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Slow Response of Societies to New Problems: Causes and Costs

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Abstract

Human societies are confronted with a continuous stream of new problems. Many of these problems are caused by a limited sector of society but cause "spillover costs" to society as a whole. Here we show how a combination of mechanisms tends to delay effective regualtion of such situations. Obviously, problems may remain undetected for some time, especially if they are unlike those experienced in the past. However, it is at least as important to address the dynamics preceding the solution because societies that are systematically slow in suppressing problems in the early phases will pay a high overall cost. Here we show how a combination of mechanisms tends to delay effective regulation. Obviously, problems may remain undetected for some time, especially if it is unlike those experienced in the past. However, even if a problem is recognized by experts, the time lag before society in general recognizes that something should be done can be long because of the hysteresis in change of opinion. This causes abrupt but late shifts in opinion, much as described for Kuhn's paradigm shifts. We use a mathematical model and review empirical evidence to show that this phenomenon will be particularly pronounced for complex problems and in societies that have strong social control, whereas key individuals such as charismatic leaders may catalyze earlier opinion shifts, reducing the time lag between problem and solution. An opinion shift may also be inhibited by downplay of a problem by a credible authority and by competition for attention by simultaneously occurring problems. Even if a problem is generally recognized, actual regulation may come late. We argue that this last phase of delay tends to be longer if a central decision-making authority is lacking and if disproportionately powerful stakeholders that benefit from the unregulated status quo are involved.

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Introduction

Countless human activities affect our environment in ways that are undesirable from the viewpoint of large parts of society. In economic terms, such activities cause a "spillover cost" or "nonpecuniary externality" that is not taken into account by market prices (McCloskey 1982). For example, a motorcycle can give great pleasure to the rider it but it irritates those who have to listen to the noise. The market price of a motorcycle does not take into account the noise costs on third parties. Hence, from a social efficiency point of view, there is too much motorcycle riding and too many motorcycles being produced under a free market system. Most environmental problems are examples of such uncompensated negative spillovers.

When a new spillover problem is recognized, a regulation of some sort may result. Such regulation is the outcome of political pressure mechanisms of various sorts, and it may be far from representing a socially fair solution in that it does not optimize total welfare (Scheffer and others 2000). Although this is clearly an important problem to address, the dynamics before regulation are at least as important for understanding the total cost carried by societies. At any instant in time, many activities that cause environmental deterioration are not regulated at all. This is inevitable due to the continuous development of new activities that result in new environmental problems. Societies that are slower in detecting and regulating these new problems will experience a higher overall cost.

Part of the explanation for slowness in response may be difficulty in detecting a new problem. As in an immune system, detection of a new problem will depend upon past experience (Klein 1998). If a problem is unlike anything that has been encountered in the past, detection may be delayed. An example of a problem that has existed for a long time without being detected is that of so-called endocrine disrupters. The fact that numerous chemical substances of widely varying origin may disrupt the endocrine hormone systems of animals and humans was simply not known until recently. Now, the potential of chemicals that are released into the environment to disrupt the chemical communication between organs, tissues, and cells in organisms has become a major cause for concern (Colborn and others 1996) and a strategy for detecting new cases has been identified (Taylor and others 1999).

Unfortunately, problem detection by those on the "front lines" such as scientists does not guarantee quick regulation. In this article we attempt to diagnose the main mechanisms responsible for delays in regulation of problems. We first show that public opinion tends to change in a nonlinear way. A shift to recognition of a problem may occur only after a long period of inertia. Subsequently, we discuss the lag between recognition and regulation, which is strongly affected by political issues.

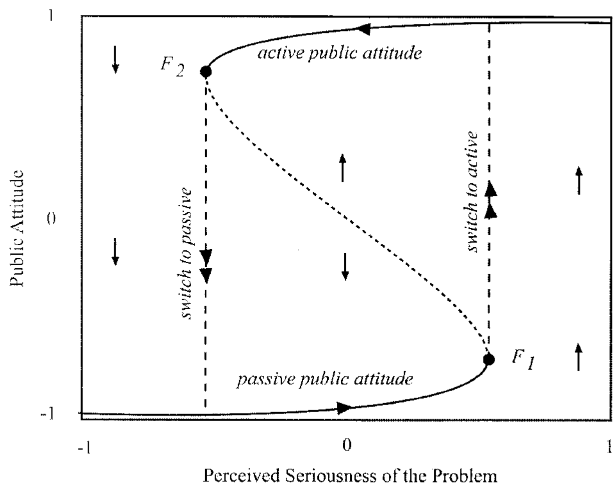

Figure 1. In societies with little difference among individuals and high peer pressure, the response of public attitude to an increase in perceived problem size is predicted to be discontinuous. When the problem is perceived to be small (and the perceived pay off of taking action is low), the attitude of most individuals is passive with respect to the problem. Society abruptly shifts to a predominantly active attitude (creating political pressure to regulate the problem) when the perceived severity of the problem has grown sufficiently to reach a critical point (F_1). If, subsequently, the severity of the problem is reduced, the active attitude towards regulation remains until another critical threshold point (F_2) is reached where an equally abrupt transition to a passive attitude occurs. The graph is produced from our model (Appendix) by plotting h on the horizontal axis and on the vertical axis.

Inertia and Sudden Shifts in Public Opinion

Empirical studies suggest that public opinion exhibits the phenomenon of "tipping points," remaining seemingly resistant to change and then suddenly shifting to another opinion (Gladwell 2000). Contingency of opinion appears to be the central mechanism responsible for this pattern, which is essentially similar to the paradigm shifts described by Kuhn (1962). In this section we present and analyze a simple mathematical model that explores this mechanism, discuss empirical evidence, and highlight other factors that may affect the delay in general recognition.

A model of shifts in public opinion

To explore how contingency of opinion may cause inertia and sudden shifts, we constructed a simple mathematical model of the dynamics of opinion in a society (see Appendix). In the formulation we assumed that for each individual there are two modes of "opinion" (or attitude) with respect to the question of whether action should be taken against a problem: passive or active. Individuals take an attitude depending on their image of how serious the problem is and on how effective it would be to push for regulation. However, their attitude is also affected by peer group "social pressure." In addition, there is a stochastic component that reflects differences between individuals. In our formulation the individuals take an attitude through a cost–benefit argument, assuming a cost of deviating from the overall group tendency (going against peer pressure) and a perceived net utility of taking the positive attitude.

The model can be used to predict how the mean public attitude changes in response to a new and slowly increasing environmental problem (Figure 1). The sigmoidal equilibrium curve is known as a catastrophe fold and implies that the response to a slow increase in perceived problem size is discontinuous. Most individuals favor a passive attitude until a critical point (F_1) is reached at which a sudden and fast transition to an active attitude towards combating the problem occurs. As argued, this dynamic is not unlike the "paradigm shifts" described by Kuhn (1962) where the accumulation of scientific anomalies in data collected using one perspective or set of assumptions results in a sudden and radical shift in scientific perspectives and the birth of a new theory that "explains" the anomalies.

The model also predicts that if, subsequently, the size of the problem is reduced, the public attitude remains in the "active" mode until another critical threshold point (F_2) is reached where an equally abrupt transition occurs to a state in which action against the problem is generally considered unnecessary. The two "folding points" in the curve (F_1 and F_2) correspond to so-called *fold bifurcations*, and the phenomenon that the forward and the backward switches occur at different conditions is known as *hysteresis*. Note that this is a more strict definition of hysteresis than the general meaning of a tendency to remain constant in spite of environmental change.

The predicted hysteresis is due to the peer group effect but also depends on variation among individuals (Figure 2). If contingency due to the peer group effect is weak and individuals differ in their perception, each individual takes an attitude dependent on their idiosyncratic perceived size of the problem. The resulting average attitude in society smoothly changes with the size of the problem (Figure 2a). However, with increasing peer pressure, the mean attitude starts to shift more steeply around a critical perceived size of the problem (Figure 2b). Eventually, if peer contingency is strong enough, the equilibrium curve takes the sigmoidal shape that gives rise to hysteresis and sudden transitions (Figure 2c). Decreasing individual variation has practically the same effect in this model as increasing the peer effect. Obviously, in the unlikely case that all individuals are equal in the sense that they all happen to shift attitudes independently at the same size of the problem, there would be a sudden synchronous shift in overall attitude even without peer group effects.

In summary, the model predicts that homogeneous societies with strong peer control will remain locked into inaction until relatively high problem levels. However, once the critical threshold is passed, such societies are also predicted to switch swiftly to a high action level. Once active, the reverse switch to inaction is delayed till perceived costs are quite low. Thus, there is also a tendency to hang on to old problems until they are thoroughly solved.

Empirical evidence for hysteresis in public opinion and peer group effects

As mentioned earlier, empirical studies confirm that public opinion exhibits the predicted phenomenon of sudden rather than gradual shifts (Gladwell 2000). Controlled experiments in small groups suggest that context plays a very important role in whether groups will act on an issue or hold back. For instance, early studies in experimental psychology have documented that people's response to calls for help in emergency situations depends on how they read the response of those around them (Darley and Latane 1968). This effect of group "pressure" is so strong that people are often willing to disavow the evidence of their own senses if other members of a group interpret reality differently (Festinger and others 1956). In one famous experiment, individuals working alone to match a line of a given length to one of three on a comparison card did so with less than 1% error. If, however, the individual was then placed in a group in which all other members, acting as accomplices in the experiment, chose the wrong line, the same individuals would choose the wrong line in more than one-third of the cases (Asch 1955).

The role of opinion leaders

There is also a "exceptional few" to catalyze tipping points (Gladwell 2000). Key and generally identifiable individuals appear to be able to mobilize groups to change because they are particularly well connected (Milgram 1967), have high social capital, are by nature innovators or early adopters (Rogers 1983), and/or have the charisma to cause emotional contagion (Hatfield and others 1994). An absence of such leaders connected to an issue will make a social group as a whole slow to respond, in line with the model prediction that homogeneous groups show a stronger hysteresis. This pattern has also been observed in paradigm shifts in science, where exceptional minds will reframe a pattern of discovery into new perspectives on old science, a pattern explored by Kuhn (1962). More elaborate mathematical models that have been explicitly designed to explore the potential effect of strong leaders in social networks confirm the idea that such leaders can precipitate a shift in opinion which would otherwise remain inert to change in external conditions (Kacperski and Holyst 1999; Holyst and others 2002).

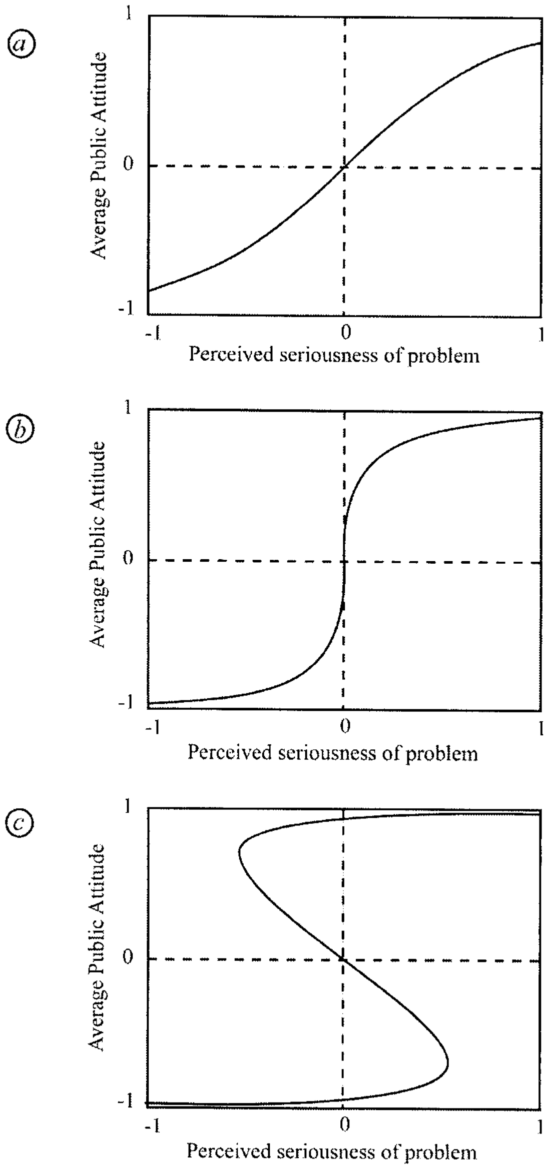

Figure 2. Modeled relationship between public attitude about the need to take action against a problem and the perceived severity of the problem. **a** If the cost of taking a deviating position ($c = 0.1$) is low, the average level of action smoothly increases with the perceived size of the problem and the net utility of taking action against it. **b** With increasing cost to deviating, the action level starts to rise more steeply around a critical perceived size of the problem at which the perceived net payoff of taking action becomes positive. **c** At higher costs of deviating from the rest of society, the equilibrium curve takes a sigmoidal shape. The figures are produced from the model (Appendix) by plotting $\bar{A}$ on the vertical axis and h on the horizontal axis using $c = 0.1$, 0.5, and 1.0 for a, b, and c, respectively. Reducing variation among individuals (s) in the model has largely the same effect as increasing the cost of taking a deviating position.

Problem complexity and the credibility of authorities

Our model (Appendix) departs from the notion of the *perceived* size of a problem and a corresponding *perceived* net utility of taking action (h_1) against it. Obviously, perception may deviate strongly from reality. Complex problems are difficult to "make sense of" (Weick 1995; Stacey 2001). Therefore, one may expect the attitude of individuals with respect to the problem to become more dependent on peer attitudes rather than their own independent assessment, which would enhance the hysteresis in our model. Obviously, the roles of opinion leaders and authorities will be expanded in complex situations. Simplified stories may be told but can be easily counteracted by other stories stressing opposite viewpoints. The net effect upon public opinion may, therefore, strongly depend upon the credibility of the parties involved. Also, the economic power to hire scientists and "storytellers" may play a significant role in such cases (Maguire 2000). Importantly, (dis)information campaign strategies may also have long-term implications through a credibility "memory effect". For instance, activist groups that raise false alarms will be less credible on the next occasion, reducing their ability to muster pressure. The same holds true for governments or industries that may, in the long run, lose credibility by denying problems that subsequently appear to have large costs, as in the poor handling by the English government of the recent "mad cow disease" crisis (Leiss and Powell 1997).

Interference with attention for other problems

A final point we should stress with respect to delay in problem recognition by the general public is competition for attention. The fact that multiple problems occur simultaneously may have large implications for responsiveness. Generally there is only so much space on the "public agenda," represented most vividly by the amount and length of media coverage of any given issue. Therefore, simultaneous occurrence of multiple problems reduces the chance that they will all be "taken care of" effectively. Focus on clear problems that easily mobilize large audiences but really have limited spillover costs may thus go at the cost of attention for serious but complex problems.

In summary, hysteresis in public attitude towards a problem (Figures 1 and 2c) is likely to be strongest if the problem is complex and the society is homogeneous, lacks opinion leaders, and has a high peer pressure (Figure 3). In addition, the critical problem

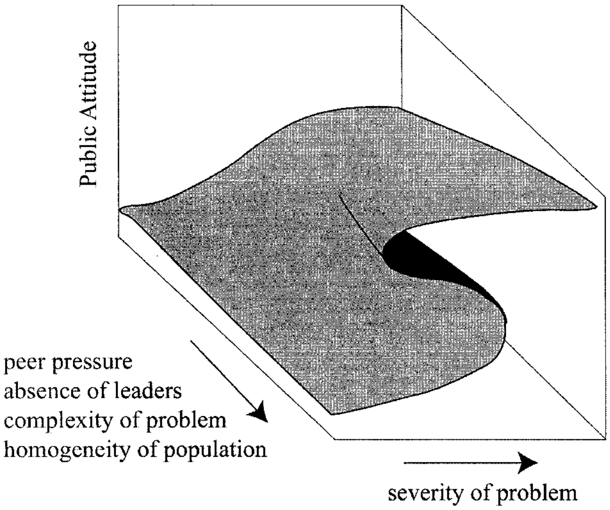

Figure 3. The degree of hysteresis in public attitude towards the need to regulate a problem (see Figures 1 and 2) is predicted to be larger in situations with high peer pressure, lack of strong opinion leaders, complex problems, and relatively homogeneous populations.

severity needed to trigger a shift to an active overall attitude (F_1 in Figure 1) can become higher due to interference with other problems and downplay of the severity of the problem by credible authorities.

Delays between Recognition and Regulation

So far we have focused on the factors that cause societal delay in recognition of the need for action on a problem. However, the next phase, commonly seen to be the disconnect between belief and behavior or between science and policy, can be lengthy and occasionally can result in gridlock. As in the case of perception, how long and difficult this phase is can vary significantly from one situation to another. Among the many variables which may contribute to this variation are centralization of decision making and equality in the distribution of resources.

Resource distribution

Management science literature suggests that less hierarchical, flatter organizations, such as professional organizations or networked organizations where resources are more uniformly distributed, are associated with more rapid and continuous change and adaptation (Quinn 1985). Obviously, if the proposed regulation of a problem requires the redistribution of resources, than those who benefit most from the status quo will resist moving to action. The more they have to lose, the longer they will wait and the higher the perceived costs of inaction need to be to offset the perceived cost of action. It has been shown that in very hierarchical organizations where resources such as money and prestige are concentrated in some parts of the organization, resistance to change by those with vested interests in the existing situation can be strong. Here change becomes a highly political process, blinding organization members from seeing the need for it (Westley 1990). At the societal level, concentrated powerful groups that benefit from activities with spillover costs to the general public may effectively delay or block regulation (Magee and others 1989). Note that, as overall wealth rises in a society, the demand for control of problems such as pollution tends to rise (Grossman and Krueger 1995).

Centralization of decision making

A second variable which can have a large effect on the length of time it takes to move from recognition to regulation is the distribution of decision-making power in society. In highly centralized, more authoritarian decision-making structures, once the central authority is convinced of the need to change, the system can react more quickly and with tight coordination. In a decentralized system, where decision-making authority is equally distributed across all parties, change demands a negotiated agreement to coordinate actions (Mintzberg 1983). This may take longer and results in a pattern of change which is less uniformly effective across the system. On the other hand, such slowly reached solutions may be of high quality and more sustainable than decisions that happen more quickly (Pascale 1981) such as in centralized systems. Indeed, natural experiments in history suggest that "productivity, creativity, innovation, and wealth" are boosted by competition and some degree of fragmentation (Diamond 2000) rather than tightly governed united societies.

Four configurations

When these two dimensions are combined, we see four different configurations (Figure 4). The first model, in the upper-left-hand box, combines relative equality of resource distribution and centralized/authoritarian decision making and might be termed the communist or *socialist* model. In such a system, a decision by the central government results in effective and relatively quick action, even on such legendarily difficult policy issues as birth

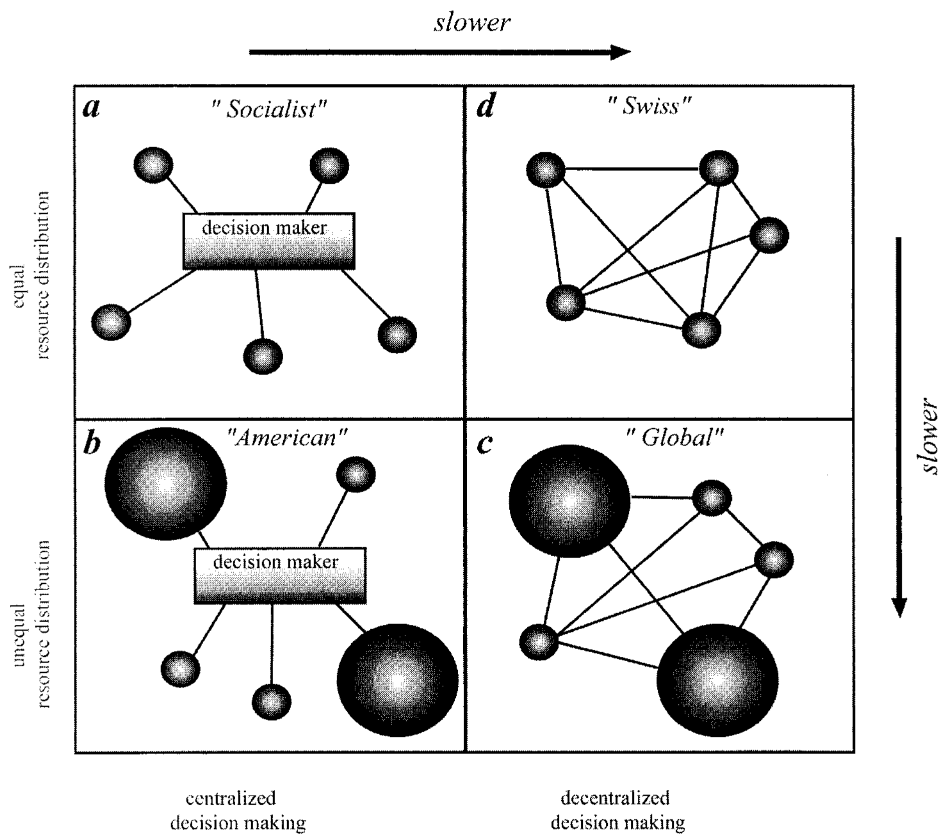

Figure 4. The likelihood that an environmental problem becomes quickly (and effectively) regulated once it has been recognized is lower if resources or power are distributed unevenly between stakeholders (bottom panels) and if there is no centralized decision-making authority (right-hand panels).

control. Although a country like China has not had a particularly strong environmental policy to date (Brown 1995), the ability of the populace to act as one implies a high potential to come to effective regulation. A similar system may be seen to exist in semisocialist European countries such as Holland and Sweden where the central government is quite strong and high interlevel collaboration is the norm (Scheffer and others 2002).

The lower-left-hand diagram (Figure 4b), in contrast, may encompass the current North *American* as well as Latin American context. Here a central regime is in place, but the disparity between the wealthy and the poor is large. The central regime in such circumstances retains the authority to move quickly to action, but the vested interests of many of the power holders can result in a lag or even a block to changing the status quo. In such a situation one might anticipate relatively quick movement to action of those policies which do not involve redistribution of resources and very slow movement to action in the case of policies which do. In addition, such disparity of power has been shown to create distortions in perception on the part of decision makers as a result of a decline in transparency of information (Perrow 1984). Indeed, much depends upon the presence of open democratic institutions with a mutually respectful feedback mechanism between the governors and the governed (Farber 1992).

In the lower-right quadrant (Figure 4c), decision making is decentralized and resource distribution is unequal. In these circumstances, negotiations are necessary to coordinate actors, and stonewalling is likely to occur on the part of privileged actors. Many environmental issues that are truly *"global,"* such as global warming, may fall into this category. Although certainty about the problem and the need for action is fairly high, it is unclear whether effective action is possible at all as illustrated by the disagreements over the Kyoto Accord.

In the last quadrant (Figure 4d), we find systems characterized by a relatively equal distribution of resources and relatively decentralized decision making. The route to regulation in such systems would require lengthy negotiations and would retain the decentralized idiosyncracies of implementation, but it would likely represent a "learning" model, where, over time, coordinated action would be less time consuming and where the variation at the grassroots level could be used to build in variety and redundancy. This is particularly true when trust and communication is good. An example might be 19th century United States (as described in de Tocqueville) or the *Swiss* situation, where local self-governance is strong and coordination is achieved through a process of reciprocities and connections of exchange between groups. The danger in such a system is that there may be a tendency towards compromises which are suboptimal when viewed from a larger perspective (Scheffer and others 2000).

Discussion

Although we have attempted to address some of the major factors responsible for the lag between the birth of new problems and regulation, the fields of relevant adjacent research are vast. Here we briefly discuss some insights that should be explored in this context.

The collective action problem

Delays in action on spillover problems obviously depend upon the abilities of the "general public" to come to a collective decision to apply pressure on authorities to regulate the problem. In our model analysis and discussion we have stressed how the peer group effect can lock groups into a passive attitude. However, another mechanism that comes into play in large diffuse groups is that individuals are unlikely to invest in a solution because the larger a group, the more anonymous each member will tend to feel. Hence, self interest may lead each individual in a large group to take a free ride, that is, to shirk his/her contribution to a "fair" share of the group effort. Therefore, the ability to overcome the collective action problem also depends upon how effective the group is in making each member feel "noticeable" so that he pulls his own weight in the joint effort of applying pressure. This collective action problem is analytically similar to the prisoner's dilemma made famous by Robert Axelrod (1984). Axelrod's examples show that groups that are in a repeated long-term relationship quite easily self-organize to produce the group optimum and free riding is minimal. Closely related issues arise in the literature on management of common property resources (Ostrom and others 1994). The overall result of the collective action problem is a bias in public policy towards the interests of coherent groups that are better able to organize pressure on authorities. Such a bias is not in the overall social interest (Magee and others 1989). Often, a small group benefiting from the activity that causes a spillover problem will be better able to muster pressure than the large diffuse part of society that is affected (Scheffer and others 2000). Obviously, power to lobby and organize (dis)information campaigns may delay general recognition of a problem and also delay and bias a final regulation.

The role of scientists

Certainly, scientists can play an important role in catalyzing the process of detecting and regulating problems. Early detection of new environmental problems may be largely in the realm of natural sciences. It is clear that early problem recognition is heavily dependent on experience and expertise (Shulman 1965; Shulman and others 1968; Klein 1998). However, research suggests that general recognition involves not only detection but also definition of a problem in ways conductive to action. Experts are key in framing problems in ways that make action likely. Their experience allows them to identify leverage points and to bring attention to them. Indeed, as argued, sense-making by credible authorities is crucial in tipping public opinion in complex cases. A thoughtful approach is key because not only reluctance to make policy recommendations due to insufficient data (Baskerville 1995), but also willingness to act in debates of high uncertainty [resulting in "bad policy masquerading as science," and "bad science masquerading as policy" (Commoner 1990)], may paralyze rather than promote action.

Obviously, the role of socioeconomic scientists in speeding up problem solution can be key too. Economic scientists can contribute much to the design of more effective ways to regulate spillover problems. Traditional command and control strategies of regulation simply place quantitative restrictions on the activity that causes the problem. Innovative market-based regulation schemes can be more efficient and stimulate agents, for instance, to invent solutions to the problem or economize on emissions before a legal limit is reached (Weitzman 1974; Pizer 1996). Also, social scientists may play an important role in designing strategies to prevent delay and gridlock in the social process involved in problem regulation. Better solutions than a simple compromise usually require more effort in analyzing and communicating the problem, as was discussed by Mary Parker Follett (1924). Social sciences may help to detect and overcome the barriers to social processes that result in integrative solutions, which go beyond superficial tradeoffs and produce innovative and more long-lasting solutions (Gunderson and others 1995).

When delays matter most: "irreversible" problems

Finally, we feel that it is important to stress one additional issue. Many environmental systems are known to possess alternative stable states, which causes them to respond to gradually changing conditions in a discontinuous, so-called "catastrophic" way (Scheffer and others 2001) much as the hysteresis in social action described here (Figure 1). For instance, shallow lakes may remain seemingly unaffected by gradual increases in the nutrient load until they suddenly collapse into a turbid state from which recovery is difficult (Scheffer and others 1993). Also, coral reefs may collapse into an algae-dominated state (Nystrom and others 2000), woodland loss can be practically irreversible (Wilson and Agnew 1992), and dry regions can shift to a desertic state that is resistant to recolonization by perennial vegetation (Van de Koppel and others 1997). As a larger-scale example, consider the risk of the thermohaline circulation switching off. Gradual climate warming is thought to lead to an increase in freshwater inflow into the North Atlantic. At some point this may block the "Global Conveyor Belt" oceanic current that transports warm water to eastern North America and western Europe (Rahmstorf 1996). Such a change to an alternative stable state would cause the climate in these regions to become dramatically colder and it would likely be a rapid shift (Taylor 1999). By definition, symptoms of such hysteretic change are minor until the practically irreversible shift occurs (Scheffer and others 2001). In light of the delay mechanisms we discussed, this has important implications. If the problem is unlike anything we have seen before, which may be the case for rapid climate change scenarios, first detection may already be too late to prevent the switch even if further delays in regulation are avoided. Also, because the perceived seriousness of the problem will seem small until the irreversible switch occurs, the shift to general recognition of the problem will tend to occur too late. Certainly, integrative solutions are not easily reached under such urgent situations when responsible actors are more likely to resort to the first workable option [a tendency called "satisfying" by Simon (1957)]. In any case, delay in decision making is likely to be long for global problems because no central authority exists and solutions will be most costly to the most powerful countries (Figure 4c). All this suggests that our diagnosis of delay mechanisms may be particularly relevant in designing policy strategies that prevent sudden irreversible shifts due to global change such as a collapse of the thermohaline circulation.

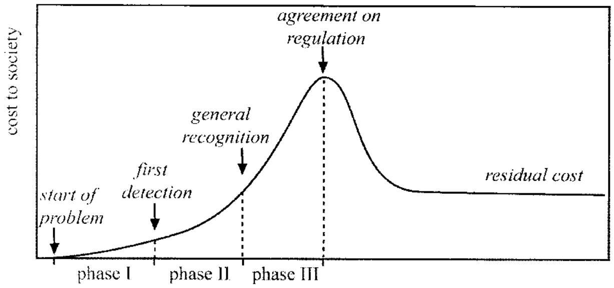

Figure 5. The costs to society of a new activity that causes a "spillover" problem are initially very small but will grow as the intensity of this activity increases. There may be a long time lag before regulation of the problem in which three phases can be distinguished. Phase I:A period in which the problem goes undetected altogether; Phase II: A period in which general recognition of the problem is lacking; and Phase III: A delay before the onset of actual regulation.

CONCLUSIONS

In summary, slowness in the response of societies to new problems may be due to late detection by scientists, hysteresis in public opinion, and delay in regulation (Figure 5). Since new environmental problems arise continuously, societies that are slower to respond will pay a higher cost from such problems at any instant of time (Figure 6). Certainly, the mechanisms that determine the slowness of response of societies to new problems are tremendously complex, and we merely scratched the surface. Nonetheless, our attempt to combine insights from our ecological (MS), economical (WB), and sociological (FW) backgrounds suggests some major factors that may increase the tendency of regulation to lag behind:

1. Slow detection of a new problem because of the absence of a search image shaped by previous problems, as in the case of endocrine disrupters.
2. Hysteresis in the switch from ignoring to general recognition of the problem as a result of contingency of opinion causing a positive feedback.
3. Downplay of the severity by a credible party.
4. Absence of a decision-making authority leading to slow negotiation over final regulation.
5. Disproportionately powerful stakeholders who benefit from status quo and delaying or blocking regulation.

The consequences of slow response may be more serious if obvious signs of the problem remain minor until an irreversible collapse of the environmental system to an alternative stable state occurs,

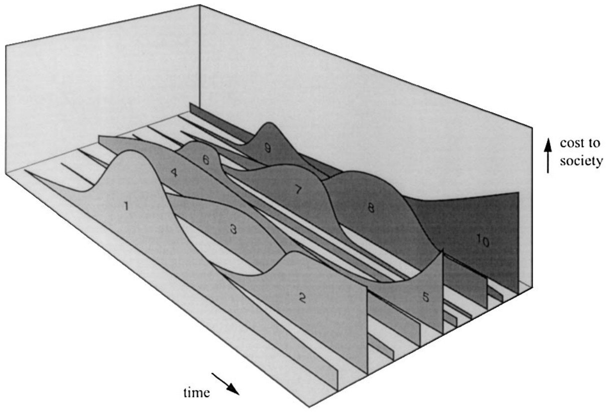

Figure 6. New problems continuously arise and the total costs of all these problems to society depend on the ability to recognize and regulate problems in early phases. Some problems may be regulated relatively quickly (for example problem # 6) and eliminated almost entirely (for example #6 and #7), whereas others grow unregulated for a long time (for example # 10), or correspond to irreversible switches that cannot be solved (for example #2). The area below the curve of a specific problem represents its cumulative cost to society starting from the moment of its introduction. The sum of the costs of all individual problems at one instant of time is the total environmental spillover burden to society at that moment. The grand total of environmental spillover costs carried by society is the sum of the areas under all the curves.

as may be the case in various environmental systems.

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A Mathematical Model of Opinion Shifts

Suppose that for each individual there are simply two modes of "opinion" or "attitude" with respect to a problem: active (+1) or passive (-1). It takes effort to be active, but activation also generates pressure on authorities in the direction of one's own interest as well as a "warm glow" feeling (Andreoni 1998) that one is doing "the right thing." Let $\tilde{U}(+)$ denote the perceived pay off or utility to being active and $\tilde{U}(-)$ the utility of being passive. These utilities have a random component to reflect idiosyncrasies across people: $\tilde{U}(a) = U(a) + \epsilon(a)$ for action $a = +1, -1$, where $U(a)$ is deterministic, $\epsilon(a)$ is a random variable, and s scales the variance. It turns out that if $\epsilon(a)$ is independently and identically distributed across people and action, we may apply the law of large numbers and compute the probability (P) of action a as a function of $U(a)$, a, and s:

$$P(a) = e^{U(a)/s}/(e^{U(+1)/s} + e^{U(-1)/s}) \qquad (1)$$

We now introduce peer group "social pressure" effects. We define $n_t(a)$ as being the probability P of action a at time t, and overall tendency for action as

$$A_t = n_t(+1) - n_t(-1) \qquad (2)$$

and assume the perceived utility for person i at time t of taking a certain action to be affected also by the cost $c(a_{i,t} - A_t)^2$ of deviating from the overall group tendency obtaining:

$$V_t(a_i) = U_t(a_{i,t}) - c(a_{i,t} - A_t)^2 \qquad (3)$$

Then adapting the probability function Eq. (1) replacing U with V, we have

$$A_t = T[(h_t + 2cA_{t-1})/s],\ h_l = (U_t(+1) - U_t(-1))/2,\ T(x) = (e^x - e^x)/(e^x + e^x) \qquad (4)$$

Details of this development in a different context are presented elsewhere (Brock and Durlauf 1999). Our figures of the response of public attitude to an increasing problem (Figures 1 and 2) were obtained by plotting the equilibrium action level [solving Eq. (4) for $A_t = A_{t-1}$] as a function of h_t.