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Environmental Valuation – To Use or Not to Use?

A Comparative Study of the United States and Europe

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Abstract. Valuation methods have been used for five main purposes in environmental decision-making. Cost–benefit analysis (CBA) of projects, CBA of new regulations, natural resource damage assessment, environmental costing, and environmental accounting. The relatively lower importance attached to economic efficiency in environmental decision-making in most European countries compared to the U.S.A., both legally and in practice, might account for our general finding that there are very few valuation studies in Europe which have served as a decisive basis for environmental policy and regulations. However, with EU's goal to establish environmentally adjusted national accounts and to apply CBA to environmental policy and regulations, time seems ripe for an increased use of valuation techniques in Europe.

Key words: environmental valuation, contingent valuation, cost–benefit analysis

1. Introduction

In the absence of market prices special techniques are needed to place consumers' preferences for environmental goods and services on the common ground with demand for more conventional commodities. Three types of procedures have been applied to value environmental goods and health impacts: *household production function methods* based on the demand for complements and substitutes (especially the Travel Cost method which is used to measure the demand for recreational activities), *hedonic price analysis* of decomposing prices for market goods to extract embedded values for related environmental attributes (e.g. studying the housing market to elicit people's willingness-to-pay (WTP) to avoid impacts on health, visibility and aesthetic from air pollution), and *experimental methods for the elicitation of preferences*, either by using hypothetical settings, mainly *Contingent Valuation*, or auctions and other simulated market experiments. All three methods stem from applied welfare economics.[1]

The first two approaches are classified as *revealed preference* methods while the Contingent Valuation is a *stated preference* method. The revealed preference methods are based on actual rather than intended behaviour. Intentions are usually costless to express, which means that they may not be considered as carefully as

real consumption choices. However, only Contingent Valuation and other stated preference methods are able to measure Total Economic Value (TEV) of environmental goods and services, i.e. both use and non-use value (also named existence or passive use value). It is difficult to see how the revealed preference approaches of the Travel Cost (TC) and Hedonic Price (HP) methods could capture the non-use value holistically.[2] Therefore, the current research effort within nonmarket valuation is very much concentrated on developing the Contingent Valuation (CV) method, and more recently the Contingent Choice (CC) analysis to yield reliable estimates of the TEV.

Valuation of environmental and health impacts using these nonmarket valuation methods has evolved from being mainly a U.S. activity in the 1960s and 1970s to become an important field also in Europe in the 1980s and 1990s (Navrud 1992). At the same time nonmarket valuation methods are applied at an increasing rate in developing countries in Asia, Latin America and Africa. Indicators of this development include the preparation of Environmental Valuation Field Guides by the Organization for Economic Cooperation and Development (OECD) in cooperation with the World Bank (OECD 1994, 1995), the United Nations Environmental Program (UNEP) guidelines on environmental valuation in their program of country studies of biodiversity, and similar efforts by the Asian Development Bank (ADB 1996), the United Nations Development Program (UNDP), and the World Health Organization (WHO). A recent report to UNEP reviewing valuation techniques in developing countries concludes that economic valuation is (i) extremely useful in raising the profile of environmental aspects of development projects and policies, (ii) widespread in terms of its application in developing countries, and (iii) generally successful in application (Pearce et al. 1994). The report does not discuss the use of the valuation studies in the decisionmaking process.

While guidelines for the valuation of environmental impacts can be found in project appraisal manuals for developing countries and in U.S. manuals for evaluating water projects (Water Resource Council's Principles and Standards), recreational use of forest land (U.S. Forest Service's Resource Planning Assessment) and Natural Resource Damage Assessments (cf. proposed rules in the Oil Pollution Act and the Comprehensive Environmental Response, Compensation and Liability Act), no such guidelines exist in Europe. Manuals for cost–benefit analyses (CBA) exist in a few European countries for transportation projects, but most often they do not contain guidelines for economic valuation of environmental impacts. In this paper we will try to shed some light on the reasons for the limited use of nonmarket valuation estimates in project evaluation and other environmental decisionmaking in Europe compared to the U.S.A., and the lessons to be learned for Europe from the U.S. experience.

In Section 2 we construct a framework for analysing the differences in use of nonmarket valuation methods in Europe and the U.S.A. Section 3 provides a short review of nonmarket valuation studies in the U.S.A. and Europe with respect to the methods used and the nonmarket goods that have been valued. Differences

within Europe are emphasized. Sections 4 and 5 analyse the political applications of nonmarket valuation in the U.S.A. and Europe, respectively. Section 6 provides conclusions and policy recommendations for future use of environmental valuation in Europe.

2. An Analytical Framework

When comparing the use of environmental valuation methods in decisionmaking in Europe and the U.S.A., it is useful to distinguish between (i) different types of use, and (ii) the different valuation 'products' which are used. The 'product' refers to economic values from original valuation studies versus values which have been transferred from previous valuation studies and adapted to a new policy issue. The latter is often referred to as benefit transfer, and has become increasingly popular over the last few years, especially in the U.S.A., due to the large time and cost savings of this approach.

2.1. Different Types of Use

Five different types of use can be identified:

- Project evaluation
- Regulatory review
- Natural resource damage assessment (NRDA)
- Environmental costing
- Environmental accounting

Cost–benefit analysis (CBA) is the applied tool of welfare economics, and started out as an attempt to more systematically incorporate economic information in public investment decisions involving water resources. CBA is used for project evaluation and regulatory review.

2.1.1. *Project evaluation*

Nonmarket valuation started out as a part of the project evaluation process. The first valuation studies were carried out in the U.S.A. in the 1950s to deal with 'intangibles' in CBA in a more systematic and consistent way (Hanemann 1992). Hence, it comes as no surprise that environmental valuation techniques have been mostly used at the project level both in the U.S.A. and in some European countries.

2.1.2. *Regulatory review*

One important difference between using CBA to evaluate a project versus a regulating involving, for example, standards for ambient concentrations or emission standards of designated pollutants, is that the focus is shifted to a new type of output. In project evaluations the outputs provided are defined and estimated as

part of the cost analyses and environmental impact analyses for that project. Regulations, however, aim at 'changing the rules' for private production or consumption activities, and the output will depend on the action of these private parties, i.e. to what extent they will comply. Regulations generally impose fewer requirements on federal budgets. Any costs of making these changes are indirect and fall on those who have to respond to their mandates.

From being primarily a tool for project evaluation, CBA was also considered for evaluating new regulations in the U.S.A. in the late 1970s. Several analyses were undertaken, but they were limited in scope, often retrospective, and therefore rarely a part of the information available to policy makers. However, since 1981 CBA has been extensively used for evaluating new regulations under Executive Order 12291 and renewals of this E.O.

In Europe, no legal requirements for CBAs of new regulations exist, with the exception of the 1995 Environment Act in the U.K. It requires their new Environment Agency, where required by the Minister, to prepare reports on the costs and benefits of environmental protection options. However, it is not quite clear at present how these powers will be implemented. Even though some countries, including the U.K. and Norway, have general guidelines recommending that social costs and benefits should be considered, few attempts have been made to compare the costs and benefits of new regulations. Environmental benefit estimation has often been aimed at retrospectively justifying the large sums of money being used to reduce air and water pollution, but without undertaking comprehensive cost–benefit analyses.

2.1.3. *Natural Resource Damage Assessment (NRDA)*

One striking difference between using CBA in regulatory reviews and Natural Resource Damage Assessments (NRDAs) is that while money is exchanged directly or indirectly in both cases, we do not know precisely to whom the money is paid in the regulatory case. That means the policy case includes a hidden distributional issue. The parties are relatively more easily identifiable under NRDA.

The concept of natural resource damage liability has also changed the focus of the economic literature on nonmarket valuation in the U.S.A. NRDA focuses on natural assets and on how injuries to natural resources influence the value we would attribute to them as assets. To date NRDAs are only undertaken in the U.S.A., and have not become an issue in Europe due to different legal statutes. Smith (1992) identifies three aspects of the NRDA process which are important to nonmarket valuation methods:

1. A well-defined group pays what is estimated as the monetary value of an injury to a natural resource.

   NRDA payments differ from the results of CBA on public projects or regulations. Neither the government's payments for public investments nor a private firm's contributions as part of their response to environmental regulations represent aggregate values, but embody investment or compliance costs.

Equally important, the agents responsible for the payment are diffuse. People as taxpayers or consumers always pay indirectly for public investments and regulatory policies. While people pay taxes for public investments, we expect private costs to increase to satisfy regulatory mandates. Liability rules associated with natural resource damages are also expected to increase costs, but the initial impacts are more focused. Individual firms held liable for injuries to natural resources must pay restoration costs or the monetary value of the damages from the injuries due to release of hazardous waste or oil. Thereby, not all firms within an industry may experience the same treatment, as is frequently the case with regulations.

2. The public good aspect of the services of injured natural resources has now received much more attention. This has lead to an increased effort to improve methods for estimating non-use values, i.e. the Contingent Valuation method.
3. NRDA assigns a crucial role to scientifically establishing injury to the natural resources involved. This was also part of the CBAs of public projects and regulations, but it was associated more with the development of physical damage functions (i.e. linking concentrations of ambient environmental quality with fish kills, health impacts etc.), and less with the development of the connections between the physical damages to environmental goods and the services these goods provide to people, and how the injury affects these services. This last step in an economic damage function approach, which is based more directly on people's perception, is crucial to the valuation research.

Project evaluation, regulatory review and NRDA, however, have two features in common which distinguish them from other uses of nonmarket valuation. First, a discrete change is assumed to arise from the action being evaluated. Second, the objective of the analysis is either normative (CBA of public projects or regulations) or compensatory (NRDA). The last two uses of nonmarket valuation, environmental costing and environmental accounting, have neither of these features.

2.1.4. *Environmental costing*

Environmental costing derives its conceptual rationale from the conditions for an efficient allocation of resources in the presence of externalities. That is, prices should reflect the marginal private costs of production as well as the marginal social costs arising from externalities involved. Environmental costing can be used to affect decisions about both investments and operation. So far valuation exercises have focused on environmental costing in the energy sector. There is now an increased interest that environmental costs of waste disposal be reflected in product prices.

There are two main aspects of environmental costing which distinguish it from CBAs and NRDAs: its focus and the responsiveness to changing economic conditions.

1. The focus of environmental costing is ideally a *marginal* value.

2. The value an individual places on an environmental service is not a parameter. Values are no constants to be assembled in a 'big book of values'. Marginal values of environmental services are defined as realizations of people's decision processes that analysts represent using a constrained optimization framework. When factors that influence these decisions change, the values they place on environmental services may also change. Since public or quasi-public goods characteristics preclude many types of private adjustments in quantities, we should expect more variation in the marginal values in response to exogenous factors. One implication is that methods that treat these marginal values as constants may well do more harm (in terms of creating inefficiencies in resource allocations) than good. Another implication is that we need separate price indexes for environmental goods and services.

2.1.5. *Environmental accounting*

There has been growing recognition that the failure to account for the services of environmental assets seriously biases the accounting framework used to measure aggregate economic activity. At a conceptual level recognition of these limitations in the national accounts is not new (see Peskin 1976). What distinguishes this recent attention from the discussion above is the widespread effort to develop and implement practical approaches for incorporating natural and environmental resources.

One important motivation has been to respond to criticism that we cannot use the existing accounts to judge people's well-being when these factors are omitted. To develop a parallel structure including these services along with marketed goods requires shadow prices for them when they are used in production and consumption activities. Because environmental services are available outside the market, no mechanisms assure that the respective implicit prices are equal across activities, either between production and consumption or, indeed, even among the components of production and consumption. Some elements of the environmental services will be valuable to the production activities (e.g. the resource's ability to assimilate waste), while other elements would be valuable to consumption (e.g. the resource's ability to support recreation and other natural species). Once again there is the need for a marginal value and price indexes for environmental goods.

2.2. Original Valuation Studies Versus 'Recycled Values'

Due to the time and financial costs of doing original valuation studies, *benefit transfer* has become popular. Benefit transfer is an application of monetary values obtained from a particular valuation study to an alternative or secondary policy decision setting, often in another geographical area than the one in which the original study was performed. There are several sources of bias inherent in benefit transfers. The most important one is that benefit transfers can at best be considered

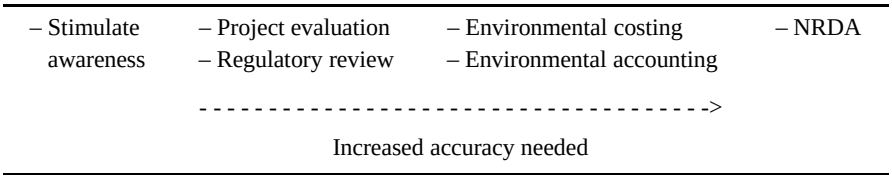

Figure 1. Different types of use of original valuation studies and the demand for accuracy. Benefit transfer is best suited when the demand for accuracy is low.

to be as accurate as the initial benefit estimates. Thus, the problems that are associated with nonmarket valuation methods are magnified in benefit transfer applications. The existing studies should therefore be carefully examined, before they are used in a benefit transfer exercise. Moreover, only a few original studies are using methods designed to be transferable in terms of site, region and population characteristics.

Benefit transfer is best suited for tasks where the need for accuracy is low, i.e. to stimulate awareness and screening (i.e. rough, back-of-the-envelope cost–benefit analyses of public projects and regulations). This is supported by a recent test of the validity of benefit transfer. Bergland et al. (1995) found that transferred WTP estimates for water quality improvements gave significantly different results than a CV study at the policy site for all the three main approaches to benefit transfer: transfer of mean unit values, adjusted unit values and the benefit function. However, the estimates are close enough for the transferred estimate to be used for screening. Ad hoc benefit transfers procedures have also been used in more detailed CBAs of projects and regulations, but even at this level there is a need for a benefit transfer protocol (like the CV-protocol developed by the NOAA Panel (Arrow et al. 1993)). The need for a protocol is further increased as we move on to higher accuracy in environmental costing and environmental accounting (Figure 1), and finally when direct, actual payments are made to identified persons. Especially, in this last case of NRDA the current practice in benefit transfer is not defensible.

Transferring results from U.S. studies to Europe, without any corrections is questionable. Such uncritical benefit transfers can provide invalid estimates and undermine the trust in nonmarket valuation work undertaken in Europe. Benefit transfer has been limited mostly to the U.S.A., and the Environmental Protection agency (EPA) has started to develop a data base for valuation studies, in order to improve their benefit transfer practises. The European countries should carry out their own state-of-the-art valuation studies to get a stock of studies to be utilised for benefit transfer in Europe. This follows the NOAA Panel who suggested that new, original CV studies, complying with their recommendations, should be conducted for all major environmental goods and services in the U.S.A. Even though the NOAA Panel's concerns about temporal reliability, question format, and social desirability biases appear unwarranted, Carson et al. (1996) conclude from a series of large scale, in-person surveys that there is support for the NOAA

Panel's proposed protocol for CV surveys, and that we do not have a basis as yet for relaxing these standards. Thus, new original studies should try to follow these guidelines closely.

3. Review of the Stock of Valuation Studies

The most updated and complete bibliography of CV studies can be found in Carson et al. (1995), listing more than 2000 CV studies from all parts of the world, but with a majority from the U.S.A. A review of some of the TC and HP studies in the U.S.A. can be found in Braden and Kolstad (1991).

Navrud (1992) reviews CV, TC and HP studies for most European countries that had undertaken such studies by 1992 (Finland, France, Germany, Norway, the Netherlands, Sweden, Switzerland, and the United Kingdom; see also Hanley and Wright (1992) for a separate review of UK studies). For a review of studies in Italy, which has a long history in environmental valuation, see Merlo and Della Puppa (1994). In Denmark, Spain and Portugal several valuation studies have also been conducted over the last few years (Dubgaard et al. 1994), and in 1993 the first valuation study was completed in Austria (Pruckner 1994). Moreover, the first valuation studies are now reported from Eastern European countries; Hungary and Poland (e.g. Zylicz et al. 1995). For Europe, there are now in total more than 200 CV, TC and HP studies. Most of them have been undertaken in Northern Europe, especially in United Kingdom, Norway and Sweden, but an increasing number of studies are now carried out in Central and Southern Europe.

If we look at which environmental goods that dominate in the valuation studies literature, there are some differences between the U.S.A. and Europe. Valuation research in the U.S.A. has focused on health risks from air pollution, while the main focus in Europe has been on none-use values of environmental amenities. Both have done their share of recreation studies and studies on water quality.

Most of the valuation studies in the U.S.A. and Europe are TC and CV studies. Some HP studies were carried out in the 1970s and early 1980s in both the U.S.A. and Europe, but there are very few examples of recent applications of HPM. In both the U.S.A. and Europe there is now a move away from TC towards CV studies, but in the U.S.A. there is still much research on the use of the TC methods and Random Utility Models (RUM) to value outdoor recreation activities.

In Europe a number of TC studies, but very few CV studies, were conducted in the 1970s and early 1980s. Then there were relatively few valuation studies in Europe until a few years ago, when the number of CV studies increased drastically. This move towards CV occurred later in Europe than in the U.S.A, where the activity in the CV field has been large since the early 1980s, and with a significant increase in research as a result of the controversy following the Exxon Valdez oil spill in 1989.

4. The Use of Environmental Valuation in the U.S.A.

4.1. Project Evaluation

There has been a long tradition of applying cost–benefit analysis at the level of project appraisals in the U.S.A. As early as 1902, the River and Harbor Act established a Board of Engineers to assess navigation projects and directed the Board to value commercial costs from these projects compared to their benefits. Thirty years later, a Water Resources Committee was appointed to develop a system of distributing the costs of water resource projects using not only private but also social accounting. The Flood Control Act of 1936 contained some of the Committee's recommendations which also pointed at the need to study the role of intangibles. Subsequently, several federal agencies tried to identify intangibles, and the notion of secondary or indirect costs and benefits occurred related to water resource projects. One of the keystones in the development of CBA in the U.S.A. was the Green Book of 1950 which represented ' systematic, consistent, and theoretically sound framework for the economic analysis of river basin projects' (Hanemann 1992: 11). The goal of putting monetary values on outdoor recreation benefits, which finally lead to the TC method, marked another important milestone in the development of the application of environmental valuation in the U.S.A. during the late 1950s and early 1960s.

By 1960 CBA became a standard tool of government expenditure analysis. It was introduced in the Department of Defense (Program Planning and Budgeting), and was directed by President Johnson to all federal agencies. The application of CBA was thus widened from water resource projects to other government activities such as transportation, health care, education and job training. The CV method was introduced in the 1960s. After a number of CV studies had been conducted, official recognition was given to this valuation technique by the Water Resources Council's revisions of their Principles and Standards in 1979 to evaluate water projects. The revisions recommended TC, CV and unit day values[3] as the three valuation instruments. Other important applications of environmental valuations were promoted by the U.S. Forest Service's effort to collect data on the economic values of recreational uses of forest lands in preparation for the 1980 Resource Planning Assessment.

4.2. Regulatory Review

At a more general level, economic issues have been promoted during the evaluation of environmental policy in the U.S.A. In the 1970s and 1980s costs of environmental regulations became more important and entered into the public discussion.

Formal CBAs and economic impact studies have been directed to support federal environmental regulations. For example, President Reagan's Executive Order 12292 of 1981 necessitates a formal analysis of costs and benefits for rules which impose significant costs or economic impacts (Regulatory Impact Analysis,

RIA). Under this Executive Order, agencies were directed to select the regulation which maximizes net benefits to society.[4] It should be mentioned that the impact of EO 12291 fell disproportionately on environmental regulation. This happened because, on the one hand, there was a general bias towards actions which entail more regulation and, on the other hand, the EPA was eager to do CBAs of environmental regulations to show that the benefits of environmental protection exceeded the large costs of control programs. Furthermore, some statutes require a weighing of costs against benefits in the setting of standards. Depending on the particular legislative statute in question the EPA, which is in charge of interpreting, implementing and enforcing environmental laws passed by the Congress, is either

- required to balance health protection and the preservation of the ecosystem against costs which are bound with the setting of standards;
- allowed to consider the costs of technology-based source discharge standards;
- prohibited from taking costs into consideration in standard setting;
- or required to apply a combination of these above (Burtraw and Portney 1991).

As a matter of fact, only two of the seven major statutes definitely require the EPA to balance costs and benefits in setting environmental standards, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA).

These statutes, which are quite similar in spirit, give EPA the authority to impose restrictions on the manufacture and use of agricultural products and to deny manufacturers the right to introduce new chemicals into commerce. They instruct EPA to avoid unreasonable risks to human health or the environment. In determining whether a risk is unreasonable or not, the economic benefits associated with the use of the substance in question (e.g. the increased agricultural output by applying pesticides) should be taken into account under both laws. The reduction of health risks represents a very important benefit component of the imposition of restrictions on the production and use of toxic substances. Therefore, the monetary valuation of health effects was primarily driven by FIFRA and TSCA which require the weighing of costs and benefits.

On the other hand, the early keystones of environmental policy in the U.S.A., namely the Clean Air Act (CAA) and the Clean Water Act (CWA), do not allow the balance of costs and benefits in issuing environmental regulations (Cropper and Oates 1992). The EPA cannot take costs into account in setting national ambient air quality standards under the provisions of the CAA. Rather the EPA has to set these standards such as to 'provide an adequate margin of safety . . . requisite to protect the public health' (Burtraw and Portney 1991: 298). While the CWA does not permit the consideration of benefits in setting effluent standards, EPA is directed to establish cost-effective discharge standards for industrial polluters.

However, a very interesting observation has recently been made about EPA's behavior in setting environmental standards. A study by Houtven and Cropper (1993) on EPA's regulatory decisions over the last 20 years found that both costs and benefits appear to have influenced the regulations which were issued by the EPA,

irrespective of whether the statutes in question require or even explicitly prohibit the balance of costs and benefits.[5] Thus, EPA has performed both environmental costs and benefits studies, even if this was not required by the legislative or executive mandate. This might be due to the fact that EPA employs many academically well-educated economists who are aware of the importance of costs and benefits of environmental measures and undertake self-propelled efforts to set more efficient standards. Also, if it can be shown that the benefits of a regulation or standard exceed the costs, it serves EPA's own interest to perform a cost–benefit analysis.

The observation that EPA's actual behavior in considering environmental costs and benefits deviates from legal requirements indicates that an international comparison of cost–benefit applications to value environmental policy measures can miss important practises whenever this comparison is based solely on legal statutes. EPA's actual behavior in setting the environmental standards suggest that the differences between Europe and the U.S.A., based on different legal frameworks, are even greater if the comparison is based on environmental regulations already implemented.

4.3. Natural Resource Damage Assessment (NRDA)

The most dramatic, and probably also most controversial, interrelations between environmental valuation and policymaking in the U.S.A., however, occurred when Congress passed the Comprehensive, Environmental Response, Compensation and Liability Act (CERCLA) in December 1980. This law provided the creation of what is known as the Superfund to finance the remedial clean-up of existing hazardous waste sites and established a liability system for potentially responsible parties (PRP) to pay for injuries to natural resources which resulted from released hazardous substances. Federal and state governments became trustees for natural resources owned or controlled by federal, state and local governments, and these trustees would undertake steps to assess the natural resource damages and try to recover the damages from the PRPs (Hanemann 1992). However, the U.S. Department of the Interior (DoI), which was in charge of promulgating the valuation criteria, issued its final regulations as late as August 1986 and March 1987. These standards contained a 'hierarchy of assessment instruments' which impled that nonmarket valuation techniques, such as TC, HP and CV, could be applied only if neither market prices nor commercial appraisal techniques were appropriate.

After different parties filed appeals against these regulations, the District of Columbia Court of Appeals promulgated its ruling on the so-called *Ohio vs. DoI* case. It stated that, pertaining to environmental valuation questions, non-use values ought to be included in a NRDA. Moreover, the hierarchy of valuation methods was struck down, and the court found that the CV method was approved as a 'best available procedure' and could be applied as a 'valid, proven technique . . . when properly structured and professionally applied'. The DoI was instructed to revise its regulations in accordance with these findings (Hanemann 1992: 27).

Subsequently, litigation over natural resources occurred, in the course of which non-market valuation techniques were applied.

In 1989, an accident involving the Exxon Valdez tanker brought about the largest oil spill in U.S. history. Eleven million gallons of crude oil ran off into the area of the Prince William Sound in Alaska causing severe environmental damage. Consequently, natural resource damages litigation of a new order of magnitude was expected and non-use values were likely to occur. In response to this accident, the Congress passed the Oil Pollution Act (OPA) of 1990, a law which superseded CERCLA pertaining to oil spills. Many CERCLA elements were kept, but the scope of recoverable damages was extended and the *Ohio* ruling followed with respect to non-use values. The National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce (DoC) was in charge of promulgating the regulations under the new Act.

One year later, the DoI issued its revised regulations for public comment which did not follow the *Ohio* ruling very closely with respect to the hierarchy of the valuation techniques, contingent valuation and non-use values. Meanwhile, Exxon's economic consultants presented several theoretical and empirical studies which, in general, stated that CV did not measure economic values conforming to economic theory of preferences. Moreover, they argued this technique did not provide reliable and unbiased non-use values which, for this reason, should be omitted from natural resource damage assessment (Hausman 1993). Based on inconsistencies in the papers, these findings were roundly critizised (Hanemann 1994; Smith 1993).

A blue-ribbon panel headed by the Nobel laureates Kenneth Arrow and Robert Solow was established to advice NOAA on the use of CV in environmental damage assessment. Both NOAA's decision on the oil spill regulations and the DOI's final rule writing were put on hold awaiting the NOAA Panel's final report. This report, which was published in January 1993, summarizes in its general assessment of the CV method that the technique may produce reliable results for the evaluation of environmental goods when applied carefully. *Thus, the Panel concludes that CV studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values* (Arrow et al. 1993: 42). For the purpose of proper application, the Panel has drawn up a list of guidelines for CV surveys. These guidelines serve as a standard for deriving reliable results in future CV applications.[6] However, the Panel's recommendations have also been criticized. The most important objection is that the guidelines are not sufficiently strict. On the one hand, the report says that the guidelines should be followed as close as possible. On the other hand, however, it does not provide reference to which deviations would be accepted with the empirical results still remaining valid (Smith 1993).

Relying heavily upon the recommendations of the Panel, NOAA published its proposed regulations on natural resource damage assessment in January 1994 (NOAA 1994). These regulations confirmed that passive-use values are part of diminution of value and expressed NOAA's opinion that lost passive-use values

may be reliably estimated using CV studies that follow the standards in the proposed regulations. NOAA's proposed regulations contained an oddity, the requirement to calibrate (discount) estimated WTP figures reflecting the discrepancy between hypothetical and actual payments. Unless trustees justified a particular calibration factor, they are required to reduce estimated WTP by 50%. The rationale behind this was the lack of external validation and on a set of studies which indicate that hypothetical WTP turns out to overstate actual WTP. However, in the presence of NOAA's efforts to eliminate or at least greatly reduce potential biases in CV surveys and thus guarantee conservative results, the requirement to discount WTP by 50% seems counter-intuitive. Perhaps recognizing this, NOAA did ask for comments on other reasonable calibration tests (Kopp and Pease 1994: 35).[7]

Resource valuation issues in the NDRA were subject to intensive public scrutiny during the OPA rule-making process (as they continue to be in the CERCLA reauthorization process). NOAA issued the final rule for NRDA covered under the OPA on January 5, 1996 (NOAA 1996). During the rule-making process, academic economists joined with the commercial and environmental interest groups in submitting extensive public comments on valuation issues. As a result of the wide-ranging public dialogue, NOAA re-framed the concept of compensation in damage claims to place greater emphasis on restoration of public resources.

The standard measure of damages is the costs of restoring the resources to baseline plus the interim loss in value from the time of the incident until full recovery. However, trustees are allowed to spend their recoveries only on enhancing or creating natural resources. This statutory restriction has motivated the development of an alternative to a monetary measure of interim losses: compensation in the form of resource projects, or "resource compensation". Jones and Pease (1996) conclude that this resource compensation approach focuses the trustees from the beginning on the ultimate goal – providing public resources as compensation to the public for interim losses due to public resources injuries – rather than performing the valuation of interim losses prior to resolution of the claim, and then planning compensatory restoration projects after resolution of claims. Thus, the role of valuation methods is downplayed in this final NRDA rule. Also, all on "how to do CV" has been taken out in the final rule. The CV method is listed as one of many methods, including other stated preference methods (especially Contingent Choice analysis), revealed preference methods, combinations of the two, and benefit transfer. All these methods are allowed to use in determining the scale of projects required to compensate the public.

4.4. Environmental Costing

The Electric Consumers Act of 1986 requires the Federal Electric Utility Commission to take environmental impacts into account when issuing licenses for new hydro faculties or relicensing existing ones. This statute represents the legal basis for the use of environmental valuation to consider potential externalities

of electricity production and initiated research in what is called 'social costing' or 'environmental adders'. The battle over whether and how to insert environmental adders has raged on both the theoretical and practical level. The level of discord among scientists, economists and policymakers regarding environmental externalities is reflected in the diversity of Public Utility Commissions (PUCs) approaches to the subject. Fox-Penner (1994) cites results from a survey of the PUCs in 49 states and the District of Columbia (D.C.). Four states concluded that they lacked jurisdiction to implement externality valuation, 9 were still studying the issue, 10 used the cost-of control (COC) approach, 6 permit the damage function (DF) approach, and the reminder fall into none of these categories. The COC approach measures abatement costs and not environmental protection benefits. Thus, only when these coincide on the margin does the COC method provide reliable estimates of environmental benefits (or damages). The DF approach is the only one using environmental valuation techniques.

The New York State Energy Research & Development Authority (NYSERDA) commissioned the first major U.S. study on environmental costs of electricity production in 1988 (Pace 1990). This study used the DF approach. NYSERDA recently carried out a new, more advanced study using the same approach (Rowe et al. 1995). The DF approach is also used in one of the most detailed and thorough studies on 'social costing' of energy so far; the joint U.S. Department of Energy (DoE) and European Commission (EC) project: 'External Costs of Fuel Cycles' (ExternE); see also Section 5.3.

According to Brennan et al. (1996) social costing is in use in seven states and under consideration by several others. This type of policy requires utilities to estimate the environmental damage that could result from alternative generating technologies and, for each option evaluated, to incorporate the results into the estimated private costs of producing electricity. The power plants that the utilities invest in must be chosen based in part on the results of this exercise.

Broader access to electricity transmission lines could undermine state efforts to encourage generators to reflect social costs in investment and operating decisions. And if competition were to extend to the consumer level, social costing as it is now practised would become virtually unworkable.

Since the emission rates for new facilities are relatively low, social costing programs have had minor impacts on investment decisions for new plants. Brennan et al. (1996) envision extending social costing beyond investment considerations to encompass the operation of existing facilities, which often has emission rates several times higher than the new plants do. This could lead to utilities making business decisions that would lead to dramatic environmental gains at relatively low costs.

4.5. Environmental Accounting

There are no legal statutes in the U.S.A. which require the consideration of environmental issues for the measurement of aggregate GDP. However, the President has instructed the Bureau of Economic Analysis to develop a 'green' GDP (CBO 1994). The discussion about establishing ecology-oriented national accounting systems therefore takes place on a scientific level, and models have not yet been implemented in practice.

Espinosa and Smith (1994) develop virtual price indexes for environmental goods and use the solutions of a computable General Equilibrium (GE) model including an environmental good to evaluate the properties of these price indexes and to subsequently adjust measures of aggregate GDP. The authors illustrate that for revisions of national accounts to effectively incorporate environmental and natural resources they must consider the 'pricing' of nonmarket resources. This is different from the previous approaches to green accounting which have focused on other ways to develop and implement practical instruments to incorporate natural and environmental resources (Mäler 1991; Repetto et al. 1989; CBO 1994; Pearce and Warford 1993).

Dasgupta et al. (1994) review the empirical applications of environmental accounting. Several international organizations, such as the OECD, the World Bank and the United Nations, are actively supporting the development of resource accounting systems. A particularly significant publication is the Handbook on Integrated Environmental and Economic Accounts developed by UNSTAT, the Statistical Division of the United Nations. This system complements the System of National Accounts in two important respects: (i) depletion of natural resources in both production and final demand, and (ii) changes in environmental quality. it contains both physical and monetary accounts. The physical accounts have a structure very similar to Norwegian accounts (Lone 1987). In transforming the physical data into monetary units, the Handbook discusses three different approaches: (i) market prices, (ii) nonmarket valuation techniques (i.e. TC, HP and CV methods), (iii) avoidance and restoration cost methods. The Handbook is a work-in-progress report. Several issues remain to be clarified and discussed before the system matures into a powerful vehicle in exploring and understanding the linkages between the economy and the environment. Dasgupta et al. (1994) point out that the appeal to economists is limited by the fact that the welfare foundations are weak, and show how an accounting system can be constructed using conventional tools of welfare economics.

The acceptance of the use of the CV method in NRDAs (see Section 4.3) might also lead to the prescription of environmental accounting in monetary terms[8] at the firm level in the U.S.A. Although many corporations market themselves as being concerned with the environment, few go so far as to record liabilities in their financial statements. Coller and Harrison (1994) argue that the CV method is a practical way for accountants and managers to estimate appropriate amounts, and

indicate how they could use the CV method in a cost-effective way by presenting an application of its use in making accruals for environmental clean-up. We might also see similar accounting practises prescribed for communities.

5. The Use of Environmental Valuation in Europe

5.1. Project Evaluation

In Europe, the history of both research and applied work in CBA is much shorter than in the U.S.A. and the development of environmental valuation methods has been very slow. In a number of European countries CBA has been used as a decision tool in public work schemes, especially in road construction. Usually, environmental impacts are not valued in monetary terms. Germany has been an exception, since noise, air pollution and other impacts from road traffic have been valued using the restoration cost approach (Schultz and Schultz 1991). In Norway, however, the Directorate of Public Roads has used results from Contingent Valuation and Conjoint Analysis surveys to provide values for selected environmental and health impacts in their new CBA handbook for transportation projects.

The valuation practise varies among the European countries, but in general most European environmental valuation studies have been at the project level. The development of the CBA in the U.K. seems to be representative for many countries especially in Northern Europe. In the U.K. CBA started in 1960 and was primarily focused on transportation projects such as road construction, the closure of road and rial routes, the Channel Tunnel proposals and the construction of airports (Hanley and Spash 1993). In practice, these analyses calculated net present values which included monetary equivalents of time and accident savings but did not comprise environmental effects. A few non-transportation projects were subjected to CBA in the 1970s such as the New Covent Garden Market and the choice of sources for the generation of electrical energy. In recent years, however, environmental valuation studies have been conducted in the areas of water and sewerage management, coastal defence and afforestation. The U.K. has used Contingent Valuation in project appraisal on water quality improvements, through the actions of the National Rivers Authority (now the Environmental Protection Agency). The Forestry Commission also uses valuation results in CBAs of new forests. The same trend of CBA and environmental valuation spreading from transportation to the environmental, health, and energy sectors can be observed in, e.g., Norway and Sweden (Navrud 1992).

Usually, environmental effects are not valued in monetary terms within the European Union. Specific types of projects have to be submitted to non-monetary assessment of environmental impacts under the EU Directive on Environmental Assessment, but there are no guidelines for use of CBA in project evaluation. To our knowledge, there is no legal requirement for doing CBA of projects in any European country.

5.2. Regulatory Review

In Europe, comparisons of costs and benefits of environmental regulations have only been made in a small number of cases, and even less use was made of the results. Norway seems to be the only European country where CBAs of environmental regulations are now conducted on a regular basis (by the National Pollution Control Authority, SFT), but still the use of environmental valuation estimates is relatively limited. When new valuation studies have been conducted to evaluate an environmental regulation, they have either not been used at all when the final decision was made (as in the case with car emission regulations; see Navrud 1991), or they have been used mainly to confirm the environmental goal already set by the environmental authorities (as in the case with the North Sea Plan, i.e. the plan for a 50% reduction in nitrogen and phosphorous emissions to the North Sea; see Magnussen 1995).

In Norway, the most successful use of valuation estimates have been the Locally Adapted Regulatory Impact Analysis (LARIA), which the SFT started doing in 1986. They conducted four LARIAs, which aimed at giving a priority ranking of regulatory actions in areas with large air and water pollution problems. All possible regulatory actions aimed at reducing pollution in a given area are assigned a benefit/cost-ratio which is used to arrive at a priority ranking. Benefits of each regulatory action are calculated using a set of weights for different benefits (for instance, one person not living in an area where air pollution exceeds threshold values for SO_2, NO_X, CO, soot; one person not strongly affected by noise; one ton of reduced SO_2 deposition, etc.) multiplied by the reduction in number of persons affected; the reduction in deposition, etc. The set of weights was constructed from expert opinion and crude transfers of results from Norwegian and U.S. valuation studies. In this case, benefit estimates are used to rank regulatory actions, although in the presentation of the results, SFT did not explicitly mention this monetization of benefits, but, so to speak, 'hid' it behind a set of normalized weights. An example of such weights is presented in Table I. Because of the inclusion of the benefit '1000 NOK saved costs' in Table I, one can easily assign a monetary value to all benefits. Although the LARIA approach has been criticized because the weights (benefit estimates) have been rather randomly chosen, it nevertheless seems like a promising approach to incorporate benefit estimation in environmental decision-making. The SFT has now conducted regional and national Regulatory Impact Assessments (RIAs) of water and air pollution programs, and continues to improve their technique and the accuracy of their benefit estimates (i.e. weights) by commissioning new valuation studies.

Several national or regional damage estimates made to stimulate public environmental awareness in order to justify new regulations ex ante or ex post have been made in Germany (Wicke 1986; Schulz and Schulz 1991) and the Netherlands (MPHPPEM 1985). The Dutch valuation studies, providing an additional justification of environmental government actions to other government departments, do not

Table I. Average weights used to aggregate environmental and health benefits in a LARIA (Locally Adapted Regulatory Impact Analysis) of reduced air pollution in the Sarpsborg/Frederikstad area in southeastern Norway. The weights can be converted into annual monetary estimates by multiplying the numbers with 1000 (since '1000 NOK saved costs' is given the weight 1)

Benefits	Weight
1 person above the threshold for health impacts from	2.0
SO_2	4.0
NO_X	6.0
CO	4.4
Soot	
1 person troubled by dust from industry	0.3
1 person troubled by smell from industry	0.4
1 person troubled by dust/smell from other sources	0.2
1 person 'strongly affected' by noise	8.0
1 traffic accident with persons injured	1400.0
1000 NOK saved costs	1.0
1 ton SO_2 emitted (with respect to acidification)	2.7
1 ton NO_X emitted (with respect to acidification)	1.4

Source: Navrud (1991); modified from a Norwegian source, T. Syversen (1988), Weighing of different benefits, (in Norwegian); Memo, National Pollution Control Authority (SFT), Oslo, Norway.

rely on willingness to pay estimates but on forgone productivity losses, decreasing money outlays for protection, cleaning, repair and replacement. Schulz and Schulz (1991) argue that environmental benefit/damage valuations at the national level has significantly influenced the political discussion in Germany. The authors state that these studies contributed to making people aware of the real dimensions of environmental pollution and to put environmental discussions on a rational basis.[9]

In the U.K., there is an appraisal process including a CBA component for expenditure plans, but the monetary valuation of environmental impacts has been strictly limited. In 1990, however, the British government started revising its CBA procedure with respect to environmental issues. Subsequently, it was recommended that formal appraisal procedures for valuing environmental impacts should be applied wherever possible. In 1990, the government published guidelines on how to incorporate environmental impacts in policy appraisal and recommended the application of nonmarket valuation methods. The guidelines' introductory statement, which presumably also applies to many other European countries, reflects the state-of-the-art of environmental valuation:

> A government's policies can affect the environment from street corner to stratosphere. Yet environmental costs and benefits have not always been well integrated into government policy assessments, and sometimes they have been

> forgotten entirely. Proper consideration of these effects will improve the quality of policy making (Hanley and Spash 1993).

In the Environment Act of 1995 the two new pollution control agencies in the U.K. (the Environmental Protection Agency and the Scottish Environmental Protection Agency) are both given a legal duty to consider the costs and benefits of all regulations. However, it remains to be seen how this will be implemented.

Looking at the relevant publications, one may not count on a substantial improvement in the application of broad based environmental valuation as a basis for policy measures in the European Union. One important statement referring to environmental valuation issues is found under paragraph 130r in the Maastricht Treaty (Maastricht Vertrag 1992). This paragraph, which focuses on EU's environmental goals, environmental protection measures and international cooperation in general, says that the EU will consider the burden and advantage of environmental action or non-action but does not include any details. However, a few more details can be found in the so-called 'Fifth Activity Programme for Environmental Protection Towards Sustainability' which provides the future prospects and needs of action in environmental protection for the period from 1993 to 2000. It is recognized that the ultimate benefits of the proposed concept of sustainability should more than offset its costs over time. Even though the European Commission is aware of several problems which arise in environmental valuation, the importance of costing environmental policies is acknowledged in general.

> In accordance with the Treaty, an analysis of the potential costs and benefits of action and non-action will be undertaken in developing specific formal proposals within the Commission. In developing such proposals every care will be taken s far as possible to avoid the imposition of disproportionate costs and to ensure that the benefits will outweigh the costs over time (European Community 1993: 142).

Recently the European Commission performed CBAs of two new regulations; the large combustion plant directive and the air quality standards. Both analyses rely heavily on the work done within the EC Directorate Generale (DG) XII's ExternE project (see chapter 5.3). The Environment Directorate (DG XI) of the EC has also started training courses in CBA for their administrative staff to promote better priority setting.

Because of the transboundary dimension of many environmental problems, it seems obvious that the discussion of interrelations between valuation issues and policy measures within the European Union should also cover the developments in the Central and Eastern European countries (CEE). Environmental degradation is severe in many CEE regions, including acid rain damage to forests, poisoning of river systems, and there is a permanently high risk of industrial accidents such as nuclear and chemical disasters.

Even though cooperative environmental programmes were already launched, very few valuation studies exist which could serve as a basis for choosing the most

efficient or cost effective environmental measures in these countries.[10] However, in cooperation with the World Bank and the International Institute for Applied Systems Analysis in Austria, scholars at Resources for the Future investigated some of the pollution problems in CEE countries and how these problems might be addressed. Krupnick et al. (1996) estimated the health benefits of improvements in environmental quality in central and Eastern Europe for the determination of priorities for pollution abatement strategies. In particular, the authors examined the health effects of reductions in ambient concentrations of particulates, sulfur dioxide and lead in Bulgaria, the Czech Republic, Hungary, Poland, and Ukraine. The study reports that the reduction of air pollution to meet current European Community standards in these five countries had the potential to yield health benefits which are at least between 1% and 3% of each country's GDP and possibly greater. Even though there is no information on the costs of these pollution abatement activities to conduct a comprehensive CBA, Krupnick et al. argue that the size of the potential benefits should make air pollution control an important objective of environmental and economic policy in these countries. Especially the reduction of particulate emissions represents an important target because this pollutant contributes significantly to health problems and may be cheap to abate.

5.3. NRDA, Environmental Costing and Accounting

NRDAs have not been performed in Europe due to the different legal systems in the U.S.A. and Europe. Therefore, we do not expect to see the equivalent of U.S. NRDAs based on environmental valuation in Europe in the near future.

While the majority of the state Public Utility Commissions (PUCs) in the U.S.A. are planning to incorporate (quantitative or qualitative) estimates of the environmental costs of alternative means for generating electricity into the process of investment decisions of electric utilities, many European countries are focusing more on the possibilities of using such estimates to introduce environmental taxes for different energy sources to make energy prices reflect total marginal costs. These environmental taxes would influence both operation and investment decisions in a more direct way. However, the environmental taxes introduced in different European countries have not been based on environmental valuation estimates.

The first thorough environmental costing exercise of energy was conducted in Germany (Hohmeyer 1988). In 1991 the European Commission, in co-operation with the U.S. Department of Energy (DoE), launched the joint project 'External Costs of Fuel Cycles' (ExternE). The main aim of this project is to develop methods to measure and monetize all externalities associated with incremental investments in electric power production, taken account of the different stages of the fuel cycle (extraction of the fuel, transportation to the power plant, generation and transmission of the electric power, and decommission of the plant, but not consumption of electricity, i.e. not a full life cycle analysis). The first phase of the study was completed in 1995 with analyses of eight fuel cycles (coal, nuclear,

oil, gas, lignite, hydro, biomas, solar and wind) and four conservation options for energy generation. Since fuel cycle analysis is very site specific, the methodology is now being implemented at specific sites in different European countries. This second phase of ExternE is taking place in Europe only. The methodology is based on a damage function (DF) approach, utilizing the data from an extensive and critical reviews of ecology, health sciences and economics literature in transfers of dose-response/exposure functions and valuation estimates (ORNL and RfF 1992; EC-DGXII 1994).

Work on environmental accounting has been undertaken in several European countries. The Statistical Bureau of the Netherlands is particularly active in promoting 'Green GDP' calculations. Germany, Sweden, Denmark and Norway have also been active in resource accounting, but both Denmark and Norway are pessimistic about the calculation of green 'GDP' (Dasgupta et al. 1994).

In developing the European Community's future perspective on costing, the 'Fifth Activity Programme for Environmental Protection Towards Sustainability' demands the fullest possible assessment of all relevant costs and benefits. Furthermore, the programme recommends the selection of least-cost instruments to achieve environmental targets. A five-point plan to be pursued during the term of the programme was advanced in order to devise effective pricing mechanisms. This plan addresses the need for improved information on the state of the environment and for further research in environmental valuation, and underscores the requirement of environmentally adjusted national accounts being established by the end of the decade. In particular, a Community cost–benefit methodology, which should be applied to all environmental projects and policies, is recommended to be drawn up urgently. The 1994 Communication from the Commission to the Council of the European Parliament, entitled "Directions for the EU on Environmental Indicators and Green National Accounting – The Integration of Environmental and Economic Information Systems" (COM (94)670, final 21.12.94) states a specific action for "improving the methodology and enlarging the scope for monetary valuation of environmental damage". More recently, the EC's Green Paper, entitled "For a European Union Energy Policy" states that "internalisation of external costs is central to energy and environmental policy". However, from the present perspective, it still remains unclear what the Community's policy is going to be with respect to the application of valuation studies in the years to come.

6. Conclusions and Policy Recommendations for Europe

This paper discusses the use of environmental valuation. Even though efficiency arguments play a major role in establishing environmental programmes, there are also distributional aspects of policy decisions. Furthermore, the objective of low administration costs cannot be neglected. The fact that politicians also consider these other objectives in addition to economic efficiency might account for our general finding that we have very few cost–benefit studies in Europe which could

serve as a decisive basis for environmental regulations and practical policy issues. Many reasons exist for the relatively low importance that has been attached to CBAs in environmental decisionmaking in Europe.

1. First, CBA techniques have been confronted with a variety of criticisms which primarily relate to the measurement of benefits.[11] In particular, stated preference methods applying various survey techniques are criticized with respect to their accuracy and interpretative meaningfulness.
2. Legislative statutes often prohibit the use of CBA in setting environmental standards. Environmental laws are enacted by lawyers who usually are not trained to think in economic terms.
3. The recognition that environmental policy measures are associated with economic costs and benefits might not be sufficiently wide spread among European voters. There is much more public information on valuation issues in the U.S.A. than in Europe.
4. Moreover, there is no institution in Europe like the U.S. Environmental Protection Agency, which employs many applied researchers, including economists, who are able to close the gap between academic personnel and environmental decisionmakers.

The institutional shortcoming is reflected by an insufficient availability of environmental data. Europe does not possess a coherent appraisal of its natural resources and habitats, or of its environmental damage. This is mainly because there has been no uniform methods of measurement. No economic data such as costs and benefits of regulations are collected systematically.

The main task of the European Environmental Agency in Copenhagen is the establishment of an information and observation network to collect, assess and exchange environmental data. The major drawback of this institution, which definitely represents a step in the right direction, is that the agency is not endowed with any executive agenda. Furthermore, increased cooperation of scientists and economists, who would assess risks and weigh costs and benefits, is called for to inject greater rationality and cost effectiveness into environmental rule-making within the EU.

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Notes

1. Deriving values implicitly from policy decisions, see e.g. Carlsen et al. (1994), is a fourth method. However, there is no microeconomic basis for such estimates, and they are at best crude approximations.
2. Farrow and Larson (1995) argue that the faint behavioral traces that are associated with nonuse values, e.g. television news viewing of pollution events, can be used to estimate non-use values. They focus on the opportunity costs of time used to obtain information about e.g. a pollution event. In this way they hope to develop a revealed preferences method which can measure non-use values.
3. Based on a study of entrance fees and other costs at several hundred private recreation sites, the dollar values per visitor day (unit day values) represented a measure of recreation benefits.
4. The previous Reagan order was replaced by E.O. 12866 in the first year of the Clinton administration. However, the central role of CBA remained.
5. The study also reveals that EPA implicitly attaches values to prevent one case of cancer which vary between 15 million and 45 million US$. That is more than the value of a Statistical Life (approximately US$5 million) estimated from individuals' willingness to pay to reduce their own death risks (Houtven and Cropper 1993). For a comprehensive survey on value-of-life estimations, see Viscusi (1993).
6. These strict guidelines, which imply high costs, were meant for NRDAs, and it can be argued that CV surveys for purposes demanding a lower level of accuracy (see Figure 1) need not follow all of these guidelines.
7. Comments were also requested on scope tests, response rates, additional tests for determining the reliability and others. In particular, the establishment of so-called threshold factors for using CV surveys was considered. NOAA asked whether a minimum level of expected damages should be established to proceed with a CV survey. A minimum expected value of US$5.00 per household and other alternatives were discussed (NOAA 1994: 1147 F). Benefit transfers are considered for 'minor' events.
8. Environmental accounting at the firm (and community level) has been performed in physical units.
9. Rough estimates of all environmental damages furthermore exist for Poland (Famielec 1991) and parts of Spain (Munoz and Armengol 1991). Moreover, there is a Norwegian study on the national damages of air pollution (Brendemoen et al. 1992).
10. For a survey of studies on environmental damage costs in Poland, see Sleszynski (1994).
11. Hanley (1992) points out that the main difficulties for CBA in its application to environmental issues are nonmarket good valuation, ecosystem complexity, discounting, institutional capture and the concentration on efficiency. He concludes that CBA could be argued to be an inappropriate stand-alone decision-making device on any one of these grounds, but that it remains useful as one input to decision making, so long as decision makers bear these limitations in mind.

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