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Title

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Publication Date

2006-06-26

Adaptive Management of Irrigation with Feedback Control to Avoid Groundwater pollution by Nitrate

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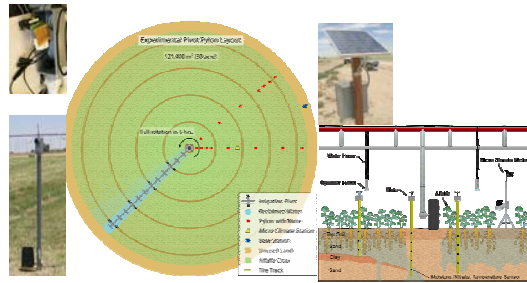
1. Reclaimed Water is Reused for Irrigation



Agricultural Irrigation with Secondary Effluent from Palmdale Reclamation Plant

The Secondary Effluent is Irrigated with Center-pivot Sprinkler System

4. Embedded Networked Sensing System in Palmdale, CA



Drawing by Jason Fisher

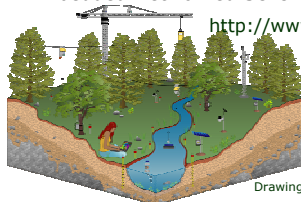
2. But, the problem is ...

Nitrate in the reclaimed water has **the potential to pollute** underlying groundwater

3. Solutions are ...

- **Observations** to identify our system
 - Embedded Networked Sensing (ENS)

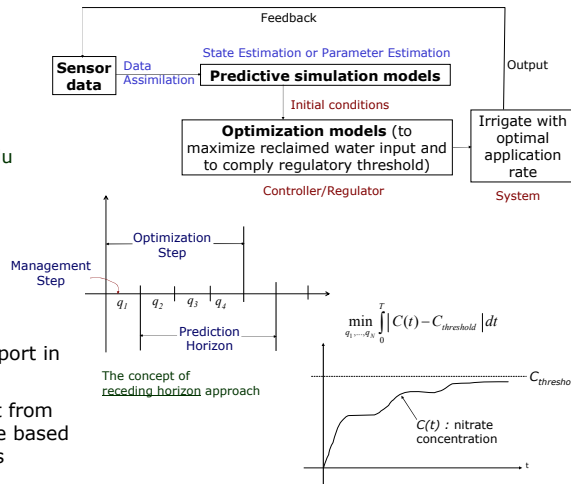
<http://www.cens.ucla.edu>



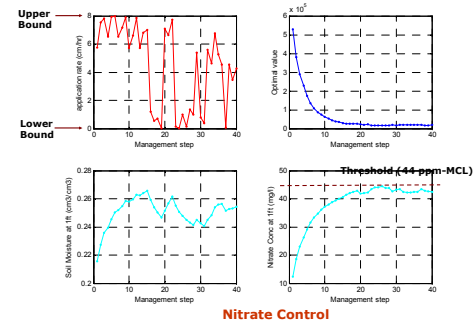
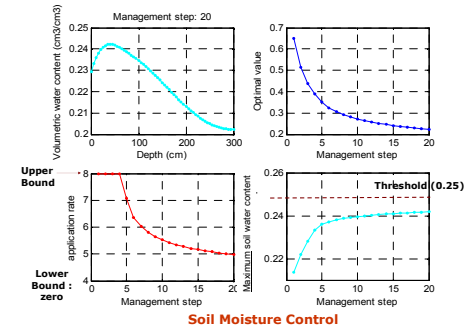
Drawing by Jason Fisher

- **Prediction models** to forecast nitrate transport in subsurface system - Simulation models
- **Adaptive Control methodology** to prevent from nitrate pollution by adjusting the irrigation rate based on current observations and simulation models
 - Receding Horizon Feedback Control

5. Adaptive Control - Receding Horizon Feedback Control (RHFC)



6. Results of Adaptive Control



7. Conclusions

Adaptive control using **sensor networks** and **Receding Horizon Feedback Control** is efficient and promising to identify a system, to control irrigation process, and eventually to **prevent groundwater pollution** while realizing the benefits of reclaimed water.

Acknowledgement
 UCLA's Center for Embedded Networked Sensing (CENS) under cooperative agreement #CCR-0120778 with the National Science Foundation is gratefully acknowledged.

