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Rethinking Environmental Economics: Missing Links between Economic Theory and Environmental Policy

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This article deals with the discrepancy between environmental economics and environmental policy regarding the abatement of environmental deterioration. In short, in mainstream economic textbooks environmental problems are seen as a market failure that, in the tradition of A.C. Pigou, can be corrected by imposing charges on polluting and natural resources-depleting activities. In environmental policy, however, this recommendation is almost fully neglected, as in almost all OECD-countries only physical regulations are used to decrease pollution and depletion of natural resources. Section 1 describes this discrepancy more extensively.

In general, economic theory provides the basis for policy measures. Without any idea about the causes of, for example, unemployment or

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inflation, state interventions with the intention to increase employment or decrease inflation would be groping in the dark. In other words, theory and policy are two sides of the same coin. In the following sections we will demonstrate that this usual complementarity hardly exists in the case of mainstream environmental economic theory and current environmental policy practice. It is our concern that economic theory and environmental policy have been severed on vital elements—that is, on the determination of the goals and the choice of instruments. These missing links make current environmental policy often look like an attempt to cure the patient without a sound diagnosis.

The explanation of these missing links is partly related to the fundamental obstacles Pigovian internalization efforts meet. Section 2 briefly deals with these obstacles. Furthermore, as is set forth in Section 3, lack of ecological knowledge hampers an optimum use of natural resources for human production and consumption, as is the idea behind neoclassical analyses and policy recommendations. Economic interest groups abuse this uncertainty about impacts on the environment as an alibi for doing nothing or for a retardation of policy measures ('more research is needed'). In Section 4 the pressure of vested economic interests concerning environmental policy is illustrated with some typical events in the development of the Dutch abatement policy of acid rain.

But if mainstream environmental economics falls short in analyzing environmental issues and, subsequently, provides a flawed basis for environmental policy, the question arises whether alternative theories could be developed describing and analyzing environmental problems more appropriately. And if this is the case, does this imply that the link between economic theory and environmental policy could be restored? Section 5 is devoted to the contours of an alternative economic theory on natural resources.

Before going on, it has to be mentioned that we use a broad definition of natural resources. First, we do not restrict ourselves to natural resources that are traded on a market. A considerable portion of natural resources used in production and consumption processes—such as clean air and the ozone layer—do not have a price. Second, we consider natural resources insofar as they have a function in production or consumption. This implies that the deposits of minerals and fossil fuels in the earth's crust are defined as natural resources. The possibility of generating new living organisms is another benefit natural resources provide to mankind. These possibilities are generally hindered by certain mechanisms within the ecosystem. These absorption capacities are also natural resources.

Mainstream Environmental Economics versus Policy Practice

Current environmental economics can be roughly characterized as an extension and application of neoclassical economic theory to environmental problems. Natural resources are an input for human production and consumption processes. In the same way as the scarcity of labor and capital forces choices, scarcity of natural resources forces economic agents to decide for which ends they are used. Consequently, given the ends of economic agents, the use of natural resources available is described as an optimization problem. Environmental deterioration, or to put it the other way round, environmental quality, is the result of the aggregated decisions of all individual economic agents, weighing the benefits derived from increasing production and consumption against the benefits enjoyed when the environmental quality is improved.

A complicating factor is, however, that the preferences for environmental quality can only partly be expressed in exchange relations on the market. Here we meet with the problem of externalities. Unfortunately, environmental problems have become outstanding examples of external diseconomies. External diseconomies prevent the natural resources available from being used in accordance with the preferences of economic agents. Since Pigou's *Economics of Welfare* [1920], an external diseconomy has been defined as the production of a negative by-product by one or more economic agents. This by-product, though unwanted and unasked for, is delivered unintentionally and "behind the back of the market" by one or more economic agents. The loss experienced by the victim is not regarded as a cost-item by the originator of the external diseconomy. As a result, the costs of exploiting nature have been consistently underestimated. Consequently, nature is more harmed by production and consumption than the economic agents wish.

In environmental economics the central issue is how to reduce external diseconomies. Pigou's formula of internalization [Pigou 1920, p. 192] is often recommended. The state corrects the market failure by imposing a tax on the production of external diseconomies (for example, charging the emission of processing water) and by subsidizing the production of external economies (for example purification of processing water). The external economy, in this case the natural resource used, receives a shadow price, which is included in the agents' private cost-benefit calculations. If the shadow prices are set at the right level, a Pareto optimum exploitation of nature—that is pollution of the environment and depletion of natural resources in accordance with the preferences of the economic agents—is considered to be possible.

Lately, the Pigovian internalization method has been elaborated in several ways [Bohm and Russell, 1985; Opschoor and Vos, 1989]. First, more or less considered as a price to be paid for pollution, various types of charges were developed, such as effluent charges, product charges, administrative charges, and tax differentiation. Second, various forms of financial assistance came under the general term "subsidies." Grants, soft loans, and tax allowances could be offered to firms as an incentive for altering their polluting behavior or given to firms facing problems in complying with imposed standards. Third, new incentive-generating instruments were developed, such as deposit-refund systems and marketable pollution rights. In deposit-refund systems a surcharge is laid on the price of potentially polluting products. When pollution is avoided by returning these products or their residuals to a collection system, a refund of the surcharge follows. Pollution rights might be bought in artificially created markets, to be used for actual or potential pollution. Unused pollution rights might be sold for the highest bid.

This theoretical picture contrasts sharply with environmental policy practice in all developed countries. The goals for environmental policy are seldom or never derived from individual preferences regarding the environment. That is, environmental policy goals are seldom or never based on cost-benefit analyses, showing which environmental quality offers society the highest benefits for the lowest costs. Instead, environmental policy goals are formulated in physical terms: rates for emission reduction, standards regarding emissions and discharges, product and process requirements.

Turning to the issue of the policy instruments, hardly any of the financial instruments recommended in economic theory are used in current environmental policy [Downing and Hanf, 1983; International Energy Agency 1988; Opschoor and Vos, 1989]. Traditionally, regulatory instruments have been used as the basic equipment for carrying out environmental policy in most countries. The basis for such direct interventions is some form of legislation. Polluters' compliance is mandatory and often sanctions for noncompliance exist. The remaining pollution is frequently treated by public authorities. The tradition of applying this "command and control philosophy" has historical roots in the urban sewerage and other public hygiene programs of the nineteenth century. Insofar as charges are applied, they only serve as a source for financing environmental policy expenditures. In addition to direct regulation, government enters more and more into voluntary agreements with specfic sectors, such as oil refinery and agriculture, concerning emission reductions.

In the next three sections we attempt to explain this gap between mainstream economic theory and environmental policy. We distinguish two explanatory grounds: (1) Problems that arise when the recommendations of economic theory are put into practice; and (2) The influence of economic interest groups on the goals and instruments of environmental policy.

Fundamental Obstacles to Pigovian Internalization

Although the neoclassical principle of including social costs of environmental damage in the calculations of economic agents seems to settle the issue of (negative) externalities, especially the assessment in monetary terms of the *benefits* of avoided environmental damage poses considerable problems. These benefits should be weighed against the costs of avoiding environmental damage. Estimates for the latter can be made easily and quite accurately. For example, the costs of decreasing the pollution level of a river that contains heavy metals from the effluent of a firm along that river, equal the purification costs of the polluted river plus the costs of adapting the polluting production process. Problems arise when the benefits of a clean river have to be estimated. Some benefits can be expressed in market prices, such as the lower costs of producing drinking water and the higher proceeds from fishing. Many benefits, however, cannot be expressed in market prices, simply because there are no markets for public goods like ecosystems and landscapes. What is, for example, the price of a square mile of wetlands?

In the absence of markets, other evaluation methods are needed to estimate the benefits economic agents experience when particular environmental damage decreases or is avoided. In the last decade much research has been done on alternative evaluation methods, including "hedonic pricing methods" and "contingent valuation methods" (CVM). Surveys of these methods can be found in K.G. Mäler [1985], A.M. Freeman [1985], G.D. Anderson and R.C. Bishop [1986] as well as D.W. Pearce and R.K. Turner [1990]. Although some progress has been made, these methods only indicate individual preferences for a sound environment. It is, for example, not clear whether CVM underestimates the willingness to pay for a particular environmental quality [Hoehn and Randall, 1987] or overestimates this willingness to pay [Crocker and Shogren, 1991]. In addition, the crucial problem of how to aggregate individual preferences into a collective statement on the value of specific natural resources cannot be solved satisfactorily. Aggregation attempts meet with problems of cardinal measuring of utility and of interpersonal comparisons of utility. Hence, unless individual preferences can be aggregated, it is impossible to weigh the value society puts on goods and services whose production and consumption pollute the environment, against the value society puts on a sound environment.

Another fundamental problem is that the preferences of future generations for natural resources are unknown. The depletion of nonrenewable natural resources (such as fossil fuels and minerals), the overexploitation of renewable natural resources (like the cutting down of tropical forests) and the irreversible pollution of ecosystems (by, for example, chemical and nuclear waste) unmistakably reduce the "stock" of natural resources available for future generations. It is not possible to deal with this problem satisfactorily by following currently known evaluation methods. Consequently, the evaluation of natural resources on the basis of the preferences of individual economic agents is myopic.

In this context of unknown preferences the application of the warmly applauded economic instruments causes problems. In the case of, for example, the imposition of a levy on SO_2 emissions, the government should be familiar with the social benefits of (partly) avoiding these emissions. Without this information it is technically impossible to determine the optimal level of the levy. Hence, policymakers more or less grope in the dark about the environmental effects of the levy—that is, which behavioral adaptions may be expected *after* the imposition of the levy.[1]

To summarize, the preferences of economic agents are not known (future generations) or are only partly known (current generation). This knowledge is essential for the design of an effective environmental policy based on the Pigovian internalization method. The environmental effects of direct regulation can be predicted much better, mainly depending on how much effort is made to uphold legal regulations. This is not to say that the advantage of predictable effects completely explains why direct regulations dominate environmental policies to such an extreme. But up to now it has hampered a more extensive use of economic instruments in most countries.

Uncertainty about Impacts on the Environment

Unfortunately, there are more complications. Even if, in the imaginary case, we are completely familiar with individual preferences regarding environmental quality and are able to aggregate them into a collective statement on the desired environmental quality in society, this does not imply that it would be easy to combat the environmental crisis. Aggregated individual preferences could still lead to ecological disasters, especially for lack of insight into ecological relations. A striking example is that of forests dying on a large scale as a result of acid rain. One of the most important causes of acid rain is the emission of large quantities of sulphur dioxide. Yet, some fifteen-twenty years ago, in many industrialized areas measures were taken to limit the emission of sulphur dioxide.[2] These measures were taken on the basis of the deterioration of public health (complaints about irritation of the eyes and the respiratory tract, evacuation of asthmatics). Since the enactment of emission standards and the examination of the quality of the air with pollution detectors, the problem of sulphur dioxide in urban areas seemed to be under control. What was not foreseen, however, was that the emission standards, more or less effective for public health, would be utterly ineffective for preventing ecological calamities such as the death of forests as a result of acid rain.[3]

Unfortunately, such unpleasant surprises have occurred far too often already. One example is the extensive ecological damage caused by the use of DDT and other persistent agricultural pesticides. The belch of carbon dioxide can also lead to unpleasant surprises, since the climatological effects of an increase of the CO_2 content in the atmosphere are not clear. From these and many other serious and less serious examples, it appears time and again that the effects of human (industrial) actions on nature are underestimated, minimized or even neglected.

If the effects of so many interventions in and influences on nature are not sufficiently known or are consistently disregarded, an optimum use of natural resources for human production and consumption, as is the claim of neoclassical analyses and policy recommendations, becomes a problem. The point is that neoclassical optimization requires insight into the effects of alternative actions on nature (or into the availability of natural resources) with a probability bordering on certainty, or, at least with a chance that can be coped with by the theory of probabilities. The former is quite familiar as the well-known assumption of completely informed agents by which the problem of flawed ecological knowledge is simply neglected. The latter seems more advanced, but still requires far better ecological knowledge than we generally have, to construct a distribution of chances of possible ecological states as a result of a particular human intervention [cf. Drepper and Manson, 1990].

In general, processes in nature, and hence, human interventions in these processes, appear to be hardly predictable for at least three reasons. First, synergetic effects increase the impact on the environment of separate emissions. For example, laboratory experiments made clear that the combined impact of the acidifying substances SO_2, NO_x, NH_3 and O_3 on plant growth is substantially more severe than the (linear) addition of the impacts of each of these substances alone would be [Tonneijck, 1981]. Second, thresholds are very common in ecosystems. Again acidification serves as an excellent example. The sudden acceleration of the deterioration of forests and subsequent dying off of large parts of European forests in the beginning of the 1980s came for most people (a lot of scientists among them!) like a bolt from the blue. It appeared that the buffering capacity of the soil had protected trees from serious damage for decades. Once this capacity had been reached, acidifying substances could considerably damage trees and kill them within a couple of years. Third, many emissions have a delayed effect on the environment. It takes decades, for example, for nitrogen from manure and chemical fertilizers to be washed from the top into deeper layers of the soil, causing severe nitrate pollution of the groundwater, which serves in most countries as drinking water. Even if nitrogen leakages to the groundwater can be prevented from now on, nitrate pollution of groundwater will increase considerably for decades in the next century.

In short, thresholds, synergetic effects and delayed reactions make the relations between emissions and immissions rather obscure to us. We have to conclude that, as a result of human actions, ecosystems change much more capriciously than economists normally assume. The uncertainty about the impacts on the environment has similarities with "knightian uncertainty." The neoclassical approach to optimizing the use of the natural resources available is without sense so long as we cannot quite accurately assess the amount of natural resources we have. To put it another way, we cannot optimize our "ecological utilization space" [Opschoor, 1987] without knowing precisely where its limits are located; exceeding these limits, however, implies irreversible effects on nature, resulting in a decrease of the ecological utilization space.

The Impact of Interest Groups on Environmental Policy

In the imaginary case where both the preferences of the economic agents are known and the effects of human activities on nature are sufficienty known, there is still an obstacle left for a strict environmental policy: the influence of economic interest groups. The case of the abatement of acid rain in the Netherlands is quite illustrative in this respect. The abatement policy started in the 1970s, although the name for the problem, acid rain, was only introduced in the 1980s. In former 'days it was simply referred to as air pollution.

In the 1960s and 1970s there was a general belief in industrialized countries that sulphur dioxide (SO_2) was the cause of acid rain. In the course of the 1970s it became clear that nitrogen oxides (NO_x) were an important factor too. In the 1980s the emission of ammonia (NH_3) was discovered as an important source of acid rain. Until 1980, acid rain was mainly seen as a problem of public health. The measures taken in this period had the aim of decreasing the concentration of SO_2 in dwelling areas. Tall chimneys were erected everywhere in Europe to achieve this goal. The measures were criticized by many ecologists, who already argued in the 1960s that tall chimneys only dilute the polluting substances [cf. Baker and MacFarlane, 1961].

Pressure on the Goals of Dutch Environmental Policy

In the 1980s Dutch environmental policy concerning the abatement goals of acidification showed a remarkable change of philosophy. Initially, the base for policy goals was sought in neoclassical economic theory. Attempts were made to calculate costs and benefits of abatement strategies in order to determine and to achieve an optimum use of the carrying capacity of the environment. Because a substantial part of these costs and benefits cannot be calculated (see Section 2), the Ministry for Environmental Affairs was forced to look for another method. In 1984 a standard was introduced based on the impacts of acidifying substances on ecosystems. Scientific research had made clear that the deposits of more than 1800 acid equivalents per hectare per year would considerably damage ecosystems. Deposits below this figure only cause marginal ecological damage [Ministry of Housing, Physical Planning and Environment, 1983–1984; Langeweg, et al 1988]. So, the aim was no longer to optimize the use of the environment on the basis of (in the ideal case) individual preferences of economic agents or (more realistically) on the basis of the perceptions of policymakers concerning the preferences for the environment in society. Instead, ecological knowledge, combined with ethical considerations to avoid irreversible changes in ecosystems, made the Ministry for Environmental Affairs establish the standard of 1800 acid equivalents. The introduction of this standard severed the relation between economic theory and environmental policy on a vital element.

Clarity about the standard to be met, does not guarantee achieving it. Despite the rather firm evidence that a deposit larger than 1800 acid equivalents damages ecosystems, this standard is often questioned. This happens in good and in bad faith. Questioning the standard in good faith often proceeds from ignorance, followed by a reaction of alarm, or, unfortunately more frequently, disbelief and neglect ("it cannot be *that ghastly*"). At the moment, deposits in the Netherlands amounts to about 6000 acid equivalents per ha per year.[4] To achieve 1800 acid equivalents, or better, 1400 acid equivalents as recent research shows, emission reductions of 70–90 percent are required [Langeweg, et al 1988]. Most people listen to this figure with mistrust, fearing it will require a dramatic change in their way of life.

The standard of 1800 acid equivalents is also questioned in bad faith. As an example, representatives of the ammonia-emitting intensive livestock sector time and again maintain that this standard is insufficiently substantiated. They expect that much smaller emission reductions will appear to be necessary. Therefore further research has to be done. Anticipating this "expected result," strict measures meant to achieve a maximum load of 1800 acid equivalents per ha per year must be postponed. This view can also be heard at the Dutch Ministry of Agriculture, illustrating the many-sided character of the state [Dietz and Termeer, 1991]. Another example in which the deposit standard is questioned, is the "contra-research" concerning the impacts of acidifying substances on Dutch forests, which is executed by order of the joint producers of electricity and Shell Netherlands. Although official research of the Ministry of Agriculture has yearly reported a decreasing vitality of Dutch forests,[5] the electricity producers and Shell downplayed the impacts of acidifying substances on forests on the basis of their "contra-research."

However, fighting the standard will appear to be more or less a rearguard action. The pressing problem of acidification, combined with the increasing pressure of the environmental movement as well as public opinion is bringing about a consensus in society to ultimately reduce acidifying emissions by 70–90 percent. No consensus exists, however, concerning the pace at which emission reductions have to be achieved. Emitting industries are very much interested in slowing down the pace for at least two reasons: their competitiveness on world markets (an argument that scores points in the small and open Dutch economy) and sunk costs (firms seeking enough time to pay off their installed equipment before buying new, less emitting equipment [cf. Dietz and Vollebergh, 1988]). Furthermore, production costs will inevitably increase because of abatement measures, intensifying competition, closing down firms and, ultimately, jeopardizing employment, especially in emitting sectors such as oil refining, electrical generation, transportation, and agriculture. Macro-economic studies show that, because of strict abatement measures, employment growth will hardly decrease and will even increase if similar measures are taken in other countries [Klaassen et al 1985; Ministry of Housing, Physical Planning and Environment; 1988–1989]. But such aggregated figures do not dominate public debate. Instead, the need to restructure specific sectors (transportation, agriculture) and, subsequently, the threat of a considerable loss of employment in these sectors will be the burning issues. Then, short-term individual interests of those involved in polluting sectors will put the long-term collective goal of emission reductions of 70–90 percent out of sight.

Additionally, the described change in policy objective has not been followed in traditional areas of economic policy. In fact, the Ministry for Environmental Affairs stood alone in its view that economic activities have to be put on trial on ecological standards. Hence, the forces supporting traditional views on the economy and the environment are dominantly represented in the governmental machinery, which has seriously hindered the abatement of acidification. To illustrate this, the government is involved with and responsible for both the emission of a great part of acidifying substances (electric power plants, policy measures stimulating transportation by truck or protecting international competitiveness of the Dutch intensive livestock sector, oil refineries and the sole Dutch automobile plant) and the abatement of acidification.

This duality also explains why large parts of the government machinery are susceptible to well-organized sectors (oil refineries, agriculture) claiming that nature can bear far more than 1800 acid equivalents or arguing that international competitiveness prevents emission reductions of 70 percent and more. In this arena of forces the social objective of preventing severe environmental damage cannot be realized. The neoclassical recommendation to internalize external diseconomies disregards the existing imbalance of power in society. Elsewhere we demonstrated that forces in society with interests in "diseconomies" are far more powerful than forces in favor of a sound environment.[6] As a result the aim of actual environmental policy considerably deviates from the social goal that would be derived on the basis of neoclassical cost-benefit analysis.

Influences on the Choice of Policy Instruments

Turning to the policy instruments used, the discrepancy between neoclassical recommendations (to use market instruments such as charges, subsidies, deposit-refund systems and marketable pollution rights) and policy practice (to use "command and control" instruments such as standards and permits) can also be explained by the influence of economic interest groups.

In economic textbooks it is often demonstrated that economic instruments are more efficient than direct interventions in economic processes [cf. Baumol and Oates, 1988, pp. 159–89]. However, many politicians feel rather uneasy when changes in the behavior of economic agents—and, consequently, changes in environmental quality—responding to particular policy measures cannot be exactly predicted, as is the case with economic instruments. The environmental effects of direct regulation are much clearer in advance. As stated in Section 2, this is not to say that the advantage of rather predictable environmental effects explains completely why direct regulation so utterly dominates environmental policies. But it must be seen as one of the forces that hamper a more extensive use of economic instruments in most countries.

Furthermore, polluting industries do not like levies and charges, as Buchanan and Tullock already indicated [Buchanan and Tullock 1975]. From the viewpoint of an individual firm, levies and charges only cost money, without offering much opportunity to influence environmental policy, or, better, to use environmental policy to improve the competitiveness of vested firms. Regulations in the form of, for example, emission standards do not cost money once the standard is achieved. Voluntary agreements to reduce the emission level are even more attractive, because both goals and instruments can be negotiated.

So, within the government as well as in polluting industries, many forces work in the same direction, that is, aiming at voluntary agreements and physical regulations, while holding back economic instruments. Furthermore, because of the government's need for information and cooperation, industry is provided with ample rent seeking opportunities [Verbruggen, 1991]. Vested economic interests abuse environmental policy to hinder newcomers on the market ("the environment cannot bear more polluters") and to improve their competitiveness by negotiating for a large share of the legally allowed pollution (to be recorded in permits). Finally, firms and whole industries ask for subsidies to adapt their production processes to the standards imposed and to maintain their international competitiveness.[7]

To summarize briefly, the missing links between mainstream economic theory and environmental policy are caused partly by the fundamental obstacles one encounters in attempting to follow the perception and to execute the recommendations of neoclassical economists. The missing links also result from the existing imbalance of power in society, which offers vested economic interests the opportunity to put their individual and short-term interests ahead of the collective and long-term interest of a sustainable society.

Contours of an Economic Theory on Natural Resources

From the preceding sections it is clear that neoclassical approaches fall short in analyzing environmental issues and, subsequently, provide a flawed basis for environmental policy. Then the question arises whether an alternative theoretical approach could be developed to provide a more appropriate basis for descriptions and analyses of various environmental problems. And if this is the case, does this imply that the link between economic theory and environmental policy could be restored? This section deals with the contours of an alternative economic theory on natural resources.

Various alternative starting-points for the development of such an economic theory are suggested in the literature. K.E. Boulding [1966] has the concept of "space-ship earth" in mind, B. Goudzwaard [1974] proposes to economize within the bounds of nature, I. Sachs [1984] advocated an ecological development, P. Söderbaum [1980; 1982] suggests ecological imperatives for governmental policies, J.B. Opschoor [1987; 1990] wants to keep economic activities within the limits of the ecological utilization space, and the World Commission on Environment and Development—better known as the Brundtland Commission —[1987], finally, opts for the by-now famous concept of sustainable development. All these concepts have in common that the ecologically bounded possibilities of using natural resources are taken as a normative starting-point for the development of economic theory.

To make the abstract concept of sustainable development effective, ecology must be taken into account. In ecology, the notion of the "ecocycle" is generally used for the description of ecological processes. An examination is made of which course is taken by various substances in the ecological process, at what point they accumulate or decompose, and how substances get blocked in the ecocyle. The description of an ecological process is complete only if the information and energy flows in the ecosystem are also indicated. Without energy from the sun the system would not function. Apart from this, some sort of information must be present in the ecosystem on the basis of which events take place in the system. This information leads, for example, to the decomposition of substances or to the generation of new cells. Every economic model that tries to describe how production and consumption could be fitted into the ecological process, should at any rate take these relationships into consideration, as they concern an ecological problem.

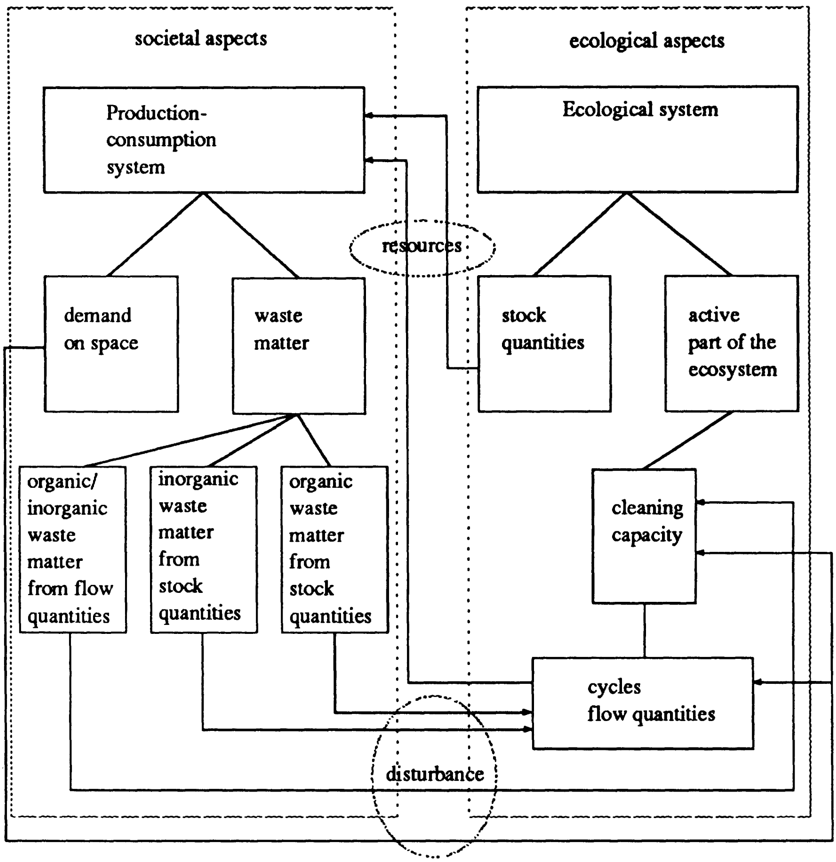
Figure 1 helps to distinguish several kinds of effects of human production and consumption on the ecological system.[8] A system of human production and consumption is based, among other things, on the need to use natural resources from ecological cycles—the active part of the ecosystem. Agricultural production is a good example of this relationship. Organic material is formed under the influence of the sun and serves as food for animals and humans. These natural resources are in principle inexhaustible and so everflowing. Since the period of the Industrial Revolution man has dramatically increased the use of fossil natural resources.[9] However, these resources are exhaustible, as is natural oil. The hydrocarbonates of which they are composed are denoted as "stock quantities," because the stock of natural oil available in the earth's crust cannot grow within a human time horizon. The fossil part of the ecological system is hardly, if at all, affected by the flow of waste products originating from the economic system. Pollution of the environment occurs in the active part of the ecological system—that is, at the level of ecocycles, whose working force is disturbed by the discharge of waste products.

Figure 1: Interactions between the economic system and the ecological system [Dietz and Van der Straaten, 1988, p. 76; Van der Straaten, 1990, p. 108].

There is a great difference between the dumping of organic materials and the dumping of inorganic and synthetic-organic materials into the ecocycles. When dumped into the cycles, organic materials generally do not cause irreversible disturbances. Such materials are already part and parcel of natural cycles and can be decomposed by bacteria as a matter of course. Yet, if too large quantities of decomposable organic material are dumped, for example, into surface water, the water's self-cleaning capacity can be impaired, so much so that stinking, rotting and deoxidized expanses of water are left. Such disturbances generally occur locally and are likely to be neutralized after some time.

Pollution by inorganic and nondecomposable synthetic-organic materials, on the contrary, cannot be reversed. In this case, it is almost impossible to restore the working of cycles, because the cycles have no mechanisms to cope with these waste products by way of processing or decomposition. Matters alien to the environment are even stored up within the cycle, causing the effects of such dumping to be felt across a

Figure 1.



large area and over a large period. Thus, when heavy metals, which normally occur in the cycles in very low concentrations, are discharged into surface water, the animal and vegetable life in it will be seriously affected. These metals do not just disappear when the organisms die; they accumulate.

Attention has not yet been paid to one category of effects on nature by human actions: the use of land. Yet this very seriously violates the ecosystems and thus threatens the cycles. The process began as soon as people, once settled at fixed residences, took up agriculture and began to change the natural layer of vegetation. In Europe the process has advanced to the point that hardly anything of the original vegetation is left. Modifications in the layer of vegetation need not *per se* lead to unacceptable changes in the natural cycles, but they do interfere with the cyclical process. Further attacks on the natural vegetation by the building of houses and factories, the construction of roads and other infrastructures have seriously affected the ecosystem. Their effect is different from that of the discharges of waste products, however, in that they threaten the functioning of cycles much faster and more directly, without complicated intermediary processes. For instance, cycles may be changed if natural woods are turned into arable land or curtailed by road construction.

If we aim at an ecologically sustainable society, it is prerequisited that we use ecocycles in such a way that their functioning is not damaged irreversibly. It is not easy to actualize this starting-point. Anyway, the discharge of materials that are alien or rare in ecocyles and mainly extracted from the stocks of fossil natural resources, should be minimized, or even better, stopped. This imperative implies that the speed at which fossil natural resources are depleted must be reduced considerably by a radical change to the recycling of minerals and synthetics. However, it is impossible to recycle all materials completely. During production, consumption and recycling processes surely a certain part of the materials will be "lost," that is, end up in the ecocycles. Technological development should be directed to a continuous decrease of the percentage of lost materials. Ultimately, the sustainable solution is to convert completely to renewable resources. Renewable resources can be extracted from the—in human time scale—ever-functioning ecocycles (on the condition of careful exploitation), and subsequently, after being used in production and consumption processes, they can be disposed of without disturbing ecocycles (on the condition that the carrying capacity is not exceeded). The same recommendation holds for the extraction and use of energy. Fossil stocks of oil, natural gas, and coal will deplete sooner or later. This implies that a complete conversion to the use of energy derived from flow quantities is inevitable in the long run.

As was demonstrated previously, traditional cost-benefit analysis cannot solve the problem of determining the optimal pollution point. Indeed, the price mechanism does not give sufficient information for this purpose. In our view, there is only one way to prevent overexploitation of the ecological utilization space: specified standards being sustainable from an ecological point of view. This implies that standards are directly derived from the functioning of the ecocycles. Such standards have to be established by the government or other authorities. Critical loads, emission standards, and extraction quotas are the policy goals in this respect. Subsequently, both "command and control" instruments and economic instruments could be used to attain these policy goals. The choice between them, or better, the specific mix of them depends on the usual criteria, such as effectiveness and efficiency.[10]

Institutional Framework and Conclusions

From previous sections it may be clear that fundamental shortcomings are present in neoclassical approaches when dealing with environmental issues. This is to a large extent because of the origin of neoclassical economics. Neoclassical economics can be seen as a scientific description of the economic expansion process, which started in the period of the Industrial Revolution. In the neoclassical framework the availability of natural resources in general was not seen as a fundamental hindrance to economic growth, representing a common societal viewpoint in the second half of the 19th century and the first half of this century. Hence, hardly any categories and concepts can be found suitable for analyzing environmental problems occurring on a large and global scale. In the neoclassical framework, environmental problems are only described as negative externalities, being effects on economic agents external to the center of the theory: the market itself.

Neoclassical economics suggests that values are exclusively found in the market, based on the individual preferences of economic agents. J. Martinez-Alier (1991) demonstrates that more than a hundred years ago this starting point was already criticized from an ecological point of view. If the preferences of individual economic agents are taken as the sole basis for valuation, ecological disasters could easily be the result. The early critics argued that economists should pay more attention to the flow of energy in the economy. The flow of energy provides more insight into the value of economic goods than is the case using traditional valuation methods based on market prices. This approach can be found again in what has recently been called ecological economics [cf. Christensen 1989].

After having discussed why economic theory and environemtnal policy have been severed on vital elements in Sections 2, 3 and 4, our view on the contours of an economic theory on natural resources was sketched in Section 5. In short, standards being sustainable from an ecological point of view must be imposed on economic activities. These ecological standards are derived from insights into the functioning of the ecocycles, combined with ethical views regarding the quantity and quality of natural resources we would like to leave behind for future generations. Attempts of this sort must be elaborated and developed into a more encompassing theoretical framework than neoclassical economics can provide.

In our view this alternative theoretical framework has to meet at least three requirements. First, the economic process is described as an open system, having various impacts on the ecological system and *vice versa.* To put it another way, economic theory must be built on the notion that production and consumption possibilities completely depend on the current quantity and quality of the natural resources available, while the current and future quantity and quality of the natural resources available is affected by current production and consumption processes. Second, in the theoretical framework, room is needed for ethical judgments concerning the quantity and quality of natural resources we would like to leave behind for future generations. This implies, for example, the adoption of the principle that irreversible effects on nature are not allowed. Besides, the introduction of ecological standards also brings about distributional issues: which countries, industries, and individuals may use which part of the (shrinking) ecological utilization space? Third, the theoretical framework must be suitable for analyzing the forces in society obstructing sustainable development. In other words, institutional barriers for attaining sustainability must be analyzed.

Söderbaum [1987; 1991] makes similar demands for a theoretical framework. Refering to the specific and complex characteristics of current environmental problems (multidimensional, multidisciplinary, non-monetary, as well as monetary, often irreversible, evoking conflicts between interests and ideologies in society), he states that a more many-sided approach is needed than neoclassical economics can offer. In his view the holistic context of institutional economics offers such an approach.

Those institutionalist economists involved in environmental issues mainly focus on the question of how essential ecological knowledge can be incorporated in economic theories. J. Swaney, for example, is of the opinion that "a holistic systems approach to environmental problems starts with the recognition that social systems coevolve with natural systems" [Swaney 1987a, p. 295; see also Norgaard, 1984]. He formulates the principle of "coevolutionary sustainability," which can be seen as an environmental application of J.F. Foster's principle of institutional adjustment [Foster 1981]. According to Swaney "coevolutionary sustainability means simply that development paths or applications of knowledge that pose serious threats to continued compatibility of sociosystem and ecosystem evolution should be avoided. Coevolutionary sustainability explicitly recognizes that environmental systems evolve interdependently along development paths that may or may not be sustainable" [Swaney 1987b, p. 1750]. Referring to the uncertainty of the impacts of human activities on the environment, he thinks that "far more research is needed to assure that institutional adjustment is consistent with a sustainable coevolutionary development path" [Swaney 1987b, p. 1750].

Swaney argues that a development of coevolutionary sustainability requires specific environmental education of individuals, interest groups and companies, namely learning by doing [Swaney 1987a]. Further, an increase of scientific knowledge is a prerequisite for improving the prevention of environmental disruption. According to Swaney, only a flexible and responsive social system can guarantee a rapid adjustment to new knowledge concerning the causes of environmental problems. Hence, the rapid penetration of new knowledge in the field of environmental protection is of great importance to ensure a sound environmental policy.

We share the prerequisites for coevolutionary sustainability Swaney mentions. But in our opinion there is at least one more prerequisite to think of. As was demonstrated in Section 4, knowledge is continuously produced, improving our insight into the process of environmental degradation. However, new knowledge and improved insights are not applied in environmetnal policy as a matter of course, because of the possibilities vested economic interests have to query new knowledge and to hamper a stricter environmental policy. Consequently, environmental economists have to pay special attention to the balance of power in society concerning environmental issues.

Despite the efforts of some authors to do so, it will not be simple to adequately incorporate natural resources in economic theories. This holds particularly if mainstream economists continue to see the economy as a closed system, operating independently from nature. In case an environmental problem emerges, its analysis and the development of an abatement strategy is thought to be a matter for specialists in the subdiscipline of environmental economics. All critical remarks about not incorporating natural resources in economic theory can be neutralized by referring to this subdiscipline. In this way an alibi is created to maintain the closed system view of society.

The result of adequately incorporating natural resources in economic theory can hardly be overestimated. For instance, the traditional system of national accounts will be untenable in the long run, as it is based on the neoclassical approach of measuring almost exclusively economic variables on the market. Such a system cannot give any insight into the unpriced scarcity of various natural resources.[11] Also, a cost-benefit analysis can only give partial insight into environmental problems, as long as important benefits (like environmental quality) have no market price. As a third example, expressing the national debt in dollars, without taking into account the national debt caused by the degradation of natural resources, fails to adequately indicate the solvency of a country in the long run as long as the loss of natural resources is neglected. Furthermore, accounts on industrial relations should no longer neglect the position of employees in industries that destroy or irreversibly affect the environment on a large scale. And finally, the concept of the optimal growth path, as it is defined in macro-economics should be regarded as a non-issue, if the effects of environmental factors are not included in the concept itself.

If economists succeed in giving natural resources an up-to-the-mark position in economic theory, there is a real chance that the link between economic theory and environmental policy could be restored. However, this does not guarantee a successful environmental policy, aiming at and attaining sustainability. Industries having strong interests in the pollution and overexploitation of nature, are well organized and are well represented in the state, giving them the obstructive power to weaken, retard, or even prevent the design and execution of a sound environmental policy. Polluting industries have, indeed, built up their strong position by appropriating the ecological utilization space without any payment. If this space decreases, as is currently the case in all industrialized countries, these industries will be confronted with increasing costs, implying an intensification of the struggle for the remainder of the shrinking ecological utilization space. Then, the imposition of strict ecological standards setting the limits for economic activities in the context of sustainable development, will be much harder to effectuate than it already proved to be in the last decade. Vested economic interests will continuously underline their economic importance by stressing their substantial contribution to traditional economic variables (GNP, employment, balance of payments, et cetera). In this case employees often take the same attitude as their employers, fearing unemployment or a lower income. This occasional coalition between capital and labor has paralyzing effects on environmental policy. For the time being, the counterveiling power lacks the strength to break down these obstructive forces in society.

The way society wrestles with the environmental problem bears a remarkable similarity to the way the "social question" was handled around the turn of the century. The social conflicts concerning the rights of employees could only be "solved" after a considerable shift in the balance of power in society, which took several decades. In our view the same holds for the "environmental question." The old balance of power has to be broken down before the principle of sustainable development has been penetrated in all branches of society and a strict environmental policy can be designed and executed to manage the ecological utilization space in a sustainable way. The environmental movement, consumer organizations, and political parties without strong ties to capital or labor must be able to take the lead. For the sake of future generations it must be hoped that the required shift in the balance of power will not take as much time as it did in the social question.

Notes

1. Marketable pollution rights partly overcome this problem. The total amount of emissions derived from the desired environmental quality can be fixed and maintained at a constant level [cf. Baumol and Oates 1988, pp. 178–80; Pearce and Turner, 1990, p. 115]. However, undesired regional concentrations of emissions are difficult to avoid. Furthermore, synergetic effects generate unexpected harmful impacts because of the combination of emitted substances that separately are rather harmless.
2. These measures concerned the construction of tall chimneys—against the advice, however, of experts who said this was no real solution—and the increased use of natural gas and nuclear energy. Furthermore, the level of production of the petrochemical industry and the oil refineries stabilized or decreased as a result of the economic crisis that started in the second half of the 1970s.
3. For many years, warnings against the ecological consequences of sulphur dioxide emissions have been given. Because it was impossible to make exact predictions about the effects of the emissions on nature, these warnings could easily be dismissed as exaggerated. The way lobbies of vested economic interests have abused ecological uncertainties to weaken environmental policy measures is elaborated more extensively in Section 4.
4. The emission from Dutch sources amounts to about 9000 acid equivalents per ha per year. Hence, the Netherlands is a net exporter of acidifying substances.
5. At the moment 60 percent of Dutch forests are reported "less than vital," which is a nice way of saying that 60 percent of the forests are seriously ill and will die.
6. Recent debates, political decisions, and influences of interest groups concerning the reduction of acidifying emissions in specific sectors are de-

scribed and analyzed in J. Van der Straaten, [1990 and 1991] (especially oil refineries and electric power plants); F.J. Dietz, J. Van der Straaten and M. Van der Velde [1991] (traffic); F.J. Dietz and N.J.P. Hoogervorst [1991] as well as F.J. Dietz and K.J.A.M. Termeer [1991] (agriculture).

7. See for an application, Dietz and Termeer [1991], in which the forces at work in the Dutch intensive livestock sector are thoroughly described and analyzed.
8. Ecological systems can be described on a global level (higher air layers, including the ozone layer in the stratospehre), in which processes regulating radiation and temperature are located on a continental level (continents and oceans) where processes, such as air and ocean currents movement take place on a fluvial level (large river-basins and coastal seas), in which various processes related to the water economy take place on a regional level (landscapes), in which various processes take place in the soil, and on a local level (work and living environment) where the environment is affected directly by human activity.
9. Although fossil natural resources like coal and iron ore had been in use for centuries, these natural resources replaced flow entities from the active part of the ecosystem, such as wind and solar energy, wood and wool, on a large scale. In this way it was possible to increase production substantially. Besides, fossil natural resources were preferred in production processes, owing to the collective character of flow entities.
10. See for an application of this approach, Dietz and Hoogervorst [1991] in which a sustainable and efficient environmental policy to abate manure surpluses in the Dutch intensive livestock sector is developed.
11. Here we encounter the discussion concerning the possibilities of a green GNP; see, for a recent state of the art, Y.F. Ahmad, S.E. Serafy and E. Lutz [1989]. However, attempts to calculate a green GNP meet with the fundamental problems discussed in Sections 2 and 3. In our view a much more promising initiative in this context is the attempt to develop indicators of sustainable development, by which the "extent of sustainability" of a whole nation, economic policy, or specific sectors could be determined [cf. Kuik and Verbruggen 1991, for potentials and pitfalls].

References

Ahmad, Y. J., S. E. Serafty, and E. Lutz. 1989. *Environmental Accounting for Sustainable Development,* Washington, D.C.: The World Bank.

Anderson, G. D. and R. C. Bishop. 1986. "The Valuation Problem". In *Natural Resource Economics; Policy Problems and Contemporary Analysis.* Ed. D. W. Bromley, pp. 89–137. Boston: Kluwer.

Baker, K., and W. A. MacFarlane. 1961. "Fuel Selection and Utilization." *Air Pollution* World Health Organization, pp. 345–63.

Baumol, W. J. and W. E. Oates. 1988. *The Theory of Environmental Policy.* 2d edition, Cambridge: Cambridge University Press.

Bohm, P. and C. S. Russell. 1985. "Comparative Analysis of Alternative Policy Instruments". In *Handbook of Natural Resource and Energy Economics, Vol. 1.* Eds. A. V. Kneese, and F. L. Sweeney, pp. 395–460. Amsterdam: North-Holland.

Boulding, K. E. 1966. "The Economics of the Coming Spaceship Earth". In *Environmental Quality in a Growing Economy.* Ed. K. Jarratt, pp. 3–14. Baltimore: John Hopkins Press.

Buchanan, J. M. and G. Tullock. 1975. "Polluters' Profits and Political Response: Direct Controls versus Taxes". *American Economic Review.* 65 (March): 139–47.

Christensen, P. P. 1989. "Historical Roots for Ecological Economics: Biophysical versus Allocative Approaches". Ecological Economics, 1 (1): 17–36.

Crocker, T. D. and J. F. Shogren, 1991. "Preference Learning and Contingent Valuation Methods". In *Environmental Policy and the Economy.* Eds. F. J. Dietz, F. Van der Ploeg, and J. Van der Straaten, pp. 77–93. Amsterdam: North-Holland.

Dietz, F. J. and N. J. P. Hoogervorst. 1991. "Towards a Sustainable and Efficient Use of Manure in Agriculture: The Dutch Case". *Environmental and Resource Economics.* 1 (3): 313–32.

Dietz, F. J. and K. J. A. M. Termeer. 1991. "Dutch Manure Policy: The Lack of Economic Instruments". In *Environmental Protection: Public or Private Choice.* Eds. D. J. Kraan, and R. J. In't Veld, pp. 123–47. Dordrecht: Kluwer Academic Publishers.

Dietz, F. J. and J. Van der Straaten. 1988. "The Problem of Optimal Exploitation of Natural Resources: The Need for Ecological Limiting Conditions". *International Journal of Social Economics.* 15 (3/4): 71–79.

Dietz, F. J. and H. R. J. Vollebergh. 1988. "Wishful Thinking about the Effects of Market Incentives in Environmental Policy". In *Environmental Policy in a Market Economy.* Eds. F. J. Dietz, and W. J. M. Heijman, pp. 40–60. Wageningen: Pudoc.

Dietz, F. J., J. Van der Straaten, and M. Van der Velde. 1991. "The European Common Market and the Environment: The Case of the Emission of NO_X by Motorcars". *Review of Political Economy,* 3 (January): 62–78.

Downing, P. B. and K. Hanf. 1983. *International Comparisons in Implementing Pollution Laws.* Boston: Kluwer.

Drepper, F. R. and B. A. Mansson. 1990. *On the Role of Unpredictability in Environmental Economics.* Paper presented at the conference "Economics and the Environment, 17–19 September 1990, Center for Economic Research, Tilburg University.

Foster, J. F. 1981. "Syllabus for Problems of Modern Society: the Theory of Institutional Adjustment". *Journal of Economic Issues,* 15 (December): 932–33.

Freeman, A. M. 1985. "Methods for Assessing the Benefits of Environmental Programs". In *Handbook of Natural Resource and Energy Economics, Vol. 1.* Eds. A. V. Kneese, and F. L. Sweeney, pp. 223–70. Amsterdam: North-Holland.

Goudzwaard, B. 1974. *Schaduwen van het groeigeloof.* Kampen: Kok.

Hoehn, J. P. and A. Randall. 1987. "A Satisfactory Benefit Cost Indicator for Contingent Valuation". *Journal of Environmental Economics and Management,* 14 (September): pp. 226–47.

International Energy Agency. 1988. *Emission Controls in Electricity Generation and Industry.* Paris: OECD/IEA.

Klaassen, G. et al. 1985. *Werk maken van zure regen.* Utrecht: LMO.

Kuik, O. and H. Verbruggen. (Eds.). 1991. *In Search of Indicators of Sustain-*

able Development. Boston/Dordrecht: Kluwer Academic Publishers.
Langeweg, F. et al. 1988. *Zorgen voor morgen*. Alphen aan de Rijn: Samsom Tjeenk Willink.
Mäler, K. G. 1985. "Welfare Economics and the Environment". In *Handbook of Natural Resource and Energy Economics, Vol. 1*. Eds. A. V. Kneese, and F. L. Sweeney, pp. 3–60. Amsterdam: North-Holland.
Martinez-Alier, J. 1991. "Ecological Perception and Distributional Effects: A Historical View". In *Environmental Policy and the Economy*. Eds. F. J. Dietz, F. Van der Ploeg, and J. Van der Straaten, pp. 117–37. Amsterdam: North-Holland.
Ministry of Housing, Physical Planning and Environment. 1983/1984. *De problematiek van de verzuring*, Handelingen 18225, nr. 1–2.
______. 1988/1989. *Nationaal Milieubeleidsplan*, Handelingen 21137, nr. 1.
Norgaard, Richard B. 1984. "Coevolutionary Development Potential", *Land Economics*, 60 (May): 160–73.
Opschoor, J. B. 1987. *Duurzaamheid en verandering: over ecologische inpasbaarheid van economische ontwikkelingen*. Amsterdam: Free University.
______. 1990. "Ecologisch duurzame ontwikkeling: een theoretisch idee en een weerbarstige praktijk". In *Het Nederlandse milieu in de Europese ruimte*. Eds. P. Nijkamp, and H. Verbruggen, pp. 7–41. Leiden: Stenfert Kroese.
Opschoor, J. B. and H. Vos. 1989. *Economic Instruments for Environmental Protection*. Paris: OECD.
Pearce, D. W. and R. K. Turner. 1990. *Economics of Natural Resources and the Environment*. London: Harvester Wheatsheaf.
Pigou, A. C. 1920. *The Economics of Welfare*. London: MacMillan (1952).
Sachs, I. 1984. "The Strategies of Ecodevelopment". *Ceres, FAO Review on Agriculture and Development*, 17: 17–21.
Söderbaum, P. 1980. "Towards a Reconciliation of Economics and Ecology". *European Review of Agricultural Economics*, 7 (1): 55–77.
______. 1982. "Ecological Imperatives for Public Policy". *Ceres, FAO Review on Agriculture and Development*, 15: 28–32.
______. 1987. "Environmental Management: A Non-traditional Approach". *Journal of Economic Issues*, 21 (March): 139–65.
______. 1991. "Actors, Roles and Networks: An Institutional Perspective to Environmental Problems". In *Linking the Natural Environment and the Economy: Essays from the Eco-Eco Group*. Eds. C. Folke, and T. Kaberger, pp. 31–42. Boston/Dordrecht: Kluwer Academic Publishers.
Swaney, J. A., 1987a. "Building Instrumental Environmental Control Institutions". *Journal of Economic Issues*, 21 (March): 295–308.
______. 1987b. "Elements of a Neoinstitutional Environmental Economics". *Journal of Economic Issues*, 21 (December): 1739–1779.
Tonneijk, A. E. G. 1981. *Research on the Influence of Different Air Pollutants Separately and in Combination in Agriculture, Horticulture and Forestry Crops*. Wageningen: IPO Report, R 262.
Van der Straaten, J. 1990. *Zure regen, economische theorie en het Nederlandse beleid*. Utrecht: Van Arkel.
______. 1991. "Acid Rain and the Single Internal Market: Policies from the Netherlands". *European Environment*, 1 (February): 20–24.

Verbruggen, H. 1991. "Political Economy Aspects of Environmental Policy Instruments". In *Environmental Policy and the Economy.* Eds. F. J. Dietz, F. Van der Ploeg, and J. Van der Straaten, pp. 141–49. Amsterdam: North-Holland.
World Commission on Environment and Development, 1987. *Our Common Future.* Oxford: Oxford University Press.