Seasonal-Scale Optimization of Conventional Hydropower Operations

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Goal

- **Explore alternative management strategies**
  - **Considering**
    - **Revenue**
    - **Environmental goals and constraints**
    - **Trade-offs**
    - **Long-term allocation issues**
  - **Hope to add flexibility**
    - **Manage for revenue as well as for environmental performance**

Hydro-SCOPE

- **Hydropower Seasonal Concurrent Optimization for Power and the Environment tool**

- **Integrated simulation and optimization tool**

- **Systems level , seasonal scale**

- **Allows us to**
  - **Explore different operational strategies**
  - **Understand tradeoffs between objectives**

- **Flexible (can be applied to different systems)**

Test Case

- **Cougar Reservoir**
  - **South Fork of the McKenzie River**
- **Using historical data**
- **Evolving example**
  - **Exploring different optimization strategies**
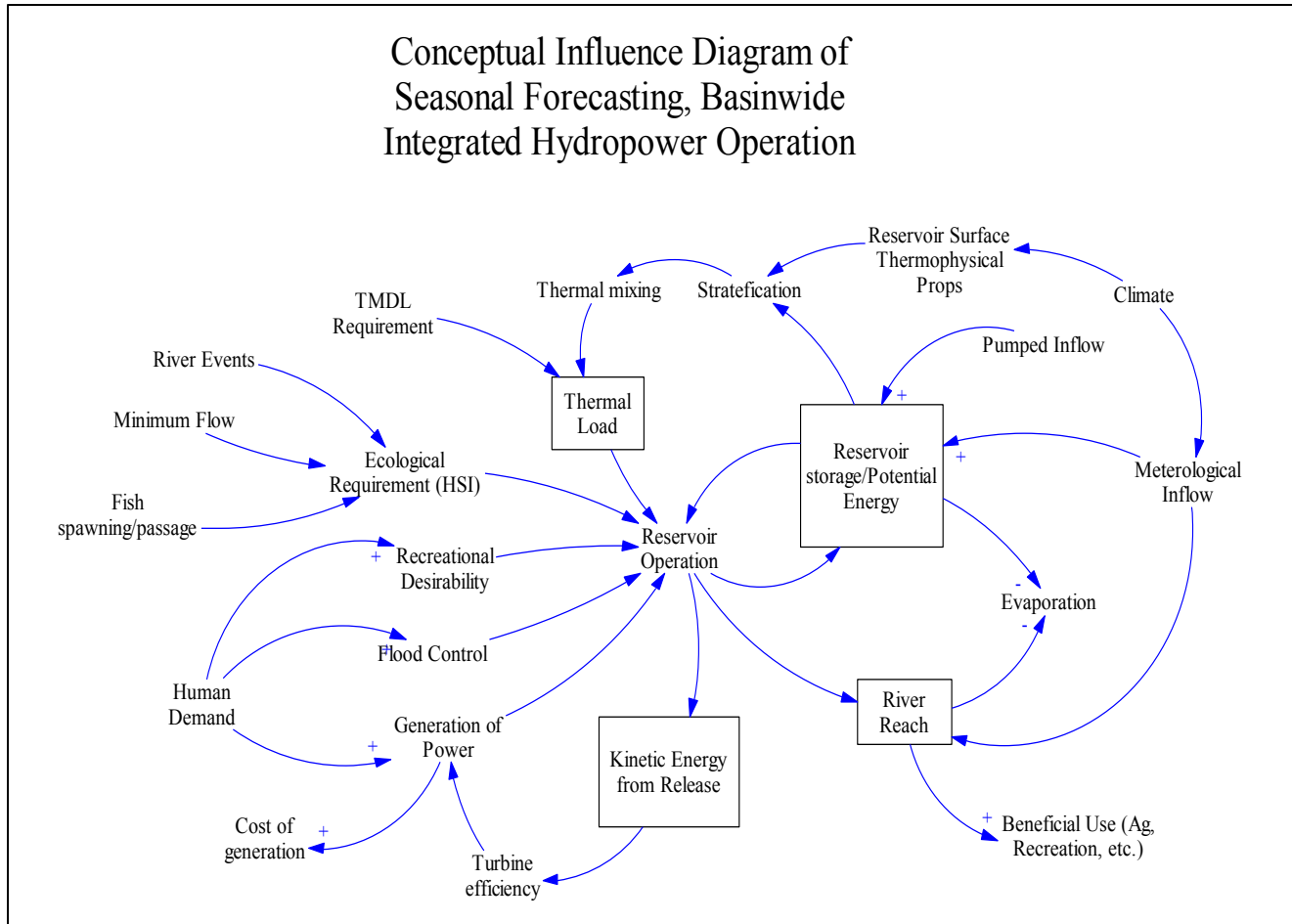

Map from nationalatlas.gov

Project Framework

Optimization Engine (Dakota)

Simulation Model
(Matlab)

- **Can be adapted to any hydrologic system**
  - **Model specifications**
  - **Management goals (objectives and constraints)**

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Simulation Model

Conceptual Influence Diagram of
Seasonal Forecasting, Basinwide
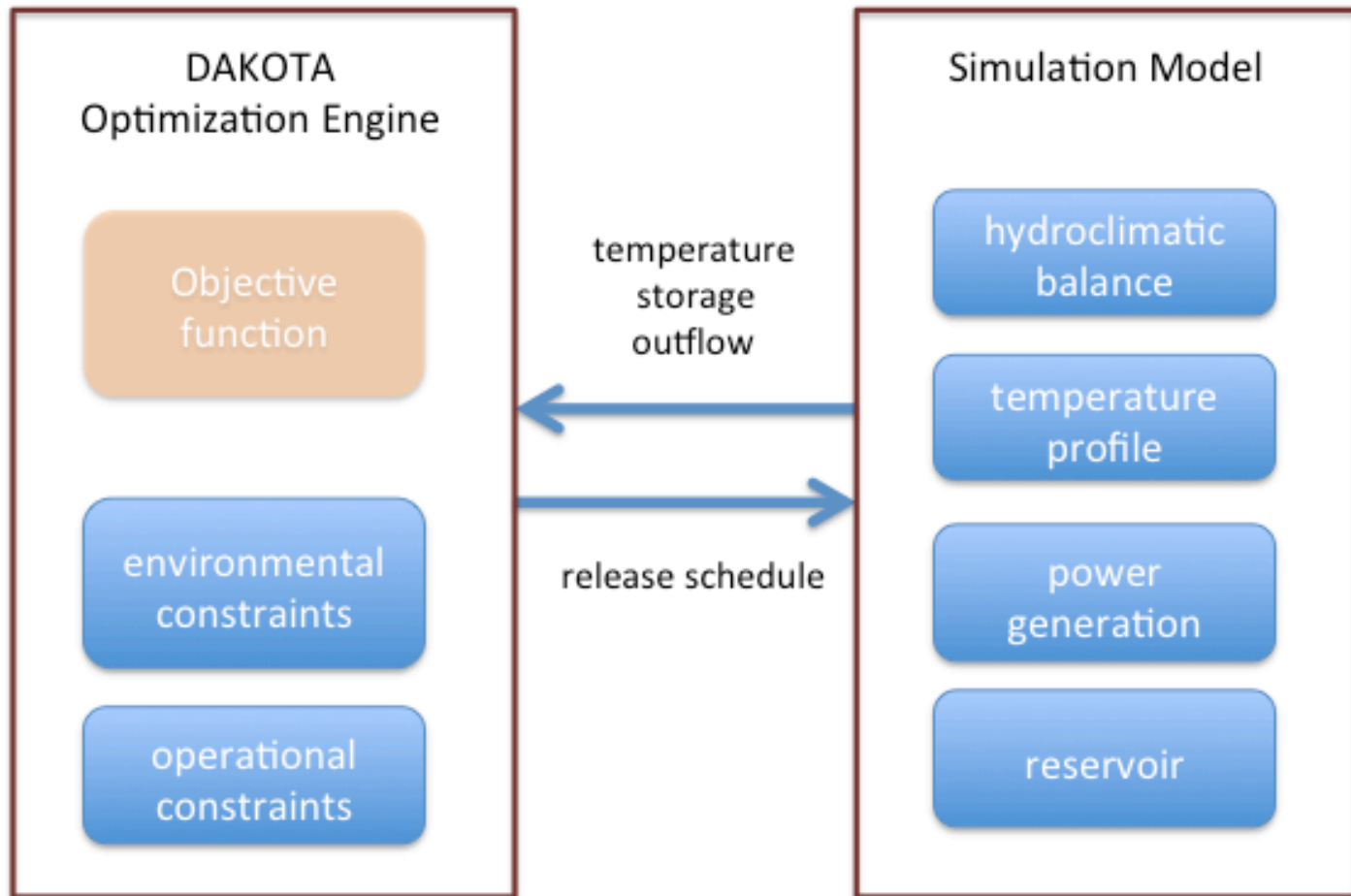Integrated Hydropower Operation

DAKOTA

- **Design Analysis Kit for Optimization and Terascale Applications**

- **Open source software**

  - **Developed at Sandia**

- **Optimization, Uncertainty Quantification, Sensitivity Analysis**
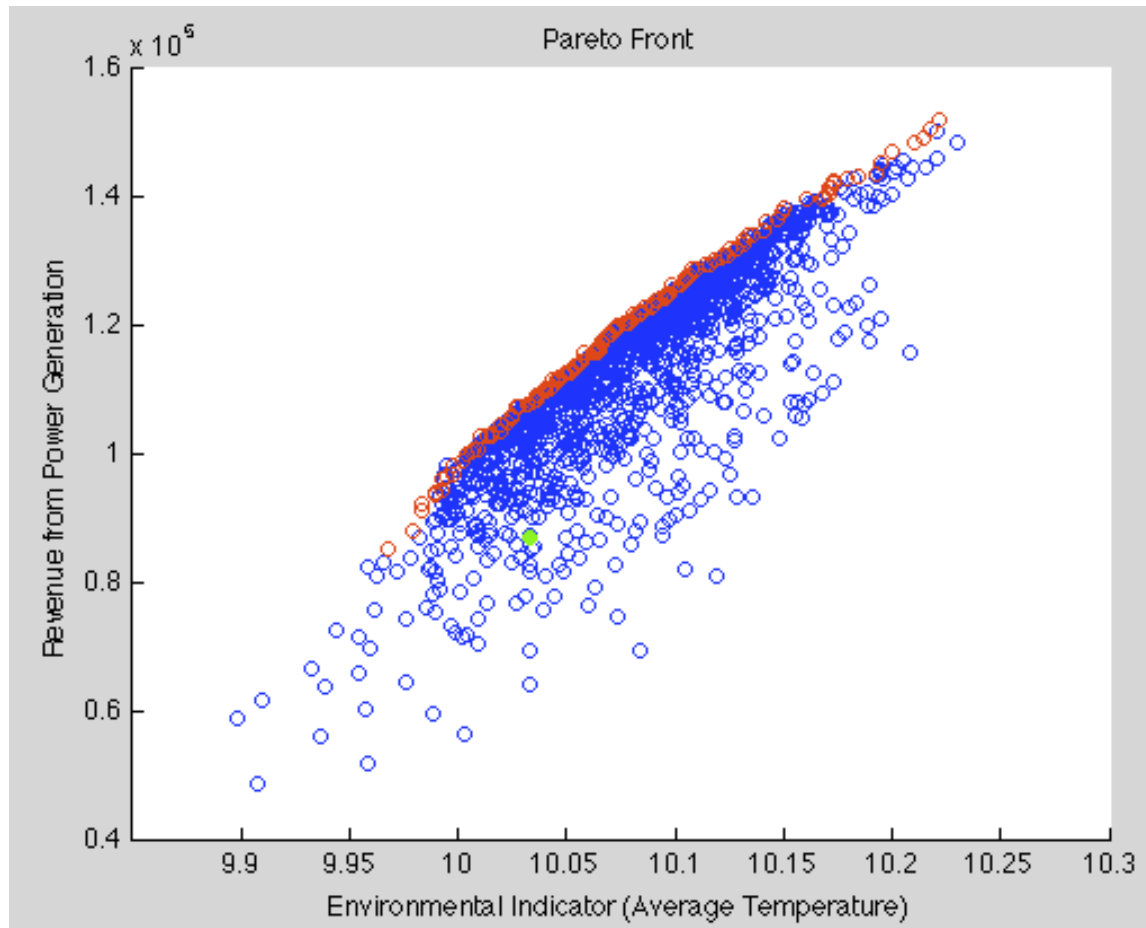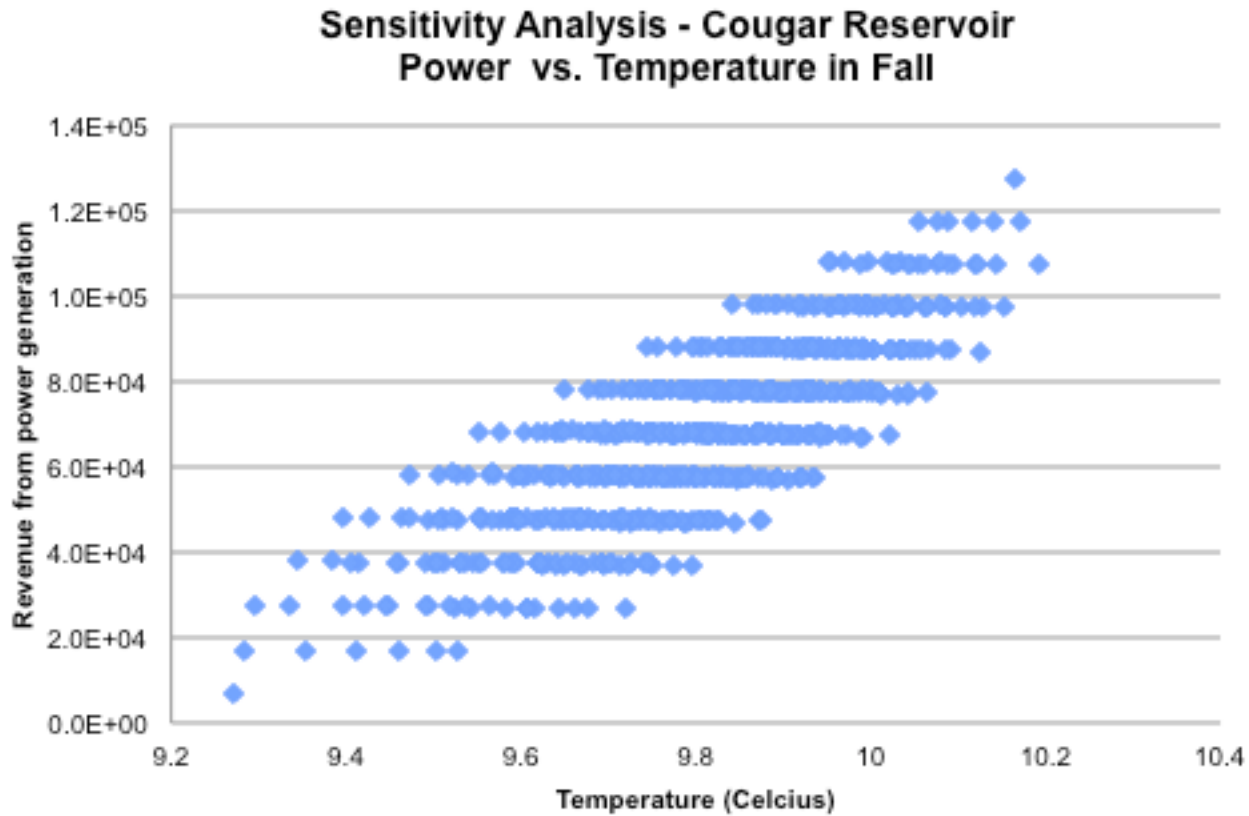
Optimization Framework

Optimization Test Problem

- **Objectives**
  - **Maximize revenue from power generation**
  - **Minimize average temperature of releases**
- **Constraints**
  - **Minimum flow requirement**
  - **Maximum temperature requirement**

Pareto Front

Sensitivity Analysis

Sensitivity Analysis - Cougar Reservoir
Power vs. Temperature in Fall

Next Steps

- **Demonstration sites**
- **Integrate with multi-lab project**
    - **Day-ahead model**
    - **Environmental objectives**
    - **Hydrologic forecasting**
- **Including uncertainty**
    - **Ensemble forecasts**

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