PART 4: Modes of engagement

After we install the solar panel,
maybe we should fix the ladder.

Chapter 15: Innovation is required to solve complex environmental problems

15.1 Introduction

The world is complex and may be getting more complex because of human society employing increasing amounts of power to manage and control the environment. Innovation brings together technical and social ingenuity to address problems in novel ways. Our environmental situation is changing substantially and so must the approaches that we use to diagnose and solve these problems. In addition, human control over the environment has accelerated the pace of change and this will require a level of innovation just to deal with the pace as well as the substance of efforts required to maintain a healthy environment.

The complexity of our problems has six major features (Homer-Dixon ****, pg 104). 1) There are multiple interacting components that are involved in any problem. 2) The causal connections are dense which results from them being tied to human actions on some way. 3) All of the problems are interdependent. There are no single solutions to single problems anymore. Everything is connected. 4) Complex problems exhibit synergy that can be good if we are on the path to solving them, but it can be worse if the situation is deteriorating. These problems are often called "vicious spiral" because as deterioration happens the rate is accelerating and the scope is broadening. 5) These problems exist because the environment is an open system and all of our actions *** check this ***. 6) Many of the problems we face have thresholds and exhibit non-linear or catastrophic behavior. As we near these thresholds we may risk huge negative effects even for the same incremental new damage that the system had absorbed in the past. Worst of all, these thresholds are mostly shrouded in uncertainty and we may not realize we have crossed the threshold until too late. These complex problems pose new challenges to our society and will require new, innovative technology, methods and institutions to deal with them. The key question facing us is whether our educational, science and political systems will be able to provide the required amount and quality of innovation to solve these problems, or will we continue to widen what Homer-Dixon calls the "ingenuity gap," where we create new problems faster than we attend to solving them?

15.2 Old problems in new contexts

Some of our current problems have been around for a long time but are now taking on new dimensions. For example, 40% of the people use firewood or charcoal for cooking and for about half of these people, wood is their primary energy source. In addition, 1.2 billion people lack access to clean drinking water. Compounding this, 40% of all protein consumed by humans requires synthetic fertilizer (Smil ****). With the expanding global population, these problems are all coming together. Fuel wood sources are being depleted at the same time that people are converting forests to farmland. Runoff from agriculture and industries is polluting water sources for both rural and urban poor. The costs of energy are driving up the costs of fertilizer and, in turn, the costs of food. New technologies, local institutions that control the use of these technologies for social benefits, and methods to disseminate both technology and institutions around the globe are needed.

Treadle powered water pumps are a case study in innovation to serve the public good.

- Insert example
- References Elkington and Hartigan 2008, Polak 2008
- Pump design
- Use by farmers to increase production

- Make profit which pays for the pump
- Develops ownership and markets
- Picture of a treadle pump
- Summary of social enterprise/innovation

15.3 Combinatorial Innovation

Although it is common to use the word "innovation" to mean or imply something totally new, the most common and powerful form of innovation is to combine tested components into new configurations for new uses. This process defines a problem and then searches for potential solutions by piecing together and connecting parts. A simple example is the creation of solar-powered community water in rural areas of Nicaragua. This required both technical and social components that worked together to address the entire problem and provide substantial value to the community. In the case that I was involved in (and there are many other examples), this included at least the following components:

- Drilling a well
- Creating a storage system and distribution pipes to homes
- Installation of a solar array to power the pump
- Creation of community organization that could handle the billing for installation and continued maintenance
- Establishing local technicians to monitor and service the solar panels, pumps, pipes and storage tank
- Involvement of public health professionals to change health habits

The completed project had community support, community financial backing, and local experts. In addition there were a range of benefits to families that could be developed, such as the ability to wash food, sustain personal hygiene (including brushing teeth), and maintain kitchen cleanliness, all of which were not possible when they were drawing water from a semi-polluted stream.

The community water project also served as a platform for several other related projects. These projects would not have been successful if an outside agency had simply piped in potable water to the houses. For example, several homes explored the use of the grey water from their tap to create patio gardens. These gardens were used to raise fruits and vegetables that were needed in their personal diets. A beneficial side effect was for these families to put fences around their houses to keep the pigs, cows, goats and chickens away from the patio garden, which improved the quality of the family's health. Some farmers explored the use of drip irrigation by essentially using some of the same components (at a smaller, cheaper scale) to provide seasonal drip irrigation of vegetables and fruits that they could eat or even take to the local market. A storefront was set up in a local town to sell solar panels and ancillary equipment using a revolving micro-credit scheme. Thus, a whole host of projects grew out of an initial innovative combination of solar power and community organization. The green technology and the institutional development together made this possible and lead to the diverse benefits for the community.

Figure 15.1 A happy group of community members and capstone students celebrate the final attachment of the water reservoir to the solar drip-irrigation project.

15.4 Nurturing and supporting innovation

It has been said that "invention is a flower, innovation is a weed" (Metcalfe 1999). By this he means that a flower garden takes continual tending and is delicate, but innovations should be able to spread on their own given the right conditions. If innovations are crucial to continued progress with environmental problems, as I claim, then how can we promote socially beneficial innovations that have all the necessary attributes to spread on their own? There are three aspects to this support: identifying the gap, modeling problems to create new insights, and creating synergistic institutions.

We have to recognize that there is a gap between the problems that we are creating and our ability to solve these with current technology and social institutions. Part of the reason for this gap is our over-confidence in technology as a panacea for all problems. Another aspect of this gap is that we have a poor understanding of, and in fact a general social aversion to, uncertainty. When we add a new chemical to the catalog, create a novel plant of bacteria strain, or construct a new dam, we are actually creating uncertainty. If it takes a few good inventors to come up with a totally new compound, as it did to invent CFCs, it may take thousands of research scientists, government employees and policy analysts to come up with a way to reduce the CFCs in the environment after only a couple decades of use. In the case of CFCs the uncertainty multiplier was enormous because of its rapid adoption, global use and remoteness of the immediate cause (catalysis of ozone destruction). The unintended consequences of CFC invention were astounding. But there are many other inventions or novel actions that had unintended consequences. Tenner describes several of these in detail in his book entitled "Why things bite back: technology and the revenge of unintended consequences". *** final sentence on the gap ***

In order to encourage innovation, the exploration of environmental problems has to take a more empirical approach, relying on actual observations, data and evidence. Starting with theory and generalizations is more likely to result in general solutions that are not place and issue specific enough. Remember Wendell Berry's exhortation to "solve in the pattern" (Berry 1972). New approaches to data analysis (Andrienko and Andrienko 2006) provide the background and tools to explore large environmental data sets, look for possible connections in a rigorous manner, and develop new types of hypotheses for testing. Many of these methods depend on using software to create visual representations that serve to stimulate discussion and lead to a more insightful treatment of the problem. Figure 15-2 gives an example of the type of visualization tool that can be used to explore observations and formulate working hypotheses.

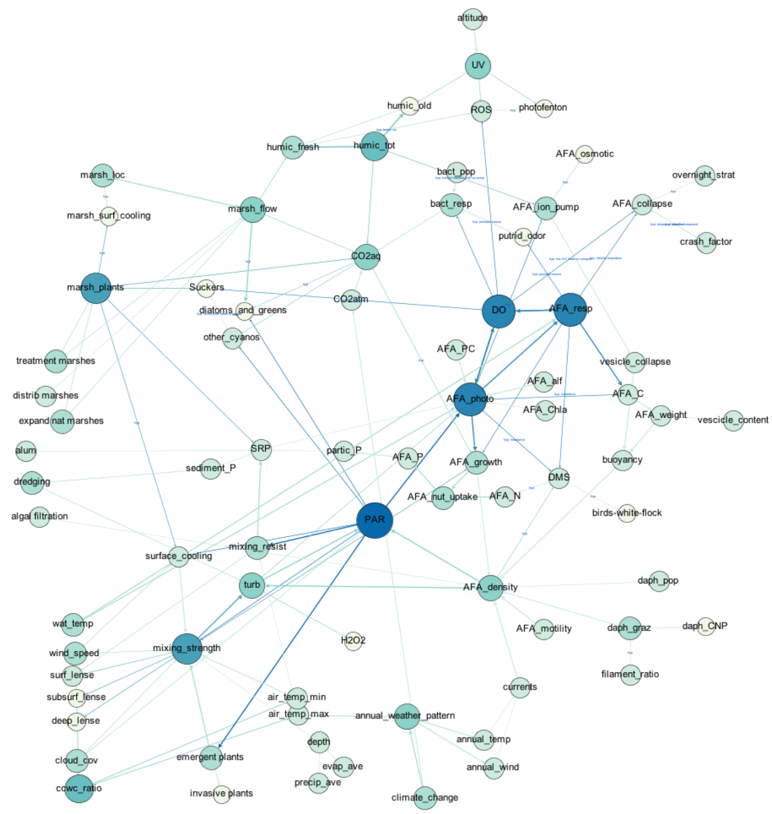

Figure 15.2 Network "graph" of possible interactions that could lead to toxic algal blooms in Upper Klamath Lake, Oregon. All linkages can be documented and described as observed or hypothetical. The graph itself can be modified on the fly as a group of lake researchers might add new connections or insight.

Why we need the institutional or cultural - reason 1: rapid change from cultural evolution--- Every innovation needs to be wrapped in a social understanding of how and when it will be used, i.e. an institutional framework.

Homer-Dixon 194 - "the greater complexity of our world requires greater complexity in our technologies and institutions" <!-- which is applying Ashby's Law of requisite complexity to the solution of these problems -->

*** more here from Homer-Dixon

Homer-Dixon – 205 cultural evolution is rapid enough and refering to Peter Richerson's work - "culture is "information -- skills, attitudes, beliefs, values -- capable of affecting individuals' behavior, which they acquire from others by teaching, imitation, and other forms of social learning."

225 - Solow's study capital only explained 12.5 to 20% of improvements in labor output, the rest was called the "residual" and came from better methods, not more machines

reason 2: need to have growth and innovation under our social control *** important not to launch innovations on their own – as described by Norgaard 1994– positivism leads to too much confidence in progress, - need co-evolving ecological and socials systems that are more pluralistic,

Adams – indeterminancy,

Vitek and Jackson 2008 – take an approach that acknowledges our ignorance

Schwartz - Practical wisdom, i.e. cultural context, provides situational context for making decisions about new ideas that strict rules can't keep up with

final sentence – Understanding and dealing with the uncertainty and indeterminancy of novel approaches requires a strong social construction ….

15.5 Examples of innovative solutions to environmental problems

several examples with technology components being combined and social and institutional support

1. water purification in Kenya – (Evan Thomas) -
    - SWEET lab – develops sensors
    - See pdf-articles/SWEET…

2. smart grid in Salem (Hughes)– with substantial social component
    - List of technologies
    - Cooperating businesses
    - Role of the home – power use, power generation, power storage

3. localization of agriculture De Young and Princen 2012
    - How to prepare for the downshift in energy and materials
    - Not all new components – many familiar and tested from previous generations
    - Many small experiments with everybody involved – all of us
    - Information availability and how it is used is the main piece of how this is different than 4000 years ago, including technology that helps share this information (examples urban orchards, hyperlocal food purchasing apps for your neighborhood, on-line CSAs)
    - The process is innovative – support for these experiments

- Requires a shift in dominant worldview away from competitor-winner/looser society toward a partnership society

15.6 Summary

There is an ingenuity gap – need innovation and institutional ***

We even need innovation to address older problems that are morphing into complex and wicked problems as we have population growth

Many, if not most, innovations are the result of combining tested parts into a new solution. These parts include technology, institutions,

Innovation requires nurturing and on-going support,

Examples demonstrate combining technology, social, economic components

Chapter 16: Institutions

16.1 Introduction

A range of institutions necessary for environmental management

All environmental problems contain natural and human components. Addressing these problems will require working with ecological constraints, scientific knowledge and social structures. These can be viewed as the "rules" that are in practice in a particular situation. Rules in practice are institutions. When we address rules that govern environmental problems and what we need to do about them, we are either creating or modifying institutions. In this section we will view institutions as a social constructions that allow us to integrate both knowledge-generating frameworks (such as the "systems" and "network" views presented earlier) and decision-making frameworks (such as the "games" framework). In this view, the purpose of an institution is to serve as a vehicle to solve an environmental problem by bringing together appropriate information and decision-making skills.

As we discussed in Chapter 1, environmental problems can be characterized by either their alignment between costs and benefits or by their complexity (Figure 1-1). This categorization of problems shows that not all problems can be solved by collecting more information or applying more regulations. In particular, wicked problems require political involvement, community- and consensus-building processes that may take a long time and require substantial resources.

Of immediate interest is whether the problem is being solved to meet some external requirement or for the benefit of the members of the group. In small groups of people or groups of organizations, the formation and organization of these has been characterized as either "work groups" or "clubs" (Arrow et al. 2000). This distinction forms an important constraint on the ability to change the rules, to modify the institution itself, in response to the problem. Externally formed groups are more likely going to have to work within the institution, but these groups have the advantage that there are other values associated with maintaining the larger group that can be brought to bear on the problem. On the other hand a self-contained club can change the rules but might not have any other social or economic capital to draw on.

16.2 Example institutions in the background

Several simple examples illustrate the embedded, almost background role that institutions play in solving environmental problems. The recycling of beverage containers makes sense because of diminished energy costs (especially for aluminum cans), reduced litter and pollution, and minimized effort on behalf of the consumer who is returning to the store anyway. However straightforward you might think this is, it took the creation of an agreement between many parties, i.e. an institution, to make recycling work. In Oregon, one of the first states to have a bottle bill, the institution involves grocery store owners collecting the deposit from shoppers; some of the deposit goes directly to the store and some goes to an industry group overseeing the deposit, some of it goes back to the consumers when then return bottles and cans. The reason this works is that the store and industry group gets to keep unclaimed deposits. Unclaimed deposits are really a tax on shoppers who don’t make the effort or who can’t return the cans and bottles for some other reason. Even in a place as environmentally conscious as Oregon, this turns out to be a lot of money. So for all the civic pride in having a bottle bill, the recycling program may actually work (i.e. be profitable to the stores) because enough Oregonians don’t recycle.

Carbon credits are another example where there has to be institutional infrastructure in the background for this to work. The media has paid a lot of attention to the amount of money that might change hands for carbon credits in which an energy company in the USA (that emits excess carbon dioxide) might pay some entity in the Amazon for protecting forests (that sequester carbon dioxide). In order for any such an exchange of money to take place, there needs to be a bank for carbon credits that verifies the carbon sequestration amounts and monetorizes and securitizes these into a certain number of credits. The bank also has to establish some method for dealing with the risk involved with natural resources, such as from fires or other natural disasters. In addition to carbon trading, there are similar banks for wetlands and pollutants.

16.3 Creating institutions to deal with CPR

It is important to establish that institutions, sets of rules, can resolve environmental and resource problems and, in particular, that CPR problems can and have been solved successfully without resorting to either overwhelming exogenous force (federal intervention) or privitization (turing a common resource into a private resource). This observation (by Ostrom and others) contradicts the simple analysis proposed by Hardin, i.e. that a tragedy will occur unless strong, external governance protects the commons. The following examples presented by Ostrom (1990) illustrate the design principles that are characteristic of successful CPR institutions.

Add in from –

Ostrom-2005.html

Ostrom_and_Walker_1997.html

16.4 Innovations require new institutions

see Homer-Dixon

16.5 Governance forms as institutions

Democracy – tenets

SAM as a internal regulation institution

Conflict between science and democracy

See democracy-SAM folder

See section in NALMS 2012 talk

16.6 Summary

many institutions are required
need to fit the purpose
maybe in the background
CPR is good example
Governance institutions are not necessarily matched to current environmental demands, however good environmental stewardship may lead to good governance

