# Understanding and controlling hillslope hydrology to assess water quality within sustainable dairy manure management

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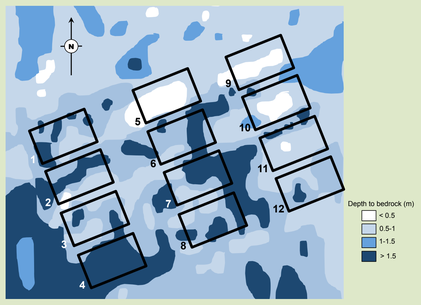
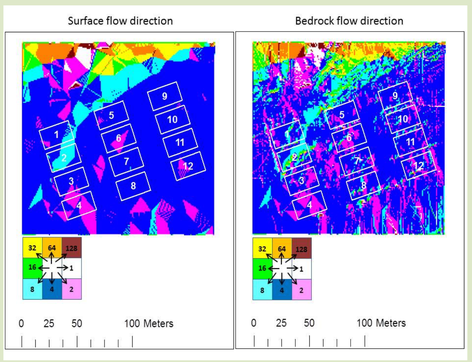
## Landscape variability

- How do we explain the variability observed between plots?
- Gathered ground penetrating radar (GPR) data of the subsurface and bedrock
- Modeling surface and subsurface water flow paths using GIS and TWI modeling

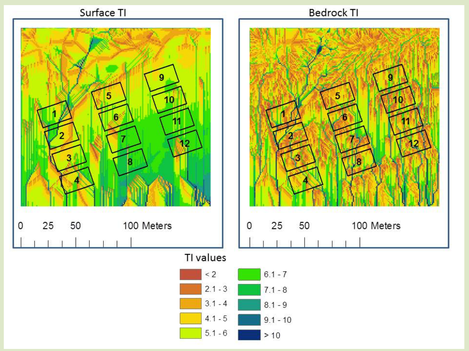



GPR depth to bedrock map




Flow direction calculated in ARCGIS using the bedrock topography and DEM of the site

Observed color variation in corn July 2012- related to soil depth.



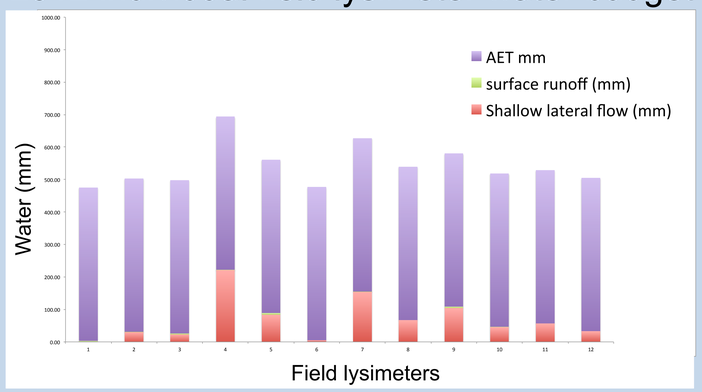

Topographic wetness index calculated in ARCGIS using the same GPR and DEM layers

- Recorded 19 runoff events, no events occurred in March, April, July and August
- 2012 was punctuated by Hurricane Sandy at the end of October (10-28-12)

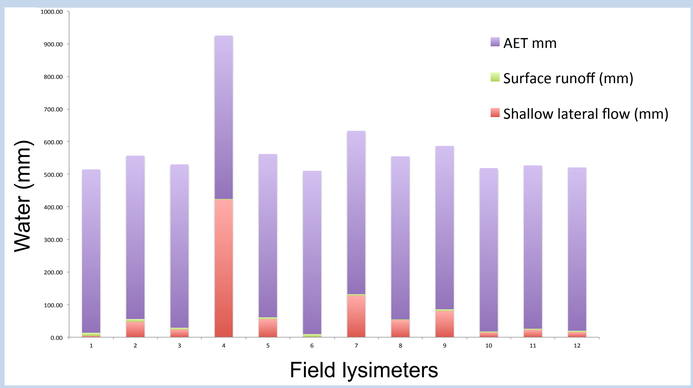
- Recorded 30 runoff producing events, unlike 2012, events occurred in all months of the year
- Majority of plots for both years produced more subsurface flow than overland flow

## Where is the water going?

2012 individual field lysimeter water budget

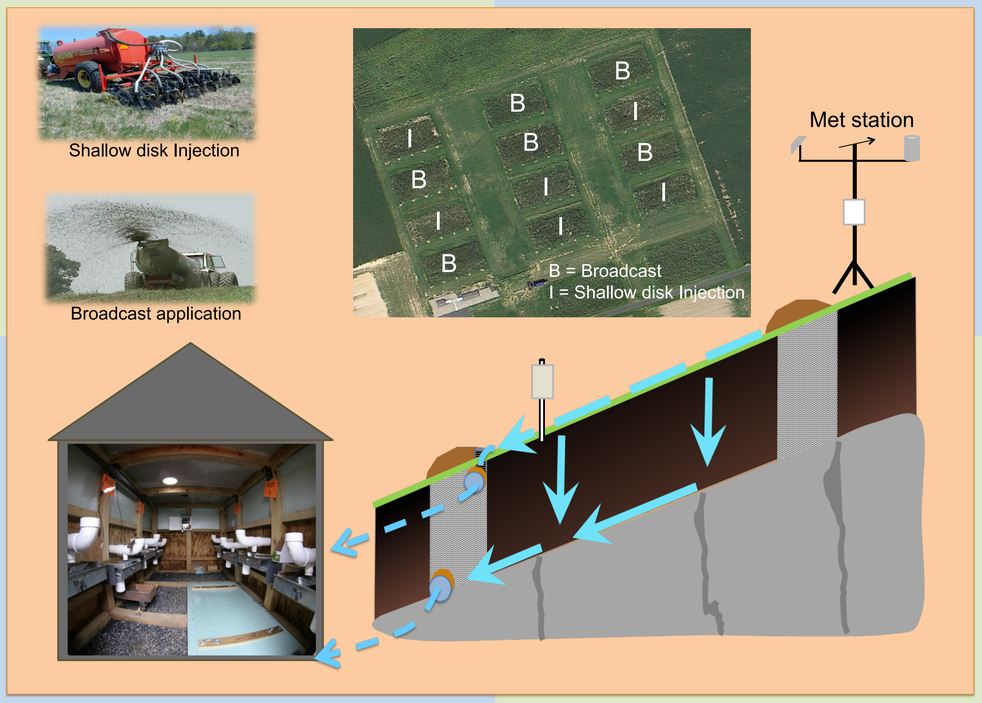



2013 individual field lysimeter water budget

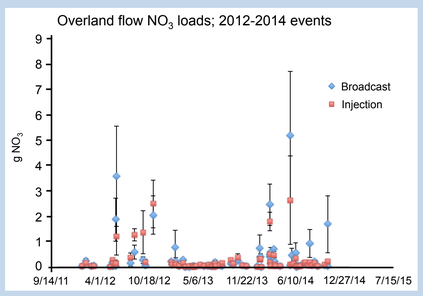



Not included above: soil storage component

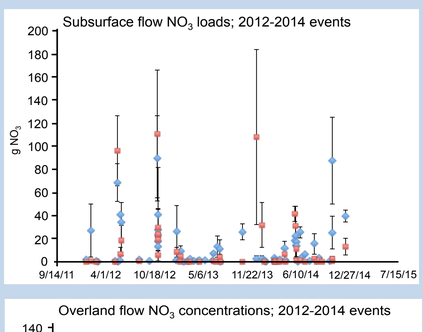
- Estimate using total soil volume numbers for each plot, calculated using GPR, DEMs
- Using this value estimate how much water is being retained in the soil system

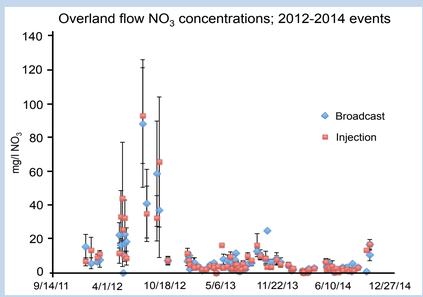


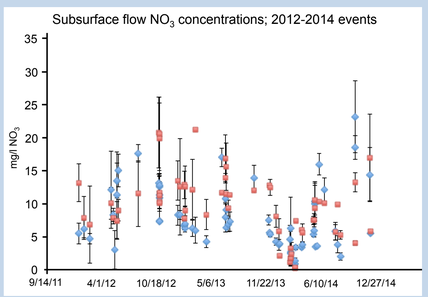

## Nitrogen in water and soils

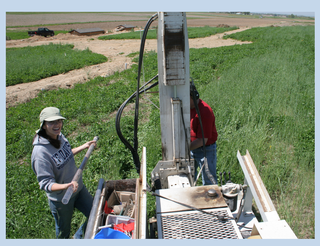



- Where is the $NO_3$ moving throughout the seasons?
- Higher $NO_3$ concentrations in 2012
- Fewer precipitation events in spring/ summer of 2012
- How can $NO_3$ loads and concentration data support soil concentrations?
- Greater concentrations in soil $NO_3$ after corn silage harvest

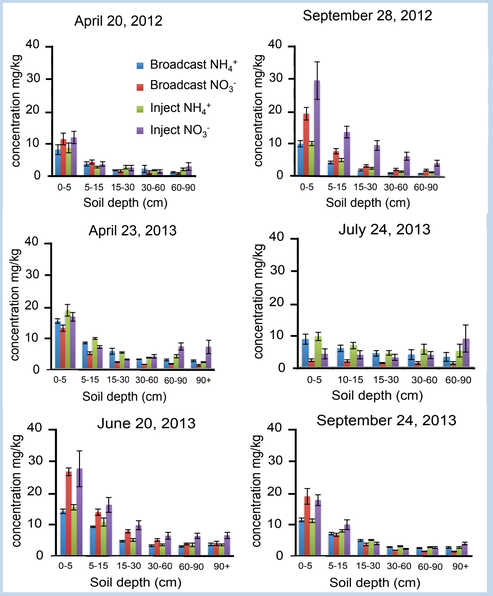


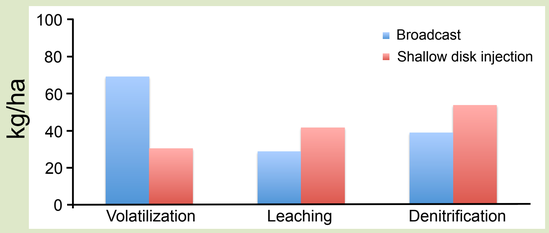
- Increased soil sampling in 2013
- Seasonal trends and fluctuations in soil $NO_3$ and $NH_4$ reflect corn growing season



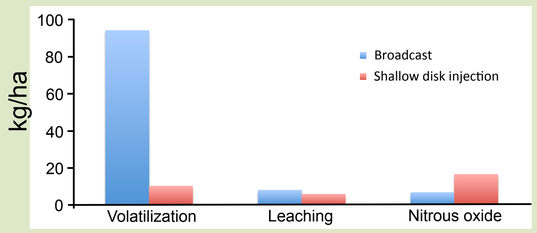

## Integrated Farm System Model

- Increase the scale of analysis
- Investigate environmental losses on an annual bases averaged over 25 years of weather
- Can consider whole farm economics

IFSM simulated results:

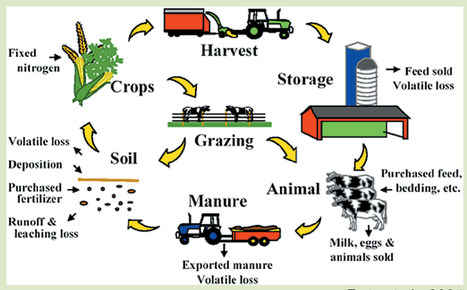



Measured data: Oct 2012- Oct 2013:




- Simulated results provide total denitrification losses
- Measured data: $N_2O$-N losses
- Volatilization trends similar

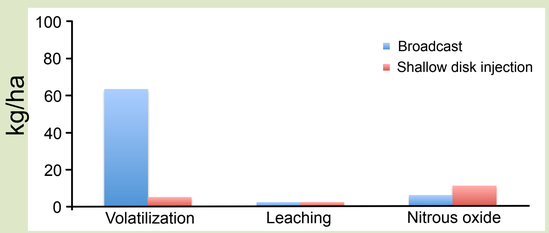
IFSM




Rotz et al., 2004

- Options to investigate other farm management practices: manure storage and manure application timing and frequency

Measured data: April 2012- Sept 2012:




Economics: similar cost for both strategies

| | Broadcast | Inject |
|---|---|---|
| Cost parameter | $/cow | |
| Equipment | 541 | 541 |
| Facilities | 754 | 754 |
| Labor | 439 | 439 |
| Custom operation cost | 31 | 32 |
| Net purchased feed and bedding cost | 595 | 588 |
| Milk and animal sale income | 4041 | 4041 |
| Net return to management | 647 | 653 |
| Standard deviation in net returns | 161 | 165 |