SPRING 2020

Manitoba forage & grassland Association

mfga aquanty project's

# the grasslander

## OAK RIVER WATERSHED SCENARIO

# Project Backgrounder

**This project scenario utilizes the Manitoba Forage and Grassland Association's (MFGA) Aquanty Model – a HydroGeoSphere high resolution water-movement model completed in 2018 on the Assiniboine River Basin – for a project scenario titled "Investigating the influences of soil health and land drainage on the hydrologic behavior of the Assiniboine River Basin".**

This model scenario looked at a wide range of landscape factors that influence the hydrologic behavior and hydrologic resiliency of watersheds in Western MB. In this project, a detailed assessment of the 2000 sq-km Oak River Watershed *(see map)*, which includes Shoal Lake and the Shoal Lake catchment area, was conducted with a HydroGeoSphere fully-integrated groundwater – surface water model in order to evaluate watershed sensitivity to physical and climate characteristics. During construction, detailed structural characteristics of the watershed were incorporated into the model, including the spatially varying 3-dimensional hydrostratigraphy, surficial soils, landcover, lakes, river channels, and surface topography. Model scenarios were designed to test the sensitivity of watershed behavior to soil permeability, wetland/depression water storage, agricultural field microtopography, and precipitation and evapotranspiration variability. The sensitivity analysis was conducted for the 2009-2015 time interval which includes the 2011 and 2014 floods, as well as a number of drier years, such that the influence of landscape factors can be assessed for both wet and dry conditions. Model performance was evaluated using measured surface water flow from a Water Survey of Canada hydrometric station, and to augment the insights gained from model behavior at the physical hydrometric station, synthetic surface water gauges were added at 10 additional locations within the model, and a synthetic stage height gauge was added in Shoal Lake. Because landuse and landscape topography vary considerably across the watershed, with depression storage and natural landcover more predominant in the northern, as opposed to southern regions within the watershed, the spatial variability in synthetic gauge location allows a model-based assessment of which physical and climate factors are most influential under different landscape configurations.


## Project Funders

*The MFGA Aquanty's Oak River Scenario Project came to reality via the generosity of the Canadian Agricultural Partnership (CAP) Manitoba Agriculture Resource Development Department's Research and Innovation Stream funding up to $60,400 of the project while Aquanty, MFGA and the Assiniboine West Watershed District teamed up on the necessary project match and in-kind work of approximately $65,000 to help make it happen.*

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## MODEL FINDINGS SUPPORT VITAL ROLE OF GRASSLANDS, WETLANDS AND HEALTHY SOILS IN FLOOD TO DROUGHT YEARS

The early results of this Manitoba Agriculture Resource Development Innovation and Research stream-funded modelling project under the Canadian Agricultural Partnership and led by Manitoba Forage and Grassland Association (MFGA) is clearly showing that when climatic events flip quickly from very wet to very dry in back to back years that regions with healthy soils, grasslands and wetlands are much better-positioned to deal with the negative impacts to the system.

Investigating the influences of soil health and landscape management on the hydrologic behavior of the Assiniboine River Basin (ARB): Oak River/Shoal Lake – HydroGeoSphere Modelling Study, was recently concluded by project lead scientist Dr. Steven Frey from Aquanty Inc., Waterloo, Ont. The model scenarios clearly showcase that in years that shift from very wet to very dry that these landscape characteristics are even more valuable to the Agro-Manitoba landscape than what many assume.

"Producers, land managers and conservation professionals who work on agricultural-based lands will tell you that healthy soils, grasslands and wetlands – vital components of livestock production and conservation focuses – are valuable forces in buffering the impacts of flood and retaining water supplies during drought," says Larry Wegner, MFGA Chair. "As producers, we manage our lands and we know our lands. However this information from the Oak River scenario clearly shows the power of soil, grasslands and wetlands as they interact with the natural groundwater system in order to buffer flood and drought impacts in back to back years. And that is something many Manitobans should be aware of. It's a natural water management system that Manitobans directly benefit from."

The project provided a detailed assessment of the 2000 sq-km Oak River watershed, which includes Shoal Lake and the Shoal Lake catchment area, conducted with a HydroGeoSphere fully-integrated groundwater – surface water model in order to evaluate watershed sensitivity to physical and climate characteristics. Model scenarios looked at watershed behavior to soil permeability, wetland/depression water storage, agricultural field microtopography, and precipitation and evapotranspiration variability. The water infiltration abilities of healthy soils, the slowing of water by grasslands and the healthy soils below them, and the water storage and water-slowing abilities of wetlands really shone.

"The sensitivity analysis was conducted for the 2009-2015 time interval which includes the 2011 and 2014 floods, as well as a number of drier years, such that the influence of landscape factors can be assessed for both wet and dry conditions," says Frey. "The unique ability of the HydroGeoSphere modelling approach to emulate the dynamic interplay between land surface, soil, and groundwater systems is proving crucial for addressing questions pertaining to sustainable water resources management in this hydrologically complex region."

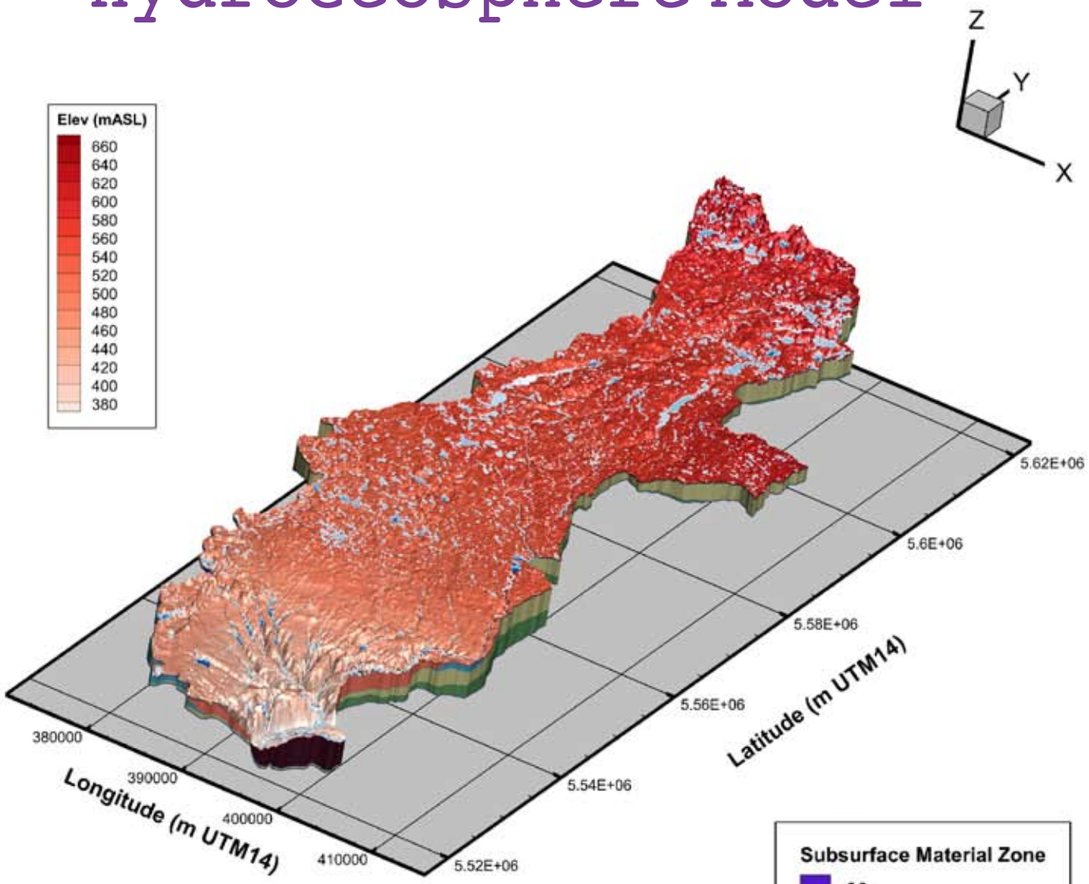
Ryan Canart, AWWD manager, says the Oak River information will become a key focus in the extension and outreach materials of the district as well as a key planning tool for on-farm, retention and restoration projects in the future. He feels the model can help target limited resource management dollars at the most cost effective activities.

"Assiniboine West Watershed District believes that the HGS model will help in the long-term planning and management of the water resources of the watershed," says Canart. "In this complex and multi-jurisdictional watershed, the ability to model various water management strategies helps save time and resources. The model gives us the ability to test various practices and management scenarios and inform the broader stakeholder group on how the watershed responds to the various scenarios."

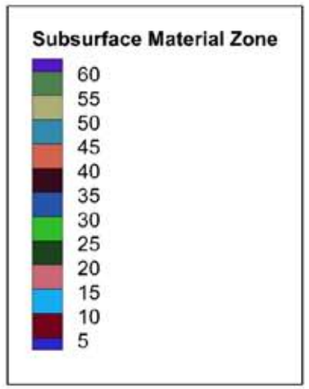
Frey believes the MFGA Aquanty Model and the Oak River scenarios as well as 2018-completed scenarios on the Scallion and Birdtail Creek clearly signal the importance of soils, grasslands and wetlands in water management, community resiliency and producer engagement.

"This work is exciting in that it is providing a bridge between state-of-the–art science and on-the-ground practices in order to help guide us towards an agricultural landscape that is optimized for climate resiliency," says Frey.

# Oak River Watershed
## HydroGeoSphere Model

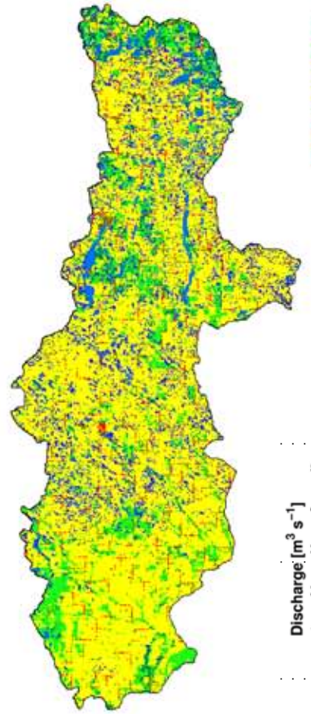



50x Vertical Scale Exaggeration

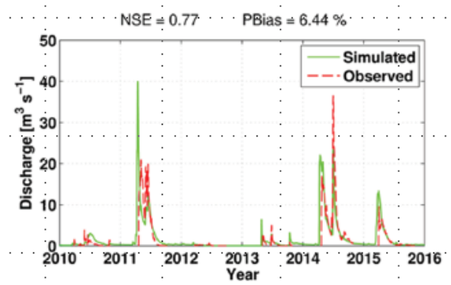



With topography represented by a LiDAR-based DEM, and 61 individual subsurface zones used to represent soil, aquifer, and aquitard properties, the model provides a high resolution digital perspective of the real world.

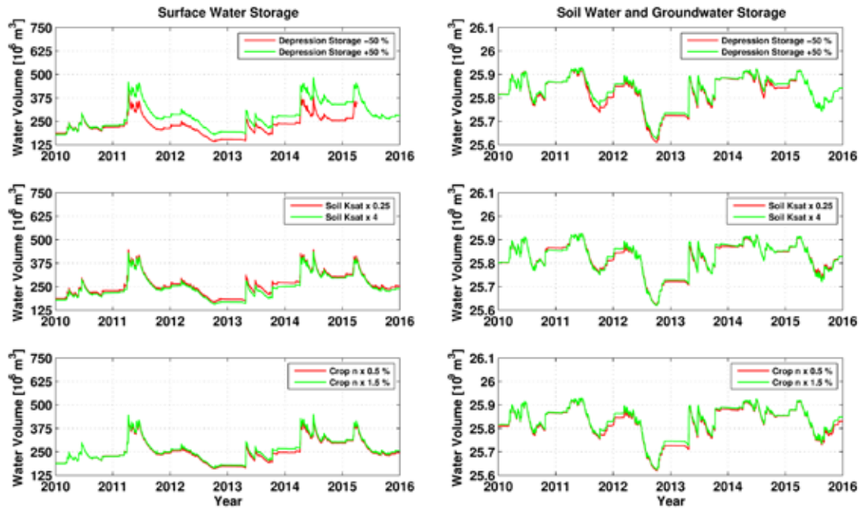
**"The interplay between land use and water management will be characterized from soil health and drainage perspectives," says Dr. Steven Frey from Aquanty, who is the principal investigator on the project. "New insight will be generated on how to build and maintain resilient agricultural landscapes that can reduce producer risk exposure to extreme weather events."**




Model performance was validated prior to scenario analysis.




Model results help us understand the influence of land management on surface water, soil moisture and groundwater.



# HYDROLOGIC BENEFITS OF GRASSLANDS

## SUMMARY OF RESULTS

- All 3 BMPs tested act to:
  - Reduce peak flows during floods
  - Increase ground water recharge
  - Provide a faster recovery of evapotranspiration driven groundwater draw down
- Higher depression storage and higher soil K both act to shorten the flood hydrograph tail
- Higher surface roughness extends the flood hydrograph tail (slows down runoff)
- Higher depression storage and higher surface roughness both act to hold more water on the land surface
- Higher soil K reduces water on the land surface (which increases available storage during floods)
- Flood mitigation capabilities of BMPs are sensitive antecedent conditions (e.g. wet fall of 2013 - flood in 2014)

Want to learn more about our

## mfga aquanty project?

Do you have a model scenario that you're curious about? **Contact: duncan@mfga.net** and lets get the conversation started!

visit: **mfga.net/aquanty**

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