The Economics of Soil Erosion and Sedimentation in the Great Lakes Basin

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Executive Summary

The purpose of this report is to present the current state of knowledge on the economics of soil erosion and erosion control in the Great Lakes basin. Soil is defined as the unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Sediment is eroded soil from the landscape, which is generally transported by river systems and eventually deposited into a lake, reservoir or larger body of water. Estimating the economic costs associated with soil erosion and the benefits of erosion control can be very difficult. To understand the full picture, one must recognize the linkages between soil erosion and its impacts, which are not always clear or well-documented, and be able to assign an economic value to these impacts, which can also be complex. This report describes what is known about: 1) the status of erosion and sedimentation in the Great Lakes basin; 2) impacts from erosion and sedimentation on environmental resources, beneficial uses, and market goods; 3) monetary damages from erosion and sedimentation and the benefits of erosion control; and 4) the cost-effectiveness of erosion control programs and practices. It is anticipated that this information will be useful in assessing the monetary damages of erosion and sedimentation for the Great Lakes basin.

The first section of the report describes the status of soil erosion and sedimentation in the Great Lakes basin. In order to understand the economics of soil erosion and erosion control, it is important to understand the rate of erosion and soil deposition in the basin. There is currently a lack of good data on sediment loads and their impacts. In fact, there are few direct measurements of loadings to help assess the effectiveness of control measures. In order to conduct a realistic assessment of the costs and damages of erosion and sedimentation in the Great Lakes region, the following information is needed: 1) a more accurate measurement of the total soil loss in the basin, including all sources of sediment (not just agriculture); 2) a better understanding of how sediment is transported through watersheds in order to better predict its impacts throughout the system; and 3) a more accurate measurement of sediment delivery ratios and sediment loads to the Great Lakes.

The second section of the report describes the process of soil erosion, soil transport and soil deposition, as well as the land-use activities which have the potential to exacerbate soil erosion. Understanding the movement and storage of sediment in rivers is a key to understanding its impacts on the watershed system. However, there are many factors that influence the rate at which soil erodes and the types of problems sediment can create downstream. The linkage between sediment and its potential impacts is neither distinct nor simple.

The third section of the report describes the impacts of sediment on aquatic environments, beneficial uses, and market goods and resources. Sediment can cause a wide array of damages as it erodes from the land, is transported by water or other means and eventually settles out in a lake, reservoir, or other location. These impacts are diverse and are influenced by complex hydrological, physical, chemical and biological factors. Sediment pollution also impacts environmental systems, such as rivers, streams, lakes, reservoirs, wetlands and fisheries as well as resource uses such as recreation, drinking water, navigation, flood control, drainage, and property values.

There have been very few comprehensive studies that have examined the monetary impacts of erosion and sedimentation in the Great Lakes. One of the most comprehensive studies to examine this issue in Great Lakes basin is the 1970s Pollution from Land Use Activities Reference Group (PLUARG) study by the International Joint Commission. PLUARG was the first study to document in detail the water quality impacts associated with land use, including impacts from sediment. Many problems identified by PLUARG remain today, including excess nutrient loads and contaminants, both of which can be tied either directly or indirectly to sediment.

Another seminal study on the impacts of erosion and sedimentation was conducted by Clark, Haverkamp and Chapman for the Conservation Foundation in 1985. This national study, entitled *Eroding Soils: The Off-farm Impacts,* looked at the impact that sediment has from the time it erodes from the land to the time it accumulates in a lake, reservoir, or other location. The study researchers found that many types of damages are weakly documented, and that even for those damages that are well-documented, the direct linkage between these damages and sediment is not well-understood.

The fourth section of the report describes what is known about the monetary costs associated with erosion and sedimentation, and includes a literary review of nearly 75 economic valuation and impact studies. Determining the monetary costs associated with erosion and sedimentation – or the benefits from reduced sediment load – is difficult for three key reasons. First, an estimation of impacts requires an understanding of ecosystem health and the status of environmental resources, which often are not very well documented or monitored. Second, even if environmental impacts are identified, the linkage between soil erosion and these impacts is not always clear. Third, if the impacts are identified and the linkage between sediment and the impacts is determined, an economic value must still be assigned to these impacts and is often difficult to assess.

In short, the total monetary costs of damages from erosion and sedimentation are largely unknown for the Great Lakes basin and no comprehensive studies to document these costs have been conducted. Most of the research in this area is site-specific and focuses on prescribing an economic value to a particular ecosystem good or service. The most comprehensive study to date that documents the monetary impacts of soil erosion and sedimentation was the Clark, Haverkamp and Chapman study, *Eroding Soils: The Off-Farm Impacts.* This study concluded that, in 1985, the total nationwide off-site damages of erosion from all sources totaled $7.0 billion per year. Monetary damages are provided for several specific categories, such as recreation, navigation, water supply and habitat. In 1989, M.O. Ribaudo conducted a national study of sediment damages resulting from agricultural erosion, entitled *Water Quality Benefits from the Conservation Reserve Program,* and found damage estimates to be between $2 billion and $8 billion per year. These estimates include damages or costs to navigation, reservoirs, recreational fishing, water treatment, water conveyance systems, and industrial and municipal water use.

In order to assess the costs of soil erosion and sedimentation, it is also important to look at the cost-effectiveness of soil erosion and sedimentation control programs and practices. The fifth section of the report provides an introduction to the current state of knowledge on the cost-effectiveness of sediment control programs, policies and practices, with summaries of nearly 35 studies and reports. Erosion control practices help keep soil on the land and reduce the amount of sediment that accumulates in rivers and lakes, but they can be costly and time-intensive to implement. Understanding the economic benefits of intervention strategies can help determine if these practices are worth the time and money.

Economists have developed methods by which to quantify the economic benefits of environmental programs. However, there are serious limitations to choosing the most cost-effective strategies, due to the complex nature of erosion and sedimentation. First, erosion is difficult and expensive to measure because it is diffuse and is impacted by random natural events such as weather. Also, the process by which sediment is transported to and through rivers and lakes is influenced by a number of factors, some of which are unpredictable. Therefore, the random and unpredictable nature of the erosion and sedimentation process imposes serious limitations when crafting programs and policies that are cost-effective. Another issue to consider is the scale of application. Erosion and sedimentation depend on many site-specific factors. Thus, the more site-specific that policies and programs are, the more efficient they will be. However, designing and implementing site-specific programs can be very costly as they require the collection of site-specific data and information, which can be expensive to acquire.

In recent years, there has been pressure to expand the scope of estimating costs and benefits in national policymaking, including proposals to require federal regulatory agencies to address costs and benefits of legislation. Furthermore, there also appears to be growing pressure to incorporate nonmarket values in economic analysis and decision-making. This trend will likely spur research into new methods of applying economic valuation to policy and decisionmaking. In addition, an accurate measurement of the total amount of soil loss in the Great Lakes basin (as opposed to state-wide data for each entire Great Lakes state) is sorely needed, as is an accurate measurement of sediment delivery ratios and sediment loads to the Great Lakes and a better understanding of how sediment is transported through the basin.