SOME CONCEPTUAL PROBLEMS IN THE EVALUATION OF WATER POLLUTION DAMAGES

Burl F. Long*

INTRODUCTION

A great deal of attention has recently been focused on the problems of environmental pollution and the search for desirable solutions to environmental quality problems. While water and air pollution problems may appear to be of less significance than many other ills confronting society, they nevertheless must be considered serious problems which have aroused a great deal of public concern. It is becoming increasingly popular to advocate the importance of economic, social, and political inputs in the decision-making process regarding pollution abatement and control [2, 5]. I have no quarrel with such advocacy as the need for better information inputs of all types is obviously a necessary condition for improved decisionmaking.

It is not always clear what is implied by the expressed need for more economic analysis. It may often mean that public agencies charged with carrying out pollution abatement programs are interested in having economists "justify" the decisions which have already been made, but are less interested in having economists "evaluate" alternative abatement programs. Obviously, the need and opportunity is great for economic analysis to contribute to decisions regarding pollution abatement.

This discussion is not an attempt to summarize damages by water pollution, nor is it an attempt to present a model for group or individual decision-making. Its purpose is a modest attempt to focus attention on one aspect of the difficulties inherent in providing useful economic information to decision-makers, and to suggest a conceptual rationale for viewing the effects of a legal starting point on the evaluation of pollution damages. Some implications of the theoretical case discussed will be examined through the use of an example drawn from a study in Pennsylvania.

POLLUTION DAMAGE FUNCTIONS

The Concept of Consumer Surplus

The existence of externalities seriously complicates the search for optimal solutions to pollution problems. Economists have long considered water and air pollution as classic examples of the divergence between private and social costs resulting from uncompensated effects of "technological external diseconomies." Unfortunately, we have not developed very good measures of the external damages imposed by pollution nor effective institutions for causing such effects to be taken into account in the decisionmaking process. Legal prohibitions and quality "standards" have been the usual methods used and advocated by legislators. However, these may or may not bear a close relation to the damages imposed on "external users," and may not be the most efficacious approach to water quality improvement. The need to relate pollution control programs to damages imposed raises problems for which economic research results are meager and desperately needed. One of many difficulties in measuring the value of benefits accruing (or damages reduced) by raising water quality is that the value depends somewhat on the legal starting point. Put another way, specification of who had the right to what uses before pollution occurred takes on a great deal of significance in evaluating pollution damage functions. The effect of legal starting point, or vesture of prior use rights, on the evaluation of external effects has recently been raised in this context and others [1, 8]. We cannot escape the fact that specification of property rights play a major role in our approach to environmental quality and a re-examination of our concept of property may be necessary. There is a precedent for the consideration of such effects in economic theory, and it may be helpful to economists to view this problem through a familiar economic concept – a version of consumer surplus using indifference curve analysis.

*Burl F. Long is an agricultural economist, Natural Resource Economics Division, ERS, USDA, Pennsylvania State University.

The concept of consumers' surplus is an old and controversial one and its practical usefulness has been debated by several distinguished theoreticians [3, 4]. Among the clearer expositions of the concept is that of I. M. D. Little in his chapter concerning indivisibilities and nonmarginal changes [4]. Following Little's definition, consumer surplus is defined as the amount of money required to compensate a consumer (or which he would be required to pay) after some change, in order to leave him at the same level of satisfaction as before the change.[1] By definition, consumer surplus does not arise with respect to marginal changes in which the consumer remains on one "behavior line."[2] Environmental quality problems often appear to present situations involving nonmarginal changes, and this causes problems with our traditional marginal analysis. In many cases it may be more appropriate to think of environmental quality improvements as creating "new" products rather than as marginal changes in existing products. The following theoretical structure may be useful in viewing this sort of problem.

Suppose a stream of water has in the past been relatively free from pollution, and activities such as fishing and boating have taken place. However, an increase in effluent from municipal and industrial sources has recently occurred and severely polluted the water, and, hence, greatly restricted or even completely destroyed the possibility of water-related recreational activities. The purpose of this exercise is to demonstrate that the value of the damage depends on whether the fishermen or the polluters had the property right to use of the water before pollution occurred. The hypothesis is that the damage suffered by recreational users will be different, depending on the vesture of this right, broadly considered a property right.

Assume an individual has had the right to use the water for recreation. At a given price of $\frac{OA}{OX}$, (the slope of the budget line AX) the individual will consume OE_1 of the recreation product (fishing) in order to equate his marginal utility with the price ratio, which is his optimum consumption point (Fig. 1). If we suppose pollution occurs, which makes the stream completely unsuitable for fishing, we can ask how much would be required to compensate the individual and leave his utility unchanged. If the behavior line is as depicted in I_1, than AB would be the amount required to compensate him for his loss of privilege without changing his utility, i.e., leave him on his same indifference curve. This is the amount required to compensate him for the withdrawal of X from the market or the "quantity compensating variation."

Assume the individual has never had the privilege to use the water for fishing even though the fish may have been prevalent and physical conditions would have supported recreational activities. Nevertheless, he was legally prohibited from using the water even before pollution destroyed its potential.[3] Thus, we find him at point A on the diagram, a different starting point, where he consumes none of X and has all his income. The relevant damage might now be what he would be willing to pay to have fishing restored and be entitled to use the stream, but be permitted to purchase different amounts rather than go without it entirely. Assume that the price of recreation and the shape of the behavior curve would remain the same as in the previous example.

Starting from point A, the individual would theoretically be willing to pay a maximum of AC for the privilege of fishing the stream of the same quality as previously, and would buy OP (which is less) of the product X. P' is the point at which the consumer would be equally well off as at point A. AC is referred to as the "quantity equilibrating variation." This situation is closely analogous to the situation discussed by Little in which the question involves the removal of an existing product from the market or the introduction of a new product [4].

Questions can be raised concerning the nature of the assumed behavior lines. The product in question is represented on the horizontal axis while the vertical axis can be thought of as representing all other goods, or as money income. The curve represents the individual's willingness to trade money for fishing in this particular stream. The fact that the curves intersect the vertical axis implies that there is some amount of money sufficient to compensate him for the loss of the privilege of buying the product. If these curves approach but never intersect the vertical axis, it implies that there is no amount of money sufficient to

[1] While Little's exposition of the concept is excellent, he is not an advocate of the usefulness of consumer surplus, and is critical of those who advocate its usefulness in practical problems.

[2] Little prefers "behavior lines" rather than "indifference curves" although he indicates that one could use them somewhat synonymously. The term behavior line or hypothetical choice functions seem to more accurately connote the idea of choice.

[3] An alternative assumption would be that the waste dischargers had the right to use the stream for waste disposal, and the recreationists were required to bargain for the use rights.

compensate for the loss of this product. The availability of substitutes for this particular product is reflected in the shape of these curves.

The conclusion from this over simplified example is that the benefits of pollution control (or damages foregone by eliminating pollution) to fishing would be greater if the individual (and others similar to him) had previously had the privilege of using the stream for fishing before it became polluted than would be the case if he had not previously had this privilege. Thus, specifications of property right becomes very important in the evaluation of damage functions. We need to understand that "where we start" makes a great deal of difference in the outcome.

A Case in Point

Cordorus Creek is a small, shallow gradient stream which flows in a northeasterly direction through York County, Pennsylvania, and drains into the Susquehanna River. The normal average streamflow in the West Branch of Codorus Creek is approximately 2.6 million gallons per day, with the volume falling much lower during the dry summer months. However, the streamflow is augmented by 16 MGD highly treated effluent from a large pulp and paper manufacturing plant located on the stream. From the point of effluent discharge to the junction of the West Branch with the South Branch (above the city of York), the water quality will not support fish life. The major problems in this 10 mile stretch are low dissolved oxygen levels and high discoloration. The pulp and paper manufacturing plant currently provides high level secondary treatment which removes about 85-90 percent of the raw waste load, but because of low natural streamflow the water is still polluted from the standpoint of supporting fish life. The Pennsylvania Department of Health has established quality standards and criteria for protecting specific uses of the stream, including warm water fish which will require very expensive tertiary treatment, perhaps about $300,000 per mile annually [6]. No requirement for determining economic values of the uses to be protected is required under provisions of "The Clean Streams Law" of Pennsylvania. It is implied that the uses to be protected are worth whatever it cost to protect them. I am bothered by this approach and believe that more attention to the evaluation of benefits would likely improve the decisions made. We have made some estimates of the costs of waste treatment, but we know much less about benefits or damage

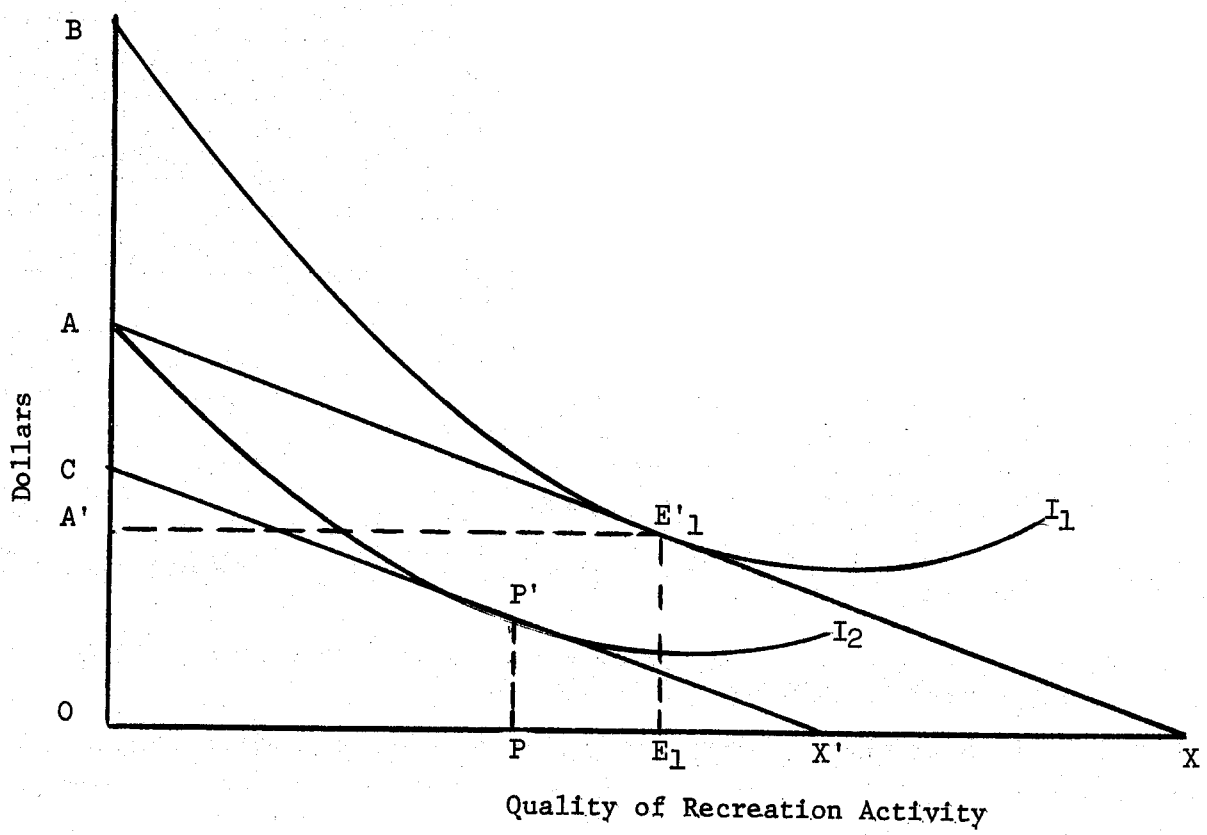

FIGURE 1. ILLUSTRATION OF EFFECTS OF PRIOR RIGHTS ON VALUE OF RECREATION DAMAGES

reduction associated with improved water quality.

In view of the extremely low natural flows during critical periods, it seems apparent that little or no fish life could be expected in the absence of the 16 million gallons of treated effluent which currently supplements streamflow. It follows that sport fishing could not be expected to occur in the absence of the paper mill and its treated effluent, unless other streamflow augmentation were provided. Thus, fishing was not an available alternative in this stream even if it had not been polluted by the treated effluent of the plant. The point to be emphasized is that it seems reasonable to evaluate the damage to fishing on this stream in recognition of the fact that fishing could not be considered a real alternative in the absence of the mill and its treated effluent. On the other hand, it does not seem realistic to evaluate the damages to fishing reduced by pollution abatement as though an existing sport (fishing) had been destroyed by pollution of a fishable stream. In placing a value on fishing damages reduced by pollution abatement, there is the question of how much compensation would be required to leave fishermen as well off as they would have been without the paper mill and its treated effluent, rather than with the effluent in an unpolluted state. Thus, defining who had the right to which uses before pollution occurred may make a significant difference in the evaluation of damages reduced by pollution abatement.[4]

CONCLUSION

The intent of this article was to call attention to an often neglected aspect of evaluating pollution damages. In addition to other difficulties of quantifying damage functions, consideration must be given to the distribution of use rights. The fact that the evaluation of damages depends, among other things, on the legal starting point cannot be ignored.

Although the case discussed has some unique aspects, it is not an unrealistic case. Only one aspect of the problems encountered in the economics of water quality has been considered. A crucial need exists for economic inputs into the decisionmaking process in water quality management, but we must also clearly understand the institutional aspects of the problem.

There is indeed a crucial need for empirical studies to estimate pollution abatement benefits or pollution damages associated with alternative levels of water quality. Decisions are being made and will be made with or without economic inputs. The evaluation problem cannot be ignored; values will be assigned either explicitly, or implicitly as is often done in the absence of economic data. Economists have a major role to play in water quality and other environmental quality issues. The major needs are multidimensional and are particularly acute in the economic institutional area.

Take note of Pigou's admonition that abstract arguments, if they only construct empty boxes, cannot show what is empirically right, but can often indicate what is wrong, and perhaps even more often, what is unproved. In order to even come close to giving good answers, we must be sure we know what questions we are asking. Unless we are careful to recognize institutional as well as physical and economic aspects, we are unlikely to get answers which will be of maximum usefulness in the decisionmaking process. Economists have an important contribution to make in the field of water quality management, not only in providing answers but also in the choice of questions to be answered.

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[4]It should be noted that the availability of close substitutes is assumed here. The product in question is fishing in this particular stream, not fishing generally.

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