Toward a better understanding of water flow dynamics in tile drained fields under drainage water management

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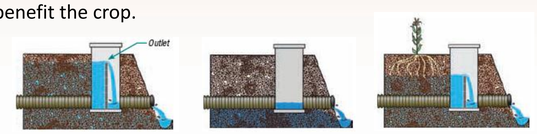
Drainage Water Management

Numerous field studies have demonstrated the potential for the Drainage Water Management (DWM) conservation practice in reducing agricultural drainage outflow to the surface water and thereby decreasing the flushing of nitrogen from agricultural fields . Yet, more field experiments that use state of the art instrumentation should be conducted for a better understanding of where nitrate goes.

Drainage water management: uses a water control structure in a tile drainage system to raise the drainage outlet during parts of the year when a higher water table will not harm and may benefit the crop.



The outlet is raised after harvest to reduce nitrate delivery.

The outlet is lowered a few weeks before planting and harvest to allow field to drain.

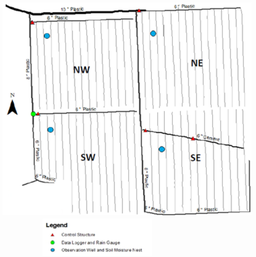
The outlet is raised after planting to potentially store water for crops.

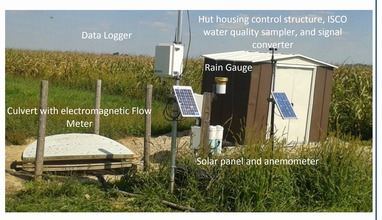
Project Goals

- Determine the impact of drainage water management on drain flow.
- Quantify the impact of drainage water management on both lateral and vertical seepage losses.

Field Methods

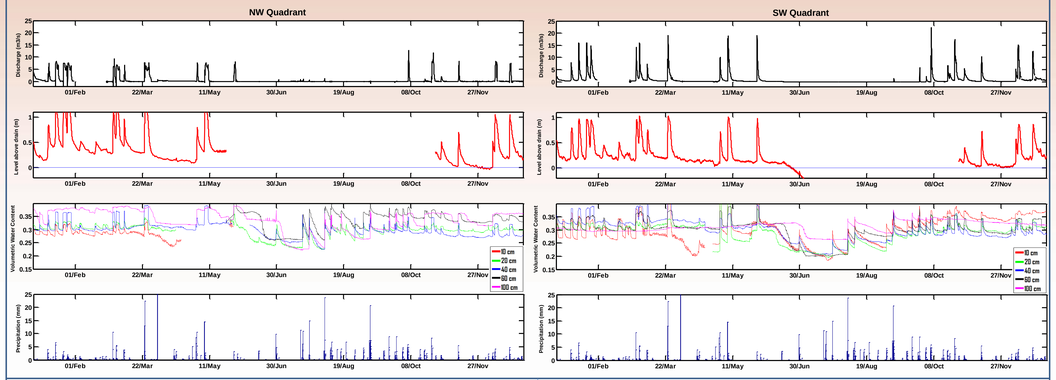
- **Site:** Davis Purdue Agricultural Center (DPAC), eastern Indiana. The field has 4 quadrants: Two are subject to DWM (NW, SE), and two are left to drain freely (NE, SW).
- **Drain flow measurement:** Electromagnetic flow meters
- **Water table monitoring:** 2 meter deep wells, equipped with pressure transducers
- **Soil Moisture Measurement:** Nests of Decagon 5TM dielectric permittivity sensors at 5 depths





A year long of hydrologic monitoring

The monitoring has been installed and started operation at the end of 2011. The following two figures show 2012 data of two paired quadrants. NW is under drainage water management and SW is left to drain freely.



Field Response to single events

(Preferential flow & Variable Impermeable layer)

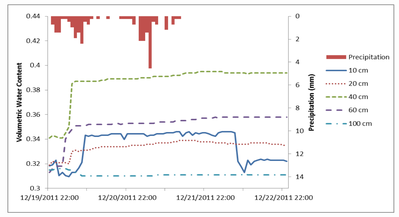


Figure 1 – South West Quadrant – Event Starting at 12/19/2011

Above, the 40 cm and 60 cm soil moisture sensors responded earlier and with a greater magnitude to precipitation than the shallower sensors. This displays evidence for preferential flow that may occur at our site.

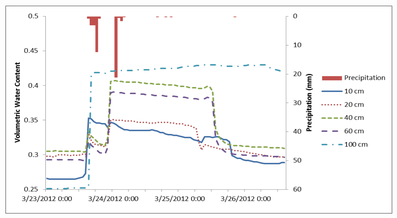
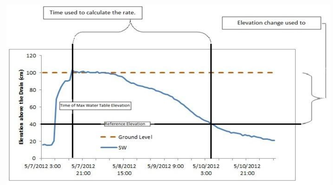


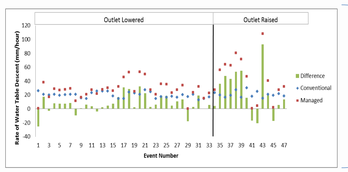
Figure 2 – North East Quadrant – Event Starting at 3/23/2012

Here the 100 cm sensor of the NE quadrant responded quickly to a precipitation event, while in the SW quadrant the 100 cm sensor does not react to precipitation. It is most probable that the sensor does not react to precipitation because it lies in a restrictive layer.

Water Table Recovery Study

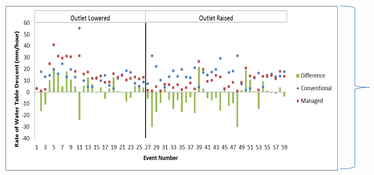
- Why? : To investigate if DWM lengthens the time for the water table to fall after a precipitation event.
- The rates of descent were examined for 47 and 59 events for the Eastern and Western quadrant pairs, respectively.





Eastern Quadrants

Diff= Man- Conv



Western Quadrants

Diff= Man- Conv

Water Table Recovery Study cont.

- As shown in the figures, the rate of water table decline in the western pair did decrease with management (more negative differences).
- This is expected, because the water table height above the outlet is higher in the freely drained case.
- In the eastern quadrant, differences were primarily positive, indicating that water is lost more quickly with management.
- This suggests that lateral or deep seepage from the SE quadrant during management may be a more important flow pathway than previously thought.

Mean Differences (Managed - Conventional) of rates of water table decline

	Western Differences (mm/hr)	Eastern Differences (mm/hr)
Lowered Outlet	3.09	7.66
Raised Outlet	-5.02	23.71
Percent Change	-262%	210%

Conclusion & Future Work

- Our preliminary data analysis suggests that lateral and vertical seepage may be more important at this field scale than originally suspected.
- As a continuation of this investigation we plan to deploy transects of observation wells at the interface of the Managed/Conventional fields to monitor the water table profile at the quadrant interfaces.
- Nests of piezometers will be installed in managed and conventional quadrants at three different depths so that the difference in pressure head, if it exists, may be used to calculate the vertical seepage.
- The field experiment may be complimented by numerical modeling.

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