Modelling Objectives

- Assist regulator(s) of the Water Act using groundwater flow models required to:
 - \square Evaluate groundwater authorizations
 - Support a change from well by well (Q20) evaluations to cumulative impact based assessments
 - D Understand groundwater resources and patterns of development
 - Senerate regional models to assess water-balance, drawdown and yield forecasting
 - Identify current areas of stress to groundwater and surface water resources
 - Enable scenario modelling to evaluate future groundwater developments





Modelling Approach

\square Nested scales



- Enables basin- and regional-scale models to inform management-scale objectives
- D Basin- and regional-scale models ensure appropriate boundary conditions, spatial flexibility, and cumulative effects assessment





Alberta Regional Groundwater Flow Models











Southern Alberta Regional Groundwater Simulation



PK: Paskapoo, SC: Scollard, HSC: Horseshoe Canyon, BP: Bearpaw, BR: Belly River, LP: Lea Park.

Bedrock Map

Colorado Group)	0	
Lea Park (Top of	Confining	AER\AGS\SWA
Belly River	Aquifer	picks\AGS\Saskatchewan \Outcrops AER\AGS\SWA
Bearpaw	Confining	Hamblin(GSC)
Horseshoe Canyon	Aquifer	
Battle	Confining	AER\AGS
Scollard	Aquifer	AER\AGS
Paskapoo	Aquifer	
Recent	Variable	AER\AGS
Layers	Property	
Hydrostatigraphic	Hydraulic	Source

SARGS (9 Layers)



Model Domain





Southern Alberta Regional Groundwater Simulation

- \mathbb{D} 1st order regional flow model
- Successfully calibrated, steady state Modflow model
- Indicates regional flow patterns
- Serves as foundational model for higher resolution models
- Enables rapid regional water budget calculations
- Provides lateral and vertical boundary conditions for management-scale models



Sylvan Lake Study Area: **Sub-basin Scale Modelling**



Government

www.ags.gov.ab.ca





Olds



Wetaskiwir

Model Cross-Section



Phase III Regulatory Development Targets

- D Quantify cumulative effects
- Solution Series Seri
- D Advance current groundwater management framework

Q_{20} : 20 year safe yield

- Well-based concept (drawdown vs. time)
- Does not quantify cumulative effects (multiple wells)
- Does not address the ultimate source or sustainability of pumping



What Are Others Doing?

- Water resources management in The Netherlands and United Kingdom (NGMS)
- Support continued geological mapping and 3-D modelling
- D Tiered approach to groundwater resource management
- Develop groundwater flow models with results freely available to regulator, industry & public
- D Models are hosted & run within updateable architecture to adapt to increased model complexity





NGMS – The National Groundwater Modelling System for England and Wales

D Purpose of NGMS:



- D Manage sustainable development of groundwater resources
- Σ Identify sustainable yield of groundwater units
- D Regulate extractions and their impacts on springs, rivers, wetlands and existing licenses
- Conduct strategic planning for European Commission directives (e.g., Water Framework Directive)
- D Provide water availability forecasts





NGMS in A Management System

nvironment



Capabilities includes:

- 1. Reference situation
 - Historic (calibration)
 - Natural (zero extractions)
 - Recent (actual)
 - Fully licensed
- 2. Scenarios (impacts of change)
 - Groundwater extractions
 - Surface water extractions and discharges
 - Climate change (rainfall)
- 3. Output of Interest
 - Absolute values and differences in:
 - Surface water flows
 - Hydraulic heads
 - Water budgets





AGS-ESRD-Deltares Project: Starting Phase III

- Collaboration between governments of Alberta and Netherlands initiated in October 2011
- Project initiated in August 2012 with support from AI-EES which resulted in 4 technical workshops and reporting
 - D Implementing a regulatory groundwater framework
 - D Mid- and long-term numerical modelling approach/workflow
 - D Utilization of airborne geophysics in groundwater resource assessments
 - D Uncertainty analysis in water resources
- Σ Technology for sharing and displaying groundwater information
- D Types of information that are interesting and useful
- D Methods and technology to update models
- The ability for standard procedures to be coded into a system
- D The ways data can be stored, retrieved and disseminated widely





Phase III: The Link Between Models and Managers

- ➢ Flood Early Warning System (*FEWS*)
- Creates scientific linkage between regulators, model developers, managers and the public
- D Run & view model results
- D Configure FEWS to meet Alberta specific needs
- D Compare model results from different scenarios
- \square Pre-defined metrics, graphs & thresholds
- **<u>N</u>** *Key is distributing information*





FEWS Workflow







Integration of Numerical Model in FEWS



About FEWS:

- The software is free
- Any model can be linked to FEWS
- New displays can be added to the user interface

• Wide variety of data can be imported, displayed and used in the models

- New data can be added anytime
- Output can be automatically formatted and posted to a web server

• Support tools should provide additional insight on hydrogeological system and realistic appraisals of an aquifer's potential for development over the medium and long term time scales.





Groundwater Model Displays in an Operational System





Alberta Energy

Regulator

AGS

ALBERTA GEOLOGICAL SURVEY

20

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Summary

- AGS Groundwater Program is focused on identifying, characterizing and quantifying Alberta's groundwater resources throughout the province
- Our objective is to provide AER, GoA, industry, and public with peer-reviewed scientific research, mapping and reporting on Alberta's groundwater
- D Current initiatives include
 - D Publication of Cold Lake Beaver River Basin Groundwater Atlas
 - D Complete and publish regional scale SARGS model
 - Sylvan Lake sub-basin groundwater flow modelling and management system
 - D Linking management tools to policy and regulatory development
 - Evaluating architecture to host and allow for ongoing refinements to groundwater flow models





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