Homework # 1 Solution

CIVE 646 - Water Resources Systems: Planning and Management

(Fall 2011-12)

2.1. What is a system?

A collection or set of interdependent components acting together to provide a product or service.

2.2. What is systems analysis?

The search for component designs and operating policies that maximize the performance of the overall system.

2.3. What is a mathematical model?

A mathematical representation of a system that can be used to simulate the performance of the real system.

2.4 Why develop and use models?

Either to better understand the system and how it functions, or for predicting the performance of the system under alternative inputs and other assumptions.

2.5 What is a decision support system?

A computer program or model having a graphics based interface that allows the user to interactively input and edit data, control the operations of the model, and display the outputs in meaningful ways.

2.6 What is shared vision modeling and planning?

Involving stakeholders in model building and operation, giving them the sense of model ownership, and providing them a way to test their assumptions regarding input data and system parameter values, all in an effort to have them gain a better understanding of how their (modeled) system works and perhaps how they would like it to work. This is

commonly done with generic decision support systems suited for the particular analyses needed.

2.7 What characteristics of water resources planning or management problems make them suitable for analysis using quantitative systems analysis techniques?

- A decision has to be made with regard to a problem or an issue or opportunity.
- There exists many possible ways to solve or address the problem or opportunity.
- The best alternative is not obvious.
- Many aspects of the problem can be quantified.

Many water resources planning problems involve interdependent structural and nonstructural components whose interactions and performance can be quantified and whose design and operation affect the performance of the entire water resource system. It should also be clear that there are often many possible designs and operating policies and the best one is not obvious. In such situations systems analysis techniques, if applied properly, can help identify preferred designs and operating policies.

2.14. Suppose you live in an area where the only source of water (at a reasonable cost) is from an aquifer that receives no recharge. Briefly discuss how you might develop a plan for its use over time.

Groundwater mining is common in may semi-arid regions of the world. The challenge is to determine the best rates of abstraction over time realizing that the resource is finite. One strategy is to attempt to equate the present value of marginal net benefits, however measured, over time, and hope that improvements in technology will make it possible to obtain water in other ways once the groundwater resource is depleted, but estimating future benefits is tough, and will always be uncertain, and thus the abstractions over time must clearly be adaptive to new knowledge and conditions.

3.1. Briefly outline why multiple disciplines are needed to efficiently and effectively manage water resources in major river basins, or even in local watersheds.

No one discipline has all the knowledge to manage water within a region. Economists, ecologists, engineers, planners, lawyers, sociologists and anthropologists, and political scientists all have useful inputs to water management.

3.6. Consider the following five alternatives for the production of energy (10^3 kwh/day) and irrigation supplies (10^6 m^3/month):

Alternative	Energy Production	Irrigation Supply
A	22	20
B	10	35
C	20	32
D	12	21
E	6	25

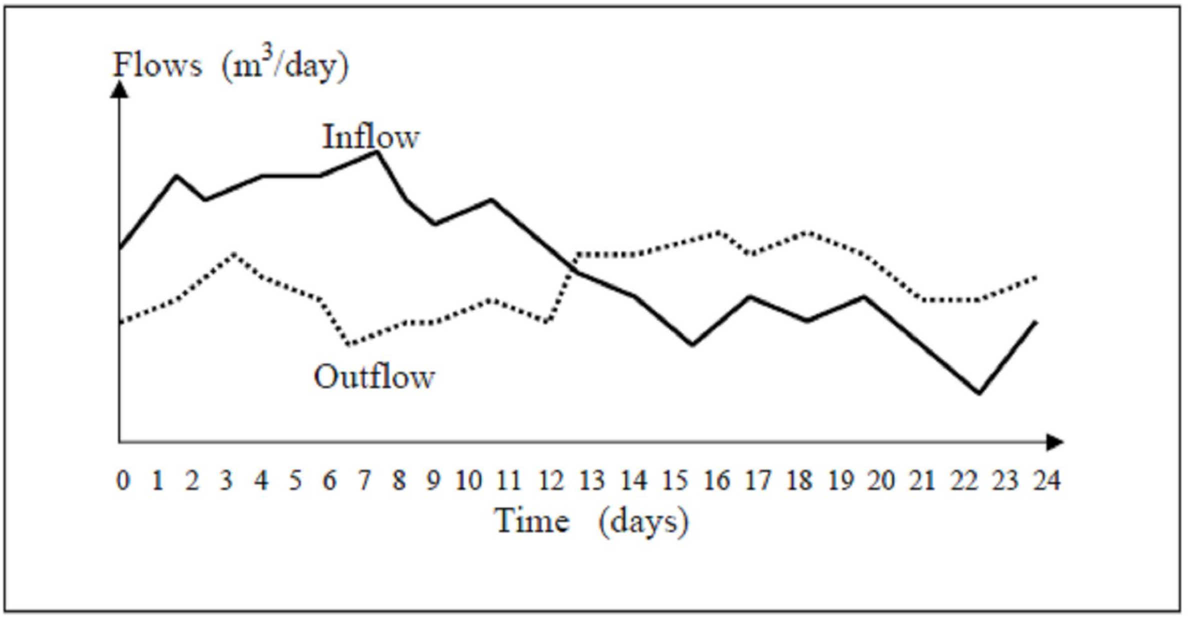
Which alternative would be the best in your opinion and why? Why might a decision maker select alternative E even realizing other alternatives exist that can give more hydropower energy and irrigation supply?

The alternatives that are efficient in that you have to give up one benefit to get more of another are easily seen on an energy vs irrigation plot of these five alternatives. Alternatives A, C, and B are efficient. Based on these two types of benefits, the selection would be one of these three alternatives. If either D or E are chosen, clearly other objectives are being considered.

3.8 Briefly distinguish between simulation and optimization.

Simulation is used for determining system performance associated with specified values of all model variables and parameters. Optimization is often used for the preliminary screening of alternatives to determine a set of good decision variable values that can then be simulated to determine more precisely the system performance.

3.9 Consider a tank, a lake or reservoir or an aquifer having inflows and outflows as shown in the graph below.



a) When was the inflow its maximum and minimum values?

b) When was the outflow its minimum value?

c) When was the storage volume its maximum value?

d) When was the storage volume its minimum value?

e) Write a mass balance equation for the time series of storage volumes assuming constant inflows and outflows during each time period.

a) Maximum at about day 7, minimum between days 22 and 23.
b) Minimum at about day 6 or between days 6 and 7.
c) Maximum at about day 12 or between days 12 and 13.
d) Minimum at day 0 since the net inflow is greater than the net outflow just from observing the net inflow and outflow areas between the two graphs.
e) Let S_t represent the initial storage volume in period t. (Note: it cannot represent the storage volume <u>during</u> period t, since that volume will change during the period anytime the inflow and outflow values differ.) Let Q_t^{in} represent the inflow and Q_t^{out} represent the outflow during period t. The mass balance equation is:

$$S_t + Q_t^{in} - Q_t^{out} = S_{t+1}$$

since the final storage in period t equals the initial storage in period t+1.