



Optimization Models for Hydrosystems: An introduction

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Overview

- The meaning of Hydrosystems.
- Types of Hydrosystems problems.
- Conventional design and analysis.
- Simulation vs Optimization approaches.
- Methodologies and steps to solve optimization problems.
- Application of optimization models in Hydrosystems.

The meaning of Hydrosystems.

- Hydrosystems is a term originally coined by V.T.Chow to describe collectively the technical areas of hydrology, hydraulics, and water resources including the application of economics, optimization, probability, statistics, and management.
- **Types of Hydrosystems water projects including;** Storage systems, Groundwater systems, Distribution systems, Flood control systems, Urban drainage systems...etc.

Types of Hydrosystems problems.

The major types of problems (Buras, 1972) that must be solved for various types of Hydrosystems are:

1. Choosing the best scale for the project's development.
2. identifying the optimal dimensions of the system's various components
3. determination of the system's optimal operation

If the solutions to these problems are denoted as x_1, x_2 , and x_3 , then the **Profits** of these solutions are : $P=f(x_1, x_2, x_3)$;

The objective of many projects is to maximize the **Profits** or minimize the **Costs**

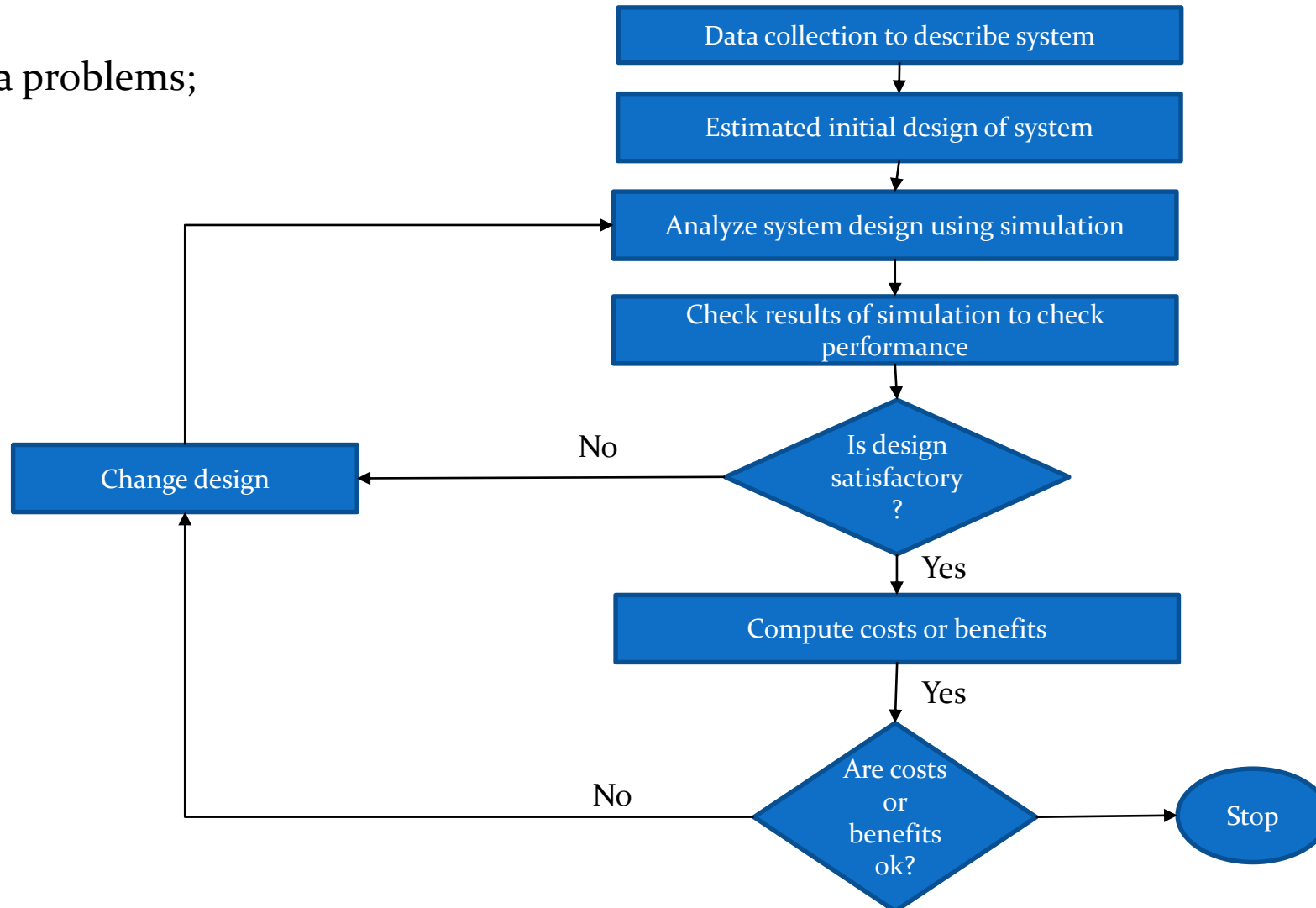
Maximize $P=f(x_1, x_2, x_3)$ or Minimize $C=f(x_1, x_2, x_3)$

Subject to various constraints including;

- Technological constraints.
- Economic or budgetary constraints.
- Design constraints.
- Operation constraints.
- Demand constraints and others.

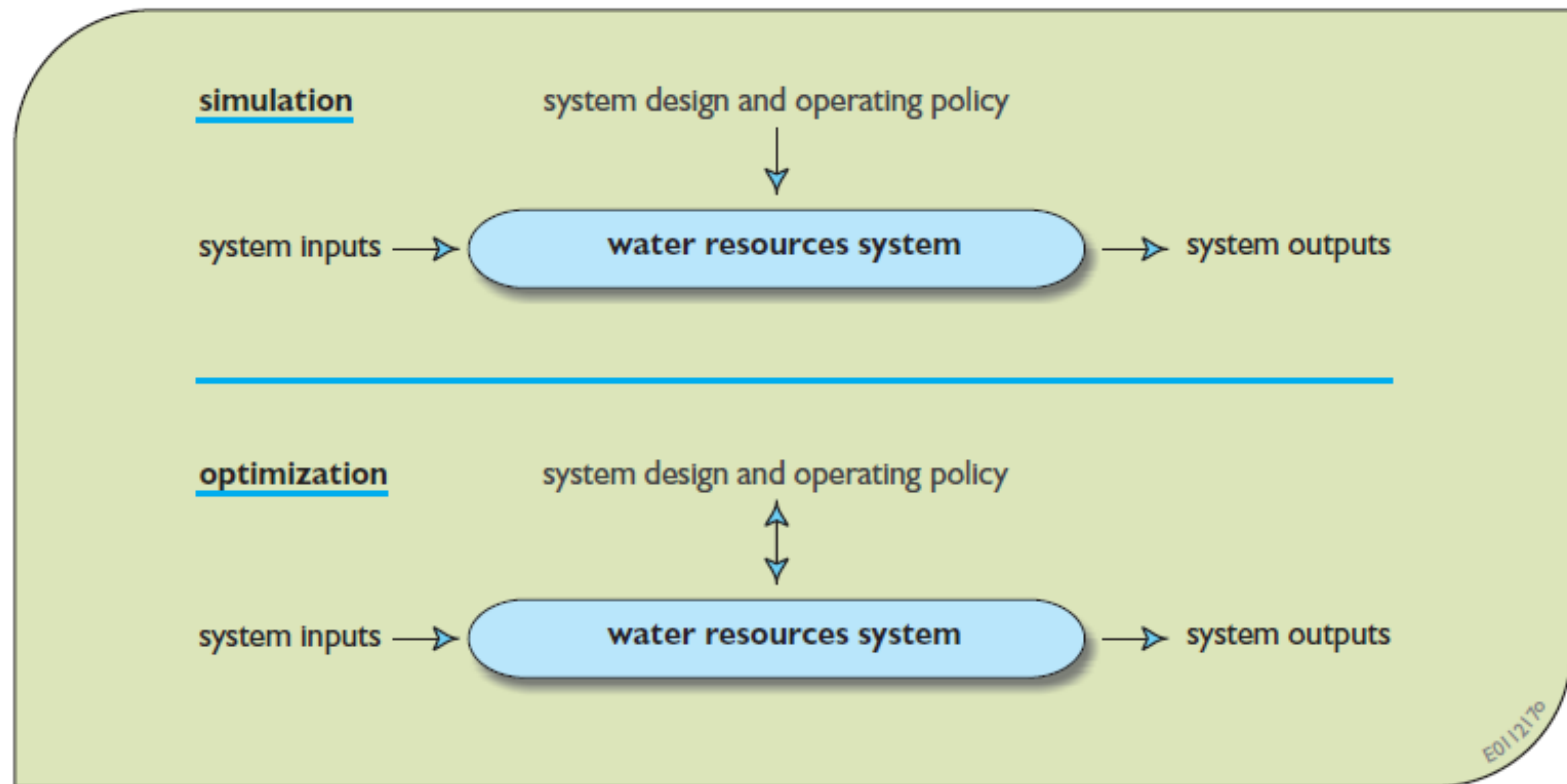
Conventional design and analysis

Engineering for solving a problems;
Trial-and-error



Simulation vs Optimization modeling

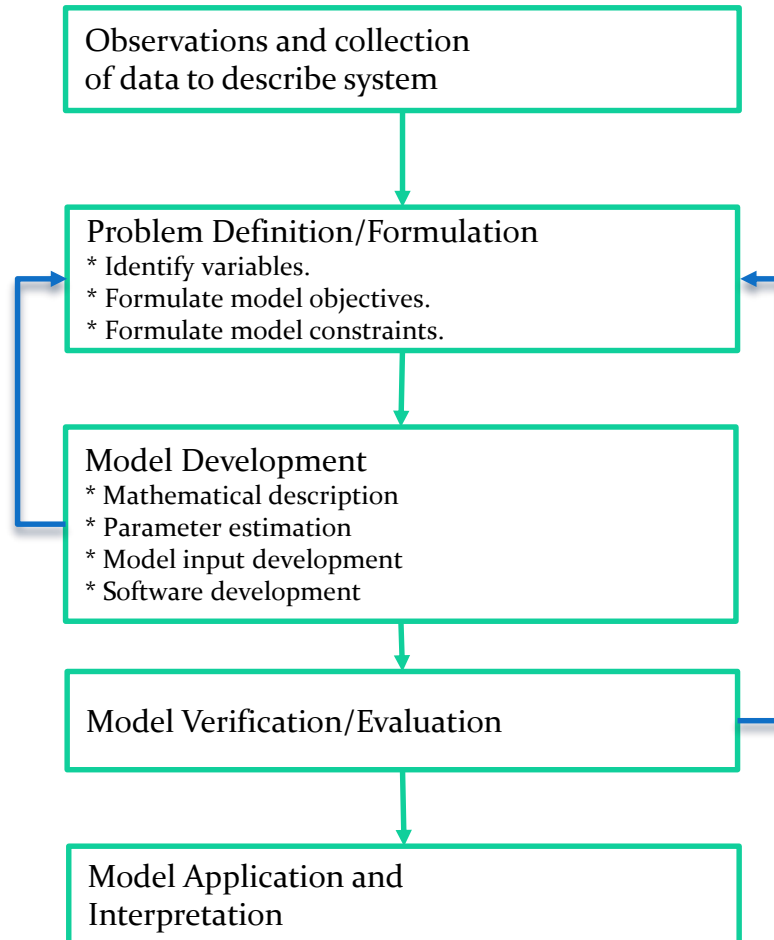
Figure 3.5. Distinguishing between simulation and optimization modelling. Simulation addresses 'what if' questions; optimization can address 'what should be' questions. Both types of models are often needed in water resources planning and management studies.



Methodologies of Optimization modeling

- Linear programming (LP)
- Nonlinear programming (NLP)
- Integer programming (IP)
- Dynamic programming (DP)
- Simulated annealing (SA)
- Genetic algorithms (GA)
- Goal programming (GP)

Steps to solve optimization problems



Software development is the **LAST** step in the model development!!

Mays and Tung (1992)

Application of optimization models in Hydrosystems.

Applications of Optimization in Hydrosystems can be applied to many types of engineering projects including:

1. Determination of operating policies for reservoirs.
2. Design of reservoir capacities and location.
3. Operation of irrigation systems.
4. Operation of regional aquifers to determine recharge and pumpage.
5. Minimum cost design and operation of water distribution systems.
6. Replacement and rehabilitation of water distribution components.
7. Minimum cost design of storm sewer systems.
8. Determination of irrigation crops and reservoir firm yield.



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Thank You