What's Law Got to Do with It? The Relationship of Law to Environmental Systems Management and Sustainability Research

N. Theresa Hoagland, Attorney and an Environmental Protection Specialist, U. S. Environmental Protection Agency, National Risk Management Research Laboratory, Cincinnati, OH

Abstract—*Legal concepts cannot be described as the area under the curve or in terms of equilibrium equations; however, law is one of several dimensions of a complex system that must be included in an interdisciplinary study of sustainability. It is one of the initial conditions to be considered in projecting the systems trajectory and it is also a constraint on implementation of research findings and recommendations for sustainable actions to be taken. Two methods for incorporating law into sustainability research are described. One is theoretical and is illustrated by how property rights affect foodweb and societal decision-making models. The second is more practical and is illustrated by how law affects the implementation phase of a study on stormwater runoff volume reduction.*

Introduction

Sustainability can be thought of as effectively managing environmental systems, including ourselves. The concept is illustrated in figure 1, which depicts a complex system composed of four dimensions through time: economic, technological, ecological, and legal-social. (Cabezas and others 2003) The system that results from the interaction of these dimensions is shown here as a trajectory through state space. The goal of sustainability is to keep the system trajectory within a "tunnel" that represents desirable conditions through time. The goal of sustainability research is to understand what the tunnel boundaries are and how the dimensions interact to create the system trajectory. The initial questions to be answered include: what are the variables in each dimension; how can they be measured or otherwise accounted for; and how do the variables in one dimension relate to variables in the other dimensions?

Three of the four dimensions are human-based (only the ecological dimension could exist without humans), but variables in the economic, technological, ecological, and (to some degree) social dimensions are similar in that they can be quantified and analyzed using scientific methods and mathematical formulas. When dealing with the legal aspect of the social dimension, however, science and math seem to play no part. How, then can law be integrated into a scientific study or mathematical model for analysis?

Comparing the dimensions in the context of the disciplines they represent yields the following perspective. Economics is the study of how people make choices, while social science is the study of what those choices are and why people make them. Science and technology represent what choices are available--what is physically possible given the basic laws of nature. Law is about what choices people (as a society) allow themselves to make. Thus, law is more malleable and one could question why we include it at all, since we can change it at will to serve our purpose.

There are several reasons for including law in our sustainability research. Existing law is one of the initial

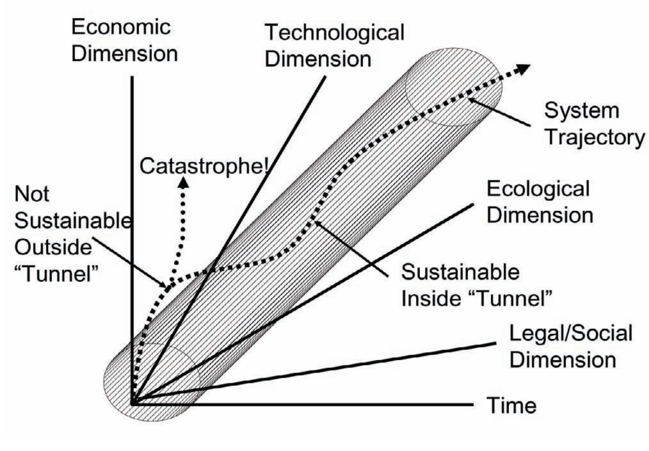

Figure 1. Multidimensional Concept of Sustainability.

conditions that must be considered in any attempt to project the system's future trajectory. There is a practical aspect, as well—the constraints of current law must be taken into account to avoid a solution that is theoretically satisfying, but has little hope of being implemented. Finally, law is itself a complex system and one hypothesis is that we are following systems rules in creating our laws without realizing it (perhaps law is not so malleable, after all).

This paper addresses the first two reasons. The next section describes how we include law in a foodweb model. Following that is a section on the more practical aspects of current law as a constraint in the analysis of options for reducing stormwater runoff volume. The conclusion proposes the next steps to be taken in incorporating law into sustainability research for effective environmental systems management.

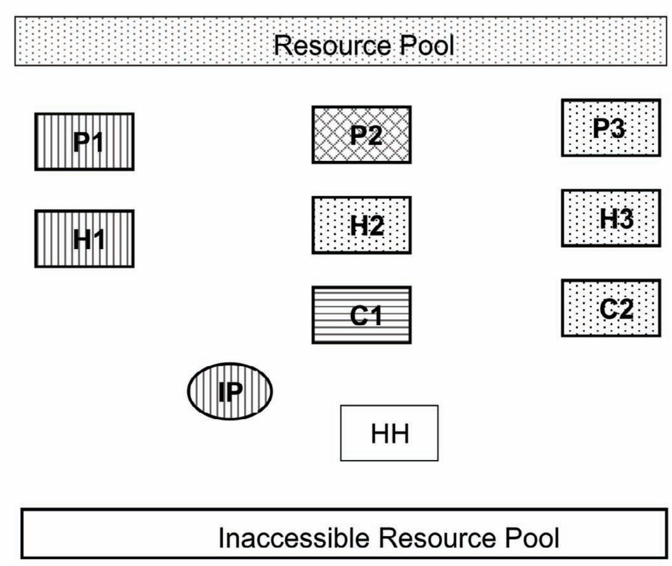

Figure 3. Legal Foodweb.

Foodweb Model

Figure 2 represents a basic foodweb with several trophic levels. (Cabezas and others 2004) The system is open to energy, but closed to mass and the arrows indicate transfers of mass within the closed system. This represents the ecological dimension (fig. 1) and the variable is mass. (We have added an Industrial Process [IP] to the model to account for the mass that is appropriated by humans for its vast infrastructure and non-food products).

Figure 3 represents the same foodweb from a legal perspective. Here, the variable is not mass, but rights attached to the mass (property rights). The conservation of mass still applies, but there is no corresponding conservation of rights (in fact, the transfer of mass is immaterial). It is common to have multiple rights attached to the same mass. For example, one person (the lessor) may have the ownership rights to a parcel of land, while another (the lessee) holds the right of possession, and a third (the heir) has a right to own the parcel at some time in the future. We therefore identify the compartments in terms of the type or property they represent. H1, H2, and IP are private property and are shown in boxes with vertical lines, P2 is government property (shown with cross-hatched lines), and H2, P3, H3, and C2 are "commons" (shown with a dotted background) to which no rights yet attach—they are free for the taking. C1 (shown with horizontal lines) represents a special category. It is wild in that no one owns it, but it is valued by society and so is protected by the government. (At this point, the resource pool is considered commons, but in reality, it, too, is an amalgamation of private, public, and commons property).

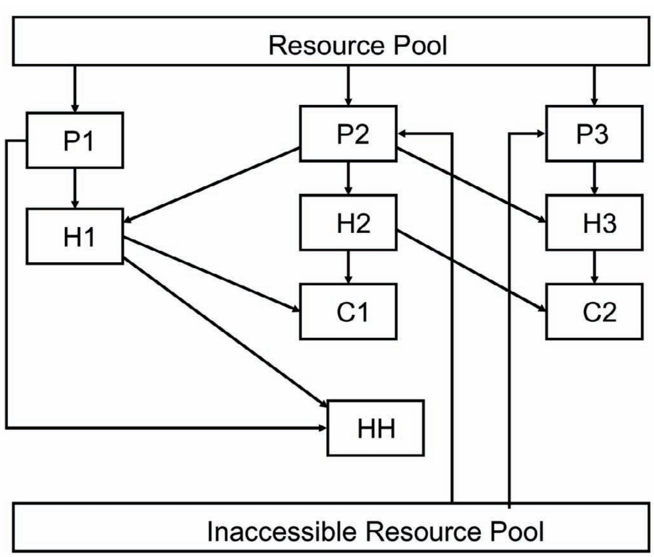

Figure 2. Ecological Foodweb.

Once property rights attach to the mass, a basis exists for an economic system that determines the value associated with the mass and its transfer. It also becomes evident that the foodweb can be divided into domesticated and non-domesticated species because the rules for the transfers of mass will be very different for each. Transfers of mass associated with the domestic species can be modeled according to economic principles (although unlike traditional economic models, since this system is closed to mass, there can be no assumption of infinite resources or substitutability). Transfers of mass between non-domesticated species are governed more by biological rules and sometimes by policy decisions.

Thus, with the addition of the legal perspective, the foodweb represents a more realistic picture of current conditions. We can now use it to test various ecological, economic, and/or policy scenarios and observe the effect on the overall system trajectory.

As an example of how this might translate into a model of societal decision-making, consider figure 4. In this model, the ecological and technological dimensions are considered first. If a desired transfer of mass is not physically or technologically possible, the story ends there. If, however, it is possible, then society considers the economic ramifications. If the transfer of mass is profitable or will otherwise have positive social value, either the private sector or the government may cause it to occur. If, however, society decides against the transfer, how it goes about stopping or modifying it depends on the type of property involved. (How society makes that decision is a function of the political process, not addressed here). In the U. S., the options are greatest if no one owns or controls the property. It takes a more effort to affect government property, but it is most difficult to stop or modify transfers of mass to which private property rights attach. Society (through its government) must buy the property or pay to use it, or it must impose limits on those rights. Limiting rights involves Constitutional issues and is rarely a popular approach. The next section on our stormwater volume reduction research project illustrates this point.

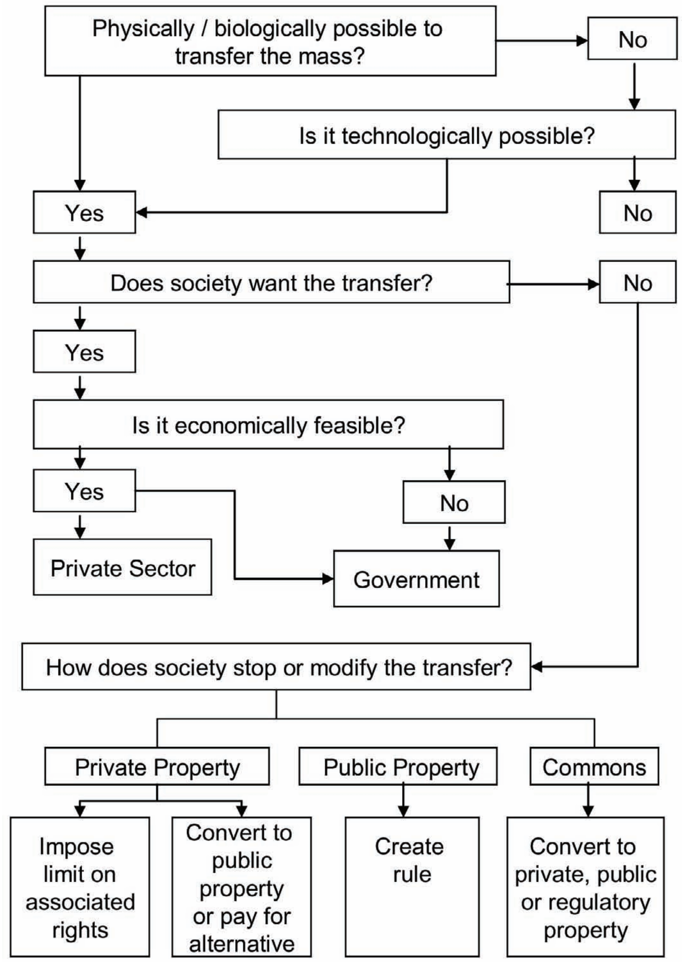

Figure 4. Societal Decision-Making Model.

Stormwater Volume Reduction

The stormwater volume reduction project is testing the hypothesis that small best management practices or "BMPs" (such as rain gardens) distributed throughout a watershed would be ecologically and economically superior to centralized stormwater conveyance and storage systems. (Thurston and others 2003). To explore the likelihood of success, our interdisciplinary team of hydrologists, engineers, ecologists, and attorneys identified four implementation scenarios for using economic incentives to encourage landowners to install the BMPs on their property. The options are: (1) use the existing stormwater fee and credit system in place in many communities; (2) institute a new charge that would be high enough to influence behavior; (3) place a mandatory limit on stormwater runoff volume, such that a cap and trade system could be used; and (4) pay property owners to reduce stormwater runoff volume, using an auction system to determine the participants. (Parikh and others 2004a) Table 1 ranks these scenarios according to the preference of the team members (1 being most preferable). A detailed discussion of each scenario is beyond the scope of this paper; however, Scenario 3 will be used to illustrate how current law functions as a constraint to be factored into the analysis.

For a legal analysis, we start with a basic premise of U.S. law that rights are inherent in or given to the people and powers are given by the people to the government to protect those rights. (A very real conundrum is that the government must sometimes limit the rights of some to protect the rights of all). Applying this to Scenario 3, the questions can be stated as: does the property owner have a right to allow stormwater to run off his/her property (in other words, can the mass be transferred to others who may not want it)? If so, does the government have the power to limit that right?

Table 1. Ranking of Implementation Scenarios.

Scenario	Economic	Ecological	Legal
Use Existing Fee/Credit System	4	4	1
Create a New Charge	2	2	4
Impose Limit for Cap and Trade	1	1	3
Pay Landowners/Voluntary Auction	3	3	2

Much to the frustration of the scientist or engineer, the answer to the first question is that it depends. Stormwater is from a naturally occurring phenomenon and rules governing its drainage onto another's property are considered part of state water law. States can vary significantly in their laws and state drainage law is a good example of this diversity.

Assuming the property owner does have a right to allow the stormwater runoff to occur, the powers side of the analysis focuses on whether the government can limit that right? In the United States, private property rights are very important and receive Constitutional protection, so the government must go through several "hoops" to limit them. Questions to be answered include: Is the power specifically delegated to the Federal Government (such that a Federal law like the Clean Water Act could be used)? If not, is it specifically prohibited to the States? If not, does the State Constitution allow it? Even if it does, would the limit violate the due process or equal protection guarantees of the U. S. Constitution? If the new limit can pass all these hurdles, it may be legal, but landowners may still challenge it as the government's taking private property for public use without paying for it.

The point is not to discuss the legal issues, (Parikh and others 2004b) but to illustrate that such issues exist and must be taken into account when evaluating the potential benefit of pursuing one research agenda over another. In this case, our research team chose to devote its limited resources to Scenario 4, because it offered a more straightforward path to actual implementation. As indicated in table 1, Scenarios 2 or 3 may promise superior economic or ecological results on paper, but if they are unlikely to be implemented in the real world, those results will never be realized. By the same token, the scenario that is most likely to be implemented from a legal standpoint (Scenario 1) is less likely to meet the economic or ecological objectives. Thus, by concentrating our efforts on the best compromise, we can maximize our research efficiency and hopefully influence sustainability in a very real sense.

Conclusion

"Interdisciplinary research" usually means that more than one type of scientist or engineer is involved, but in sustainability research, all of the dimensions (economic, technological, ecological, and legal-social) are equally important and must be represented. Law is typically applied, if at all, after the fact by those charged with interpretation and implementation of research findings and conclusions. Since sustainability is as much about the future as the present or past, it is well to remember that to a large degree, the future, like law, is made and not found. Our sustainability research attempts to integrate all of the dimensions within the existing rules of science and the existing rules of law.

Future plans include a refinement of the foodweb and application of measures, such as Fisher Information to various what-if scenarios. (Fath and others 2003). In the stormwater volume reduction project, a test case is being conducted in a local watershed in which landowners will be paid to install BMPs on their property. As time permits, a third project will begin to explore the idea of law as a complex system—do our rules of law follow the natural rules of systems and order to which even inanimate systems adhere and if so, what are the ramifications for sustainability?

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