

EPA Water Infrastructure Adaptation R&D Programs and Tools for Planning and Engineering

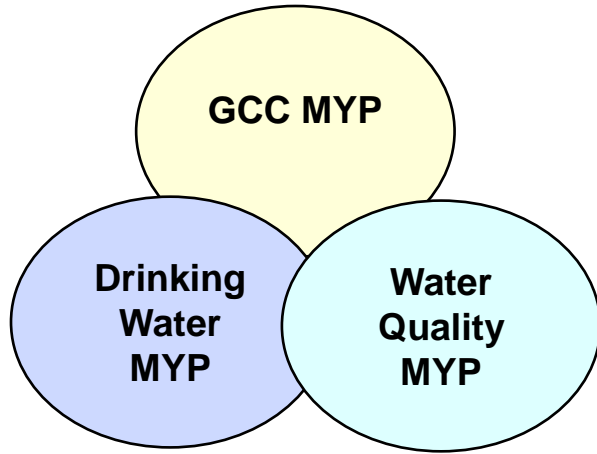
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EPA National Risk Management Research Laboratory

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Programs and focus



- **Geological CO₂ sequestration** and impact on groundwater
- **National infrastructural assessment and adaptation strategies**; 1st National Experts and Stakeholders Workshop on Infrastructure and Water Resources Adaptation to Climate Changes (Jan.6-8, Washington DC)
- **Prediction uncertainties** on hydroclimatic parameters for water engineering and management
- **Climate change mitigation** (e.g., biofuel) impacts on water resources and adaptation measures
- Draft report on the potential of ***sustainable/green infrastructure***
- Reports on **adaptation techniques** (e.g., water reuse) and **advanced water conservation**
- **Synthesis report on adaptive** water resources **development** and water infrastructure **engineering**

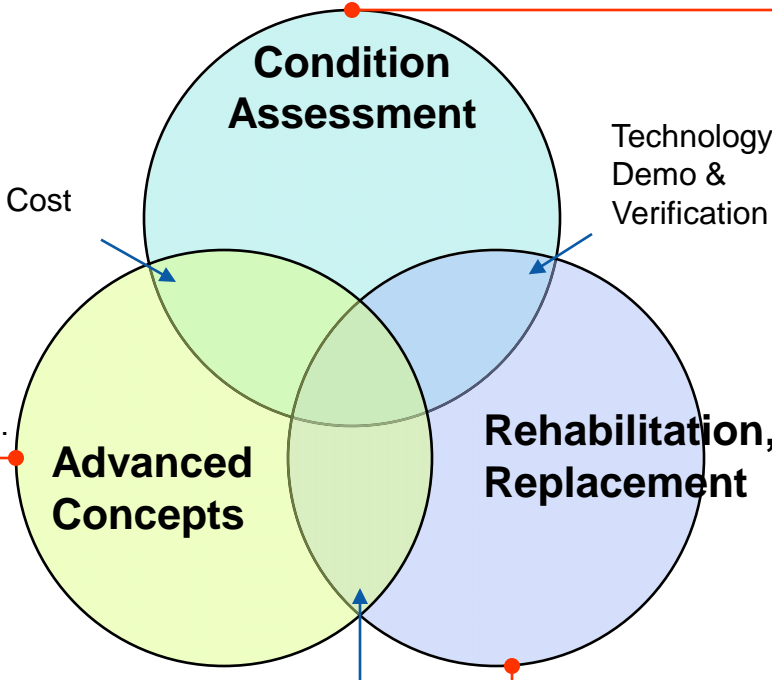
ORD Infrastructure Program: Climate Change as an Important Variable

Condition assessment, water quality and asset management...

Economics and Life Cycle Cost

Technology
Demo &
Verification

- CCTV and other non-intrusive methods
- Gravity sewer IF/EF detection methods
- **Pressured network (e.g, drinking water pipe) leak detections**
- Advanced data analysis, management, and decision support systems



Rehabilitation,
Replacement

Advanced
Concepts

Integrated Management &
Decision Support Systems

Water quality, system rehabilitation and replacement

Global change, energy, sustainability...

- **Multi-scale infrastructure assessment and adaptation strategies**
- Dual systems and non-centralized system management
- **Energy-saving and water conservation**
- **Alternative water sources development and utilization**
- Innovative collection system designs

- Pressure pipe rehabilitation technology demo/verification
- Pressure pipe rehabilitation methods and materials
- Gravity sewer rehabilitation methods and technologies
- Odor and corrosion control

R&D for Adaptation Tools

Engineering tools for planning and management

- National infrastructure assessment – Tool box 1
 - Downscaling in precipitation, overland runoff and flow rate
 - Water quality modeling / prediction
 - Water and wastewater treatment plant performance and adaptive engineering
- Water availability – Tool box 2
- Water resource impacts in biofuel productions – Tool box 5

Engineering measures for adaptation

- Alternative water resource development – Tool box 3
- Water conservation – Tool box 4

Tool box #1: Engineering analysis and process design under climate changes – Water treatment plants, storm water systems, water quality programs

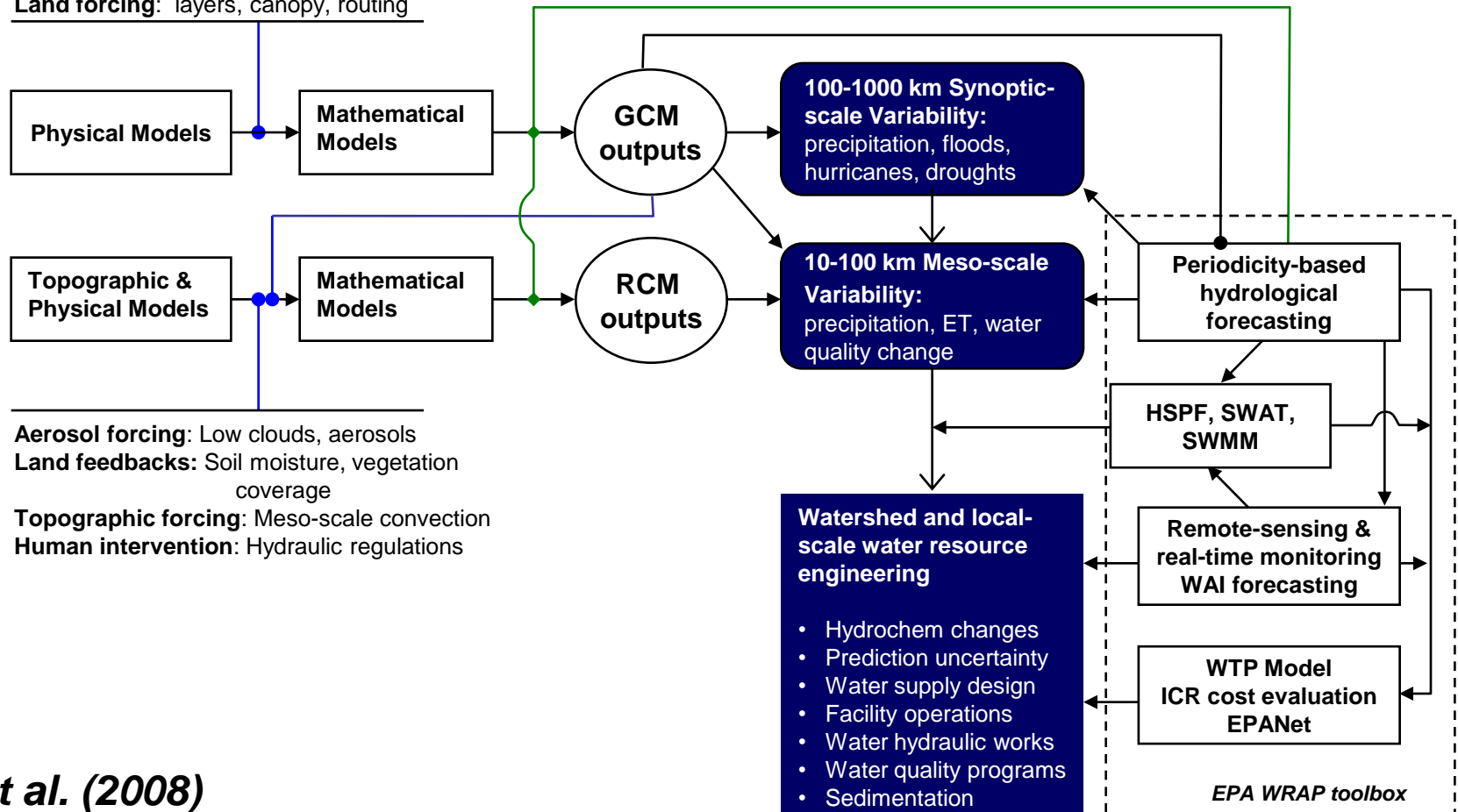
Radiative forcing: Gas emissions

Orbital forcing: Sun radiation variance

Oceanic forcing: Sea ice, radiation absorption

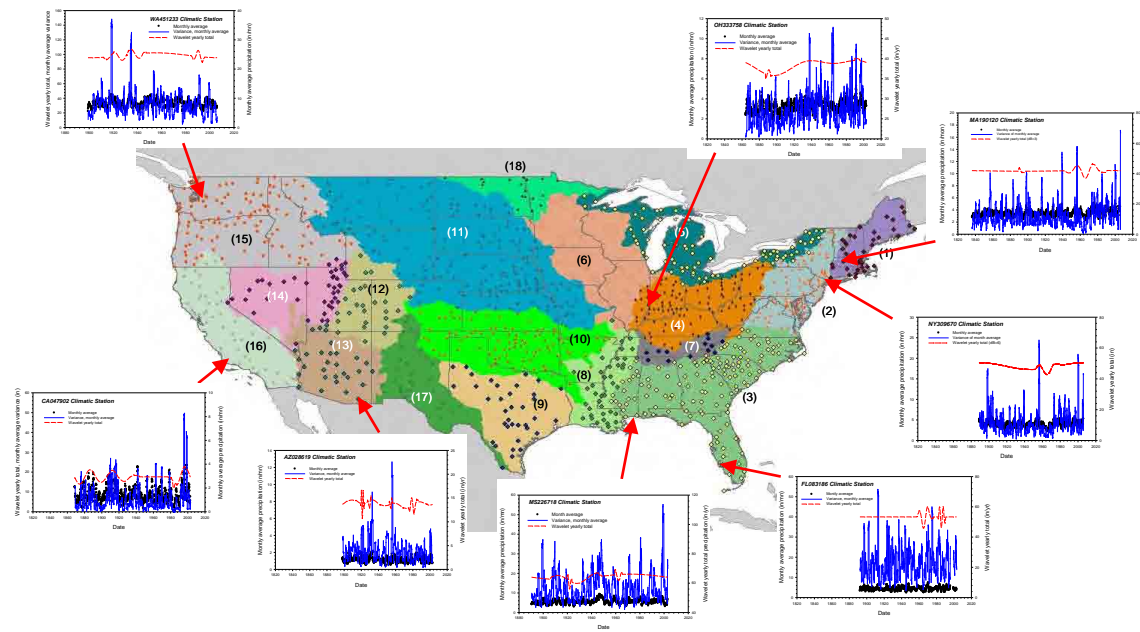
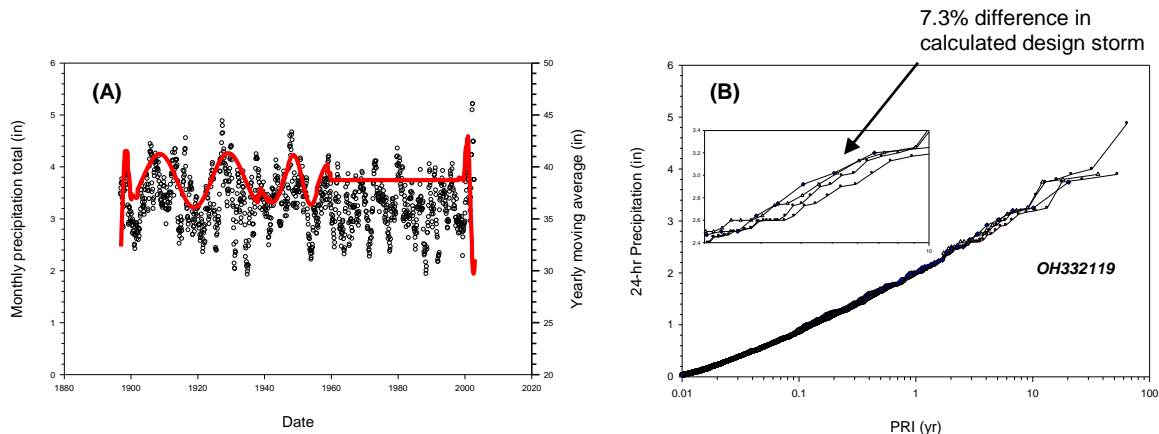
A-O interactions: Oceanic circulations, CO₂ flux

Land forcing: layers, canopy, routing



Nationwide Hydrological Characterization and Regional Studies

- Nationwide hydroclimatic change studies
 - Several large regions / areas have responded and will continue to respond to climate change differently
 - Boundaries are being delineated
 - Large changes in design storm for some locations
 - Near completion
-
- Talking to NOAA in updating the return storm interval
 - Release to public some time in the future

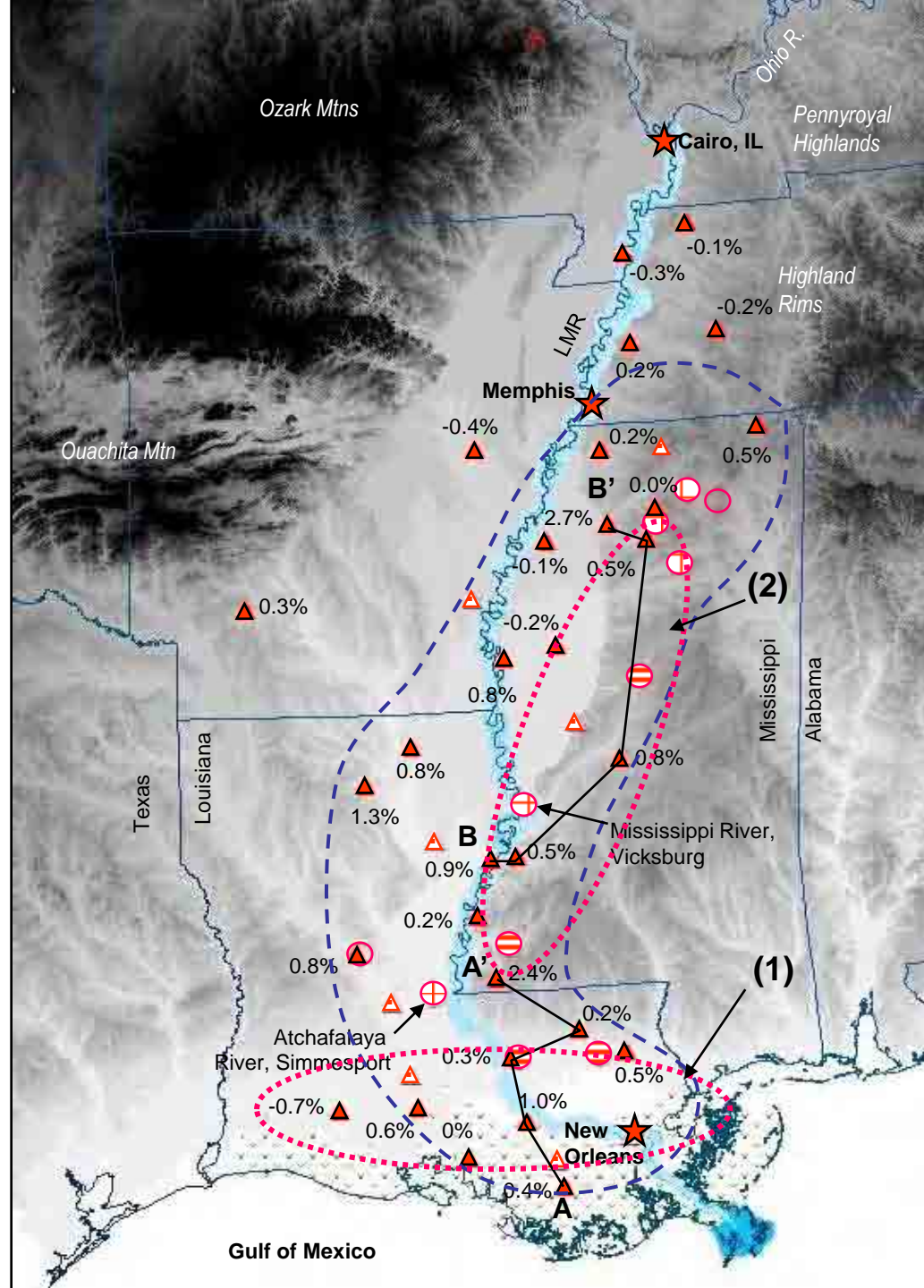


Case Study: Lower Mississippi River Basin

- Topographically controlled precipitation variation and changes
- ENSO influences on precipitation, floods and nutrient flux
- Upstream nutrient reduction key to hypoxia control. BMP designs incorporating hydroclimatic changes
- Source water impact to water plant operations

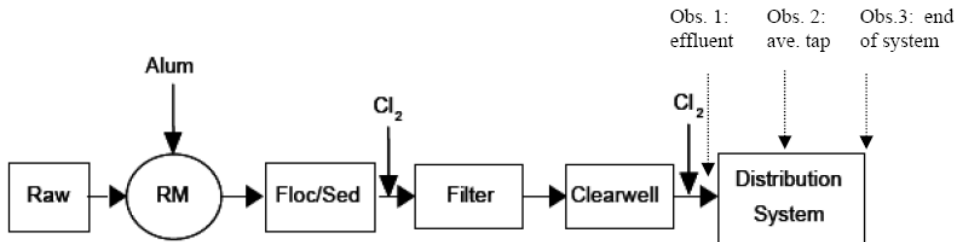
Outcomes:

- Methodology for downscaling
- Techniques linking water quality and flow changes to synoptic-scale climatic systems
- Technical basis for adaptation preparation



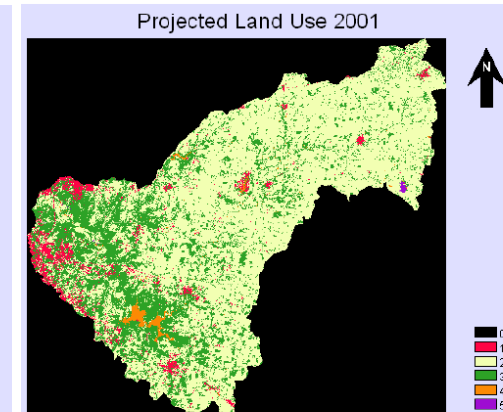
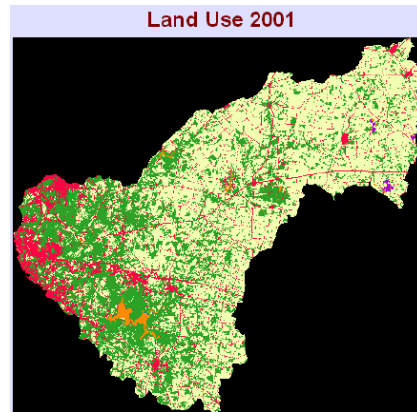
Case Study: Little Miami River Basin (Ohio)

- **BASINS model.** Climate change scenarios, and corresponding hydrologic changes in water quality and flows
- **BASINS-CAT.** ORD/NCEA model – to be released soon
- **Land Use Model.** Predict future land use under climatic changes using Markov chain modeling and GIS predictors
- **WTP model.** Assess treatment plant performance and necessary process engineering / retrofitting for predicted new source water qualities in future climates

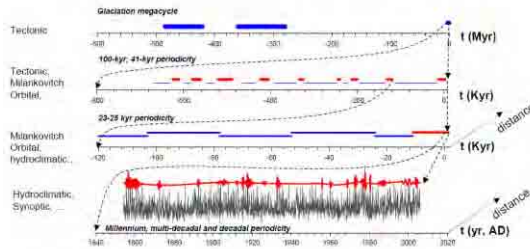


Outcomes

- Methodology for downscaling
- Tools for land use planning
- Tools for water treatment plant assessment and adaptive engineering
- In an integrated platform



Tool Box #2: Water Availability Forecasting

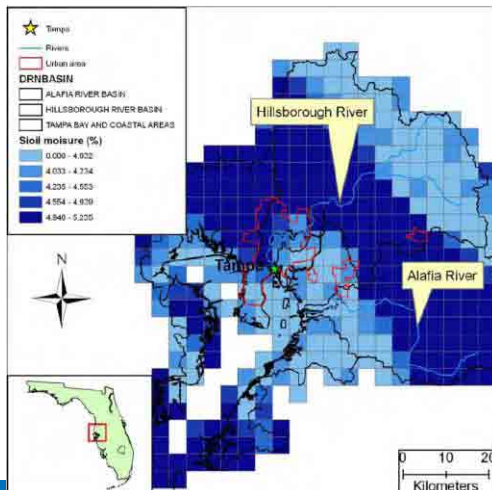


Periodicity-based long-term predictions (decades)



2050.jan

Water Availability

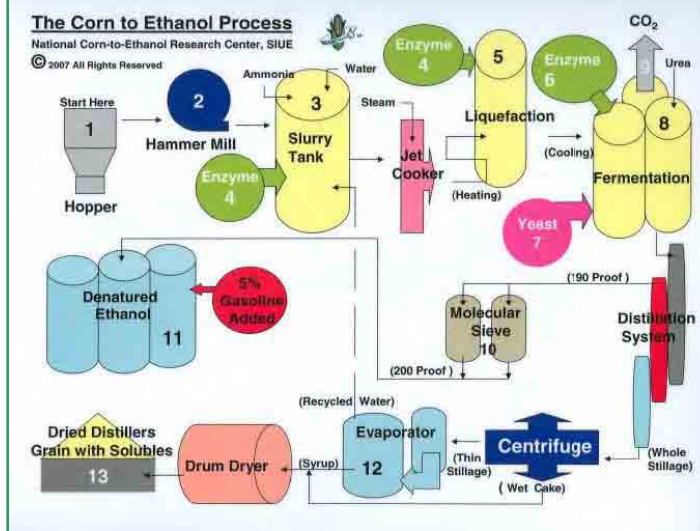
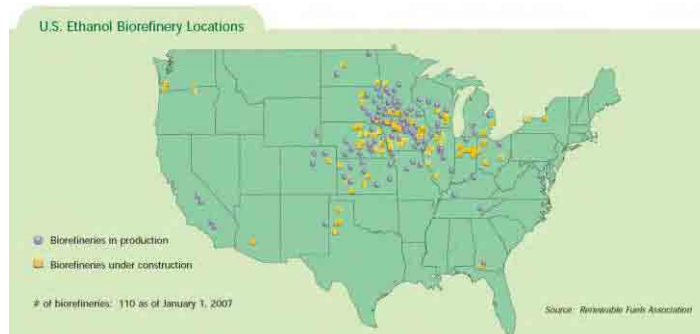


WAI-based short-term predictions (days, weeks)

- Methodology and techniques published, being applied in case studies
- GIS and wavelet modeling, RCM calibration, and remote-sensing based Water Availability Index (WAI) techniques in an integrated platform
- Support long-term planning and short-term operations
- More pilot-testing sites wanted

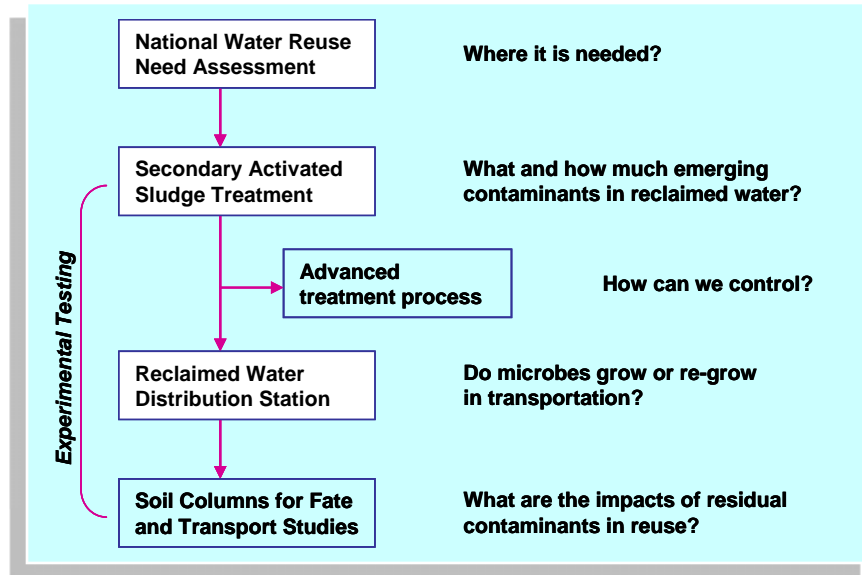
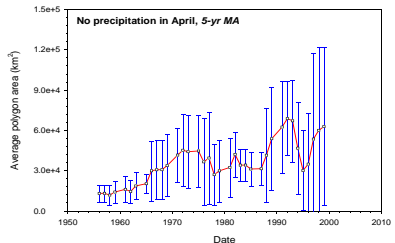
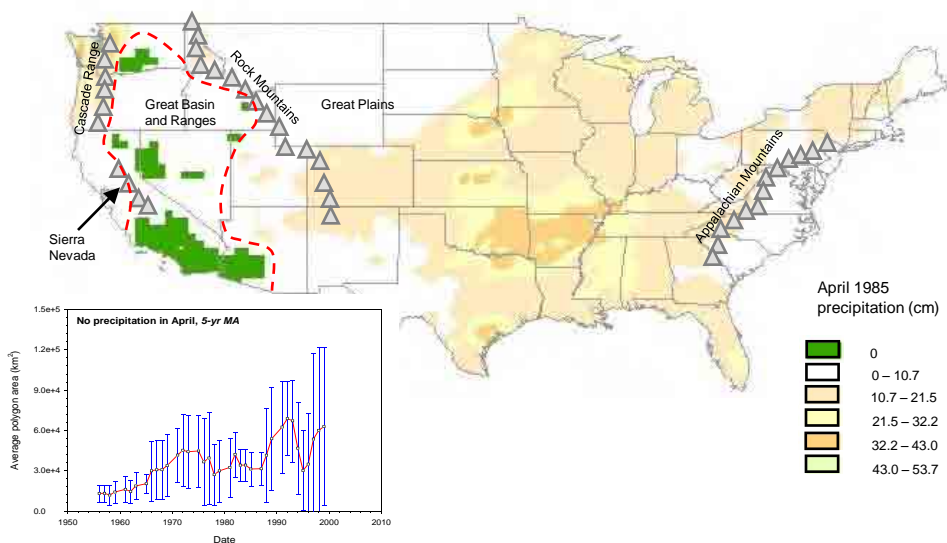
Tool box #5: Water resources need assessment and water reuse in biofuel productions

- Investigation of **water usage**, **waste water generation**, contaminant by-product formation during corn-based ethanol productions.
- Engineering studies of **wastewater reuse** in ethanol fermentation for better economics
- Collaborative studies with universities and the Southern Illinois Ethanol Research Center
- First report on **water resources impact and water reuse potential assessment** by 2008



Tool Box #3: Alternative water sources development & utilization – wastewater reuse

National water reuse need spatial analysis



Wastewater reuse experimental testing



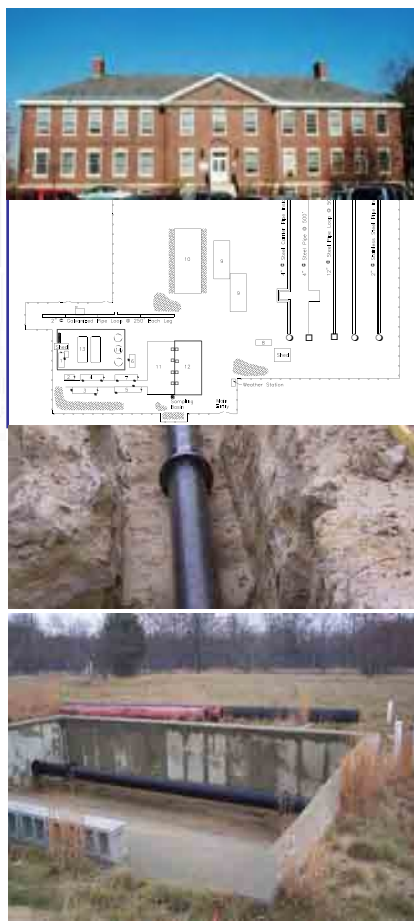
Tool Box #4: Water conservation - Pipe leak detection and water loss prevention



Pilot-scale Experimental Station at EPA T&E facility (Cincinnati, OH)



Field-scale Experimental Station at EPA-Edison Facility (New Jersey)



- Aim to find economic and effective technologies to reduce water loss and prevent water quality deterioration in pipes
- Conservation is a major adaptation measure at stake for both water and energy
- New non-intrusive detection technology in focus: networked sensor array with acoustic and water quality sensors
- Manual for water pipe leak detection and management
- Water pipe leak and infrastructure database on pipe failure modes, geographic distribution, network age, network operations, ...
- New field testing sites are needed in cooperation.

A part of:

- EPA 21st Century Sustainable Infrastructure
- EPA Climate Change and WRAP Research

Summary – Thank You!

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Engineering measures for adaptation

- ❑ Alternative water resource development – Tool box 3
- ❑ Water conservation – Tool box 4

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