Geog 464 Learning Objective Outline

LOO 13 Conjunctive Water Resource Planning Case Study
13.1 What is conjunctive administration of water and why is it important?
13.2 What constitutes a workflow task model for water resources planning-level analysis about conjunctive water resource management?

13.1 What is conjunctive administration of water and why is it important? *RUGIS* Chapter 9

Boise River Basin Regional Water Resource Planning – Case Study
- Background materials to set the stage for the decision problem. (LO 13.1)
- GIS-based operations used in addressing the planning decision problem. (LO 13.2)

Motivation: Stakeholders consider uncertainties about water resource planning in an iterative fashion and become part of the decision-making process prior to the issue becoming unmanageable or seriously contentious in court.

Conjunctive Administration – the context (Boise River Basin shown in **Plate 9.1)**

- Water supplies in many areas of the arid western United States are inadequate to meet all demands.
- In State of Idaho and in all other western states, many streams and aquifers are unable to provide sustained water supplies that fully satisfy all uses during good water years, let alone drought years.
- The appropriation doctrine of "first in time is first in right" provides a consistent basis for distributing limited supplies of surface water in Idaho.
- Impacts of ground water pumping on surface water supplies have often been ignored because of the legal and technical complexities.

Conjunctive Administration decision problem focus - develop a plan whereby a combination of groundwater wells are to be managed conjunctively with surface water over a ten-year period. The temporal aspect of the decision problem is as important as the spatial aspect of the problem.

The Boise River Water Plan provides a 10-year conjunctive administration process for addressing the interaction between ground water wells and surface water extraction.

A decision situation assessment case study was developed as a Boise River collaborative planning process, and here we focus on the planning process. The core of that process involves conjunctive administration. A *conjunctive administration framework* outlined in **Figure 9.1** involves use of a conjunctive administration platform, including a GIS-based decision support software package called WaterGroup.

In the context of a stakeholder group discussion, the foundational elements form the basis of the conjunctive administration platform from which implementation recommendations are made. Note the four legs of platform: 1) Water rules and laws, 2) water rights, 3) technical information, and 4) stakeholder involvement. Technical information supported by GIS-based decision support software system called WaterGroup. WaterGroup was developed using the ArcObjects software library from Esri (Jankowski et al. 2006)..

13.2 What constitutes a workflow task model for water resources planning-level analysis about conjunctive water resource management? *RUGIS* Chapter 9 Section 9.2

Face-to-face decision sessions were conducted to create conjunctive administration scenarios. Each scenario proposed a ten-year plan, over which groundwater wells would be administered together with surface water extraction from the Boise River.

Planning process conducted as a field experiment. Control session was traditional process used as in years past. In one treatment session, WaterGroup software was used by a facilitator-chauffeur (**Plate 9.2**), and displays were depicted on a single "public" screen to evoke discussion about water planning. In a second treatment session, several stakeholders made use of the software to explore the water planning options (**See Plate 9.3**).

The **main toolbar** in WaterGroup GIS consists of ten tools (**See Plate 9.4**). The ten tools on the WaterGroup toolbar are sequenced in order of anticipated use, with a first pass through the software. As such the toolbar presents an expected workflow, but does not dictate the workflow as a user can make use of any tool at any time.

The first tool provides access to **red false-color images** (See **Plate 9.5**). The image shows vegetation including riparian vegetation where moisture is abundant (more moisture more red), as this site is along the Boise River near the top of the photo. Controls for working with imagery are in the upper left corner of the screen.

Two-dimensional displays - blue line in **Plate 9.6** through the center of the map is the Boise River. Across the basin, there are hundreds of wells that are shallower (yellow color) than deeper wells (black color). **The goal of the decision problem is to decide which wells, at what depth, are to be administered conjunctively starting in which year of the ten-year process.** The wells shown in Plate 9.6 are a "representative" sample (928 wells) of all of the wells. There are literally thousands of wells, but using data from a representative sample can be used to formulate a plan.

Three-Dimensional map displays depict the well depths (**See Plate 9.7**). Those displays can be tilted and rotated to get a better sense of the distribution of the well depths across the basin. Although 3-D is often preferred to 2-D displays, the 2-D display was more effective for stakeholders because it was more important to view location of wells, than depth of wells to explore problem. However, 3-D displays became more significant as depth entered three frame of reference for decision problems.

Flow detail maps depict response functions at particular locations to understand water flow in the river given certain management scenario assumptions (See **Plate 9.8**). A response function describes water draw-down at the upper end and the lower end of the basin in Plate 9.8. Water draw-down occurs when water is in short supply, i.e., lower water quantity than desired by all.

Well details depict information in quadrants, with 4 thumb-nail windows in each of the display quadrants (See **Figure 9.2**). The details provide information on water quantity, viewed from various perspectives.

After reviewing the well locational distribution and depth displays and then examining some of the details regarding the situation, the capability to "define options" allows a user to establish a plan scenario (See **Figure 9.3**). **Each plan option is based on some assumptions, which is why we refer to these plan options as following a policy scenario.** Remember back to the Steinitz modeling framework and phase 2 scenario modeling. What are the phases leading and following that scenario phase? Actually, Steinitz called phase 2 "evaluation" – so scenario evaluation is quite appropriate. This is the phase when criteria are selected for analysis.

A plan is devised by identifying wells at a specified distance from the Boise River AND having a specified depth that are to be managed in each of the years, starting with whatever year appears appropriate. However, all wells must be managed by the end of the ten-year period.

Remembering that stakeholder groups commonly have considerable knowledge about an area and water demand for various groups, several "plan scenarios" were established from which to construct options. The scenario is basically "number of wells managed and when".

Once plan options are defined, the impacts of those options can be computed (**Figure 9.4**). The **impacts are the aggregate flow rate and response function from all wells** taking part in the plan. The objective is to manage all wells without adversely affecting any particular collections of wells to a significant degree in any given year being managed.

Once the plan options are created, then the stakeholders can provide feedback on which plan is preferred, or in essence prioritize the plans given the circumstances at hand. The feedback comes in the form of a **"vote" on the plans, so that a ranking of the plans can be established.** Each stakeholder votes on the **top-three plans** that they prefer. The result is a ranked (i.e., prioritized) list of plans in terms of those votes (**Figure 9.5**).

The workflow process above can be repeated as many times as necessary until the stakeholder groups are satisfied with the results. Each pass takes about three hours to arrive at a ranked list of plans for a group of 12 people.

After each planning meeting, the resulting plan rankings are forwarded to the Director of the Water Resources Department as a recommendation of how conjunctive administration could be implemented. The recommendation is not binding, as the Director is empowered by the legislature to actually make the decision.

Each year such a ranking of plans can be established, and forwarded, to adjust the direction of the plan. Since each plan incorporates a ten-year horizon, the plan-years roll forward to consider what has happened up until that time.

In this case study we saw a specific workflow for conjunctive administration. In the previous lecture several workflows were described. How might we generalize to build basic knowledge?