Notes from Lectures by Dennis Meadows

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LECTURE 1: OBSTACLES TO EFFECTIVE CLIMATE POLICY

Most of our lectures focused on theory, and the possibilities of what can be accomplished. Dr. Meadows emphasized that sustainability does not do society any good "in theory". Instead, we need to have sustainability operational in practice. But there are obstacles in the way to achieving practical results, and Dennis focused in his first lecture on identifying some of these roadblocks. Although he focuses on climate change, the lessons are translatable to the other major sustainability challenges faced by society.

The Reference Scenario

In 1972, Dennis Meadows and a group at MIT made a global model to understand the implications of physical growth on the planet. Dr. Meadows and his coauthors detailed their results in the book *Limits to Growth*, portraying a global economic system would peak and crash sometime between 2020 and 2040. While these coming decades will see major changes in demography and politics, the biggest stresses and on society are occurring now as our environment strains to provide for ever-increasing consumption (e.g. food scarcity and water shortages). Dr. Meadows suggests that these incredible forces may sweep away democratic authority, as societies forgo short-term responsibility to central authorities attempting to handle the crises.

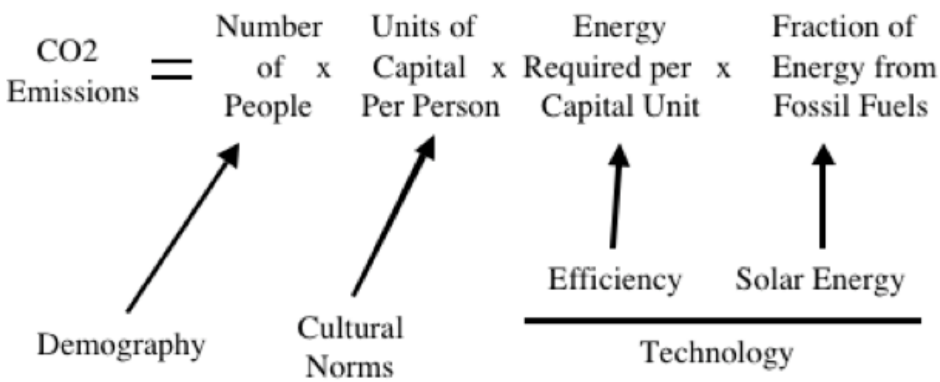
Thus, society is faced with an option. We can foresee these dramatic changes and deal with them proactively, or we can wait for pressures to mount and society may "overshoot" the earth's limits. While physical growth, population, and material growth will decline, we can choose to structure our response to these changes and aim for a peaceful, sustainable society.

Back in 1972, climate change was not a major societal issue. Yet Dr. Meadows and his coauthors published a record of CO_2 changes over time in *Limits to Growth*. They sought to show the impact of human activity in a persistent atmospheric pollutant. These days we know that CO_2 and other greenhouse gases cause climate change that threatens human and ecological systems.

Today scientists are in widespread agreement that something must be done to deal with climate change. Yet five major obstacles are blocking the adoption of policies combating the problem: policy is directed at the wrong levers, leaders do not understand the dynamics of climate change, the wrong criteria are being used for economic decisions, the time horizon for policy is too short, and positive feedback loops have already removed much control from our hands.

#1: Policy is Directed at the Wrong Levers

The CO_2 emissions from society can be summarized as follows:



Traditional technologies have focused simply on the energy required per capital unit (efficiency measures) and the fraction of energy from fossil fuels (renewable energy). Yet demography (number of people) and the units of capital per person (cultural norms and living standards) are also out of balance. Population continues to rapidly grow: when *Limits to Growth* was first published, the population of the earth was 3 billion people. Today we have 6 billion people, and stabilizing at 8 billion is likely a fantasy. Even if we focus all of our efforts bringing the fraction of fossil fuels to zero, we would still have many other major environmental problems to confront. This can be seen clearly in work looking at human society's ecological impact; already society would need nearly an earth and a half upon which to support our current level of consumption! Thus, until we deal with population and lifestyle changes, we cannot deal with global climate change in a holistic manner.

#2: Leaders Do Not Understand the Dynamics of Climate Change

In the climate system, there is a fundamental disconnect between major policy tools and the concern about climate change impacts. Society's main policy levers operate to stop or slow greenhouse gas emissions. Yet we are concerned about the impacts on geophysical variables: ice cover, species diversity, agricultural productivity, etc. Society tends to take environmental policy actions when negative effects arise in the geophysical variables of concern. Yet in the climate system, by the time we see changes it may be too late to prevent major catastrophes.

Dr. Meadows related the climate system to a bathtub. If the incoming flow of water is equal to the flow of water heading down the drain, the system reaches equilibrium. Even when one decides that it would be a good idea to turn off the flow of incoming water, the water level still will increase quite a lot while one turns off the faucet. In terms of climate, this phenomenon is the same: CO_2 concentrations in the atmosphere will continue to increase for an extended period (perhaps centuries) even after *the rate* of CO_2 emissions start to decline.

Thus, climate change is unique in that we must choose major change before we see devastating impacts if we wish to avoid catastrophe. Leaders do not understand this phenomenon, and scientists must do their best to be effective educators.

#3: The Wrong Criteria are Being Used

The view of the economic community towards climate change was radically altered when Sir Nicholas Stern came out with his report on the issue for the British Government. Stern advocated prompt action because the costs of tackling climate change were far outweighed by the costs of inaction. The main reason why Stern arrived at this result, as we discussed with Partha Dasgupta, is because he utilized a far lower discount rate (the rate at which future benefits are discounted relative to present-day costs) than the studies of some other economists, including William Nordhaus at Yale. Now a lively debate has emerged in the climate change economics literature attempting to discover the proper discount rate to utilize for the climate issue.

Dr. Meadows argued that discount rates are ill-suited for use in decision-making about climate policy because they are based on the following assumptions:

- All consequences of an action are known.
- All the consequences of an action can be expressed in monetary units.
- Those who decide the discount rate are those who are most affected by the consequences of climate policy.
- Maximizing present financial benefits is the goal of society.
- The bad results of current mistakes can be corrected by paying some monetary cost in the future.

In the case of climate change, every one of these assumptions is false. Thus, discussion what the proper discount rate to use is the wrong debate; as soon as we do that, we have conceded that discount rates should be utilized in the first place. Many other decision-making tools could be utilized instead of discount rates. For example, we may choose to appoint a council to represent the interests of future generations or we may follow the precautionary principle (in the words of Dr. Meadows, "Don't gamble if you can't afford it.").

#4: The Time Horizon is Too Short

In the case of a simple problem, actions can be taken and then evaluated to see whether the actions are achieving the desired results. In more complex problems, sometimes the path to solving a problem may make the problem look worse at the evaluation point. Climate change is one such problem: our path to solving the crisis will incur some costs to society while we still must endure the challenge of the climate change we have already created.

Lengthening the time-horizon of evaluation could help deal with these complex environmental challenges. For example, the Australian environmental office is politically independent, so that they may deal with these environmental challenges in a length of time longer than a political cycle. In Hungary, a committee has been formed to represent the interests of future generations in the political process. Ideally, such actions could help lengthen the time horizon for evaluation of environmental policies.

#5: Positive Feedback Loops Have Taken Control of the Climate Out of Our Hands

Positive feedback loops in the climate system are already wresting control of climate from human hands. To begin with, changes in the climate system were driven by increasing amounts of anthropogenic greenhouse gases. Now, positive feedback loops may be taking control: melting arctic sea ice increases surface albedo, melting permafrost releases methane stores, melting ice sheets may positively amplify ice stream flow (Note: lectures from Dr. Schellnhuber and Dr. England suggest that these dangerous positive feedback mechanisms will likely happen with an increase of global mean temperature more than 2°C).

Positive feedback loops can be very surprising and very powerful. Dr. Meadows illustrated this point by folding a cloth in half, then in half again. The cloth was now considerably thicker than it was before, but the change was not dramatic. Yet if Dr. Meadows could fold the cloth in half 28 more times, suddenly it would be capable of stretching between Boston and Frankfurt. Looking at a graph of cloth folds and the distance that the cloth could extend, we see a dramatic inflection point were distances skyrocket. Yet nothing changes at the inflection point, it is just the simple result of a positive feedback loop.

What Can Be Done?

With these challenges obstructing leaders from crafting effective climate policy, what can researchers and citizens do?

- Educating leaders is of primary importance: the more leaders know, the more likely society will head in a good direction.
- We must work to establish consensus in our society, so we must educate and have conversations about sustainability in within our own communities.
- Dr. Meadows stressed that actions speak louder than words – educating others is much more effective when we are making attempts to live our own life in a sustainable manner.
- Give up any idea that the trajectory of the world will be a catastrophe or a utopia; we will end up somewhere in between. Instead, know that one can influence this trajectory through action and education.
- Block out time for yourself and your family; getting burnt out will only hurt you and prevent you from tackling the big issues.

LECTURE 2: GAMES AND LESSONS FOR SUSTAINABILITY

Dr. Meadows has developed a number of educational games that are designed to help people gain a deeper understanding about natural resource management, financial markets, and other complex systems. In his second lecture, Meadows provided an overview of the use of games in learning, as well as a detailed look at his *Fish Banks, Ltd.* game.

Use of Games in Learning

Although learning games may seem random, there is a discipline to creating a game that conveys insight. The following are nine steps to develop an effective interactive, educational process.

Step 1: Frame it.

The first step is to create context for the game. Every game is based on a model, and every model is a simplification of reality. One should also keep in mind that much of the learning that occurs through a game comes from what the people who participate bring to the table.

Step 2: Play the game.

Games can take minutes, hours, or even days to play. One occupational hazard of gaming is for the game to consume so much time that it squeezes out learning. If you are trying to facilitate learning, you must ensure to leave enough time to debrief after playing a game.

Step 3: Discuss the game.

After the game, ask participants to reflect on the following questions:
- What actually happened in game?
- What were some of the surprises and mistakes in the game?
- How did people feel during the game?
- What were the emergent phenomena of the game?

Step 4: Identify whether or not phenomena from game also occur in real life.

Is what happens in real life similar to what occurs in the game? If the phenomena from the game do not translate into real life, then there is little value in the game.

Step 5: Identify why the phenomena happened.

Ask participants to reflect on the following questions:
- Why did the phenomena occur in the game?
- Were there structural features of the game or the rules that caused the phenomena to occur? Do these analogues of these features exist in real life?

- Can you map the learning lessons to real life?

Step 6: How could you change the game?

Reflect on how one could change the game to realize a better outcome. Could you change the rules, structural features to create a better end result?

Step 7: Do the changes have counterparts in real life?

Just as you might be able to change the rules or structure of the game to create a better outcome, do those changes have parallels in real life? Could one nudge "real life" towards a better outcome?

Step 8: Get people to commit to making those changes.

In order to affect change in real life, secure the commitment of people to implement changes that can produce better options in the real world.

Note: I couldn't find a Step 9 *anywhere* among my notes or anyone elses!

Games can be used to engage people who are in positions to lead business or public policy. They can be used to educate and intervene. However, to affect political change, one must have a mechanism for gaining commitment from decision-makers to change the structure and rules of the real world.

Fish Banks, Ltd. and Natural Resource Depletion

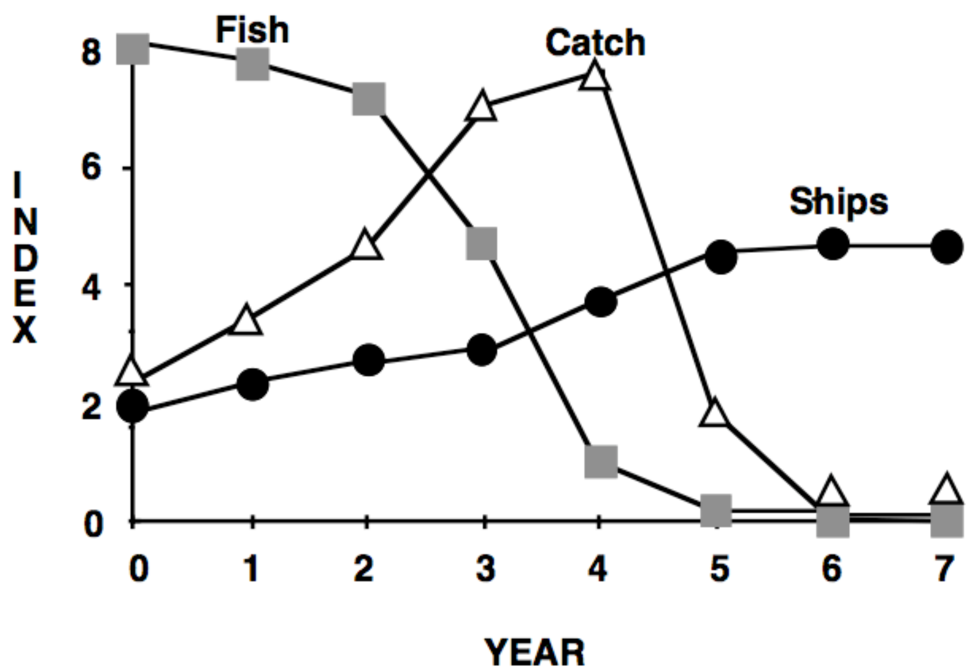
Fish Banks, Ltd. Overview

Fish Banks, Ltd. is a game designed to give participants insight into natural resource management. In the game, a number of teams take part in a simulation where they each represent a principal fishing company. There are two primary fishing areas where the teams may fish, the coastal region and the deep sea, each with population dynamics that have natural birth and death cycles. The teams make two primary decisions in each round: 1) how many ships to build, purchase or sell, and 2) how many ships to send into the deep sea, coastal regions, or dock at the harbor. Each team's goal is to maximize their total assets by the end of the game, after six to ten cycles (years).

Typical Game Outcomes

During the Fish Banks game simulation conducted at the SFI Sustainability Summer School, the game ended with the teams' depleting the entire deep sea fish stock, and nearly depleting the coastal region population as well. In a typical game, the teams build up their ship fleets, and send as many ships as possible into the fishing areas during each round. At some point, the catch begins to plummet as a result of overfishing in both regions, and it is no longer profitable to send ships out to sea. The teams then typically reduce the number of ships sent into the fishing areas; however, by then, the fish populations are so devastated that they are unable to recover.

Figure 1. Typical outcome for the Fish Banks game.



In an optimal game in which average team profits are maximized, the teams send out only as many ships as can obtain a profitable catch while maintaining healthy fish populations in the deep sea and coastal regions. In a typical game, where the fish populations are depleted due to overfishing, all team profits on average are *lower* than if the fish were caught in a sustainable manner.

Analysis of the Fish Banks Game and Real Life Examples

When the Fish Banks game is played, it is often frantic and hectic, similar to the real world. There is little time for the teams to make decisions, and they make them from round to round with little long-range planning. The game has been played with natural resource managers, real fishermen, environmental nonprofit leaders, and policymakers, all with similar results: a total or near devastation of the fish populations.

Sadly, what typically happens in the Fish Banks game is happening in global fisheries. Global fish catch has increase by about five times since 1920, and it is estimated that 75% of global fisheries are either severely degraded or on the verge of collapse. The dynamics of system are such that fish populations usually decline dramatically before there is any feedback to the fishing companies to change their course of action. By using fishing technologies where harvest is linearly related to density, people can gain earlier feedback. For example, in Goa, local populations using fishing boats would back off from fishing as soon as the density of fish went down. When Norwegian ships introduced "modern" fishing boats with sonar, overfishing quickly occurred, and the fisheries collapsed.

Dr. Meadows suggests several strategies to avoid tragedy of the commons within global fisheries:

- Partition the seas;
- Establish quotas;
- Farm fish;
- Move down food chain;
- Change consumption preferences;
- Reduce destruction and pollution of fisheries;
- Limit ship fleets, technology;
- Develop better methods to assess stock;
- Change social values and economic incentives.

Renewable Resource Systems

In any renewable resource system, there are two primary questions one must ask:

1. What is the sustainable use of the resource?
   For example, in the Fish Banks game, what is the maximum number of fish that can be harvested from year to year without devastating the fish population? In the game, because the catch is deterministic and the regeneration rate is given, it is possible to calculate how many boats can be sent out year after year without degenerating the fish stock.

2. How to allocate the proceeds to the various players?
   In the game and in the real world, the allocation of benefits obtained from a common natural resource to various competing groups must be dealt with. This challenge needs to be taken care of explicitly; if not, then the classical situation of the tragedy of the commons is often the outcome.

Shifting Dominance and Climate Change

One characteristic of complex systems is that of "shifting dominance." In a complex system comprised of various feedback loops, shifting dominance occurs when a change emerges from the system through a feedback loop that comes to exhibit dominant behavior. When a shift in dominance is observed in a system, scape-goating can often occur; there is also often a tendency to look for blame outside system, when in fact the problem actually lies within the system, and has been present all along.

At the beginning of the Fish Banks game, when teams built more ships and sent as many as possible out to sea, the catch would increase, along with profits. However, the fish population was soon unable to replenish itself, at which point sending the most possible ships out to sea did not result in higher catches of fish (nor profits). We also see this phenomenon within the oil system. In the past, when reserves went down, exploration went up, and then reserves went back up again. However, now, exploration does not always replenish reserves. The system is the same, but particular components within the system are now playing a dominant role.

Climate change presents us with a similar phenomenon. The primary lesson? We cannot solve the problem with old behavior. There are actions that may have had a positive affect in addressing environmental problems in the past, but will have unintended negative consequences in the future. Rather than exhibiting the same old behavior, we have to change the rules of the game, change the structure of the system. One of the greatest challenges is that in real life, rules become embedded in institutional structures and the incentives of people working within those structures. For example, Exxon will not allow people to change the rules of the energy system very easily. However, in order to address the problems of climate change, we have to change the rules and structure of the system. After doing so, we can open up new possibilities that affect the change we want to see in the system.