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# **National dialogue on groundwater (NDGW) - April 20, 2022**

## **Dialogue national sur les eaux souterraines (DNES) - 20 Avril, 2022**

**Geological Survey of Canada  
/ Commission Géologique du Canada**

**Canada**

# Overview

1. Greetings (Éric Boisvert) – 5 minutes
2. Breaking News or New development (all)
3. Recap 2020-2022: Eric – 5 minutes
4. Presentation – 25 minute
  - **Abigail K. Burt** - “Southern Ontario Groundwater Open House: A 7 year success story”
  - **David Lapen** – “Quantifying groundwater’s (GW) role in sustaining ecosystem services (ES) in a Canadian Watershed”
5. Questions (all) – 10 minutes
6. Wrap-up and next meeting June 22nd (tentative) from 1 to 2 p.m. (ET)



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# Southern Ontario Groundwater Open House

## A 7-year success story

Abigail Burt (OGS)  
Elizabeth Priebe (OGS)  
Hazen Russell (GSC)

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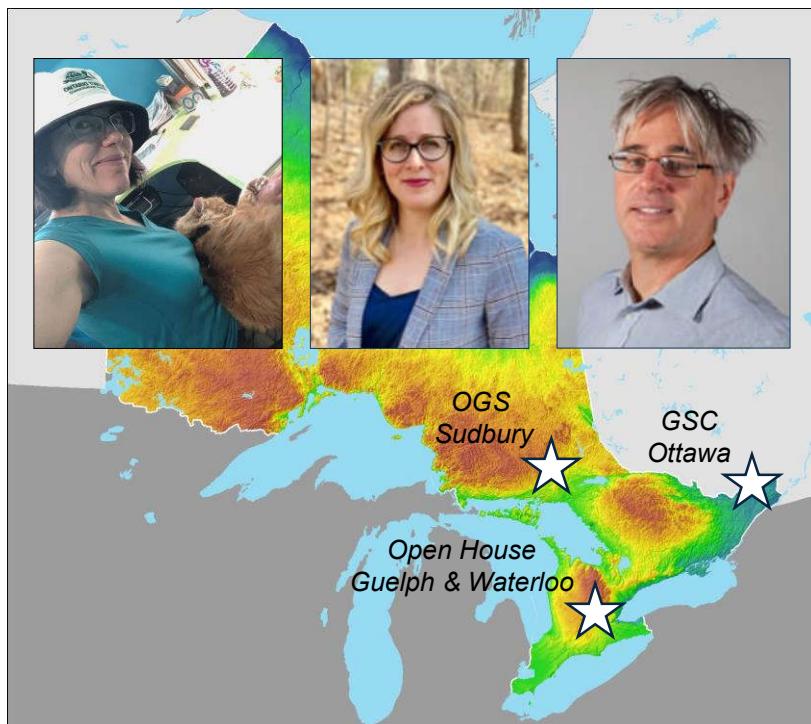


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## OGS-GSC Groundwater Collaboration 2014-2019

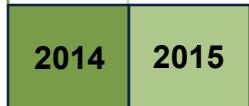
- OGS core business
  - Groundwater initiative
- GSC – Groundwater Geoscience Program
  - Southern Ontario Groundwater Geoscience Project
  - Archetypal Aquifer Project



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## Timeline

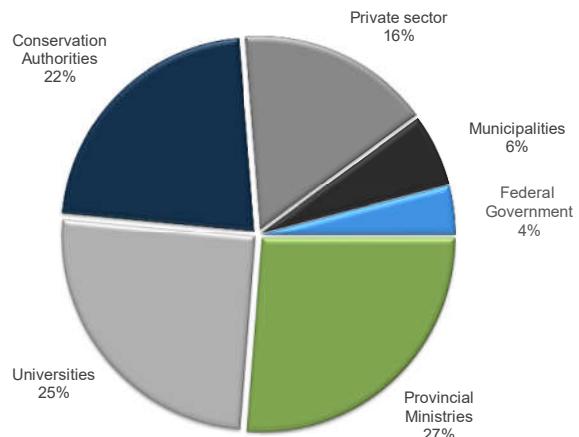
- Start of 5-year OGS-GSC collaboration
  - GAP analysis, University of Guelph,
    - Title: Unified Approach to Sustainable Groundwater use in Southern Ontario



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## 2015 Gap analysis

- 150 invited, 74 attended
- Session 1: Groundwater geoscience information gaps post 2004-2015 SWP
- Session 2: Need for data management unification and accessibility
- Framed by talks (7+5) by OGS, GSC, CAs, municipalities and academia
- 30 gaps in 7 categories
  - Communications
  - Data management and dissemination



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- Start of 5-year OGS-GSC collaboration

- GAP analysis

- Inaugural open house

## Timeline

Showcase groundwater related products and services  
 Advance groundwater geoscience across southern Ontario  
 Engage and network with clients and stakeholders

2014	2015	2016
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## Inaugural Event

- In-person, free
  - 95 registrants
- 1-day event
- 16 presentations
  - 20-minutes
- Themes
  - OGS-GSC project overviews
  - Great Lakes Accord
  - Modelling
  - Geochemistry
  - Mapping



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## Growth – Conservation Authorities

- Coordinated with Conservation Ontario Geoscience Group (COGG)
- Watershed scale groundwater issues
- Broadened presenters to collaborators with COGG
  - Consultants
  - Academics
  - Conservation Authority scientists
- Panel discussion



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## Growth – Panel Discussion

- Discussion topics
  - Utility of numerical flow models in a post SWP time (2018)
  - Future direction of groundwater management in Ontario (2019)
- Format
  - Mediated
  - Prepared questions
  - Questions from the floor
  - Attendees participated in the discussion
- Panelists
  - Consultants
  - Municipal water managers
  - Conservation authority scientists
  - Academics

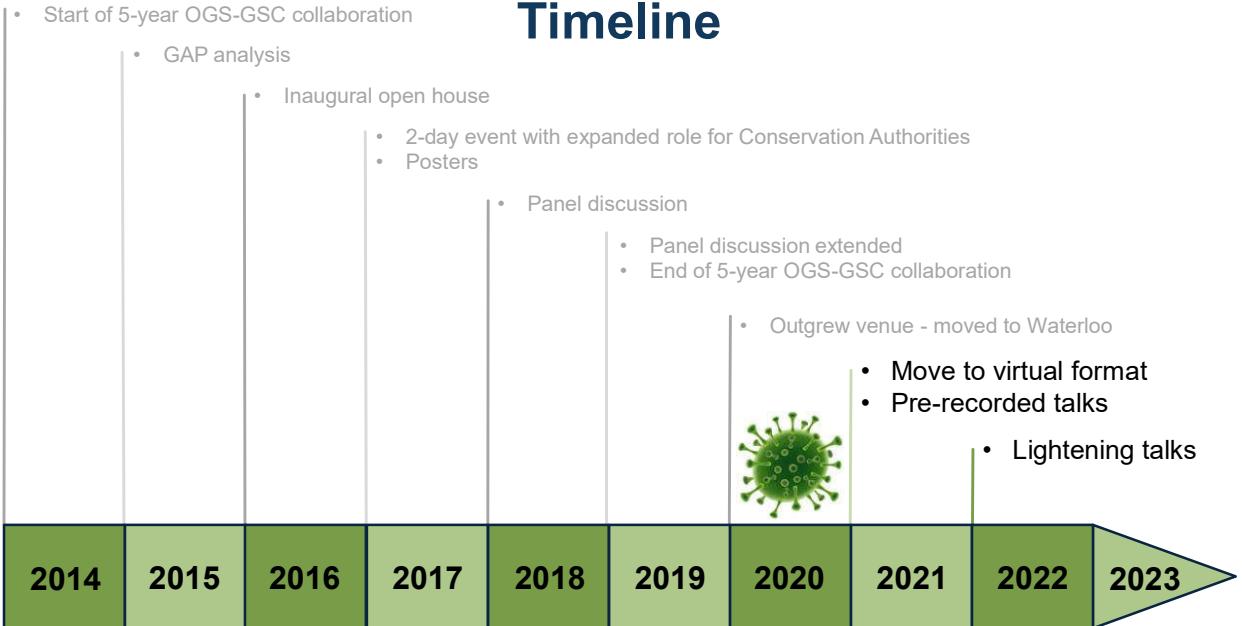


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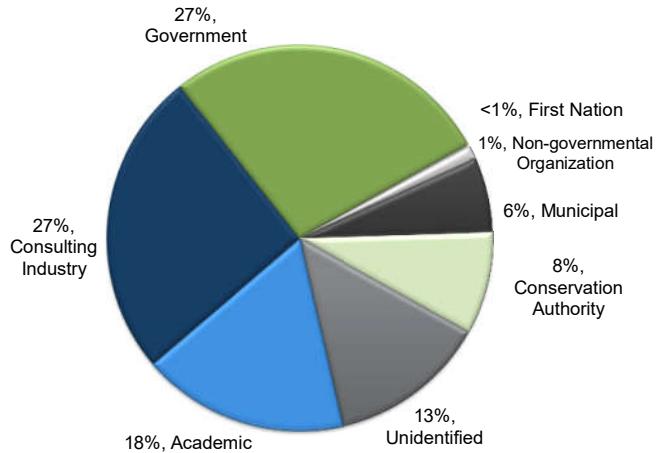
## Timeline



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## Going Virtual - Attendance

- Eventbrite
- Online registration totaled 675
  - Day one – 469
  - Day two – 348
- Average time 110 minutes
- ~4% USA, ~1% other international
- Advertising campaign
  - Direct emailing
  - Professional associations
  - Universities and colleges
  - Social media



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## Going Virtual - Platform

- Zoom Webinar
  - Ontario Investment and Trade Centre
  - IT Senior system support analyst
  - Meeting statistics
- Practice sessions
  - Meet speakers
  - One-on-one test of functions
- Link sent to registrants right before event

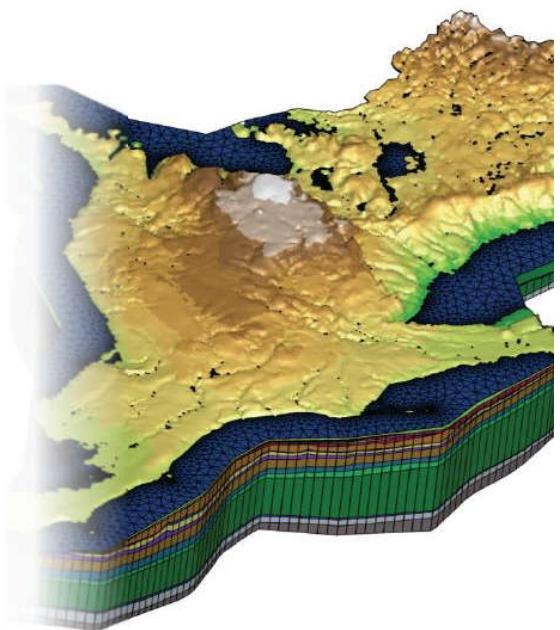


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## Going Virtual - Format

- 2 half-day sessions
  - Afternoon
  - 20-minute break
- Pre-recorded talks
  - Prevent glitches with screen sharing
  - Scheduling
  - Submitted early to ensure people didn't forget
- Invited speakers
  - Government organizations
  - Conservation Authorities, partner organizations
  - Universities
  - USGS participation maintained



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## Going Virtual - Program

- Opening remarks
  - OGS director and GGP manager
  - Conservation Ontario
- Themes
  - Groundwater programs and policies
  - Groundwater and surface water modelling
  - Aqueous geochemistry, isotopes and contaminants
  - Paleozoic and surficial geology modelling, characterization and applications
  - Geophysics, remote sensing, methods and techniques



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## Going Virtual – Keeping it Fresh

- Vary lengths
  - Keynote address
  - Regular talks
    - 12-minute presentation
  - Lightening talks
    - 4-minute presentation
  - University students (Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health)
- OGS moderators
- Chat – hosts only
- All questions via Q&A function
  - Speaker could answer live or by direct message



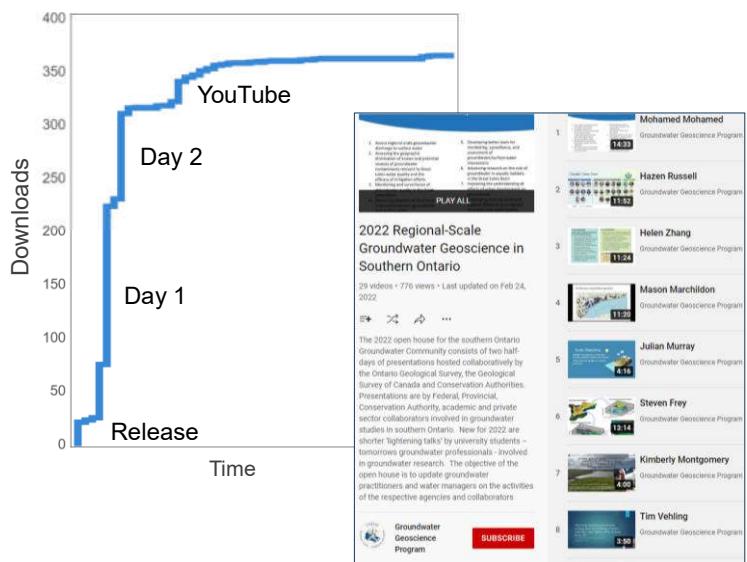
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## Going Virtual – Publication and Videos

- Abstract volume
  - OGS open file report - released in advance
  - Link provided with zoom invite
  - 364 downloads
- Pre-recorded talks
  - GSC Groundwater Geoscience Program YouTube channel

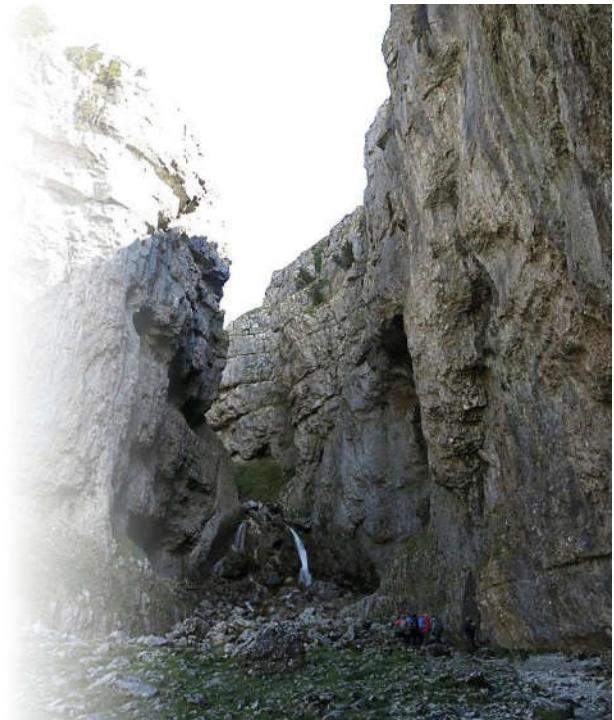


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## Survey results

- 28% response rate (158 responses)
  - Overall satisfaction 92% (93% in 2021)
  - Relevant to work and decision-making 85% (91% in 2021)
  - Opportunities for networking, discussion and collaboration – mixed review
  - Attend again (if virtual) 95%
- Can't please everyone...



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## What Should We Keep?

- Specific topics (modelling, updates, regional activities, work from other provinces) 50%
- Variation in talk lengths 20%
- Virtual format (delivery, digital program, Q&A, no cost/travel benefit) 14%
- Scheduling (multi-day, punctuality) 10%
- Pre-recorded content, ability to rewatch 6%
- Positive impact, good coverage of topics, useful information, valuable updates, 95%

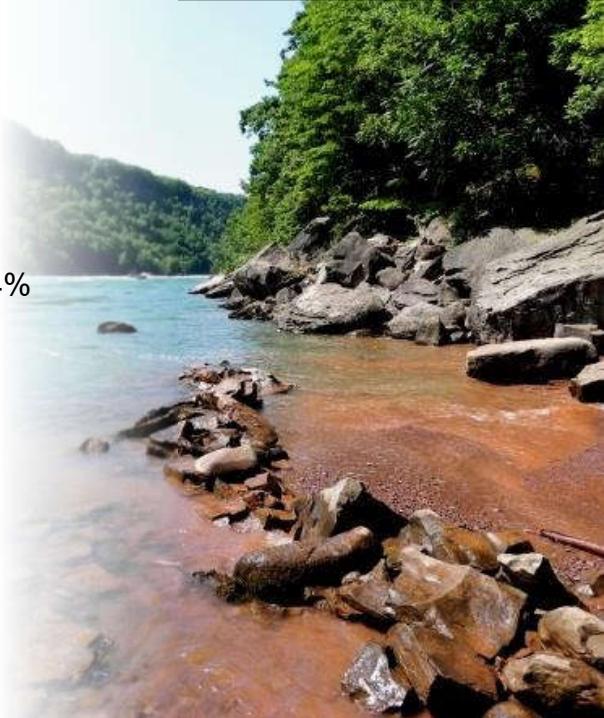


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## What Should We Change?

- In-person or hybrid event 23%
- More/less of a specific topic 19%
- More time for questions and discussions 14%
- More networking (virtual or in-person) 13%
- Happy with current format 9%
- Presentations (more dynamic, interactive, live>pre-recorded) 9%
- Scheduling and programming (number of days, longer talks) 8%
- Technology or accessibility issues 2%
- Missed the poster session 2%



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## Want to see more?

### OGS Open File Reports

- 2022 OFR 6379 [http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm\\_dir.asp?type=pub&id=OFR6379](http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=OFR6379)  
 2021 OFR 6378 [http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm\\_dir.asp?type=pub&id=OFR6378](http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=OFR6378)  
 2020 OFR 6361 [http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm\\_dir.asp?type=pub&id=OFR6361](http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=OFR6361)  
 2019 OFR 6349 [http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm\\_dir.asp?type=pub&id=OFR6349](http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=OFR6349)  
 2015 OFR 6310 [http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm\\_dir.asp?type=pub&id=OFR6310](http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=OFR6310)

### GSC Open Files

- 2019 OF 8528 <https://doi.org/10.4095/313529>  
 2018 OF 8363 <https://doi.org/10.4095/306472>  
 2017 OF 8218 <https://doi.org/10.4095/299750>  
 2016 OF 8022 <https://doi.org/10.4095/297722>

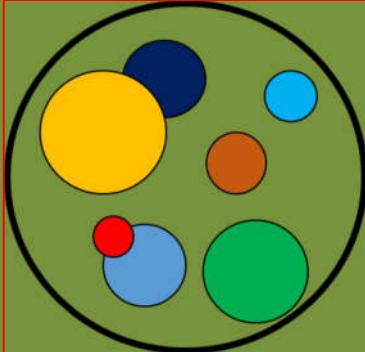
### Groundwater Information Network (GIN) Under News

[http://gin.gw-info.net/service/api\\_ngwds:gin2/en/gin.html](http://gin.gw-info.net/service/api_ngwds:gin2/en/gin.html)

### Groundwater Geoscience Program YouTube Channel

<https://www.youtube.com/channel/UCHlc7ff3vEdII708VhgsLsg/playlists>

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ECO<sup>2</sup>

Environmental Change Onehealth Observatory



Canada



# Quantifying groundwater's role in sustaining ecosystem services in Canadian Watersheds: a framework

**Steven Frey, Aquanty Inc. Waterloo, ON**

**PRESENTER: David Lapen, Agriculture and AgriFood Canada, Ottawa, ON**

**Hazen Russell, Geological Survey of Canada, Ottawa, ON**

**Tariq Aziz, Aquanty Inc., Waterloo, ON**

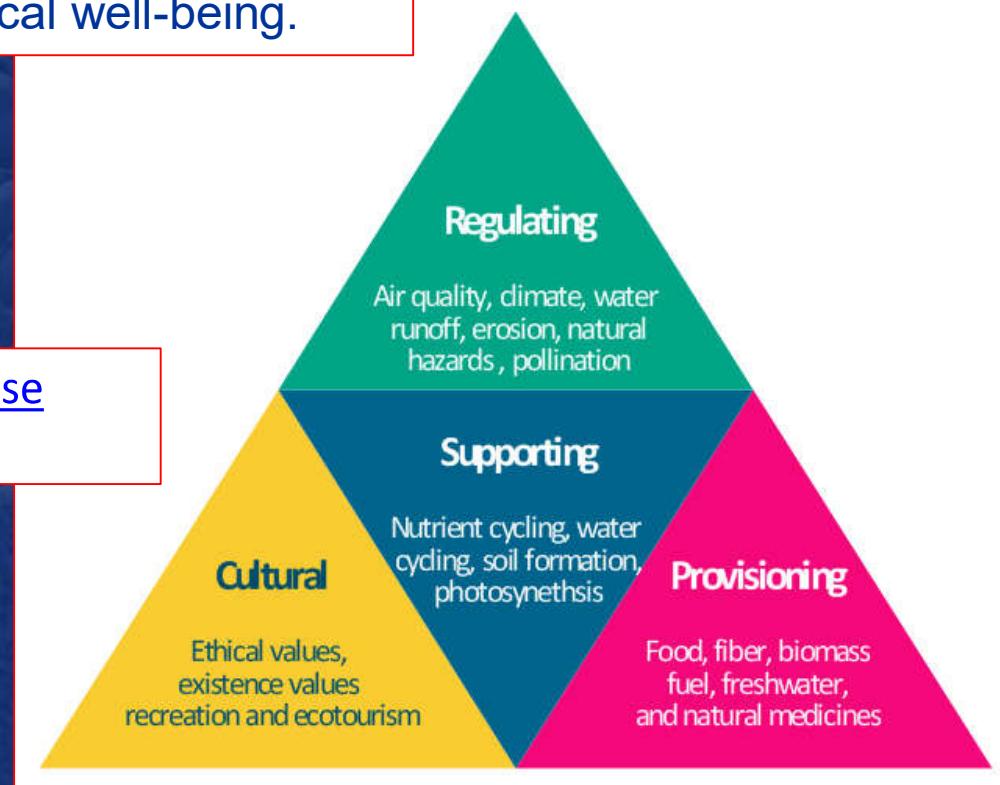
**Susan Preston, Environment and Climate Change Canada, Gatineau, QC**

# What are Ecosystem Services?

**Ecosystem services** are the many and varied benefits to humans provided by the natural environment and from healthy ecosystems. Such ecosystems include, for example, agroecosystems, forest ecosystems, grassland ecosystems and aquatic ecosystems. These ecosystems, functioning in healthy relationship, offer such things like natural pollination of crops, clean air, extreme weather mitigation, and human mental and physical well-being.

[Ecosystem service - Wikipedia](#)

[What are Ecosystem Services? – Earthwise Aware](#)



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# Groundwater ecosystem services: a review

Christian Griebler<sup>1,2</sup> and Maria Avramov<sup>1,3</sup>

<sup>1</sup>Helmholtz Zentrum München, German Research Center for Environmental Health, Institute of Groundwater Ecology, Ingolstaedter Landstrasse 1, D-85764 Neuherberg, Germany

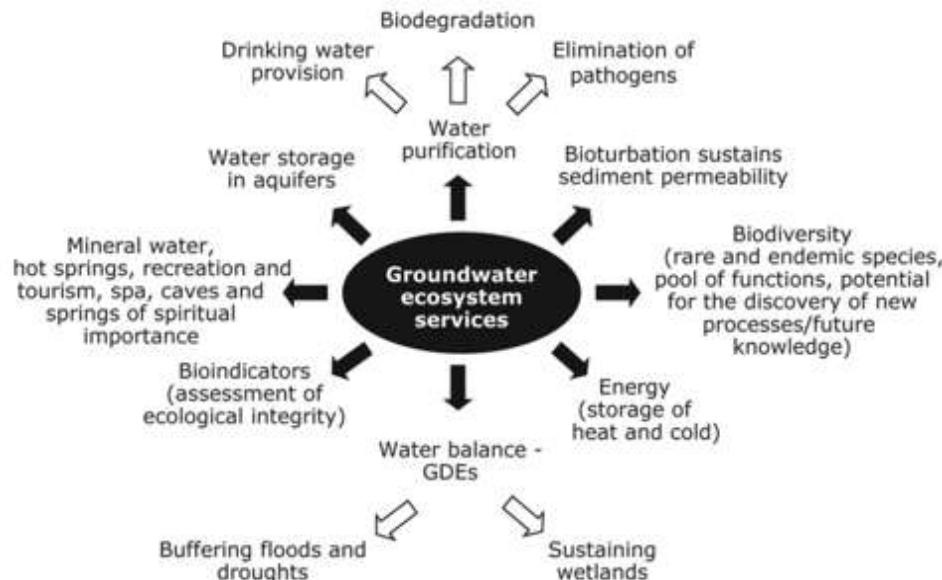


Figure 1. Groundwater ecosystem services. GDEs = groundwater dependent ecosystems.

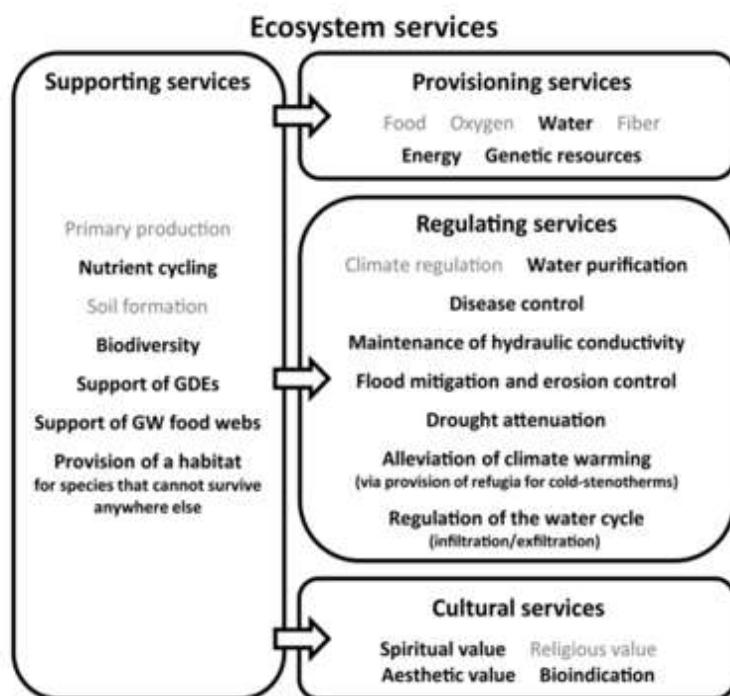
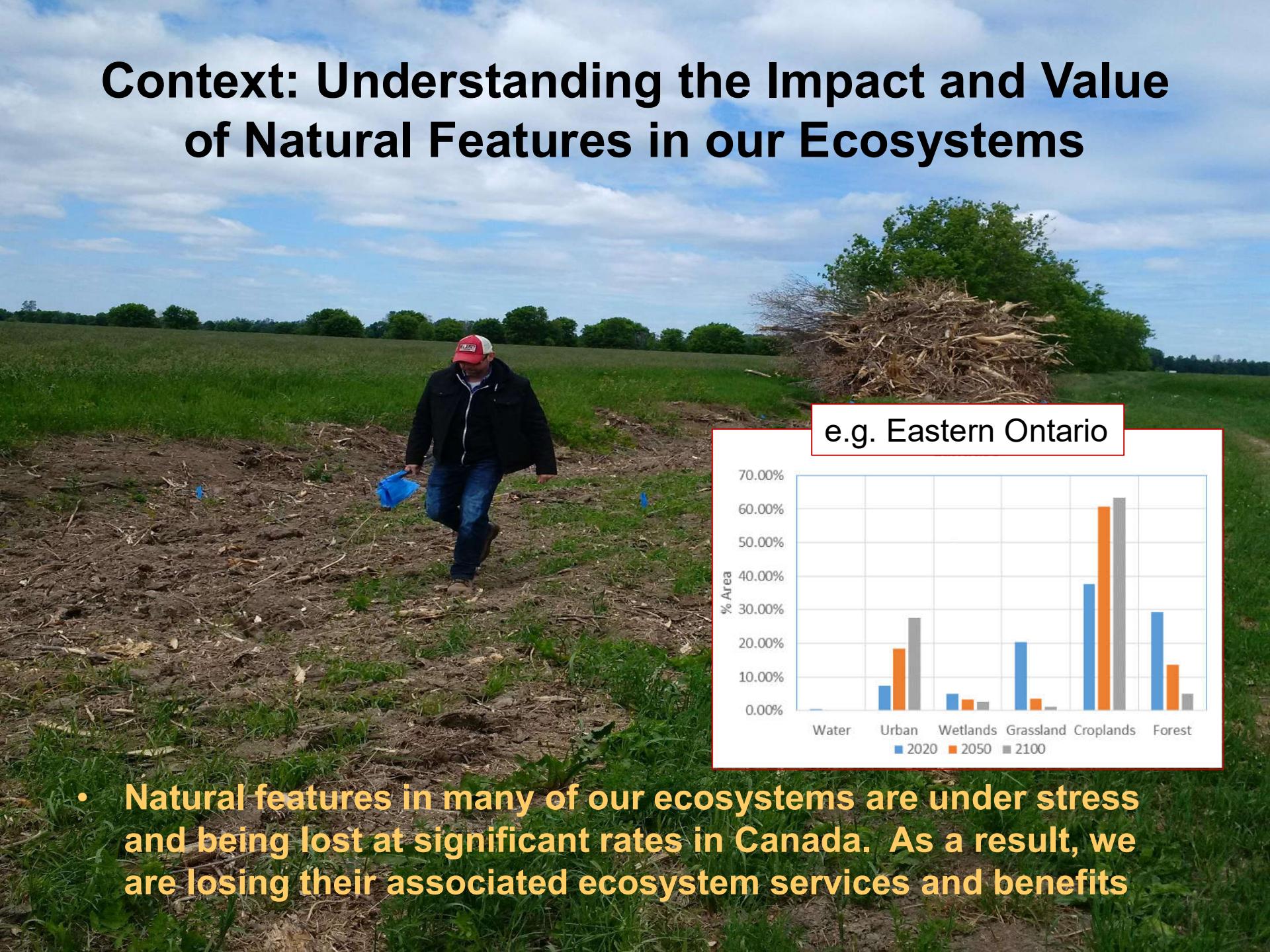


Figure 2. Selected examples of ecosystem services and goods sorted into the 4 categories of services as defined in the Millennium Ecosystem Assessment report (MA 2005). The goods and services that are directly related to groundwater ecosystems are highlighted in bold print. GW = groundwater, GDEs = groundwater dependent ecosystems.

# Context: Understanding the Impact and Value of Natural Features in our Ecosystems



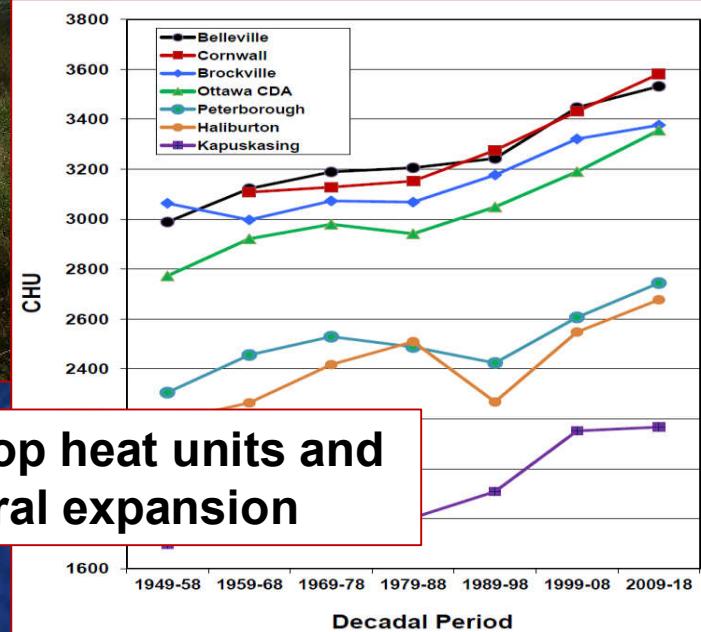
- Natural features in many of our ecosystems are under stress and being lost at significant rates in Canada. As a result, we are losing their associated ecosystem services and benefits

# Global Aim

- Linking Government of Canada initiatives to characterize and ultimately value emerging, new, and existing ecosystem services of natural features in ecosystems across Canada under changing climate and land uses.



Increasing crop heat units and agricultural expansion



# Operational Objectives

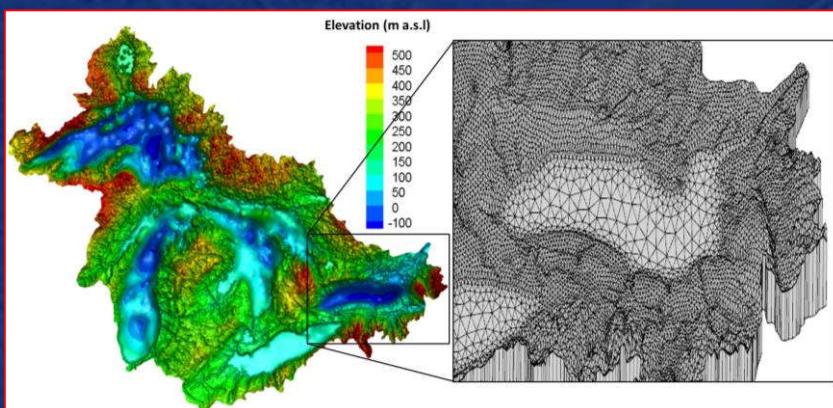
**Develop fully-integrated groundwater/surface-water model(s) using the HydroGeosphere (HGS) modeling platform for the entirety of Canada (common platform and output fidelity)**

- Groundwater endpoints
- Surface water endpoints
- Soil moisture endpoints

**Multiple resolutions depending on end user requirements**

**Dynamic forecast, realtime, and spatially-distributed mode**

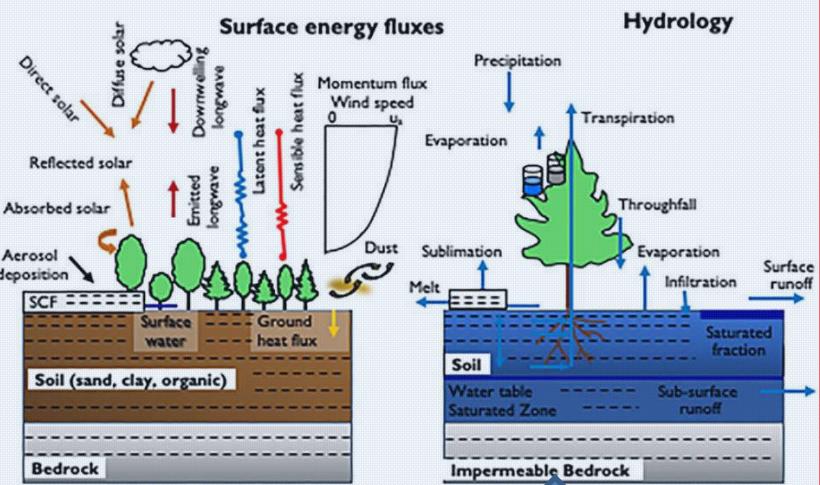
- Use models to evaluate climate/land use influences on water resources and ecosystem services: standardized and quantified means for valuation
- Use model outputs to estimate other societal-envir. relevant metrics



# Modeling Framework

## Land Surface Modelling

5 km resolution

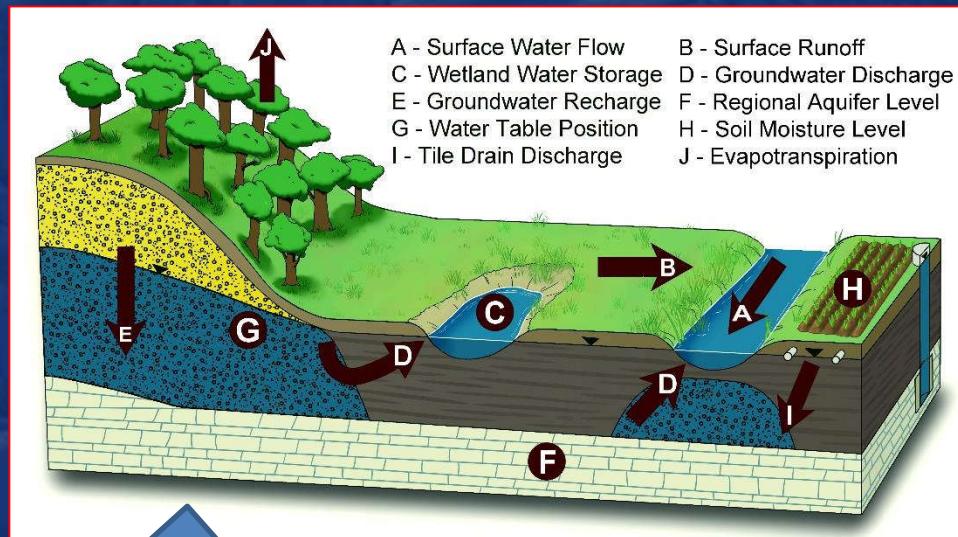


## Regional Climate Modelling

12.5 km resolution

## GW – SW Modelling

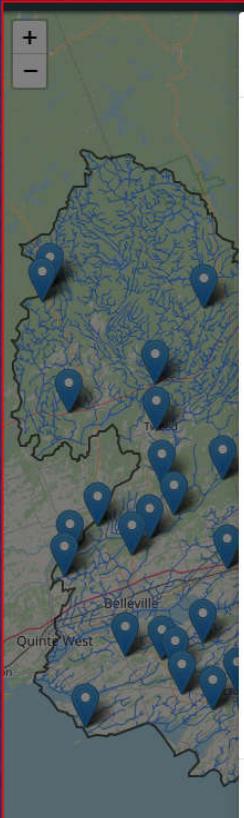
<1 to 5 km resolution



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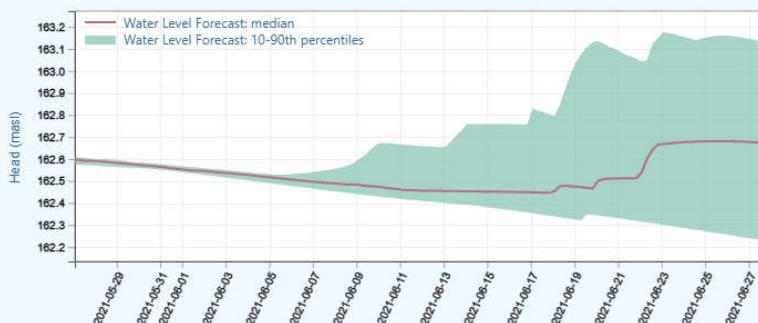
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Station: W152 (Tamworth)

## Groundwater Levels

### Hydrologic Forecast



Select forecast launch date

Latest Forecast

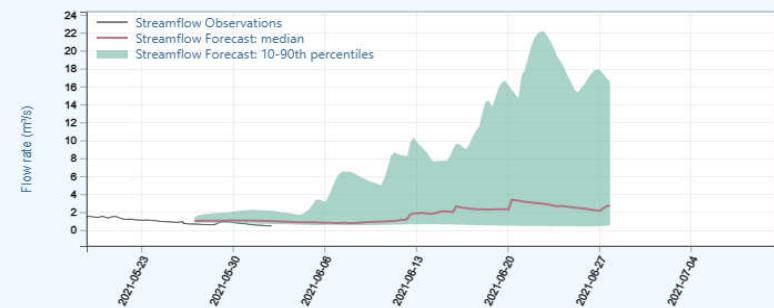
> Station Metadata

# Realtime-Forecast Hydrological Endpoints via HGS

Station: 02HL008 (CLARE RIVER NEAR BOGART)

## Surface Water Flow

### Hydrologic Forecast



Select forecast launch date

Latest Forecast

Download Forecast

Download Observations

> Snow Water Equivalent

> Station Metadata



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# DIRECT Linkages Between HGS Modeling and Ecosystem Services

Model Output	Water Supply	Flow Regulation	Erosion Regulation	Water purification and waste treatment		Disease Regulation	Natural Hazard Regulation	Nutrient Cycling	Water Cycling
1 Stream/river flow rate	yes	yes	yes	yes			yes		yes
2 Stream/river cumulative discharge	yes	yes	yes	yes			yes		yes
3 Watershed cumulative discharge	yes	yes	yes	yes			yes		yes
4 Wetland water storage		yes	yes	yes			yes		yes
5 Groundwater level	yes	yes					yes		yes
6 Groundwater storage	yes	yes					yes		yes
7 Groundwater recharge	yes	yes					yes		yes
8 Groundwater discharge	yes	yes					yes		yes
9 Soil moisture level		yes					yes		yes
10 Soil water storage		yes					yes		yes
11 Cumulative evaporation							yes		yes
12 Cumulative transpiration							yes		yes
13 Stream/river nutrient concentration				yes				yes	
14 Stream/river nutrient discharge				yes				yes	
15 Watershed nutrient discharge				yes				yes	
16 Stream/river FIB concentration				yes	yes				
17 Stream/river FIB discharge				yes	yes				
19 Watershed FIB discharge				yes	yes				



# INDIRECT Linkages Between HGS Modeling and Ecosystem Services

	Model Output	Food Production	Disease Regulation	Pest Regulation	Pollination	Aesthetic Experience	Recreation	Primary Production
1	Stream/river flow rate		yes			yes	yes	yes
2	Stream/river cumulative discharge							
3	Watershed cumulative discharge							
4	Wetland water storage		yes	yes	yes	yes	yes	yes
5	Groundwater level	yes						yes
6	Groundwater storage	yes						yes
7	Groundwater recharge							yes
8	Groundwater discharge					yes	yes	yes
9	Soil moisture level	yes	yes	yes	yes	yes	yes	yes
10	Soil water storage	yes	yes	yes	yes			yes
11	Cumulative evaporation							
12	Cumulative transpiration	yes				yes	yes	yes
13	Stream/river nutrient concentration		yes			yes	yes	yes
14	Stream/river nutrient discharge		yes			yes	yes	yes
15	Watershed nutrient discharge		yes			yes	yes	yes
16	Stream/river FIB concentration		yes					yes
17	Stream/river FIB discharge		yes					yes
19	Watershed FIB discharge		yes					yes



# **Examples Using the HydroGeosphere (HGS) Platform to Evaluate Ecosystem Services in Canadian Watersheds**



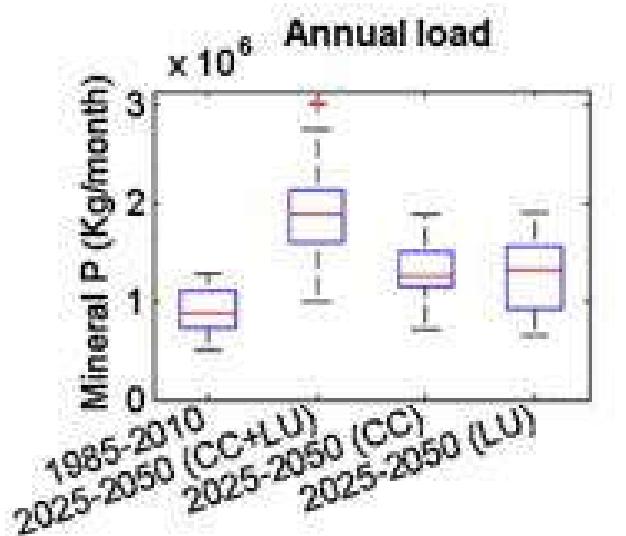
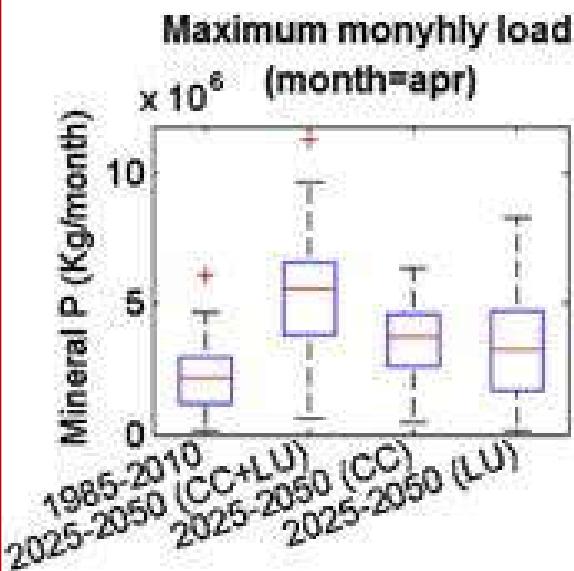
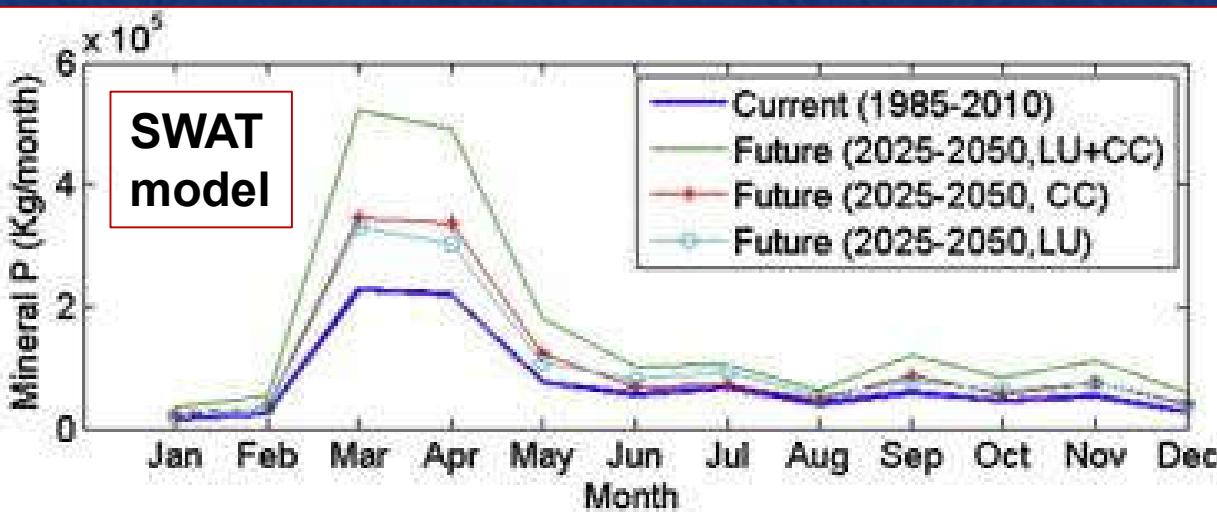
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# Modeling Water Quantity and Quality Trends In future

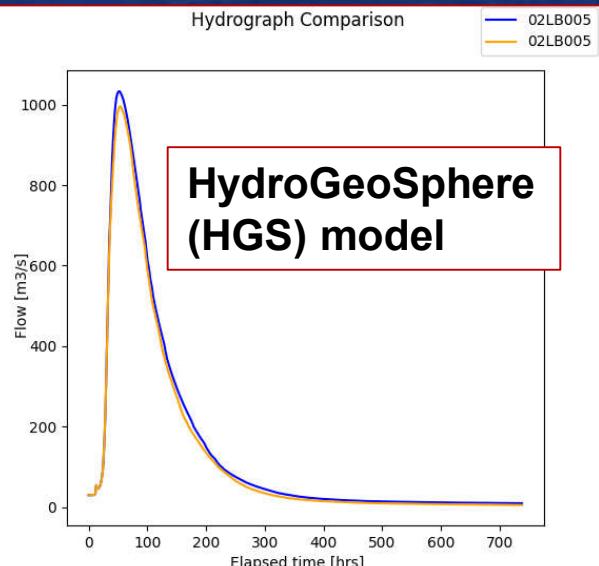
Imperative to consider both climate and land use changes concurrently



OPEN Sim Dir

Station

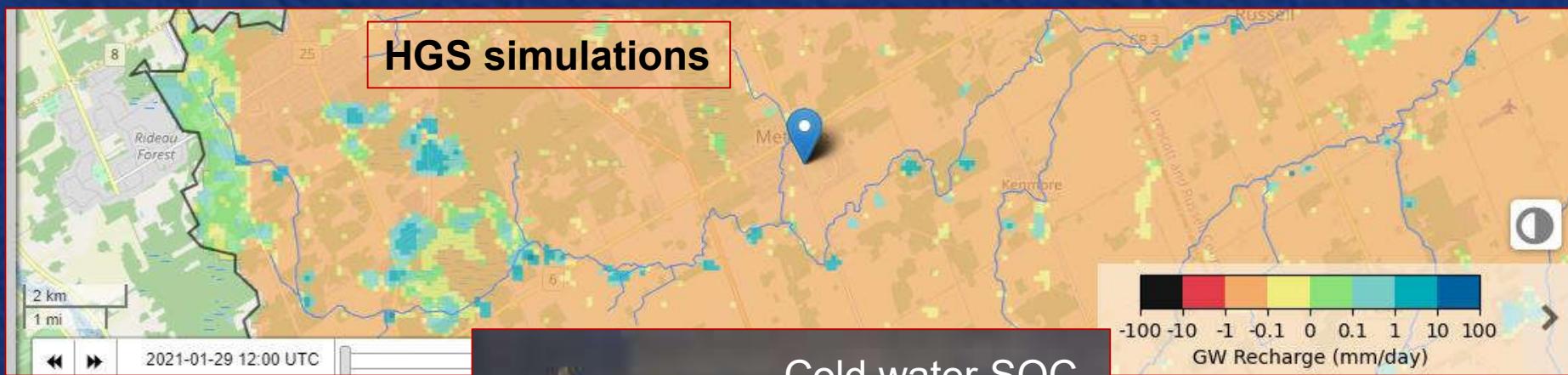
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# Modeling Recharge-Discharge: Supporting and Identifying Cold Water Species Habitat in Otherwise Warm Surface Water Systems



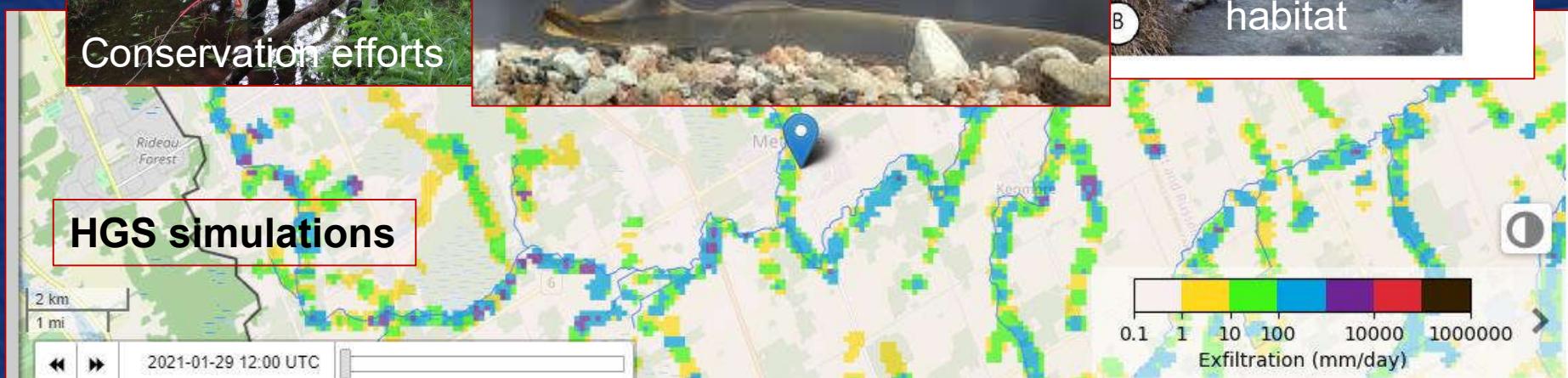
Conservation efforts



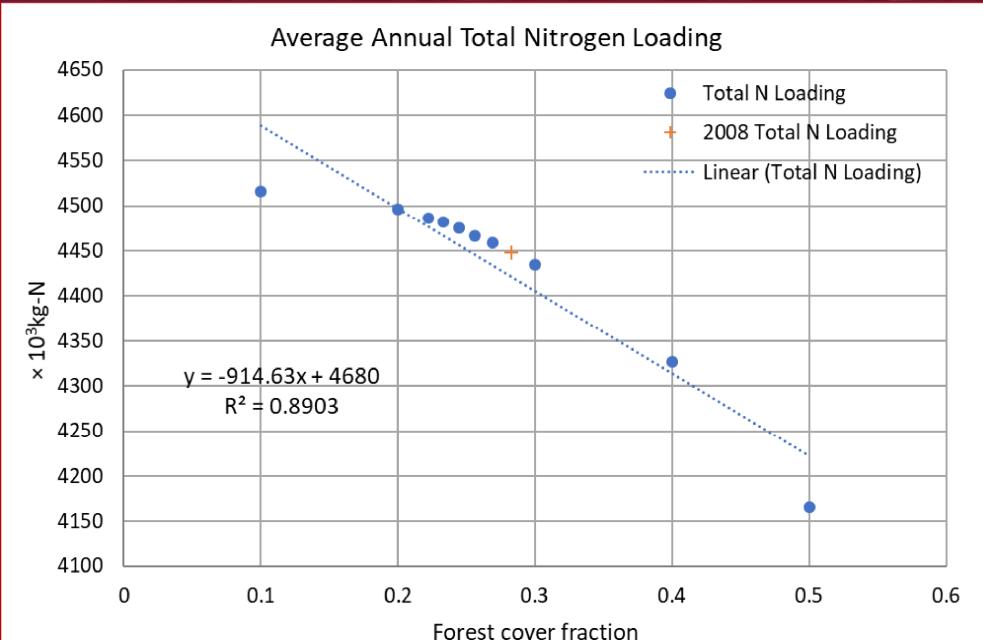
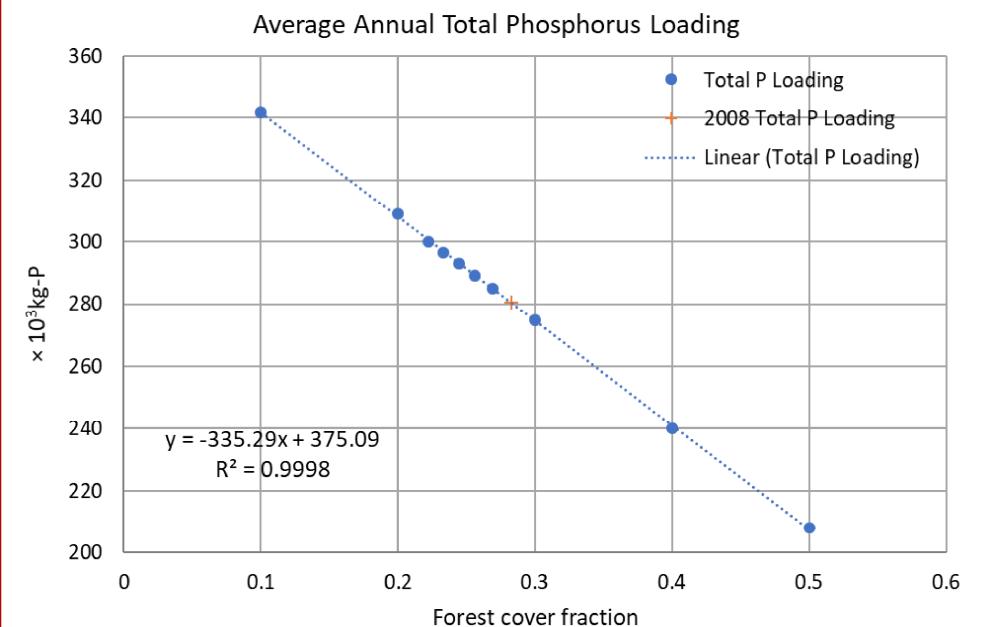
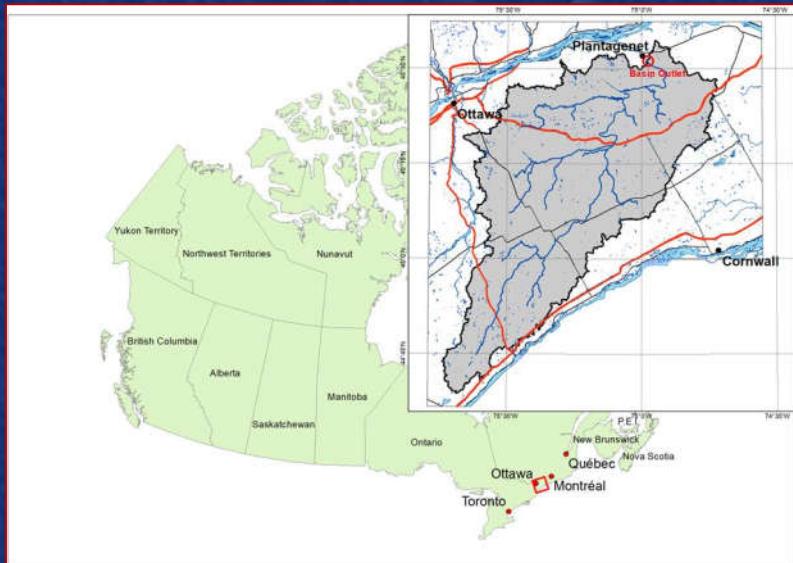
Cold water SOC



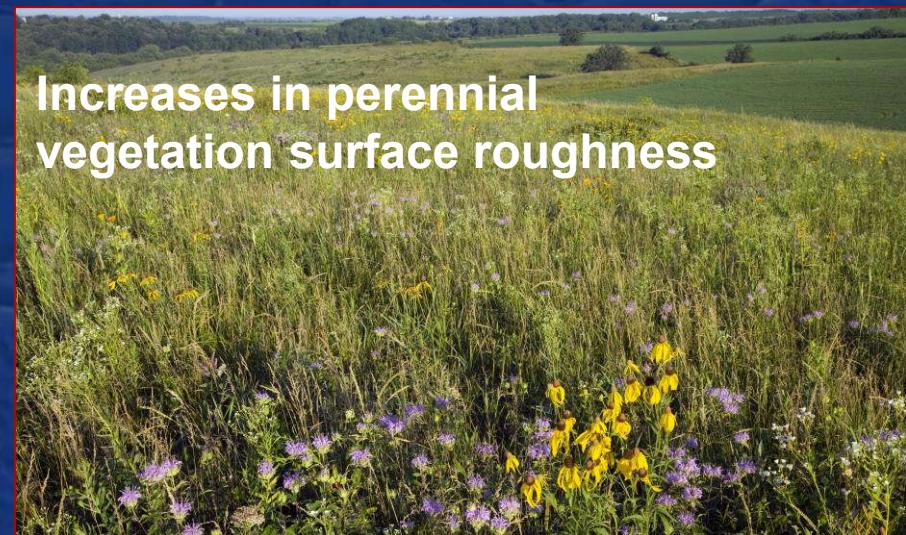
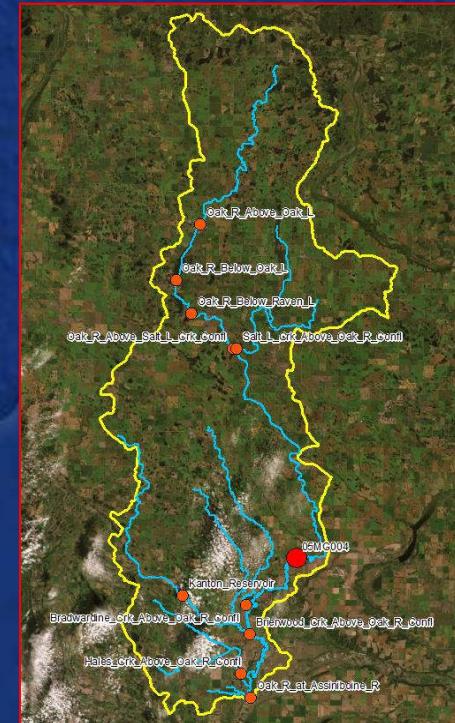
Glacial features (eskers) support habitat



# Effect of Forest Cover on Total Nitrogen and Total Phosphorus Loading at Watershed Scale



# Flood and Drought Regulation at Watershed Scale

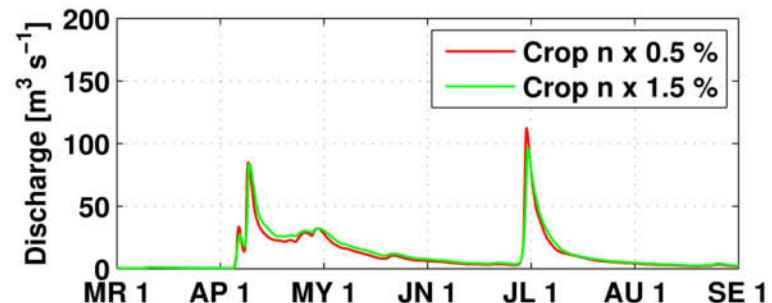
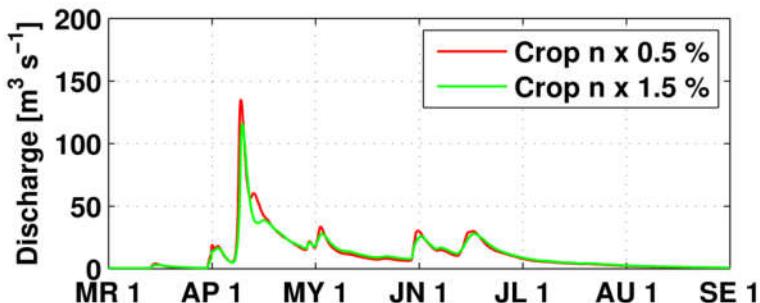
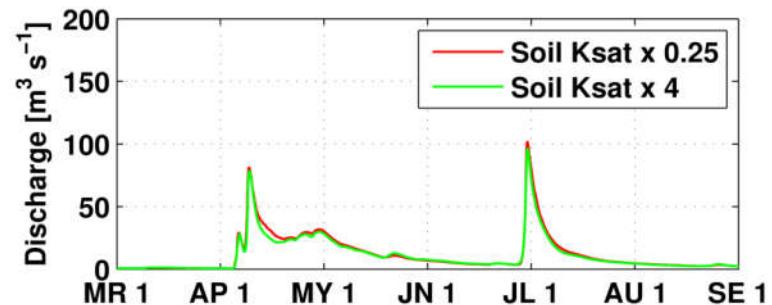
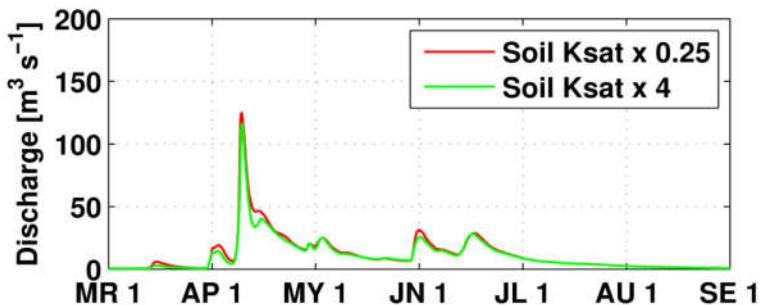
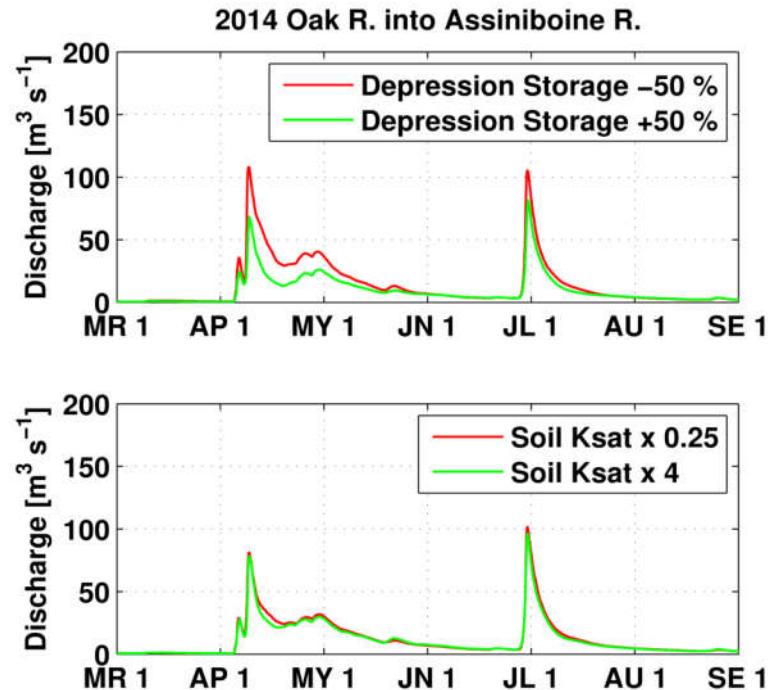
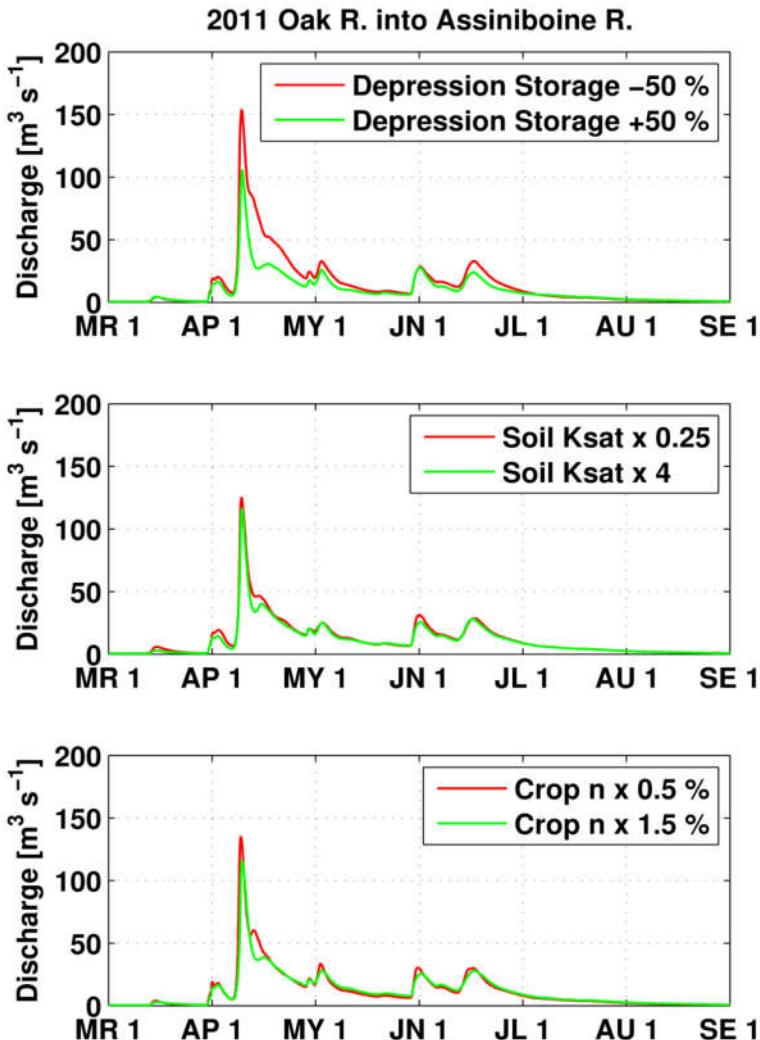


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# Depression, Infiltration, Surface Roughness Influences on Flood Hydrograph Using HGS



# Riparian Zones and Flood Regulation

1. Full tree/woody vegetation coverage



3. Patchy tree/woody vegetation coverage



2. Zero tree/woody vegetation coverage



4. Blocky tree/woody vegetation coverage

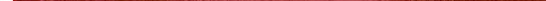
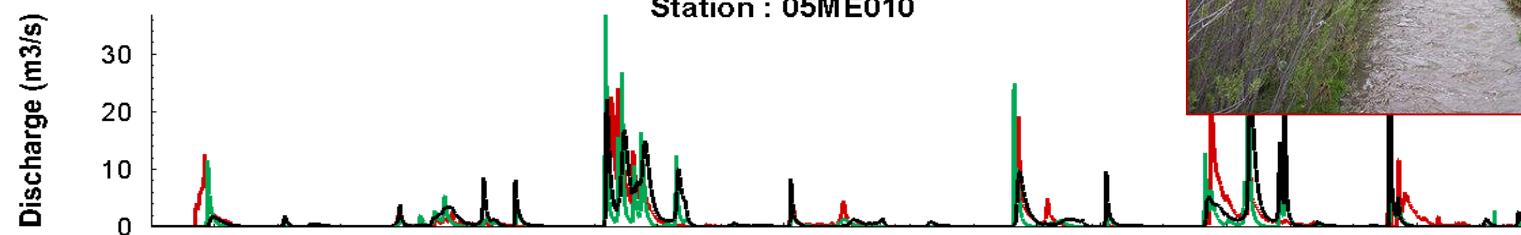
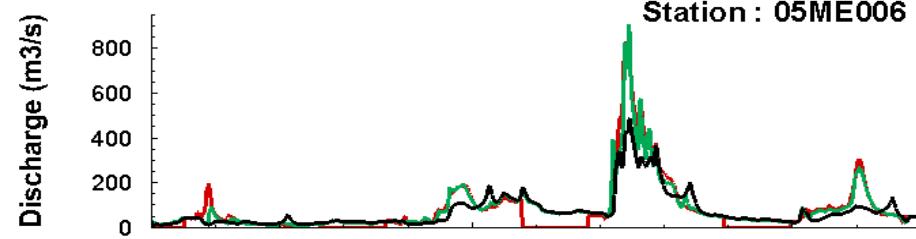
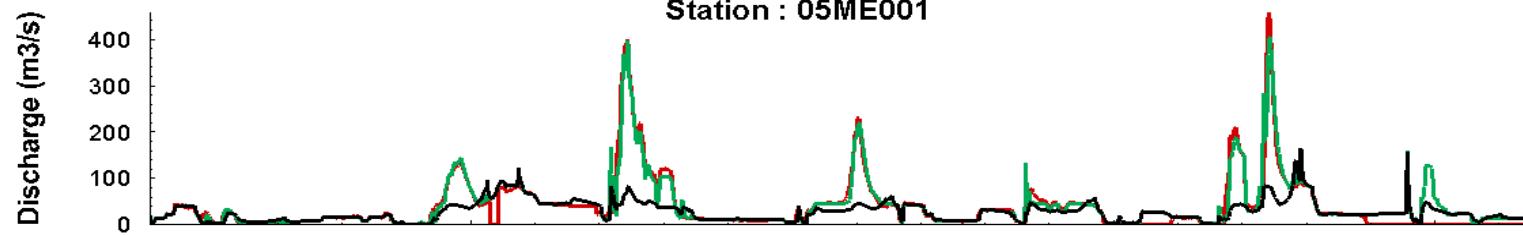
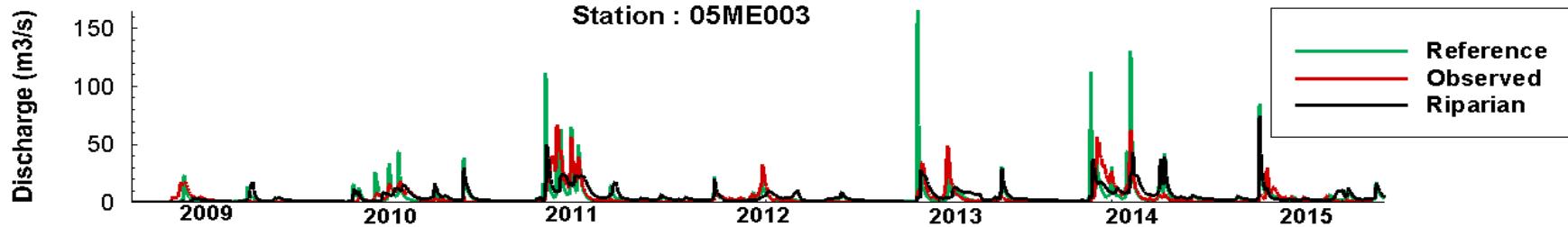


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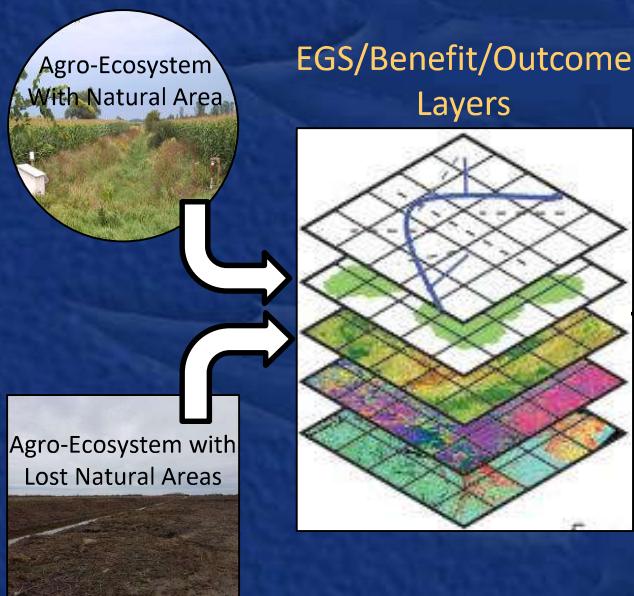
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# Predicting Riparian Zone Influences on Flood Regulation using HGS Integrated Flow Modeling at Watershed Scale



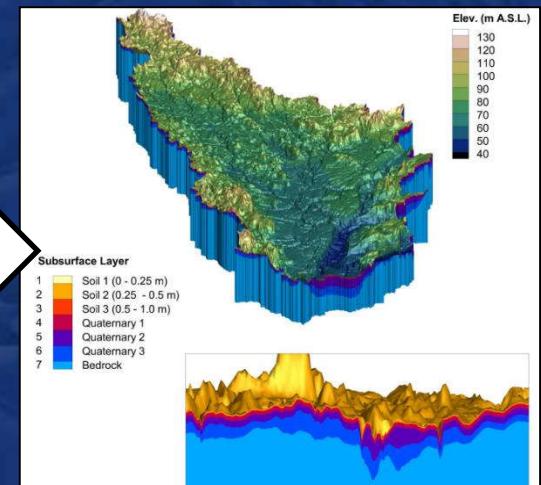
# Example of How the Research Could be Used to Incentify Protection of Natural Infrastructure/Features in Watersheds



- GHG emissions
- Aquatic vert. and invert. biodiversity/ecotox.
- Aquatic/sediment/soil microbiome functionality
- Airborne pathogens
- Terrestrial wildlife
- Pollinators
- Biocontrol agents
- Botanical composition invasive/alien species
- Vector born disease (ecology of vectors)
- Livestock/wildlife emerging diseases
- Water nutrient fate/trans.
- Water pest/PPCP fate and transport
- Crop production
- Waterborne pathogens
- Flood regulation
- Soil moisture regulation
- Wind regulation

Valuation

Economic Instruments: Watershed ES Trading Program eg.



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# Thank you / Merci

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Thank you and see you all at the next meeting:  
**June 22<sup>nd</sup>, 2022 from 1 to 2 p.m. (ET)**



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