CVEN 664 – Water Resources Planning and Management
Study Questions #2

Water Quality/Waste Assimilation

1. How are "water quality" and "waste assimilation" two sides of the same issue? Why is this issue almost always labeled with the name "water quality"?

2. Name the 5 categories of wastes and pollutants commonly introduced into surface and ground waters as named in class. For each, name a specific example of the category, and describe the reasons for concern over each category (i.e., why are they "bad"?).

3. What is "eutrophication"? What casues it, and how can it be corrected?

4. What are the two major types of pollutant sources? Which is the more difficult to address?

5. Name two major programs of the 1972 Clean Water Act. Which type of pollutant source (à la the previous question) did these programs address? How has U.S. federal legislation addressed the other type of pollutant source? What other actions have occurred relevant to this second pollutant source?

6. What is a "TMDL"? What is a "BMP"? Explain the significance of each.

Ecology/In-stream Flows (Part a)

1. What are some the effects of water resources development that may adversely affect aquatic ecosystems?

2. Explain the concept of an "indicator organism." Why do fish often make good indicator organisms for in-stream flow studies? What are "anadromous" fish?

3. Describe the "Tennant" or "Montana Method" for in-stream flow recommendations. What are the advantages and disadvantages of this method?

4. Describe the IFIM/PHABSIM methodology for in-stream flow analysis. How is "habitat" defined in this method? How are "habitat preference curves" determined and used? How is hydraulic analysis used in the method? What is "weighted usable area"? What is the final product of a PHABSIM assessment? How is this product useful in water resources planning and management?

5. What are the advantages and disadvantages of the IFIM/PHABSIM method?

6. Describe the RCHARC methodology for in-stream flow analysis. What is the final product of an RCHARC analysis? How do the habitat preference curves of the IFIM/PHABSIM method relate to probability distributions of habitat factors in RCHARC?

7. Describe the rationale behind individual-based models for in-stream ecology? What useful information can individual-based models provide to the WRPM process?

Recreation

1. What are the two important types of recreation to consider in WRPM? What other WR objectives tend to be closely linked to recreation and what objectives tend to be in opposition to recreation? Is it possible to have competition between the two types of water-based recreation?

2. Explain the "Travel Cost Method" (TCM) for recreation valuation. What items are included in trip costs?

3. Explain the "Contingent Valuation Method" (CVM) for recreation valuation. What items are included in values? How does the concept of "willingness-to-pay" enter into the CVM? What is the primary means for gathering data to be used in CVM? What are special concerns in the data gathering process?

4. Contrast the TCM versus the CVM. How do conceptions of economic value differ between the two methods? Would it be possible to see similar debates over economic value conceptions for other WR objectives? How might those debates go (i.e., what would be the arguments for each valuation alternative)?

Planning and Multi-Objective Analysis

1. What are the nine steps of the "planning process" as outlined in class? How might specific steps be repeated or performed in an order different from the original order given? Explain the tasks associated with each step in a WR context.

2. What is a "Production Possibilities Frontier" (PPF)? What are the three regions of the PPF (i.e., inside, on, and outside the curve)? What two factors determine the location of the PPF curve in production-space? How can the curve move "out" from the origin, and how can it move "in" towards the origin? How does the PPF exist geometrically with more than 2 things being produced?

3. What is an "Indifference Curve"? Where does the name "indifference" come from? What is the difference between two indifference curves at different distances from the origin (i.e., what does it mean when one curve is in-between the origin and another curve)? How does the indifference curve exists geometrically with more than 2 things being consumed?

4. How does the tangential intersection of a PPF and an Indifference Curve represent the best combination of production of multiple outputs? Who is typically responsible for determining PPF's? Who is typically responsible for determining Indifference Curves?

5. What is Pareto-optimality? How does it fit in to multi-objective analysis as discussed in questions 2-4 above? What are two techniques that can be used to determine Pareto-optimal points on a PPF? What are advantages and disadvantages to each?

6. How does the discussion of multi-objective analysis in questions 2-5 above fit into the planning process of question 1 above?

Technical Articles

Several of the articles you've read thus far defined and applied models to specific water resources problems. Although not explicitly stated in the papers, these models were exercises in "Systems Theory". Be able to demonstrate that you can use "Systems" principles to understand these models, the systems the models are addressing, and the appropriateness of the models in their original contexts and other potential contexts. In other words, for each paper:

1. What is "THE SYSTEM" that each article is addressing? What are the components, component interactions, boundary, inputs, outputs, environment, etc., of THE SYSTEM? Is THE SYSTEM static or dynamic, closed or open?

2. What are the "states" of and what is the "state-space" of THE SYSTEM?

3. Who are the possible "observers" of THE SYSTEM? Which observer's perspective is used to formulate THE MODEL of THE SYSTEM? What is the state-space of THE MODEL? How does this represent a "projection" of the state-space of THE SYSTEM? Which states have been projected into other states?

4. What are the basic descriptions of the behavior of THE SYSTEM as represented in THE MODEL? What is the "notation" use by the modeler/observer? Are there violations of the "Principal of Indifference"?

5. Knowing from 3. above how the state-space has been projected in the construction of a model, what are alternative model state-spaces that could have been used? The obverse of this question is to ask, "How might a different observer have constructed a model of the same SYSTEM?"

6. From your answer to 5., what can we say about the validity of THE MODEL? That is, when will the model work, and when will it not work? Again, using your answer to 5., how can the validity of the model be expanded? This is an application of the "General Law of Complementarity."

As a warm-up exercise, read the following excerpt from a recent New York Times article about the Euphrates River Basin. Perform an analysis of the case study using the systems principles outline above.

Excerpt from: Jehl, Douglas. "In race to tap the Euphrates, the upper hand is upstream." *The New York Times*, August 25, 2002. Made available online at *http://www.nytimes.com/2002/08/25/international/middleeast/25WATE.html?ex=1031545990&ei=1&en=ea569db8439c91a7*

In Race to Tap the Euphrates, the Upper Hand Is Upstream

August 25, 2002
By DOUGLAS JEHL

TELL AL-SAMEN, Syria - The Euphrates River is close by, but the water does not reach Abdelrazak al-Aween. Here at the heart of the fertile crescent, he stares at dry fields.

The Syrian government has promised water for Mr. Aween's tiny village. But upstream, in Turkey, and downstream, in Iraq, similar promises are being made. They add up to more
water than the Euphrates holds.

So instead of irrigating his cotton and sugar beets, Mr. Aween must siphon drinking and washing water from a ditch 40 minutes away by tractor ride. Just across the border, meanwhile, Ahmet Demir, a Turkish farmer, stands ankle deep in mud, his crops soaking up all the water they need.

It was here in ancient Mesopotamia, thousands of years ago, that the last all-out war over water was fought, between rival city-states in what is now southern Iraq. Now, across a widening swath of the world, more and more people are vying for less and less water, in conflicts more rancorous by the day.

From the searing plains of Mesopotamia to the steadily expanding deserts of northern China to the cotton fields of northwest Texas, the struggle for water is igniting social, economic and political tensions.

… … …

The stories of Mr. Aween and Mr. Demir illustrate how the growing fight for water can make or ruin lives.

Until last year, Mr. Demir, 42, a father of nine in Turkey, was living an itinerant life as a smuggler and a migrant laborer. But on a recent scorching afternoon, he stood sunburned and content, his striped pants rolled above his knees, bare feet squishing in Euphrates mud.

"It seems like we have all the water we need," Mr. Demir said, leaning on his shovel and running a hand through his close-cropped hair. What has changed in this swath of southern Turkey is the arrival of irrigation. It is part of one of the world's largest water projects, an audacious $30 billion plan by

Turkey's government to spread the Euphrates' gifts across a vast and impoverished region of the country.

By now, Mr. Aween, the Syrian, might have been celebrating, too. Under Syria's irrigation plan, ambitious in its own right, water from the Euphrates should have reached Mr. Aween's door, less than 50 miles from Mr. Demir's.

But strong doubts are emerging about whether the vast scope of Turkey's project will leave enough water for its neighbors downstream - so much so that Syria appears to have put the brakes on its development plan.

"We're still waiting," Mr. Aween, 40, said on behalf of his 2 wives, 3 children, and 17 brothers and sisters, who all live in a hamlet that bears the family name. He wore a loose, Arab-style outer garment and cheap plastic sandals as he hitched a rusty tanker trailer to a sputtering tractor, his water bearers. "But the water hasn't come."

The trouble over the Euphrates can be expressed in a simple, untenable equation.

As best as anyone can determine, the river, in an average year, holds 35 billion cubic meters of water. But the separate plans drawn up by Turkey, Syria and Iraq for building dams and irrigating fields would, taken together, consume nearly half again more water than the river holds.

Each country has acknowledged the impossibility of marrying their schemes. But none has shown any willingness to scale back. Trying to accommodate fast-growing populations and to head off a migration to the cities, each country is still clinging to its irrigation dreams.

On both sides of the Turkish-Syrian border, snapshots of those dreams still unfold on summer dawns, in fields thatused to be good for little but grazing, but where new irrigation canals are now delivering Euphrates water in regular supply.

Thirsty crops like cotton and sugar beets have begun to thrive. Farm incomes have tripled. Young women who turn out in sparkling dresses tend prized plants with special care, shepherding the water down each muddy row. Young boys cavort in irrigation ditches that provide relief from the intense midday heat.

Now that there is water, Mr. Demir said, it would not be such a bad thing if his four sons, ranging in age from 4 months to 22 years, decided to stay and work the land - something he could not have imagined only a year ago when farming was far harder.

But in a world in which so much depends on having water, he bristled at the idea of sharing it. "If I used any less, the others would use more," he said. "I use what I need, and as for the rest, it's their business."

That kind of thinking has not helped Mr. Aween's village, not far from Tell al-Samen, where the absence of water is almost equally on display. With his family, Mr. Aween raises scraggly goats and grows whatever barley and wheat he can coax from dry, unirrigated land. It is a far cry, he said, from the lush green crops he would grow with irrigation - the difference between sustenance and comfort.

Syria and Turkey have been at odds since the late 1980's, when Turkey decided to proceed with its development project without consulting its neighbors.

To Turkey, the plan was an essential step in the country's development, a means of transforming an area that is home to six million people, including many restive Kurds, into a zone of greater economic and political stability. But to Syria, which depends on the Euphrates for half its fresh water, it continues to be seen as a major threat. Iraq, the far downstream neighbor, has been mostly a bystander because of its international isolation.

The basic disputes between Turkey and Syria - over water rights and allocations - would be familiar to any landowner who has struggled over competing claims to a stream or a well. But the fact that the parties are nations, with large armies at their disposal and large populations at stake, has added to the weight of the clash.

Less powerful militarily than Turkey, Syria resorted through much of the 1990's to indirect pressure, by giving support to the terrorist leader Abdullah Ocalan, the No. 1 enemy of the Turkish government. In response, Turkish officials sometimes went so far as to warn that the flow of the Euphrates into Syria could be cut.

Such talk has cooled in the last three years since the arrest of Mr. Ocalan. But the potential for trouble lingers.

Over the last year, as Turkey has completed many dams and has begun to extend its irrigation, the flow of Euphrates water into Syria has grown consistently smaller. The flow has fallen below levels allowed under Turkey's only existing commitment to Syria, an interim 1987 agreement intended for the period of dam construction.

Turkey has blamed drought and the overuse of the new, cheap water by farmers for the shortfall. The government says much of that can be reversed. But Turkish officials have also said they no longer see the 1987 deal as binding. The trend has raised deep concerns in Syria, which is already facing water shortages in Damascus, the capital.

Both countries say they are ready to strike a deal, but cannot imagine scaling back their development plans. "For half of Syria, the Euphrates is life," said Abdel Aziz al-Masri, a top official at Syria's Ministry of Irrigation.

Mumtaz Turfan, the director of Turkey's department of hydraulic works, echoed the sentiment. "Without our dams, life in Turkey would be impossible," he said.

It has been a decade since Syria, Turkey and Iraq sat down to formal negotiations, and their positions remain as starkly opposed now as they were then.

Syria and Iraq want the water to be divided roughly in thirds. Turkey, on the other hand, claims more than half for itself. It says any sharing must take into account Turkey's status as the source of most Euphrates water and the home to a population that is half again as big as Iraq's and Syria's put together.

"I am sure that if we forget about borders, we can solve the problem," Mr. Turfan said. Over the last 30 years, he has presided over the construction of 700 dams in Turkey, and a map that stretches across his wall details plans for 500 more.

"I am providing water for 22 million people who take drinking water from our dams, and for 35 percent of our agriculture," he said. It would be a mistake, he suggested, for Turkey to accept less than the lion's share of the Euphrates. "Without irrigation, we can't do anything," he said. "We can't give it up and destroy our people."

Around the world, the question of water ownership has never seemed so divisive.

Despite efforts by the United Nations and others, the world has yet to come up with an accepted formula on how shared waters should be divided. That situation applies to nearly 300 rivers, including the Nile, the Danube, the Colorado and the Rio Grande, all subject to major disputes.

In 1997, a United Nations convention declared that international waterways should be divided reasonably and equitably, without causing unnecessary harm. But Turkey, along with China and Burundi, refused to sign the agreement, a sign of reluctance on the part of major upstream countries to cede their dominant positions.

Beyond current water shortages, one reason for the tension is a lack of optimism that pressures on the world's water supply might be eased.

Of course, some new technologies, including advanced irrigation techniques, innovative desalination methods and bold water-moving schemes, offer some hope.

But experts say the task of making fresh water available where there is none - from seawater, from icebergs or by moving surface water long distances - remains too costly to be widely adopted. Most easily accessible fresh water sources have already been tapped.

To those who would bend nature, there are many cautionary tales, including the Soviet-orchestrated drying up of the Aral Sea, an environmental catastrophe. Even for its project on the Euphrates, Turkey could not win World Bank support because of the plan's significant costs, including the submerging of an important archaeological site.

But sometimes, as in Turkey's case, the thirst for water is greater than any such opposition. Along the Euphrates, Turkey is paying its own way, despite the financial hardship and despite the uncertainty over how its plans will affect others.

In the dry heat of a Mesopotamian summer, how that tenacity is regarded depends on which way the water is flowing.

In an office in Al Raqqa, a Syrian city on the banks of the Euphrates, Iliaz Dakal, a consultant to Syria's land development agency, was studying a map of his own. It depicted, in vivid green, the land that Syria is already irrigating along the river. Much more land, though, like the fields that are home to Mr. Aween, was crosshatched to show uncertainty - its water and its fate now perhaps in Turkey's hands.

"For now, thank God, we have enough to grow the wheat we need," Mr. Dakal said. "But what about the future?"

Mr. Demir, in his muddy Turkish field, had an answer, saying he had come to see water as a byproduct of power.

"If Turkey is stronger," he said, "then I get to keep my water."