Casting Radical Uncertainty on the Precautionary Principle: Shackle and Foucault revisited

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ABSTRACT

This article interprets the Precautionary Principle in environmental regulation from the perspective of radical uncertainty embedded in knowledge as well as the knowledge-power networks formed in the existence of such uncertainty. In this sense, the article makes an epistemological critique of the current application of the Precautionary Principle (using Shackle) and extends the paradox of uncertainty to read its implications for networks of knowledge and power (using Foucault). Participatory decision-making is questioned as an alternative to current environmental forms of regulation.

''There would be no uncertainty if a question could be answered by seeking additional knowledge. The fundamental imperfection of knowledge is the essence of uncertainty (Shackle 1955, 52).

''Time is a denial of the omnipotence of reason. Time divides the entirety of things into that part about which we can reason, and that part about which we cannot. Yet the part about which we cannot reason has a bearing on the meaning of the part that is amenable to reason. The analyst is obliged to practice, in effect, a denial of time. For he can reason only about what is in effect complete; and in a world where there is time, nothing is ever complete (Shackle 1992, 27).

Key Words: *Precautionary Principle, Uncertainty Inherent, Decision Making*

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1. Introduction

The introductory quotes, one from Shackle's earlier work *Uncertainty in Economics and Other Reflections (1955)* and the other from his more recent work *Epistemics and Economics (1993)*, suggest a radically different understanding of *uncertainty* and *time*, which shake the grounds on which mainstream ideas on environment rest. Every day social choices are made that alter the distribution of benefits derived from environmental assets as much as the costs externalized on such assets. However, the process under which such choices are made cannot be understood by a simple analysis of costs and benefits as suggested by the mainstream environmental economics. For individuals do never have complete information about the future; as Shackle says, ''knowledge of the future is a contradiction in terms''—as future is unlived, and can only be imagined, not reasoned (Shackle 1993, 47). This principle appears to be recently recognized – over the last twenty years – by environmental bodies all round the world as they change their legislations in line with the Precautionary Principle.[1]

The Precautionary Principle is based on the notion of acting with caution. In particular, it emphasizes the necessity to act *before* potentially harmful activities to environment and human health occur since the harmful impact is often irreversible. Various environmental organizations and protection agencies thus recognized the *time* dimension in environmental regulation, which is tightly related to *uncertainty* inherent in scientific knowledge and its implications. An environmentally conscious agent has no longer the luxury to rely on 'scientific certainty'—proved by the statistical significance of the effect of a toxic chemical on environmental pollution—for acting (1) to restrict its emissions and (2) to search for substitutes that will lead to less environmental problems. Such consciousness requires not only *restrictive* action as claimed by some of the opponents of precautionary principle, but also *creation* of alternative products, unconventional methods of production, and substitutes for harmful emissions to nature. Precaution is not the *regressive* force that limits and restricts the very activities causing pollution. Instead it is the *positive* force in the imagination of *novel* ways of doing the same activities for attaining desirable future outcomes for the environment.

The paper will begin with a discussion of *uncertainty* in environmental decision-making, distinguishing it from the conventional concept of *risk*. Next, the role of *time* in environmental decision making process will be elaborated, and finally we will analyze the knowledge-power networks in the application of the Precautionary Principle.

2. Uncertainty Inherent in Knowledge

2.1 The Question of Knowledge

Discipline of economics, long ago, claimed to be a self-subsistent profession, consi-

[1] Precautionary Principle is incorporated into several legislations some of which are 1982 United Nations World Charter for Nature, 1992 Rio Declaration on Environment and Development, 1998 Wingsread Declaration, 2000 European Commission Report. For a historical account see Jordan, Andrew and Timothy O'Riordan (1999).

dering questions of epistemology irrelevant and unnecessary. It was the business of philosophy to ask the question of what is known and what is unknown. The assumption of a rational agent that possessed the knowledge of preferences, endowments and technologies in order to reach optimal outcomes was indeed more than sufficient to avoid any kind of epistemological question. Even the introduction of imperfect information into recent forms of institutional economics did not abandon the assumption of economic agents acting to maximize self-gain, recognizing solely the asymmetries of incomplete information set. Yet the individual capacity to imagine the unforeseen future and shaping future environment through this creative process—transforming the future itself and the re-thinking individual—is left out of the picture. This point is very explicit in the works of Shackle:

''...economic theory took on a character belonging to the manipulable, calculable, external world of things, not the void of time, the conscious mind whose being consists precisely in the endless gaining of knowledge'' (ibid, 3).

The notion of ''endless gaining of knowledge'' is particularly important for Shackle's theory since it illustrates the idea that knowledge is in the process of being gained, and therefore, it is neither sufficient nor complete. The future which will be created from individuals' decisions does not exist right now, and therefore it cannot be known. But it is imagined by every individual for himself/herself, and the imagination process is the site of expectations out of which decisions right now are made.

2.2 Cost-Benefit Analysis

The process of imagination cannot possibly be explored in mainstream environmental economics where the rational calculation of social marginal costs and benefits results in the static optimum level of an environmentally degrading activity or activities as a whole. The typical methodology here is the cost-benefit analysis, and the agent to implement the optimum of pollution is the rational policy-maker. To account for the lack of knowledge of future outcomes, rational-agent models assume a ''one size fits all'' theoretical approach, which is solely based on rational expectations, and ignores the role of each individual's expectations on the resulting outcomes.

It is also assumed that the cost-benefit analysis can identify all the consequences of a (potentially) harmful economic activity, and then evaluate the positivity/negativity of each consequence. First of all, the claim for determining all the possible consequences is absurd given that any act or event has an infinite number of effects now and in the future. Secondly, there is indeed no mechanism by which one can assign probabilities to these infinitely many consequences of a particular economic event on environment.

2.3 Probabilities, Risks, and Uncertainty

The sheer impossibility to set probabilities is one of the distinguishing characteristics of uncertainty from the conventional concept of risk. It is possible to assign probabilities

and construct a probability distribution for a set of risks if and when these risks are part of a system that are already known to the subject. It is useful here to consider the analogy provided by Keynes in distinguishing the two concepts:

''By 'uncertain' knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty. The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention, or the position of private wealth owners in the social system of 1970'' (Keynes 1937, 213-4).

The game of roulette is the kind of ergodic-stochastic-process presupposed by the probabilistic understandings of uncertainty. There are several mainstream theories of expectation formation, but they can be categorized into 'subjectivist' and 'objectivist' in terms of the kind of probability distribution that they use. While the subjectivists, i.e. Savage, Friedman, etc, argue that probability distributions are fundamentally epistemic and need not conform to reality, the objectivist rational expectations theorists, for instance Lucas, suggest that expectations of agents correspond to the nature of actual world. Some post-Keynesians argued that these two positions are reducible to each other in terms of the positivist claims they make. But more importantly, both subjectivist and objectivist positions are far more different than what Keynes was describing when he was addressing the problem of uncertainty in economic decision making. For Keynes, the future is fundamentally uncertain, and ''we simply do not know'' (ibid, 214). Life, however, continues, and we need to make decisions even though we are well aware of the fact that we do not know the future. Those decisions that are most important economically are also those that are most likely to be fundamentally uncertain. Shackle's understanding of crucial or momentous choices illustrates this idea:

''A choice of one step or one policy rather than another can be called momentous if it will drive the course of events down a road from which there can be no getting back to any of the other roads which are available before the choice is made'' (Shackle 1992, 384).

Such crucial choices are often referred as irreversible actions provided that the effects of the action cannot be reversed, either absolutely or because the costs of doing so are extremely high. In Keynesian theory, such choices usually underline the irreversibility character of investment decisions. If an entrepreneur is planning to start up a business whose profitability is unknown at the beginning and can only be known over time, then his decision to invest on what type of activity and with what sorts of production method is crucial because his investment can be irreversible, i.e. he may not be able to cover his fixed capital back into the previous amount of money capital.

2.4 Crucial and Irreversible Decisions about Environment

Crucial decisions apply to any type of long-term economic activity that depends on

all kinds of ever-changing social conditions to achieve success. Now that the idea of restricting the amount of green-house gas emissions to a socially desirable level is taken seriously, the investment in green technology required to achieve this goal gains importance. Such an investment is a crucial decision since the effects of these emissions could be irreversible unless precautionary measures are taken. In this sense, the implementation of the Precautionary Principle—by imagining ways to prevent global warming from reaching unacceptable levels—is by no means less important than the investment decisions of the firms. However, the application of the Precautionary Principle is not solely about preventing pollution, but also constructing alternative imaginaries of environment.

Sunstein suggested to apply the minimax principle ('choose the policy with the best worst-case outcome') in the face of uncertainty, i.e. when there is a lack of knowledge to assign probabilities to outcomes (Sunstein 2003, 11). Implicit in his suggestion is the idea that the policy-makers have the knowledge to assess which policy might lead to the best worst-case outcome even if they cannot know what the probability of that outcome is. Note that this idea is incompatible with Shacke's theory of uncertainty. For Shackle not only the probabilities but also the outcomes themselves also uncertain since one cannot account for all the possible effects of an economic event. Therefore, one can no means rely on the ability of policy makers to compare the worst-case outcomes of different policies. Who could determine, by what means, what the worst case outcome of a policy will be, let alone determine how would that compare to another policy's worst case outcome? Sunstein also argues that ''risks that are in the realm of uncertainty will, over time, move into the realm of risk'' (ibid, 11). The implicit assumption at this point is the faith in progression of scientific knowledge so as to eliminate the uncertainty about the harmful effects of a potential hazard. However, uncertainty can still exist in cases of potential hazards about which plenty of information is available. While acquiring new information can decrease uncertainty to some extent, it also has the potential to have the opposite effect, particularly if it sheds light on the presence of uncertainties that were previously unknown or were underestimated. Acquiring further knowledge about a potential hazard may demonstrate that our understanding was more limited or the effects on bio-systems were more complex than previously thought. The introductory quote from Shackle directly addresses this issue:

''There would be no uncertainty if a question could be answered by seeking additional knowledge. The fundamental imperfection of knowledge is the essence of uncertainty'' (Shackle 1955, 52).

2.5 Is there an Uncertainty Paradox in the Precautionary Principle?

Asselt and Vos (2006) argue that Precautionary Principle, which recognizes the need to take action even if the situation lacks scientific certainty, also includes in most of its legal formulations a ''knowledge condition''—''the level of proof needed to trigger application''. This condition implies that the policy-makers need to appeal to scientists for some level of scientific 'proof' before they can take precautionary actions (Asselt and Vos 2006,

5). The knowledge condition existing in legal formulations of Precautionary Principle thus poses an ''uncertainty paradox'': there is no need for scientific certainty to act in principle and paradoxically there is still need for some form of scientific evidence before precautionary action can be legally started.

It is possible to object the basis of Precautionary Principle by pointing out the thin line between the lack of scientific certainty and the presence of some scientific evidence. If the absence of scientific certainty still implies the existence of some level of scientific evidence, then there is no paradox in the statement of uncertainty within Precautionary Principle. However, if the former does not imply the latter, and it is plausible that it may not since lack of scientific certainty may also cover the cases in which there is no scientific evidence at all, then the application of Precautionary Principle poses a paradox in its essential premise.

Distinct from the existence of 'uncertainty paradox', and more interestingly, one can ask the question of 'to what extent do policy-makers rely on science to exercise power, and how does science in general serve the interests of policy-makers?' The more conventional answer to this question is provided by Kriebel, Tickner, Epstein, et al. (2001) as follows:

''There is a complicated feedback relation between the discoveries of science and the setting of policy. While maintaining their objectivity and focus on understanding the world, environmental scientists should be aware of the policy uses of their work and of their social responsibility to do science that protects human health and the environment'' (Kriebel, Tickner, Epstein, et al. 2001, 875).

Their call for doing science with social responsibility is indeed a plea for scientists to create material for policy-makers, which they can in turn use as a means for 'knowledge condition' in order to apply the Precautionary Principle. Such a plea illustrates the substantial degree of policy-makers' dependence on the existence of scientific knowledge when it comes to taking precautionary action. This dependence is present despite the fact that the Precautionary Principle already empowers them to act without having the sufficient scientific evidence.

Asselt and Vos make an interesting comment on this very intricate relationship between science and policy-making, or more generally knowledge and power:

''The precautionary principle is then seen as 'tool to compensate' in situations of unavoidable uncertainty. However, it is not recognized that uncertainty may also erode the traditional positivistic model of knowledge, in which science speaks truth to power. Although uncertainty is recognized, science is still expected to tell the truth about uncertain risks. Strikingly, advocates of the precautionary principle are willing to rethink regulation, but overlook the need to rethink science and its role in regulation'' (Asselt and Vos 2006, 6, emphasis added).

Perhaps the growing support for Precautionary Principle has something to do with the desire to move beyond the traditional positivist conception of knowledge. If the recog-

nition of uncertainty within the Precautionary Principle will be a key stone in the deconstruction process of the hegemonic forms of knowledge creation, it can also be a means to reconstruct non-positivist forms of knowledge, and thereby radically alter the modernist power-knowledge networks.

3. Time in Environmental Decision-Making Process

3.1 Anticipation of Potential Hazards

Anticipation of potential hazards requires imagination if we live in a world where time intervenes into the process of decision-making. For introduction of time separates what we can reason from what we cannot, and we need to form expectations by imagining what the future outcome could be. Thus, we simply anticipate, and cannot possibly reason, the part of things that will be lived in the future. Anticipating the harmful effects of environmentally degrading activities requires acting ex ante, or what Jordan and O'Riordan called ''pro-action''—'a willingness to take action in advance of scientific proof of evidence on the grounds that further delay may prove to be ultimately more costly to society and nature' (Jordan and O'Riordan 1999, 24). Pro-action underlines two themes that we have discussed so far: uncertainty and irreversibility. But there is one more theme necessary to characterize what we mean by anticipation: expectations. The future is uncertain and the crucial decisions made ex ante will result in irreversible outcomes ex post. There is only one way to bridge the gap between ex ante and ex post. Here our reason cannot help us; we need to form expectations. Pro-acting, acting before the hazards are realized, or before we have sufficient information that they will be realized, requires constructing expectations about what kinds of effects such a substance or activity can have on environment and human beings. Such expectations are not just about preventing emissions of a potential hazard; but they are about anticipating such hazardous activity beforehand and taking precautions accordingly.

One of the achievements of Precautionary Principle is to change the questions posed in the process of decision making. In conventional mode of thinking, reason was the driving force, and the important question was the following: ''How much pollution is socially optimal given the social marginal cost and benefit curves?'' If the society is seen merely as a summation of rational individuals optimizing in the face of potential risks, then the only problem faced in this social calculus is the aggregation problem, i.e. how to aggregate the individual marginal cost and benefit curves in order to obtain the social cost/benefit curves. Once the aggregation problem is somehow solved, the rest of the issue was to find the optimum and create policies, either command-and-control type or market-incentives-based, in order to reach such an optimum. With the introduction of Precautionary Principle, the entire set of questions is transformed because it is no longer the reason that guides policy, but also the expectations. Tickner lists some of these questions as follows:

''How much contamination can be avoided while still maintaining the necessary values? What are the alternatives to this activity that achieve a desired goal (a service, pro-

duct, etc.)? And do we need this activity in the first place?'' (Tickner 1999, 163).

All of these questions have a forward-looking motivation, i.e. taking into account actively reconstructing future given fundamental uncertainities, instead of making a static social calculus.

3.2 Scientific Conservatism and the Burden of Proof

For several theorists, including Dorman, the objection to the lack of scientific evidence as a criterion for taking precautionary action is not due to the uncertainty inherent in the knowledge itself, but rather due to the so-called scientific conservatism. The notion of 'scientific conservatism' refers to the bias in scientific research towards minimizing Type I error in the results, at the expense of larger Type II errors. Scientists are charged to be extremely cautious in avoiding Type I error, i.e. rejecting the null hypothesis when it is true, while they are not so much concerned about avoiding Type II error, i.e. failing to reject the null hypothesis when the alternative hypothesis is true. Kriebel, Tickner, et al. clarify the existence of scientific conservatism as follows:

''Twenty percent of the time, a real phenomenon will be missed because the data are not strong enough to convincingly demonstrate its existence. There is an implicit bias here: the test is set up to be more cautious about falsely detecting something than about failing to detect something'' (Kriebel, Tickner, et al. 2001, 873).

For these theorists Precautionary Principle represents a corrective mechanism for the implicit bias in scientific research so that 'failing to detect' a potential hazard does not become the common mistake in policy-making. While Dorman agrees with them in fighting against the 'dogmatic minimization of Type I error', he thinks that Precautionary Principle is 'overreacting' such dogmatic view by going to the other extreme of 'minimizing Type II error' (Dorman 2005, 171). His central problem with the formulation of Precautionary Principle is shifting the burden of proof to those undertaking hazardous activities. His opposition to such a shift comes from two reasons: (1) the problem of incentive compatibility, (2) the impossibility to 'prove' that some activity is safe (ibid, 172). When the environmental research is conducted by the firms who are undertaking hazardous activities, it is incompatible with their interests to highlight potential dangers involved with the product they produce or the production method they use. It is possible to shadow the potential costs while making benefits seem larger in the cost-benefit analysis conducted by the firms themselves. However, the problem of incentive compatibility is likely to arise even if it is the government agencies that conduct the research on potential hazards since for the most part they are connected to several business groups. Furthermore, even if they are somewhat autonomous from those groups, it is likely that the government agencies have a subjective position which might obscure some of the potential problems related to the safety of a product. For example, central governments might be concerned with the larger context of the national economy in the process of conducting environmental research while local community institutions might be focused on a smaller scale at the expen-

se of the effects in the larger picture. Thus, it is not quite possible to totally avoid the problem of incentive compatibility even if it is not the firms themselves that conduct research on environmental hazards.

The second problem that Dorman suggests concerns the failure to ''prove'' that some activity is actually safe. However, none of the formulations of Precautionary Principle actually state that the products or activities have to be ''proven'' safe before they are approved. Advocates of the Precautionary Principle are well aware of the impracticality of attempting to prove that something is totally harmless for the environment. Yet the whole purpose of shifting the burden of proof over to those who support hazardous activities is to challenge the assumption that any activity is safe until proven dangerous. But challenging that assumption requires courage since it puts all kinds of activities under scrutiny. Since the governments lack funds to conduct research on all of them, it is plausible to ask the active engagers of those activities to demonstrate that ''no safer alternative exists before engaging in that activity'' (Tickner 1999, 168). Note that such a statement is requiring evidence for relative safety compared to alternative ways of conducting the same activity, instead of demonstrating absolute safety. Furthermore, the problems with incentive compatibility can be overcome if an ''independent peer review funded by the proponent of the activity'' is required before the approval of the activity under scrutiny (ibid, 169).

For the reasons of incentive incompatibility and the impossibility to prove the safety of the activity, both Dorman and Sunstein reject the application of the Precautionary Principle in the way it is formulated in legal documents right now. They both argue that the Precautionary Principle leads to no direction at all, rather it overemphasizes the need to escape from the minimization of Type I error, while falling into the trap of minimization of Type II error instead. While Sustein does not propose an alternative method of decision-making for environmental policy, Dorman suggests a time-consistency model where the policy-maker acts as a rational agent to maximize social benefits at the expense of costs given the updated information set available to him at each time period. I will evaluate this model in the next section, and demonstrate that the assumption of rationality does not take us far from the traditional models of static cost-benefit analysis due to the inconsistency of rationality with time.

3.3 A Critique of Dorman's Time-Consistency Model

The particular assumptions that Dorman presumes for setting up his model are the following: (1) There are decision-makers who act as a body of rational agents in order to maximize the best-practice determination of an activity that might pose potential harms to society, (2) there is an information set available to the decision-makers at each point in time, (3) this information set is subject to 'a sequence of random perturbations', (4) for each updated information set at time period t, the decision-makers decide on the best-practice of the activity by some previously decided criterion, and (5) at each time period, they take into account the random effects on the information set to update the best-practice activity (Dorman 2005, 174).

One of the implications of the time-consistency model in this context is that the best-practice chosen today is expectation of tomorrow's best practice while taking into account all available information set. The inclusion of expectations into the model is certainly an improvement over the static cost-benefit analysis. However, the way that expectations are introduced into the model suggests a simple expected-value calculation, leaving the rational cost-benefit analysis still in force. Furthermore, the set-up of the model assumes that $E(x^*_{t+1} * \hat{E}t) = x^*_t$, which implies that future's best-practice is somehow taken into account when deciding on today's best-practice. However, note that the information set is given for time t. How could it be possible to determine future's best-practice given today's information set which is subject to random perturbations in the future periods?

Apart from the intricacies involved within the dynamics of the model itself, it is also quite possible to criticize it for violating fundamental uncertainty inherent in the knowledge itself. Moreover, it destroys one of reasons for implementing Precautionary Principle in the first place: the insufficiency of scientific knowledge. If the decision-makers are thought as rational agents maximizing with the given information set, then they would not be able to anticipate the effects of potential hazards since there is no space for anticipation in this model. Rational agents can reason to find the best-practice given the decision-criteria. Since it is not possible to reason for the part of time that we simply do not know, they are incapable of acting to compensate for the insufficiency of knowledge. Shackle's concept of the bounds of rationality is illuminating at this point:

''Rationality cannot span a temporal succession of situations. Each situation in such a series includes within its specification a specific collection of data available to a given individual. These data in the nature of things are confined at most to the present and the past. But what is relevant for choice of action is the future, except in so far as available action is strictly confined to the immediate now, a single moment divorced from any temporal sequel. Each present moment by itself can, conceivably, be so dealt with by suitable organization that its actions are pre-reconciled. But everything that one moment bequeaths to a subsequent moment, everything now present which depends for its meaning, purpose and value on a subsequent moment, removes choice of action from any possibility of being rational, in the strict sense of demonstrable superiority of outcome over all other available courses; demonstrable, that is to say, in advance of the taking of action'' (Shackle 1992, 84-5).

The time-consistency model proposed by Dorman to replace the Precautionary Principle, in the form it exists right now, is a typical attempt to have rationality act upon what Shackle calls a temporal succession of situations. Such an attempt is doomed to failure simply because the collection of data available to the policy-makers is limited to the past and the present, not future; for data about the future is a contradiction in terms. Neither the possibility of having the full relevant information, nor the ability to demonstrate that one outcome is superior to all other outcomes is compatible with the Shackle's conceptualization of time and uncertainty. In a model where time and uncertainty are incorporated in a realistic sense, there can be no rational decision-making in the way formalized by the ti-

me-consistency model. Thus, the time-inconsistency model, overall, is inconsistent with the notions of time and uncertainty, and destroys the space for anticipation and imagination created under the formulations of Precautionary Principle.

3.4 Backcasting

In its current formulations Precautionary Principle suggests a challenge to traditional ways of making decisions about environment and human health. In particular, it is a challenge directed towards changing cost-benefit analysis and risk-assessment procedures as we have discussed so far. The broader set of challenges that Precautionary Principle poses are portrayed by Jordan and O'Riordan as follows:

''…challenging the authority of science, the hegemony of cost-benefit analysis, the powerlessness of victims of environmental abuse, and the unimplemented ethics of intrinsic natural rights and intergenerational equity'' (Jordan and O'Riordan 1999, 16)

Despite the on-going controversy over the methods to operationalize the Precautionary Principle, it needs to be at least respected for the challenges it brings to revise the contemporary political mechanisms. If the hegemony of cost-benefit analysis is undermined under the Precautionary Principle, what kind of other mechanisms of decision-making can be imagined in order to act in advance of scientific certainty? Although there is certainly not a single answer to this question and the principle's history-to-come is non-existent until people make decisions regarding its implementation, one can imagine the ways in which the principle can actually become actively lived.

If the cost-benefit analysis and other risk-assessment methods try to forecast potential hazardous effects of a substance or an activity, then the Precautionary Principle can go one step further and ask the question of ''where should we be as a society?'', instead of ''where will we be?''—which is not possible to determine anyway, given the uncertainty about the future. Tickner refers to this vision of setting up a goal and imagining policies that would bring the society as ''backcasting'' contrasting it with ''forecasting'' (Tickner 1999, 167). A lived example of backcasting is the Dutch case where:

''The Dutch government establishes five-year environmental plans with clear goals and then works with the municipalities, industry associations, and specific companies to establish ''covenants''. These covenants are voluntary agreements between the government and the industry that establish interim and final goals but that place responsibility on the company to achieve these goals in the most efficient way possible (without creating new risks). The covenants are backed by strong enforcement and regulation if goals are not met'' (Tickner 1999, 167-8).

The backcasting mechanism illustrated as the Dutch case differs from the traditional decision making mechanism in two respects: (1) The future is not forecasted, and its knowledge is not attempted to be derived from the complete information set, (2) the futu-

re outcomes are imagined and put into long-term perspective by backing-up from the imagined future outcome. The creation of a space for rethinking where the society should be is an ultimate goal for implementing the Precautionary Principle. But it is still not clear how the whole imagination process takes place. Next section will focus on how participatory politics can serve as an instrument for the actual execution of the principle.

4. Participatory Decision-Making to Challenge the Authority of Science

4.1 Modern Science as form of Micro-Power

Modernity relied on science to control, manipulate, and radically alter the functioning of modern societies. Science became an instrument for modernity to discipline the labor-force, regulate the population increase, and build cultural values in support for capitalism in general. Foucault (1977) refers to each particular science as constituting a micro-power which justifies its workings through the truth claims spoken by science. An example to micro-power would be biopower, which is a 'political technology' that allows for the control of entire populations. The modern nation state relies on biopower which entailed ''an explosion of numerous and diverse techniques for achieving the subjugations of bodies and the control of populations'' (Foucault 1977, 140). Central to these techniques was the development of relevant disciplines such as anatomy and statistics, as well as wide-spread application of regulatory controls that directly constructed reproductive practices. Thus, sciences such as anatomy and statistics constituted mechanisms of biopower that were crucial to the control exercised by the modern nation-state. Getting into the discussion of the ways in which such a knowledge-power network was established is beyond the purposes of this section.

4.2 Truth Spoken by Science

The sophistication of modern science went along with its creation of modern intelligentsia. One had to be an expert in a scientific profession in order to make a truth claim. For all other kinds of knowledges that are not based on positivism were excluded and rendered useless. As the experts spoke science to the authorities, the authorities gained the means to justify whatever aims they had for 'protecting' the 'life' of the individuals. Thus, science itself became the authority to speak the truth to the ordinary people excluded from the construction of scientific knowledge.

The authority of science came under attack from the need to act prior to the 'truth' of science. Precautionary Principle identifies with that need and challenges the ways in which environmental science has been speaking to the regulatory bodies so far. One of the projects implicit in Precautionary Principle is to democratize the decision-making process that has so far characterized environmental policy-making.

4.3 Inclusion of People's Voices: Participatory Decision-Making

In order to vitalize the project of Precautionary Action, society needs to design institutions that will work on including people who have been thus far excluded from the decision-making process. We have seen how benevolent policy-makers have been so far, and we know that we do not need them as long as we have some mechanism to participate into making decisions as a collective. Indeed, such participatory decision-making mechanisms, which allow individuals to collectively imagine the future and act upon it, do currently exist in ''Denmark, Norway, Sweden, and the Netherlands''(Tickner 1999, 175). Examples of these participatory decision-making bodies include ''consensus conferences, scenario workshops, and science shops'' (ibid, 175-6). Consensus conferences are organized to form a consensus based on people's opinions about a selected subject(s). In Scandinavian countries, a group of citizens were randomly selected to participate in the conference where experts reported their knowledge, but did not create the final outcome. Instead, the final report was produced by these individuals who are randomly chosen and do not have expertise on the subject matter. Such a report led to the forbiddance of genetically-produced crops in Norway (ibid, 175). Even though most of these conferences with participatory decision-making were made on the national level, it is plausible and even desirable that smaller conferences can be held in local communities where more specific issues regarding the local environment can be discussed.

The implementation of Precautionary Principle bears upon the spread of participatory democratic forms of decision-making in order to actively anticipate and imagine future use of natural assets in a sustainable and equitable manner. Stripping away from the disguise of scientific assessment, participatory decision-making enables individuals to actively participate into discussions with other individuals to attain a community imaginary, and through backcasting, anticipate the steps to reach that imaginary. Here the point is not to paint an optimistic picture and leave it there, but rather think about ways in which such a participatory decision-making can produce results where Precautionary Principle is taken seriously. If it were possible in Denmark and Norway, why could it not be in other parts of the world at different points in time?

Conclusion

When one of his long time friends asked Shackle in a private letter his opinion about the key issues that need to be addressed in British economic policy, Shackle's answer was the following: ''(1) Food: the need for self-sufficiency, (2) occupation: something interesting to do for everyone, (3) education: conservation and the arts (music, painting, theatre, etc.), (4) excellence: a universal dedication to beauty and efficiency in products and performances, (5) clarity of tone in our lives: a muting of the blatancy of advertising; a pursuit of ends rather than distractions'' (Littlechild 2003, 113). Although the last item in the list concerning the pursuit of ends rather than distractions may be thought of looking ahead for taking precautionary action, we see that environment did not appear in the key issues list of Shackle. Indeed, as far as I know, Shackle never wrote anything that addresses en-

vironmental problems per se. However, his critique of economic doctrines is central in evaluating the existing environmental economics, and rational actor models of decision-making process. The wide-spread recognition of scientific knowledge as being insufficient to take precautionary action against potential hazards to environment and human health led to the incorporation of Precautionary Principle into several legal frameworks. Yet the question of operationalizing the principle still remains. If the future is essentially unknown and uncertainty is an inherent characteristic of knowledge, then the future of the environment will flow from the complication interaction of each individual's choices falling upon what they expect and imagine for their own future. Neither strong men nor queen of the sciences can decide the future for the people; the people themselves need to imagine it in themselves.

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