

ALTERNATIVE FUTURES LESSON
Undergraduate level
DRAFT

Project:

Data Sets and Inquiry in Geoscience Environmental Restoration Studies (NSF GEO-0808076)

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A. INTRODUCTION

An alternative futures study is one in which **models** are developed and run that predict future impacts of different human policies and practices on ecosystems. The output of the model is a **scenario** for what the future will look like. Each scenario is the result of the enactment of the preferences of different stakeholder groups. For example, farmers would prefer more farmland and more irrigation, developers would prefer more housing and commercial construction, and conservationists would prefer more preservation or restoration of natural habitats. Each scenario portrays a future that reflects assumptions about the ecosystem's future characteristics. The characteristics described in the scenarios are reflected in output from the running of the model.

Alternative future scenarios are useful because they provide a baseline for starting a discussion about which scenario would be most desirable for the most people. A review of different alternative future scenarios can inform decision-making about what policies and practices should be enacted. The alternative future scenarios also become a framework from which negotiations between stakeholders can occur. In these negotiations, stakeholders can compare results of the alternative future scenarios and figure out which are likely to be most acceptable to the most stakeholders.

To find a common ground in these negotiations requires detailed analysis of the trade-offs of different policies. Ideally, what should result from these negotiations is a new alternative future scenario that integrates the visions expressed in the scenarios in ways that maintain the most benefit for the most stakeholders. These benefits can be expressed as policies that prove successful in meeting their restoration goals while at the same time providing the most benefit and the least adversity to stakeholder groups.

The following excerpt from an Alternative Future report about Oregon's Willamette River¹ provides a good overview:

"The growing use of *scenarios* as anticipatory planning tools results from the robustness and generality of the approach. Articulating an explicit story about how the future may unfold forces strongly held but vaguely defined viewpoints into written specificity. Significant and conflicting sets of values as to what the future should be can each be given a fair test against what is possible, enabling progress to

¹ Text quoted from Branscomb, A. Scenario Development. In Hulse, D., Gregory, S., Baker, J. (Eds) (2002). *Willamette River Basin Planning Atlas: Trajectories of Environmental and Ecological Change*. Oregon State University Press, p. 48.. Retrieved 3/5/2010 from http://www.fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/7.Trajectories/7b.scenario_develop_web.pdf

be made on complex and partially understood problems in spite of incomplete information and widely divergent opinions. The creation of scenarios can be undertaken in ways that engage the interest of the public and that improve communication among parties, making it possible to inform present-day choices with their plausible future consequences. The scenario approach used in this work emphasizes the importance to decision making of evaluating plausible alternative policy sets rather than in seeking a single preferred alternative. In order, the approach is to:

- express the principal alternatives of conservation and development in quantitative forms,
- express these quantities as digital maps of the future,
- evaluate these spatially explicit futures using a range of scientifically defensible biophysical and social measures.

The evaluations are accomplished by applying quantitative models of important phenomena like water availability, agricultural crop yields, or wildlife habitat quality to the maps of the future landscape as if the maps were the actual land condition. Comparing the evaluations of the various futures to each other and to present and past conditions provides insight into the possible consequences of choices concerning land and water use. The comparisons provide decision makers with tangible evidence of the ways different policies produce outcomes. For citizens and officials, it may be as important to learn that two policy sets produce nearly the same outcomes as it is to learn that they produce divergent ones."

For example, a criterion for selection of river restoration sites could be at least partially based on distance from urbanized areas. This is what the Willamette River report authors concluded when they identified certain optimal sites where "the potential for recovery of complex and biologically diverse river habitats and floodplains is high while at the same time the economic and social constraints are comparatively low (p. 130)." In particular, they found that:

"The reach between Corvallis and Eugene offers some of the highest remaining channel complexity and at the same time has lost more than most other sections of the river. It combines both existing qualities to be protected and high potential for additional recovery. This reach also includes some of the most extensive bank armoring and revetment outside the Portland metropolitan area. These structures could be strategically modified or removed to restore channel function. This is also true of the second area near Albany. A third important area for river restoration is the portion of the middle reach downstream of Salem. This section has lost channel complexity and includes substantial amounts of land in state parks and other public ownerships. This combination of recovery potential and public lands makes it well-suited for restoration of channel complexity. The distribution of areas for restoration of channel complexity along the river also is an important flood storage design criterion for river managers and restoration planners." (p. 144).

As all models do, alternative future models have quantitative inputs and outputs. The inputs reflect whatever historical data and knowledge of correlations between variables we are aware of that can be fed into the model. The outputs are the future outcomes that are

likely to occur if the trends assumed in the model continue. The trends reflect assumptions about whether the different inputs will increase or decrease. On the following table is an example of a model input and causally-related output. *Add two or three additional examples of your own for each category.*

Input indicator	Output indicator
the shape of a river channel	flood behavior on the floodplain

This exercise in modeling provides a basis for determining the effects of human policies that are intended to change the inputs and hence affect the outputs in a certain intended direction. In the example, we all know that the shape of the river channel affects flood behavior on the river's floodplain. If we look at data showing a history of human straightening of a river channel, we are likely to see a corresponding relationship to more catastrophic, yet less frequent flooding events. Knowing this correlation between channel shape and flood behavior, we can predict through modeling what flood behavior to expect in the future if human policies were carried out to restore the naturally meandering shape of the channel. In other words, the characteristics of this future flood behavior get described in an alternative future scenario which is the product of the running of a model that assumes that people are going to carry out this channel restoration effort.

Yet, alternative future models do more than simply predict relationships between single inputs and outputs because they reflect complex systems that have multiple characteristics and multiple interacting cause-and-effect relationships. So, a model examining flooding behavior in the face of channel restoration policies would be too simplistic if it were not also inclusive of other inputs such as rate of soil erosion along the bank or the presence or absence of revetments along the river banks. Those variables in turn are related to other interdependent factors, such as amount of logging occurring near the river, which would increase the amount of soil erosion, plus factors beyond human interference such as the steepness of slopes surrounding the river bank at different spots along the river, which affects differences in how much erosion is occurring and which places along the river. A good model would incorporate all of these variables to predict the future. Furthermore, a good model would try to differentiate between outcomes in different geographical sections of the river since each section will have its own set of characteristics.

There are two categories of types of models: those which assume that current trends will continue, and those which assume that people will change the current trends by doing things that will either inflate or deflate them. Table 2 shows an example of hypothetical impacts of three alternative scenarios. *Add a few hypothetical examples of your own.*

Alternative scenarios		
No change	Pro-development policies enacted	Pro-conservationist policies enacted
Population increases at current, historically derived	Population increases to a rate of 10% per year	Population remains flat but becomes more concentrated

rate of 4% per year		in cities

The following are two hypothetical examples of the application of alternative future analysis. In each case, models can be developed and run to explore likely outcomes (i.e., the quantitative outputs of the model). Each alternative future expresses a particular stakeholder group's ideal vision of the future, plus additional impacts of the implementation of that vision. Each different alternative future models the outcomes of different types of changes to the current situation and presents how the different stakeholders could potentially come together around a negotiated scenario that is most mutually beneficial and least costly to any one group.

Example 1:

In a particular city, an ideal future scenario expressed by a group of business owners is a future when business taxes are very low and there is a large market for their products. Yet, for a group of educators, an ideal future scenario may be that all children graduate from high school with a 12th grade reading level and all schools have enough money to afford libraries and athletic programs. It is possible that the visions of the business owners and the educators may conflict in some respects. For example, the tax cuts sought by the business owners may be viewed by the educators as threatening adequate school funding. Yet, there may be intersecting areas of mutual interest. For example, models may reveal that the school funding cuts that would have to occur to keep the tax rates as low as the business owners want would lead to a situation where the quality of education gets so bad that the business owners no longer have enough qualified people to hire to run their businesses.

Example 2:

In a particular developed area along a river, factory owners who pollute the river water are worried that they will go out of business if the government forces them to stop polluting, yet hospitals are worried that if the pollution doesn't stop, the hospitals will be forced to deal with many more emergency cases of people getting sick from the pollution and that would threaten the hospitals' capabilities for staying in business. Alternative future models are developed that (1) predict what factory profits would be with or without the enforcement of new government imposed pollution regulations and (2) predict what the sickness rates will be with or without the pollution. After reviewing the predictions from the models, the factory owners and the hospitals find common ground in mutual agreement that the status quo amount of polluting will eventually lead to such a big increase in sickness that the factory would have to pay for many more sick workers' medical bills, hence cutting into their profits. They also come to the conclusion that a middle-ground future scenario would be acceptable. In this scenario the factory would clean up most of the pollution but leave a small amount in the water system that would not cause sickness. Through examining model-based predictions of this scenario, the factory owners become assured that the amount of money they would lose from their profit margins to reduce pollution levels would be enough to keep their employees healthy and would cost the

owners less than the increased medical expenses they would have to pay if they keep polluting at the current rates.

B. BRAINSTORMING

Brainstorming questions (revisit your answers at the end of the lesson)

1. How would you go about constructing models that you could use to predict future characteristics of a particular river ecosystem? What types of input data would you put into the model? *Apply what you've learned in the course to answer this question.*
2. Describe different scenarios you would try to model.

C. HYPOTHETICAL CASE STUDIES

A particular river basin in Washington State has gone through many changes. Originating in the heavily forested mountains of Western Washington, its tributaries join in a valley, then the main stem of the river empties into an estuary which empties into the Puget Sound. Before European settlers arrived, salmon were abundant in the river. These salmon use the estuary as a place to adjust to the salt water of the ocean as they came down from their spawning grounds in the upper parts of the river. The river had many side channels and oxbows and frequently changed its meandering course. It was also full of logjams from trees that fell into the river due to natural attrition from storms and other natural events. Salmon benefited from the logjams, meandering channeling, islands, and forest canopy because they had quiet shady spots to spawn. Indian tribes used the natural resources of the rivers to carry out seasonal hunting for salmon and cultivated plants for their diets and other needs. The river frequently overflowed its banks onto the floodplain so the Indians were accustomed to relocating away from the floodplain during likely flooding seasons, yet the floods were rarely severe because the course of the channels was such that relatively small amounts of water would spill out onto the landscape. Once it did, there was on the landscape enough plants and soil to absorb the water quickly. Hence, the environment was a system of interdependent parts in which the geology, the plants, the animals, the climate, and the Indians coexisted in a balanced system for their mutual benefit.

European settlers did a number of things to upset the system. They began to cut down many of the trees in the forest for timber. They straightened channels and removed the logjams in order to allow for logged timber to be capable of moving downstream to processing plants. To prevent seasonal flooding on the floodplain where they wanted to settle, they straightened channels and erected dikes and levees. To be able to farm on the flat riparian soils surrounding the estuary, they erected dikes to lower the salt content of the estuary water and dams for crop irrigation. As time went on, developers urbanized more and more of the landscape, cutting down trees and other plants and paving over soil with nonporous concrete. More urbanization came as a result of industrialists building factories that dumped pollutants either directly into the river through a system of pipes (source point pollution) or indirectly into the river through rain water runoff polluted by toxic substances

emitted from automobiles, paints, and other human sources. Loggers denuded hillsides, causing greater erosion of sediment into the river due to the fact that the hillside soils, without their trees, could not absorb as much water as they could before.

The results of these practices were increased sediment buildup in the rivers. This resulted in fewer yet more extreme flooding events. These more extreme flooding events owed to the increased shallowness of the main channel. This increased shallowness was a product of increased deposition of sediment from the increasingly eroded land. This increased shallowness was made more dangerous by the fact that the channel had increased force, as a result of the fact that natural constraints on the force of the river flows (i.e. oxbows, islands, and logjams) were removed. Salmon suffered from the loss of habitat for spawning, inability to traverse the river waters in their migration from the fresh water to the sea and back again, and removal of salt from the estuary water.

Indian populations suffered from white settlers' persecution practices, which included forced relocations to reservations and loss of rights and access to traditional grounds that they needed to sustain their livelihoods. The native populations also suffered from the loss of the salmon and native plants that they depended on for their diets. As a result of these catastrophic losses to their economic sustenance, coupled by relocations, diseases, and forced boarding school-induced assimilation into white culture, the tribal communities became far less populated and increasingly impoverished.

At this point in time, there has been much urban development along the river, and farms and logging operations continue to exist along the river as well. Yet, there are in addition fairly large naturally beautiful areas that are relatively well preserved which could be cultivated, logged, or further developed for commercial or residential uses. Recently the main reservation along the river has accumulated a lot of money from opening a casino, which has become the reservation's primary source of income.

A group of researchers and policymakers have come together to vet the interests of different stakeholders and model alternative future scenarios. These scenarios are based on recognition that different policies may have very different consequences and that before policies are enacted it is important to identify what outcomes may occur. The scenarios are ideal visions of the future in the eyes of different stakeholder groups.

D. IDENTIFYING STAKEHOLDER INTERESTS.

Introduction: In order to envision a scenario of the future, one needs to envision the characteristics of the scenario (i.e. the characteristics of outcomes of policies and practices that would make the scenario become a reality). One also needs to identify possible types of policies that can be enacted. Examples of such policies are

- More construction of dikes and levees
- More removal of dikes and levees
- More revetment of river banks
- More straightening of channels
- More restoration of meandering channels
- Turning more riparian areas into natural preserves
- More development of land for commercial and residential uses
- Permitting more logging
- Buying up logging rights to prevent more logging

- Mandate preservation of farmland rather than permitting development.
1. What policies would **developers** want to have enacted that would ensure that their *desired scenario* of maximum development becomes a reality? What would be outcomes of these policies?
 2. What policies would **environmentalists** want to have enacted that would ensure that their *desired scenario* of a healthy and aesthetically appealing natural environment becomes a reality? What would be outcomes of these policies?
 3. What policies would **farmers** want to have enacted that would ensure that their *desired scenario* of maximum allotment of water for irrigation becomes a reality? What would be outcomes of these policies?
 4. What policies would **local residents** want to have enacted that would ensure that their *desired scenario* of optimal quality of life (sustainable, healthy, safe environment) becomes a reality? What would be outcomes of these policies?
 5. What policies would **local residents** want to have enacted that would ensure that their *desired scenario* of maximum economic prosperity and high employment becomes a reality? What would be outcomes of these policies?
 6. What policies would **loggers** want to have enacted that would ensure that their *desired scenario* of maximum logging becomes a reality? What would be outcomes of these policies?
 7. What policies would **property insurance companies** want to have enacted that would ensure that their *desired scenario* of a healthy environment becomes a reality? What would be outcomes of these policies?
 8. What policies would **tourist industry members** want to have enacted that would ensure that their *desired scenario* of maximum aesthetic appeal becomes a reality? What would be outcomes of these policies?

E. SYNTHESIZING DIVERGING STAKEHOLDER INTERESTS.

Directions: use your answers to the questions above to fill out the cells of Table 1 below. The purpose of this exercise is to get you to integrate your answers above so that you can think about how outcomes of different policies may prove to be in a particular stakeholder group's interest or disinterest. By identifying how outcomes cut across the interests of different stakeholder groups, we can begin to move from a paradigm of competing winners and losers to a paradigm in which everybody wins or loses.

Stakeholder Groups

- A. Developers
- B. Environmentalists
- C. Farmers

- D. Local residents
- E. Loggers
- F. Property insurance companies
- G. Tourist industry members

Policy	Likely outcomes	"Winners" (identify stakeholder groups in the cells)	"Losers" (identify stakeholder groups in the cells)	Neutral (identify stakeholder groups in the cells)
More construction of dikes and levees				
More removal of dikes and levees				
More revetments of river banks				
More straightening of channels				
More restoration of meandering channels				
Turning more riparian areas into natural preserves				
More development of land for commercial and residential uses				
More development of land for commercial and residential uses				
Permitting more logging				
Buying up logging rights to prevent more logging				
Permitting more farming				
Buying up farms to stop their continued agricultural use				

E. FINDING COMMON GROUND.

Use the information you put in Table 1 to answer these two questions:

1. List outcomes that benefit the most groups:

2. List outcomes that hurt the most groups:

F. THE MODEL DEVELOPMENT PROCESS

To develop a model requires not only examining the correlations between historical trends among the different systemic variables but also using those analyses to put together a schema of presumed causes and effects. It is inappropriate to assume that a correlation between different variables in the system represent cause-and-effect relationships unless there is scientific theoretical grounding for making such claims.

1. What are examples of potential correlations between river ecosystem variables that are likely to be manifestations of cause-and-effect relationships?

2. What are examples of potential correlations between river ecosystem variables that are not likely to be manifestations of cause-and-effect relationships? Might there be intervening causal variables that are making it appear like there is a cause-and-effect relationship when there really isn't?