Title

CON2: Management of Soil Moisture and Nitrate Transport Using Sensor Networks and Feedback Control

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Authors

Yeonjeong Park
Juyoul Kim
Jose Saez
et al.

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Management of Soil Moisture and Nitrate Transport Using Sensor Networks and Feedback Control

Yeonjeong Park[1], Juyoul Kim[1], Jose Saez[2], and Thomas C. Harmon[3]

[1]UCLA Civil & Environmental Engineering, [2]Loyola Marymount University Civil & Environmental Engineering, [3]UC Merced School of Engineering

Introduction: Sensor Networks to Nitrate Monitoring for Protecting Groundwater Quality

Reclaimed Water for Irrigation in Palmdale, CA

Nitrate Pollution in Groundwater

- Reclaimed water is recycled for agricultural irrigation
- Nitrate in the reclaimed water serves as a fertilizer, but has potential compromise underlying groundwater quality
- The objective of this project is *to systematically develop sensor networks and design a control system to monitor and respond to nitrate propagation in soils*

Problem Description: Determine the Best Management Strategy for Pollution Prevention

Irrigation Control and Management in Support of Wireless Sensor Networks

- A *control algorithm* is required to maximize the reclaimed water input subject to groundwater protection.
- Real-time *parameter estimation* of the simulation models is needed using on-line data from sensors
- Due to the *spatial variability* of soil properties, parameter estimation for the simulation models requires *geostatistical treatment* (e.g., semivariogram and kriging)

- Novel *multi-level sensing stations (pylons)* are deployed at varying spatial densities over a portion of a 30 acre test plot.
- Each *pylon monitors conditions* (temperature, moisture and nitrate distributions) in its own 1-D setting
- Pylons *communicate with other nearby pylons* to delineate dissolved nitrate distribution in time and space

Proposed Solution: Near Real-Time Parameter Estimation and System Control
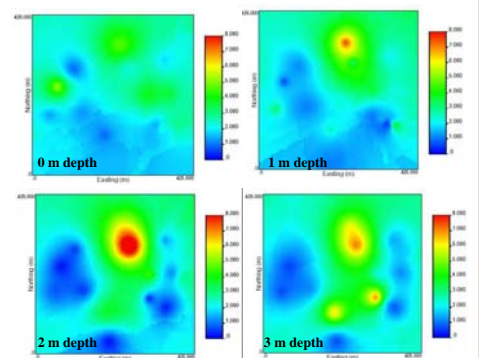
### Feedback Control for Optimal Irrigation
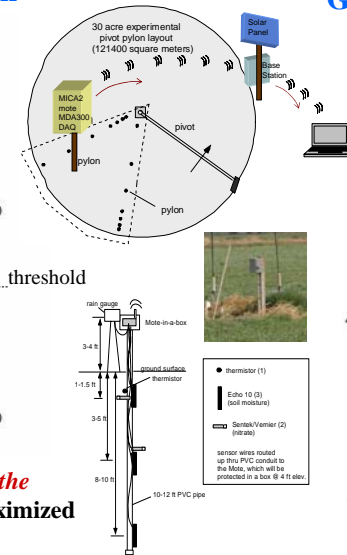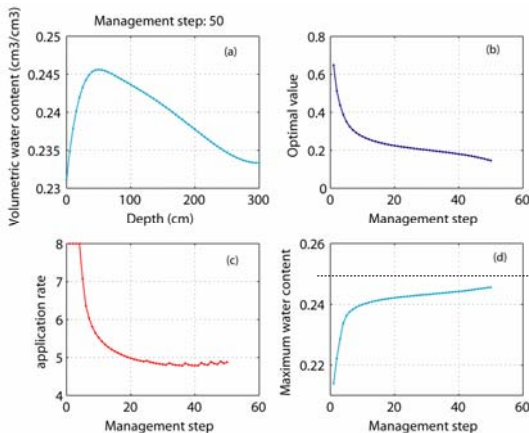
Geostatistical Parameter Estimation
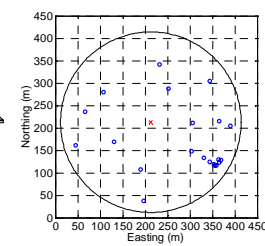
Soil samples have been collected *to observe spatial variability* throughout the research site.

- The objective of irrigation control is *to determine the application rate* such that wastewater usage is maximized and the nitrate regulatory level is not violated.
- The control scheme is executed by using the *on-line data feedback* from the pylons and providing control to the watering pivot.

0 m depth   1 m depth

2 m depth   3 m depth
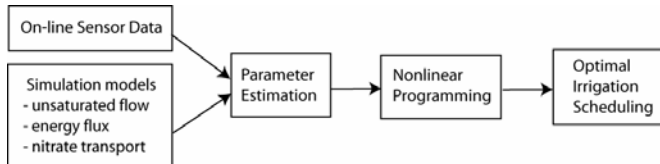
- Spatial distribution of hydraulic conductivity is visualized in contour maps created by *kriging* methods.

- We can then estimate soil properties at unsampled locations with geostatistical realizations.

Control Scheme Combined with Parameter Estimation