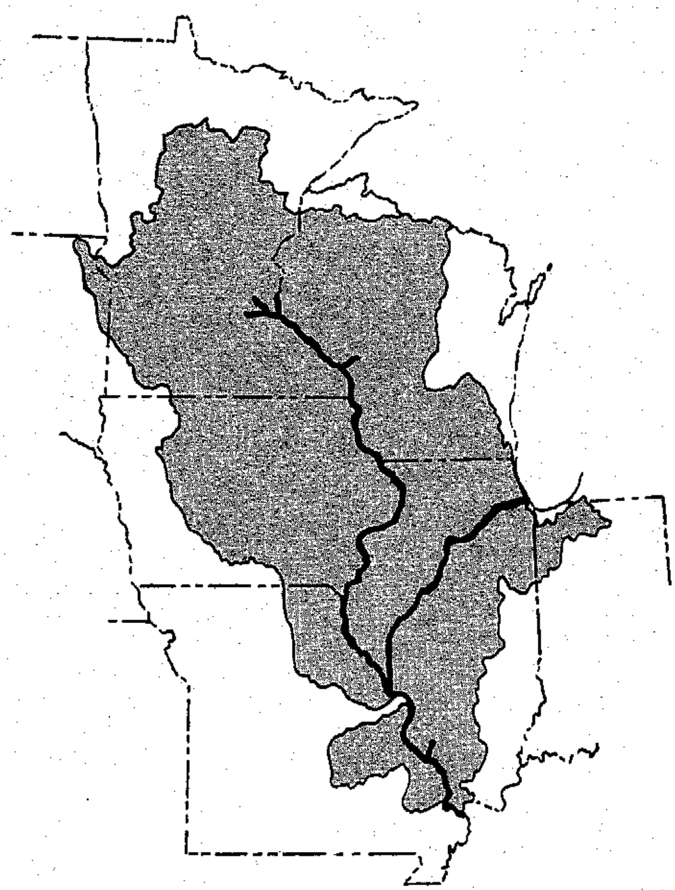
Erosion in the Upper Mississippi River System: An Analysis of the Problem

January 1984

Upper Mississippi River Basin Association



UPPER MISSISSIPPI RIVER BASIN ASSOCIATION

(Chairman: William Crews)

Illinois
Donald Vonnahme
Director
Div. of Water Resources
Illinois Department of Transportation

Iowa
William Crews
Iowa Department of Water, Air, and Waste Management

Minnesota
Thomas Kalitowski
Chairman
Minnesota Environmental Quality Board

Missouri
Fred Lafser
Director
Missouri Department of Natural Resources

Wisconsin
Linda Bochert
Executive Assistant
Wisconsin Department of Natural Resources

Advisory Members

U.S. Department of Agriculture
U.S. Department of the Army
U.S. Department of Interior
U.S. Department of Transportation
U.S. Environmental Protection Agency

MASTER PLAN IMPLEMENTATION COMMITTEE

Illinois
Kay Whitlock
Illinois Department of Transportation

Iowa
Kevin Szcodronski
Iowa Conservation Commission

Minnesota
Jack Ditmore
Minnesota State Planning Agency

Missouri
Charles Michael
Missouri Department of Natural Resources

Wisconsin
Dr. David Kennedy
Wisconsin Department of Natural Resources

Advisory Members
U.S. Dept. of Agriculture
U.S. Dept. of the Army
U.S. Dept. of Transportation

Preface

The "Comprehensive Master Plan for the Management of the Upper Mississippi River System" was prepared by the Upper Mississippi River Basin Commission and transmitted to Congress in January 1982. The preparation of that Plan, authorized by Congress in 1978 by P.L. 95-502, addressed specific questions related to navigation capacity and environmental impacts of navigation operation and maintenance. The recommendations of the Plan cover a broad range of Upper Mississippi River System problems and issues. Among other things, the Master Plan recognizes the need to control erosion and reduce the large amounts of sediment entering the Mississippi River and its backwater areas. Similar conclusions were reached in the GREAT studies and the Main Stem Level B Study. One of the recommendations of the Master Plan is that:

> "Immediate action should be taken to reduce erosion rates to tolerable levels to help preserve the integrity of all resource values on the UMRS."

Upon completion of the Master Plan and termination of the Commission, the five states of the Upper Mississippi River System (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) formed the Upper Mississippi River Basin Association. The Association provides a cooperative forum for discussion and coordination of water resource programs and a focus for the implementation of the Master Plan. The Association is committed to advancing all the recommendations of the Master Plan. As part of that effort, this paper has been prepared to supplement the Master Plan recommendation that erosion in the basin and sediment entering the river system must be reduced through immediate action.

This report attempts to define the scope of the erosion problem in the Upper Mississippi Region and to analyze possible alternatives for its reduction. In one sense, the Upper Mississippi Region is not unlike other areas of the nation that experience severe erosion. Our current land management practices are not adequately controlling soil erosion and additional action is essential. Whether this action should involve greater financial incentives, mandatory compliance, cooperative agreements, or educational programs is not determined in this paper. Rather this paper provides justification for focusing an accelerated erosion control effort in the Upper Mississippi Region. Not only is soil loss continuing to reduce crop yields, but sedimentation from upland and streambank erosion is threatening river resources. Sediment transport and deposition reduces water quality, causes shoaling in the navigation channel, and damages fish and wildlife habitat.

Table of Contents

List of Figures

List of Tables

Background

Erosion of upland soils and streambanks is a severe resource problem; it depletes productive agricultural topsoils and the eroded material damages aquatic habitat and water quality. Upland erosion contributes most of the fine-grained sediment that enters the river system, while streambank erosion contributes the course sediments that settle in the main channel and side channels. The U.S. Department of Agriculture estimates that over a 50-year period, uncontrolled soil erosion (at an annual rate of 15 tons per acre) could result in a total production loss of 375 bushels of corn per acre. Besides reduced soil productivity, the costs of producing agricultural commodities increase with erosion. Both fertilizer and fuel usage rise to compensate for declining topsoil depth.

The natural erosion process has been intensified through agricultural practices and other land surface modifications. Conventional tillage in the planting of row crops leave large areas of ground uncovered during the periods of the year when the land is most susceptible to erosion. Various forms of conservation tillage can reduce erosion on many soils 50 to 90 percent. The amount of soil erosion also depends on climate, topography, soil composition, and vegetative cover. Most soil particles move only a few feet from where they are eroded. Soil particles may be deposited and re-eroded many times before finally reaching water.

Figure 1 depicts the drainage patterns from land parcels within a watershed. The runoff from each parcel contains sediment and nutrients, some of which reach watercourses and are discharged from the watershed. Combined with information on topography, land use, and storm events, the contribution of each land parcel in the watershed to sediment movement can be modeled. In cooperation with a number of Minnesota state agencies and the USDA Soil Conservation Service, the Agricultural Research Service station in Morris, Minnesota developed a model which illustrates the process of sediment movement in a watershed.

The model simulates the transport of sediment, nutrients, and flow from the headwaters of a watershed to the outlet in a step-wise manner so that an assessment can be made for land parcels in the watershed. The simulation is based on single storm events defined in terms of frequency and duration. Table 1 provides an example of sediment and nutrient contributions from a watershed of nearly 8700 acres during a 25-year frequency storm lasting for 24 hours. The simulated storm would produce a runoff volume of 2.4 inches at the watershed outlet, with a peak rate of 3916 cubic feet per second. The total sediment yield would be nearly 22,300 tons.

This model helps in understanding the process of sediment movement, in addition to determining the major sources of sediment. The sediment that reaches the Upper Mississippi River may move through smaller watersheds before its ultimate deposition in the river or its backwaters. The problem is to reduce the initial soil erosion at the source and to limit the transport of sediment into the river sytem.

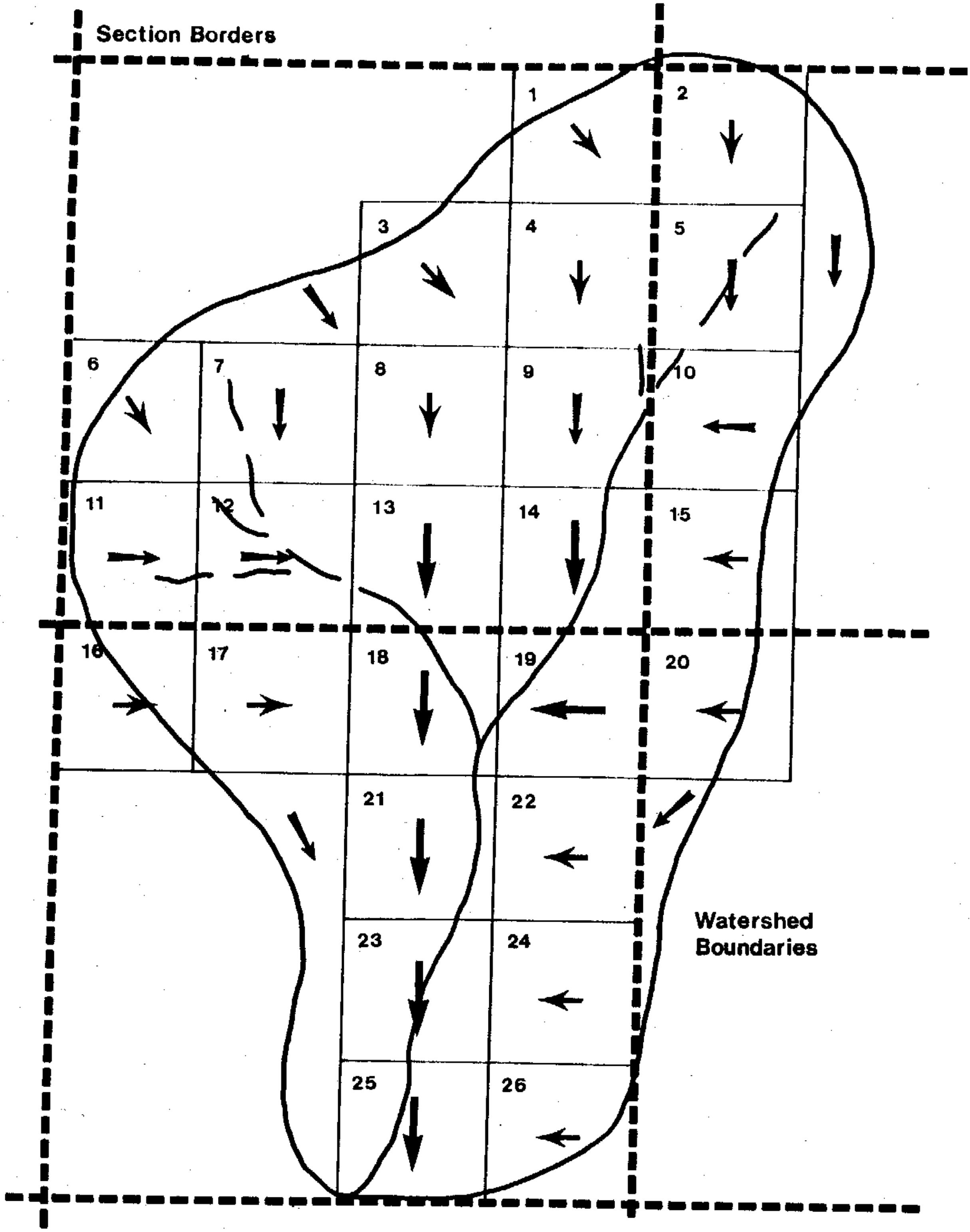


Figure 1. Illustration of Sediment Movement in a Watershed

Table 1
Sample Output of Sediment Movement Model

****

AGRICULTURAL NON-POINT SOURCE POLLUTION MODEL
Watershed studied: Meadow Brook

****

The area of the watershed is:	8600 acres
The area of each cell is:	40.0 acres
The characteristic storm precipitation is:	4.4 inches
The storm energy-intensity value is:	99

VALUES AT THE WATERSHED OUTLET

Runoff volume (in.):	2.4
Peak runoff rate (cfs):	3916
Total Nitrogen in sediment (lbs/acre):	6.73
Total soluble Nitrogen in runoff (lbs/acre):	2.33
Soluble Nitrogen concentration in runoff (ppm)	4
Total Phosphorus in sediment (lbs/acre):	3.36
Total soluble Phosphorus in runoff (lbs/acre):	.83
Soluble Phosphorus concentration in runoff (pp):	2

SEDIMENT ANALYSIS

Particle Type	Area Weighted Erosion Upland (t/a)	Area Weighted Erosion Gully (t/a)	Delivery Ratio (%)	Enrichment Ratio	Mean Concentration (ppm)	Area Weighted Yield (t/a)	Yield (tons)
Clay	.29	.00	99.3	2.2	1081	.29	2520.1
Silt	.45	.00	85.2	1.9	1440	.39	3357.2
Sagg	2.86	.17	56.6	1.3	6385	1.71	14884.2
Lagg	1.76	2.22	3.7	.2	550	.15	1282.2
Sand	.34	.47	3.5	.2	106	.03	246.0
TOTAL	5.70	2.76	30.4	1.0	9562	2.57	22289.6

VALUES AT EACH CELL

	RUNOFF				SEDIMENT				
Drainage Area/cell (acres)	Volume (in.)	Generated Above (%)	Peak Rate (cfs)	Cell Erosion (t/a)	Generated Above (tons)	Generated Within (tons)	Yield (tons)	Deposition (%)
1040	2.4	96	1079	4.3	2263	172	2421	1
320	2.2	95	421	.1	976	5	514	40
360	2.3	86	461	7.3	514	291	685	15
40	.9	0	53	.1	0	5	5	0
40	1.9	0	106	5.6	0	223	223	0
2560	2.4	99	1849	.1	8081	6	6242	23
40	2.2	0	121	7.7	0	308	308	0
120	3.1	63	405	4.5	359	180	307	43
2160	2.4	98	2102	8.0	8450	320	9280	-6
8600	2.4	100	4974	.5	24910	19	33164	-33

NUTRIENT ANALYSES

Drainage Area/cell (acres)	Runoff (in.)	NITROGEN Sediment (lbs/a)	NITROGEN Water Soluble Within Cell (lbs/a)	NITROGEN Water Soluble Cell Outlet (lbs/a)	NITROGEN (ppm)	PHOSPHORUS Sediment (lbs/a)	PHOSPHORUS Water Soluble Within Cell (lbs/a)	PHOSPHORUS Water Soluble Cell Outlet (lbs/a)	PHOSPHORUS (ppm)
1040	2.4	6.22	3.26	2.31	4	3.11	1.21	.82	2
320	2.2	4.62	.16	2.70	5	2.31	.03	.99	2
360	2.3	5.29	.58	2.47	5	2.65	.10	.89	2
40	.9	.59	.16	.16	1	.29	.03	.03	0
40	1.9	12.52	1.23	1.23	3	6.26	.41	.41	1
2560	2.4	6.45	.37	2.80	5	3.23	.06	1.01	2
40	2.2	16.19	3.26	3.26	7	8.10	1.21	1.21	2
120	3.1	6.71	.70	.62	1	3.36	.12	.10	0
2160	2.4	10.51	3.26	3.05	6	5.08	1.21	1.11	2
8600	2.4	9.31	.29	2.35	4	4.66	.05	.83	2

Source: Agricultural Research Service.

Effects of Sedimentation on the Upper Mississippi River System

Although erosion and sedimentation problems are not unique to the Upper Mississippi Region, some of the most severe recorded soil depletion occurs here. Soil losses caused by sheet and rill erosion on cropland vary considerably but average about 6.4 tons per acre per year for the entire Upper Mississippi Region. Nationally, erosion averages 4.8 tons per acre per year.

East-central Iowa and northeastern Missouri are among the most severely affected areas. Soil losses greater than 9 tons per acre per year are common. Northeastern Iowa and southwestern Wisconsin are also experiencing severe cropland erosion where annual rates average more than 7 tons per acre. Over 30 percent of the 67 million acres of total cropland in the Upper Mississippi Region has erosion rates that exceed 5 tons per acre annually. Nearly 7 million acres have erosion rates that annually exceed 14 tons per acre (U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980).

Erosion has economic effects on crop production, particularly where soils are thin. In addition, the resultant deposition of eroded material in the river, backwaters, sloughs, and marshes also has severe consequences. Suspended sediment reduces water quality and increases water treatment costs for removal of sediment. Sediment deposition causes shoaling in the navigation channel, damages fish and wildlife habitat, and often impedes recreation.

The sediment that reaches the river and its backwaters generally originates from streambank erosion and upland sheet and rill erosion. Streambank erosion is the major source of sand-sized sediment. Sand can be carried in suspension but sudden changes in sediment carrying capacity cause deposition. Sands are the primary eroded material that must be dredged to maintain the navigation channel.

The riverine sedimentation process has been altered by the placement of locks and dams and wing dikes in the river corridor, which have reduced the sediment transport capacity of the Upper Mississippi River. Tributaries that transport more sediment per unit volume of water than the Mississippi River will deposit their sediment load in the main channel. Between 1979 and 1982, 30 million cubic yards of sediment have been dredged from the Upper Mississippi River at a cost of $44 million (Corps of Engineers, "Annual Dredging Summaries").

The principal source of sediment, however, is upland erosion. Upland sheet and rill erosion contributes most of the fine-grained sediment that enters the river system. Fine sediment has a tendency to settle in side channels and backwaters.

Off channel backwaters, wetlands, and side channels provide diverse habitat for fish and wildlife. Sediment and turbidity in these areas can destroy spawning beds, alter habitat areas, decrease light penetration to photosynthetic plants, and fill-in shallow waters.

Sediment is considered the greatest pollutant in the Upper Mississippi River. In addition, fine sediments can transport such residuals as phosphorus, pesticides, and heavy metals which further degrade the environment.

The accumulation of fine sediments in backwaters, low-flow areas, and isolated side channels has caused significant loss of productive aquatic habitat and has diminished water quality. It is expected that, unless upland soil conservation practices are intensified and expanded, major segments of the rich, diverse, accessible fish and wildlife habitat, including national refuges, and recreation areas may become shallow marshes, mudflats, or even dry land.

Critical Sediment Producing Area

Throughout the Upper Mississippi Region upland soils and streambanks erode at different rates. Land along the Mississippi River bluffs erode at an annual rate of greater than 15 tons per acre. Along the Illinois River, rates of 8 to 10 tons per acre per year are common. The topography and soils of southeast Minnesota, southwest Wisconsin, northeast Iowa, and northeast Missouri can lead to severe erosion unless adequately treated. Although other parts of the region have severe erosion problems, their contribution to the sediment problem along the UMRS is less. Therefore, the primary effort, in terms of sediment control, should focus on major sediment producing areas.

A critical sediment producing area has been delineated for the Upper Mississippi River by the U.S. Soil Conservation Service. This 103-county area is 39 million acres and covers five states (Figure 2, Table 2). Nearly half of the land has soil erosion at more than double the national average. The area is about 61 percent cropland, 13 percent pastureland, 17 percent forest land, and 9 percent other land. One-third of the critical area is in Illinois (Table 3).

The area is part of the major livestock and grain producing area of the nation. In 1980, $4.1 billion of crops and $4.1 billion of livestock and livestock products were produced in these 103 counties.

Intensive agricultural land use, highly erodible soils, and a mid-continental climate with intense rainfall events all contribute to the estimated 164 million tons of sheet and rill erosion each year. Cropland areas have the most severe erosion problem; 73 percent of the problem acres is cropland (Table 4). Almost half of the problem cropland acres has erosion rates exceeding 10 tons per acre per year.

The control of upland erosion in this critical sediment producing area coupled with streambank erosion control along tributaries could reduce the amount of sediment reaching the Upper Mississippi River and its backwaters. While federal, state, and local programs are addressing the erosion problem, an accelerated or redirected effort is necessary to reduce sedimentation to a level that will preserve the ecosystem of the Upper Mississippi River.

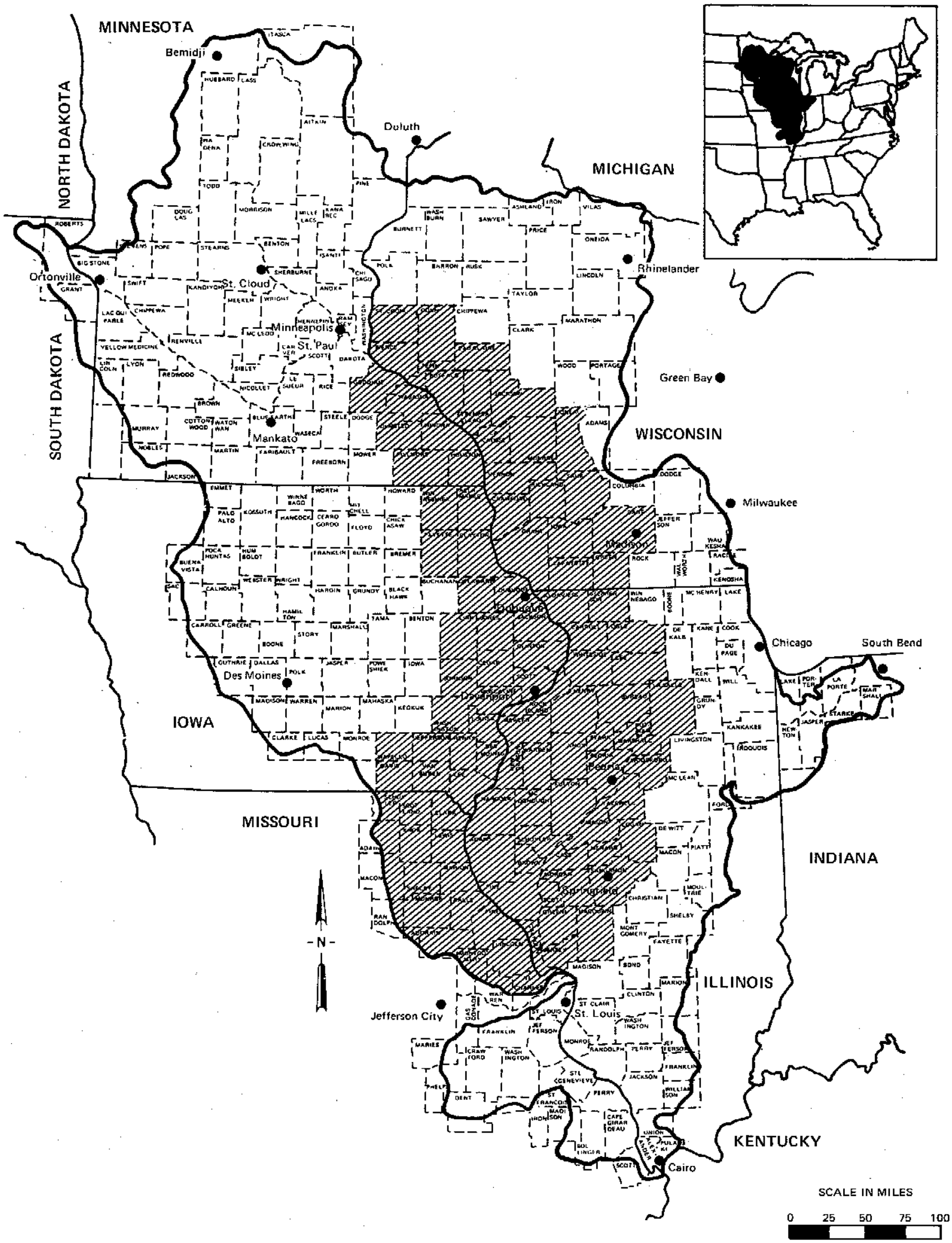


Figure 2. Upper Mississippi Critical Sediment Producing Area

Table 2

Counties in Critical Sediment Producing Area

Wisconsin	Minnesota	Iowa	Illinois	Missouri
St. Croix	Goodhue	Winneshiek	Jo Daviess	Clark
Dunn	Wabasha	Allamakee	Stephenson	Scotland
Pierce	Olmsted	Fayette	Carroll	Lewis
Pepin	Winona	Clayton	Ogle	Knox
Eau Claire	Fillmore	Delaware	Whiteside	Marion
Buffalo	Houston	Dubuque	Lee	Shelby
Trempealeau		Linn	Rock Island	Ralls
Jackson		Jones	Mercer	Monroe
La Crosse		Jackson	Henry	Pike
Monroe		Clinton	Bureau	Audrain
Juneau		Johnson	Henderson	Lincoln
Vernon		Cedar	Warren	Schuyler
Crawford		Scott	Knox	Adair
Richland		Washington	Stark	Montgomery
Sauk		Louisa	Putnam	St. Charles
Grant		Muscatine	Marshall	Warren
Iowa		Wapello	Peoria	
Dane		Jefferson	Woodfood	
Lafayette		Henry	Fulton	
Green		Des Moines	Hancock	
		Davis	Jersey	
		Van Buren	McDonough	
		Lee	Calhoun	
			Mason	
			Macoupin	
			Tazewell	
			Greene	
			Logan	
			Adams	
			Schuyler	
			Brown	
			Cass	
			Morgan	
			Pike	
			Scott	
			Sangamon	
			La Salle	
			Menard	

Table 3

Land Use in Critical Sediment Producing Area

State	Crop Land	Pasture Land	Forest Land	Other Land
	ACRES			
Wisconsin	4,218,800	1,532,000	3,195,800	658,400
Minnesota	1,414,700	300,000	520,900	273,000
Iowa	5,435,400	1,169,000	895,600	804,100
Illinois	10,168,500	1,429,200	1,361,900	1,083,100
Missouri	2,601,000	564,000	641,000	726,000
TOTAL	23,838,400	4,994,200	6,615,200	3,544,600

Source: U.S. Soil Conservation Service.

Current Erosion Control Programs

Most federal and state erosion control programs are directed toward landowners. Federal and state government hope to achieve erosion control by encouraging landowners to apply management practices that preserve the soil. Financial incentives and technical assistance are the basis for most erosion control programs.

Within the U.S. Department of Agriculture, the Agricultural Stabilization and Conservation Service administers cost-sharing funds for individual conservation practices through long-term agreements with landowners. The Soil Conservation Service provides technical assistance for conservation plans which sometimes leads to long-term agreements and application of resource management systems. The Cooperative Extension Service directs information and educational programs.

The states have traditionally followed the lead of the federal government in erosion control efforts. Most states have soil and water conservation boards which work with USDA agencies and guide local soil and water conservation districts. States have initiated their own erosion control cost-share programs under the realization that federal funding has fallen far short of the money needed to adequately address the problems.

The State of Iowa initiated the nation's first state soil conservation cost-share program in 1972 and has $8.5 million for FY 1984. Iowa's program provides 50 percent cost-sharing for the installation of voluntary cost-share measures and 75 percent funding for mandatory erosion control. In addition, Iowa has two different loan programs. One provides low interest loans for installation of

Table 4

Distribution of Land Having Severe Erosion Problems

State	Problem Acres				Distribution of Problem Acres							
	Crop Land	Pasture Land	Forest Land	Other Land	Crop Land T-2T1/	Crop Land >2T2/	Pasture Land T-2T	Pasture Land >2T	Forest Land T-2T	Forest Land >2T	Other Land T-2T	Other Land >2T
Wisconsin	1,975,300	298,700	1,585,100	111,500	1,063,900	911,400	122,400	176,300	1,506,700	78,400	93,500	18,000
Minnesota	548,000	64,000	177,600	31,700	317,000	231,000	39,400	24,600	113,000	64,600	17,800	13,900
Iowa	3,212,700	398,400	196,200	57,800	1,534,000	1,678,700	288,900	109,500	112,200	84,000	37,700	20,100
Illinois	4,382,100	371,600	374,500	129,500	2,839,600	1,542,200	334,600	37,000	331,300	43,200	93,800	35,700
Missouri	1,842,000	244,000	219,000	67,000	726,000	1,116,000	195,000	49,000	192,000	27,000	--	67,000
TOTAL	11,960,100	1,376,700	2,552,400	397,500	6,480,500	5,479,300	980,300	396,400	2,255,200	297,200	242,800	154,700

Source: U.S. Soil Conservation Service.

1/ Acres with erosion rates between five and ten tons per acre per year.

2/ Acres with erosion rates greater than ten tons per acre per year.

permanent soil conservation practices and for purchase of certain minimum tillage equipment. The second loan program which is just starting has a $1 million amount for no-interest loans for installing permanent soil conservation structures.

The State of Illinois established the Illinois Farm Development Authority in 1982 to provide low interest loans for soil and water conservation practices, and for land and equipment purchases. Since December of 1982 the Authority has approved 46 loans totalling $1.45 million dollars for conservation practices. A state cost-share program for conservation tillage was initiated in FY 1982, however, the $500,000 appropriation was discontinued the following year. In addition the state has developed a comprehensive cost-share program primarily designed to provide financial assistance to farms on which a valid erosion complaint has been filed (under the State Soil Erosion Control Program). The FY 1984 appropriation for this program is $50,000.

The State of Minnesota established a state-funded soil and water conservation cost-sharing program in 1977. Under this program, the state Soil and Water Conservation Board (SWCB) allocates funds to soil and water conservation districts (SWCD) to be used to share in the cost of voluntary implementation of systems and practices for erosion or sediment control or for water quality improvement. The state SWCB must allocate at least 70 percent of available cost-sharing funds ($1,541,000 in FY 1984) for conservation practices to address high-priority erosion, sedimentation, or water quality problems based on statewide priorities established by the SWCB and identified in SWCD plans. Seventy-five percent cost-sharing is provided. The State of Minnesota also funds a sediment and erosion control grant program focused on streambanks, lakeshore, and roadside controls. The SWCB provides 50 percent cost-sharing grants for eligible projects. In FY 1984, the Legislature has appropriated $158,400 for this program.

Missouri initiated its state cost-share program in FY 1983 with a $1 million general revenue appropriation. This was supplemented later in that same fiscal year with the passage of a bond issue that will provide $24 million over a 5-year period. In FY 1984 a low interest loan program for conservation application is being tested. And, in November, 1984, a constitutional amendment will be put before the voters of the state that would result in $15 million a year for five years for soil and water conservation efforts that would, if passed, include watershed construction as well as cost-share and loan programs.

In 1978, Wisconsin became the first state to enact a statewide non-point source water pollution abatement program. Since 1978, over $21 million has been appropriated for the program. Funds are used for financial, technical, and educational assistance and are targeted toward watersheds that are significant contributors to water quality problems.

There are approximately 133,000 farms in the critical sediment producing area, 33 percent are in Illinois, 22 percent in Iowa, 22 percent in Wisconsin, 13 percent in Minnesota, and 9 percent in Missouri. Total fiscal year 1983 inputs of cost-share funds for erosion control were $12.8 million, an increase of 17 percent from fiscal year 1982 (Table 5). Federal cost-share and technical assistance funds were also targeted toward counties in Wisconsin, Minnesota, and Iowa. While the federal government has increased its funding, primarily because a section of the critical sediment producing area has been designated a target area, cost-share funds provided by the states has changed between fiscal years

1982 and 1983. The states of Iowa, Missouri, and Wisconsin have increased cost-share funds; the states of Minnesota and Illinois have decreased funding. Of the $12.8 million in fiscal year 1983 cost-share funds, 76 percent is federal, 22 percent is state, and 2 percent is local.

Approximately 356 staff years of technical assistance were provided in fiscal year 1983. Of this total, 76 percent was provided by the Soil Conservation Service, the remaining by states and local districts.

Table 5
Cost-Sharing and Technical Assistance Programs
in Critical Sediment Producing Area

	- - COST SHARE FUNDS - -				- - TECHNICAL ASSISTANCE - -			
	Target	Federal	State	Local	Target	SCS CO-01	SCS Other	Other
						- - STAFF YEARS - -		
			Fiscal Year 1982					
Wisconsin	$ --	$2,536,700	$523,000	$190,000	$ --	46	17	42
Minnesota	--	$757,000	$151,800	$30,000	--	15	3	10
Iowa	--	$1,243,100	$1,006,300	$258,300	--	43	2	13
Illinois	--	$2,894,400	$60,400	--	--	68	32	14
Missouri	--	$1,110,000	$129,600	--	--	29	4	--
TOTAL	$ --	$8,541,200	$1,871,100	$478,300	$ --	201	58	89
			Fiscal Year 1983					
Wisconsin	$380,000	$2,045,000	$525,000	$200,000	$20,000	49	13	42
Minnesota	$589,000	$869,700	$136,000	--	$325,000	16	3	15
Iowa	$563,800	$1,194,100	$1,823,534	$75,000	$30,000	63	2	13
Illinois	--	$2,801,300	--	--	--	66	21	15
Missouri	--	$1,226,041	$356,222	--	--	33	5	--
TOTAL	$1,532,800	$8,136,141	$2,840,756	$275,000	$375,000	227	44	85

Source: U.S. Soil Conservation Service.

Alternatives for Enhanced Erosion Control

Even though cost-sharing and technical assistance have been significant in the critical sediment area, tolerable soil erosion rates have not been achieved. At current sedimentation rates, the Upper Mississippi River Basin Commission has concluded that substantial backwater areas and other non-main channel areas will be eliminated within the next 50 years. The following sections evaluate possible alternatives to control erosion at its source. This list of alternatives is not intended to be inclusive.

Expanded Program Emphasis

Even though cost-sharing and technical assistance have been significant in this critical sediment area, additional assistance is essential to achieve tolerable erosion rates. The Soil Conservation Service has determined that, in order to achieve sediment reduction objectives in this critical area, soil erosion should be reduced to acceptable levels on 75 percent of the land in the next 20 years. To accomplish this proposal through existing cost-sharing and technical assistance programs, funding must substantially increase. Fiscal year 1983 program funding is only 40 percent of the needed technical assistance and 15 percent of the needed federal cost-sharing funds.

The installation cost over a 20-year period for erosion control measures is estimated at $2.3 billion. In addition, over a 20-year period it will cost $290 million for SCS technical assistance, $24 million for the Cooperative Extension Service, and $90 million for the Agricultural Stabilization and Conservation Service. Federal cost-sharing funds needed are estimated at $1.2 billion or $120 million per year for enduring conservation measures (Table 6). However, greater targeting within soil conservation districts toward severe erosion-prone areas might reduce costs and achieve a comparable level of soil protection.

While this alternative of expanding existing erosion control programs appears costly, there are substantial benefits and it is cost effective. From a benefit analysis prepared by the Soil Conservation Service, a reduction in cropland soil depletion would save $2.3 billion over a 40-year period. An increase in timber and forage production on pasture land would accrue an annual benefit of $18 million, and additional timber production on forest land would generate annual benefits of $36 million. In addition, off-site benefits to water quality and wildlife habitat through a reduction of sediment entering watercourses, backwaters, and reservoirs would be substantial.

The advantage of using this alternative to achieve sediment reductions is that established programs provide the basis for the effort. But these programs rely on cooperation from landowners, some of whom may find it difficult to meet their cost-share portion. Some farmers may realize an economic benefit from soil conservation, particularly when topsoil is thin and any erosion diminishes yields. Other farmers may lack the economic incentive to reduce erosion. It may be difficult to convince a farmer to implement costly procedures when the primary benefactors are downstream environmental resources.

Table 6

Treatment Costs for Accelerated Erosion Control
in Critical Sediment Producing Area

State	Cost of Treatment on Problem Acres						Landowner Cost	
	Crop Land	Pasture Land	Forest Land	Other Land	Total	Federal	Constr.	O&M1/
	DOLLARS (Millions)							
Wisconsin	335.8	38.8	79.3	55.8	509.6	254.8	254.8	407.7
Minnesota	178.1	3.2	26.6	4.0	211.9	106.0	106.0	169.5
Iowa	518.4	24.3	7.0	5.2	554.9	277.4	277.4	443.9
Illinois	526.6	37.2	28.1	31.5	623.3	311.7	311.7	498.7
Missouri	386.9	13.4	6.6	2.0	408.9	204.4	204.4	327.1
TOTAL	1,945.8	116.9	147.5	98.4	2,308.7	1,154.3	1,154.3	1,846.9

Source: U.S. Soil Conservation Service.

1/ Total operation and maintenance cost @ 4 percent per year of construction cost for 20 years.

Regulatory Process

Where erosion is severe but farmers are hesitant to act even with financial incentives, mandatory compliance could be an option. Mandatory compliance might be accomplished through three types of regulatory programs; (1) requirement of compliance with statewide standards, (2) requirement of compliance with federally-defined standards, and (3) requirement of compliance with county standards, where a statewide regulatory program does not exist. These regulatory programs can be accomplished with a more favorable cost-sharing formula or without additional assistance. Administration could vary from federal to counties or local soil and water conservation districts.

Regulatory programs currently exist in some states and local jurisdictions. The Iowa Soil Conservation Districts under state law may require a landowner to implement erosion control practices where a complaint is filed and erosion exceeds district soil-loss standards. The district provides with state funds expanded cost-sharing assistance (75 percent rather than 50 percent) where mandatory controls are imposed. In Minnesota, regulation of a limited set of activities has been undertaken by some watershed districts and at least two counties. Some watershed districts require the implementation of certain practices (such as properly constructed side slopes and the development and maintenance of vegetated buffer strips) along the borders of waterways within their districts before development is permitted. Fillmore County has adopted a county erosion control ordinance. The latter two programs are accomplished without additional cost-sharing assistance.

The U.S. Senate Agricultural Committee is examining approaches to combating soil erosion through employment of conservation measures restricting soil losses so that the future productivity of farmland is preserved.

Regulatory programs have been strongly opposed. In recent hearings on possible amendments to the Clean Water Act requiring installation of practices to prevent land from eroding into waterways, the American Farm Bureau warned against "imposing intolerable burdens on an already severely stressed agriculture." The National Association of Home Builders and the National Cattlemen's Association both said programs should be voluntary. The central issue underlying these arguments is who should pay for benefits which accrue largely downstream of the landowner.

The potential costs of regulatory programs could be greater than the costs of voluntary programs to achieve the same level of protection. However, these programs provide greater certainty that acceptable levels will be attained.

Cross-Compliance

A cross-compliance strategy for reducing erosion and resultant sedimentation would require that farmers carry out a program of soil and water conservation acceptable to the U.S. Department of Agriculture in order to participate in the USDA's commodity, loan, and insurance programs. The application of such a strategy to non-agricultural contributors, such as developers whose construction activities result in runoff to waterways, is also possible.

Aside from the belief that cross-compliance would increase erosion control program effectiveness, the driving force behind the cross-compliance option is the idea that if a landowner abuses the land, the federal government (or, potentially, the state government) should not be providing assistance which could help continue this waste. Another argument is that such a strategy would check the biased competition that results from farmers who abuse their soil, avoiding the cost of conservation.

One draw-back of a cross-compliance strategy is that it does not direct conservation efforts to lands with the worst erosion and runoff problems; it merely applies to landowners who subscribe to the federal programs covered by the strategy. In addition, if farmers only practice conservation when they want to participate in a federal program, inefficiencies are built into the program.

Writing in the Journal of Soil and Water Conservation (March-April 1983), Jay I. Kaplan-Wildmann estimates the annual net benefits of a full USDA cross-compliance strategy at $349 million.

Federal Tax Policy

Federal tax laws affecting soil and water conservation expenditures were introduced in 1954. The 1969 Reform Act and 1979 revisions to the tax laws amended the 1954 provisions.

Tax policies can be effective in reducing the cost of conservation practices to the landowner, and presumably in promoting the implementation of practices. While the analysis of tax impacts is difficult, it appears that farmers who do not plan to sell their land in the next 20 years do realize a tax advantage.

The complex nature of current law and regulations make it difficult for a landowner to evaluate the potential tax consequences of a conservation practice. They, thereby, reduce a potential incentive to install the practice. Tax credits may provide the desired benefits in a more straight-forward manner.

Tax credits are unlikely to satisfy the wide range of erosion and sediment control needs, however. Some landowners with critical erosion and sedimentation problems may not need to take advantage of such credits. Those who do elect to use such credits may not be those with the most severe problems.

Removal of Land from Cropping and Development

For severely eroding cropland or land proposed for development, the only alternative may be to stop cropping or development patterns through purchase or development of cooperative agreements with the landowners to alter land use, with compensation.

Development limitations are routinely accomplished by many local units of government through the use of planning and zoning powers. The state and federal governments may regulate development through adoption of protection programs, such as state and federal wild and scenic rivers designations.

The removal of land from cropping patterns likely would be difficult. Agricultural land use regulation has long been controversial. A purchase or compensation program could be expensive. For example, for the six counties in Minnesota in the study area, over one-half million acres of cropland fall into the "least productive" class. However, there are precedents for such programs on a smaller scale, such as wetland acquisition programs and relocation of buildings in flood plains.

Increased Revenue to Expand Conservation Programs

An alternative way of considering the issue of providing improved protection of lands is consideration of ways of increasing revenues which could be dedicated to soil and water conservation programs. Such revenues could be used to finance several of the options above.

Some methods of increasing revenues are through conservation taxes and tariffs. All consumers of the products of our croplands, both foreign and domestic, benefit from agricultural production and could contribute to a soil conservation fund through an excise tax on agricultural food and fiber products. An excise tax on all agricultural products could be levied at a rate so low that consumers would hardly realize its effect at the retail level, yet could generate a considerable amount of revenue.

A "conservation tariff" would involve a check-off payment on agricultural exports, with the revenue earmarked for soil conservation (e.g., a one percent tariff on all agricultural exports -- estimated at $37 billion in 1980 -- or on exports of the most erosive crops). It is based on the view that foreign consumers of U.S. agricultural products share in the benefits of federal and state expenditures to assure low-cost food supplies by not being required to bear the full cost of production. The tariff would involve foreign consumers of agricultural commodities in the maintenance of the resource base required for these commodities.

The tariff approach would result in higher prices for exports from the United States and could reduce exports. How demand fluctuates relative to the price of each of the products will determine whether revenue from exports increases or decreases. Even if total revenues increase (e.g., because the United States, as a major exporter, is a price leader in the international market), farm level receipts from the sale of exported crops could still decline if part of the revenues received are earmarked for conservation efforts.

Controlling Sediment Deposition

In addition to these alternatives for controlling erosion at its source, there are other measures which can catch sediment before it reaches the river. Dredging sediment traps in tributaries can reduce the amount of sediment reaching the Upper Mississippi River. Also, planting vegetative buffers along waterways through cost-share assistance is considered an effective measure that retains soil along streambanks. By trapping eroded soil from land uphill, the buffer keeps sediment out of streams. The buffers further improve water quality by filtering out herbicides, pesticides, and fertilizers. Buffers also provide food and cover for wildlife.

A third alternative is to control sand-sized particles from reaching the river by increasing bank stabilization or deflecting flow from erodible areas. But, application of conventional streambank protection measures throughout the river system would be costly and does not address the major problem of upland erosion. However, streambank protection along tributaries that contribute large amounts of sand-sized sediment is cost effective and should continue to be implemented.

Conclusion

Sedimentation in the Upper Mississippi River System is a problem that requires the same attention as other river issues. Unless sedimentation is reduced to tolerable levels, the character of the river will change, thus, affecting all the varied river resources. The critical sediment producing area outlined in this report should be the primary focus of any efforts to further control erosion.

The States in the Upper Mississippi River Basin Association feel that additional funding beyond current erosion control programs is essential if both sedimentation and erosion control objectives are to be met. Although the States are not endorsing a specific approach in this report, the Association will continue to work toward an overall erosion and sediment program that is fiscally responsible and implementable. Implementation of any erosion control action should be done with a thorough analysis of environmental and economic effects as well as possible policy implications.

Additional Information Sources

Benbrook, Charles, "Integrating Soil Conservation and Commodity Programs," Journal of Soil and Water Conservation, July-August 1979, pp. 160-167.

Collins, Robert A., "Federal Tax Laws and Soil and Water Conservation," Journal of Soil and Water Conservation, Nov.-Dec. 1982, pp. 319-322.

Great River Environmental Action Team, GREAT II Main Report, December 1980.

Great River Environmental Action Team, A Study of the Upper Mississippi River: GREAT I Main Report, September 1980.

Great River Environmental Action Team, GREAT I Report, Channel Maintenance Appendix, September 1980.

Kaplan-Wildmann, Jay I., "Cross-Compliance to Enforce Soil and Water Conservation," Journal of Soil and Water Conservation, March-April 1983, pp. 75-78.

Mekelburg, Milton E., "New Approaches to Commodity Programs and Conservation Goals," Journal of Soil and Water Conservation, July-August 1983, pp. 334-325.

Ogg, Denley, and Clayton, "Stretching Conservation Assistance," Journal of Soil and Water Conservation, July-August 1983, pp. 326-328.

Seitz, Wesley D., "Viewpoint: A Conservation Tariff," Journal of Soil and Water Conservation, May-June 1981, pp. 120-121.

U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980.

U.S. Department of Agriculture, Soil Conservation Service, Program Proposal for Critical Sediment Producing Areas, June 1983. (unpublished)

Upper Mississippi River Basin Commission, Water Resources Management Plan, Vol. 1: Upper Mississippi Region, September 1981. (review draft)

Upper Mississippi River Basin Commission, Comprehensive Master Plan for the Management of the Upper Mississippi River System, January 1982.

Upper
Mississippi River
Basin Association

415 HAMM BUILDING
408 ST. PETER STREET
ST. PAUL, MINNESOTA 55102