

# **Watershed-scale modeling of groundwater – surface water interaction in the Canadian Prairies**



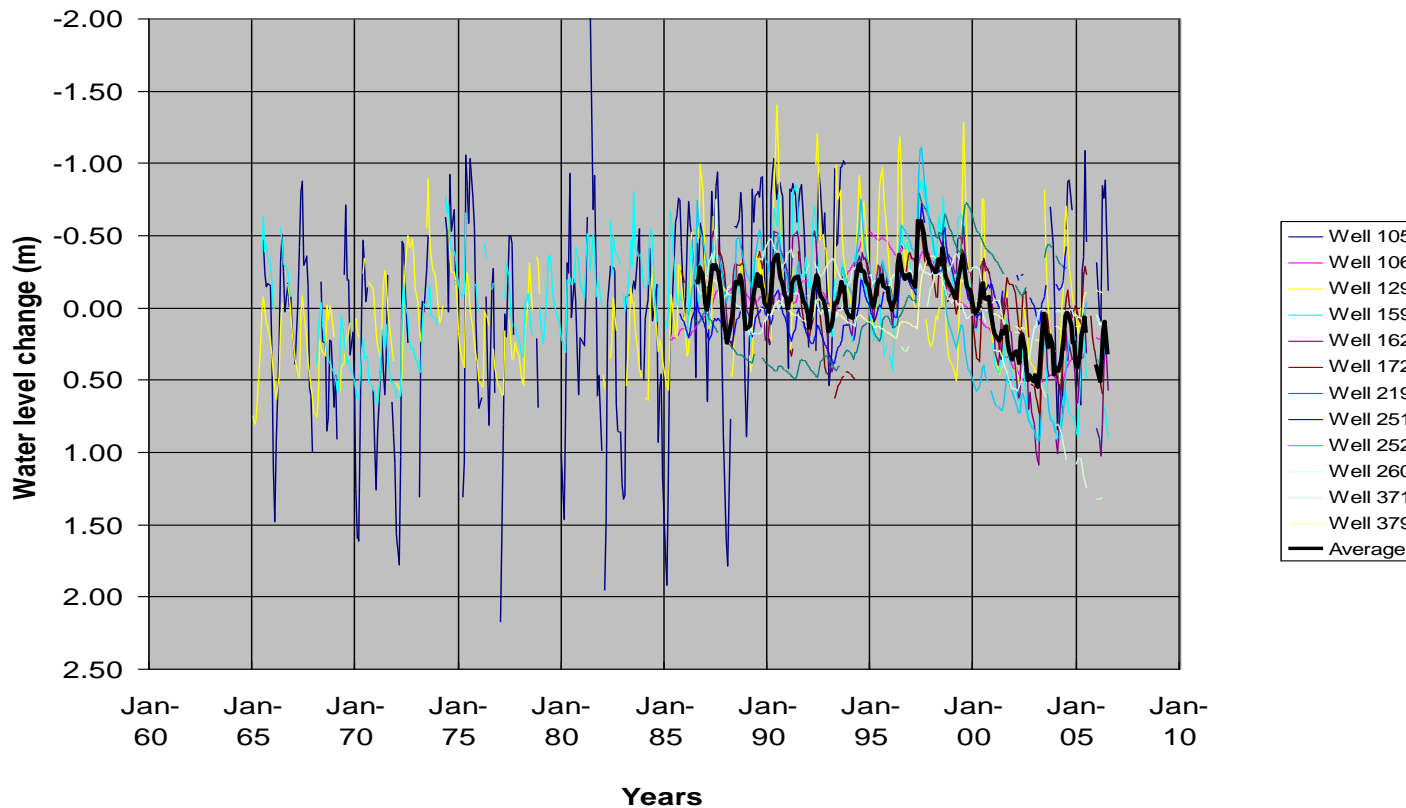
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# 1. Sustainable and drought-tolerant groundwater resource management



- Sustainable water use
  - Significant issue in rural groundwater supply
  - Sustains the baseflow of Prairie streams
- Permissible pumping rate
  - Commonly estimated using short-term pumping rate
  - Difficulty in predicting long-term aquifer response and assessing the effect of meteorological variability (e.g., drought)
  - Geological heterogeneities and recharge boundaries are not explicitly accounted

# 1. Sustainable and drought-tolerant groundwater resource management



Shallow  
observation  
wells in AB

Data compiled  
by Garth van  
der Kamp

Groundwater level changes during 1965-2006

## 2. Objective

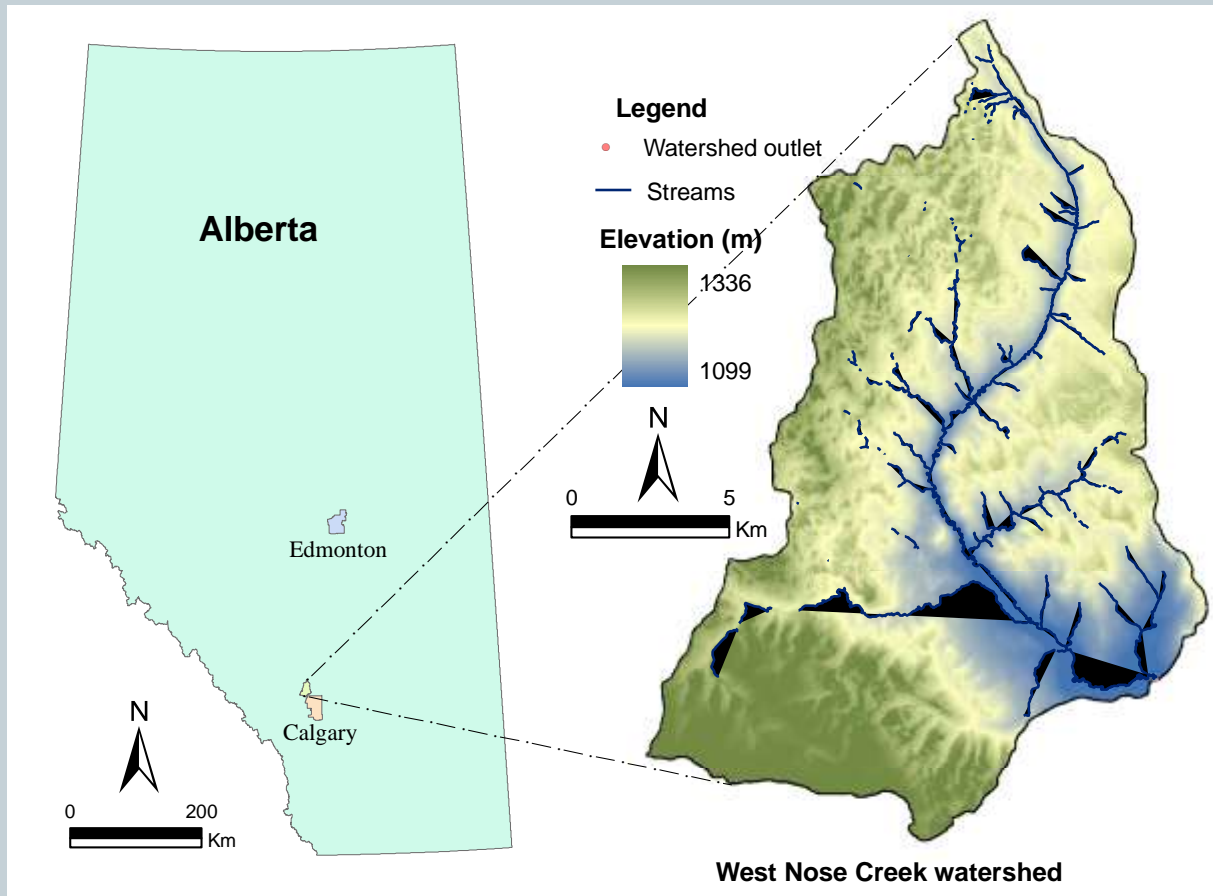


- Integrated groundwater - surface water model
  - Effective tool for sustainable and drought-tolerant management
- Develop a coupled groundwater – surface water model (West Nose Creek)
  - Watershed scale depression focused recharge estimation (VSMB)
  - Develop conceptual model of the Paskapoo Formation (ViewLog)
  - Groundwater modeling (FEFLOW)
  - Coupling VSMB with FEFLOW

### 3. Study area and site instrumentation



#### Spy Hill and Woolliams Farm

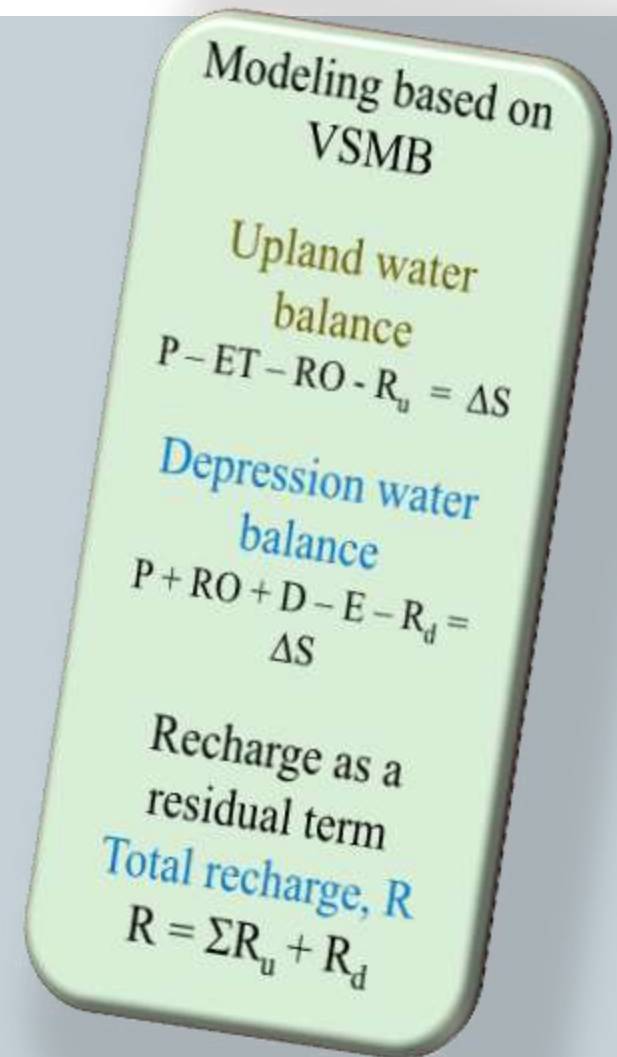
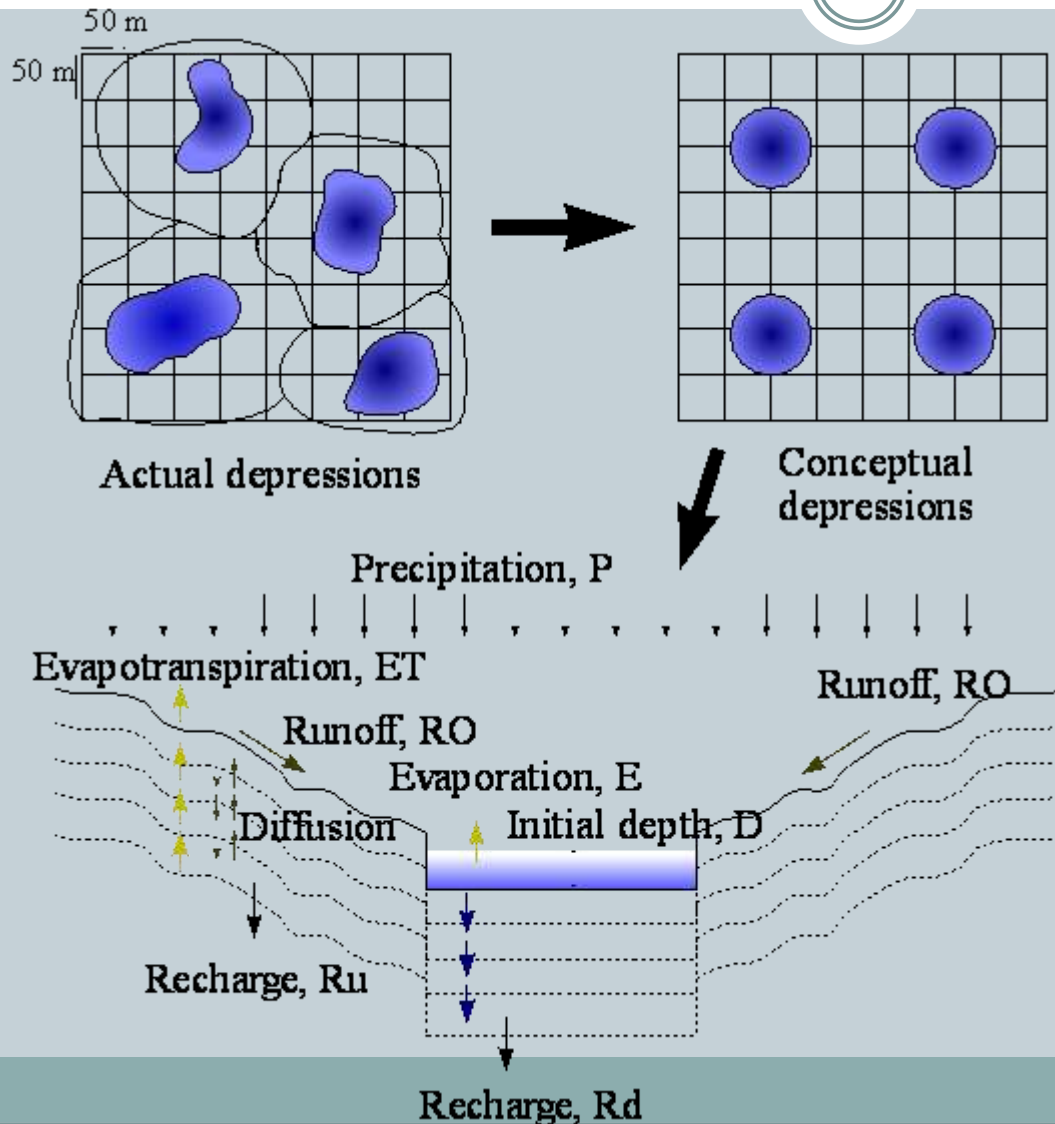


- ✓ Meteorological sensors
- ✓ Rain gauges
- ✓ TDR probes
- ✓ Capacitance probes
- ✓ Thermocouples
- ✓ Tensiometers
- ✓ Piezometers

#### Watershed

- ✓ Monitoring wells
- ✓ Weather stations
- ✓ Stream gauging

## 4. Watershed scale recharge estimation approach

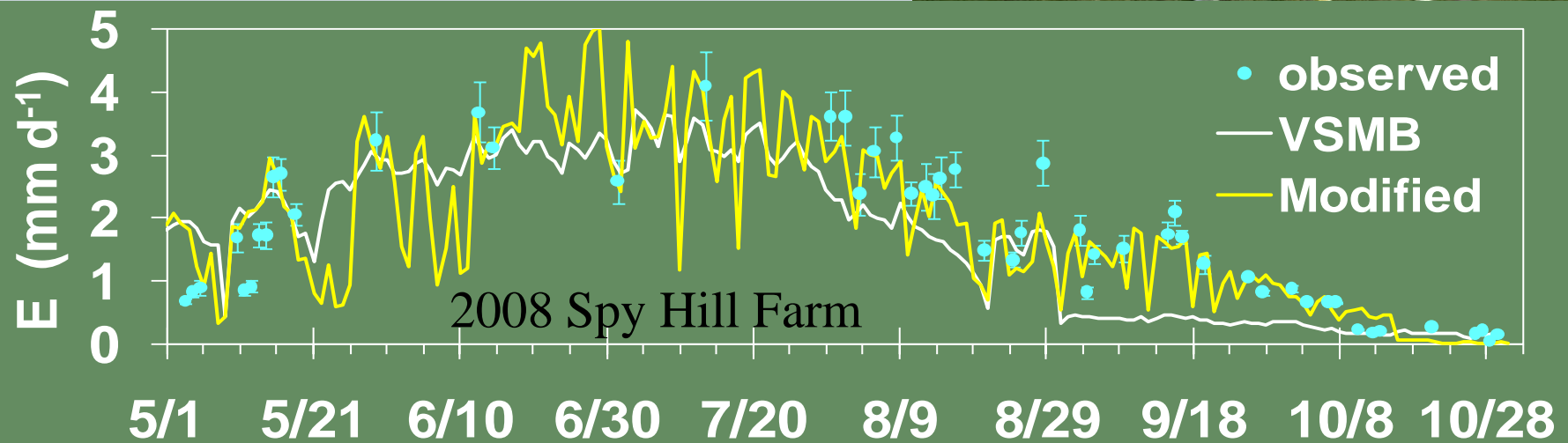


## 5. Application of VSMB for Prairie grassland



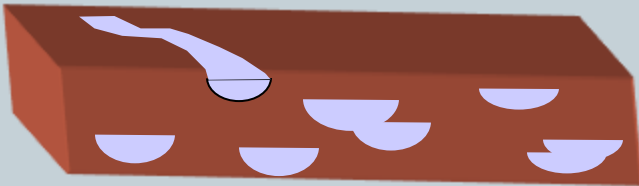
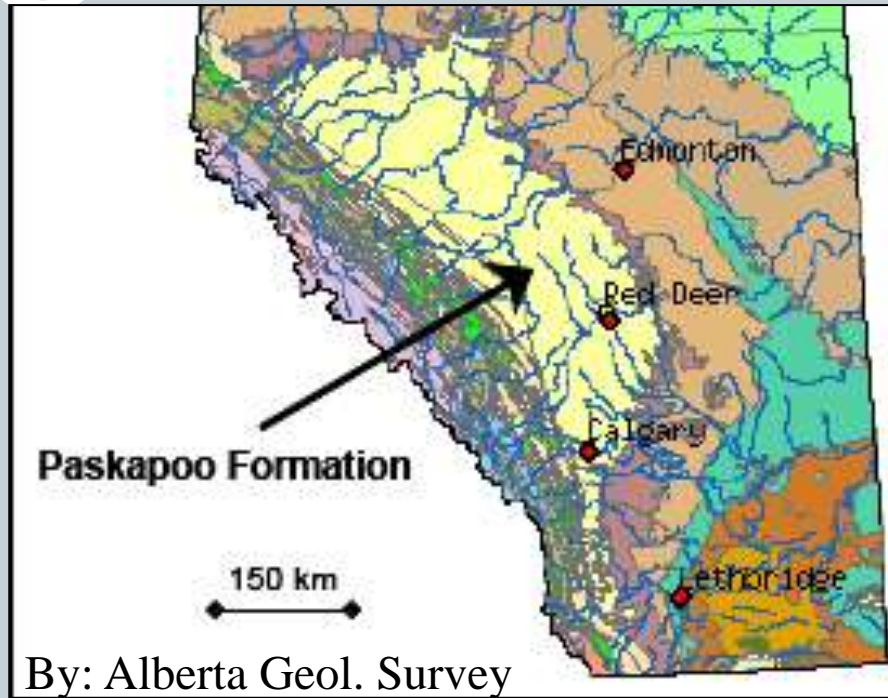
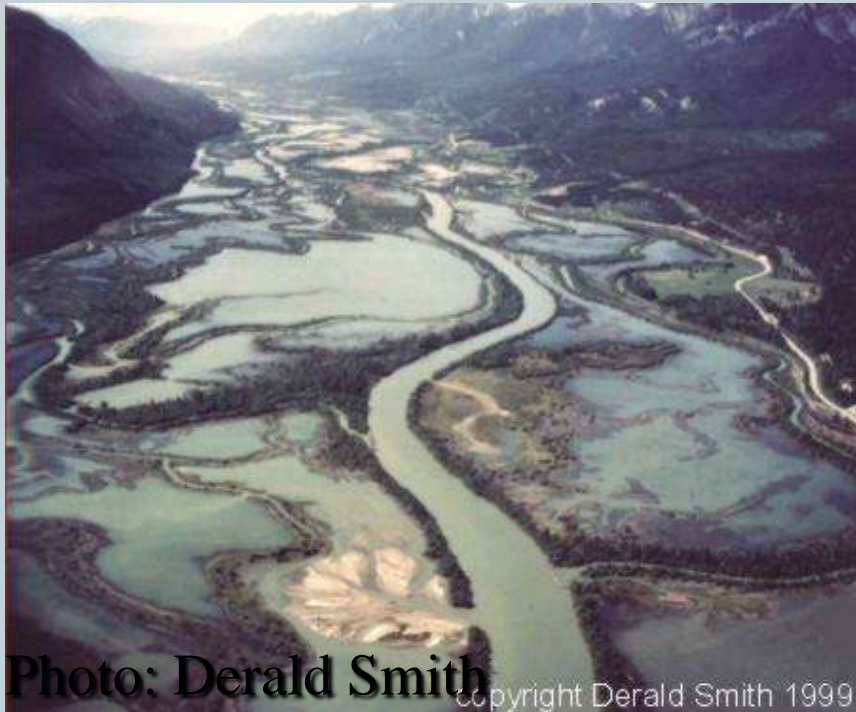
### Evapotranspiration estimation

- Eddy flux measurement.
- Current operational VSMB.
- **Modification**: radiation, crop stage, soil depth, etc.





## 6. Characterizing the Paskapoo Formation



Channel Stacking

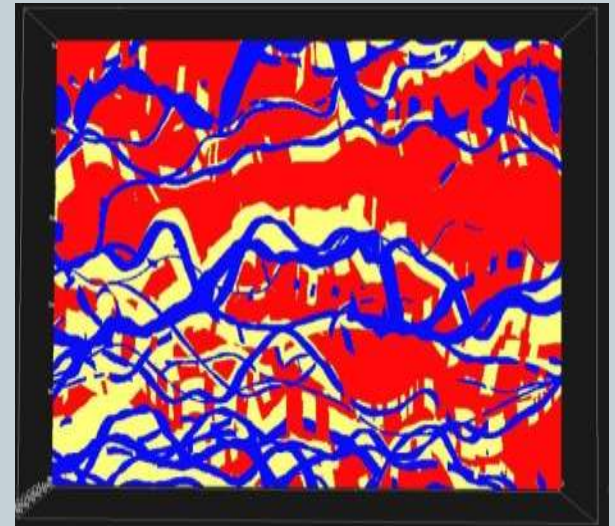
- Covers about 10% of Alberta
- Hosts about 64,000 wells (2/3 of wells in Manitoba)
- Is a highly heterogeneous aquifer system



## 6. Characterizing the Paskapoo Formation



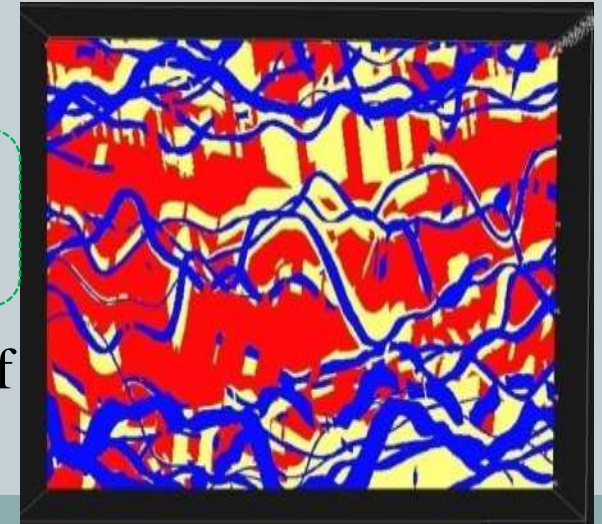
5 km



Outcrop of Paskapoo Formation

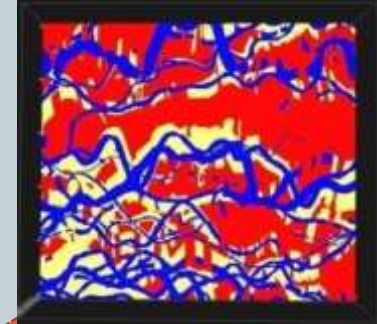
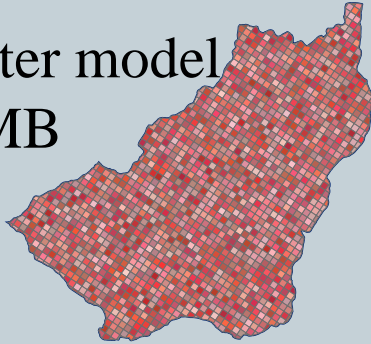
Stochastic  
aquifer model

Multiple realizations of  
facies



# 7. Groundwater modeling using FEFLOW

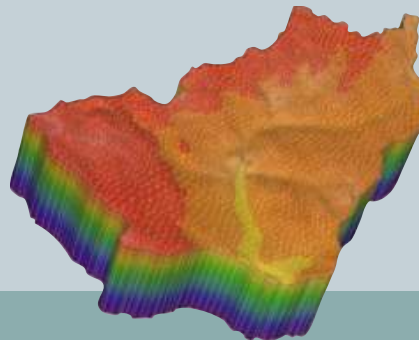
Surface water model  
VSMB



Stochastic  
aquifer  
model

Scenario (climate,  
landuse, management)

Integrated  
surface water - groundwater  
model



VSMB - FEFLOW

## 8. Conclusions



- Upland and depression water balance models
  - Estimate watershed scale groundwater recharge
- Water balance models and stochastic aquifer models
  - Develop integrated groundwater – surface water models
- Integrated groundwater – surface water models allow
  - To assess the impact of landuse, climate and manageent scenarios

# Acknowledgment



- **Funding**
  - Royal Bank of Canada
  - Drought Research Initiative
  - Alberta Ingenuity Center for Water Research
- **Data and other supports**
  - Environment Canada
  - Alberta Agriculture and Rural Development
- **Field assistant**
  - Kate Forbes