A Design Model for Subsurface Drip Irrigation in Arizona

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Water Issue

- Subsurface Drip Irrigation
  - Benefits
    - Increased water use efficiency
    - Prevents raising the water table when the level is naturally high
    - Can be used in extensively grown crops such as alfalfa, as well as in row crops such as cotton

Water Issue

- Subsurface Drip Irrigation
  - Problems
    - Determining appropriate depth and spacing of drip line
    - Depth is of special consideration in extensive crops
      - Heavy equipment is driven over the drip line
      - Soil shear strength decreases with increased water content
      - Emitters must be placed deep enough to allow adequate soil strength while still delivering water to the root zone.

Water Issue

- Subsurface Drip Irrigation
  - Problems
    - Typically determination of appropriate dimensions left to trial and error for each new soil
  - Solution
    - Use numerical modeling techniques and soil data to model the wetting pattern from a subsurface drip emitter in the desired soil

Methodology

- Modeling Program: HYDRUS 2D
  - 2 Dimensional model
  - Uses finite element methodology
  - Simulate drip emitter as constant flux between mesh nodes
    - Spacing between nodes determined by geometry of the emitter

Methodology

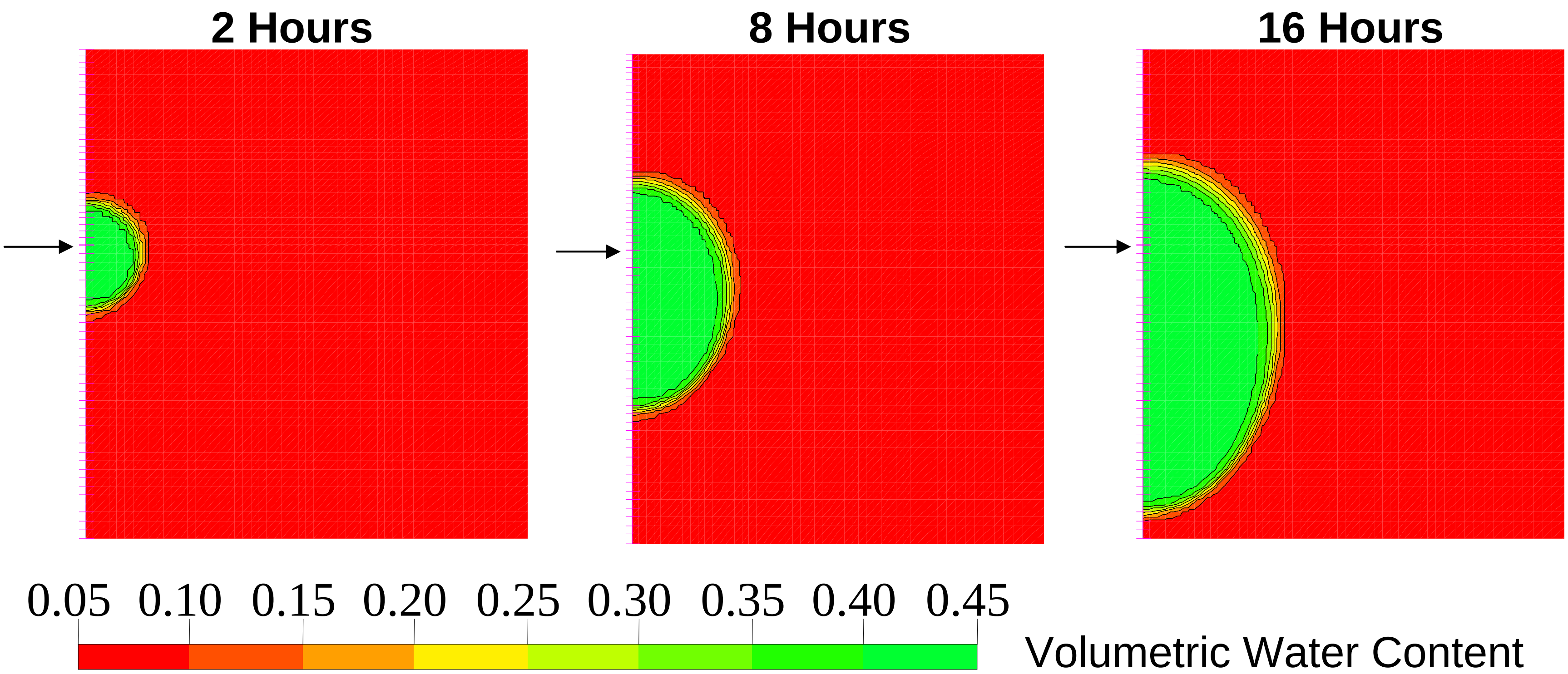
- HYDRUS 2D
  - Initial Condition
    - In the pressure head of the soil
    - Assume irrigation event occurs at a soil volumetric water content of 50% field capacity
    - Initial pressure head is the pressure due the soil matric potential at 50% field capacity
    - Uniform throughout soil

Methodology

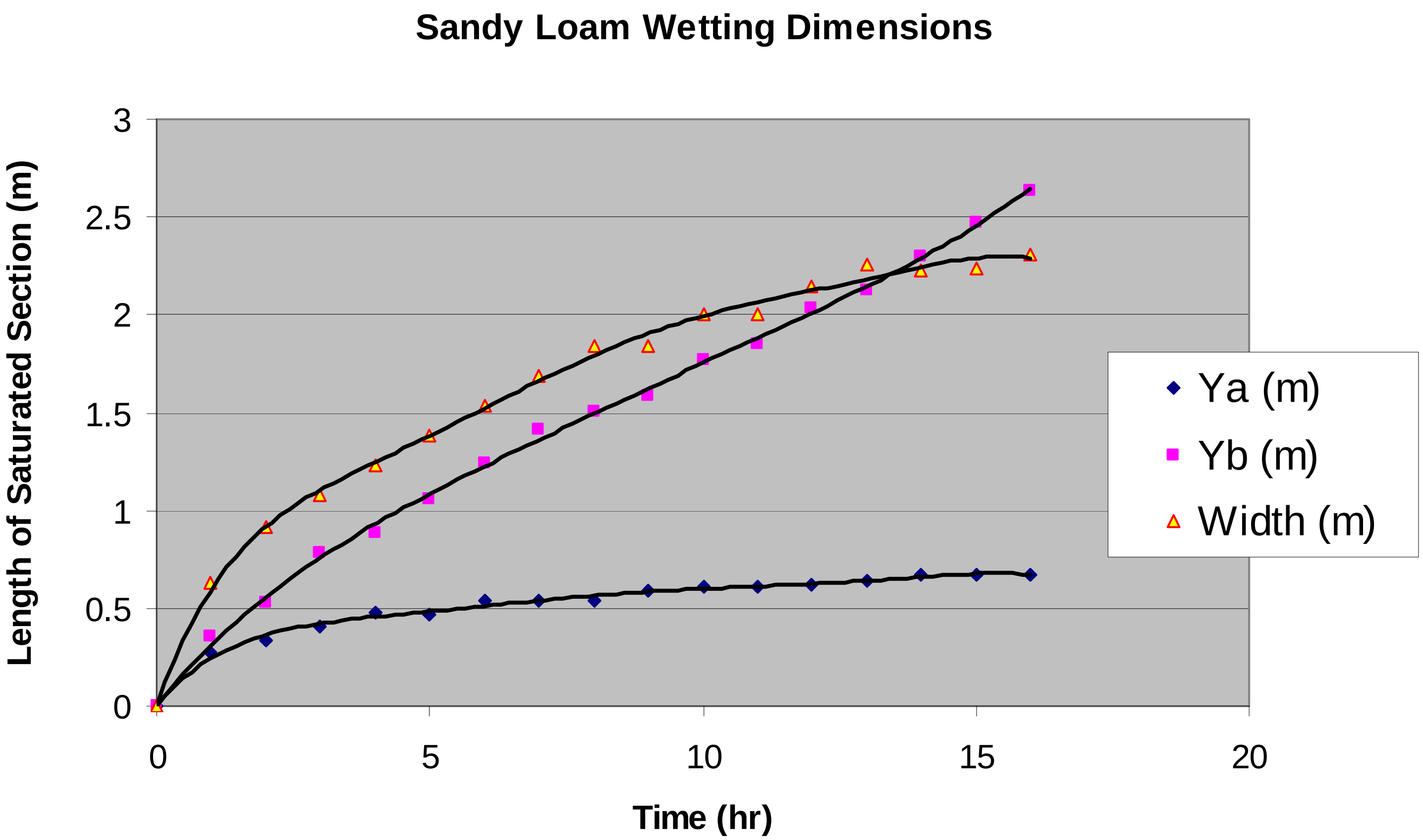
- HYDRUS 2D
  - Initial Condition
    - Sandy Loam -2.5 m
    - Loam -5.0 m
    - Sandy Clay Loam -17 m
  - Boundary Conditions
    - Free drainage across all nodes at the bottom boundary of the model space
    - Constant flux of 15.14 m hr^{-1} $emitter^{-1}$ between two nodes 5 mm apart at the midpoint of the vertical boundary

Results – Sandy Loam

Arrows point to drip emitter, Window is 5 m high and 4.25 meters wide



Results – Sandy Loam



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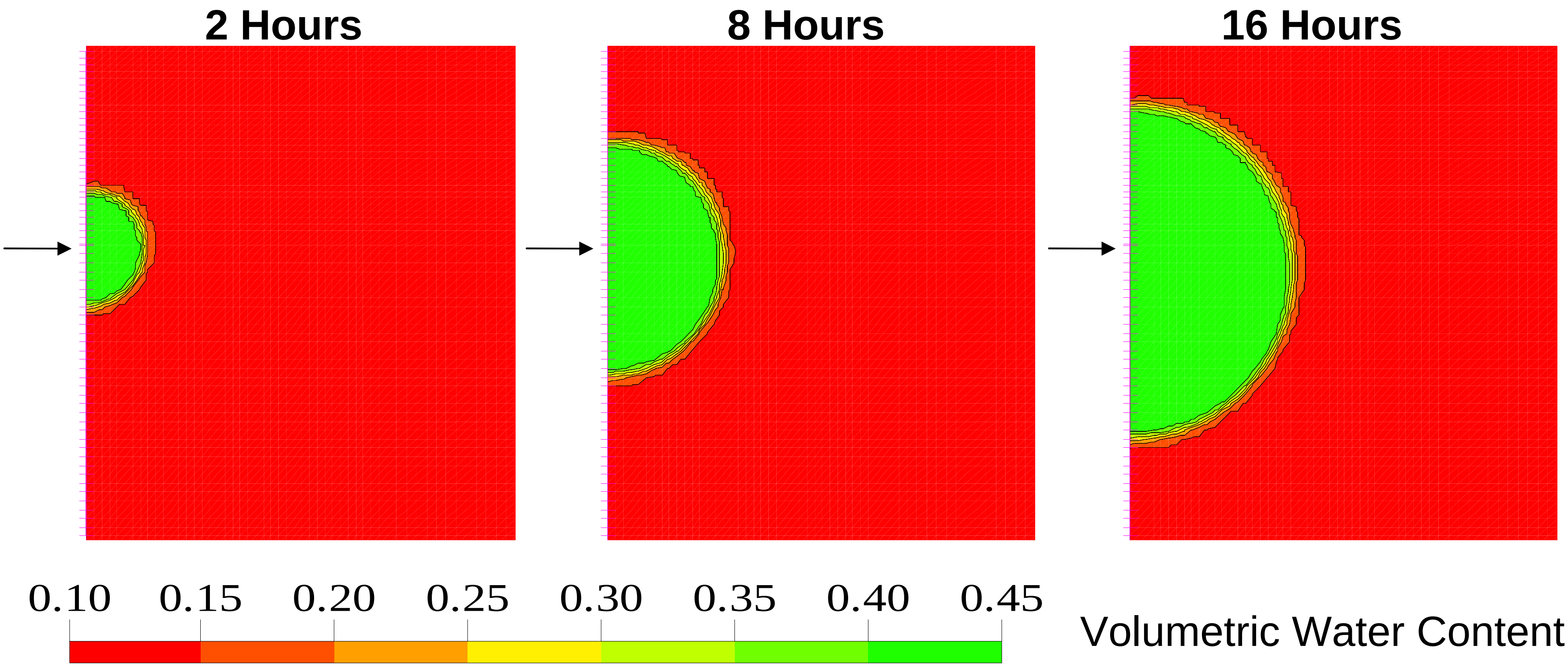

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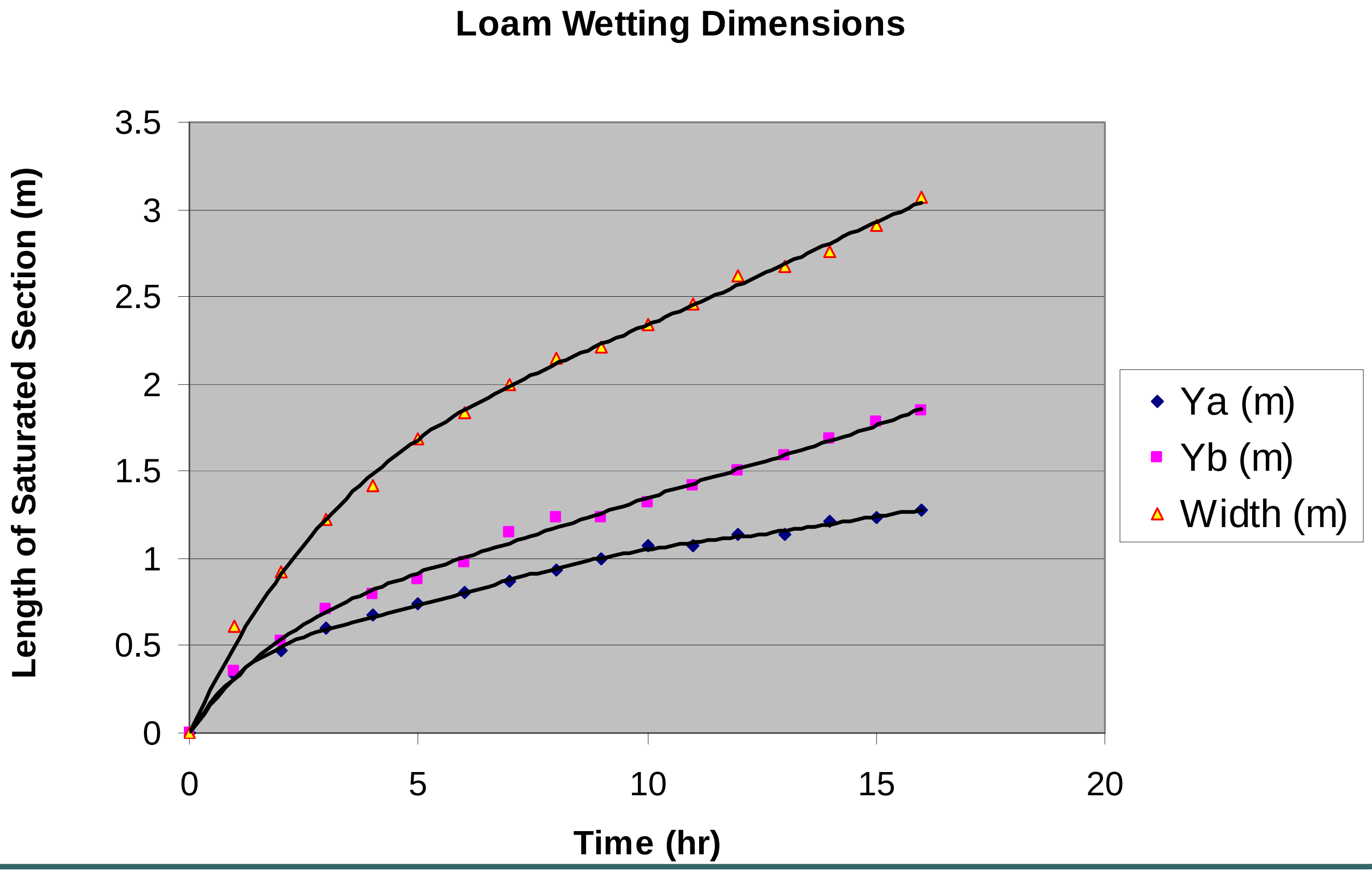

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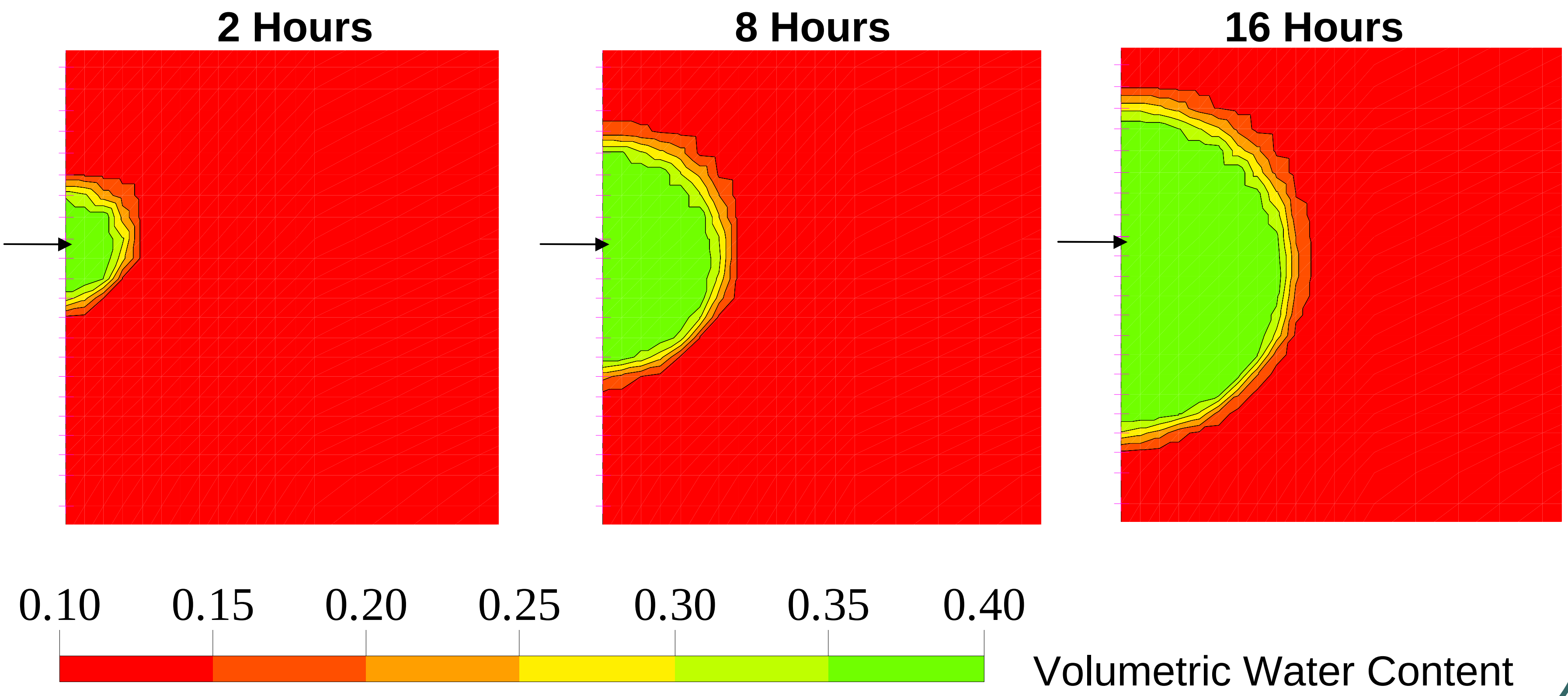

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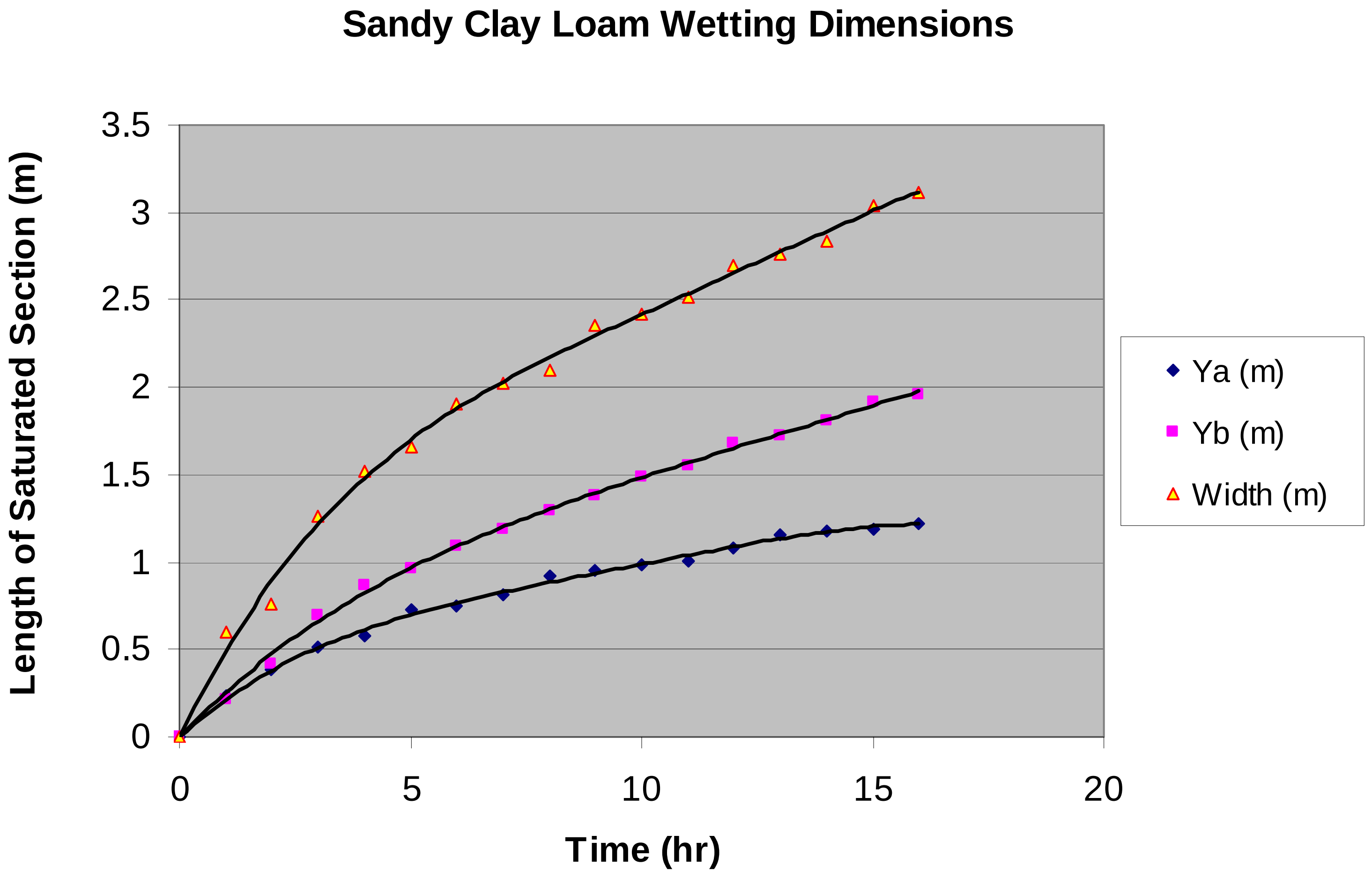
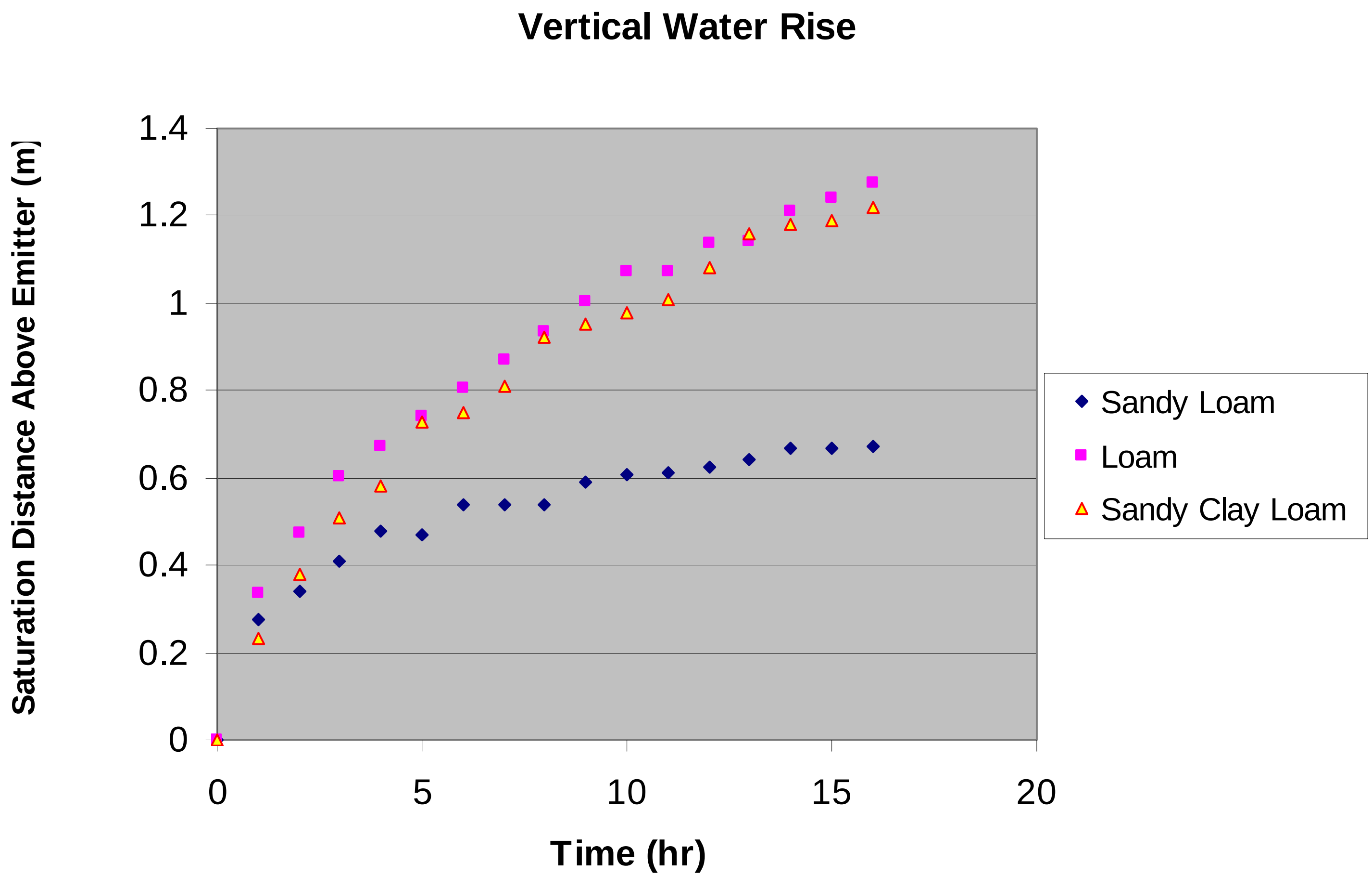


Results – Soils Comparison



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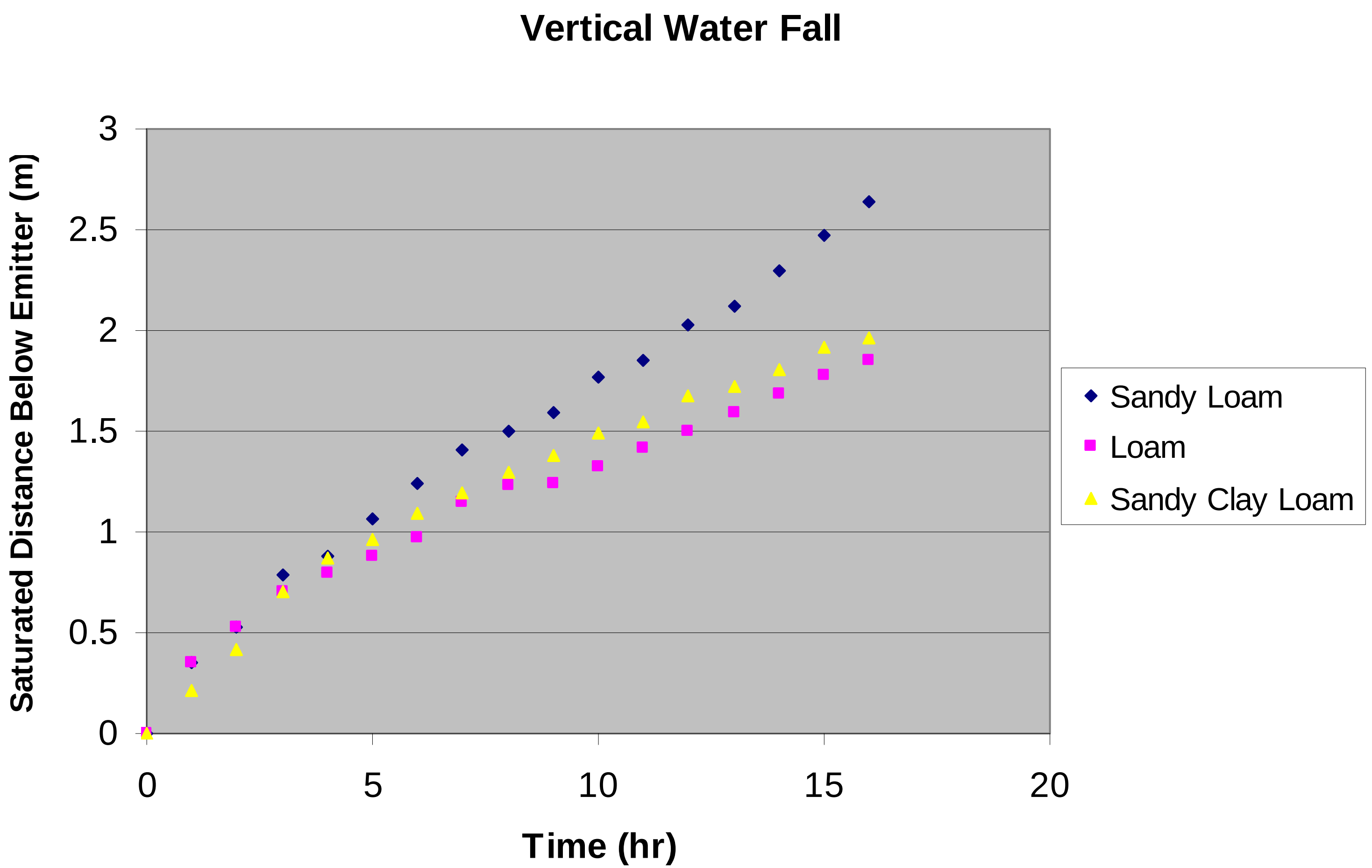

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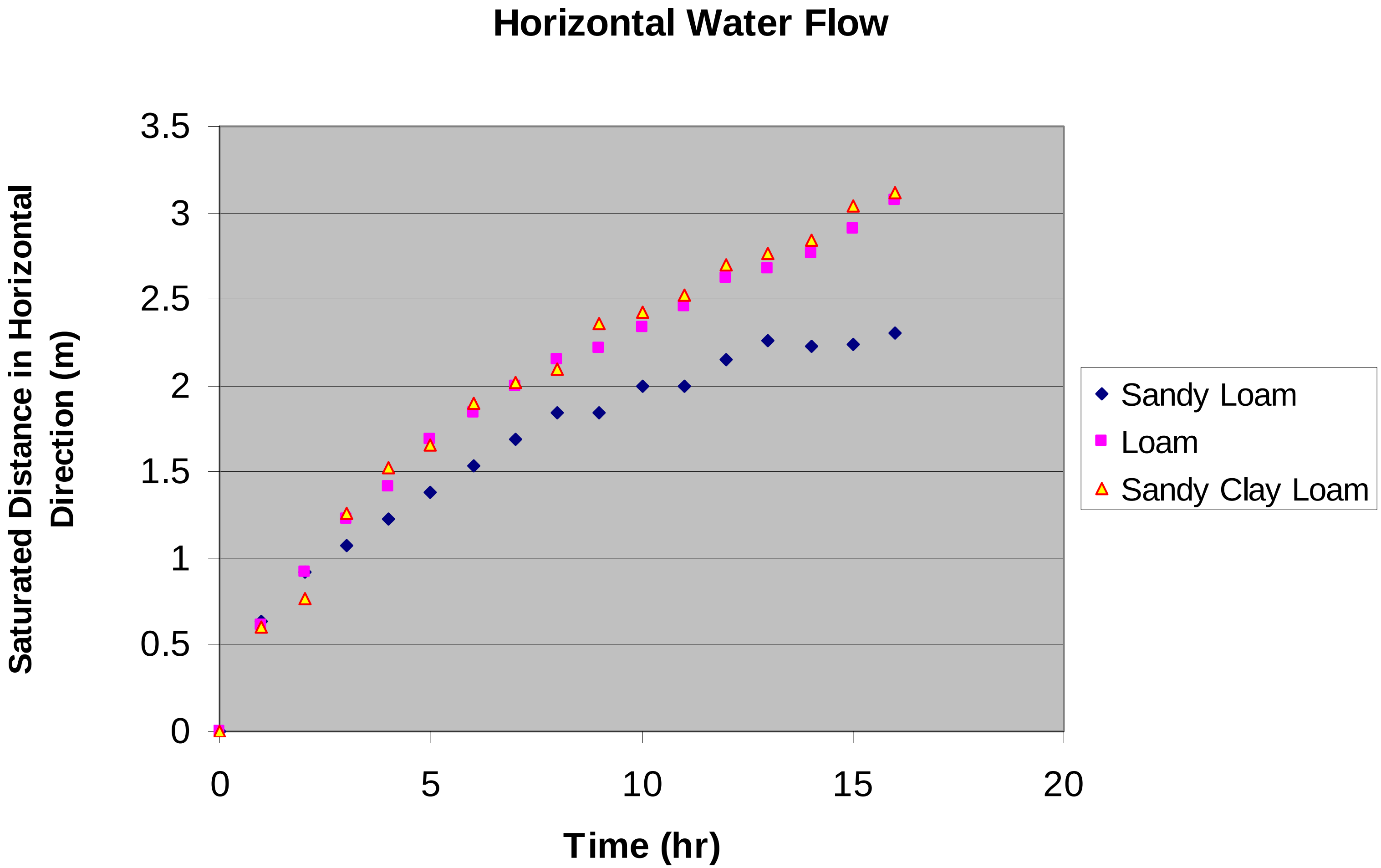

Conclusions

- Results appear accurate, but not compared to experimental data
- Shape of wetting patterns is as expected
- Uniformity of water content isolines and thus accuracy decreases with less dense mesh node structure
- Numerical modeling techniques are a very promising and useful tool when applied to the design of subsurface irrigation systems

Acknowledgements

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Questions

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