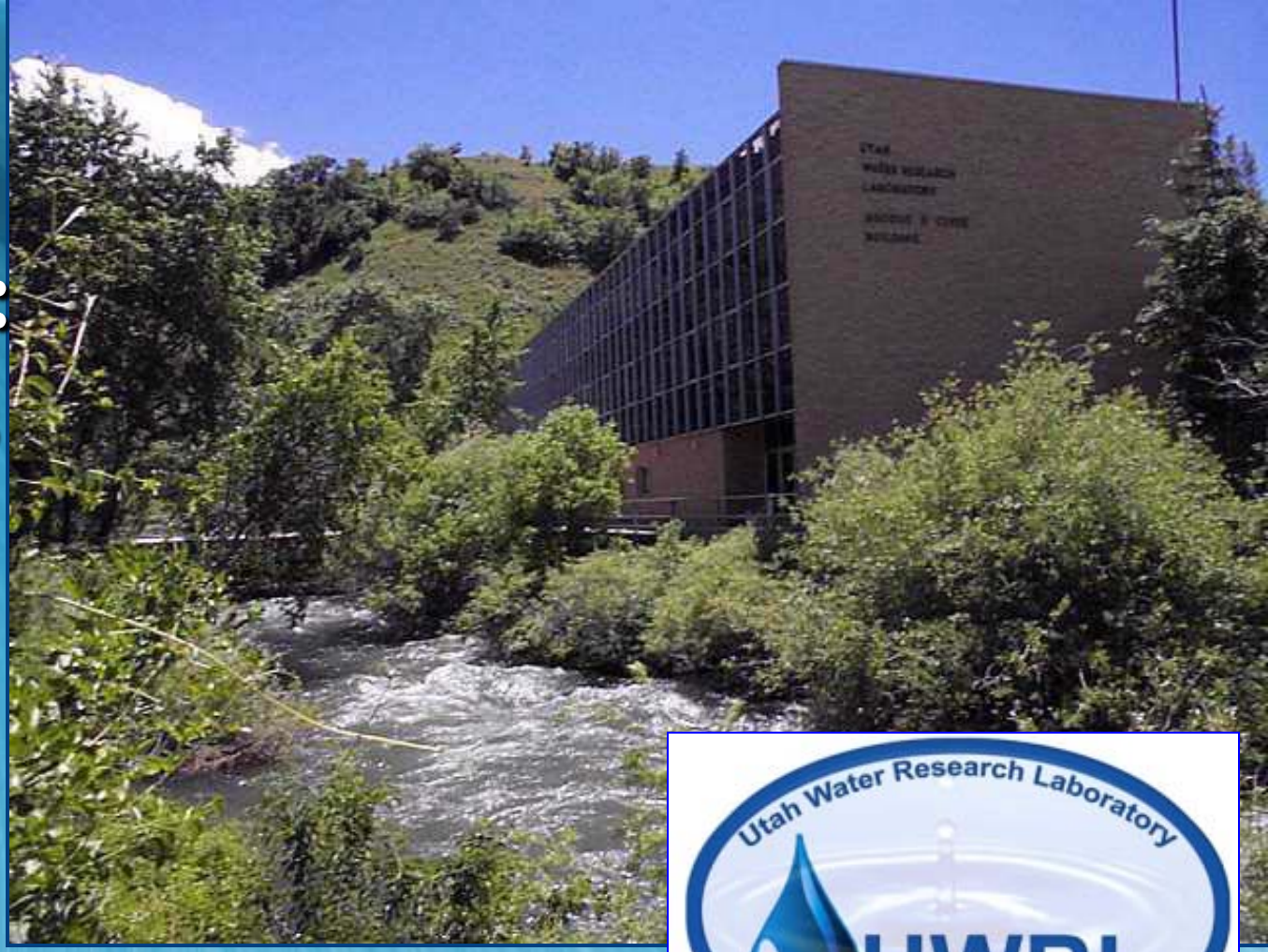
Utah Water Research Laboratory: Capabilities and Strengths



Mac McKee, Director
Utah Water Research Laboratory
and Utah Center for Water Resources Research

College of Engineering

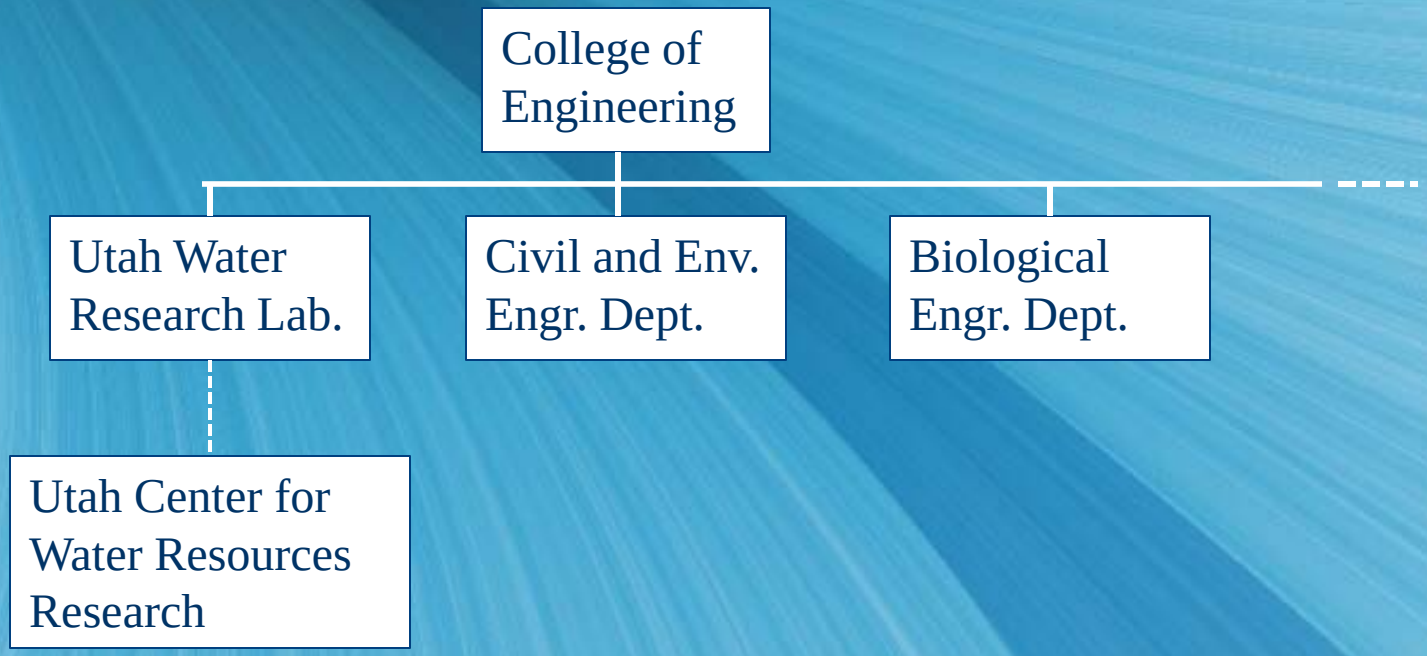
UtahStateUniversity

Overview

- UWRL Facts: history, faculty, facilities
- Areas of particular strength
- A few examples

UtahStateUniversity

UWRL Facts…


College of Engineering
Utah Water Research Lab.
Civil and Env. Engr. Dept.
Biological Engr. Dept.
Utah Center for Water Resources Research

UWRL Facts…

Utah Water Research Laboratory

- Oldest and largest of 54 university-based water research centers
- Research expenditures: ~ $9 to ~$12 million/year
- Located in the College of Engineering
- Research and training projects…

UtahStateUniversity

UWRL Facts…

Research and training projects in:

- all 29 Utah counties,
- several US states, and
- historically, more than 70 countries

Personnel:

- ~30 faculty
- ~20 research engineers/scientists/post docs/etc.
- ~70 grad students, ~40 undergrads
- ~10 support staff

UWRL Facts…

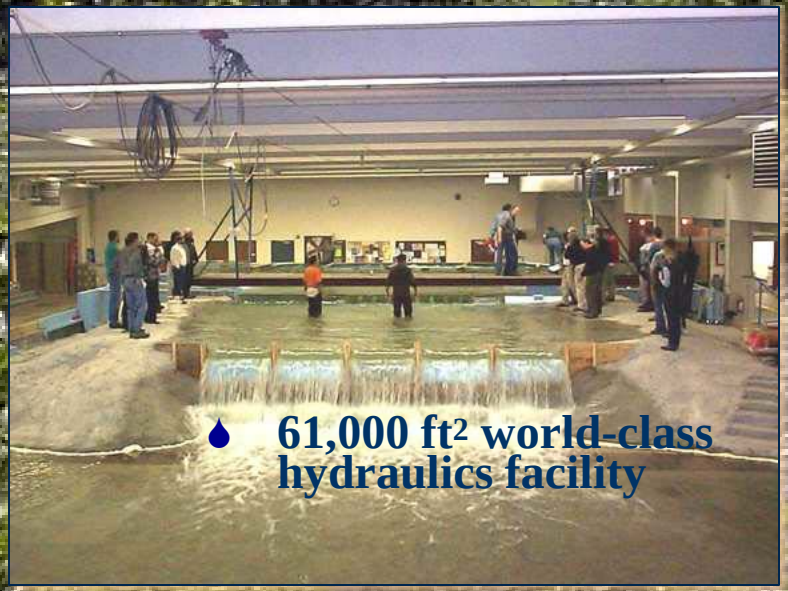
UWRL Faculty:

- water resources engineers(hydrology, hydraulics, planning/management, remote sensing, etc.)
- environmental engineers (water quality monitoring/modeling/management, hazardous waste mitigation, air quality, water/wastewater, etc.)
- irrigation engineers (on-farm, system, drainage, etc.)

co-star of the latest Hairy Potter movie?

UWRL History and Facilities:

- Created in 1959 (Gov. Clyde, Dean D.F. Peterson, state Legislature)
- UWRL building dedicated in December, 1965
- Expanded in 1979-80 to address environmental issues in water resources
- Added new hydraulics modeling building in 2009
- 113,000 ft^2 total floor space



- 61,000 ft^2 world-class hydraulics facility

- 11,000 ft^2 state-of-the-art environmental quality labs

UWRL Centers…

Research units within the UWRL:

- AggieAir™ Flying Circus
- Institute for Dam Safety Risk Management
- Institute for Natural Systems Engineering
- International Irrigation Center
- Utah Center for Hydrologic Information and Computing
- Utah On-Site Wastewater Treatment Training Program
- Utah Center for Water Resources Research

UWRL Areas of Strength…

Bioprocess Engineering

Hazardous/Toxic Waste
& Air Quality

Water Quality
Engineering

Water Resources Planning
& Management

Utah Water Research Laboratory
UWRL

Groundwater & Contaminant
Hydrogeology

Hydrology

Fluid Mechanics
& Hydraulics

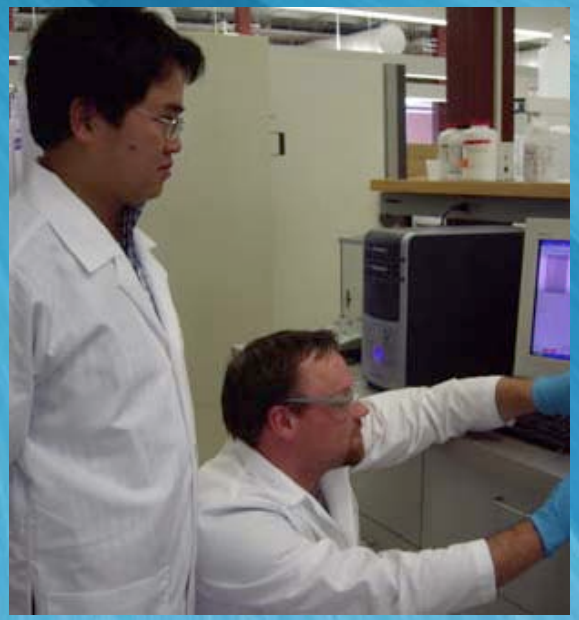
Water Education &
Technology Transfer

UtahStateUniversity

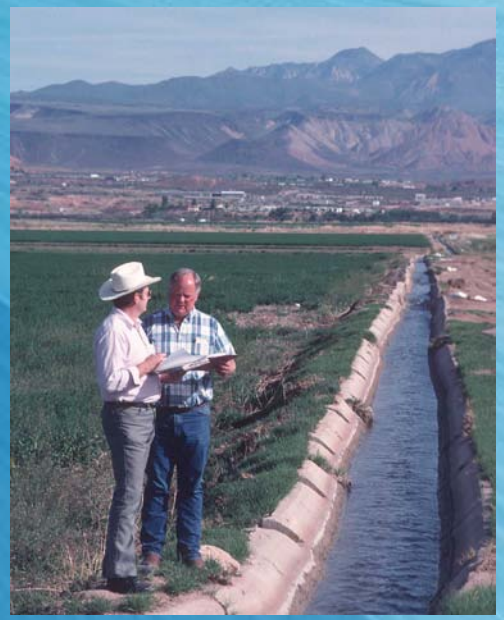
UWRL Example Projects…

- 1. Phosphorus management

- 2. Salinity management



- 3. Irrigation management



UWRL Example Projects: Phosphorus…

1. Phosphorus Management:

The Little Bear River

Problems:

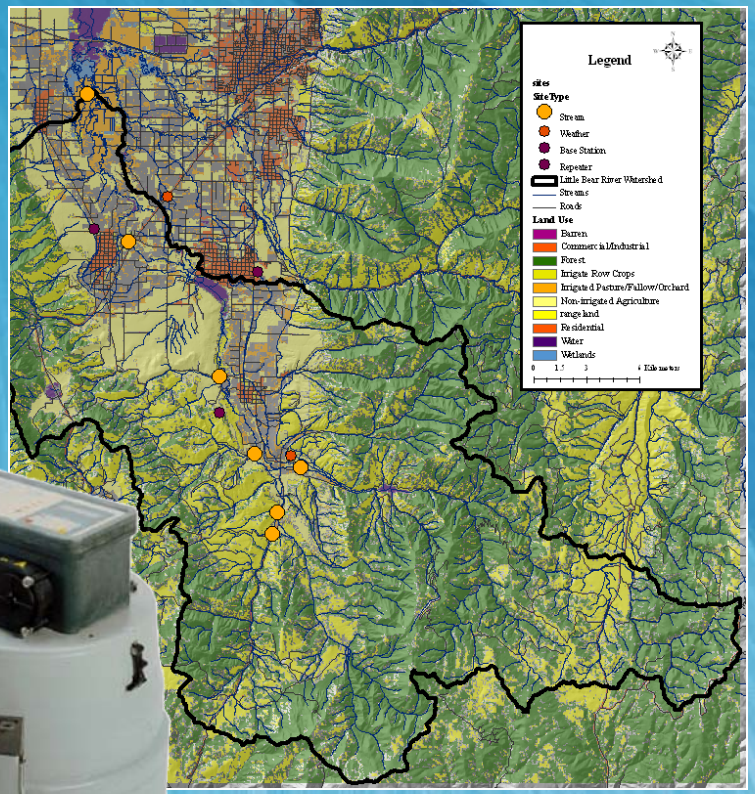
- Too much of it
- Difficult to measure and control
- An EPA-imposed treatment plant: perhaps ~$200 million!

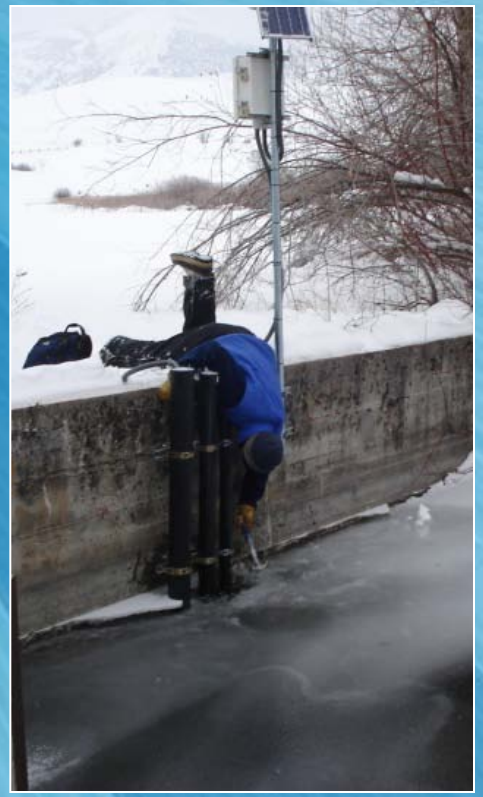
Solution:

- Enhance data collection
- Real-time data + state-of-the-art models = better information
- Establish a pollution rights trading bank

UWRL Example Projects: Phosphorus…

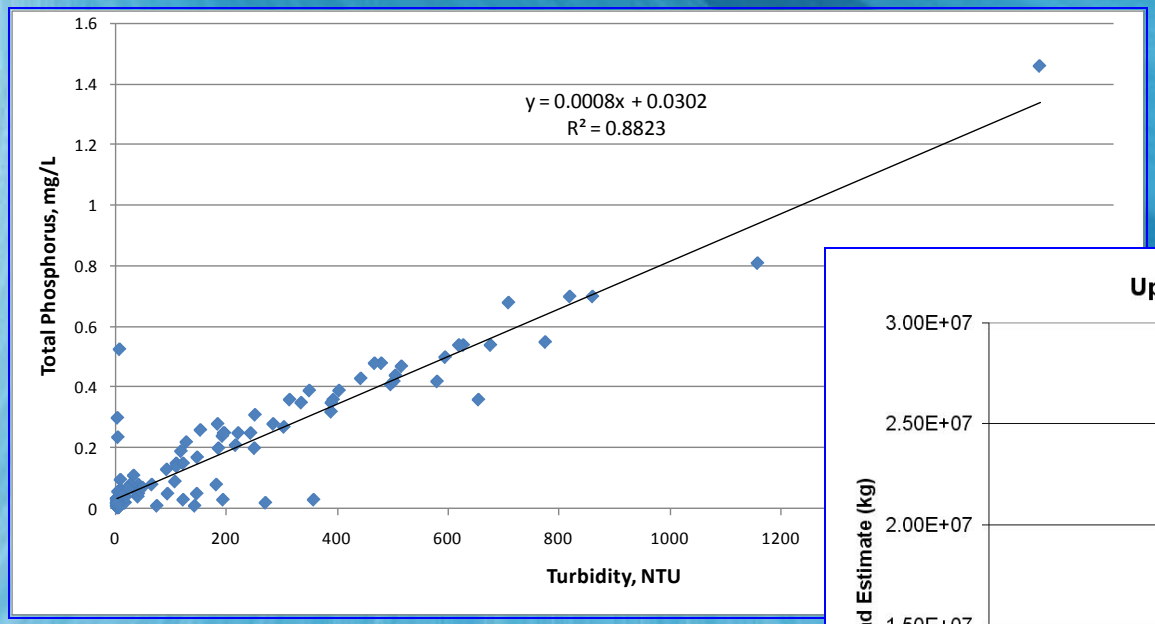
Data Collection

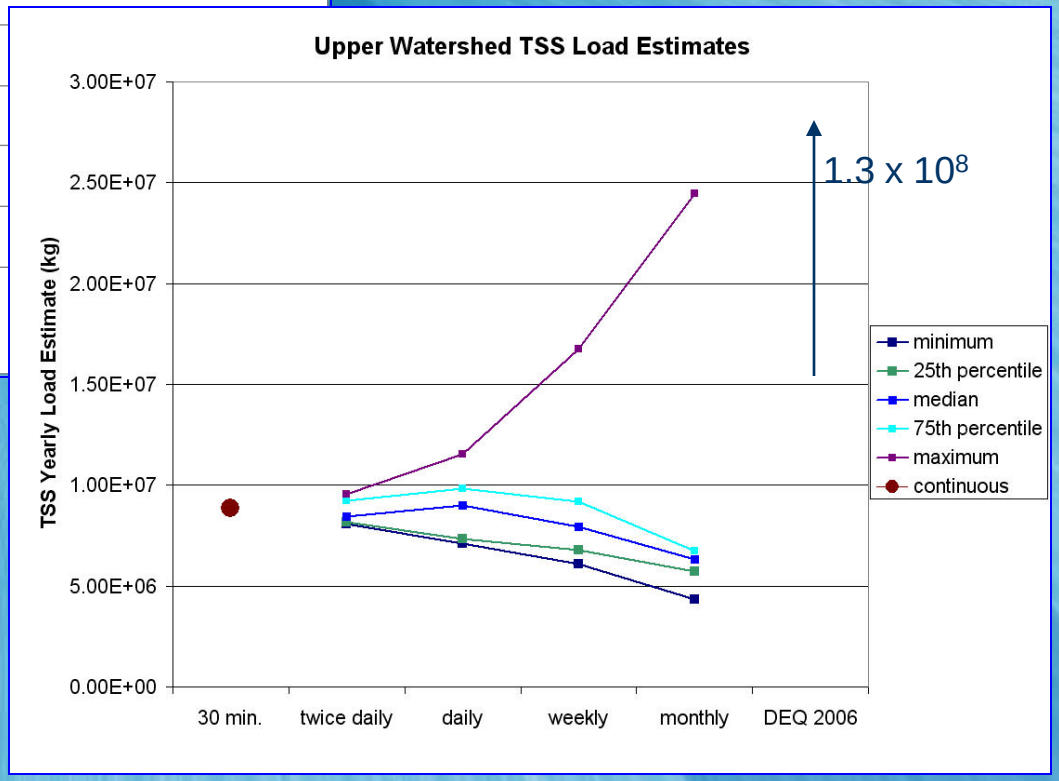




UWRL Example Projects: Phosphorus…

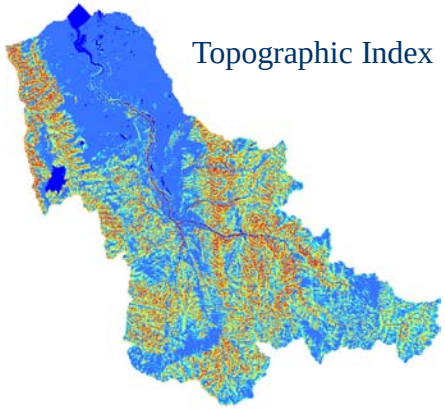
Analysis

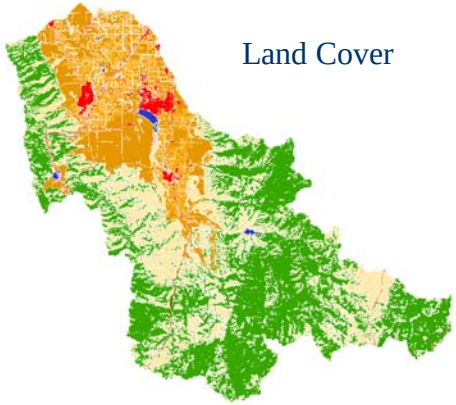


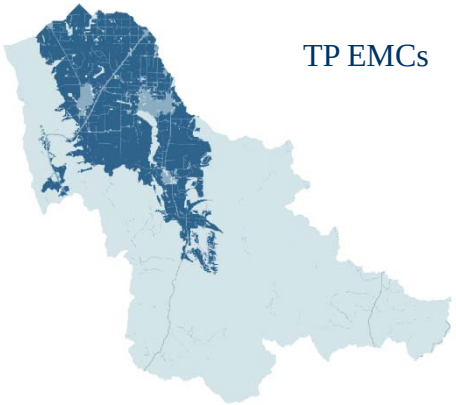


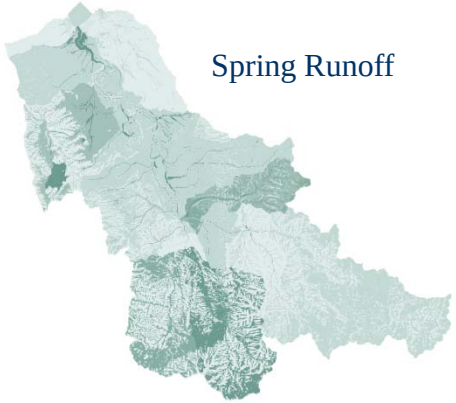
UWRL Example Projects: Phosphorus…

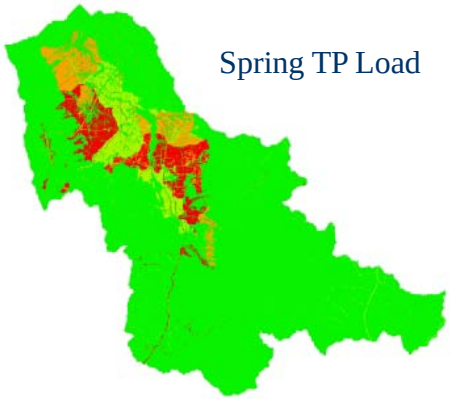
Modeling

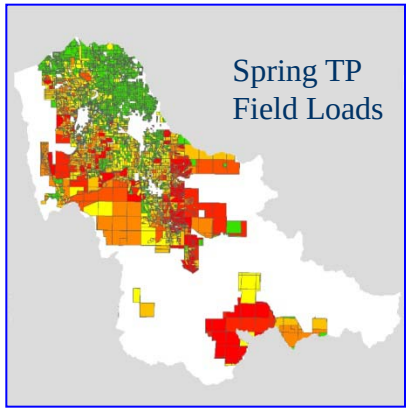












UWRL Example Projects: Phosphorus…

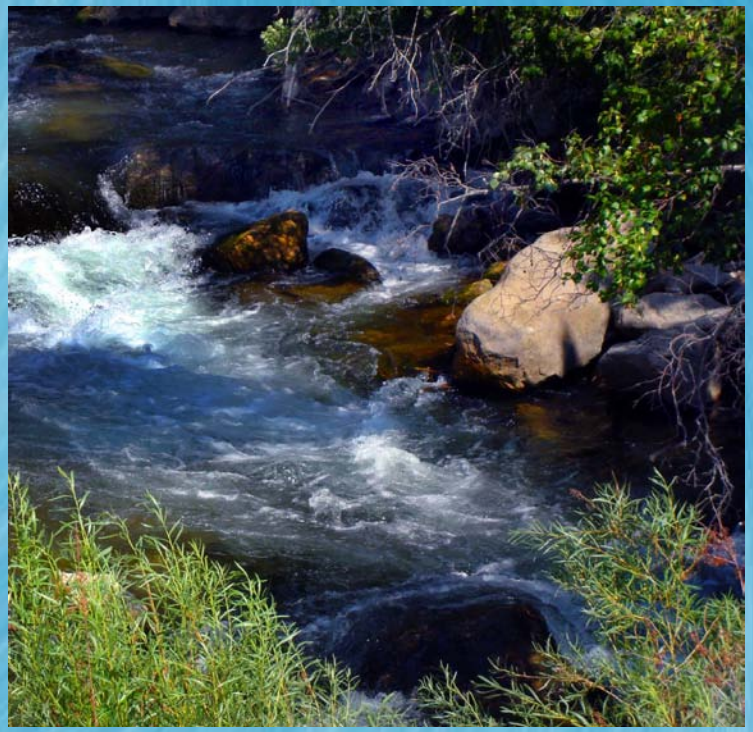
Results

- Estimates of phosphorus concentrations and loadings are greatly improved with real-time data and modeling.
- Bayesian modeling approaches provide information about uncertainty in loading estimates.
- The first phosphorus pollution trading contract are now possible.
- If such investments can be made to happen, the cost to meet EPA standards will be much less than the estimated conventional treatment approach.

UWRL Example Projects: Salinity…

2. Salinity Management:

Ion-specific salinity probes



The problem:

- Salt in US rivers causes hundreds of millions of dollars of damage yearly
- Measurement of salt loading is uncertain

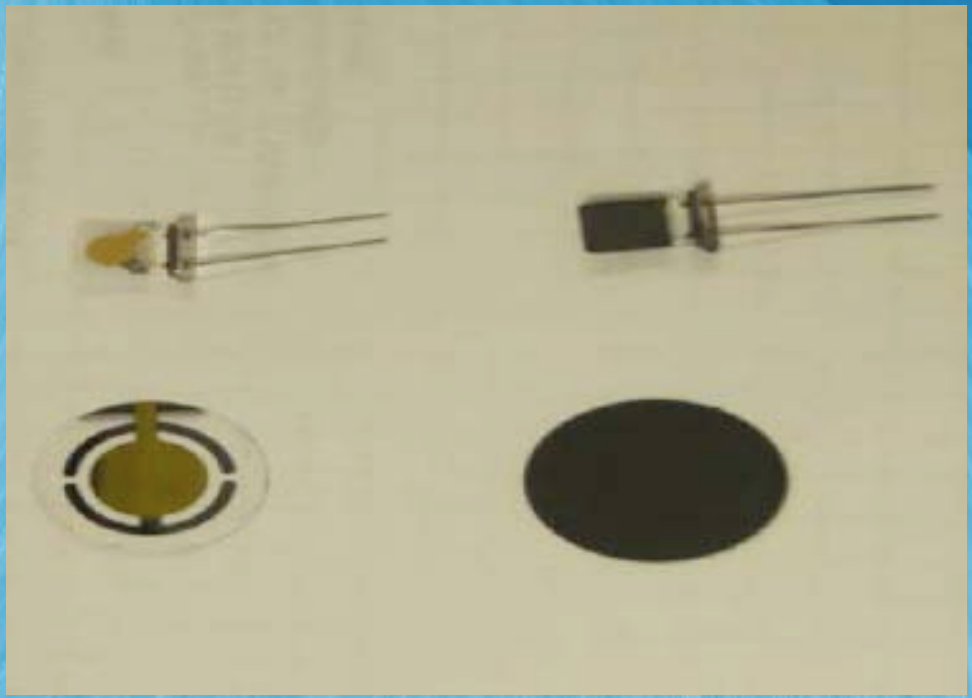
Part of the solution:

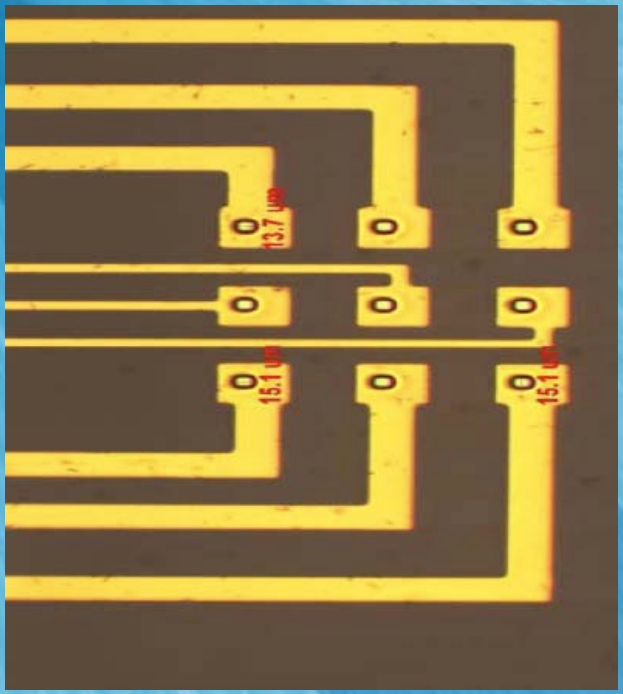
- Develop a salinity probe that is:
  - ✓ Multi-ion-specific
  - ✓ Low-cost

UWRL Example Projects: Salinity…

Progress

Micro-electrode array: developed, tested, patented

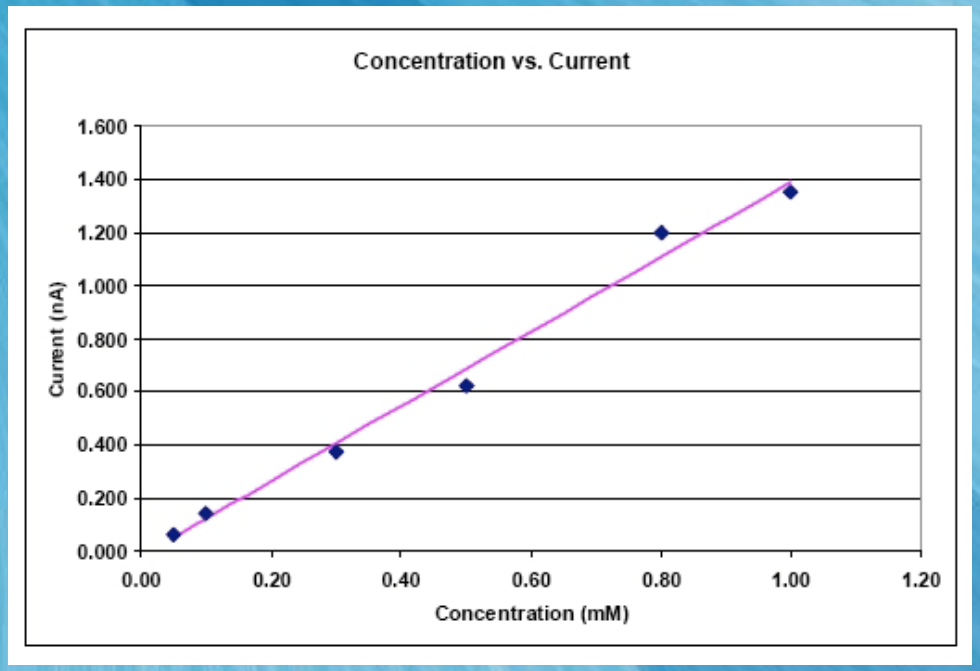




UWRL Example Projects: Salinity…

Progress

Ion sensors under development:
SO_4^{2-}, Cl^-, Na^+, Mg^{2+}, Ca^{2+}, HCO_3^- (each will be patented)



UWRL Example Projects: Irrigation…

3. Irrigation Management:

Motivation

- Irrigation: largest water user in Utah; inefficient
- Remote sensing: high cost, poor spatial resolution, bad timing
- Need to acquire more frequent and higher resolution imagery, and merge with data from satellites and on-ground sensors
- Must provide tools so water managers can use the resulting information

UWRL Example Projects: Irrigation…

Capabilities:

Telephoto image,
Desert Lake test flight,
July 2007

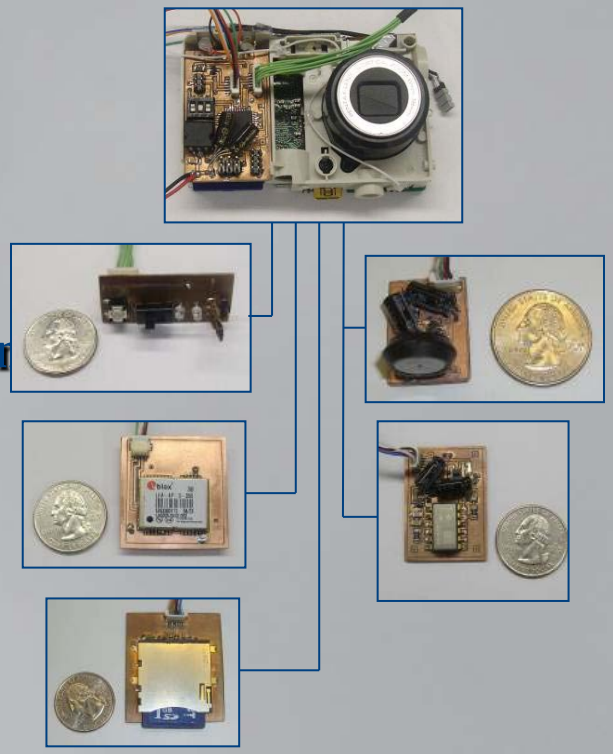
- UAV aircraft: 6-ft wingspan, ~8 pounds; equipped with computer, avionics, GPS, RC, flight control and payload management software; battery powered; fully autonomous or radio-controlled, easy to use
- Speed/Distance: approximately 30 mph/approximately 30 miles per battery charge
- No runway needed
- Coven-capable
- Data acquired: visual spectrum and near-infrared; infrared is being added now
- Image resolution: approximately 5 cm to 25 cm, depending on flight elevation
- Fast turnaround of images (minutes to a few days)

http://AggieAir.usu.edu/

UWRL Example Projects: Irrigation…

Cameras:

- **"GhostFoto" control**
  - ✓ software interface
  - ✓ high resolution
  - ✓ accurate synchronization
- **Off-the-shelf:**
  - ✓ Typical Canon SX-100
  - ✓ Modified to take photos under computer control
  - ✓ Also records GPS, altitude, orientation data



http://AggieAir.usu.edu/

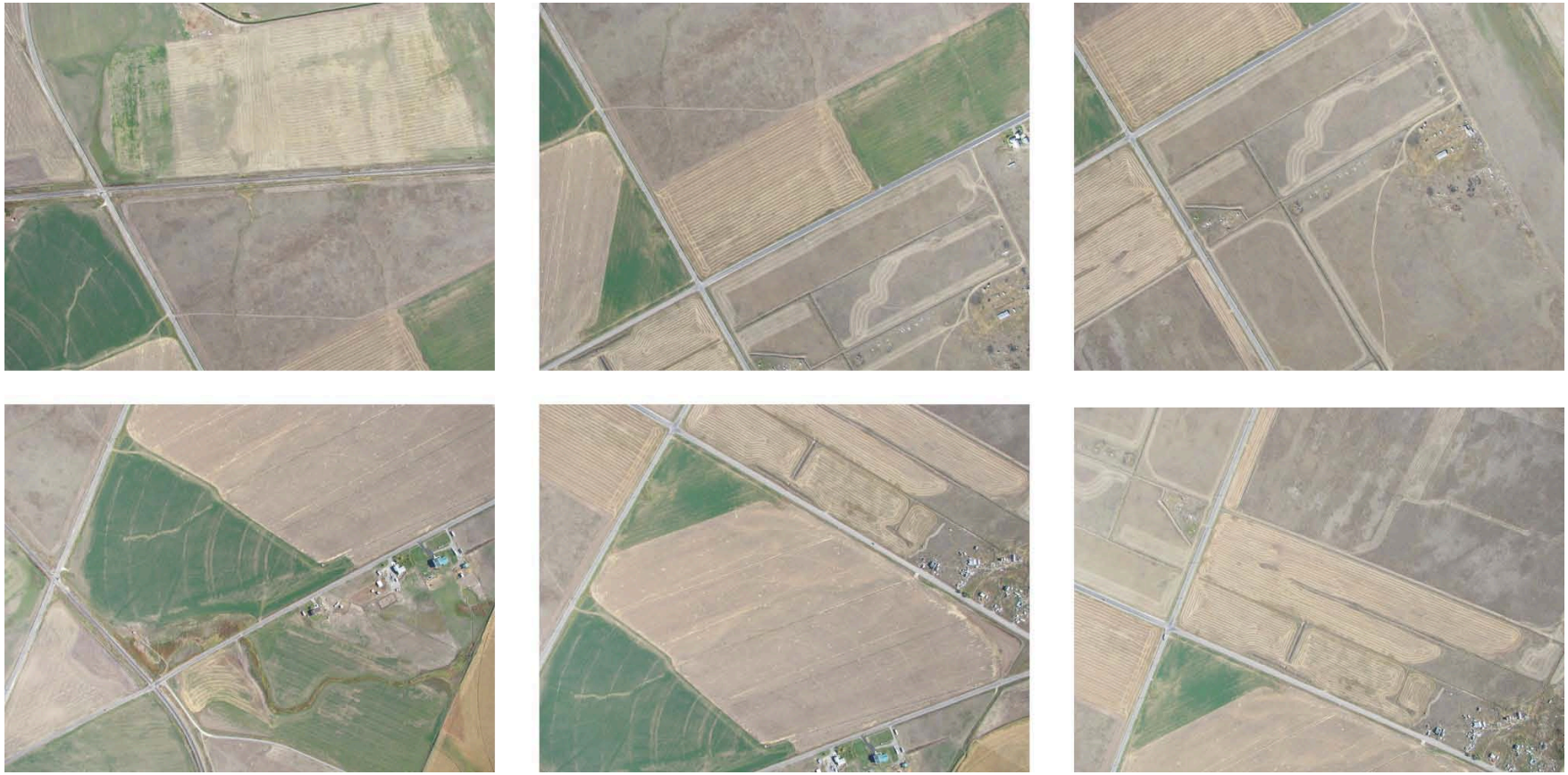
The “Raven”: autonomous launch

http://AggieAir.usu.edu/

The “Raven”: autonomous landing

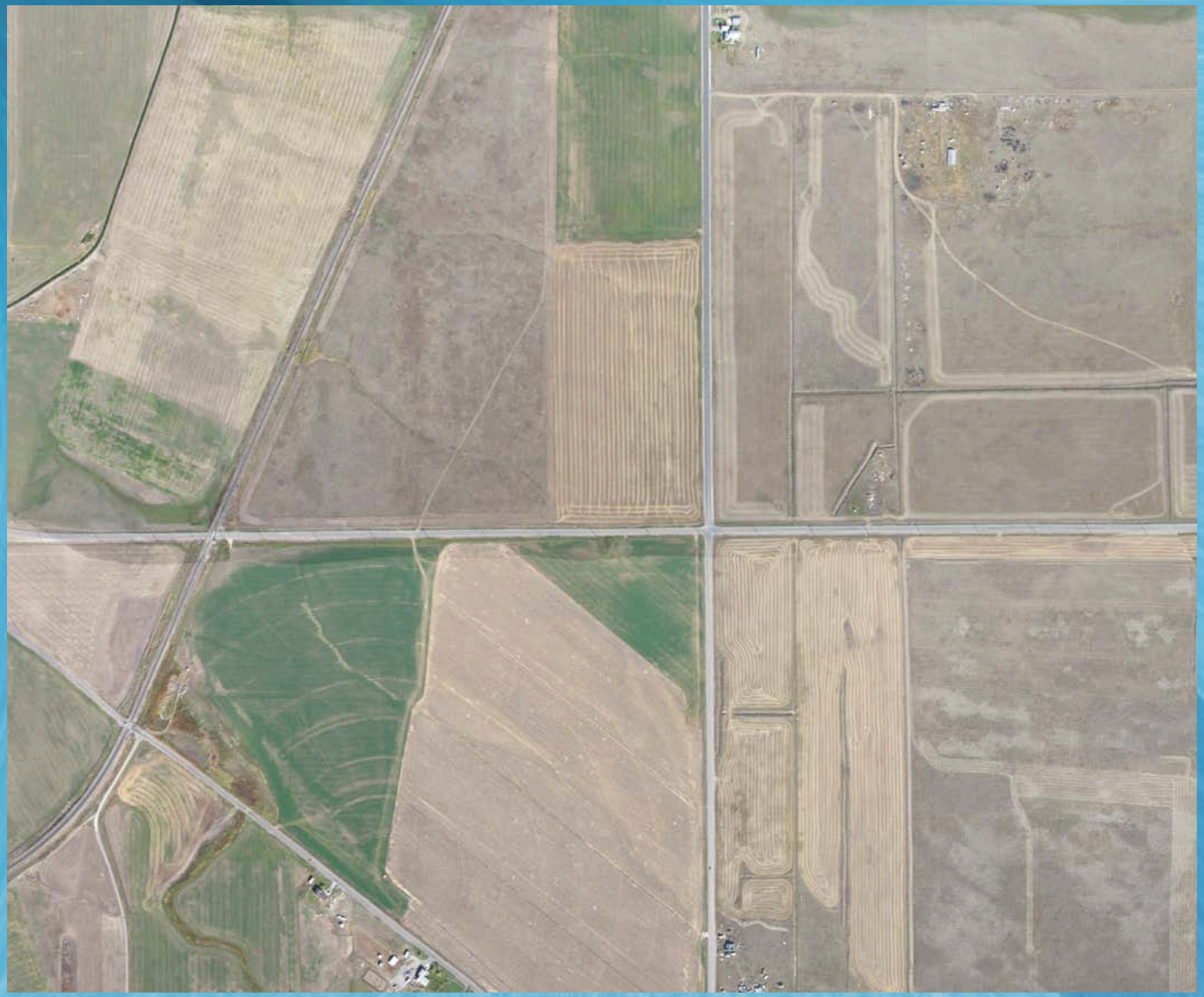
http://AggieAir.usu.edu/

Example Aerial Photos: raw images



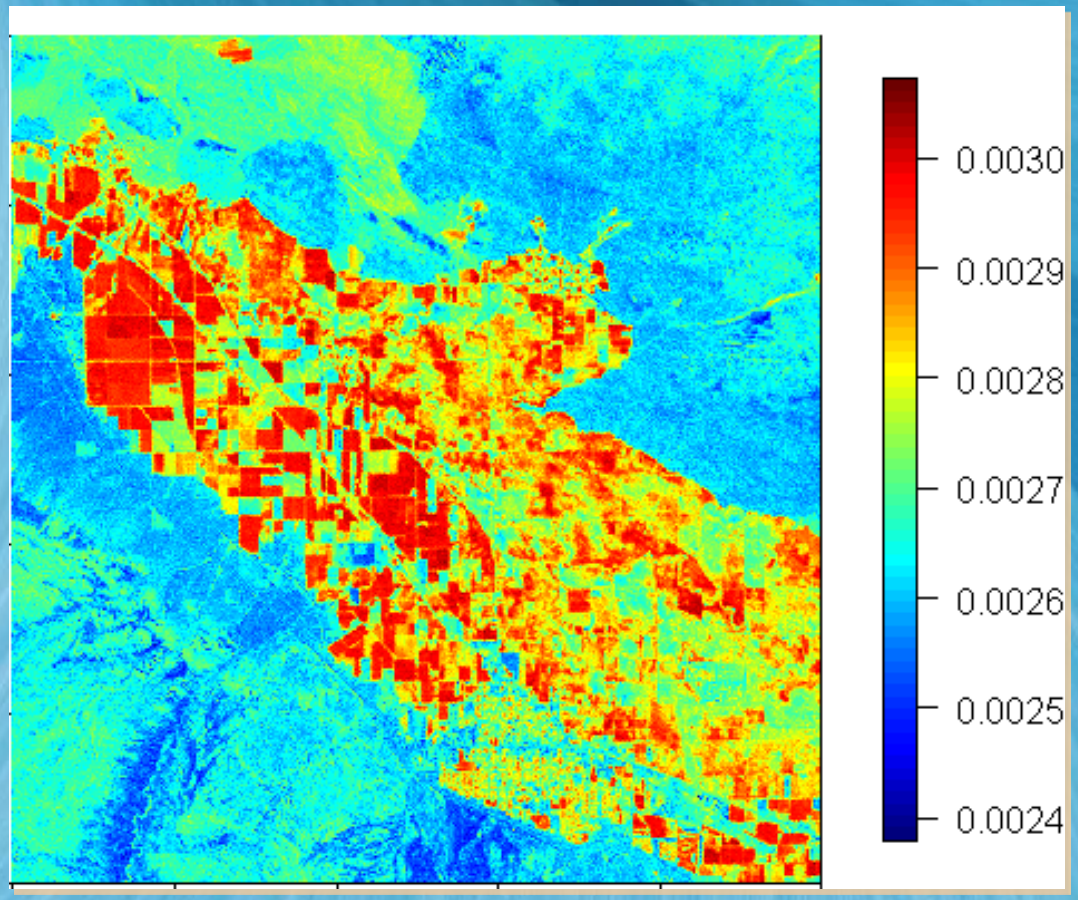
Images from test flights at Cache Junction, Utah

Example Aerial Photos: georeferenced images



Georeferenced images from test flights at Cache Junction, Utah (~25 cm resolution)

UWRL Example Projects: Irrigation…

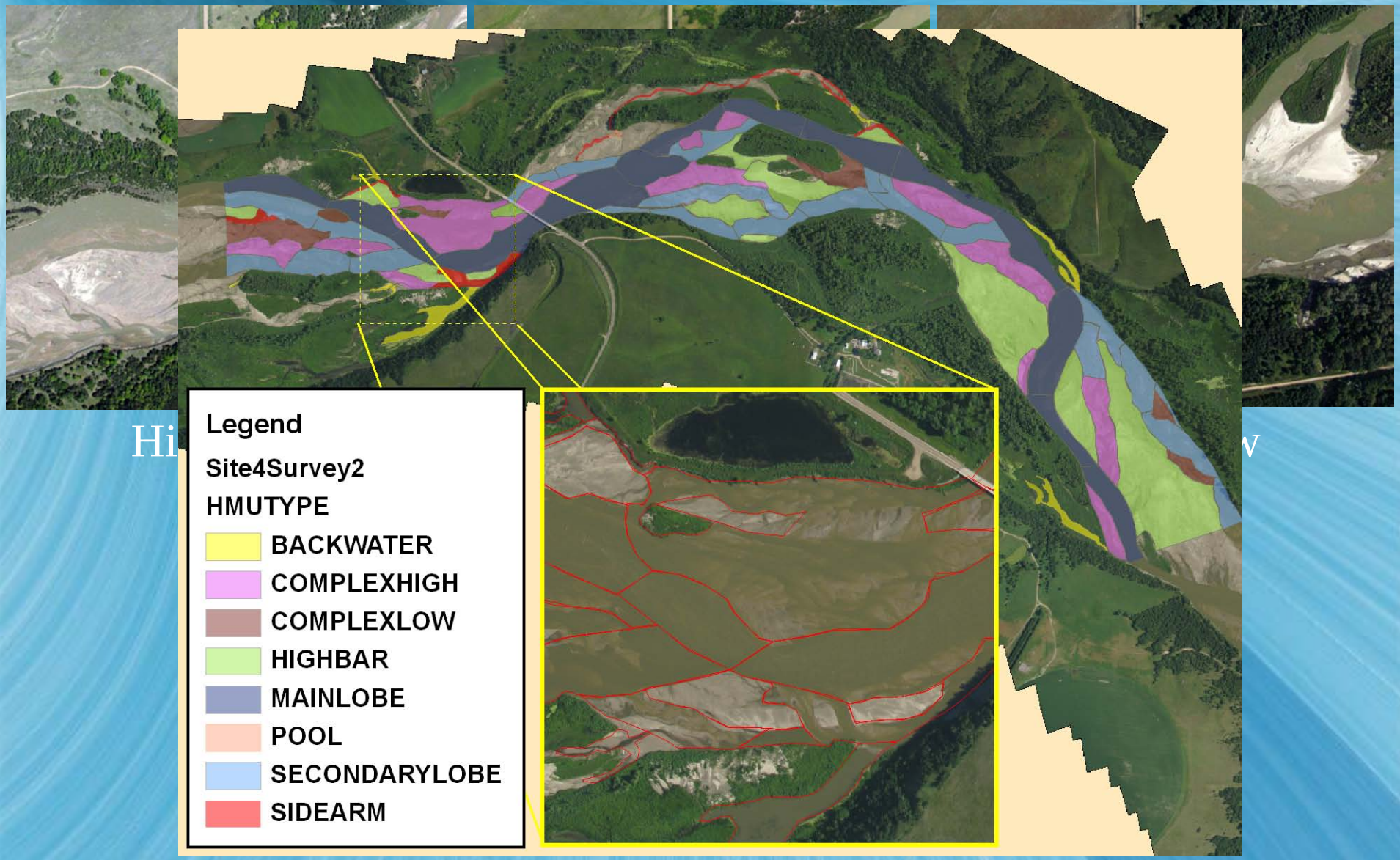


…produce: estimates of evapotranspiration and soil moisture at 5-meter resolution…

…forecast soil moisture for 7 days into the future…

…use data-driven models for canal and reservoir operations ⇒ greater water use efficiency

Other UWRL AggieAir examples: Riparian



Annotated mosaic <48 hours after flight

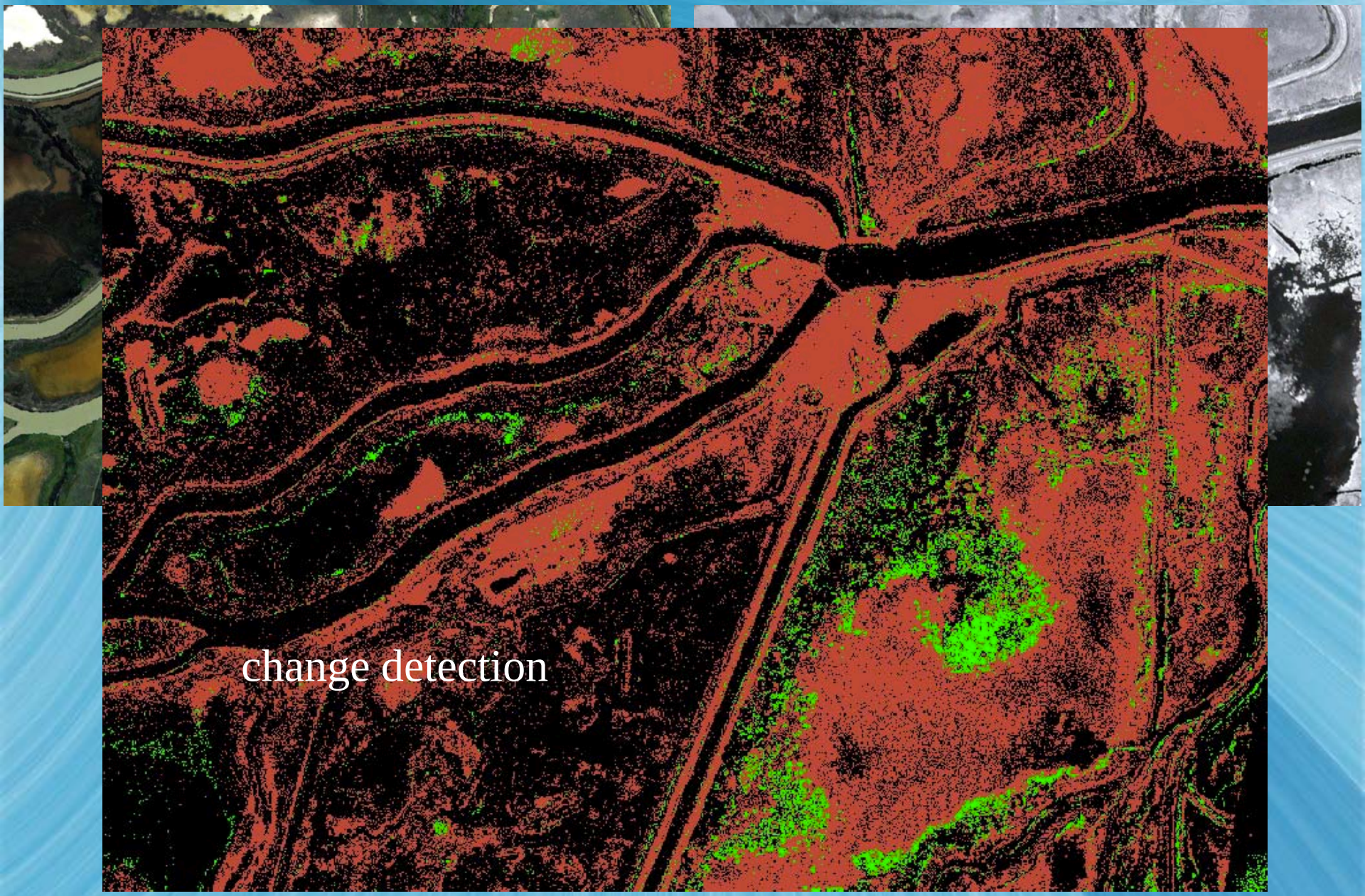
Other UWRL AggieAir examples: Civil…

before construction

during construction

after construction

Other UWRL AggieAir examples: Wetlands…



Questions?

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Utah State University