DASEES

Decision Analysis for a Sustainable Environment, Economy, and Society

Sustainable and Healthy Communities Research Program
U.S. EPA Office of Research and Development

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EPA Disclaimer

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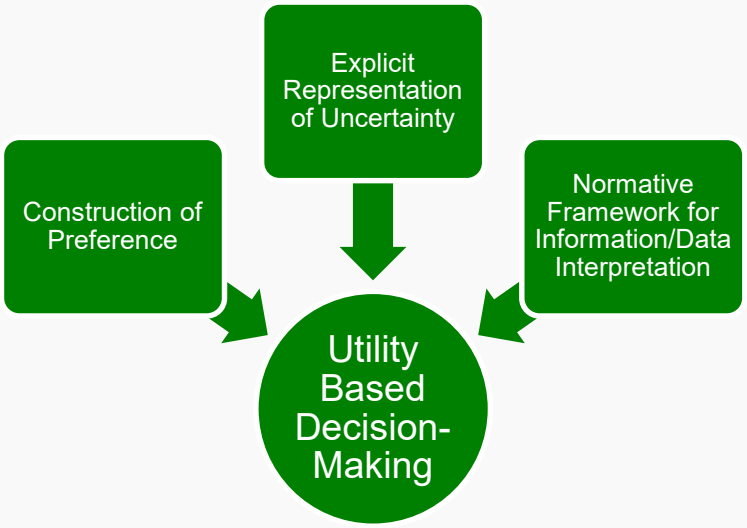
Decision Analysis in DASEES

Two Key Concepts in DASEES

- *Decision Analysis* provides intellectual rigor and theoretical underpinning
  - Prescriptive application of decision theory
  - Multi-Attribute Utility Theory (MAUT)
  - Probabilistic Causal Modeling
- *Structured Decision Making* provides logical process for group decision-making



Multi-Criteria Decision Analysis (MCDA)

The way good decisions are made

MCDA is useful for:

- differing views of decision makers (DM) and stakeholders
- guiding DM with problems that have no single best solution (tradeoffs)

MCDA helps:

- Quantify value judgments
- Score alternatives via criteria
- Facilitate selection of a preferred option

Multi-Criteria Decision Analysis

Multi-Objective Decision Making (MODM)
Compromise among competing objectives

Multi-Attribute Decision Making (MADM)
Choosing among competing alternatives

Continuous Variables
Engineered systems
More control/less variability
Optimizing processes

Computer finds optimal solution in decision landscape
Efficiency

Discrete Alternatives
Complex social/political Systems
Less Control/ More variability
Adaptive Management

Decision-maker uses ranking techniques to choose alternative
Effectiveness

Varieties of Decision Support Approaches

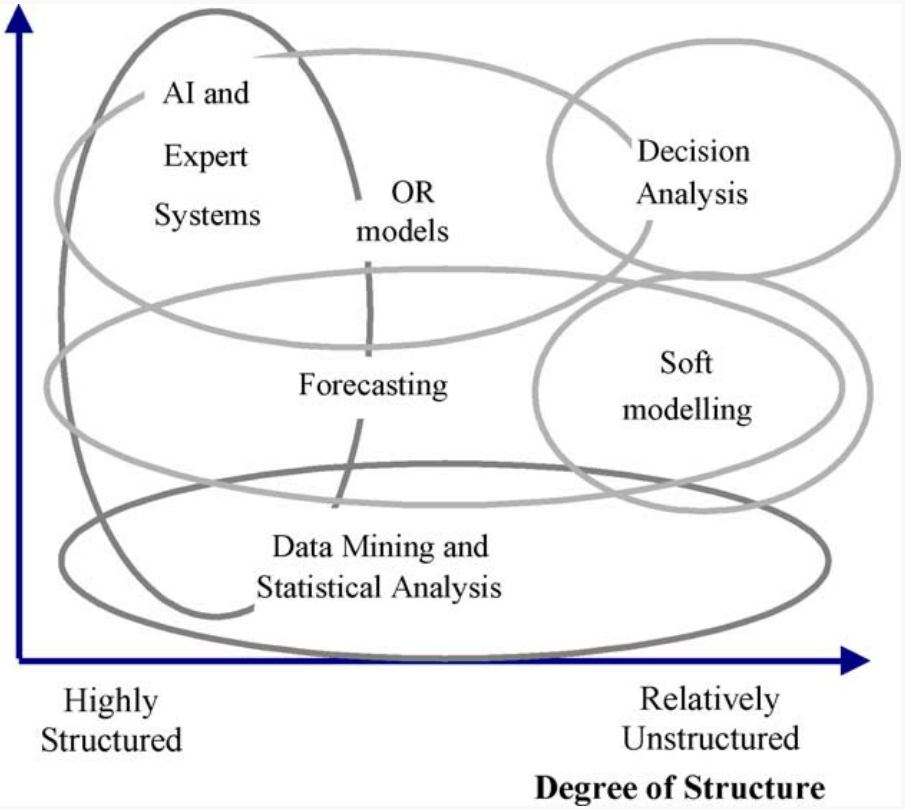
Levels of Decision Support

Level 3: Evaluation and ranking of alternative strategies in the face of uncertainty by balancing their respective benefits and disadvantages.

Level 2: Simulation and analysis of the consequences of potential strategies; determination of their feasibility and quantification of their benefits and disadvantages.

Level 1: Analysis and forecasting of the current and future environment.

Level 0: Acquisition, checking and presentation of data, directly or with minimal analysis, to DMs



– French et al, 2009

Structured Decision-Making

" A formalization of common sense

for decision problems which are too complex

for informal use of common sense"

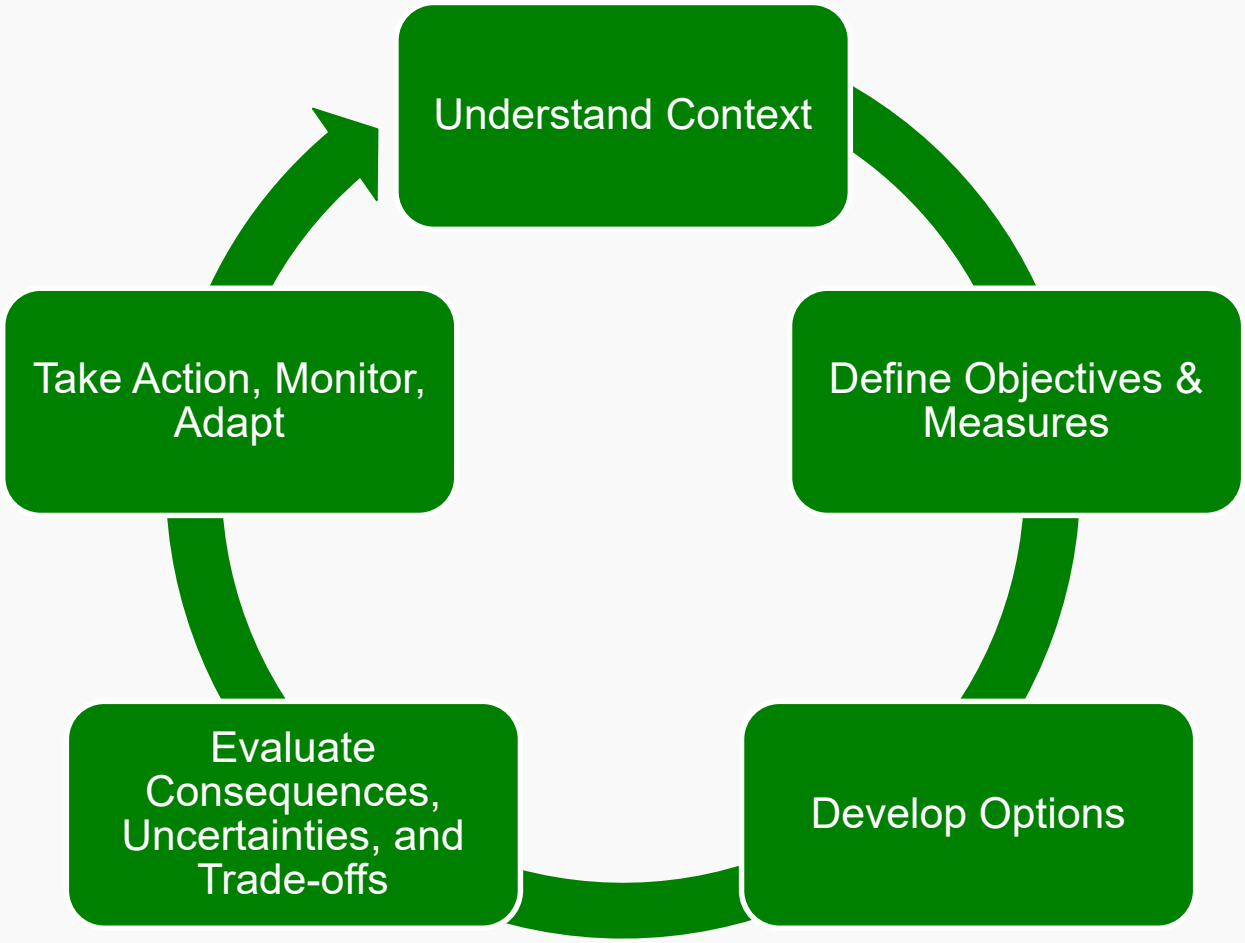
- Keeney, 1982

Structured Decision-Making

An organized approach to integrate Facts (Scientific Knowledge) & Values (Stakeholder Concerns)

- **Problem Structuring**
  - Find common understanding of complex multi-faceted problem
- **Solution Creation, Evaluation, Implementation**
  - Identify and evaluate innovate management alternatives
  - Implement, monitor, adapt

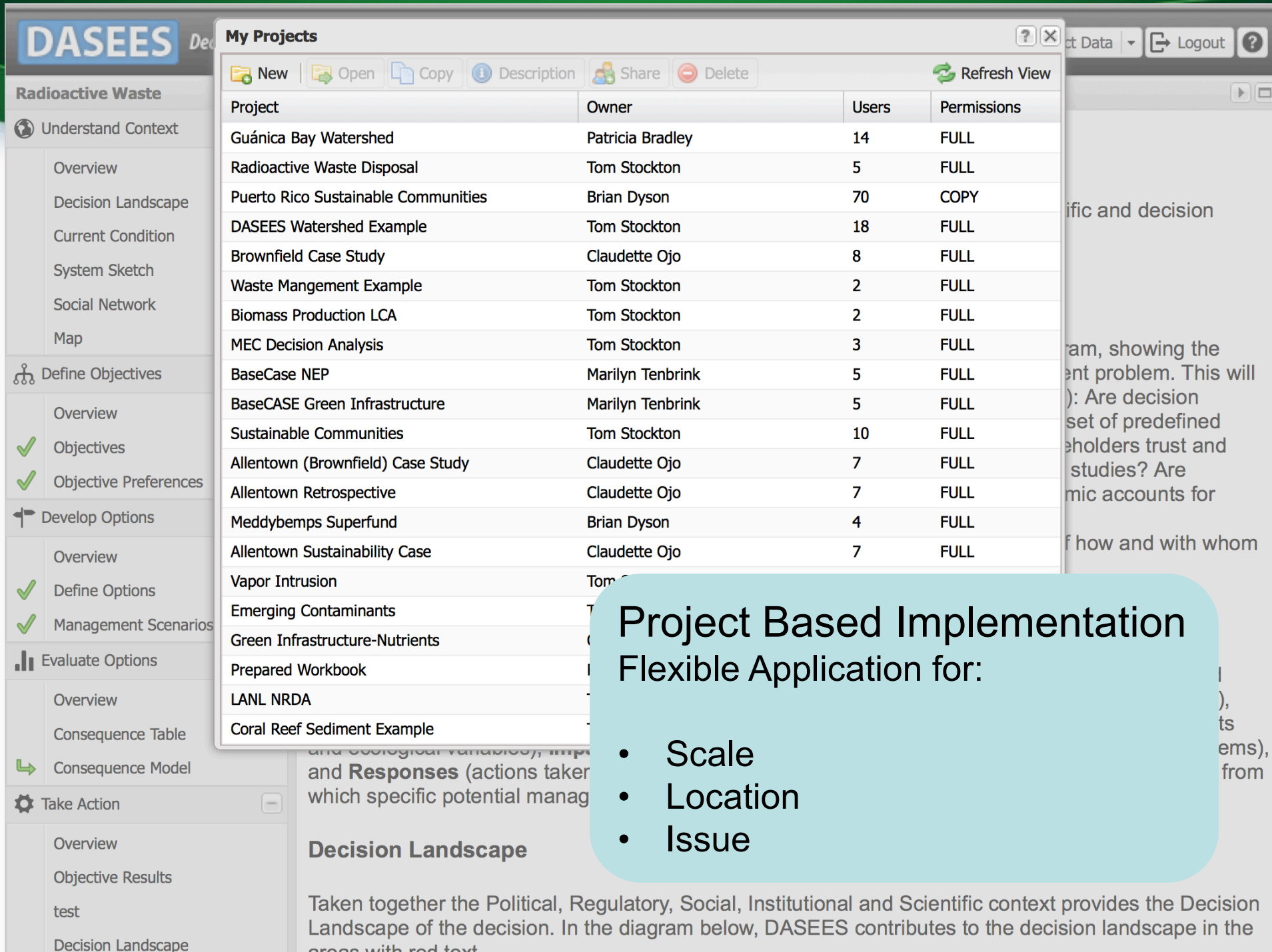
DASEES SDM Process



DASEES Function and Philosophy:

- **Web-based framework supporting stakeholder-driven group decision-making**
- **organizes use of tools/data/information needed for decision**
- **Includes stakeholder perspectives and tools for analysis and evaluation**

Problem Formulation – Alternative assessment, selection, implementation


DASEES
Logout
Radioactive Waste
Understand Context
Overview
Decision Landscape
Current Condition
System Sketch
Social Network
Map
Define Objectives
Overview
Objectives
Objective Preferences
Develop Options
Overview
Define Options
Management Scenarios
Evaluate Options
Overview
Consequence Table
Consequence Model
Take Action
Overview
Objective Results
test
Decision Landscape
My Projects
New
Open
Copy
Description
Share
Delete
Refresh View
Project
Owner
Users
Permissions
Guánica Bay Watershed
Patricia Bradley
14
FULL
Radioactive Waste Disposal
Tom Stockton
5
FULL
Puerto Rico Sustainable Communities
Brian Dyson
70
COPY
DASEES Watershed Example
Tom Stockton
18
FULL
Brownfield Case Study
Claudette Ojo
8
FULL
Waste Mangement Example
Tom Stockton
2
FULL
Biomass Production LCA
Tom Stockton
2
FULL
MEC Decision Analysis
Tom Stockton
3
FULL
BaseCase NEP
Marilyn Tenbrink
5
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BaseCASE Green Infrastructure
Marilyn Tenbrink
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Sustainable Communities
Tom Stockton
10
FULL
Allentown (Brownfield) Case Study
Claudette Ojo
7
FULL
Allentown Retrospective
Claudette Ojo
7
FULL
Meddybemps Superfund
Brian Dyson
4
FULL
Allentown Sustainability Case
Claudette Ojo
7
FULL
Vapor Intrusion
Emerging Contaminants
Green Infrastructure-Nutrients
Prepared Workbook
LANL NRDA
Coral Reef Sediment Example
Project Based Implementation
Flexible Application for:
Scale
Location
Issue
and Responses (actions taker
which specific potential manag
Decision Landscape
Taken together the Political, Regulatory, Social, Institutional and Scientific context provides the Decision Landscape of the decision. In the diagram below, DASEES contributes to the decision landscape in the

Guánica Bay Watershed
Understand Context
Overview
Decision Landscape
System Thinking
Social Network
Map
Define Objectives
Overview
Objectives
Objective Preferences
Develop Options
Overview
Define Options
Management Scenarios
Evaluate Options
Overview
Consequence Table
Consequence Model
Take Action
Overview
Decision Landscape
Adaptive Management

Decision Landscape

Save | Revert | New | Delete | Rename | Help

Overview | Stakeholders | Regulations | Scientific Setting

Tahoma

What is DASEES?

DASEES implements a formal process often termed Structured Decision Making (SDM) that facilitates decision-making through the integration of science and fact-based information with stakeholder-derived values in an analytic-deliberative structure (Gegory et al., 2012). The deliberative side of **DASEES** supports common understanding, objective development, and measures identification. The analytic side supports the integration of data, information, models, and tools necessary to solve the decision problem at hand. **DASEES** aids this through the combined use of embedded decision-analytic tools and user-selected external resources.

Formalized Common Sense

Applying the ideas of value-based decision-making to complex environmental management problems requires a conceptual framework or formalized process to ensure that a decision is c

(1982) described t

sense."

Understa

The first step in **DASEES** is to understand the decision context.

The **Decision Landscape** compiles the perspectives of Stakeholders, requirements of Regulation, and available Scientific Knowledge to scope the context of the decision. Bringing together the background information for a decision problem combined with the other tools in this step support the identification of common values, leading to the development of decision objectives.

Ralph Keeney (1982) Decision Analysis: An Overview. Operations Research, Vol. 30, No. 5 (Sep. - Oct., 1982), pp. 803-838.

R. Gregory, L. Failing, M. Harstone, G. Long, T. McDaniels, D. Ohlson (2012) Structured Decision Making: A Practical Guide to Environmental Management Choices. John Wiley & Sons

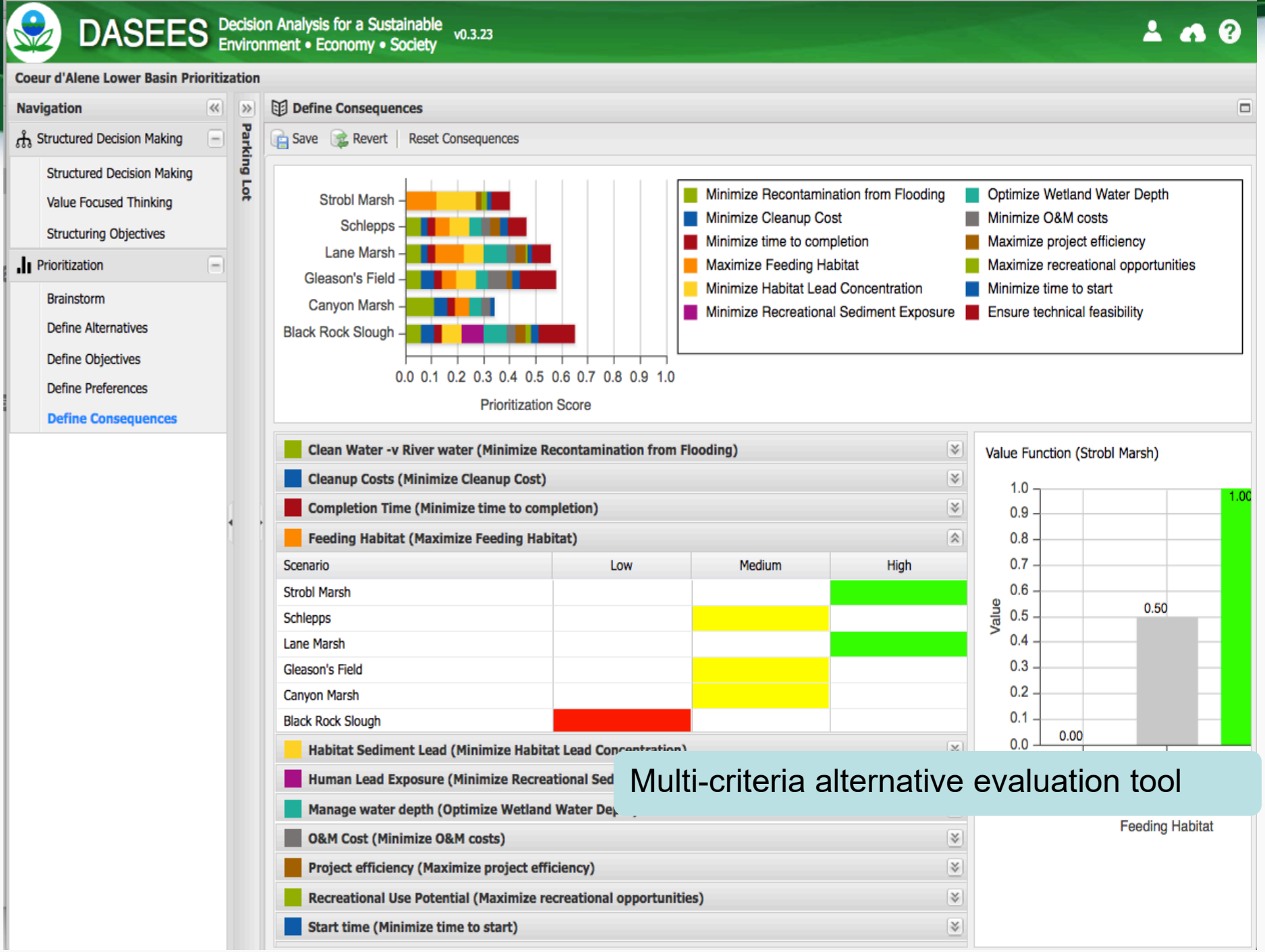
Overview

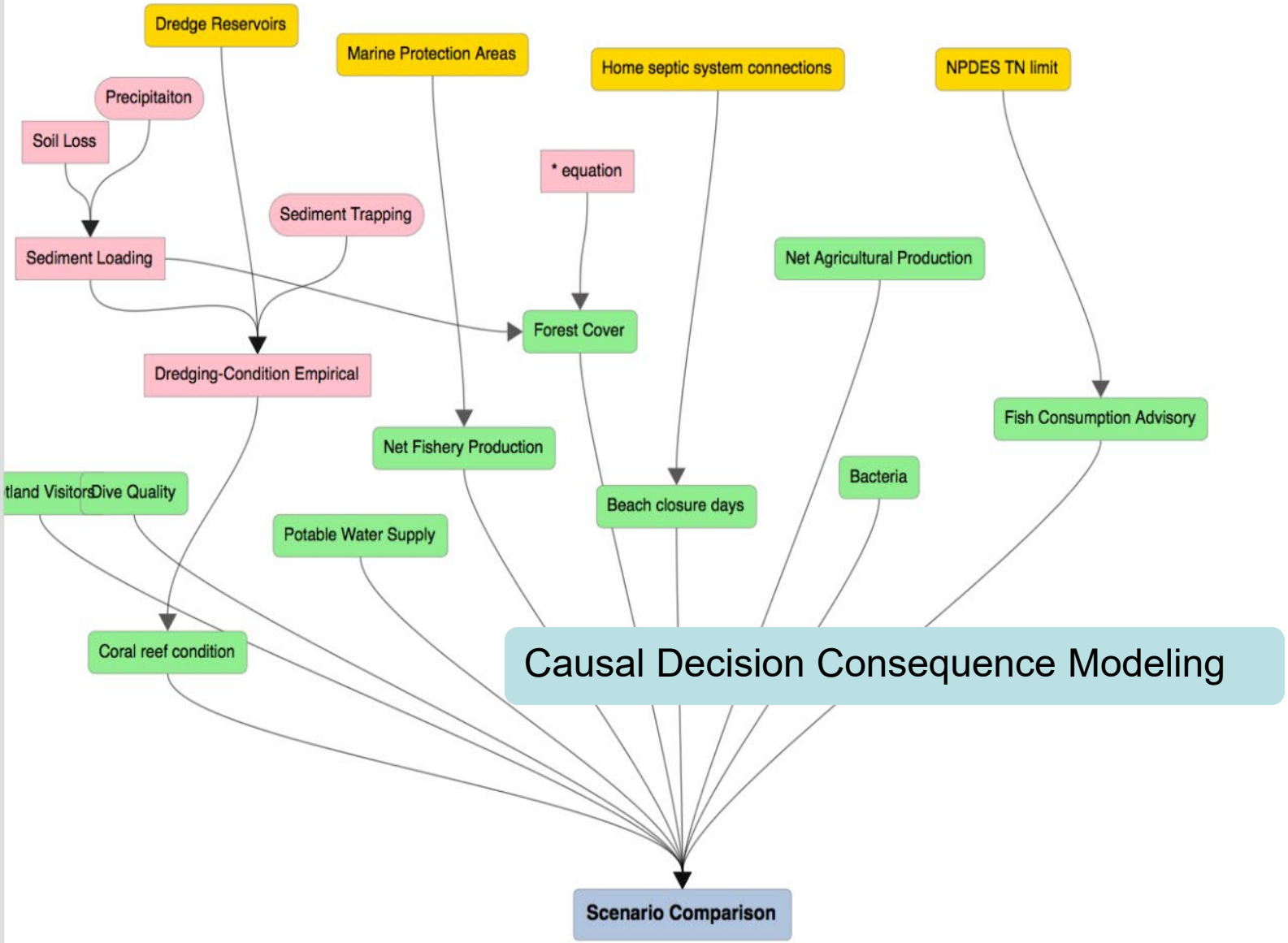
The **Guánica Bay watershed** is located in the southwestern corner of Puerto Rico, approximately 20 miles west of the city of Ponce and 100 miles southwest of San Juan. The watershed is approximately 151 square miles and discharges to Guánica Bay near the town of Guánica. The Guánica Bay watershed includes the urbanized areas of Yauco and a portion of the Lajas Valley agricultural region.

The Guánica Bay watershed is a highly manipulated watershed. It has been artificially increased in drainage area by a series of interbasin or inter-watershed water transfers, five reservoirs and two hydroelectric plants (Yauco 1 and 2) known as the Southwest Water Project. This project, operated by Puerto Rico Electric Power Authority (PREPA), was completed in order to increase and regulate potable water from the high elevation watersheds of the central cordillera (mountain region) for use by the local populations in Yauco, Guánica and the Lajas Valley for irrigation of crops and flood control

Progress Tracking

- Helps user navigate through steps of process


DASEES
Decision Analysis for a Sustainable Environment • Economy • Society
v0.3.23
Coeur d'Alene Lower Basin Prioritization
Navigation
Structured Decision Making
Structured Decision Making
Value Focused Thinking
Structuring Objectives
Prioritization
Brainstorm
Define Alternatives
Define Objectives
Define Preferences
Define Consequences
Parking Lot
Define Consequences
Save
Revert
Reset Consequences
Strobl Marsh
Schlepps
Lane Marsh
Gleason's Field
Canyon Marsh
Black Rock Slough
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Prioritization Score
Minimize Recontamination from Flooding
Minimize Cleanup Cost
Minimize time to completion
Maximize Feeding Habitat
Minimize Habitat Lead Concentration
Minimize Recreational Sediment Exposure
Optimize Wetland Water Depth
Minimize O&M costs
Maximize project efficiency
Maximize recreational opportunities
Minimize time to start
Ensure technical feasibility
Clean Water -v River water (Minimize Recontamination from Flooding)
Cleanup Costs (Minimize Cleanup Cost)
Completion Time (Minimize time to completion)
Feeding Habitat (Maximize Feeding Habitat)
Scenario
Low
Medium
High
Strobl Marsh
Schlepps
Lane Marsh
Gleason's Field
Canyon Marsh
Black Rock Slough
Habitat Sediment Lead (Minimize Habitat Lead Concentration)
Human Lead Exposure (Minimize Recreational Sed
Manage water depth (Optimize Wetland Water De
O&M Cost (Minimize O&M costs)
Project efficiency (Maximize project efficiency)
Recreational Use Potential (Maximize recreational opportunities)
Start time (Minimize time to start)
Value Function (Strobl Marsh)
Value
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.00
0.50
1.00
Feeding Habitat
Multi-criteria alternative evaluation tool



DASEES Watershed Example

Understand Context
- Overview
- Decision Landscape
- Current Condition
- System Sketch
- Social Network
- Map

Define Objectives
- Overview
- Objectives
- Objective Preferences

Develop Options
- Overview
- Define Optic
- Management Scenarios

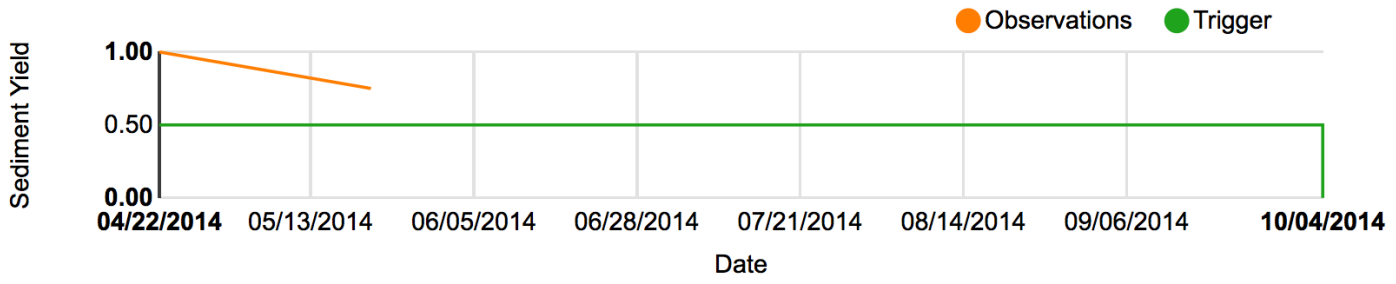
Evaluate Options
- Overview
- Consequence Table
- Consequence Model

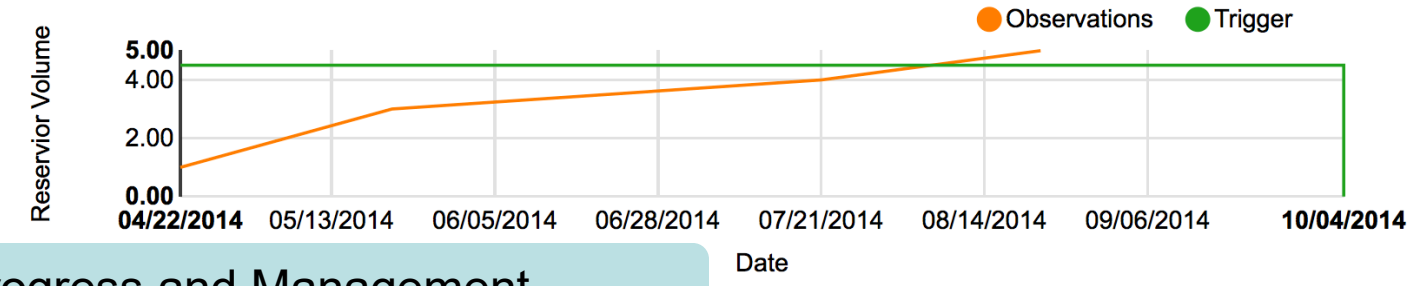
Take Action
- Overview
- Decision Landscape
- Adaptive Management

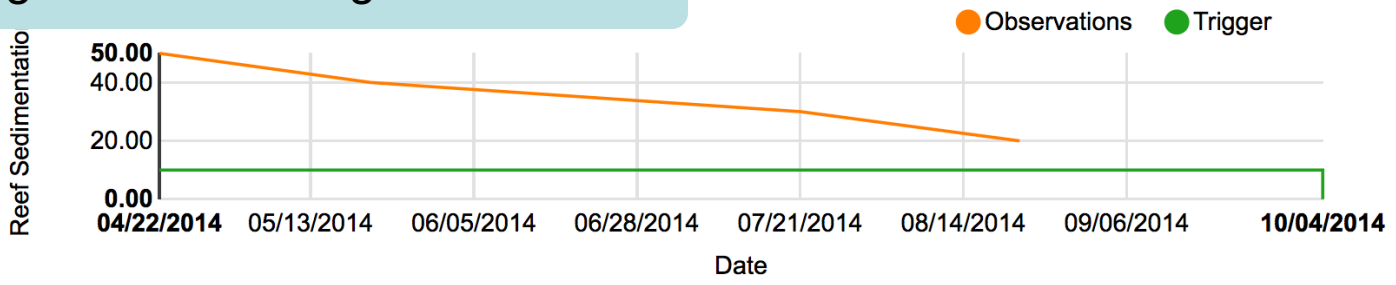
Adaptive Management

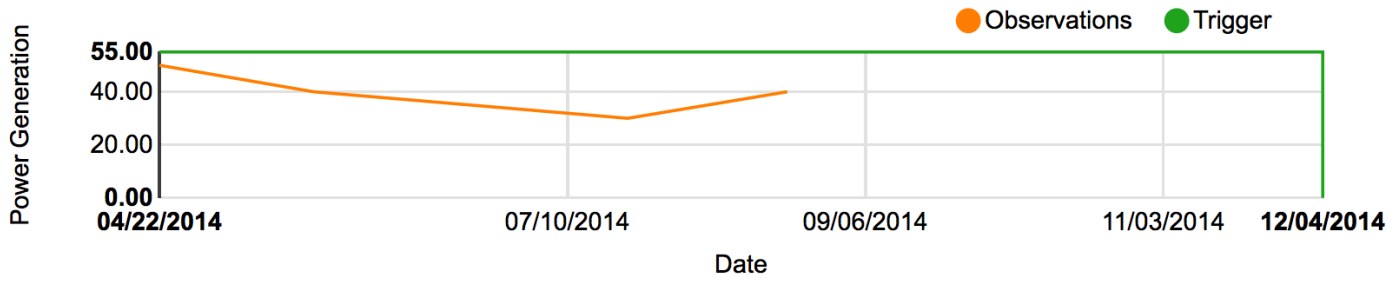
Overview | Summary | Triggers

Tracking Progress and Management



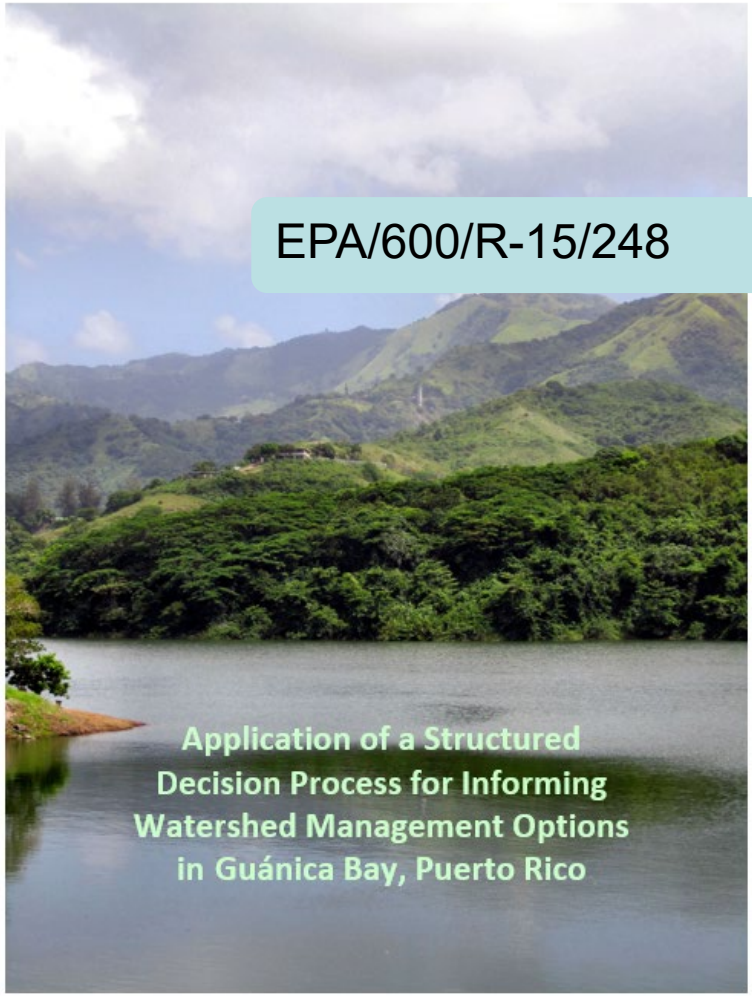






Regional Scale: Guanica Bay, Puerto Rico
Issue: Watershed Management

EPA United States Environmental Protection Agency



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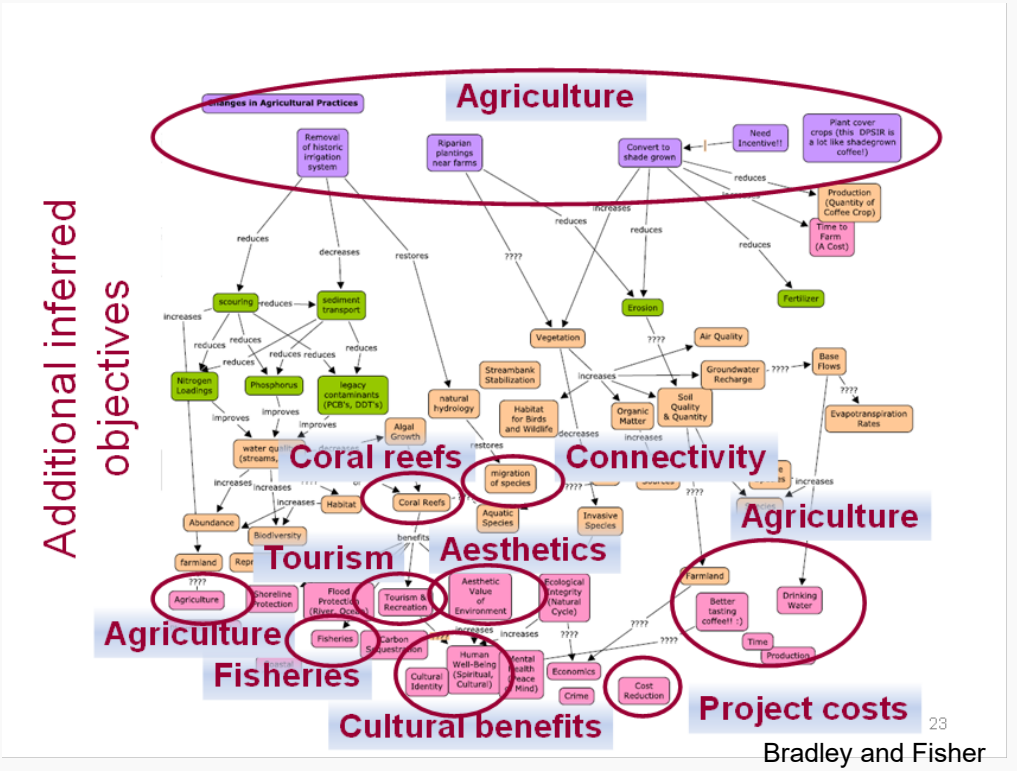
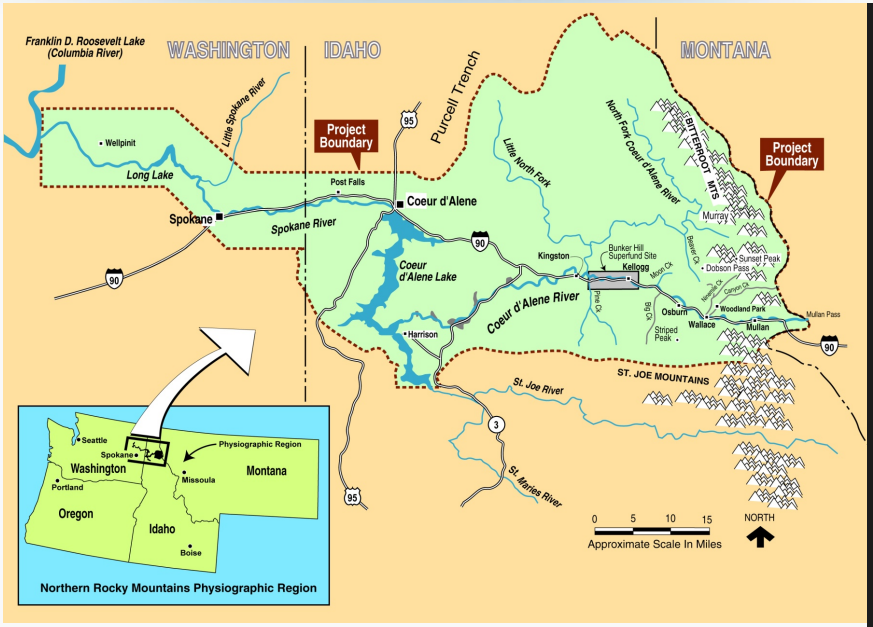
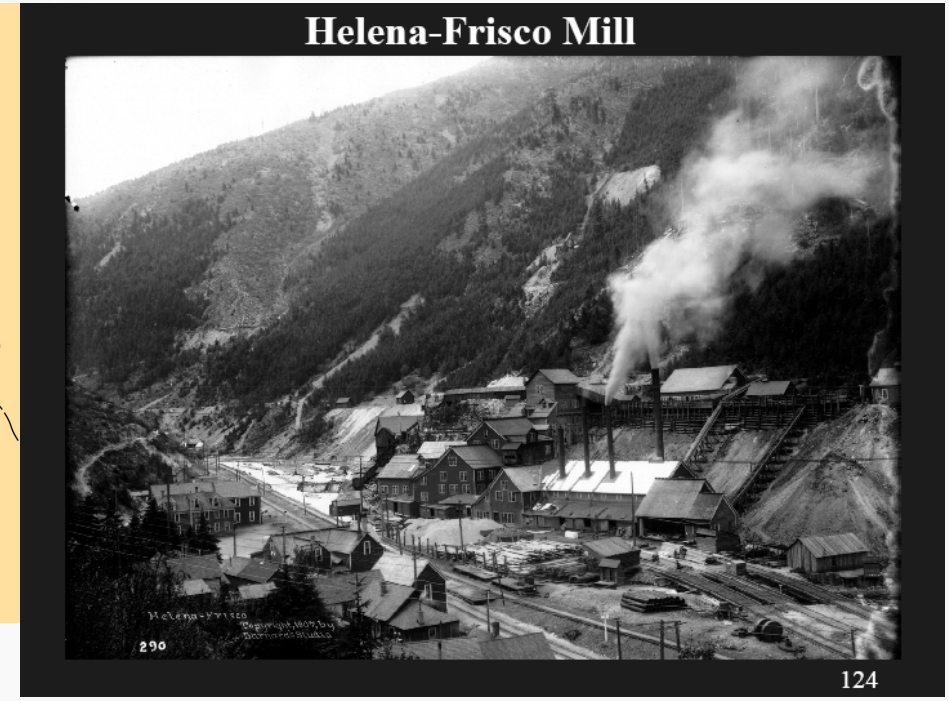


Bradley and Fisher

Managing for economic, environmental and social concerns





Coeur d'Alene Basin

- Mining and milling began in the 1880s
- Until 1968, mine waste discharged directly to creeks and rivers
- Estimated over 100 million tons of mine waste over thousands of acres

Dania Beach Resiliency Planning Workshop

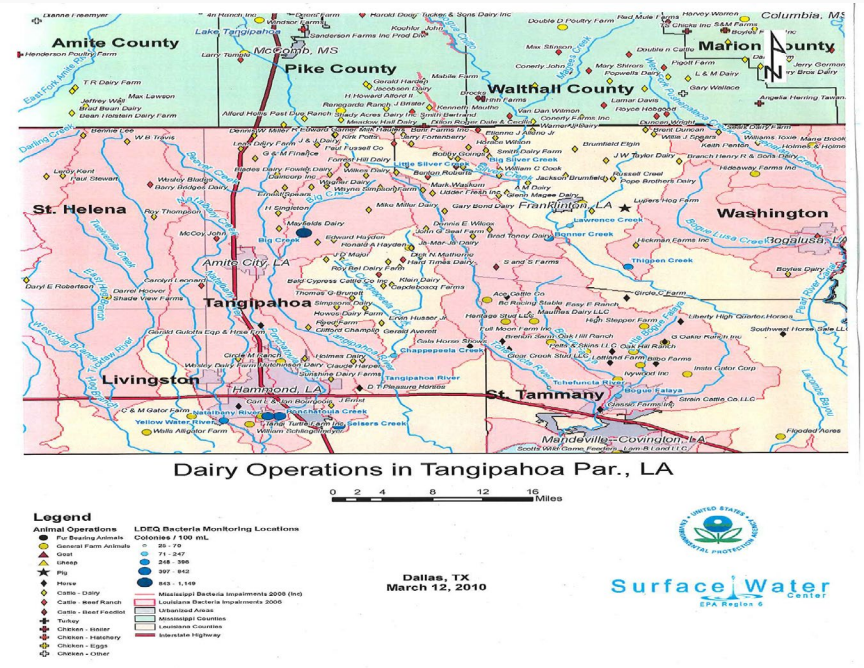
Purpose:

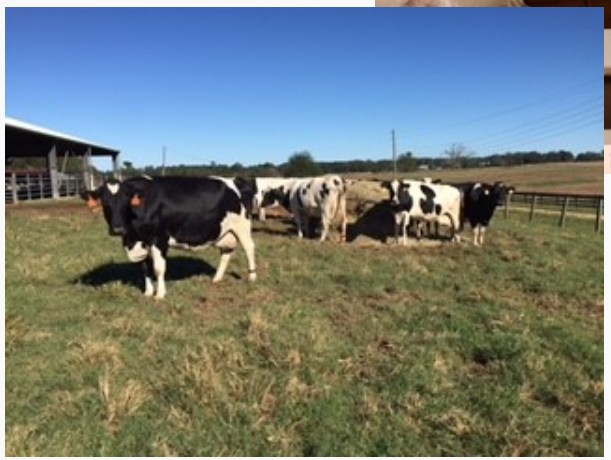
This two-day meeting will bring stakeholders together to develop common objectives and solutions for the resiliency challenges facing Dania Beach and identify the technical needs to evaluate those solutions.

Workshop Objectives

- Bring stakeholders together to develop a shared understanding of the inter-related economic, social, and environmental challenges facing Dania Beach.
- Identify resiliency goals for the region, including health & safety, community well-being, ecological integrity, and economic competitiveness.
- Devise management actions responsive to identified goals
- Develop conceptual models to evaluate proposed resiliency management actions, and identify scientific, technical, and socio-economic data/information needs.

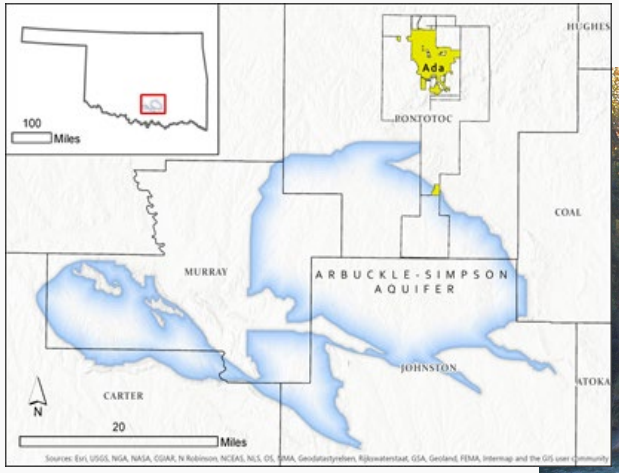
Louisiana Dairy Farms

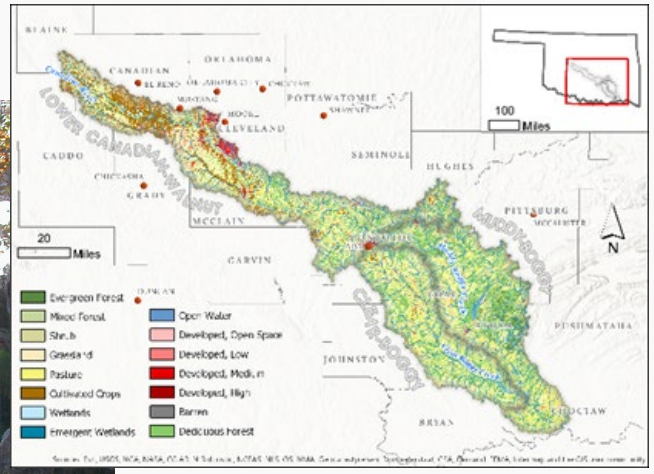




- Small Dairy Farms have challenges related to waste management
- Waste Lagoons failing, causing discharge directly to creeks and rivers
- Need to find better, cheaper ways to manage waste and achieve WQS

City of Ada Sustainability and Resiliency





- Arbuckle-Simpson Aquifer is sole source water supply for several Communities
- Community Growth is putting increasing demands on aquifer
- Need for multi-stakeholder, multi-community sustainability and resiliency plan

DASEES in Summary

- DASEES will help:
  - Find common understanding of complex problem
  - Create, analyze, select, and implement solutions
  - Manage the overall decision-making process
  - Organize decision-relevant information
- DASEES application is user defined
  - Useful for complex decision problems with uncertainty
- Adaptable data/information needs
  - Expert judgment
  - Varied data sources, e.g. local, government, NGOs, etc.