# The Wetland DEM Ponding Model

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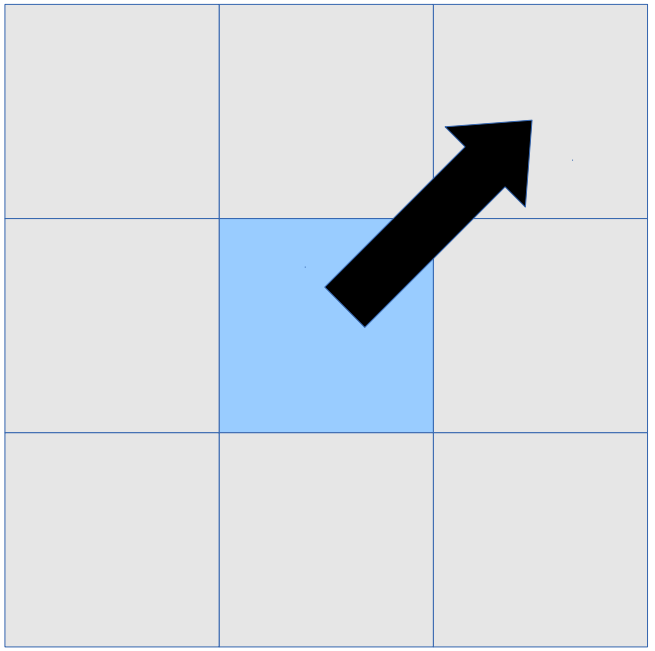
# The Wetland DEM Ponding Model (WDPM)

- NOT a hydrological/hydraulic mode
- Simulates redistribution of runoff on a DEM
- Distribution of water validated by remote sensing

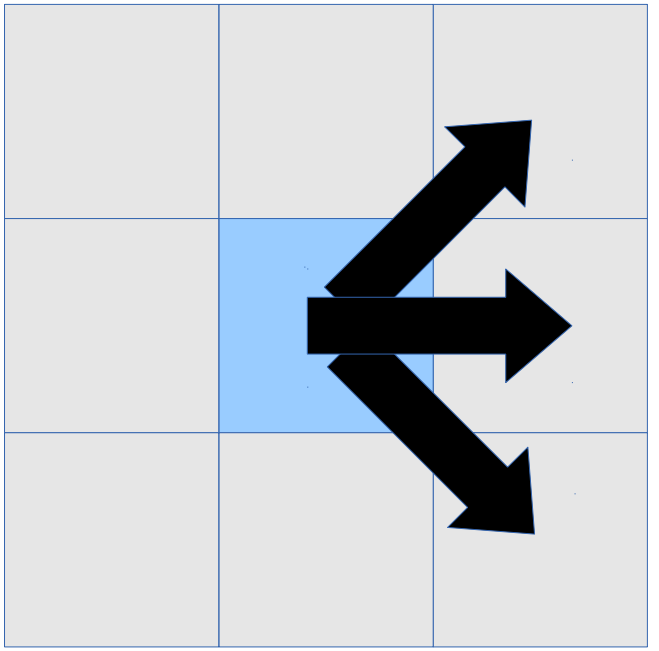
# DEM runoff algorithms

## Conventional D8 algorithm



- Drains in direction of max. slope
- Fast
- ‘pits’ are problematic

## Shapiro and Westervelt algorithm



- Drains in all downhill directions
- Iterative
- Drainage changes as storage fills

# Modules

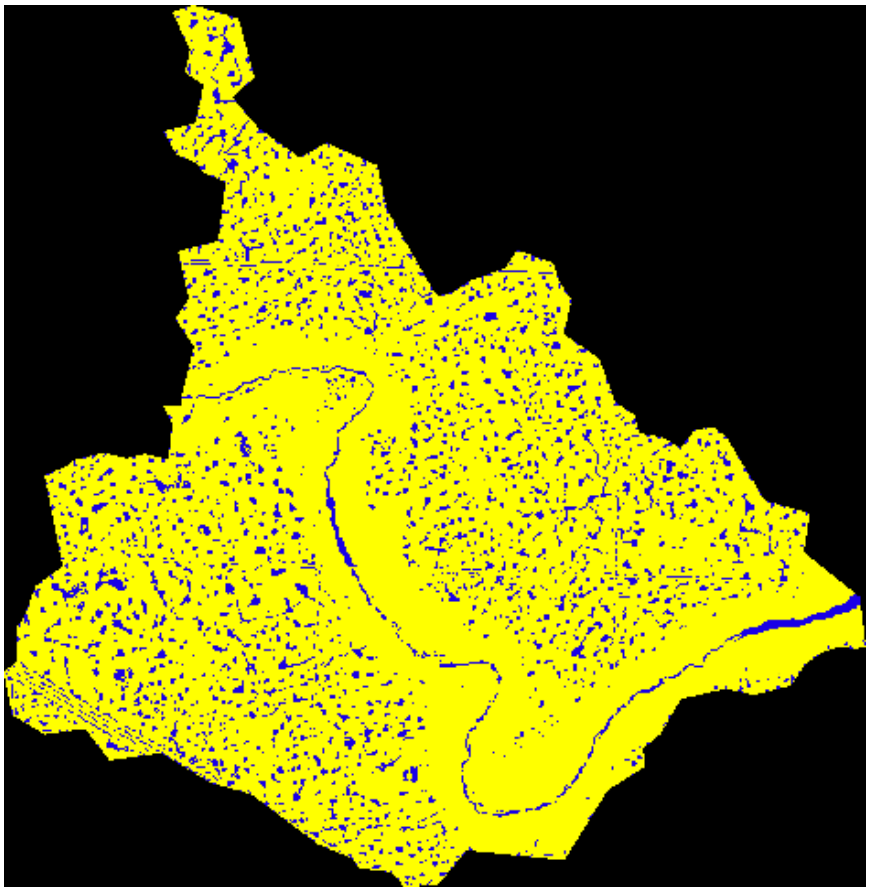
- The model has 3 modules:
  1. Add – adds water
  2. Subtract – removes water
  3. Drain – drains water
- All modules use the Shapiro and Westervelt algorithm

# 1. Add

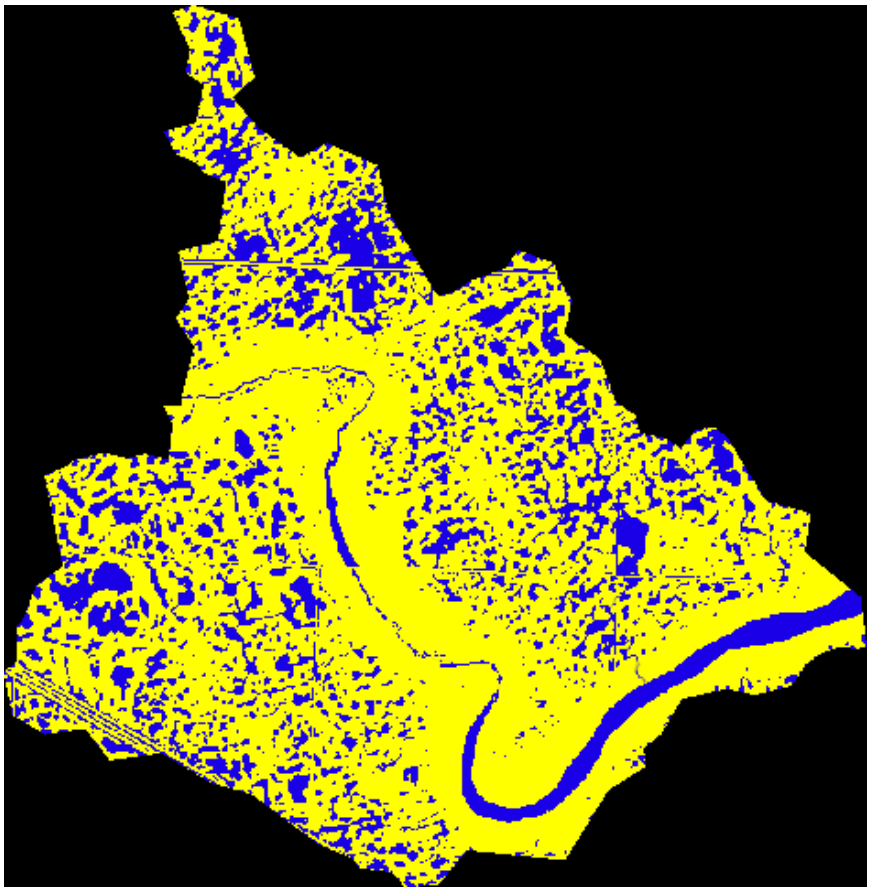
- Adds a spatially uniform depth of water
- Can use a runoff coefficient
- Water is redistributed
- Edges of DEM act as dams

# Add

10 mm added



100 mm added



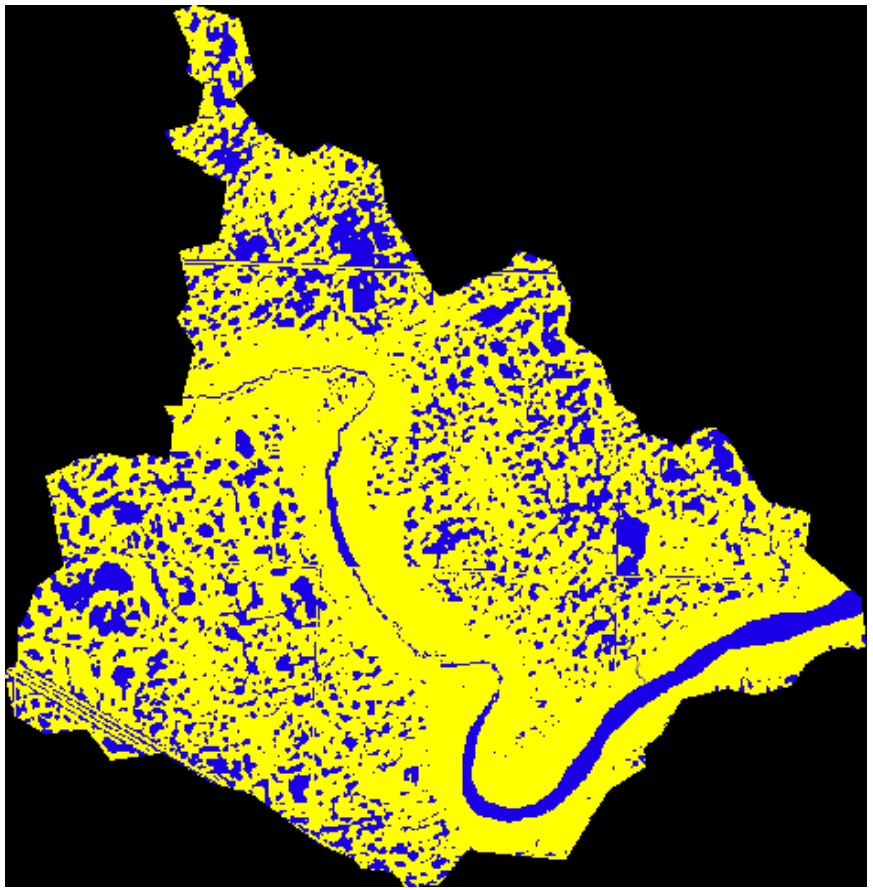
Smith Creek SK, Sub-basin 5, 10m LiDAR DEM

# 2. Subtract

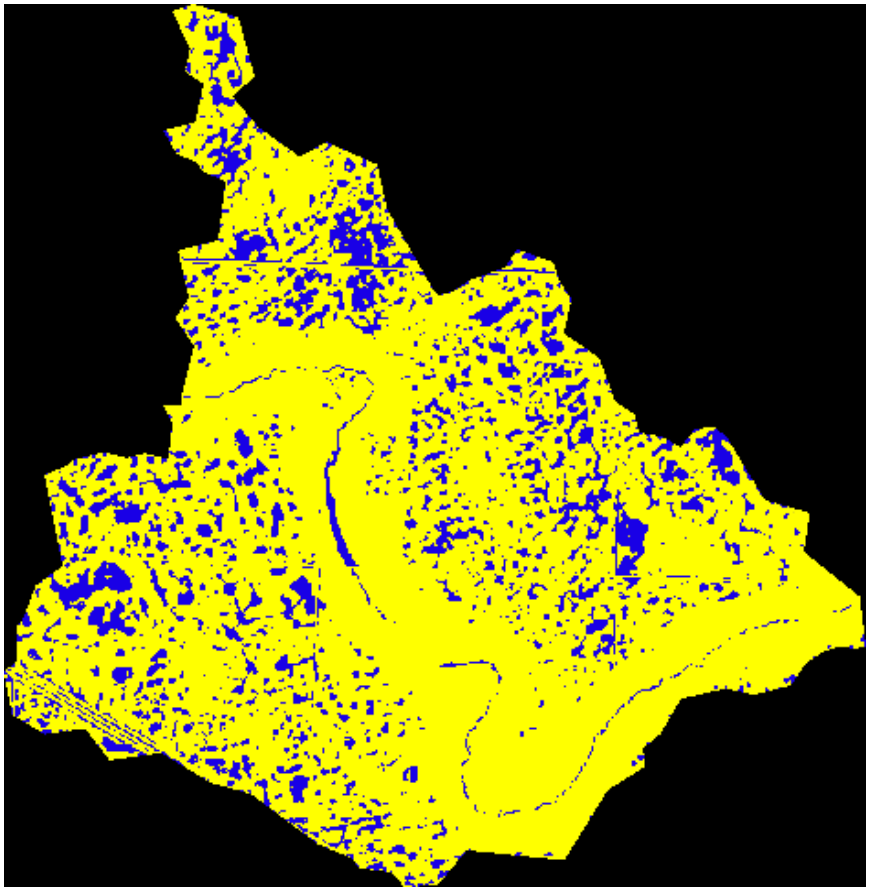
- Removes a specified depth of water
- Does not currently allow for any spatial variability
- The process is not just the reverse of adding water
  - Adding and subtracting change the frequency distributions of water areas in very different ways

# Subtract - Smith Creek

100 mm added



100 mm added,
100 mm subtracted



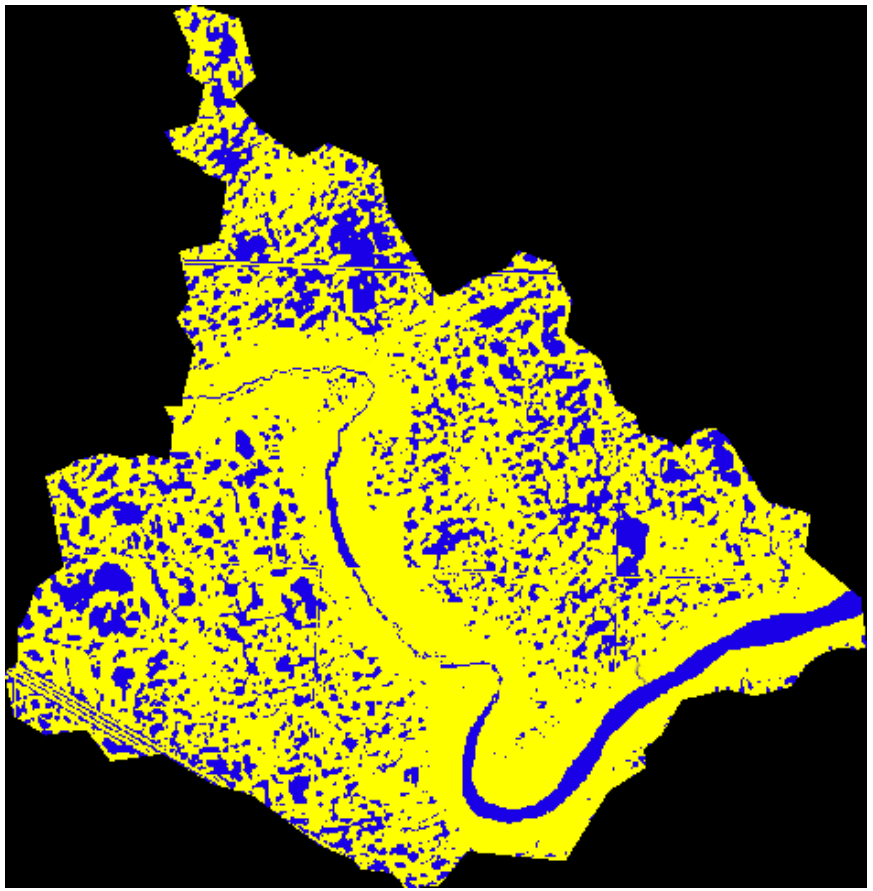
Smith Creek SK, Sub-basin 5, 10m LiDAR DEM

# 3. Drain

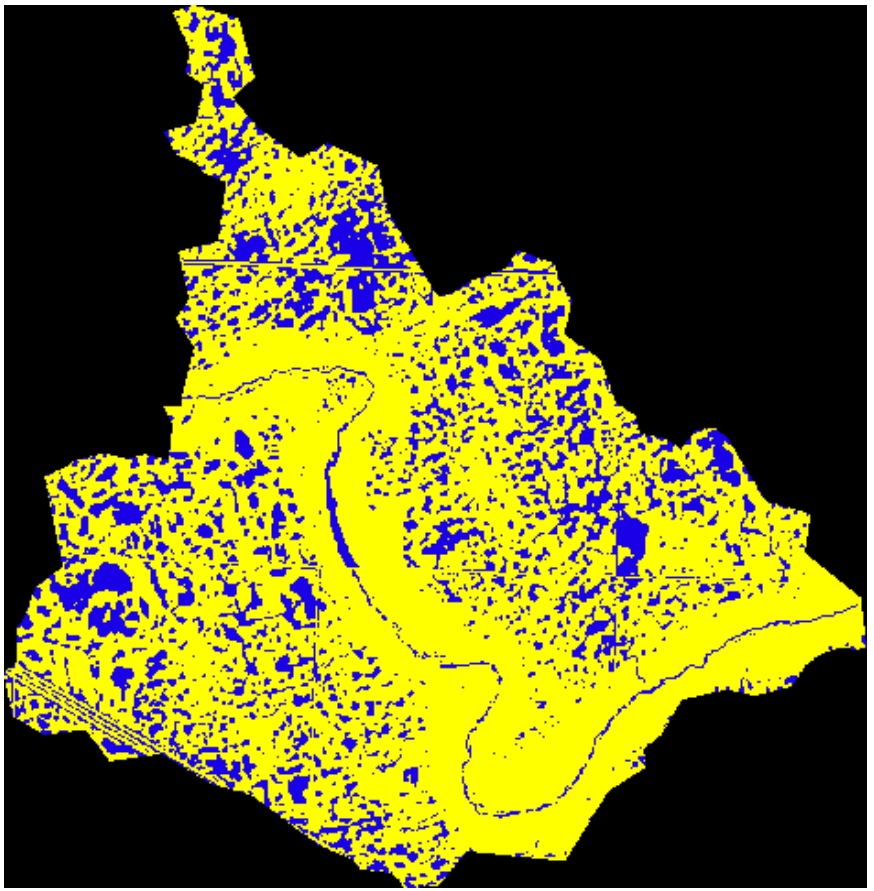
- Drains water from lowest point on DEM
- Only useful for DEMs with streams
- Might not want to use this module, if your objective is to see how streams back up onto the landscape

# Drain – Smith Creek

100 mm added



drained

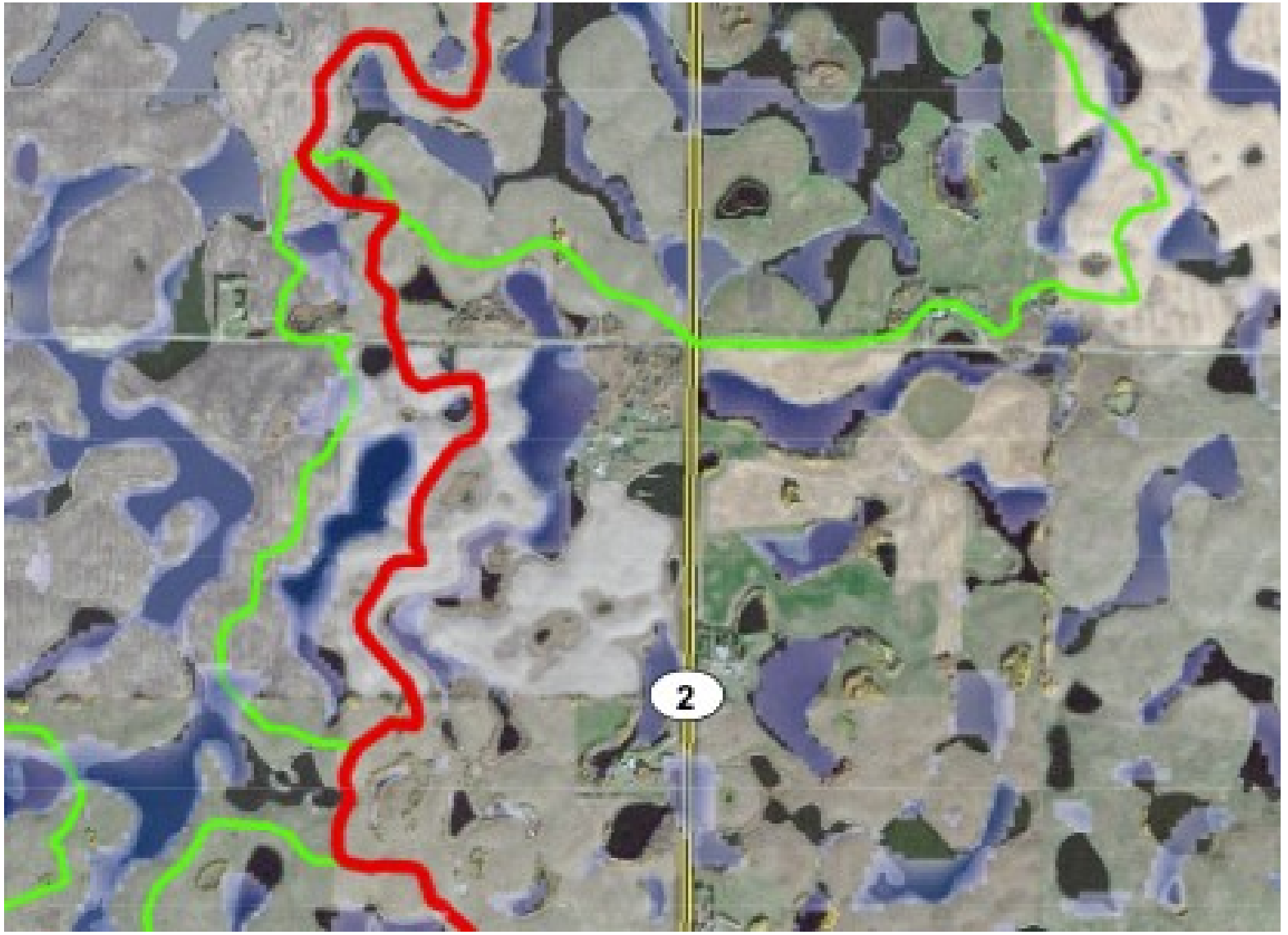


Smith Creek SK, Sub-basin 5, 10m LiDAR DEM

# Validation

- The WDPM has  been validated against remotely-sensed images
- Only validates the spatial distribution of water
- The amount of water added is arbitrary

# WSA simulation
## Highway #2, Fall 2013 – 100 mm added




15 m Ortho-DEM

# Caveats and limitations

1. GPL
2. Amount of water added/removed
3. Limitations of DEMs
4. Effects of roads
5. Execution time

# 1. GNU Public Licence

- The WDPM is Free Open Source Software (F.O.S.S.)
  - Distributed under the GPL version 3
  - Free as in ‘free speech’ as well as in ‘free beer’
- Means 2 things:
  1. You can’t sue the authors, and
  2. You have to distribute the source code if you make the program (or any program derived from it) available to others

# GPL

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

# 2. Water addition/removal

- Should be determined using a physically-based model (CRHM)
- The WDPM doesn’t allow for spatial variability in fluxes
- Can’t lump additions and removals together

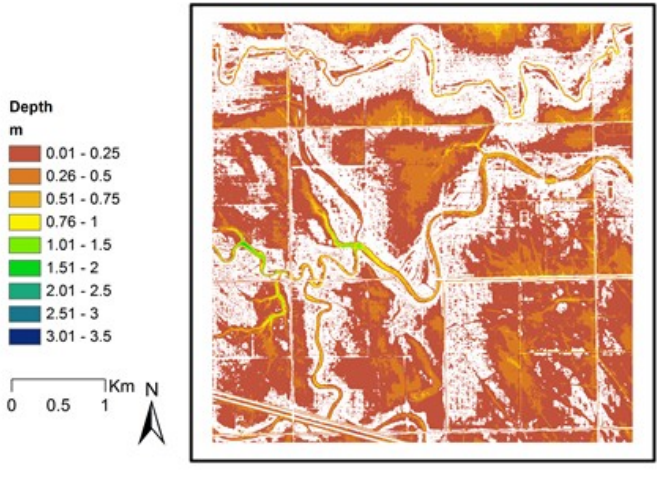
# 3. DEMS

- A DEM only approximates reality
- All changes in water are relative to water stored when DEM was constructed
  - Can’t go below this level
- Horizontal and vertical resolution and accuracy of DEM affect how well the WDPM works

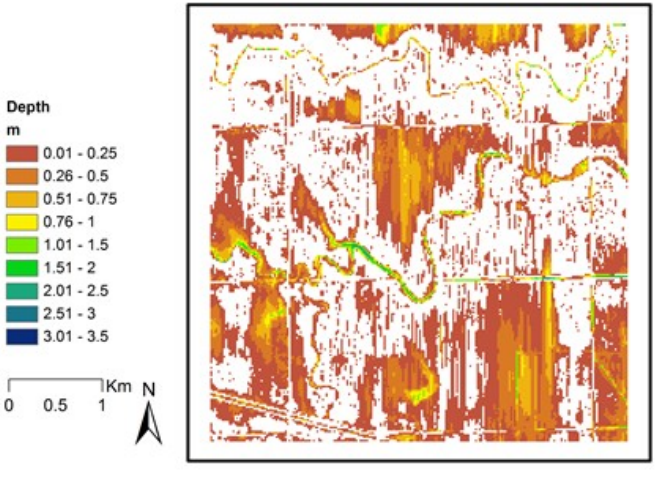
# Effect of DEM resolution

by Rob Armstrong

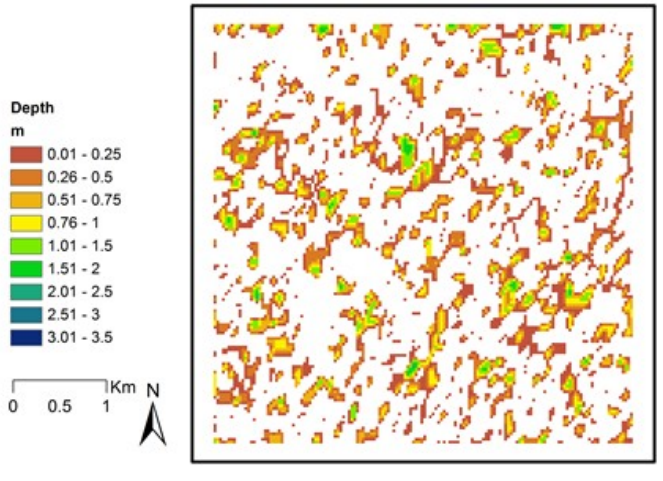
LiDAR 5 m Runoff Distribution Near Winnipeg, Man



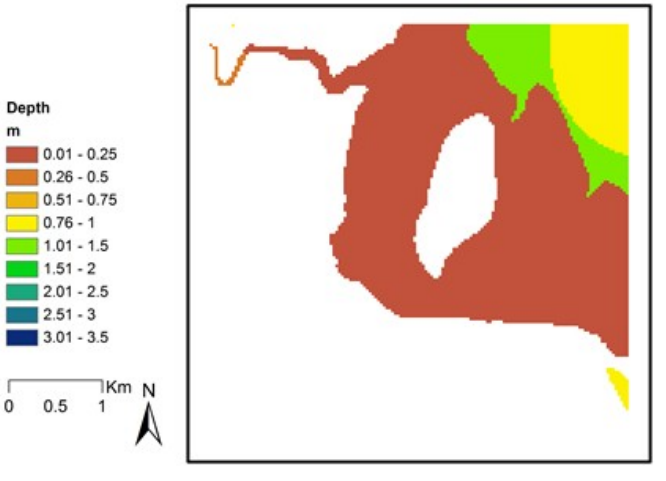

Ortho 20 m Runoff Distribution Near Winnipeg, Man




SRTM 30 m Runoff Distribution Near Winnipeg, Man

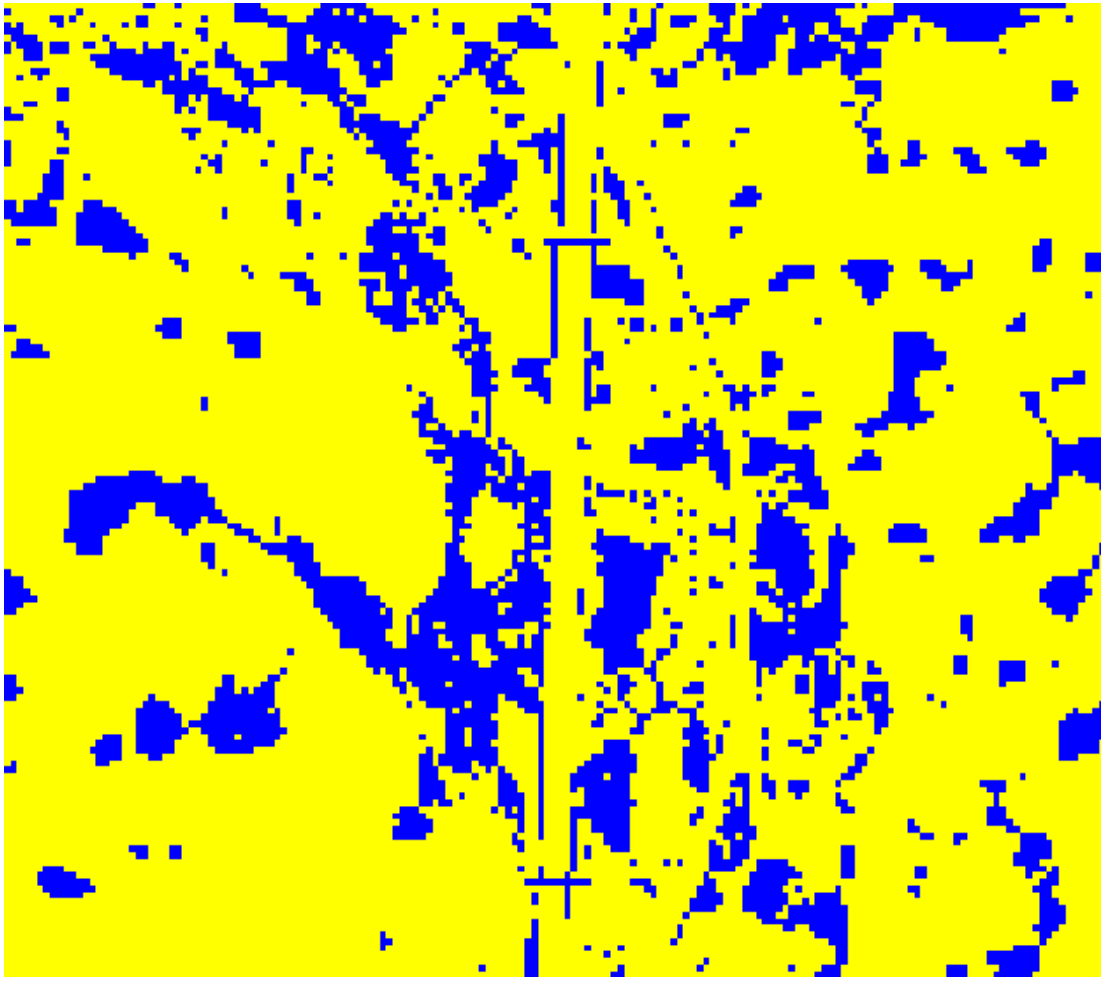



CDED 30 m Runoff Distribution Near Winnipeg, Man



# 4. Roads

- Roads act like dams to runoff
- Have to include culverts and bridges
  - Breach roads in the DEM
  - Requires manual intervention with GIS



Smith Creek sub-basin 1, 5m LiDAR
10 mm added, undrained

# 5. Execution time

- Depends on the module, the volume of water (depth and DEM area) and the tolerance
- Subtract is always the fastest to execute
- Drain is often the slowest

# WDPM recoding

- WDPM needs to be faster
- WDPM has been re-written to use CPUs *and* GPUs for parallel processing
  - Funded by AAFC
- Now has a GUI

# Future developments

- Speed improvement by more efficient use of GPUs
- Coupling the WDPM with CRHM
  - Use CRHM to determine the fluxes of runoff/evaporation
  - Map the CRHM HRUs to the WDPM grid
- The coupled models could solve for precipitation in regions without precipitation gauges, where the water areas can be found by remote sensing

# Acknowledgements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