

# 39TH INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS CONGRESS



## Congress Program and Abstracts

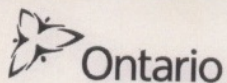
September 16-21, 2012 • Niagara Falls, Canada

HOSTED BY:



International Association of Hydrogeologists -  
Canadian National Chapter

PLATINUM SPONSORS:



# TABLE OF CONTENTS

Acknowledgements .....	2
Message from the Chairs .....	5
Message from the IAH-CNC .....	5
Congress Sponsors .....	6
Trade Exhibition .....	12
Hotel Floor Plans .....	13
Social Program .....	14
Plenary Speakers .....	15
Distinguished Lectures (NGWA) .....	15
Congress Program Overview "At A Glance" .....	22
Monday Technical Program .....	26
Tuesday Technical Program .....	32
Thursday Technical Program .....	38
Friday Technical Program .....	42
Abstract Table of Contents .....	48
Abstracts .....	52

# ACKNOWLEDGMENTS

## IAH 2012 Congress Secretariat

Steve Holysh, Congress Co-chair, Events  
Ken Howard, Congress Co-Chair, Technical Co-chair  
Rick Gerber, Technical Co-chair

Andrew Piggott, Finance  
Christopher Munro, Publicity  
Joanne Thompson, IAH-CNC Liaison

## Technical Committee

Rick Gerber, Ken Howard, Steve Holysh, Andrew Piggott, Bob Betcher, Don Goodyear, Katie Howson, Dave Ketcheson, Claire Milloy, Leif Nelson, Martin Shepley, Mike Fairbanks, Steve Davies, Tony Lotimer, Rasheeda Byer-Coward, Mandy Meriano, Dave Sawicki, Wendy Kemp

## Finance Committee

Andrew Piggott, Jim Roy, Diane Bloomfield, Daron Abbey, Patty Meyer, Mary Jane Conboy

## Publicity Committee

Christopher Munro, Ken Howard, Joanne Thompson, Don Ford

## Events Committee

Steve Holysh, Karina Howard, Gunther Funk, Wendy Kemp, Lloyd Lemon, Scott MacRitchie, Magdi Widaatalla, Shelly Cuddy, Tanya Kampher Martin, Nicholas Howden, Don Ford, Christopher Munro

## Field Trips

Steve Holysh, Jayme Campbell, Kevin Fitzpatrick, Karina Howard, Ken Howard, Rick Gerber, Mike Mateyk, Derek Ford, Stephen Worthington, Daryl Cowell, Tony Shaw, Rob Blair, Gunther Funk, Eric Hodgins, Frank Brunton, Steve Usher, Andy Bajc, Stewart Hamilton, Hazen Russell, Terry Carter, Shelly Cuddy, Dave Slain

## International Scientific Advisory Committee

Ian Acworth	Australia
Peter Dillon	Australia
Ricardo Hirata	Brazil
Didier Pennequin	France
Willi Struckmeier	Germany
Alistair Allen	Ireland
Bruce Misstear	Ireland
Joel Carrillo Rivera	Mexico
Antonio Chambel	Portugal
Alan MacDonald	Scotland
Christine Colvin	South Africa
Alper Baba	Turkey
Kevin Hiscock	United Kingdom
Richard Taylor	United Kingdom

## North American Scientific Advisory Committee

Steve Davies	Canada
Gunther Funk	Canada
Dick Jackson	Canada
Marie Laroque	Canada
Tony Lotimer	Canada
Leif Nelson	Canada
Chris Neville	Canada
Martin Shepley	Canada
Dale Van Stempvoort	Canada
Steve Worthington	Canada
Lenny Konikow	United States
Vicki Kretsinger	United States
Jim Lamoreaux	United States
Jack Sharp	United States



## Volunteers – Session Leaders

The following people acted as “champions” for the Congress technical sessions. They proposed and helped to organize the sessions, helped promote the Congress, encouraged abstract submissions and reviewed abstracts. Many are also volunteering to help chair the sessions. Their efforts are greatly appreciated and invaluable to the success of the Congress.

### Energy and Climate

#### Groundwater and Climate Change: Linkages and Adaptation

*Richard Taylor (UK), Diana Allen (Canada), Makoto Taniguchi (Japan), Jianyao Chen (China)*

*Jason Gurdak (USA), Tim Green (USA), Bridget Scanlon (USA)*

#### Geothermal Energy

*Grant Ferguson (Canada), Han Zaisheng (China), Alper Baba (Turkey)*

#### Hydrogeological Issues Surrounding Shale Oil and Gas

*Avner Vengosh (USA), Ramon Aravena (Canada)*

#### Hydrogeological Issues Related to Oil Sands

*Steve Wallace (Canada), Jon Fennell (Canada)*

#### Carbon Sequestration

*Dan Palombi (Canada), James Brydie (Canada)*

### Karst Hydrogeology

#### Karst Aquifers, Environmental Problems and Global Change

*Derek Ford (Canada), Liu Zaihua (China)*

#### Characterization and Management of Karst Aquifers

*Nico Goldscheider (Germany), Barbara Mahler (USA), Geary Schindel (USA)*

#### Modeling Karst Aquifer Systems

*Neven Kresic (USA), Nicolas Massei (France)*

#### Topics in General Karst Hydrogeology

*Stephen Worthington (Canada), Nadine Goeppert (Germany), Jiang Guanghui (China)*

#### Artificial Tracers and Environmental Isotopes to Understand and Quantify Water Flow-paths and Pollutant Transport in Karst Aquifers

*Piotr Maloszewski (Germany), Przemyslaw Wachniew (Poland), Ralf Benischke (Austria)*

### Groundwater-Surface Water Interactions

#### Groundwater-surface Water Interactions and Ecohydrology

*Bruce Misstear (Ireland), Philippe Van Cappellen (Canada), Raoul-Marie Couture (Canada), Fereidoun Rezaeezhad (Canada), Marie Larocque (Canada), Masaki Hayashi (Canada), Allison Aldous (USA), Joseph Gurrieri (USA), Hillol Guha (USA), Andrea Bradford (Canada)*

*Vadose zone processes: Edwin Cey (Canada), James Smith (Canada)*

### Groundwater Management- Technical

#### Groundwater Recharge: Advances in understanding recharge processes, characterizing spatial/temporal variability, and techniques for managed aquifer recharge

*Peter Dillon (Australia), Victor Heilweil (USA)*

#### Hydrogeophysics

*Anthony Endres (Canada), Peete Pehme (Canada)*

#### The Role of Aquitards in Aquifer Protection

*Wendy Timms (Australia), Jim Hendry (Canada)*

#### Frontiers in Numerical Modelling

*John Molson (Canada), Rene Therrien (Canada)*

#### Transboundary Aquifer Systems of the Americas

*Alfonso Rivera (Canada)*

#### Cold Regions Hydrogeology

*Jeff McKenzie (Canada), Victor Bense (UK)*

#### Hydrogeologic Characterization of Fractured Rock Settings

*Kent Novakowski (Canada)*

#### Three-Dimensional Geologic/Hydrogeologic Mapping

*Hazen Russell (Canada), Holger Kessler (UK)*

#### Regional Groundwater Flow Systems: Theory and Application

*José Joel Carillo Rivera (Mexico), Judit Mádl-Szónyi (Hungary), Jozsef Tóth (Canada)*

#### Urban Hydrogeology Issues

*Ken Howard (Canada), Dan Rogers (USA), Stephen Foster (UK)*

#### Development and Application of Conceptual Models in Numerical Modelling

*Mike Wireman (USA), Denis Peach (UK)*

## Groundwater Management - Policy and Governance

**Groundwater and Development: Towards the Effective Integration of Hydrogeology in 'Water and Sanitation' Projects**

*Alan MacDonald (UK), Cathy Ryan (Canada), Michael Campana (USA)*

**Lessons Learned from Groundwater Work Abroad**

*Alan Fryar (USA), Adam Milewski (USA)*

**Groundwater Sustainability: Locally to Globally**

*Tom Gleeson (Canada), William Alley (USA), Marios Sophocleous (USA)*

**Groundwater Quality and Policies for Groundwater Protection**

*Esther Wattel-Koekkoek (Netherlands), Jana Levison (Canada)*

**Groundwater for Decision Makers**

*Andrew Stone (USA)*

## Groundwater Quality

**Nutrients in Groundwater**

*Dave Rudolph (Canada), Ian Clark (Canada)*

**Nuclear Waste Management**

*Mark Jensen (Canada)*

**New Developments in Soil and Groundwater Remediation**

*Jason Gerhard (Canada), Neil Thomson (Canada)*

**NAPL Source Zones: Flow and Mass Transfer**

*Kevin Mumford (Canada), John Christ (USA)*

**Fate of Nanoparticles and Colloids in the Environment**

*Denis M. O'Carroll (Canada), Sarah Dickson (Canada)*

**Groundwater Tracers/Isotopes**

*Robert Michel (USA)*

**Contaminant Hydrogeology**

*Dale Van Stempvoort (Canada)*

## General Hydrogeology

**Education and Core Competencies for Professional Hydrogeologists**

*Dick Jackson (Canada)*

**Book on Groundwater Resources in Canada**

*Alfonso Rivera (Canada)*

**Young Scientists: Showcasing Research of Early Career Hydrogeologists (Posters Only)**

*Judith Flügge (Germany), Grant Ferguson (Canada)*

**Data Management and Analysis**

*Jamey Rosen (Canada)*

## Volunteers – Students

Numerous students have graciously volunteered their time to assist the Congress organizing committee with various tasks including help with technical presentations and mid-Congress field trips. We wish to specifically thank Adrienne Bangsund, Mahsa Shayan, Marie-Claude Lapointe, Tibor Lengyel, Behnam Doulatyari, Robin Barnes, Candace Freckelton, Sarah Beatty, Patricia Bobeck, Thair Patros, Owen Miles, Uwe Schneidewind, Tianjiao Li, Carlos Maldaner, Patrick Scannell, Gabrielle Klappstein and Daniel Skoreyko. We also wish to thank those student volunteers who come forward to offer assistance following the printing of this program. Thanks everyone, your assistance is vital to the Congress success and greatly appreciated.

# ABSTRACT TABLE OF CONTENTS

Session M1-A: GW & Climate Change I .....	52
Session M1-B: Vadose Zone Processes I.....	54
Session M1-C: Hydrogeological Issues Related to Oil Sands I.....	57
Session M1-D: Karst Artificial Tracers and Isotopes I.....	59
Session M1-E: Contaminant Hydrogeology I.....	61
Session M1-F: Lessons Learned from Working Abroad .....	65
Session M1-G: Management and Utilization of Saline Waters.....	68
Session M1-H: Groundwater Quality and Policies for GW Protection I.....	71
Session M2-A: GW & Climate Change II .....	74
Session M2-B: Vadose Zone Processes II .....	76
Session M2-C: Hydrogeological Issues Related to Oil Sands II .....	79
Session M2-D: Karst Artificial Tracers and Isotopes II.....	81
Session M2-E: NAPL Source Zones .....	82
Session M2-F: Groundwater sustainability I .....	85
Session M2-G: Groundwater For Decision Makers I .....	87
Session M2-H: Groundwater Quality and Policies for GW Protection II.....	89
Session M3-A: GW & Climate Change III .....	92
Session M3-B: GW/SW Interaction Session I .....	94
Session M3-C: Hydrogeological Issues Related to Oil Sands III .....	99
Session M3-D: Topics in General Karst Hydrogeology.....	103
Session M3-E: Contaminant Hydrogeology II .....	107
Session M3-F: Groundwater Sustainability II.....	111
Session M3-G: Groundwater For Decision Makers II .....	115
Session M3-H: Groundwater Quality and Policies for GW Protection III.....	119
Session M3-J: Tracers & Isotopes I .....	124
Session T1-A: GW & Climate Change IV .....	127
Session T1-B: GW/SW Interaction II.....	129
Session T1-C: Regional GW Flow I .....	133
Session T1-D: Fractured Rock I .....	136
Session T1-E: Fate of Nanoparticles .....	139
Session T1-F: Hydrogeological Issues Related to Oil Sands IV.....	143

# ABSTRACT TABLE OF CONTENTS

Session T1-G: Transboundary Aquifers .....	145
Session T1-H: Nutrients in Groundwater I .....	149
Session T2-A: GW & Climate Change V .....	153
Session T2-B: GW/SW Interaction III .....	155
Session T2-C: Regional GW Flow II .....	159
Session T2-D: Fractured Rock II .....	163
Session T2-E: Contaminant Hydrogeology III .....	166
Session T2-F: Aquitards I .....	171
Session T2-G: Carbon Sequestration .....	175
Session T2-H: Nutrients in Groundwater II .....	180
Session T3-A: Hydrogeological Issues Surrounding Shale Oil and Gas .....	184
Session T3-B: GW/SW Interaction IV .....	187
Session T3-C: Regional GW Flow III .....	191
Session T3-D: Cold Regions Hydrogeology .....	194
Session T3-E: Urban Hydrogeology .....	197
Session T3-F: Aquitards II .....	202
Session T3-G: General Hydrogeology I - Data Management & Analysis .....	205
Session T3-H: Nutrients in Groundwater III .....	209
Session T3-J: Tracers and Isotopes II .....	212
Session TH1-A: Groundwater Recharge I .....	216
Session TH1-B: GW/SW Interaction V .....	218
Session TH1-C: Regional GW Flow IV .....	223
Session TH1-D: Karst Aquifers, Environmental Problems and Global Change I .....	226
Session TH1-E: Soil and Groundwater Remediation I .....	229
Session TH1-F: Numerical Modelling I .....	233
Session TH1-G: 3D Geologic and Hydrogeologic Mapping I .....	237
Session TH1-H: Hydrogeophysics I .....	240
Session TH2-A: Groundwater Recharge II .....	243
Session TH2-B: GW/SW Interaction VI .....	246
Session TH2-C: Groundwater & Development - Water & Sanitation Projects .....	250
Session TH2-D: Karst Aquifers, Environmental Problems and Global Change II .....	253

# ABSTRACT TABLE OF CONTENTS

Session TH2-E: Soil and Groundwater Remediation II .....	256
Session TH2-F: Numerical Modelling II .....	259
Session TH2-G: 3D Geologic and Hydrogeologic Mapping II .....	261
Session TH2-H: Hydrogeophysics II .....	264
Poster Session: Artificial Tracers and Environmental Isotopes .....	267
Poster Session: Carbon Sequestration .....	269
Poster Session: Cold Regions Hydrogeology .....	272
Poster Session: Contaminant hydrogeology .....	272
Poster Session: Fate of Nanoparticles and Colloids in the Environment .....	277
Poster Session: Frontiers in Numerical Modelling .....	277
Poster Session: Development and application of conceptual models .....	279
Poster Session: General .....	280
Poster Session: Geothermal Energy .....	287
Poster Session: Groundwater and Climate Change- Linkages and Adaptation .....	289
Poster Session: Groundwater Quality and Policies for Groundwater Protection .....	292
Poster Session: Groundwater Recharge (including Managed Aquifer Recharge) .....	293
Poster Session: Groundwater Sustainability .....	298
Poster Session: Groundwater Tracers/Isotopes .....	299
Poster Session: Groundwater-surface water interactions and ecohydrology .....	304
Poster Session: Hydrogeologic Characterization of Fractured Rock Settings .....	318
Poster Session: Hydrogeological issues related to oil sands .....	322
Poster Session: Hydrogeological issues surrounding shale gas .....	322
Poster Session: Hydrogeophysics .....	323
Poster Session: General Karst Hydrogeology .....	327
Poster Session: Urban Hydrogeology Issues .....	328
Poster Session: Management and Utilization of Saline Waters .....	332
Poster Session: Mining Issues .....	332
Poster Session: NAPL Source Zones-Flow and Mass Transfer .....	333
Poster Session: New Developments in Soil and Groundwater Remediation .....	334
Poster Session: Nuclear Waste Management .....	339
Poster Session: Nutrients in Groundwater .....	342





# ABSTRACT TABLE OF CONTENTS

Poster Session: Regional Groundwater Flow Systems- Theory and Application .....	343
Poster Session: Three-Dimensional Geologic- Hydrogeologic Mapping .....	342
Poster Session: Urban hydrogeology issues .....	344
Poster Session: Vadose Zone Processes .....	347
Poster Session: Young Scientists-Showcasing Research of Early Career Hydrogeologists .....	348
Session F1-A: Groundwater Recharge III .....	353
Session F1-B: GW/SW Interaction VII .....	357
Session F1-C: Book on the Groundwater Resources in Canada I .....	360
Session F1-D: Characterization and Management of Karst Aquifers I .....	362
Session F1-E: Nuclear Waste Management I .....	366
Session F1-F: Development and Application of Conceptual Models I .....	369
Session F1-G: General Hydrogeology II .....	371
Session F1-H: Geothermal Energy I .....	374
Session F2-A: Groundwater Recharge IV .....	377
Session F2-B: GW/SW Interaction VIII .....	380
Session F2-C: Education and Core Competencies I .....	383
Session F2-D: Characterization and Management of Karst Aquifers II .....	386
Session F2-E: Nuclear Waste Management II .....	389
Session F2-F: Development and Application of Conceptual Models II .....	392
Session F2-G: General Hydrogeology III .....	395
Session F2-H: Geothermal Energy II .....	398
Session F3-A: Groundwater Recharge IV .....	401
Session F3-B: Book on the Groundwater Resources in Canada II .....	404
Session F3-C: Education and Core Competencies II .....	408
Session F3-D: characterization & management of karst aquifers & Modeling Karst Aquifer Systems .....	410
Session F3-E: Nuclear Waste Management III .....	414
Session F3-F: Mining Issues .....	416
Session F3-G: General Hydrogeology IV .....	419

palette of possible technological applications that can further the goal of a sustainable, independent water supply – a fundamental requirement for every human settlement. This concept should be expanded to include consideration of any necessary additional energy requirements, with the goal that these be met by renewable, off-grid sources. This poster will expand on alternative approaches for this concept (given varying local conditions), elements of which can include: disinfectant dosing pumps powered by micro turbines in pipes; coupled turbine-pump supply units; photovoltaic and wind generators; and supplementary tapping of groundwater.

### **636 - The status of groundwater protection in Serbia and the implications of new regulations**

Sobodan Vujasinović, Zoran Stevanović, Ivan Matić, Jelena Zarić & Saša Milanović

*University of Belgrade, Faculty of Mining and Geology, Department of Hydrogeology, Belgrade, Republic of Serbia*

Some 75% of the public water supply is abstracted from groundwater resources from different types of aquifers: intergranular in alluvial and terrace deposits, karst aquifers and artesian aquifers of Neogene basins. Beside the fact that Serbia still uses certain freshwater aquifers that represent real natural reserves of high-quality water, the state of groundwater protection and quality is wholly unsatisfactory. A new legislation for sanitary protection zones for groundwater sources was introduced in 2008. The new rulebook takes the time of infiltration into account as well as the distance of the intake structure from the protection zone. The new legislation separately deals with karst, fracture and intergranular environments. The time of infiltrated water propagation for the second zone of sanitary protection in a porous environment of an intergranular type is equal to 50 days, while it amounts to one day in a karst-fracture type. Areas with intensive percolation, such as sinkholes, ponors and faults could be assigned under the first zone as highly vulnerable. The implementation of the new legislation is challenging in practice, related to the application of new regulations to existing groundwater sources. Many of them have functioned for decades, and their position is now threatened due to intensive urbanization or industrialization, which have made the establishing of a zone of sanitary protection according to the new regulations difficult. According to monitoring data for the period from 2007 to 2011, the quality of raw water collected in most of the groundwater sources is satisfactory while monitoring is not being implemented in accordance with the new regulations. In 2007, out of 155 central water supply systems controlled, 29% of the waterworks had simultaneous physical-chemical and microbiological irregularities. Of the 128 tested groundwater sources in 2011, only 36 have a complete Report about groundwater sanitary protection zones. Serbia is the first country in the region to have a complete map of groundwater vulnerability on a national level (1:500.000), which provides a good basis for future spatial planning, as well as preventive protection of the most important and still not exploited groundwater resources.

### **660 - Recharge Processes and Dynamics in Intergranular Aquifer Investigated through Isotopic Composition of Spring Water: Case Study of River Radovna Springs (Slovenia, Europe)**

Anja Torkar

*Department of Geology – University of Natural Sciences and Engineering, Ljubljana, Slovenia*

Mihael Brenčič

*Department of Geology – University of Natural Sciences and Engineering, Ljubljana, Slovenia*

*Department of Hydrogeology, Geological Survey of Slovenia, Ljubljana, Slovenia*

Polona Vreča

*Jožef Stefan Institute, Department of Environmental Sciences, Ljubljana, Slovenia*

Springs of the River Radovna are situated in the north-eastern part of Slovenia, (Southern Alps), South-Central Europe. The spring water discharges through several diffuse springs located in fluvio-glacial sediments, which cover the bottom of the valley. The recharge area for the springs is positioned in high mountains which consist of karstified limestones. The River Radovna is 17 km long, almost entirely groundwater flow dominated, where several visible and invisible inflows from karstified limestone are presented. Appearances of karstic springs in the valley are related to the contact between Quaternary sediments filling the valley and carbonate rocks forming slopes of the valley. Discharge of the springs fluctuates considerably and is heavily related to snow melting period. During low flow period some of the springs dry up.

For better understanding of the recharge processes and the dynamics of Radovna springs, systematic monitoring of water chemistry and stable isotopes of hydrogen, oxygen and dissolved inorganic carbon was carried out during the years 2005 and 2008. Isotopic composition of dissolved inorganic carbon varied between -5‰ and -14‰. Isotopic composition of hydrogen and oxygen varied between -53‰ and -83‰, and between -7.0‰ and -11.8‰, respectively. For an even better understanding of processes further detailed investigations started in 2011. Instruments were built in for continuous



# IAH 2013

## Perth Australia

Solving the Groundwater Challenges  
of the 21<sup>st</sup> Century

[www.iahcongress2013.org](http://www.iahcongress2013.org)



2013 is a perfect time for the IAH Congress to be held in Australia. Australia is riding the wave of a mining and resources boom which shows no signs of slowing and groundwater issues are a critical factor in development. Globally the groundwater sector will face substantial challenges in this century and many of these mirror the challenges global society is facing. High profile international and national speakers will be presenting on a range of topics that cover the conference themes.

### KEY DATES

CALL FOR ABSTRACTS: OCTOBER 2012

ABSTRACTS DEADLINE: FEBRUARY 2013

REGISTRATION OPENS: DECEMBER 2012

EARLY BIRD REGISTRATION CLOSES: JUNE 2013

CONGRESS: 15 - 20 SEPTEMBER 2013

[www.iahcongress2013.org](http://www.iahcongress2013.org)

With the theme **Solving the Groundwater Challenges of the 21<sup>st</sup> Century**, an exciting technical programme is being planned with five parallel session Themes covering:

1. Groundwater governance, values and management
2. Groundwater in mining
3. Groundwater and climate change
4. Energy and aquifers
5. Research and technology solutions
6. Examples and failures we can learn from

An extensive Trade Exhibition is also planned. A poster exhibition will be open to all delegates and a session will be dedicated to early-career hydrogeologists to foster the next generation of ground water professionals. Delegates will have the opportunity to join mid-congress field trips to a variety of unique sites as well as five exciting post-congress tours covering extremely diverse hydrostratigraphic environments on offer in Australia.

For a detailed overview of Congress topics and themes and updates on invited speakers visit [www.iahcongress2013.org](http://www.iahcongress2013.org)

