Consequences and Climate Change with Case Study

Now we're going to talk about consequence assessment. Particularly consequence assessment in light of climate change. So you're already familiar with the problem definition, how to frame the problem, how to generate objectives, and measurable attributes, and different alternatives. And now you want to assess the performance of those alternatives according to the things that you care about.

So your consequence assessment should show the relative performance of these different alternatives, according to the measurable attributes. Again, that's the relative differences between some alternatives, on all the different objectives that you care about. It should also point out the key trade-offs across these objectives. And it should also describe and depict the degree of uncertainty around the different performance of these alternatives, according to the things that you care about.

So how do you fill in the information that would go into a consequence assessment? Well, there's a lot of different ways to get that information. One is through modeling. Often experts are involved. So we're going to talk about some different approaches that you can use if you are looking at using modeling or experts in your consequence assessment.

And first of all, the authors in Nichols et al. recommend two approaches to modeling in light of climate change, depending on the degree to which these important climactic variables can be identified and modeled. The first is-- the challenge that you're presented with is-- in deciding how to model the dynamics of the estate variables into the future.

So here you have a situation where the climactic variables can be identified. You recognize what's important to this system, and they can be modeled. And they're added to the system models as additional state variables. So here it just includes projections of the different system variables into the future. And it may include values outside of the historical experience, which we would even categorize as great uncertainty, because you're moving outside of that realm of experience.

It could include structural uncertainty, around the climate variable itself, in the form of multiple climate models. So here you could even have multiple models of how you think the climate is changing. For example, precipitation is one that's unclear in many areas, whether it will increase or decrease. So you could even include two different models, or three, where it's the same increases or decreases. But just recognize, as you increase the number of models, then you're increasing the complexity of the analysis. So the key again is to focus on the uncertainty that's relevant to the management decision.

The second situation you may find yourself in, is that you do not recognize the importance of the climate variable that actually drives the system dynamics. Or you recognize its importance, but you have absolutely no idea how to model it, and specifically to model its changes over time.

So you just say that the system is changing in a way that cannot be predicted. Even if you generated several different models, it would not capture the potential variation that you feel is warranted around this uncertainty.

So the challenge here is not to just throw your arms up in the air and say, it can't be done. It can't be modeled. But to impose double-loop learning at shorter time intervals. And do the best predictions that you can, with the information that you currently have. Which may mean not using long term historical data, but relying more heavily on recent historical data. Maybe just looking at the past 10 or 20 years, and then changing and improving those models at shorter time intervals, depending on the observations that fill in with that system.

So here the authors anticipate using deductive reasoning, and your decrease in ability to use historical data, when you're developing these new models. So those are a couple different ideas if you are dealing with models.

Some other ideas, if you are using experts in your consequence assessment, is to develop probability distributions around uncertainty. This is very common in ecological systems. We're probably all familiar with probability distributions, and they capture quite a lot of information.

But if you have probability distributions around multiple variables, and then you have multiple objectives and multiple alternatives, you can see that the consequence analysis, and the presentation of those consequences, can get quite complex. And can, in some ways, detract from the real issue at hand, and what you want the decision maker to focus on. So you can think about which parts of the probability distribution are most important to report on.

Some of you may find yourselves with a situation where the worst case, the worst plausible case, is the one that you care more about. So you want to report on, say, that downside risk. Maybe if you got a higher number of species to survive, that would be great. But it wouldn't be as important to you as if the number decreased significantly. So that's the number that you want to report on.

So then in that situation you could, instead of showing the entire probability distribution, you would just show in your consequence table or your consequence assessment, you would show the mean, the estimate, and you would show the downside-- so the lower bound on that estimate. So you're thinking about, well, some information will be lost. But you're getting a benefit of communication and clarity around what's relevant to that decision.

It's important not to overwhelm those that are participating in helping to make the decision. And this is an area where you need to understand the risk profiles, and the risk tolerance, and preferences of those decision makers and the stakeholders who are involved in the decision process. That's where you have to go back and find out, well, do you care more about the worst case, or the best case, or do you care equally about all of them? And then you do need to present all that information.

In the Structured Decision Making text, the authors mention several different ideas to consider for when a more rigorous, or a greater, exploration of uncertainty is warranted. Well, there are several triggers for further analysis.

One could be sensitivity of an estimated consequence to an uncertainty. The second, proximity of an estimated consequence to a standard or target. So here you may recognize that a consequence is approaching this threshold, or an important level that you have identified to this objective.

The third would be a high cost of being wrong. And that's again, where you think about the risks coming into the decision. The fourth is a high level of disagreement among the experts. So if you have experts involved in developing a model or otherwise engaged in the process and there is significant disagreement you might want to explore that further.

The fifth is demonstrated sensitivity of the decision to the uncertainty. And this is really the summation of all of the points. And that's the one that you want to focus on. If there is sensitivity of the decision to the uncertainty, then it demands further exploration. And that's what you want to focus on, not all the other uncertainties. But those are the ones that you would really want to invest your energy and your time in trying to reduce that uncertainty, or explore other alternatives that could help in light of that uncertainty.

So you may want to go back and revise the measurable attributes, or the objectives, to make sure that they do explicitly identify the difference in uncertainty and in performance of these alternatives, according to the things you care about. So again, recognizing that this is an iterative cycle. And there may be aspects that you want to improve to aid your decision process, and your consequence assessment in this phase.

In the next module, we'll talk more about uncertainty and the various types of uncertainty. Where they can come from, and how you can reduce them. And then some different approaches in light of uncertainty.

So now you're ready for consequences, and then thinking about some of the trade-offs associated with those. We have a decision problem, an objective, some alternatives. Maybe you've worked to clarify those alternatives and generate new ones, now you're ready to assess the consequences of those. Let's think about the uncertainties that are associated with those alternatives. A couple in particular come mind.

The last ones that we mentioned, of keeping the herd as they are but changing how he structures the time that he moves up and down the mountains. Well, there are lots of factors to consider. If he moves them up too soon, there may not be vegetation for them to eat. As the grass greens up later in the year, if he takes them too soon, it will be the dry, brown grass. And there may be some toxins associated with that.

There are also some restrictions around the timing of when he can move to the different pastures, because there are other people involved in the decision at that scale. He's part of the small group. And that small group is part of a village. And that village is part of a nature reserve.

So there are several people and groups that have a say in when and where [? Joshy ?] can take his herd on the landscape. So those are some factors to consider. He might need to explore the potential of changing the dates he moves different areas, convincing others in his small group to change those, to see if there are options available within the nature reserve to change where and when he herds his livestock. So these are things that he might need to explore as he is addressing the uncertainty related to that management alternative.

Another one is keeping the herd as they are, but providing supplements for the yaks to improve their health. Well, where is he going to get those supplements from? How much do they cost? Will they be effective? Is there risk they could actually have a negative side effect if they're applied inappropriately, or if they're somehow damaged before he receives them? Is [INAUDIBLE} going to be enough? Is this a short term fix that will help them for just another 5 or 10 years? Or will it be a long-term solution?

There are multiple levels of uncertainty associated with that management alternative as well. So you can think about how you'd want to clarify and reduce some of the uncertainty associated with these alternatives as you're assessing the consequences. In this case you don't have a lot of time to generate models or develop a background survey. So you want to sit down with a few key experts to assess the likelihood of these alternatives in achieving [? Joshy's ?] objectives.

Here's what you come up with. So you think that keeping the herd as it is has a lower chance of achieving the objective of income over the long-term. You also think that buying the yaks is probably not going to perform as well, if the concern about the yak health still remains.

Selling some of his yaks-- well, this might be a good alternative. You also need to think about if he's then supplementing with more cows, or if he's just facing the reduction across the foreseen future in his herd size that way. If he sells them all and tries to get another source of income, there are a lot of uncertainties associated with that, particularly for his son in the long-term. And then we talked about the uncertainties related to getting the supplements for the yaks, and for moving up and down the mountains at different times. So let's go back to [? Joshy ?] and hear what he says.

Would I be willing to sell my yaks and herd only cows? I'd rather not, but if it helps my family and secures my income, I think I would.

OK. We've heard from [? Joshy ?] that he'd really rather not sell off all of his yaks right now, unless he really had to. So since we don't have enough certainty around the consequences to know that he absolutely needs to do that right now, we'll eliminate that alternative. We also know that he'd really rather not try and get another job, because of the uncertainty of then his son finding a job. So the risk there is too high. So we're also going to eliminate that alternative.

So we're down to a smaller subset of alternatives. And we're going to do more detailed consequence assessment with the remaining alternatives. Keep the herd as it is, but provide more supplements for the yaks to improve their health. Second, to keep the herd as it is but change the timing, and when the livestock moved up the mountain. And three, keep the herd as it is.

So at this stage we would want to find out a little bit more about the options that are remaining. We mentioned some of the uncertainty as well. Some of that could be reduced just by talking with people, and finding out from small group leaders and the nature reserve staff if those options are truly available, or what that would entail. Also, we could talk with the local vet. Maybe even make a trip into town to talk with the vet in town. And see if he has an idea about ways to improve yak health, and if he has a sense about the predictions associated with these changes, and to health over time.

OK. We found out that moving up and down the mountain at different times isn't really going to help in this situation. If he moves up too soon and the grass isn't green, then his livestock will already be in a weakened condition from the winter. And then they'll had to have made this long journey up the mountain, and will be even weaker with no vegetation to eat. They're more likely to eat the dry things that are remaining that actually contain some toxins, and would be worse for the livestock.

So we found out that that's not an option. And that taking the livestock to other pastures also is not an option, because there simply isn't capacity to take livestock into different areas. So we've eliminated that alternative.

Now the options are-- keep the herd as it is, and to keep the herd as it is but provide some more supplements. We found out from the local vet, that there are several vaccines that are available. And that there are some theories on how to improve the yak health, particularly over the winter months. Let's see if [? Joshy ?] is interested in that.

Would I consider spending time and money to learn about yak health? Yes, I think it would be good. It would help my family and help me raise my herd. I think it would be a good thing.