27. Global and Environmental Considerations in Drinking Water Supply and Wastewater Control (Climate Impact / Energy Savings)

Presenter

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Global and Environmental Consideration in Drinking Water Supply and Wastewater Control

By

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EPA Research Strategy

Global Change Research Program (GCRP), 2000

Climate Change Research Initiative (CCRI), 2001

GCRP Holistic Approach

Assessment of the consequences of global change on:

- Air Quality
- Water Quality
- Human Health
- Ecosystem Health

Strategic Principles

Focus on:

- Future stresses and the dynamics of change
- Both risks and opportunities
- Multiple stresses
- Human dimensions considerations
- Assessment of adaptation options
- Appropriate geographic scale

U.S. Climate Change Research Initiative (CCRI)

Supplement to the Global Change Research Program (GCRP) following analysis by the National Academy of Sciences:

Comprehensive inventory of climate and global change research programs sponsored by Federal Agencies

- Criteria to prioritize current and proposed research
- Identification of gaps and overlaps in current programs
- Interagency prioritization
- Publication of joint CCRI/GCRP implementation plan

CCRI (Cont.)

Key Products:

- A series of nationwide studies conducted during the next five years that explore the effects of –
  - Climate change on ambient air quality in major metropolitan areas
  - Changes in air quality on human health
  - Waste water treatment costs may be affected by climate change and changes in extreme precipitation events
  - Climate change and climate variability on drinking water quality
  - Climate change on water-borne diseases in metropolitan areas
  - Climate variability on weather-related morbidity

CCRI (Cont.)

- Decision-support tools
  - Appropriate response strategies for public health officials
  - Evaluate responses at the societal/individual level (public health system)
- Regional Research
  - Determine the quantitative effect of climate change on tropospheric ozone and particulate matter
  - Identify geographic areas that will experience the largest changes (positive and negative)

- Regional Research (Cont.)
  - Access the consequences of climate change on:
    - Drinking water infrastructure
    - Waste water treatment
    - Surface water quality
    - Surface water/groundwater interaction
  - Examine the potential for adaptive responses to protecting drinking water and surface waters for human and ecosystem uses in urban areas

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Drinking Water and Wastewater Utility Adaptation to Climate and Land Use Change

NRMRL/WSWRD/Cincinnati

NRMRL's Role

- Provide input on how global change (climate, land use) and technology change influence (good and bad) environmental stressors such as,
  - changes in flow, nutrients, sediments, pathogens, toxics, etc. and their impacts on water quality and aquatic habitat
  - determine utility vulnerability relative to watershed characteristics and system capabilities at the local level
- Quantify the upgrades needed by the utility in terms of Q&M, new technology, and/or non-structural alternatives

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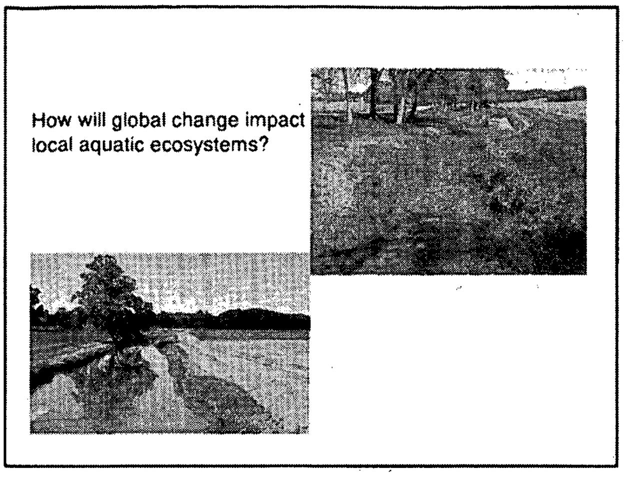
Watershed Approach:

- Integrate drinking water and wastewater adaptations
  - Identify watershed physical characteristics
  - timing, depth, and duration of wet/dry conditions
  - central vs. decentralized drinking water and wastewater systems
  - smart growth
  - spatial optimization of Best Management Practices

Employing Land-Use Schemes as a Mitigation Strategy for the Water Quality Impacts of Climate change

Little Miami River Watershed Case Study:

- Current and future land use development plans to simulate water quality changes
- Climate change scenarios overlay land use schemes
  - + or – 20% change in precipitation
  - + 2 to 4 degree Celsius change in air temperature
  - Eight combinations plus no change simulated


How will global change impact
local aquatic ecosystems?

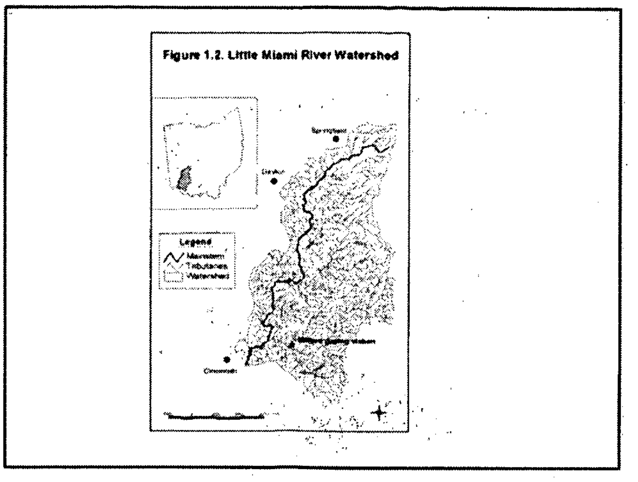
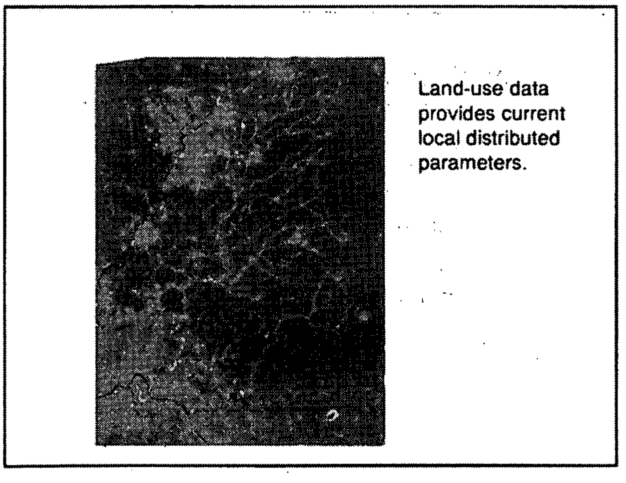
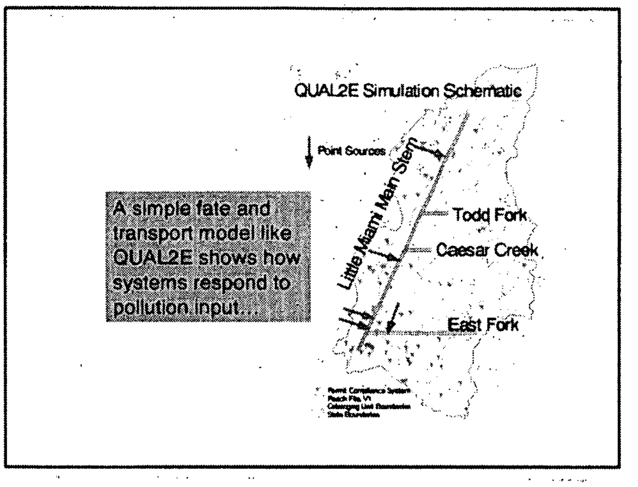
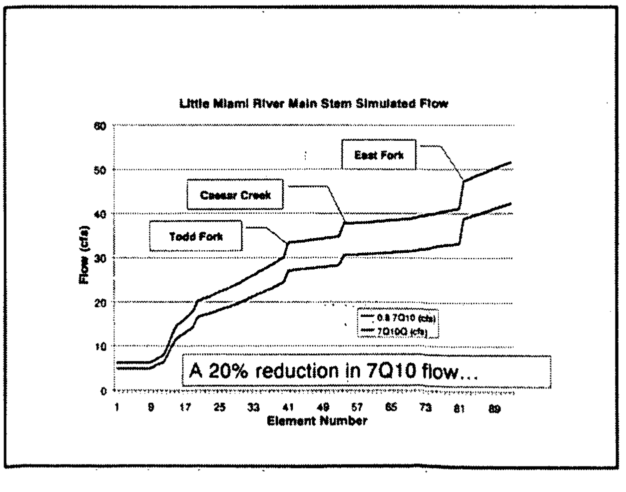
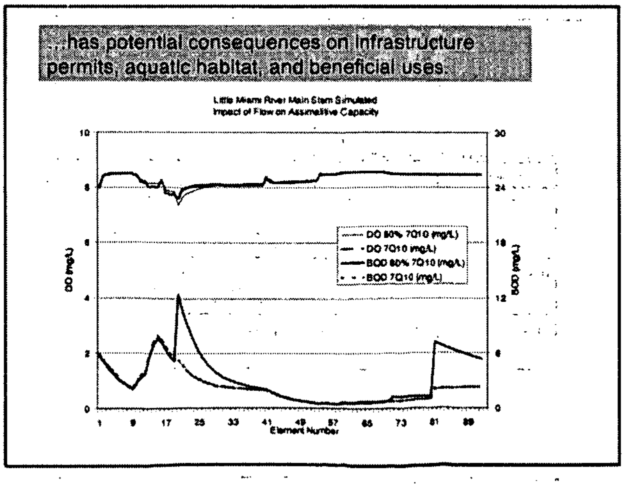


Figure 1.2. Little Miami River Watershed
Legend
Mainstem
Tributaries
Watershed


Land-use data
provides current
local distributed
parameters.

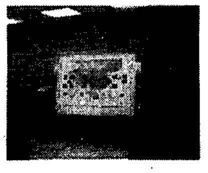

QUAL2E Simulation Schematic
Point Sources
Little Miami Main Stem
Todd Fork
Caesar Creek
East Fork
A simple fate and
transport model like
QUAL2E shows how
systems respond to
pollution input...


Little Miami River Main Stem Simulated Flow
East Fork
Caesar Creek
Todd Fork
Flow (cfs)
0.8 7Q10 (cfs)
7Q10Q (cfs)
A 20% reduction in 7Q10 flow...
Element Number

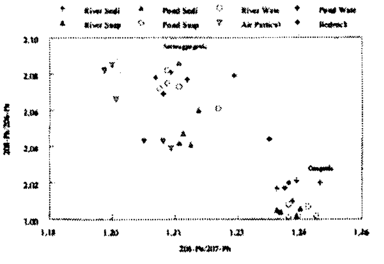

...has potential consequences on infrastructure
permits, aquatic habitat, and beneficial uses.
Little Miami River Main Stem Simulated
Impact of Flow on Assimilative Capacity
DO 80% 7Q10 (mg/L)
DO 7Q10 (mg/L)
BOD 80% 7Q10 (mg/L)
BOD 7Q10 (mg/L)
DO (mg/L)
BOD (mg/L)
Element Number

GIS Laboratory

- Image Analysis
- Spatial Databases
- Scanning
- Plotting
- Printing
- Digitizing


Provenance of Pb in Kankakee Watershed, Indiana



Results

- Most significant climate change scenarios:
  - Wettest was + 2 degree celsius increase with + 20% increase in precipitation
  - Driest was + 4 degrees celsius with – 29% decrease in precipitation
- Changes in nutrient, runoff, and sediment loads significant in both
- Land use changes can be more significant than climate change
  - Agricultural land use change to suburban actually decreased sediment load

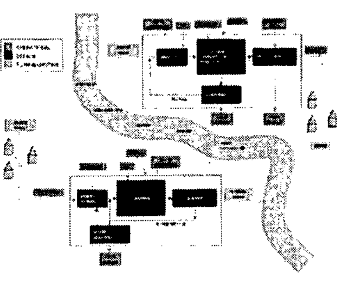
Drinking Water and Wastewater Treatment Infrastructure Adaptation

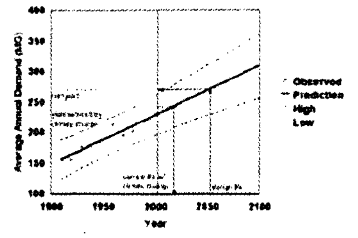
Cost Analysis Techniques:

- Planning and siting
- Design
- Operation

Table 1. Cost analysis techniques

Paradigm	Cost Method	Description
Planning and Siting	Life Cycle Analysis	The expected project life cycle expands or contracts under uncertainty of climate adding or subtracting from the project cost.
Design	Capital Cost of Alternatives	The cost of a design made under existing conditions is compared to a design made under assumptions of altered climate.
Operation	Historical O & M Costs	Frequency analysis of historical O&M costs analyzed according to expected changes in climate.





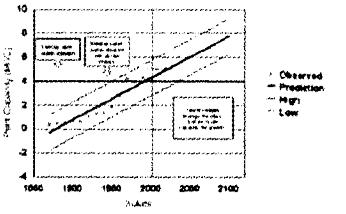
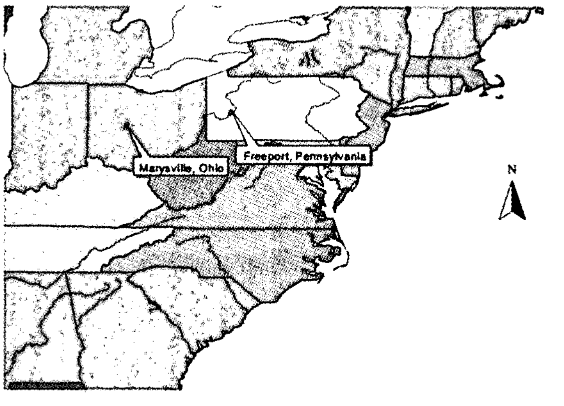
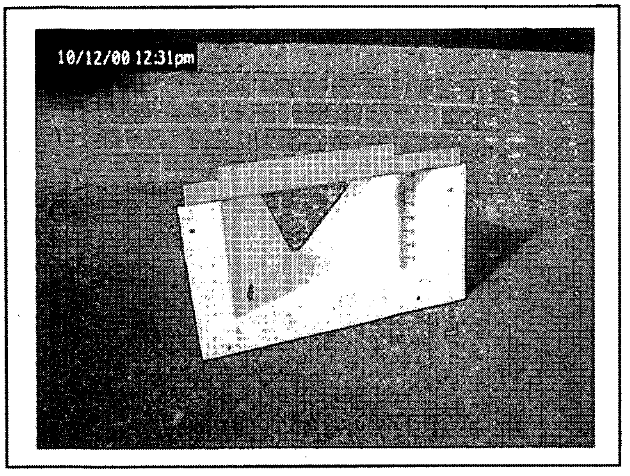


Table 3. Sensitivity of Cost of Optimized Treatment Design to Flow and Suspended Solids from (Mhaisalkar, Bassin et al. 1993)

Parameter	Change in parameter over base value (%)	Change in total annualized cost (%)
Flow	-20	-13.60
	-10	-7.82
	+10	+5.86
	+20	+13.40
Suspended Solids Concentration	-20	-1.55
	-10	Nil
	+10	+1.83
	+20	+1.83

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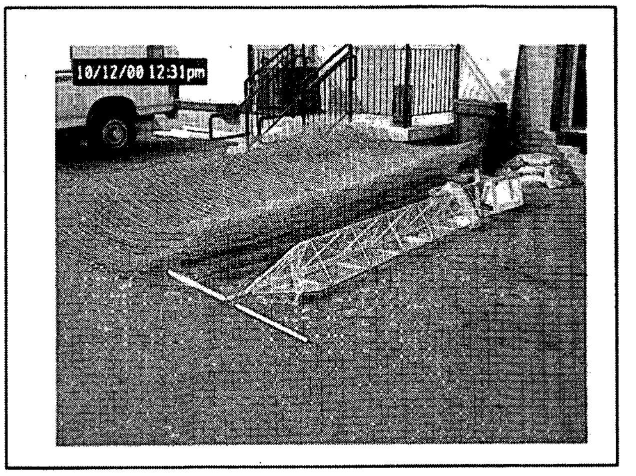
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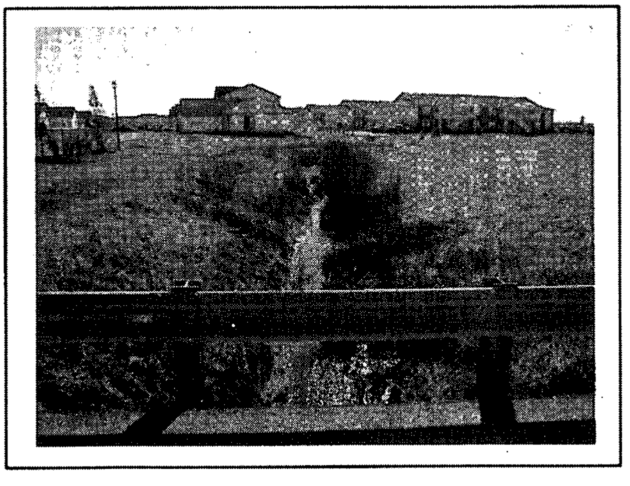
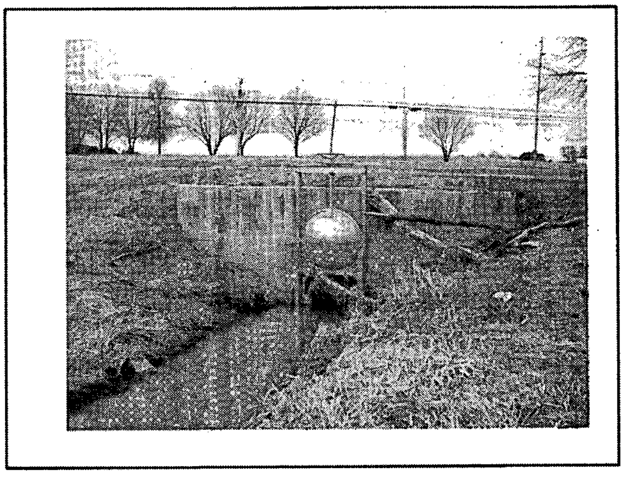
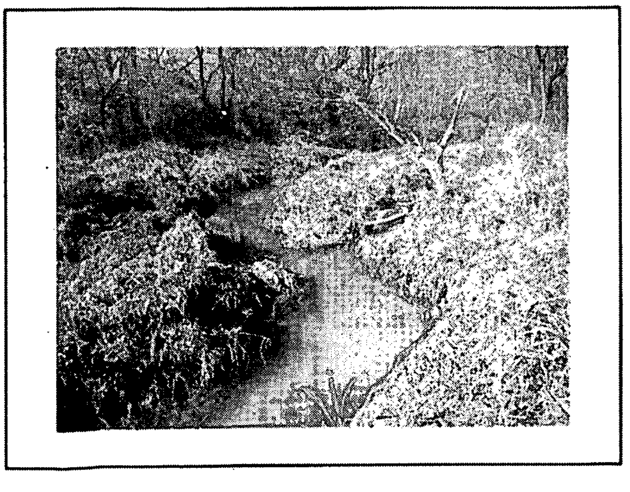
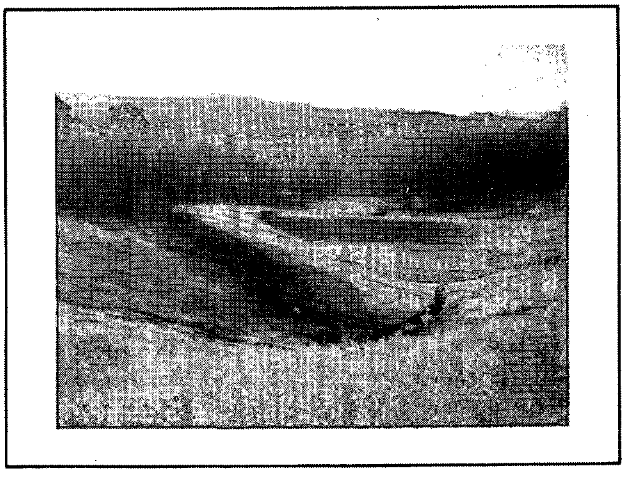

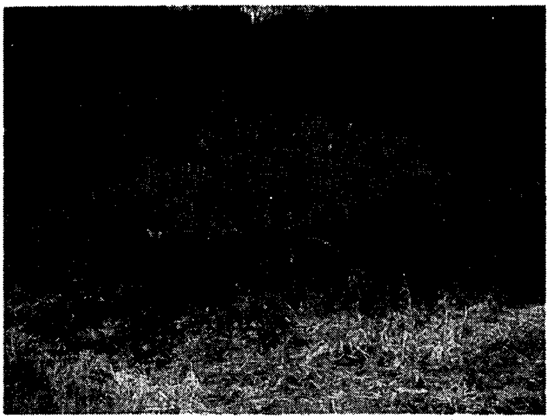

Table 3. Infrastructure Adaptation Costs

Infrastructure	Susceptibility	Adaptation	Example Costs
Drinking Water			
Planning and sizing a water supply reservoir	Yield reduced by changes in climate	Shorten life cycle	Including climate change when planning increases debt service cost by [illegible]
Designing a package drinking water treatment plant	Changes to source water	Alter design or specification	Capital cost difference is up to 15 percent during increases in flow
Operating a drinking water treatment plant	Changes to source water	Match O&M budgeting to higher past values	Expect higher chemical costs during low precipitation years
Waste Water			
Planning and sizing a wastewater treatment plant discharge	Capacity limited by changes in receiving water quality	Shorten Life cycle	Including climate change when planning increases debt service cost by [illegible]
Designing an activated sludge system for wastewater treatment	Changes to receiving water quality	Design with more redundancy and modular unit processes	Capital cost difference is up to 10 percent higher for [illegible] plant
Operating an average wastewater treatment plant	Changes to receiving water	Match O&M budgeting to higher past values	Higher O&M values expected during low precipitation years. More frequent permit changes.