Geog 464 Learning Objective Outline

LOO 05 Nuanced Workflow for GIS

05.1 How might we describe a nuanced GIS-based workflow method?
RUGIS Chapter 3. Section 3.2.2

Some times decision problems are a bit more complicated or complex. Carl Steinitz (40 years of GIS at Harvard) developed a landscape modeling workflow process to address complex, regional planning decision problems, aka a "nuanced method" to workflow. *The workflow can be used for planning, improvement programming and project implementation. However, the content, structure, process, and context of decision problems would more than likely be rather different.*

The *six-phase (stage) nuanced workflow* method has been applied in practice in several GIS-related projects that address urban-regional landscape issues over the past ten years or so around the world (Steinitz 2002).

Phases are framed by a set of critical questions that you can ask yourself, or your colleagues.

1) Representation Modeling
In a nuanced method, GIS analysts should be asking questions like:
- How should the state of the urban-regional community with regard to the particular issue at hand be described in terms of a database design that is modeled as value trees or value hierarchies?
- What data categories are to be represented by measurements of attributes, space, and time?
- Whose concerns about these design questions should we consider? Are there other groups that should be consulted to make sure we have incorporated all the relevant data into the representation model?

Complex decision problems are fraught with various interpretations of concerns about urban-regional communities. Stakeholder perspectives from diverse groups, even if these are groups within a single organization tend to align with various concerns, often these are called stakeholder interests. It can be said that those differences of interest are the basis of stakeholder groups. Working with a variety of stakeholder groups on an oil leasing decision problem in the Santa Barbara Channel, Edwards and vonWinterfielt (1987) organized stakeholder interests into *value trees (values, goals, objectives, criteria) to show the similarities and differences among environmental, social and economic objectives and criteria* according to different stakeholder groups. Where did the information from **Table 3.2-3.4** come from anyway; arriving at a database design (content categories and structure of the database)?

Lot more on value trees and databases when we get to a deeper look into database design…

2) Process Modeling
Several questions could be posed related to a process model.
- If a representation model forms a categorical content and structure foundation for a process model, then how might we examine relationships among land use, transportation, and environmental elements over time as a basis for articulating process?
- What are the relationships among the spatio-temporal elements, such as land use and transportation, that provide us insight and better understanding of urban-regional process?
- What land use, transportation, and or water resource processes do we need to consider?
- How does the land use, transportation, and or environmental transformation process work?

Urban-regional growth processes need be considered if we are to better understand how communities change. Porter (1997) characterizes growth in America's communities as being mostly driven by land use change. Landscape change is commonly a land use change issue (Steinitz et al. 2004). Land use change **is** supported by access to transportation, as it is very difficult to get to places without transportation infrastructure, e.g. like highways, in place. The land use and transportation theme connection is fundamental in growth management. Graphic in **Figure 3.6** shows a process of wastewater flow.

3) Scenario Modeling
Several questions could be posed as related to a scenario model.
- How does one judge whether the current state of the urban-regional environment is working well?
- What are the metrics of judgment, e.g., esthetic beauty, habitat diversity, cost, nutrient flow, public health, public safety, and/or user satisfaction, in order to evaluate the nature of change?
- Which of these do we want to consider in a scenario? How many can people consider without getting lost within an information glut?

A process model forms a functional foundation for a scenario model. Scenario models develop out of *tweaking* assumptions about processes, as we can change the input to a process. Given a different set of assumptions about how change might occur, we can generate a variety of scenarios. Sometimes people refer to scenarios as "worst case" or "best case". Those references must be explicit about what "worst" means and what "best" means. This comes back to understanding values, goals, objectives and criteria that are part of scenario descriptions. **Figure 3.7** highlights a portion of wastewater flow.

4) Change Modeling
Several questions could be posed as related to a change model.
- By what actions might the current representation of the urban-regional landscape be altered, whether conserving or changing the landscape in regards to what, who, where, when, how much, how many, etc.?
- At least two important types of change should be considered. One is how the landscape might be changed by current trends. Modeling trend leads to a projection model as the basis of change.
- A second could be, how might a community be changed by implementing design action? This leads us to developing intervention models as the basis of change. Intervention is a pro-active approach to change.
- Again, how many variables can we consider in these models before being overwhelmed?

Many people say that the only constant in the world is *change*. A scenario model forms the basis of what to consider about change. Scenario models provide a foundation for change models as we take the "before conditions" and contrast them with "after conditions" for a particular scenario. The result of social, economic and environmental conditions that differ in a major way (or not) is the outcome of a change model. **Plate 3.1** shows result of a change due to siting a facility.

5) Impact Modeling
Several questions could be posed as related to an impact model.
- A change model forms the basis of "what content, structure, process" to consider impacts?
- What predictable impacts, i.e., the outcomes of changes, might those changes influence and/or cause?

- What impacts are less predictable because changes and processes are not well understood?

Impact models are perhaps more difficult to construct than the above models, as impact models rely upon good information output from all of the preceding models. Impacts due to urban-regional growth - whether land use impacts, transportation impacts, water resource impacts - are difficult to estimate. The difficulty arises from what is not known about processes. Although considerable data exist, when it comes to modeling impacts, we never seem to have enough of the *right (aka appropriate) data*. **Figure 3.8** shows land parcels outside the river buffer have been excluded from consideration.

6) Decision Modeling
Several questions could be posed as related to a decision model.
- How is a decision to change, conserve, and/or improve the "landscape" to be made in regards to urban-regional impacts?
- How can a comparative evaluation, based on a sensitivity of impact change, be made among alternative courses of action?
- How are we to treat impacts in an equitable manner?

The reason this nuanced workflow process is so interesting is that the final model phase is a decision model. GIS has for a long time been touted as a decision support system (Cowen 1988). However, this nuanced workflow process makes this idea explicit and clear because of the inclusion of the decision modeling phase. One thing to remember is that all previous models lead to this model. An impact model forms the foundation for how to characterize alternatives for a decision process as in **Figure 3.9**. Weighting of objectives (site criteria), whereby area size is given the most weight (20 out of 100 points), and elevation and distance to floodplain the least (10), generates map in **Figure 3.10**, whereby site 64 is ranked the highest. When we trade-off one impact against another we can set priorities for what we value. Chapter 6 of this book will get into much more detail about these issues.

Facing UNCERTAINTY in Modeling - What if we do not have the time, resources, insight, and/or data to undertake all of the above models? If not, then we introduce information uncertainty into the GIS workflow process. It is better to know by intention than by ignorance.

05.2 What is a synthesized GIS-based workflow method? *RUGIS* Chapter 2. Section 3.2.3

Comparing the two workflow methods, we see similarities and differences in the phases.

Combining them articulates a synthesized method (**Table 3.5**). *Removing the process modeling phase and combining the change and impact modeling phases makes the nuanced workflow look similar to the simplified (basic) workflow. Every time we eliminate one of the six phases we introduce additional information uncertainty into the resulting information in our GIS project.* Eliminating the process modeling phase means that we do not have insight into the details of process change that underlie scenario development. Eliminating change modeling leaves the impact models in a naïve state – no information about change makes the impact information somewhat uncertain. What is a GIS Analyst to do? Can you/we/organization/community live with the uncertainty? Why or why not? Throughout your lab assignments, consider where information uncertainty is added to the workflow process.

ESRI President Jack Dangermond has picked up on the Steinitz method, calling in GeoDesign. In January 2010 Dangermond hosted spatial-temporal modeling conference at ESRI Redlands.

Table 3.5 Comparing Basic and Nuanced Workflow Methods to Derive a Synthesized Method

Simplified (Basic) Workflow	**Nuanced Workflow**	**Synthesized Workflow**
1) Identify project objectives - selection of criteria	1) Representation Modeling; Identify objectives in terms of all steps in workflow	1. Representation Modeling 1.1 Problem description based on information needs expressed in terms of goals, objectives, targets (thresholds to reach), and criteria (data categories and measurements). Consider human resources for implementation in particular context. What is left unknown?
2) Create Project Database	1) Representation modeling, database development	1. Representation Modeling 1.2 Database Development – Specification and Design of Schema and Implementation of Database. Consider human resources for implementation in particular context. What is left unknown?
None	2) Process Modeling	2. Process Modeling - Identify critical relationships among features about how they interact. Consider availability of resources for implementation in particular context. What is left unknown?
3) Data analysis – single scenario based on inclusionary and exclusionary constraints	3) Scenario Modeling	3. Scenario Modeling – Select the characteristics relevant to various scenarios for a new waste treatment plant. Based on human resources available consider number of scenarios to compute. What is left unknown?
None	4) Change Modeling	4. Change modeling - compute the changes in the primary feature under consideration, e.g., number of people served by treatment plant at a given site. What is left unknown?
3) Data analysis – Combined data layers	5) Impact Modeling	5. Impact Modeling – given the change model, compute the external affects of siting a plant at the particular locations. Site and situation impacts. What is left unknown?
3) Data Analysis - Single combination of impacts	6) Decision Modeling	6. Decision Modeling - Perform trade-off analysis using the impacts generated from the impact model. What is left unknown?
4) Report	None	7. Final Report - Create the final report as a model of the information from all other steps. Use the interim reports from all other steps to synthesize a final report.