ECONOMICS OF WATER QUALITY IN AGRICULTURE— A LITERATURE REVIEW

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This review describes studies in several disciplines which contribute to understanding economic impacts of reducing nonpoint pollution. Cost studies reviewed deal with controlling soil erosion, nutrient losses, and pesticide losses. Other studies reviewed suggest where and how widely control practices may be needed. One area in need of research concerns the relationships between erosion reduction and the delivery of sediment and chemicals to streams. Research is also needed on the benefits of pollution reduction.

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PREFACE

This review was done as background for ongoing research on the socioeconomic impacts of practices to reduce water pollution from agricultural sources. A wide range of studies from various disciplines are referenced, since economic studies must rely on physical production, biological and hydrologic relationships, as well as economic and social interactions. Because of the variety and number of studies, the authors do not claim to fully appreciate the relative importance of each. Some of the most significant works from the standpoint of a particular discipline may have been overlooked. Even so, the authors hope this review identifies some of the major issues and relationships and will prove useful to others in conducting economic analyses and developing information for policymakers.

CONTENTS

Economics of Water Quality in Agriculture

– A Literature Review

Clayton W. Ogg, Lee A. Christensen, and Ralph E. Heimlich*

INTRODUCTION

Economists often rely on physical production relationships from engineers and physical scientists to formulate economic relationships for public decisionmakers. Incomplete knowledge of certain physical relationships can therefore limit economic analysis concerning management systems for reducing diffuse agricultural sources of pollution. Such nonpoint pollutants include pesticides and nutrients which are transformed in ways that are highly dependent on interacting influences of soils, weather, and hydrologic parameters, as well as farming practices. In turn, stream and lake characteristics affect the transport of sediment and other pollutants and the way these pollutants affect bodies of water. Finally, the public's perception of pollution damage is an important aspect of the social impact. Research on each of these problems is highly relevant to assessment of economic impacts of nonpoint pollution abatement.

In the past few years, scientists and engineers have produced a great many studies documenting pollution from farmland sources. Most of these estimate cropland-related contributions to measured problems in a particular reach of a stream or lake. Other studies develop information systems which relate measured water quality problems to specific crop practices with their varying impacts on water quality.

Studies identified in this report will assist in the assessment of the costs and benefits of cleaning rural lakes and streams. The principal purpose of this review is to identify some of the major issues influencing the solution of agricultural nonpoint pollution problems. In particular, the report emphasizes the relationship between technical and economic factors. It seeks to identify what is known about the economic impacts of alternatives for solving pollution problems from diverse agricultural sources, and to indicate the

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limits of current knowledge. Areas which merit further effort by economists and scientists from other fields are also discussed. This review may be useful to researchers and water quality planners since it brings together several economic considerations critical to solving pollution problems.

The report first discusses publications which estimate local farm-related pollution. In some cases, authors compare local practices with hypothetically less polluting alternatives. These comparisons apply to a narrow range of soil or hydrologic conditions. This area of study primarily raises particular regional problems without attempting an indepth analysis of solution impacts.

There are, however, a number of modeling efforts which relate problems to specific practices on a full range of land conditions. Costs of various management practices are then estimated and compared with the associated biological benefits. Several erosion and sedimentation studies in particular develop important links between physical and economic relationships.

The effects of pollutants and their movement through streams, estuaries, and lakes are considered. References describe dynamics of typical stream delivery systems and impacts on different sizes and types of receiving waters. In some instances, recommended structural or biological solutions are discussed.

LOCATING POLLUTION SOURCES

Cost estimates for nonpoint pollution reduction usually call for inputs from several disciplines. Nutrient and pesticide studies reflect this diversity, providing only partial information for drawing economic implications. For instance, numerous studies have considered important nutrient management alternatives on a typical local soil. However, key economic questions of how these practices would affect potential problems and yields on other soil-slope combinations, or how widely they would be applied, are generally not addressed.

Discussion

In contrast, the studies of erosion reduction indicate that economic impacts are much more completely understood, partly because sediment models build on decades of work by natural scientists and engineers. These erosion studies make it possible to compare economic and environmental effects of crop management alternatives applied to an area's specific soil acreages.

Agricultural Chemicals

A large number of chemical studies attempt to prove the existence or absence of local agricultural pollution problems, either from stream sampling systems or from carefully controlled experiments on individual plots. Sometimes researchers were able to locate the source of a specific lake problem and identify a fairly simple solution to the nonpoint problem [a good example is a study by the Minnesota Pollution Control Agency (44)]. 1/ In a few cases, authors found that local agriculture practices were relatively harmless in terms of nutrient and pesticide contributions, while others found nutrient problems that appeared virtually unsolvable (28, 35).

A number of efforts seek to identify the physical effects of nutrient management alternatives on a particular soil using experimental plots. That phosphorus losses can be reduced by methods of application is well documented by Timmons (73). Nitrogen losses are greatly affected by the timing of fertilizer applications (8, 38, 48).

Other studies emphasize the diverse levels of nutrient losses, which depend on the soil characteristics within each region. 2/ Gambrell, Gilliam, and Weed, for instance, find wide variations in nitrate loss between two important soils in the coastal plain of North Carolina (24).

Since experiments obviously cannot be repeated for every field situation, there have been efforts to identify parameters which determine pollution from nonpoint sources. Regression analyses by Omernik relating the most general agricultural variables such as cropland to total area ratios have identified strong relationships between the amount of agricultural land and each region's pollution from other than point sources (49). Such surveys and single modeling efforts are most useful in identifying large regions where agriculture is most likely to be affected by programs aimed at cleaning rural lakes and rivers.

There are projects underway to simulate specific field sources of pollution by developing watershed nutrient models. Nitrogen models pull together basic research data on the changes that nitrogen undergoes in the soil and in plant residues to predict the amount of nitrogen and nitrates reaching streams. These models include, for example, effects of soil wetness on denitrification (65), plant uptake under different concentrations (77), effects of temperature, and direction of nitrate movement between ground water and surface water (24). Early conceptual work by Bailey and others (94), and pesticide modeling by Crawford and Donigian laid the groundwork for the comprehensive agricultural runoff model by Donigian and Crawford (15, 17). Another comprehensive model relating several parameters is the ACTMO model developed by Frere, Onstad, and Holtan (22). 3/ Lack of parameters representing nutrient and pesticide pollution from soils of differing productivity limits applicability for economic analysis.

Of the major nutrient modeling efforts, a nitrate model developed by William Schaffer provides the most systematic basis for analyzing economic impacts of management alternatives (58). Yet this work is limited to a rather

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1/ Underscored numbers in parentheses correspond with the references cited in the selected bibliography.

2/ Studies which emphasize drainage practices and drainage characteristics of soils are referenced on page 5.

3/ References in this section include many sources used by the large models. However, a number of equally important experiments, primarily of interest to specialists, are not included here.

narrow range of management alternatives on one New York watershed. Models have not yet been constructed with the capacity of accurately analyzing the interaction of management practices and soil-hydrologic relationships for any representative area. Until these relationships are established for soils of varying productivity, economic effects of nutrient reductions cannot be rigorously estimated.

Enrichment Ratios

For most soils, a large portion of the total phosphorus in runoff is adsorbed by soil and carried to streams with the eroding particles. One approach to analyzing phosphorus control alternatives is to estimate how much phosphorus is delivered with the sediment. This is the approach taken by Jacobs and Schaffer and others (30, 58). However, nutrients are primarily available for algae growth in their dissolved state; even for phosphorus, areas which produce large amounts of nutrient adhering to sediment may not be the only ones which contribute to algae growth (53, p. 323). Reduced tillage management alternatives recommended for sediment problems also alter nutrient enrichment ratios as the dissolved phosphorus losses rapidly increase (34, 55, 59).

More sophisticated enrichment studies which take into account the adsorptive capacities of soils under different practices affecting sediment concentrations in runoff are needed. Otherwise, concentration on erosion reduction may divert efforts from other potential management practices designed specifically for agricultural chemical problems. These include such practices as controls on the amount of pesticides or nitrogen fertilizer or manure applied, the method of phosphorus application, or the timing of nitrogen application (55, p. 295). Karr and Schlosser argue that creating buffer zones between crop locations and the streams deals with nutrient problems in several ways and provides for wildlife and environmental needs as well (31).

The limited nature of the economic literature dealing with nutrient and pesticide problems does not necessarily indicate that solutions are going to be particularly difficult or expensive. If nutrient use is severely reduced, the conventional wisdom is that costs will be considerable (32, 71). Yet preliminary results indicate that there are a number of important soil situations where proper fertilizer placement, combined with modern reduced tillage methods, can significantly reduce phosphorus loss from most well-drained soils without large cost (36). 4/ Likewise, soil loss management, combined with proper timing and application rates, will substantially reduce nitrogen loss (63), possibly at very low cost. Bouldin and others at Cornell even argue that summer sidedress applications of nitrogen can achieve actual profit increases while reducing nitrogen available for runoff by over 50 percent, as compared to fall plowdown (8, 38). This is supported by a Missouri study by Whitaker and associates (80). Although rigorous cost information is scarce for many soils and for exacting

4/ Again, it should be emphasized that there are heavy or wet soils where no-till does not produce as well, plus many unknown difficulties such as with management, especially for small farmers.

environmental objectives, real gains may be achieved in the next few years if available fertilizer management practices and appropriate reduced tillage technologies are adopted.

Pesticide Monitoring

Analogous to the studies for nutrients are three types of pesticide monitoring studies. The simplest of these are purely descriptive studies which record pesticide residues found in water or alluvial sediments in a particular area (96). More generally applicable are studies which derive some statistical relationships between pesticide concentrations in runoff and associated phenomena such as sediment yields (94, 98, 99). Because of the toxic effects of pesticides and their tendency to accumulate in organic tissues, a third kind of study examines these effects on particular species (95) or for all organisms in a certain level of the food chain (97).

Pollutants from Other Nonpoint Sources

Surface runoff of soil, pesticides, and commercial fertilizer nutrients is only part of the problem in many areas of the Northeast. Several studies emphasize the importance of ground water pollution, manure application, tile drainage, surface drainage of former swamps, and irrigation return flows. Management alternatives for surface runoff often do not apply, and new techniques of analysis have been developed for each of these problems. For instance, key economic variables for manure handling are storage costs and costs of soil incorporation (115). Construction of drainage outlets themselves becomes an issue for surface drainage, since drainage may open reservoirs of nutrients (125, 128). Water management is a variable unique to irrigated sources (104).

Sediment Sources

Economic analysis of erosion and sediment control has developed a standard for measuring the progress of other nonpoint pollution analysis. Wischmeier and Smith's Universal Soil Loss Equation (USLE) is now widely used (in revised form) as a common basis for identifying pollution problems for farm conservation planning (142, 145), and has been adapted for economic analysis. Based on initial fallow soil loss condition, factors for rainfall, soil erodability, slope, slope length, conservation practices, tillage, and crop rotation provide soil loss estimates for a typical year. If used correctly, the USLE can be used for regional studies as it is for individual fields (143). By relating soil productivity to aggregated soil loss for selected groups of soils, the economic effects of rather detailed soil-specific conservation recommendations are established. Since the USLE is geared to describing typical yearly events, it is particularly well suited to analyzing the broad implications of management strategies. Much of the economic analysis of nonpoint pollution has made use of the USLE.

The major weakness of using the USLE in pollution studies is that estimates are for soil movement on the field and do not indicate how much of the eroded particles reach streams. Techniques for indicating delivery of sediments to streams are far less advanced than those for estimating erosion. A method by Roehl, which is used widely (138), accounts neither for variation in delivery rates within a watershed nor for the effects conservation practices may have on delivery rates (139). The USLE, however, has been successfully adapted to provide estimates of delivered sediments, using an equation that requires estimates or measurement of total runoff and peak flows (141).

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ANALYZING CONTROL MEASURES AND THEIR COSTS

Discussion

Economic studies of soil conservation vary considerably in terms of size, ranging from national and regional linear programming models to studies of a single watershed. Between the watershed-size study and the regional model are river basin studies which are often large enough to offer limited regional implications.

National and Regional Models

The national models by Wade and Heady and Nicol, Heady, and Madsen emphasize the ability of U.S. agriculture to adjust to a common set of environmental restrictions (151, 148). Cost increases from substantial improvements in the environment are relatively small as less intensive production shifts to regions with steep, erosive soils. Limitations of the national model are clearly stated, including unresponsive output and input demands and the approximate nature of the soil loss estimates, especially from the standpoint of representing regional differences in potential soil losses. One could also argue that a common national sediment reduction goal is not applicable to existing legislation, which calls for identifying management practices on a regional basis. A national model may exaggerate the willingness of regions to sacrifice production to achieve a more uniform national water quality.

A study by Taylor and Frohberg uses a stepped demand curve to analyze the cost of reducing erosion and nitrogen use in the Corn Belt (149). While maintaining the national perspective, emphasis is changed from regional shifts in the location of production to the overall cost of alternative sediment reductions. This cost is borne by consumers since farmers benefit from farm price increases as row crop production is reduced. Since less interregional substitution is possible, this model possibly overestimates the Corn Belt's share of costs from uniform national restrictions.

Small Area Economic Studies

Watershed linear programming models have the advantage over national and regional models of providing more accurate inputs into the USLE and of analyzing more realistic planning alternatives. The problem of accurately representing farm product demands for the smaller study area still exists, however. Assuming that product demands met by other areas are not affected by nonpoint pollution legislation leads to shifts in intensive production and its pollution to areas outside the study area (162, 172). On the other hand, assuming a fixed farm product demand for a watershed size area (using a cost minimization model) is hard to justify.

River basin studies generally fall between the watershed and the national/regional studies. Comprehensive studies of the major river basins in the late sixties and early seventies encompass some of the major crop-producing areas of the Nation. More recent studies, such as the USDA-State cooperative studies and those sponsored by the Water Resources Council cover smaller river basins and use more sophisticated analytic methods. Most of these studies assume a fixed demand, which appears justifiable for the larger basins.

In recent years, more studies have included estimates of changes in land use and farm income resulting from restrictions on soil losses. Obviously, production "goals" and alternative soil loss restrictions may not be compatible, but once this limitation of model assumptions is recognized, cost analysis can provide a common basis for 208 planners and traditional conservation professionals to weigh alternatives. Cost effective practices may then be determined according to the capabilities of each soil group (153, 165, 174).

Several authors compare costs of solving a local pollution problem through nonstructural management strategies, as opposed to structural solutions such as dredging. According to estimates by Workman and Keith (180), land treatment of fragile lands in the Upper Colorado River basin yields a maximum benefit-cost ratio of only 0.12. But for an Illinois watershed, Ouishi and Swanson found that farm conservation practices represent a very practical alternative to eventually dredging a recreational reservoir (172). This Illinois linear programming study attempts to measure tradeoffs between sediment control strategies and nitrate loss restrictions. Nitrate losses are simplistically related only to fertilizer levels, thus ignoring possible effects of soil conservation practices on nitrate losses. Another Illinois study finds that individual producers receive very modest long-term benefits to conservation practices, as compared to costs, from the standpoint of maintaining the productivity of their land (169). Conservation is thus practical for the public, but benefits are largely external to the farm firm.

Cost Sharing and Other Implementation Strategies

According to economic logic, achieving maximum resource allocation efficiency requires that the production unit bear the costs of reducing pollution. Otherwise, land may be used for growing crops which could be grown much more cheaply in another location. Failure to "internalize" pollution costs may also lead to overinvestment in some crops and underinvestment in pasture or crops which cause less pollution (182).

Concern over nonpoint pollution raises the question of whether Federal programs which subsidize conservation practices should be expanded. Iowa, one of the first States to have a comprehensive sediment control law, bases its enforcement on obtaining cost sharing funds (183). Other States are likely to follow this example. Iowa's Senator Culver proposed additional Federal funding for conservation cost sharing, and $400 million dollars per year has been designated for the Rural Clean Water Program (RCWP) by 1980.

Administration of the RCWP will determine how effectively subsidies will internalize social benefits from pollution abatement or discourage undesirable practices. During years of crop surplus, certain subsidies may conflict with programs to support farm income. The impact of each subsidy on farm income may therefore depend on market conditions which vary from year to year.

In spite of their superiority from a theoretical standpoint, measures forcing complete cost internalization are generally hard to implement. This review previously discussed complexities of matching management tools to field situations. For enforcing costly restrictions, legal problems can thus be anticipated from the difficulty of proving that farm management practices will lead to the desired improvement in water quality (186).

Among control measures, those requiring uniform reductions in effluent discharge appear the simplest to administer. However, they are also the most inefficient in that there is likely to be no equality of marginal costs among producers and no equality of marginal costs and benefits of compliance (182). Effluent taxes, while more efficient than uniform reductions in pollutant discharge, would clearly add to the administrative problems already stated, and create two new ones. First, they may add a tax burden to the pollution abatement costs (182). Second, a tax will likely distort the intended level of control, since it is difficult to select the optimum tax. Although Ackerman and associates suggest that effluent charges are much more precise in this respect (152), they would be difficult to administrate for agriculture.

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POLLUTION DYNAMICS IN RURAL LAKES, STREAMS, AND ESTUARIES

Discussion

Studies of pollutant delivery through streams and eventual impacts on lakes and estuaries try to provide a link between agricultural conservation systems and current plans for achieving specific improvements in measured water quality. Although a number of studies are referenced, the link between onsite farm management practices and measurements of stream water quality is generally weak. This weakness becomes especially evident as planners attempt to locate sources of measured pollution problems during particular storms.

Stream Modeling and Pollutant Delivery

Nitrogen delivery is a particularly vexing problem, since nitrogen can change forms in a stream as well as disappear from the water system through denitrification and atmosphere N fixation (200).

Sediment and phosphorus share another transport problem: phosphorus is adsorbed to sediment and both are then deposited or removed from the bottom of streams depending on characteristics of streams and storms (188, 197). This also complicates separating the nonpoint contributions from point sources and bank erosion. To develop an effective cleanup strategy for a particular lake or estuary, it is important to know how much nutrient or sediment loss from fields at different river reaches is carried to the target area.

The importance of transport variables also will vary, depending on whether water quality objectives emphasize receiving waters or include improving streams as well. Sediment, for instance, causes some degree of damage to wildlife cover in streams and aggravates flood damage, as well as causing damage to receiving lakes and reservoirs (189). It also can be argued, however, that sediment and phosphorus reaching any location in a stream system are available for future transport to problem areas.

One way of reducing the cost of pollution control is to narrow the geographic area that requires stringent control measures. Since lakes and certain estuaries are most easily damaged by pollutants, knowledge of transport systems is a prerequisite to locating and controlling contributing sources.

Pesticide Impacts and Environmental Exposure Indices

Given the number of pesticides on the market, there is an added challenge of representing typical relationships for major classes of pesticides. The vast array of pesticides of different chemical and physical makeup makes generalization difficult, even within classes of similar materials. The concept of environmental exposure indices was developed to help reduce this complexity to a common measure which can be computed for pesticide regimens and used for comparison between them. Indices by Weber combine such characteristics as toxicity, soil persistence, and bioaccumulation ratios into a single measure (211). Environmental exposure indices are easily incorporated into economic models such as Alt's linear programming model (210). While pesticide characteristics are included in the indices, inability to incorporate specific soil, climate, and especially tillage practices limits their usefulness.

Movement and Fate of Pesticides

Pesticides' behavior in the environment is under intensive laboratory and field examination. These studies emphasize discovery of the mechanisms by which pesticides are dispersed from the application site, the rates at which pesticides degrade to harmless residues, and their effects on organisms between application and complete degradation. Pesticides that are slow to degrade and adhere strongly to sediment are most responsive to soil conservation practices.

Some studies concentrate on the transport problem, examining dependencies between dissolved and adsorbed states on environmental factors such as temperature and moisture (214, 215). An approach more closely related to economic studies examines the effects of agricultural practices, especially irrigation, on pesticide movement in the soil (221).

Other studies focus on transformations of pesticides occurring once the material leaves the land surface. Such transformations may occur in surface water or in the ground water system (223, 224). Studies of the effect of pesticides on the environment, particularly on aquatic organisms, carry this kind of analysis to a logical conclusion. Two kinds of these studies can be differentiated by methodology employed. First are continuous flow studies in which organisms are subjected to a continuous level of pesticides and the effects on behavior and bioaccumulation are noted (217, 218). A second kind of study uses a model ecosystem which exposes organisms to conditions analogous to those in nature (219). This method is more useful in that it permits incorporation of typical agricultural conditions and analysis of the effects of alternate practices (220).

A more complete approach follows pesticides from application through transport, degradation, and bioaccumulation (222). This permits viewing the entire process in a unified manner, obviating the need to piece together separate research conducted under dissimilar conditions. Unfortunately, little such complete approach research has been done, particularly regarding the effects of specific conservation practices such as no-till, with its higher pesticide use and reduction in pesticide transport by erosion.

Simulation of Pesticide Movement

Many of the studies discussing pesticide movement incorporate and test mathematical models of various transport mechanisms (215, 221). Attempts at consolidating numerous separate relations into more general and comprehensive models of pesticide movement and transformation for simulation via digital computer have been made (225, 226, 227). While achieving varying degrees of generality and accuracy, these simulation models offer a potentially important tool to examine the environmental impacts of alternate agricultural practices.

Issues Unique to Lakes

Perhaps the most visible pollution problems occur in lakes. These may or may not involve health hazards and do not usually lead to destruction of wildlife, but they can affect the esthetic enjoyment and usefulness of unique environmental or recreational amenities. Much of the nutrient and sediment loss from agriculture will have visible effects in lakes. These take the form of algae blooms, murky or shallow water, and dense weed growth.

The frequency of such problems, however, may depend as much on the nature of the receiving body of water as on the magnitude of effluent loads. Therefore, efforts to control lake problems need to consider which nutrient is limiting for algae growth and the levels which local lakes are capable of absorbing safely.

Procedures for determining whether the nitrogen or phosphorus is limiting (201, 244) are fairly simple. Usually it is the latter. For a given level of nutrient input, warm, shallow lakes with slow turnover are most affected by algae growth. Turbidity or murkiness from suspended sediment also will limit algae growth.

Simple models of lake tropic status are available (237, 243). These models are useful both from the standpoint of assessing the potential for success of phosphorus and nitrogen reduction programs and for setting meaningful water quality goals. Fixed standards based only on regional concentration goals might again lead to expensive reductions in nutrient losses in watersheds where none is needed, or to a failure to provide a stricter standard where it is required for preventing excessive growth of weeds and algae.

Alternative Measures for Lake Problems

Lake destratification techniques and use of chemicals to precipitate out phosphate ions provide short-term solutions to algae growth from nutrients, just as sediment traps and dredging can alleviate effects of sedimentation (250, 252). The cost and obvious side effects of some of these practices, such as noisy disruptions or chemical buildups, probably limit their consideration as alternatives to pollution reduction. It is conceivable, however, that further water research will lead to structural or biological alternatives to the more stringent nutrient management practices on farms. Several studies of this nature are referenced.

Estuary Problems

The immense size of some contributing drainage areas creates a special set of concerns for estuaries. The problems of analyzing delivery systems are therefore particularly relevant to locating pollution sources for estuaries. References indicate that estuary environments present their own unique set of problems due to plant growth characteristics (262) and to effects of tidal currents which add to the problems of locating pollutant sources (261).

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BENEFITS OF WATER QUALITY IMPROVEMENT

Evaluation of benefits of water quality improvement tends to be highly subjective. Information about public perceptions of nonpoint problems is therefore very relevant when measuring economic and environmental tradeoffs.

Discussion

If a pesticide is causing health problems, technical measurement of safe levels can serve as criteria for goal attainment. Loss of reservoir capacity can be converted to dollar values for cost-benefit comparisons. But where periodic green algae or odors or heavy siltation from agriculture visibly pollute an area, it is not clear which problem merits the most intensive investment.

Studies of public perceptions have sometimes concentrated on overall interest in water quality versus other goals (268, 269), rather than weighing public preferences between alternative goals for local water quality improvements.

Presumably, measurement of perceived benefits from attaining alternative goals could focus nonpoint planning on investments in controls which yield the highest amenity benefits. For instance, if a midwestern State was primarily concerned about algae problems for scarce lake resources, then nutrient loads from streams entering the Missouri River might receive less attention. In the absence of good studies of public perceptions, arbitrary technical standards will probably serve as goals. Bruce Ackerman and associates have demonstrated that this can occur under the most technologically competent planning efforts (263).

Dornbusch and Barranger measure benefits of pollution control as reflected in property values (272). Walsh and associates study water quality benefits for recreation (285).

Planning studies also provide insights into public perceptions, either directly if they undertake attitude surveys, or through study inputs from elected officials and interest group leaders. Although only limited information of this type is available (280), studies funded under Section 208 of the Pollution Control Act are expected to be an important future source of information. Studies of State legislative and executive agency involvement in water quality planning also provide indirect knowledge of public concerns by showing how ongoing programs are related to the new emphasis on water quality (274, 284). Planning relationships with ongoing Federal conservation programs are also relevant (278, 281, 282).

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