Groundwater Recharge In The Assiniboine Delta Aquifer

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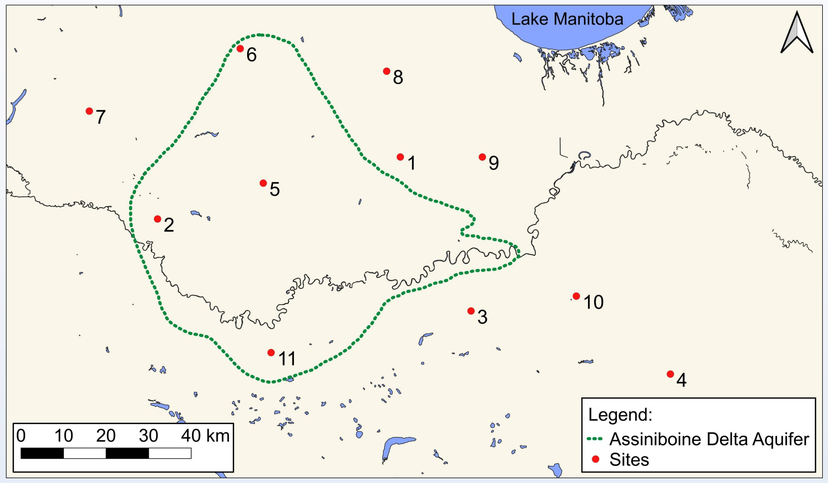
Background

- Assiniboine Delta Aquifer (ADA) is located in southern Manitoba
- The water supply is of critical importance due to high irrigation demands for agricultural purposes
- The Manitoba Agriculture Weather Program (MAWP) provides daily information on weather and soil conditions
  - The network has 11 stations in and around the ADA, labelled 1–11



Objectives

1. Create hydrologic models of study sites in and around the ADA
2. Apply historical weather data (1996–2019) to the completed models to determine historical recharge rates

Methods

Unsaturated zone modelling (HYDRUS-1D):

- One-dimensional flow through the unsaturated zone
- Model functions employed include:
  - Snow Hydrology
  - Heat Transport
  - Root Water Uptake
  - Potential Evaporation
- Lower boundary conditions:
  - Free Drainage (no groundwater influence)
  - Variable Pressure Head (groundwater influence)
- Hydraulic model: van Genuchten-Mualem soil water retention curve

Site categorization:

Sites	Site Type	Soil Type
1, 2	No Groundwater Influence	Sand
3, 4, 5, 6	No Groundwater Influence	Loam
7	No Groundwater Influence	Silt
8, 9, 10	Groundwater Influence	Sand
11	Groundwater Influence	Loam

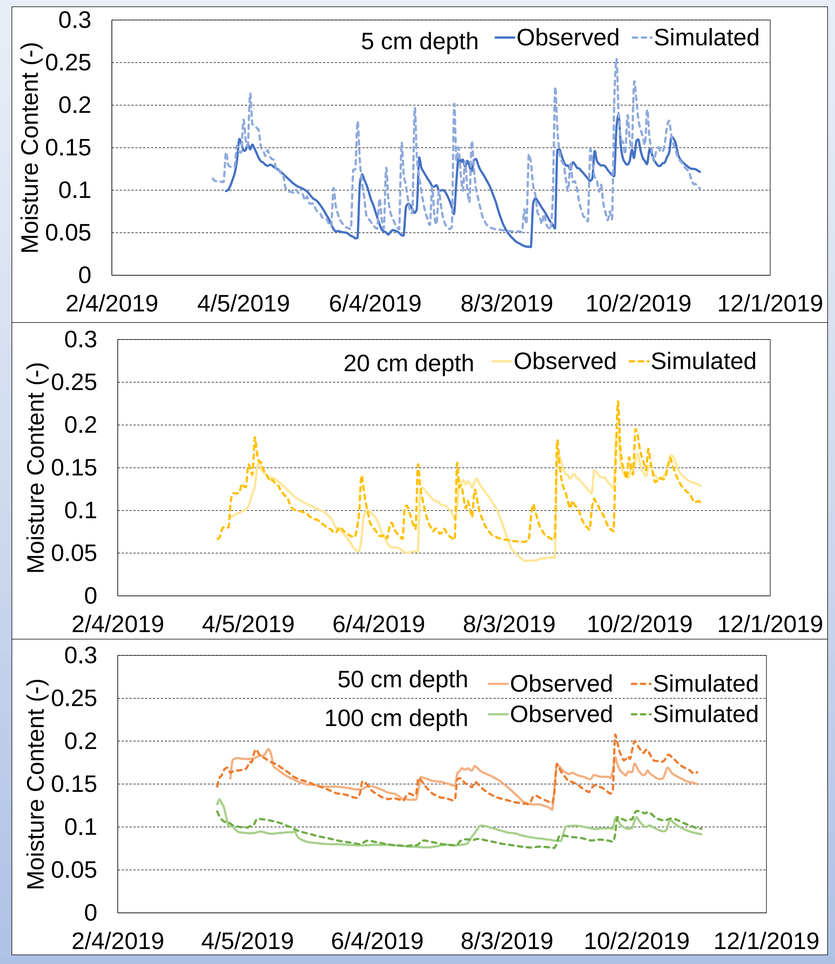
Calibration

- Initial soil hydraulic parameters estimated in Rosetta3 given MAWP soil texture
- Parameters further calibrated using known soil moisture contents
  - Calibrated to 2019
  - Validated to 2017 or 2018
- Error metrics
  - Mean Error (ME) = $\sum_{i=1}^{n} \frac{(y_i - x_i)}{n}$
  - Root Mean Square Error (RMSE) = $\sqrt{\sum_{i=1}^{n} \frac{(y_i - x_i)^2}{n}}$

Average error metrics:

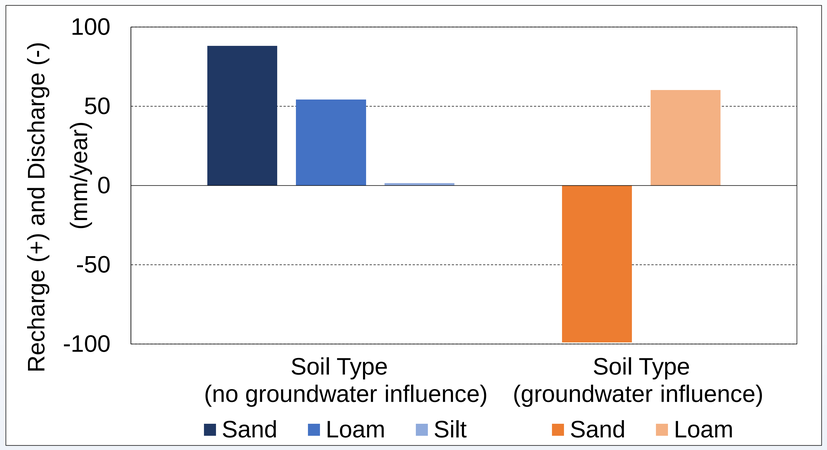
Site Type	Soil Type	Calibration ME (m^3/m^3)	Calibration RMSE (m^3/m^3)	Validation ME (m^3/m^3)	Validation RMSE (m^3/m^3)
No Groundwater Influence	Sand	-0.002	0.024	0.007	0.027
No Groundwater Influence	Loam	0.000	0.029	-0.004	0.038
No Groundwater Influence	Silt	0.000	0.025	-0.054	0.066
Groundwater Influence	Sand	0.004	0.038	-0.029	0.059
Groundwater Influence	Loam	0.002	0.033	-0.026	0.054

Site 2 observed vs simulated moisture contents during calibration:



Results

Average historical recharge/discharge rates per soil type:



Discussion

Comparison to previous studies:

Type of Estimate	Unit	Previous	Project
Aquifer Recharge	mm/year	34	56
Aquifer Recharge/Precipitation	%	10	12
Site 5 Recharge/Precipitation	%	22	26

Recommendations:

- Measure hydraulic conductivity
  - Improves model validity, reduces number of calibrated parameters
- Verify results using additional method
  - Water table fluctuation method suggested due to groundwater presence
- Interpolate results over entire ADA spatially by soil type
  - Improves estimation of recharge average

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