Sustainable Watershed Management

A short course by:
Bren School of Environmental Science & Management
and UCSB Extension

1. Introduction

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Managing water resources in a watershed in a sustainable manner

- Sustainability:
  - Consider long-term future as well as present
  - Multi-objective
  - Not equal to invariant…
  - Must consider inherent variability in natural system
  - Changing land and water uses in watershed
  - Changing public perception and interests
Objective of the Course

- Provide an approach and toolkit to develop a Watershed Management Plan
- Consider water quantity and quality within the planning process
- Incorporate short, medium and long term objectives into the planning framework
- Analyze several case studies to put approach and toolkit into practical context

Course Outline

- Day One:
  - Sustainable Management
  - Water Policy
  - Elements of a Watershed Management Plan (WMP)
  - Planning the Development of a WMP
  - Identifying Data Sources
  - Survey of Modeling Tools in Support of a WMP
### Course Outline

#### Day Two:
- Downloading datasets
- Defining the watershed
- Setting up the watershed model
- Incorporating point and non-point sources
- Modeling water quantity
- Modeling water quality
- Understanding the watershed response
- Addressing management questions with the watershed model

#### Day Three:
- Case studies of Watershed Management Plans
  - Santa Clara River, CA
  - Tucson, AZ
  - Santa Ana River, CA
  - ZeroNet Program, NM
- Incorporating Management Activities
  - Structural Best Management Practices (BMPs)
  - Non-structural BMPs
  - Other policy and management activities
- Special considerations for Watershed Management
  - Dealing with uncertainties in the planning process
    - San Cristobal, Chiapas, Mexico
    - What missing data is most valuable for the planning process?
- Summary
Mechanics of the Course

- **Day One**
  - Meet in Bren Hall (BH) 1510  (9AM – 4:30PM)
  - Lunch served at noon – one hour break
- **Day Two**
  - Meet in GIS Lab (BH 3510)  (9AM – 4:30PM)
  - Lunch served at noon – one hour break
- **Day Three**
  - Meet in Bren Hall (BH) 1510  (9AM - 3PM)
  - Lunch served at noon – one hour break

Reading Materials

- **Suggested textbook**
  - Watersheds : Processes, Assessment and Management
  - Paul A. DeBarry
  - Publisher: Wiley (July 9, 2004)
- **Supplemented with other readings**
  - Available online at:
    - www.bren.ucsb.edu/~keller/swm.htm
Water Resources
Watershed Management

- Land Use & Land Use Change
  - Ag, Residential, Commercial, Industrial, Parks
  - Forests, Grasslands, Wetlands, …
- Land Management Practices
  - Physical changes
  - Chemical use & release
  - Introduction or elimination of biota
- Water Management Practices
  - Extraction or diversion from natural system
  - Changes to recharge of natural reservoirs
  - Physical modifications

Sustainability

- Easier to define situations that are not sustainable:
  - Excessive extraction of groundwater
    - Lower watertable
    - Increased energy consumption per unit of water extracted
    - Subsidence
    - Salt-water intrusion
    - Diminished baseflow
Sustainability

- Other examples of unsustainable management
  - Pollutant loading above the capacity of the system to assimilate the load
  - Concentrated discharges that result in localized hot spots
  - Practices that increase risk of flooding
  - Decrease in aesthetic or recreational value due to physical or biological changes

Sustainable Water Resources Mgmt

- “Availability of sufficient quantity and quality of water, at acceptable prices, now and in the future, without causing the environment to deteriorate.”

  Balance short- vs. long-term socioeconomic objectives
**Sustainable Water Resources Mgmt**

- Managing for sustainability sets a clear goal:
  - Resource must be managed in a responsible manner
  - Think about long-term implications of human activities
  - Need to consider human health AND needs of other species that depend on water resource

**Sustainability and Change**

- Essential to planning is anticipation of change
  - Change in demand and/or supply
  - Change in uses and criteria
  - Change in climate
- Adaptive Management must be built into planning process
  - Control/Monitoring points in time and space
  - Decision points
  - Review of objectives and approach
Sustainability and Scale

- What is the appropriate spatial scale?
  - Too large a scale (e.g. major river basins) may overlook unique local attributes
    - Economies
    - Ecosystems
    - Resources
  - Too small a scale (e.g. every hectare) may not be self-sufficient or sustainable

- What about time scales?
  - Short time scale may seem sustainable…
  - How long is long-term?
  - Can there be periods where some objectives are not met?
  - Abrupt changes in conditions?
  - Resilience?
  - Vulnerability?

Interbasin transfers may not be sustainable in the long-term
Sustainability and Variability

- Variability in flow AND quality is a natural phenomena
  - Ecosystems are adapted to variability
  - Some systems depend on variability to start some processes
- Uncertainty ≠ Variability
  - Variability may be characterized using statistical methods
  - Uncertainty is much tougher to characterize

Sustainability and Risk

- Risk Assessment:
  - What could go wrong?
  - What is the likelihood that this will happen?
  - What are the consequences?
- Risk Management:
  - Identify high risk events
    - High probability, high damage
      - Reduce probability and/or damage
    - Extreme events: low probability, high damage
Key Elements of a Sustainable Watershed Mgmt Plan

- Identify quantifiable criteria that contribute to
  - Human welfare
  - Ecological health
- Management Plan must
  - Ensure reliability of solutions
  - Determine resilience of elements to changes
  - Assess and minimize vulnerability
  - Identify and reduce sources of uncertainty that may significantly negatively affect the plan

Guidelines to Manage for Sustainability

- Identify and involve as many stakeholders as feasible
  - May need to re-scope spatial scale
- Develop a shared vision of desired social, economic and environmental goals
  - Consider present and future generations
  - Define reasonable planning horizon
- Identify ways for all parties to contribute to achieving shared vision
### Guidelines to Manage for Sustainability

- Identify solutions/approaches that restore, enhance or maintain
  - Economic vitality
  - Environmental quality
  - Natural ecosystem biodiversity and health
  - Social and cultural community goals

### Guidelines to Manage for Sustainability

- Integrate best science available into decision-making process
  - Uncertainty ≠ no action
  - Manage uncertainty within process
- Understand the watershed (components, processes, values and attributes) and its response
- Explain watershed response to stakeholders to help them make informed decisions
Guidelines to Manage for Sustainability

- Establish baseline conditions against which change can be measured
  - Pre-development condition may be hard to determine
  - Pristine condition may not exist
- Monitor and evaluate frequently to determine if goals and objectives are being achieved

Key Points

- Planning for Sustainability is imperative
- There are many aspects involved in the concept of Sustainability
- Watershed Management approach is generally an appropriate scale for thinking about Sustainability
- It’s hard work!