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NEGLECTED FEATURES OF THE SAFE MINIMUM STANDARD: SOCIO-ECONOMIC AND INSTITUTIONAL DIMENSIONS

Abstract

Important features of the safe minimum standard (SMS) rule as outlined by Ciriacy-Wantrup are ignored in the recent literature, e.g., the critical zone, institutional and normative dimensions, and the relationship between economic and biological irreversibility. Also, seeing SMS as an adjunct to social cost-benefit analysis is inconsistent with the original concept.

Since SMS is usually applied to collective commodities, consideration of normative and institutional factors is inescapable. Hence, 'unacceptably large' social costs cannot be made operational by traditional social cost-benefit analysis. Close relatives of SMS such as discontinuous objective functions, the precautionary principle and reversal of proof are also discussed, as well as the determination of SMS by social discourse.

Neglected Features of the Safe Minimum Standard: Socio-economic and Institutional Dimensions

INTRODUCTION

Often, when decisions about resource use have uncertain consequences and probably would irreversibly destroy the resource, safe minimum standards (SMS) are called for (e.g., Randall 1986, Hampicke 1992; Perrings *et al.* 1992; Perrings and Pearce 1994; Barbier *et al.* 1994; Rogers and Sinden 1994, Berrens 1996; Ekins 1997). Yet, ideas about what a SMS is and how to determine it are vague and controversial (Berrens *et al.* 1998).

Two core writings have determined the discussion on SMS: SMS was first developed by Ciriacy-Wantrup in his book *Resource Conservation* (1963, first edition 1952). In this book SMS is considered as an economic base-level in conservation policy, usually expressed in physical terms, which "should actually be realized under all conditions" (Ciriacy-Wantrup 1963:261) in order to avoid economically irreversible depletion and hence looming immoderate social loss. SMS became widely known and accepted as a result of an article by Bishop (1978) in which an interpretation of SMS was offered, which most authors have referred to since then. Following Bishop (1978:10) a standard is adopted unless the social costs of doing so are unacceptably large. Since publication of Bishop's article, the SMS rule has been extensively discussed. The reason may be that finally a definition was proposed which provided a definite means for applying safe minimum standard, which built a bridge between ecologists and economists, and promised economic solutions to problems characterized by ecological complexity, uncertainty and irreversibility.

In the last two decades however, SMS has been interpreted in a variety of ways and discussion has hardly got beyond the theoretical stage. This may be because various fundamental issues of SMS as outlined by Ciriacy-Wantrup have been neglected, or at least de-emphasized. Main unsolved topics discussed in recent literature are how to deal with the lack of scientific knowledge to determine SMS, a problem of which Ciriacy-Wantrup was well aware. Furthermore, the literature considers whether SMS is a flagging mechanism to cost-benefit analysis, and to what degree SMS can be defined on the basis of value-free indicators (monetary valuations, risk calculation). Finally, the relationship between SMS and more recent normative concepts such as precautionary principle, reversal of burden of proof, and inter- and intragenerational justice has not been adequately discussed in the literature.

In this paper, the authors outline the core issues outlined in *Resource Conservation* and scrutinize these. This indicates that some issues have been taken up by Ciriacy-Wantrup but have been neglected or stripped off parts of their content in recent discussions of SMS. Also, it will become clear that the SMS-analysis is deeply rooted in socio- and institutional economics. Furthermore, 'mutations' of the initial SMS-analysis of Ciracy-Wantrup will be analyzed, namely Bishops' interpretation of SMS, the theoretical foundation provided by game theory, the approximation of SMS to cost-benefit analysis, the optimization issue, the use of SMS as a framework for economic activity, and finally the very recent approach of determining SMS by discourse. These 'mutations' and approaches have not been successful in providing a satisfying theoretical foundation, though understanding SMS as an overall framework to be set by discussion and discourse seems a promising path worthy of further exploration. Last, SMS and related normative concepts (such as the precautionary principle) will be explored. It will be revealed that there is some overlap in concepts but they are not identical. This paper aims at paving the way for a critical discussion of Ciriacy-Wantrup's ideas which has hardly taken place so far, at evaluating the previous discussion of SMS, and at encouraging a further development within a socio-economic and institutional approach.

CORE ISSUES OF THE SAFE MINIMUM STANDARD CRITERION FOR CONSERVATION

The following core issues will be analyzed in relation to SMS: area of application, irreversibility, uncertainty, threshold and critical zone, cost, institutions, and conservation practices.

Area of Application

The SMS rule focuses on flow (renewable) resources with a critical zone such as species, scenic resources, land, storage capacity of groundwater basins (Ciriacy-Wantrup 1963:37f.). It is supposed that once the flow is reduced below a critical zone it can not be raised again due to irreversibility. With regard to renewable resources with a critical zone, use decisions are particularly difficult as the critical zone often is uncertain and dependent on biological and socio-economic factors. Thus, the major issues Ciriacy-Wantrup highlighted refer to qualities of renewable resources.

Irreversibility

In the context of SMS, irreversibility is mainly considered as economic irreversibility, meaning it is uneconomical to reverse resource depletion. The idea of 'uneconomical' in Ciriacy-Wantrup's

thinking is based on the definition that "economic irreversibility depends … on technology, wants, and social institutions." (1963:39) Thus, the decision about what is economic (ir)reversible is a normative decision. In contrast, biological or technical irreversibility is considered as value-free. It occurs if, for whatever reason, the population (size) or quality of a flow resource flips from a higher to another (lower) domain (or attraction) and can not be brought back to its original state (Holling 1973). Hence, it is noteworthy to stress that irreversibility in Ciriacy-Wantrup's approach has an economic connotation and is defined as dependant on institutional, normative and societal valuations and circumstances. The difference between both types of irreversibility is depicted in Figure 1. It illustrates that economic irreversibility can occur at a lower degree of resource use than biological irreversibility. Due to change in values, technologies, institutional change or other societal factors, economic irreversibility can approach biological irreversibility. However, Ciriacy-Wantrup did not take up the prospect of a future convergence, but rather emphasized present uncertainty and irreversibility, and the importance of erring on the safe side.

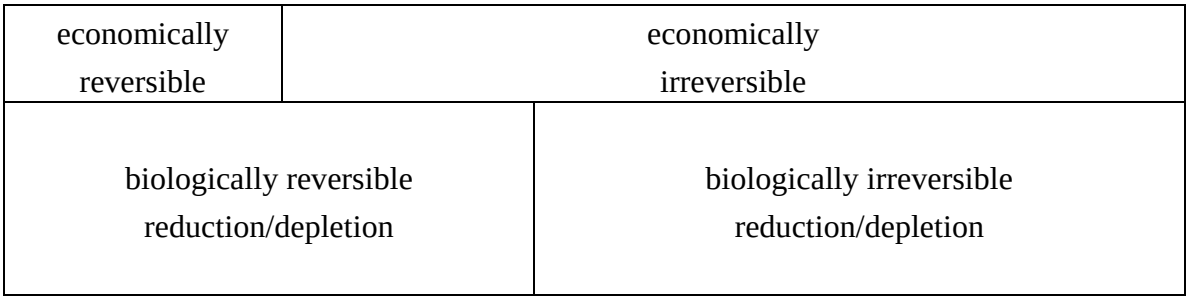

Figure 1

Uncertainty

In the SMS-framework, uncertainty is understood in Knight's sense (Ciriacy-Wantrup 1963:111, Knight 1992). This means that the mechanism of chance is not known or only poorly known (for a discussion see for example Tisdell 1968, Ch. 2). In such a situation it is impossible to calculate rationally the probability distribution of an event either by statistics or mathematical formula; such situations are rationally indeterminate. This is frequent in both natural and social systems because of complexity, novelty of events, time-lags, non-repetitive processes or unforeseeable reactions of system. In business thus, optimization of profit or utility becomes impossible. Therefore, following Knight (1992), such situations confront decision-makers with challenging decision problems which require judgements based on intuition and common sense.

For analytical proposes, two kinds of uncertainty are to be distinguished: First, uncertainty about

whether depletion is economically irreversible (Ciriacy-Wantrup 1963:252). SMS is mainly concerned with this kind of uncertainty. Secondly, uncertainty about whether the depletion is technologically (biologically) irreversible. Such uncertainty is manifold in species conservation as Hohl and Tisdell (1993) have shown (genetic, demographic, environmental, natural uncertainty). Due to these different kinds of uncertainty and the fact that each population is distinct, special viability analysis would be required for each population to eliminate uncertainty. Consequently, in most cases it is impossible to determine minimum viable populations, though these were considered as representing SMS by some authors (see Hohl and Tisdell 1993:174). Additionally, following current research, uncertainty increases with global change as the range of dispersion of uncertain events and their consequences rise. Furthermore, this uncertainty is amplified by weakened ecosystems and reduced resilience due to stress (e.g., by highly fragmented landscapes, reduced habitats, chemical emissions) (Solbrig *et al.* 1994). Hence, to stress and accept uncertainty in natural systems is beyond doubt. Acknowledging this kind of uncertainty and relationg it with uncertainty in societal institutions and systems provided the basis to comprehend SMS and resource conservation as socio-economical and institutional concepts without ignoring ecological facts. In addition, both types of uncertainty constitute the economic rationale for SMS.

Threshold and Critical Zone

The concepts of threshold and critical zone which have a central place in *Resource Conservation* help to capture irreversibility and uncertainty and therewith render the decision problem more intelligible. Thresholds are common in ecology and describe an abrupt alteration at a certain point of a system. Before reaching this point, natural systems can have a high capacity to absorb changes (natural, human induced) without dramatically altering (are resilient) (Holling 1973). However, when the limits of resilience are transgressed, a system may rapidly (and irreversibly) alter to another state out of which reversal involves uneconomically high cost or is just technically impossible. The crucial range before an ecosystem transgresses a threshold was labeled ‘critical zone’[3]. It is "a more or less clearly defined range of rates below which a decrease in flow cannot be reversed economically under presently foreseeable conditions" (Ciriacy-Wantrup 1963:39). Notice the words 'cannot be reversed economically': threshold and critical zone are not positively defined but, as mentioned above, economic (ir)reversibility is considered as dependent on technology, wants, social institutions. A heuristic diagram (Figure 2) illustrates the threshold and critical zone.

[3] Examples involving critical zones are the destruction of the breeding stock, destruction of natural habitats, compaction of soil, soil erosion, and certain forms of pollution of groundwater.

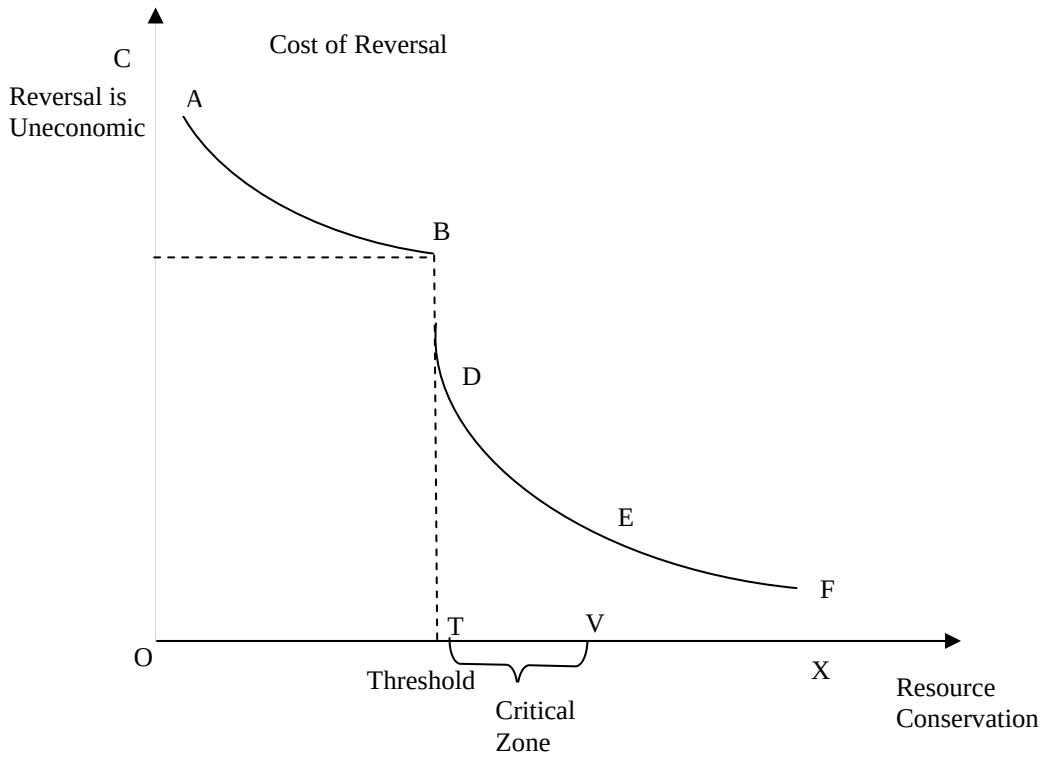

Figure 2

In the case illustrated, point T represents the (economic) threshold. The interval TV is the critical zone, and the cost of reversal relationship is shown by ABDEF. Note that by definition T is determined by the economic cost of reversal which, however, is also characterized by uncertainty. An additional difficulty is that the (economic) threshold and hence the cost of reversal presumably will vary with the speed and extent of reversal required. At T biological reversibility is supposed to be possible, otherwise no amount of expenditure would enable reversibility. Yet, the likelihood of reversal will depend both on the costs and benefits. At the interval 0T (left hand side of T), however, it is uneconomic or biologically impossible to bring about reversal (the biological threshold is somewhere on the interval 0T).

The critical zone TV is to the right of the (economic) threshold. TV is dependant on T and thus also uncertain. Hence, if one is security-conscious, one might keep above the probable (possible) threshold and the critical zone just to be on the safe side. In the words of Ciriacy-Wantrup (1963:253): '… a safe minimum standard of conservation is achieved by avoiding the critical zone….'. With respect to the figure, this means the stock of resources may not fall below V.

Pulling together the SMS-issues discussed so far leads to the assumption that confusion and misinterpretation of SMS may have been created by taking concepts with strong biological

substance (threshold, critical zone, uncertainty, irreversibility) and utilizing and defining them as socio-economic and institutional variables. Yet, there is not only confusion but various recent writers (Rogers and Sinden 1994; Rolfe 1995; Willis 1997; Crowards 1998) seem not to have acknowledged the existence of a critical zone and its uncertainty at all, but rather assumed that the threshold can be calculated and approached. This definitely violates the basic assumptions of SMS.

Costs and Benefits

One starting point of the safe minimum standard approach is the conflict between human aspirations for commodities on the one hand and for resource conservation on the other, and the costs involved. This conflict has been illustrated by a transformation curve by Hampicke shown in Figure 3 (1992:313). Let us consider the relevant indifference curve to be I_1 and present consumption of resources and goods L to be at N_L, X_L. Suppose SMS is known. Its realization would require either a descent to I_2 or a change in indifference curve to curve I_3 (e.g., through price or income variation, redistribution, institutional changes, and education).

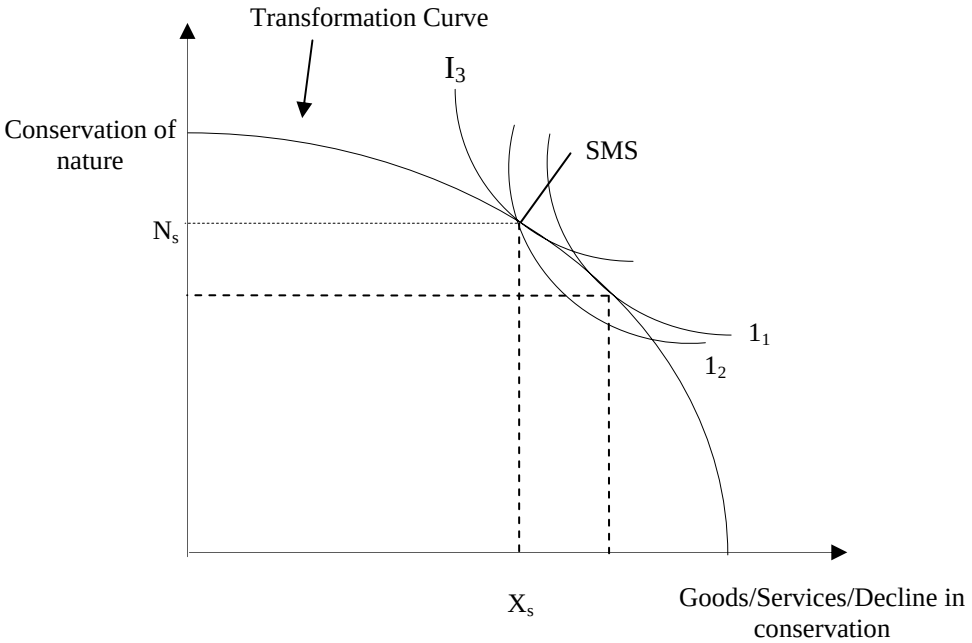

Table 3

The economic decision consists in comparing the cost of descending to I_2/adopting I_3 with the cost of remaining at I_1. I_1 involves high cost if it leads to economically irreversible depletion. In such a case adopting I_2 or I_3 would, by assumption of Ciriacy-Wantrup, involve small cost. However, any decision is charged with uncertainty.

The figure of Hampicke is instructive in that it brings in the possibility of a change in indifference curve to curve I_3. This would entail a new combination of goods/services and conservation, which, however, must not lead to a reduction in welfare or life quality per se. Thus, Hampicke's figure indicates that SMS might be sensitive to factors such as price level, income institutional factors, education and so on. This point coincides with Ciriacy- [illegible] economic irreversibility depends on societal, institutional and technical factors, and that low cost measures such as change in technology, land-use practices or education could reduce the cost of adopting SMS (Ciriacy-Wantrup 1963:254f.). Hence, such measures require an institutional analysis of resource use and of the conservation problem. Yet, previous literature discussing SMS has neglected the need and demand to carry out such an analysis as a prerequisite to the determination of SMS.

The above discussion provides the economic rationale for the SMS approach: it is assumed that in a situation of uncertainty and irreversibility the costs of adopting safe minimum standard are small compared with high cost of not doing so. High costs are explained by limited opportunities for adaptation and of a reduced potential for development of the society due to a narrowed, increasingly specialized and specific resource base (Ciriacy-Wantrup 1963:252/262). This view dovetails with that of neo-Malthusians who argue that strong conditions must be placed on natural resource conversion or use in order to achieve sustainable development.

Optimization of benefits

In cases of great uncertainty and possible irreversible outcomes, with SMS Ciriacy-Wantrup advocates deviation from the traditional economic objective of conservation economics which is to maximize (expected) social net revenue from resource utilization over time (Ciriacy-Wantrup 1963:231). It is argued that the optimal policy cannot be identified by comparing social costs and benefits of conservation because the costs of not adopting the safe minimum standard are hardly measurable and the contingency of a loss is uncertain. However, deviation from maximizing net benefits does not mean that cost and economic optimization are ignored within the SMS framework. In fact, Ciriacy-Wantrup (1963:259) states:

> "It is not sufficient to show that a given conservation practice or combination of practices is technologically effective in avoiding the critical zone. It must also be shown that no other practice or combination of practices accomplishes the same result more economically. Adoption of a SMS as an objective of conservation policy does not mean that economic calculation can be neglected: a safe minimum standard of conservation should be realized

with minimum total social costs."

Hence, SMS is considered as an economic constraint, and cost-effectiveness analysis as an instrument for economic optimization within this constraint. Therewith, the role of economic optimization is limited to determining the most efficient way of realizing the SMS which - of course - involves a considerable amount of uncertainty about the means.

Various references in *Resource Conservation* to optimization of benefits may have caused confusion about the place attributed to the valuation of costs and benefits in monetary terms and their optimization. This may be more so because Ciriacy-Wantrup endorsed methods to evaluate revenues and costs in monetary terms though he was well aware of their pitfalls and limits (Ciriacy-Wantrup 1955, 1963:230-250) and was very cautious and reluctant to assign monetary values (Ciriacy-Wantrup 1961). His ambiguity on valuation and optimization may have paved the way for various authors to concentrate on those aspects of his view concerning the determination of SMS which fit their own framework.

Significance of Institutions

A fundamental assumption of the SMS-approach is that social institutions have major influences on conservation policy. This accords with the view of other economic scholars who consider resource economics to be inherently institutional (e.g., Georgescu-Roegen 1977, Kelso 1977; Swaney 1987, Gowdy and Mesner 1998). Ciriacy-Wantrup claimed that consideration of the effect of social institutions upon the state of conservation must be the first step in the study of conservation policy (Ciriacy-Wantrup 1963:228). From there comes his definition of SMS as ‘a social objective’ (Ciriacy-Wantrup 1963:167-8) involving more of an institutional constraint than a technological constraint (Ciriacy-Wantrup 1963:267-8). This has at least two obvious consequences: On the one hand, a socially determined search for SMS implies that it may or may not be ‘optimal’, in the sense that the socially perceived economic thresholds may differ sharply from the actual one due to ignorance, imperfect institutional mechanisms for decision-making and so on. On the other hand, such a SMS is unlikely to destroy or significantly harm the socio-economic basis of the people concerned as often raised against SMS. Important in any case is a thorough analysis of the institutional constraints and influences on the resource-use in question to determine SMS, though such a procedure may be time-consuming and may require intense observation and analysis (Ciriacy-Wantrup 1963:259).

Conservation Practice

A point largely unnoticed in the literature is that due to biological uncertainty SMS should be

defined in terms of conservation practices or ecosystem qualities designed to avoid the critical zone (Ciriacy-Wantrup 1963:257) rather in terms of particular quantities. To put it in the words of Ciriacy-Wantrup:

> "The great variety and complexity of physical conditions which characterize the critical zone in the depletion of various resources make it generally impractical to define a SMS for each resource simply in terms of a single flow rate which is to be maintained. It is more practical to define a SMS in terms of conservation practices designed to avoid the critical zone. .. in terms of conditions to be maintained ... or in terms of the performance…" (Ciriacy-Wantrup 1963:257f.)

Interestingly, such conservation practice is observable in common-property resource management. Ostrom (1998 or Schlager 1994??) has observed that people generally regulate and limit their practices, and the time and space of resource exploitation rather than quantities. Acheson and Wilson (1996) argue in the same vein: folk societies regulate the use of resources by 'how' it has to be done and not by 'how much' members can use. This, they maintain, is in accordance with the political or societal possibilities of regulation and control and with ecosystem properties.

Summary: The Main Features of SMS

The main features of the SMS approach are summarized in Table 1.

Table 1 Features of the SMS Approach

Rule	Avoid transgressing the critical zone
Area of Application	Renewable resources with threshold
Basic Assumptions	- Existence of uncertainty and economic irreversibility - Economic irreversibilty = f (technology, wants, and social institutions) - Existence of critical threshold (= physical conditions making it uneconomical to halt and reverse depletion) - Cost of maintaining SMS is small in relation to possible losses due to irreversibility
Objectives of SMS	- Social objective; technological, institutional constraints in economic optimizing - 'Objective function'
Evaluation Factors	Conditions, performance, and sometimes quantities of flow resources

A challenging feature of the safe minimum standard approach is that uncertainty and irreversibility were introduced as socio-economic and institutional variables (e.g., economic irreversibility, societal uncertainty) into resource economics, and simultaneously that a social and institutional analysis was considered as an imperative to define SMS. This dependence of SMS on societal and institutional factors calls considerably for regional/local application, a fact which also has been overlooked in recent times.

Despite the time-less validity of such thinking, it is important to comprehend the work of Ciriacy-Wantrup in its historical context. In the 1950s and 1960s, conservation problems were still mainly local ones and global ecological depletion and destruction was not as advanced as today. So, it was probably justified to assume that most resource-use intensities satisfied safe minimum standards (Ciriacy-Wantrup 1963:260). However, the current environmental situation and global interdependencies may imply that the cost of maintaining safe minimum standards are much higher and the analysis of the institutional and societal setting more complex and difficult. This leads to doubt the basic assumptions of SMS, namely its small cost of realization.

DEVELOPMENTS OF SMS

A major impetus to the debate and development of SMS came from Bishop's (1978) attempt to base its theoretical roots in game theory[4]. By doing so and trying to overcome the limits of game theory, Bishop laid the groundwork for those who consider safe minimum standards to be a variant of cost-benefit analysis. Both points will be discussed by us. Then, economic optimization in the occurrence of discontinuities is considered and the discussion about SMS as a guide to economic activity will be outlined. Finally, the recent approach of defining SMS by discourse and consensus will be considered.

SMS and Game Theory

The attempt to support SMS by game theory was unsuccessful. In the examples developed by Ready and Bishop (1991), uncertainty about the amount of loss either due to protection or due to

4 "It [concept of safe minimum standard of conservation] may be regarded as a conceptual relative of the min-max solution or saddle-point in a two-person, strictly determined game." (Ciriacy-Wantrup 1993:89)

development results in an ambiguous result being obtained. This shows that game theory does not provide unequivocal results in the sense of rationally logical conclusions in the case of uncertainty. Further, equally plausible games (insurance game, lottery game) lead to opposite outcomes which indicates that the choice of the decision rule is value-laden, and finally the choice of the decision rule (in this example: minimax-loss or minimax-regret) modifies the results also. Palmini (1999) argued that Bishops' and Readys' use of the minimax-loss decision rule is not appropriate because it ignores the social cost of wrong choices and because the two games embody different kinds of uncertainty which leads to different outcomes when applying the minimax-rule. Rather, he advocates the minimax-regret decision rule and shows that under this rule both games lead to the same results. Thus, Palmini believes to affirm the game theoretical foundation of SMS. However, two problems remain: the choice of the games and of the decision rules may became subject of arguments, and as also the minimax-regret rule builds up on approximations of the costs and benefits the valuation problem of uncertain and probably irreversible outcomes will remain.

This discussion points to a major problem which is not effectively addressed by game theory: it is assumed that there is uncertainty about the set of alternative strategies is available, the possible sets of nature, and the payoffs to be associated with chosen strategies are perfectly known. But in reality perfect knowledge of such possibilities may not exist because of bounded rationality (Simon 1957 1961:xxiv; Tisdell 1968, Ch. 2) and lack of knowledge. Different individuals in society may hold different perceptions about sets of possibilities and it may not be irrational for them to do so (Tisdell 1968, Ch. 2; Tisdell 1996). So, there may be conflict due to different perceptions of possibilities by individuals and different attitudes of individuals to the bearing of uncertainty as well as to social objectives. Such conflicts are of critical importance in the supply of public or collective commodities which have inescapable impacts (non-marketed) on a wide group of individuals. Such problems are hidden in the game-theoretic approach but were, it seems, uppermost in the mind of Ciriacy-Wantrup.

Hence, game theory fails to give clear answers about whether, in cases of uncertainty, to opt for development of natural resources or for protection. This brings the concept of SMS back to where Ciriacy-Wantrup started: he considered uncertainty and irreversibility as insuperable restrictions on making optimizing decisions. As a wrong decision may trigger a huge loss, Ciriacy-Wantrup wanted to err on the safe side, which needs deliberate normative decisions about standards or prescribed and accepted practices (norms) to keep human activities within safe limits.

The request for deliberate societal and normative decisions is supported by a more general

observation of Ulrich (1993). In his view logical indeterminacy arising in situations of uncertainty points to a problem of social rationality rather than to a problem of logical rationality. In other words, logically indeterminate situation can not be solved by logical rationality such as optimizing or game theory but must be solved by well discussed and developed societal (or individual) decisions. Thus, the social framework with society's institutions and decision processes need to be rationally devised to favor socially rational decisions. These thoughts point to a recent attempt to determine SMS through discursive decisions within the communities concerned (e.g., Farmer and Randall 1998). Yet, it is desirable that the framework for these discourses is socially rational. Nevertheless, the extent to which social rationality is possible remains an open question and it may not be easy to obtain agreement on social rules for decision- making.

SMS and Cost-Benefit Analysis

As discussed above, game theory does not resolve uncertainty about the possible loss, and hence does not solve the decision problem. To circumvent this problem, Bishop introduced the proviso that the "safe minimum standard should be adopted unless the social costs of doing so are unacceptable large" (Bishop 1978:10). This decision rule has widely been taken up. In a succeeding sentence, Bishop made clear that the analysis and decision about what is 'unacceptably large' exceeds the domain of economics. Nevertheless, Bishop's modifications gave rise to views that cost-benefit analysis is an appropriate method of determining social cost, and hence, of finding an answer to whether safe minimum standard rule should be adopted (e.g., Rolfe 1995; Willis 1997; Crowards 1998) In this vein Rolfe (1995) conceives SMS merely as a flagging mechanism and Crowards (1998) sees it as a supplement to cost-benefit analysis for either bringing attention to issues which might otherwise be overlooked or for measuring the full costs and benefits of alternatives. These conceptions of the SMS rule strip it of its emphasis on socio-economic, institutional and normative aspects and aim to give it more of a positive basis.

This view, which envisages the safe minimum standard rule as a presorter of the effects to be evaluated in a cost-benefit analysis, is in stark contrast with Ciriacy-Wantrup's focus on uncertainty of expectations. He believed "that uncertainty of expectations cannot effectively be taken into account" by employing "the most probable value of expected net revenues and discounting this value for uncertainty" (Ciriacy-Wantrup 1963:87). So, as Randall points out (1986:98), the safe minimum approach tries to avoid classical pitfalls of cost-benefit approach which for instance treats gross uncertainty as mere risk and gives the false appearance of precision in benefit estimation, and in discounting. Indeed, in *Resource Conservation* there are no recommendations to determine the critical zone, the threshold or SMS by CBA although in other writings of the same period Ciriacy-Wantrup outlined a critical but favorable view of cost-benefit

analysis (Ciriacy-Wantrup 1955). Yet, in his paper of 1961 in which water management is discussed he suggests a quality standard on dissolved oxygen content which would maintain an healthy habitat for fish life (Ciriacy-Wantrup 1961:1141). There we read (p. 1143): "The 'fishy' standard suggested .. avoids the most difficult aspects of benefit-cost analysis, namely, the evaluation, in quantitative, pecuniary terms, of extramarket and collective benefits of pollution abatement." Taken together, it may be concluded that SMS was not designed to enlarge CBA or to capture cases which are difficult to evaluate in monetary terms.

Ecological Discontinuities and Economic Optimization

An analysis of whether economic optimization is possible and thus a CBA useful in the case of important ecological discontinuities (thresholds) and uncertain ecological consequences was carried out by Perrings and Pearce (1994). This research question has much in common with the inteneion of SMS. Perrings and Pearce asked whether economic optimization involving private benefit and external cost is possible in cases of a discontinuous environmental damage function as they may occur in ecological systems. A formal presentation showed that a severe disruption of the damage function impedes the satisfaction of the first order condition of a social optimum at this very point. This condition would require equality between marginal private net benefit and marginal external cost. Thus, to maximize net social benefit would imply a level of economic activity which approaches closely the point of discontinuity or threshold. However, uncertainty involves potentially high social costs. This leads Perrings and Peace (1994:22) to consider the protection of thresholds or discontinuities as a policy problem, and to recommend appropriate instruments. Perrings and Pearce (1994:26) state:

> "The result is that economic instruments required to protect thresholds or discontinuities cannot be motivated by conventional economic objectives, such as the maximization of expect utility or welfare, but must rely on non-economic criteria… They must be motivated by a judgement about the socially acceptable margin of safety in the exploitation of the natural environment. This is essentially an ethical judgement."

Thus, by acknowledging possible discontinuities or thresholds which might result in high social costs if exceeded, optimization of welfare or benefit becomes impossible, and thus the need for political or institutional measures apparent.

SMS – Setting a Framework for Economic Activity

Different authors stress the idea of a political/societal frame for economic activity (e.g., Daly 1992). With respect to ecological discontinuities, Perrings and Pearce (1994:26) see in standards the role "…to set only the aggregate limit on the exploitation …, leaving the allocation within that limit to the market [and thus] … combine efficiency in allocation with safety of the limit." In this

framework economics is assigned to find the most efficient way to keep within this frame, i.e., to realize safe minimum standards. In this sense Chisholm (1988:199) states: "…the implicit function of economists is largely to advise on cost-effective ways of attaining policy objectives." Thus, the safe minimum standard approach "is more akin to the cost-effectiveness approach than to a fully fledged benefit-cost analysis." (Chisholm 1988:199)

In another attempt to define the role and place of safe minimum standard in decision processes, the two-tier decision model has been proposed (Norton and Toman 1996). This theory mainly has a heuristic purpose. Its aim is to make a distinction between questions and normative decisions concerning the overall frame of societal life and human development, from concerns and activities belonging to day-to-day life (Page 1991). Both tiers should stay separated and due to differences in their scopes different decision procedures should apply. Within the first tier no particular policy instruments can be expected but these should be developed for application in the second tier.

SMS would be placed on the first tier as it constitutes a framework for economic and other human activities. Methods and decision rules to realize SMS would be placed on the second tier (Norton and Toman 1996). The strict separation of the two tiers and the prohibition that activities of the second tier may not overrule the first tier is in accordance with the intent of SMS of not being subordinated to narrow and short-term considerations.

Setting SMS by discourse

In recent times, some scholars claim that if local communities are empowered and able to discuss environmental problems and to find consensus , social choice will be improved (e.g., O'Hara 1996; Jacobs 1997; Norton and Hannon 1997; Sagoff 1998). The prospect of extending this approach to devise SMS has been discussed (e.g., Farmer and Randall 1998). However, in reality, it all depends! (Cf. Tisdell 1995). It is not universally true that local empowerment leads to improved social choices about the environment. Compared with environmental problems like air or water pollution, waste dumping and so on, this is especially true in the case of nature conservation which often has no direct or visible effect on daily life and where ignorance is large. However, it is a legitimate policy objective to search for institutional arrangements which will improve social choice in this regard. This all the more important as uncertainty prevents us from devising an optimal standard, be it scientific, economical or political.

However, to devise safe minimum standards within a community may be a difficult task. Not only will perceptions differ about the relationship between the depletion of resources and the survival of species or the continuance of particular environmental services, but attitudes to risk-taking and

the bearing of uncertainty will vary. How to reconcile such differences is a major challenge. The type of social welfare problem envisaged is much more complex than even imagined by Arrow who despaired of obtaining a social welfare function which satisfied 'reasonable' axioms (Arrow 1951). To what extent can the social choice problem be resolved rationally? Anyhow, a set of environmental choices will remain about which likely a fundamental social conflict is to happen due to differences in perception or in values. In practice, the final choice is often imposed, at least on some recalcitrants. Furthermore, some losers will never even qualify as legitimate stakeholders. Distilling an ideal SMS from individual preferences is probably an uphill battle (see also Norton and Hannon 1997; Farmer and Randall 1998). Yet, there are good reasons to hope that the incipient discussion on a discursive devising of SMS may be able to propose devices and methods to reduce conflicts.

The above discussion highlights the absence of a coherent theoretical basis and of a method to set SMS. Notwithstanding, it is continually invoked and suggested by environment economists and environmentalists alike. This seems to indicate a general need for normatively chosen environmental standards guiding choices about resource use alternatives involving uncertainty, irreversibility, thresholds and inter- and intergenerational justice.

SMS AND RELATED NORMATIVE CONCEPTS

In literature, there has been much mingling of safe minimum standard concept with other more or less similar normative concepts. Some closely related concepts will be discussed: the precautionary principle, the reversal of burden of proof, and inter- and intergenerational justice.

SMS and Precautionary Principle

A manifest connection exists between the safe minimum standard and precautionary principle[5] due to their common major preoccupation, namely uncertainty, and their skepticism about the accuracy of scientific forecasts. However, both concepts are relatively vague and consequently allow for a broad interpretation. Yet, they have different foci and slightly different purposes. The precautionary principle dates back to the 1970s (O'Riordan and Jordan 1995) and has become an important basic norm of conduct in international treaties and discussions (e.g., in *The Rio Declaration*, principle 15). It is strongly driven by ethical, practical and scientific arguments and focuses on a broad array of environmental problems. On the other hand, the safe minimum

[5] For a further-reaching discussion of the precautionary principle see O'Riordan and Jordan 1995.

standard approach focuses solely on conservation problems and it is motivated by the potential irreversible destruction of flow resources and the possible high cost of such destruction. Hence, the argument that 'the safe minimum standard follows the precautionary principle in assuming that the benefits of preservation are positive and large' or that safe minimum standard is less strict concerning biodiversity conservation (Willis 1997:315) is incorrect. Rather, both suggest that one ought to err in favor of keeping options open in case of possible irreversible damage of natural systems; that is in retaining flexibility (see also Tisdell 1970; Arrow and Fisher 1974; Tisdell 1996, Ch. 5). This may mean greater conservation than otherwise. It could be achieved by applying safe minimum standards, but also other instruments could be appropriate.

SMS and the Reversal of Burden of Proof

An important and inherent aspect of safe minimum standard is the reversal of burden of proof (Tisdell 1990:88; Hampicke 1992:310; Berrens *et al.* 1998:149, Palmini 1999:471). Considering or accepting the need for SMS implies shifting the onus of proof to the agent probably harming the environment. It demands from the agent probably influencing the environment the proof of ecological harmlessness as a prerequisite for allowing his/her activity or as a condition for being exempted from compensation payments. Otherwise there may be good grounds to apply safe minimum standards.

Authors who reject the reversal of burden of proof argue that absolute proof is impossible. However, they fail to realize that there are two elements of legal considerations in relation to judgements: the burden of proof and the standard of proof required. Absolute proof in either direction is difficult or impossible. Therefore, judgements are required for both: which party bears the burden of roof, and what standard of proof required. Thus, the argument that economic activities would be severely restricted does not hold without detailing judicial requirements.

SMS and Intergenerational and Intragenerational Justice

Any interest in uncertainty and irreversibility involves considering the future. The limits to human activity advocated by SMS in cases of ecological or economic irreversibility aim at conserving resources for the future, thus, at realizing some intergenerational justice. However, SMS and especially the discussion about unacceptably large cost do also highlight the question of intragenerational justice as Hampicke (1992:312ff.) has shown convincingly. To discuss this, Hampicke pushes the question about unacceptable costs further and asks: For whom unacceptable? Using as an example conservation conflicts in developing countries, he suggests that in many cases a more equitable distribution of wealth would make the question about unacceptable cost superfluous and thus would remove any doubt about the usefulness of the proposed standard.

Hampicke (1992:313) concludes: "Thus, future generations only seemingly ask for sacrifices of the present generation; in reality they ask for a fairer redistribution which has to be considered much more as legitimate." He continues by stating that in order to avoid sacrifices by all future generations, one ought to be wary in deviating from the SMS rule. So, SMS not only aims at insuring intergenerational justice but in principle also brings intragenerational justice up to the agenda, a topic which often is ignored but a main reason why not more conservation measures are realized.

The above discussion shows that SMS constitutes an elementary link in the chain of normative concepts and principles to limit the pressure on the environment and nature. It focuses especially on conservation problems which have received less attention than general environmental problems so far. It supports the need for a reversal of burden of proof, and directs our attention to the question of intra- and intergenerational equity.

CONCLUSION: SMS - A SOCIO-ECONOMIC AND INSTITUTIONAL APPROACH

The following conclusions are drawn from the above analysis of the core issues of SMS on the basis of its original outline in *Resource Conservation*, and a review of central developments of SMS:

(i) SMS may be considered to be a socio-economic and institutional approach to decision-making. It indicates are that

- resource-use is largely determined by institutional settings like norms, values, culture, education, technology, and structures of consumption;
- biophysical and social-institutional knowledge is essential in any rational social choice involving conservation issues; and,
- useful conservation policies cannot be identified using economic techniques alone – social non-economic trade-offs are unavoidable.

(ii) The analysis of Ciriacy-Wantrup cannot be satisfactorily formalized by the use of game theory or economic optimization which attempt to clothe it in precision. Yet, it must be admitted that various allusions and key words in *Resource Conservation* may lead to such a formalization. Moreover, in the relevant literature of the last two decades the purpose of social choice or decision models used is not always clear. A distinction needs to be made between whether their application is intended as a means to ‘optimize’ social welfare or resolve social conflict, or both. These are not necessarily the same objectives. Thus, no precise decision rule will guide the setting of SMS. The focus of the SMS analysis therefore should appropriately be placed on exploring its consequences

rather than aiming for false precision and determinacy.

Bishop's dictum that 'the safe minimum standard should be adopted unless the social costs of doing so are unacceptably' results in the type of issues raised by Hampicke (1992) becoming important. Income and welfare distribution, education, institutional settings ought to be taken into account when defining 'unacceptably'. Basically, possibilities for applying SMS analysis are limited until we have some ('acceptable'?) indicators of social costs. But to find an acceptable measure of these costs is not easy because measures will reflect value judgements, conflicts, institutional assignments and so on. In addition, even if social costs of not engaging in conservation are found to be unacceptably large, whether or not SMS will be put into practice will depend on existing institutional structures. These have two type of consequences: (1) they influence values and (2) determine the likelihood that social preferences will be translated in practice. Thus, questions of distribution and of institutional structures must be at the core of conservation policy.

It has been shown that in relation to cognate normative concepts of SMS, it is clear that they are not equivalent to SMS although they show some consistency with SMS analysis. Arguments based on analogies have sometimes resulted in misinterpretation of the initial SMS concept. Yet, there is obvious kinship.

In this paper it was argued that situations of uncertainty and possible irreversibility create logical indeterminacy which calls for social rationality in framing decision processes; logical rationality has no foundation in such a case. The possibility of defining SMS within a socially rational setting can be seen in a quite new discussion (although it is compatible with Ciriacy-Wantrup's original analysis). It invovles setting SMS by discourse and political consensus (Norton and Toman 1997, Farmer and Randall 1998). With respect to this discussion one important issue is Ciriacy-Wantrup's emphasis on institutional analysis. Such an analysis has to precede and go along with any discussion and discourse if people and politicians do not want to be prisoners of their own limited views and perspectives.

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