University of California, Davis
Department of Land, Air and Water Resources

Introduction to Simulation Models

ESM-121 Water Science and Management

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Presentation 4 of 10

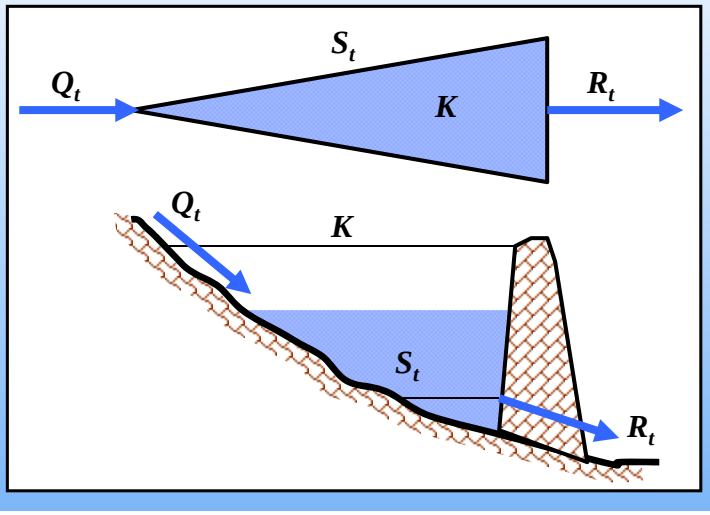
RESERVOIRS

Hoover Dam	Shasta Dam	Oroville Dam
158 m	*159 m*	*230 m*
35.2 Km³	*5.6 Km³*	*4.4 Km³*
4.2 bill. KWh	*1.8 bill. KWh*	*2.2 bill. KWh*
$49M - 1936	*$36M - 1945*	

DAMS

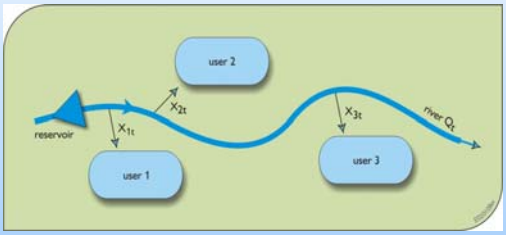
- **Masonry**
  - Arch Dams
    - Gravity Dams
- **Embankment dams**
  - Rock-fill and earth-fill dan
- **Spillways**

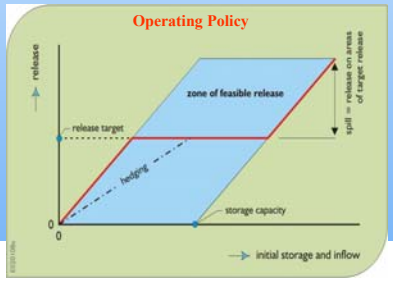
RESERVOIR

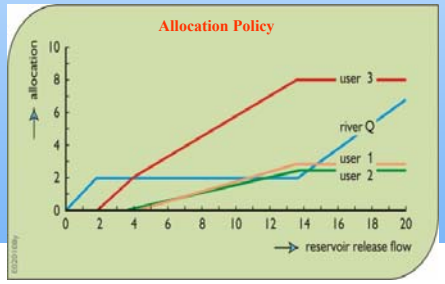


NEED FOR TOOLS …

Allocate reservoir release R_t to 3 users and provide instream flow Q_t

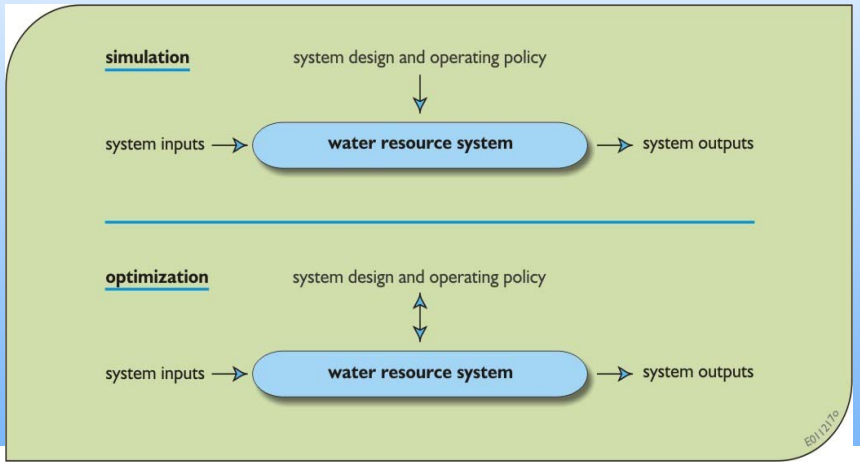






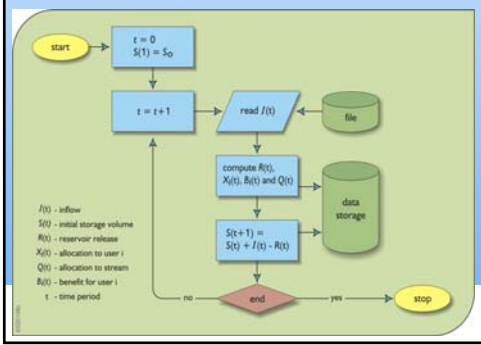
SIMULATION VS OPTIMIZATION

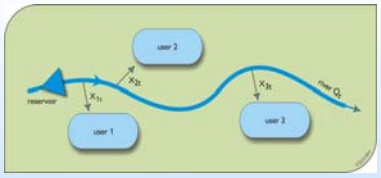
- Simulation models: Predict response to **given design**
- Optimization models: Identify **optimal design** or operation

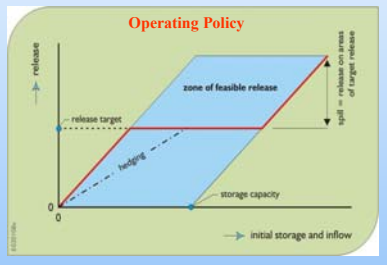


SIMULATION

- Address "**What if …**" questions
- What will likely happen
- Include larger hyd, econ, and env. data
- i.e. "evaluate change <u>given a design or policy</u>"

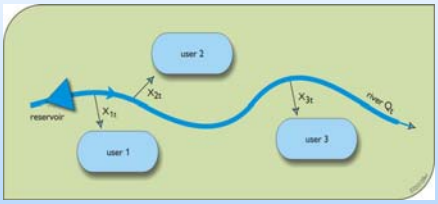






OPTIMIZATION

- Used for design:
  - "Maximize the Net Benefits …" or
  - "Minimize the shortages"
- Look for the best (ideal) operation
- Perfect foresight



Optimization model

Benefits: $B_i(x_{it})$

Decision Variables: x_{it}

Objective:

$$Maximize \sum_{t=1}^{T} \sum_{i=1}^{3} B_i(x_{it})$$

Constraints:

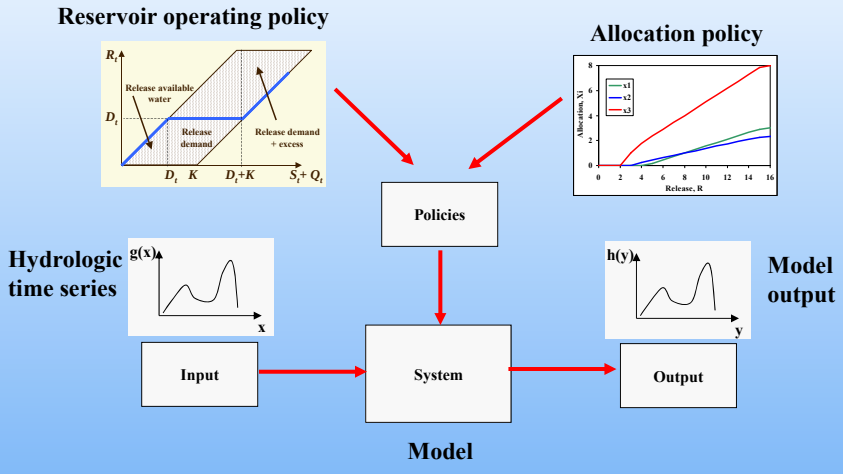
$$x_{1t} + x_{2t} + x_{3t} \le R_t \quad t = 1,2,\cdots$$

$$S_{t+1} = S_t + I_t - R_t \quad t = 1,2,\cdots$$

$$S_t \le K \quad t = 1,2,\cdots$$

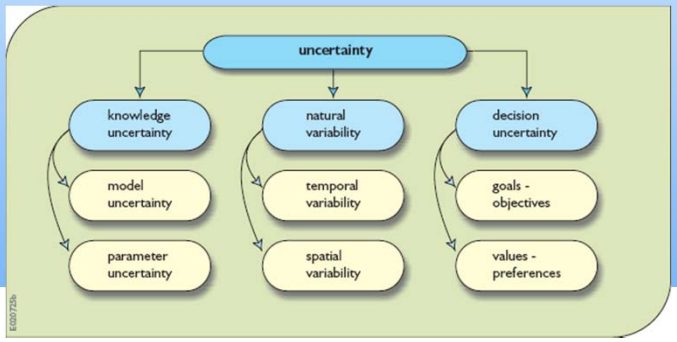
Optimization model

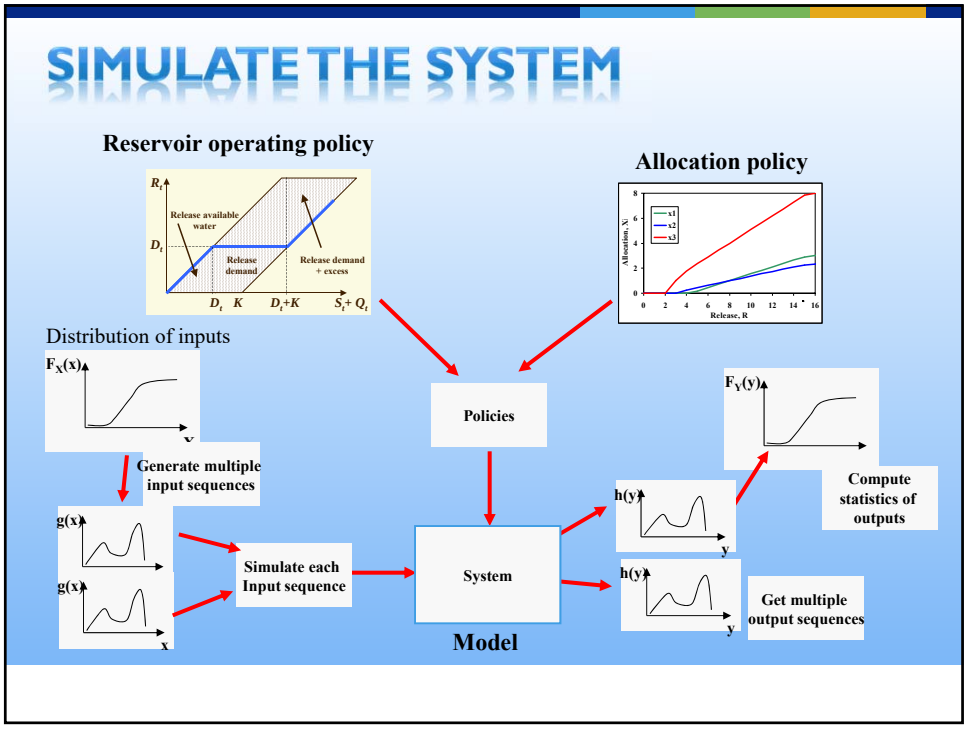
SIMULATE THE SYSTEM



UNCERTAINTY

- Deterministic process
  - Inputs assumed known.
  - Ignore variability
  - Assume inputs are well represented by average values.
  - Over estimates benefits and underestimates losses
- Stochastic process
  - Explicitly account for variability and uncertainty
  - Inputs are stochastic processes
  - Historic record is one realization of process.




SIMULATE THE SYSTEM
Reservoir operating policy
Release available water
Release demand
Release demand + excess
Allocation policy
x1
x2
x3
Allocation, Xi
Release, R
Distribution of inputs
Generate multiple input sequences
Simulate each Input sequence
Policies
System
Model
Compute statistics of outputs
Get multiple output sequences