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STREAM SEDIMENT MONITORING PROGRAM FOR ILLINOIS

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Background

Erosion and sedimentation processes have been occurring since prehistoric times. Indeed, these natural processes have resulted in topographic features such as peneplains, rearrangement of glacial materials, and the sinuous nature and maturity of rivers and streams. Erosion and sedimentation are not processes that can be completely stopped — water moving on the land surface and in streams and rivers will always move sediment. Unfortunately, human activities drastically hasten these processes. Even more importantly, human activities that lead to increases in erosion and sedimentation have increased in recent decades.

Although some of the acceleration of erosional and depositional processes is the result of increased road and building construction, much of the increase, especially in the Corn Belt, has arisen from changes in agricultural practices. Fall plowing helps ensure that crops can be planted early the next spring, but also means that highly erodible soil is exposed from fall through spring. Clean, efficient harvest techniques help ensure maximum crop production, but leave little debris on the soil surface to resist wind and water erosion. The tilling of marginal land increases acres for crop production, but exposes soil surfaces that are particularly vulnerable to erosional processes. In many parts of Illinois, the present thickness of the topsoil is in the range of 4 to 15 inches compared with the original 10 to 18 inches. In some parts of the state, almost 70% of the topsoil has been lost through erosion by the action of water and wind.

Total erosion in the United States can be subdivided as follows: 78? from sheet and rill erosion, 11% from stream banks, 6? from gullies, 3? from roads and roadsides, and 2? from construction sites. Figure 1 shows where sheet and rill erosion is most severe (1). Figure 2 depicts the annual soil loss from sheet and rill erosion on croplands (1). The state of Illinois is located near the geographical center of the Corn Belt, which is clearly the area with the most intensive erosion in the country.

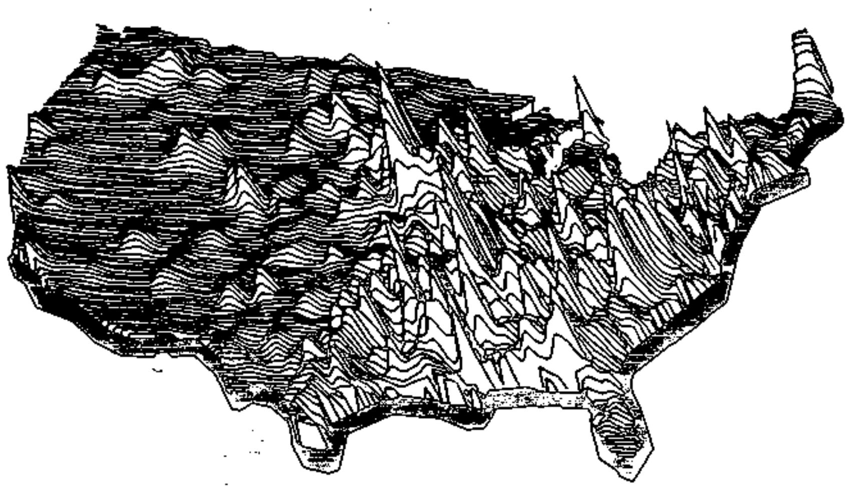

Figure 1. Sheet and rill erosion in the United States

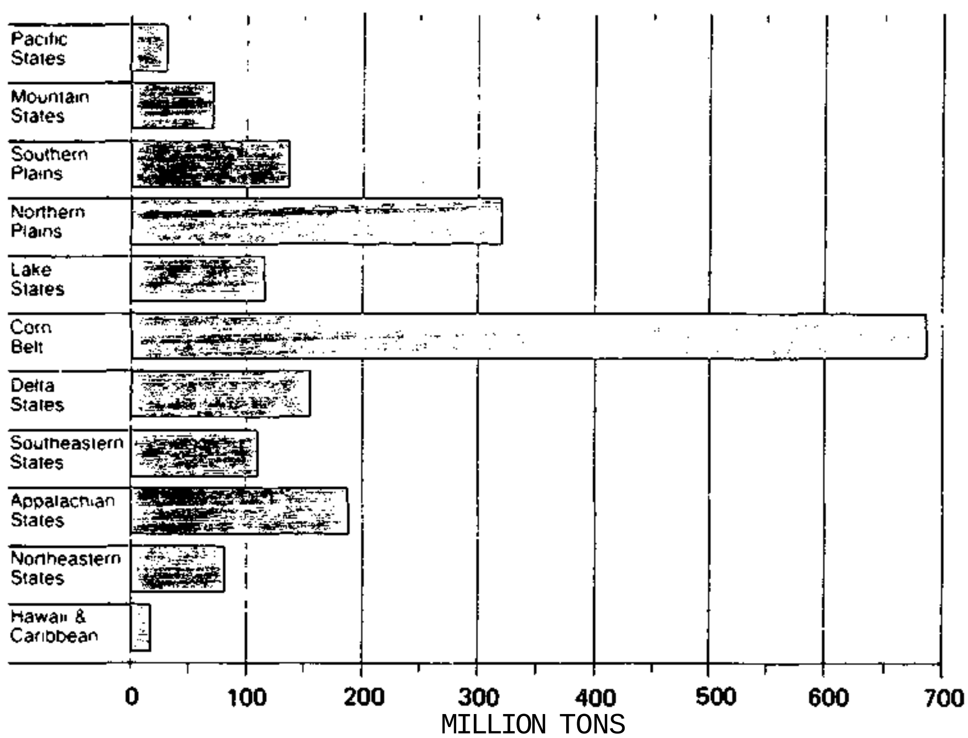

Figure 2. Estimated total annual soil loss resulting from sheet and rill erosion on cropland, by crop production, 1977

Although this erosional loss of soil is an enormous problem, the impacts are not confined to the cropland itself. Material lost from the land surface is deposited in depressions, drainage ditches, valley bottoms, streams, and lakes.

Excess sedimentation taxes the limited resources for clearing and cleaning drainage ditches, substantially decreases the storage capacities of public water supply lakes, and impairs the recreational use and biological productivity of many water bodies.

Rationale for the Program

Sedimentation in Illinois lakes and sediment transported by Illinois streams are recognized as major pollution issues. Although soil erosion, sediment transport, and sedimentation are natural processes, they interfere with stable, economical, and productive use of watersheds, streams, and lakes.

The interaction between sediment and water is now recognized as a major water resources problem. The magnitude of this problem is still ill-defined. Various physical means to control soil erosion and stream channel erosion have been considered and to some extent implemented. Increased implementation will have enormous societal and environmental ramifications. Unfortunately, many of the physical and chemical aspects of sediment in rivers and lakes are not yet known or are not understood clearly.

Knowledge of sediments in Illinois water affects a multitude of government and business decisions in the state. There are many gaps in our current knowledge in this area. For example, there are major questions with poorly quantified information on:

- Impacts of sediment on stream biota and stream environment
- Impacts of sediment on water treatment plants
- Lake sedimentation
- Locations and causes of sheet, gully, and stream bank erosion
- Relative magnitude of sheet and rill erosion and bank erosion in watersheds
- Effect of reduced field erosion on instream erosion
- Pollutants carried by sediment
- Quantity of sediment carried by Illinois streams

Even though the state has made some decisions to deal with these impacts, further data and information are needed to make regulatory decisions related to:

- Reductions in watershed erosion
- Best management practices to be followed
- Effects of changing land use and cropping patterns
- Stream channelization
- Land use and management along stream banks and lake shores

Sedimentation affects the capacity and water quality of water supply lakes and reduces storage capacity in flood control reservoirs. Sediment deposition in streams affects the conveyance of the stream and its capacity to sustain a viable aquatic habitat. The biota in all of these waters are potentially affected by the chemical composition of the sediment, sediment deposition, and sediment load.

As a consequence of these complex, wide-ranging impacts, sediment is of concern in major state activities. These include: 1) the maintenance of water quality (Environmental Protection Agency, IEPA); 2) farming (Department of Agriculture, IDOA); 3) regulation of our waterways, construction of hydraulic structures, and development of surface water impoundments (Division of Water Resources, DWR); and 4) the preservation of natural stream courses (Department of Conservation, DOC). All of these areas relate to the overall maintenance and management of the state's natural resources (Department of Energy and Natural Resources, DENR).

Program Requirements

Correct answers to the myriad technological, scientific, and policy questions can come only from high-quality data of sufficient breadth, in both time and space, to allow research and production of reliable answers. Unfortunately, these data do not exist. Data are one of the key components in the formulation of plans and policy.

Therefore, an action program is needed to establish and maintain a statewide sediment monitoring network. For this, Illinois needs to make a commitment to provide stable, long-term support. The key values of the data and information derived will be to: 1) provide real-time answers to new or current problems, and 2) provide answers and information for planning based on long-term data bases.

In the latter application, existing and envisioned issues relate to: 1) trends in sedimentation related to man-made changes (is it getting better or worse?); 2) the water quality in streams as affected by sediment load; 3) the magnitude of sedimentation in lakes and the sediment load in streams during prolonged wet and dry (drought) periods; 4) pollutants (pesticides, nutrients, and heavy metals) transported by sediments; and 5) the development of a set of direct relationships between rain and soil factors for different physiographic areas, so as to have adequate models for transferring results to all parts of the state, and for predicting sediment load in unmeasured streams.

Program Goals

To partially serve these ends, an instream sediment data collection program was initiated in October 1980 with support from three different agencies. This was envisioned to be a part of an evolving major program that would involve a multi-year project. It had twin goals:

- To collect and study data at 50 sediment monitoring stations located at strategic locations around the state,
- To prepare and carry out a comprehensive master plan for a multi-agency sediment monitoring program involving installation, operation, and study of data from a statewide sediment network.

Framework of the Program

The program presently envisioned is but one key part of a more comprehensive statewide program that is needed to provide information, data, and analyses on lake sedimentation rates, critical erosion areas, and the type and extent of best management practices on the watershed. Planning to date reveals that a long-term, statewide sedimentation network of 60 or more sampling stations is needed and should be operated for at least 10 to 20 years. The program must involve editing, analyzing, and interpreting the resulting data, while making the data available to all users.

Review of Current Program

Water Year 1981

For Water Year 1981 (October 1, 1980 to September 30, 1981), support from three different sources was obtained, totaling about $195,000. The

Illinois EPA contributed $98,000, the Illinois Department of Energy and Natural Resources contributed $50,000, and IDOT (DWR) (Title III) contributed $47,680.

Data from 50 gaging stations around the state (figure 3) were collected. Of these 50 stations, 27 were intensive stations and the remaining 23 were weekly stations. Daily suspended sediment samples were collected from the intensive stations from March through June 1981. For the rest of the year, weekly suspended sediment samples were collected.

Water Year **1982**

For Water Year 1982 (October 1, 1981 to September 30, 1982), support was obtained from Title III money through the Division of Water Resources in the amount of $39,000. In addition, DENR awarded $50,000. Thus the total support for the 1982 water year was $89,000, which was a 54% reduction in the funding level from the previous water year (1981).

Because of the reduced funding levels, it was necessary to cut back the scope of the data collection program. For that water year, suspended sediment loads at about 25 key weekly stations throughout the state were monitored. Of these 25 stations, 3 stations were maintained with partial support from another project and 4 stations were maintained by Water Survey employees.

Hater Year 1983

Support was not available from Title III through the Division of Water Resources for Water Year 1983 (October 1, 1982 to September 30, 1983). Therefore the only source of funds available to support the sediment network for the year was DENR. They awarded a grant for $60,000, which was just enough to maintain 18 weekly stations. It must be pointed out that data from 18 stations are completely insufficient for estimating the sediment loads of Illinois streams and their trends. For a state such as Illinois with extensive stream networks and high runoff rates, data from at least 60 stations are needed to determine the impacts of soil erosion.

The USGS is entering the analysis phase of a major effort to determine instream sediment loads in North Carolina. Data were collected for 10 to 13 years at over 140 stations. Considering Illinois climate, soils, and

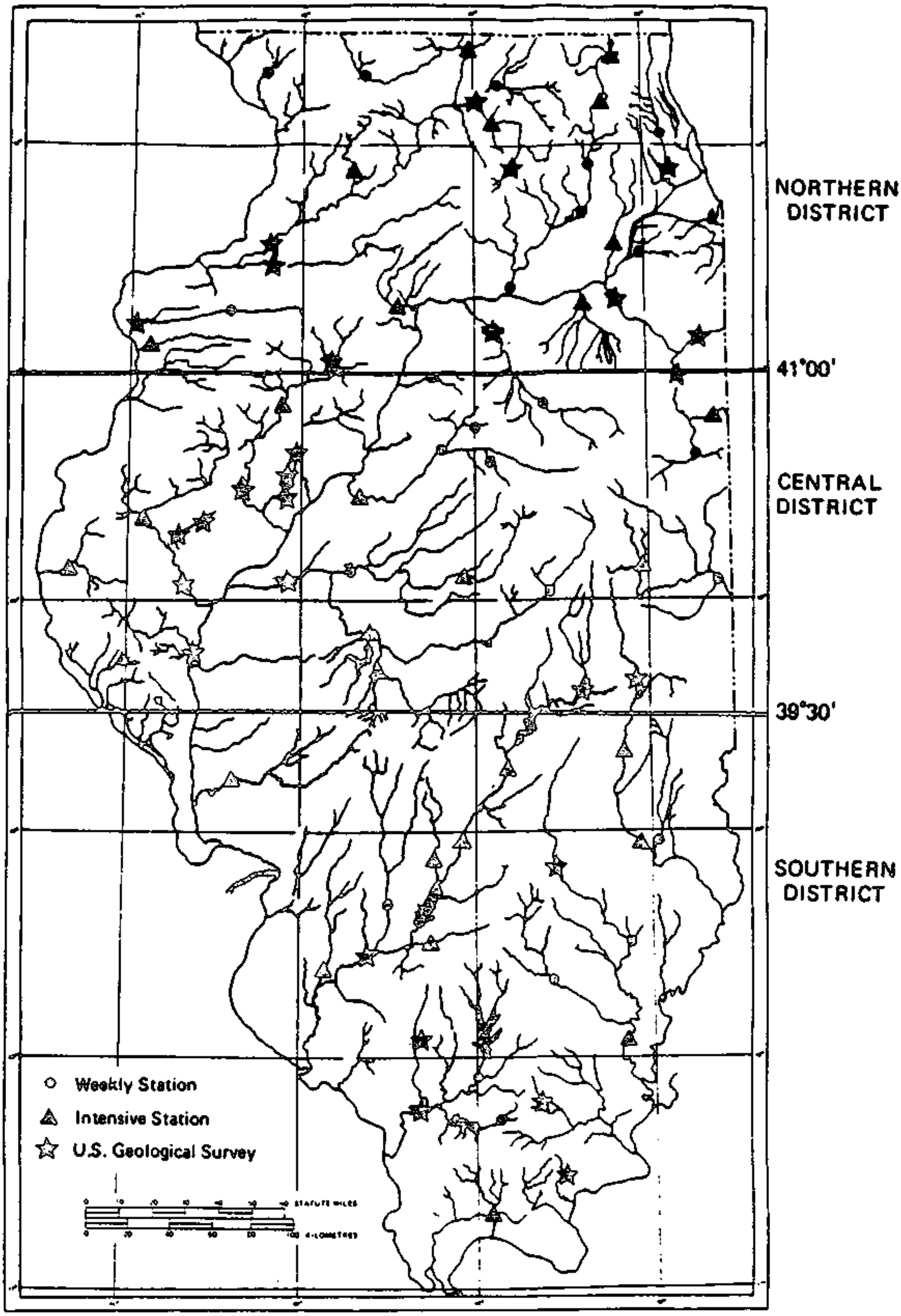

Figure 3. Sediment Monitoring Network for Illinois
for Water Year 1981 (October 1980 through September 1981)

topography, a somewhat smaller number of stations will be adequate, but 10 years of data are necessary.

Our research on the Kankakee and Iroquois Rivers and the preliminary analyses of the sediment data have shown that about 80 to 90% of the total yearly sediment load in a river is transported within a 60- to 90-day period during storms (figure 4). Moreover, sediment load varies over a year and from year to year depending upon upland conditions and climatic variability. Of the three years shown in figure 4, WY80 was a dry year, WY79 was a normal year, and WY81 was a wet year. It is clear from this illustration that in the relatively dry year, most of the yearly sediment load moved within a period of 20 to 30 days during the storm period, whereas in the wet year it took about 80 to 100 days to transport about *80%* of the yearly sediment load. Another important observation is that streams transport sediment in episodes which may or may not correlate well with the stream discharges (figure 5).

Collections of weekly sediment samples will normally miss most of the storm events. Thus the WY83 program could not show the total sediment load and its distribution over the year. This deficiency could not be avoided with the reduced level of funding.

Water Years 1984 and 1985

During late 1983, all the outside funding for the sediment network came to an end, and the Illinois State Water Survey reallocated its internal resources to maintain a minimal stream sediment monitoring network. This network was incorporated into the Water Survey's Water and Climate Benchmark Network and has since been operated by Water Survey personnel. During these two years (October 1983 through September 1985), 18 weekly stations have been maintained by the Water Survey. The locations of these stations are indicated in figure 6, along with the proposed monitoring network.

Future Outlook

The 18 weekly stations presently monitored are not sufficient to quantify the instream sediment loads in Illinois. It is imperative that a more detailed network with a well balanced geographic distribution be initiated if we are to manage the soil and water resources of the state in a judicious manner. Cooperation and support from various state agencies such as IDOT

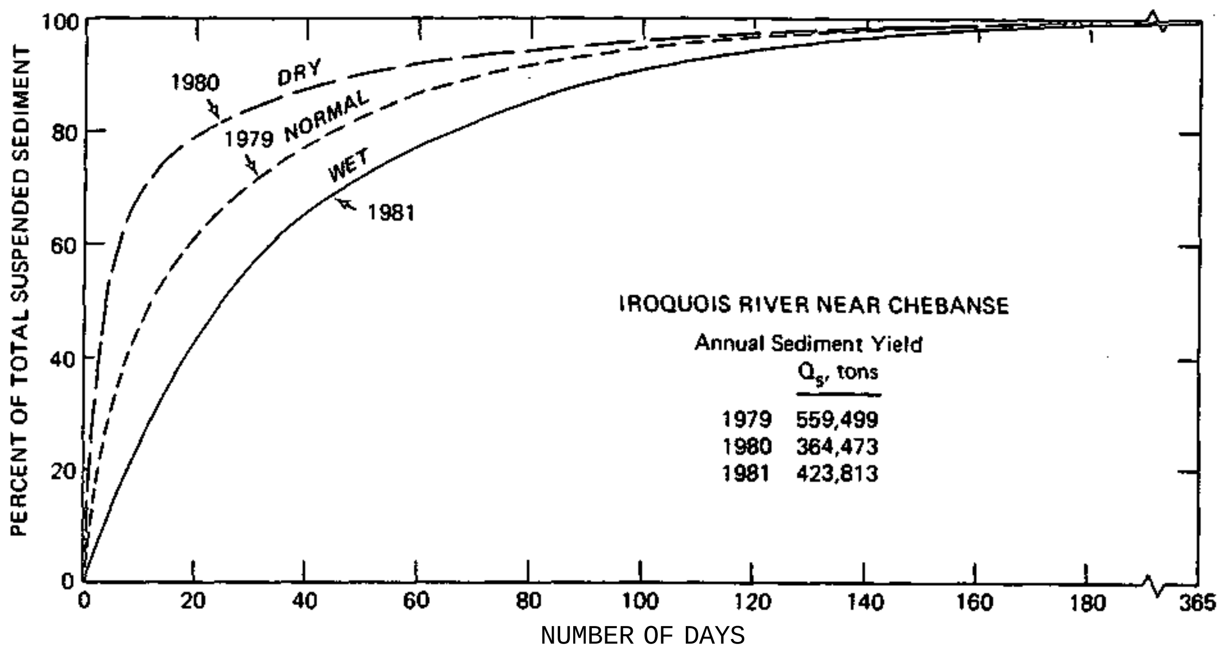

Figure 4. Percent of total suspended sediment transported in a given number of days, Iroquois River near Chebanse

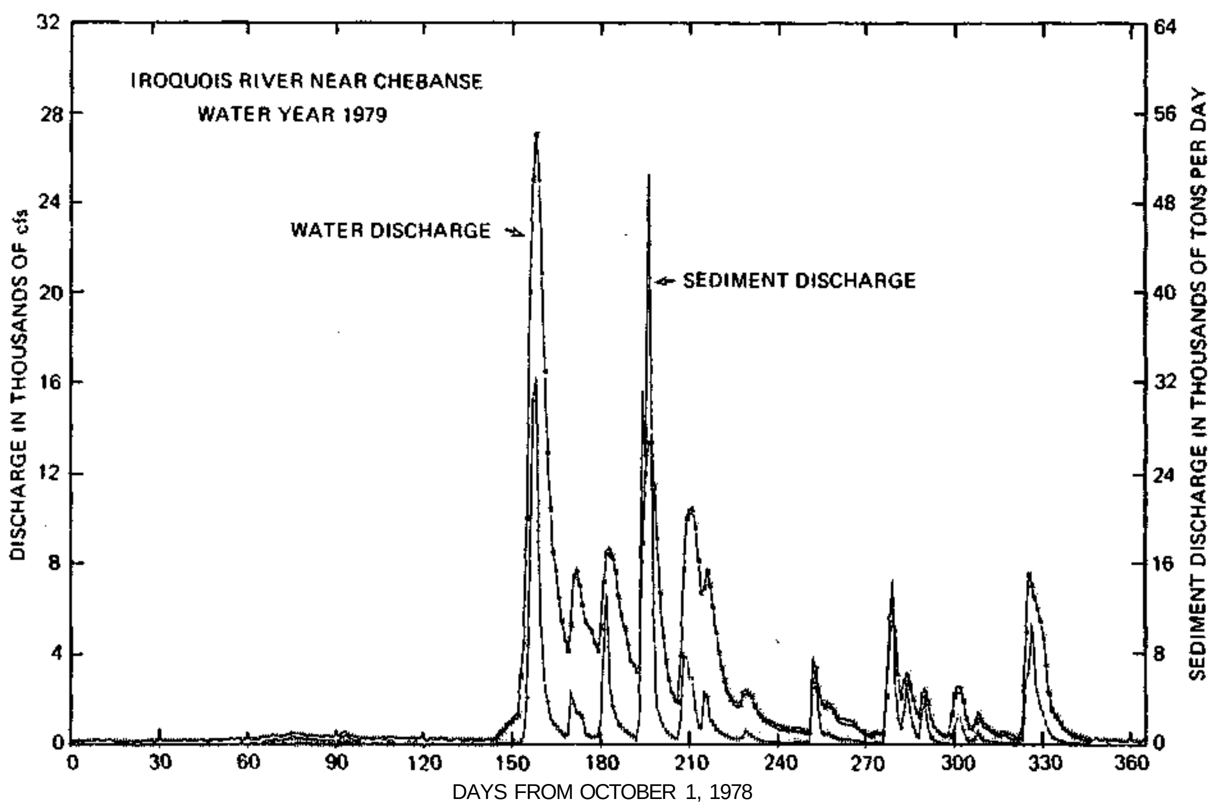

Figure 5. Daily water and suspended sediment discharges for the Iroquois River near Chebanse, water year 1979

(DWR), IDOA, IEPA, IDOC, and DENR is necessary and essential in the development and operation of a viable network.

Water Survey engineers and scientists are presently analyzing all the available instream sediment data from Illinois to arrive at a preliminary estimate of the sediment loads of Illinois streams. Moreover, this analysis has helped us to determine some deficiencies of the original network in terms of geographical and physiographic coverage of the monitoring stations. This analysis is providing an improved understanding of sediment movement in Illinois streams. With an adequate (10-year) data base for about 60 stations, the results can be refined and finalized. With daily sampling when high water and sediment loads are likely, the flood event sediment transport characteristics can be determined. It is very likely that this data base will be large enough to support development of a new, more accurate method of determining long-term average annual sediment loads. The recommendations outlined below are based on the Water Survey professionals' intimate knowledge of Illinois streams and rivers, and on the detailed analyses they have performed.

Recommendations

It is recommended that the state initiate a regular stream sediment monitoring program at 64 stream gaging sites throughout the state. The locations of these proposed stations are shown in figure 6, and table 1 gives a listing of the stations. The number and location of stations were determined by a study of the existing data for Illinois rivers, the major watersheds of the state, and the 11 sediment yield areas identified in our current research into sediment laods in Illinois streams. An adequate number of stations are needed in each major river basin for watershed analysis and in each sediment yield area for regional analysis, including multiple regression analysis. The salient features of this network will be as follows:

- All stations will be located at regular U.S. Geological Survey stream gaging sites.
- Two stations will be located on the Illinois River, one at Marseilles and one at Valley City. These two stations will be expensive to operate but will give an integrated measurement of sediment load on the largest instate river.

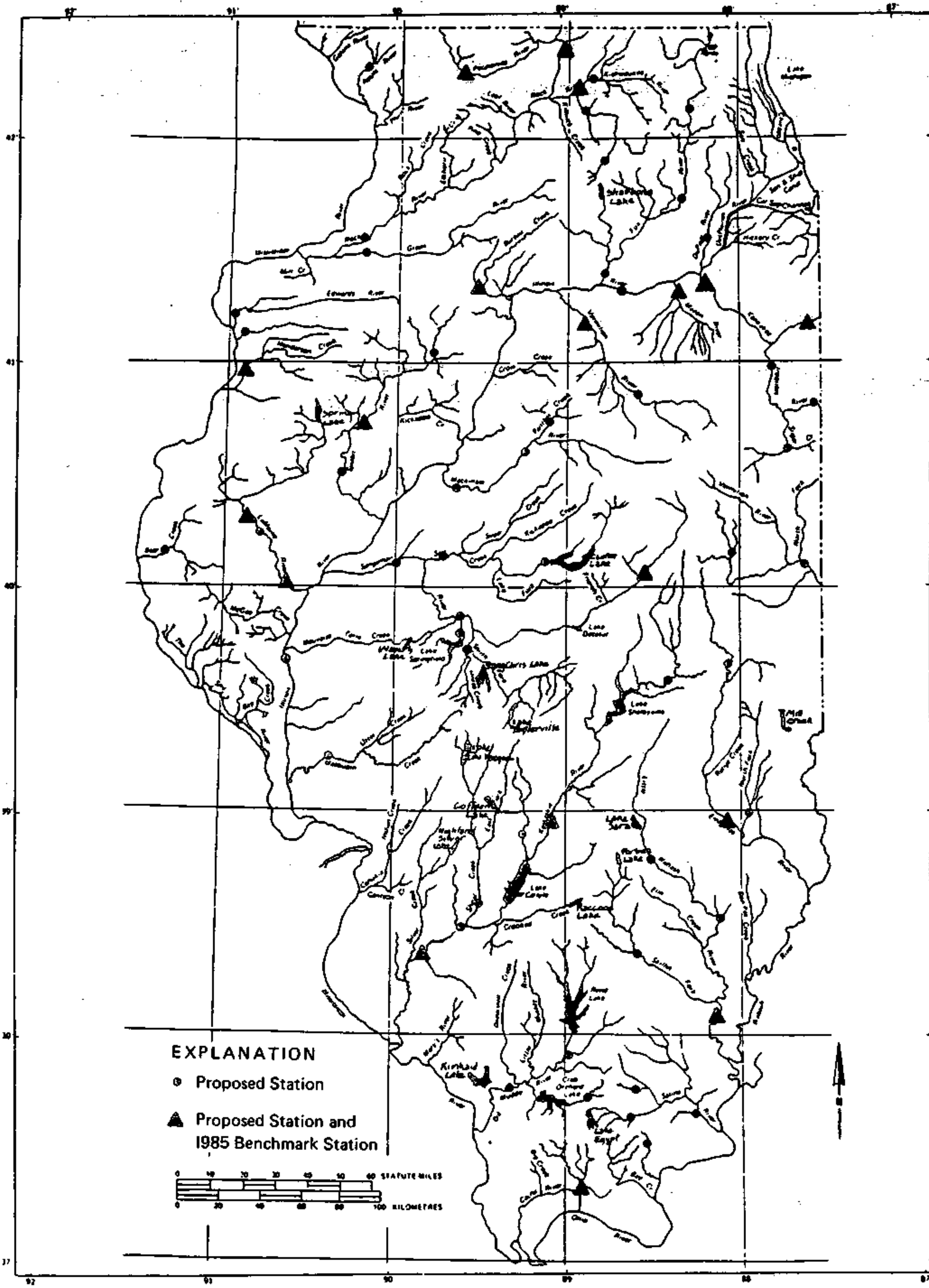

Figure 6. Proposed Sediment Monitoring Stations
(with 1985 Benchmark Stations indicated)

TABLE 1. PROPOSED SEDIMENT MONITORING STATIONS

STA. CODE	USGS STA.NO.	USGS STATION NAME	DRAINAGE AREA	RIVER BASIN
101	05418950	APPLE RIVER NEAR ELIZABETH	207	APPLE
102	05435500	PECATONICA RIVER AT FREEPORT	1326	ROCK
103	05437500	ROCK RIVER AT ROCKTON	6363	ROCK
104	05438500	KISHWAUKEE RIVER AT BELVIDERE	538	ROCK
106	05439500	SOUTH BRANCH KISHWAUKEE RIVER NEAR FAIRDALE	387	ROCK
107	05550000	FOX RIVER AT ALGONQUIN	1403	FOX
108	05529000	DES PLAINES RIVER AT DES PLAINES	360	DES PLAINES
109	05532500	DESPLAINES RIVER AT RIVERSIDE	630	DES PLAINES
111	05439000	SOUTH BRANCH KISHWAUKEE RIVER AT DEKALB	77.7	ROCK
113	05446500	ROCK RIVER NEAR JOSLIN	9549	ROCK
114	05551540	FOX RIVER AT MONTGOMERY	1732	FOX
116	05540500	DUPAGE RIVER AT SHOREWOOD	324	DUPAGE
117	05552500	FOX RIVER AT DAYTON	2642	FOX
119	05447500	GREEN RIVER NEAR GENESEO	1003	GREEN
120	05466500	EDWARDS RIVER NEAR NEW BOSTON	445	EDWARDS
122	05555300	VERMILION RIVER NEAR LENORE	1251	VERMILION
124	05527500	KANKAKEE RIVER NEAR WILMINGTON	5150	KANKAKEE
125	05520500	KANKAKEE RIVER AT MOMENCE	2294	KANKAKEE
126	05568800	INDIAN CREEK NEAR WYOMING	62.7	SPOON
127	05467000	POPE CREEK NEAR KEITHSBURG	183	POPE CR
227	05543500	ILLINOIS RIVER AT MARSEILLES	8259	ILLINOIS
228	05469000	HENDERSON CREEK NEAR OQUAWKA	432	HENDERSON
229	05569500	SPOON RIVER AT LONDON MILLS	1062	SPOON
230	05566500	EAST BRANCH PANTHER CREEK AT EL PASO	30.5	MACKINAW
231	05554490	VERMILION RIVER AT MCDOWELL	551	VERMILIO
232	05526000	IROQUOIS RIVER NEAR CHEBANSE	2091	KANKAKEE
233	05525000	IROQUOIS RIVER AT IROQUOIS	686	KANKAKEE
234	05525500	SUGAR CREEK AT MILFORD	446	KANKAKEE
236	05567510	MACKINAW RIVER BELOW CONGERVILLE	776	MACKINAW
237	05568005	MACKINAW RIVER BELOW GREEN VALLEY	1092	MACKINAW
241	05570000	SPOON RIVER AT SEVILLE	1636	SPOON
242	05584500	LA MOINE RIVER AT COLMAR	655	LA MOINE
243	05495500	BEAR CREEK NEAR MARCELLINE	349	BEAR CREEK
244	05584685	GRINDSTONE CREEK NEAR BIRMINGHAM	45.4	LA MOINE
245	05585000	LA MOINE RIVER AT RIPLEY	1293	LA MOINE
246	05583000	SANGAMON RIVER NEAR OAKFORD	5093	SANGAMON
247	05582000	SALT CREEK NEAR GREENVIEW	1804	SANGAMON
248	05578500	SALT CREEK NEAR ROWELL	355	SANGAMON
249	05572000	SANGAMON RIVER AT MONTICELLO	550	SANGAMON
250	03336900	SALT FORK NEAR ST. JOSEPH	134	VERMILION
251	03339000	VERMILION RIVER NEAR DANVILLE	1290	VERMILION
252	05576500	SANGAMON RIVER AT RIVERTON	2618	SANGAMON
253	05586100	ILLINOIS RIVER AT VALLEY CITY	26564	ILLINOIS
254	05576022	SOUTH FORK SANGAMON RIVER BELOW ROCHESTER	870	SANGAMON
255	05591200	KASKASKIA RIVER AT COOKS MILLS	473	KASKASKIA
356	03343550	EMBARRAS RIVER NEAR OAKLAND	542	EMBARRAS
359	05587000	MACOUPIN CREEK NEAR KANE	868	MACOUPIN
362	03345500	EMBARRAS RIVER AT STE. MARIE	1516	EMBARRAS
363	03346000	NORTH FORK EMBARRAS RIVER NEAR OBLONG	318	EMBARRAS
364	03378900	LITTLE WABASH RIVER AT LOUISVILLE	745	L. WABASH
366	05594000	SHOAL CREEK NEAR BREESE	735	KASKASKIA
367	05594800	SILVER CREEK NEAR FREEBURG	464	KASKASKIA
368	03380500	SKILLET FORK AT WAYNE CITY	464	L. WABASH
369	03379600	LITTLE WABASH RIVER AT BLOOD	1387	L. WABASH
370	03381500	LITTLE WABASH RIVER AT CARMI	3102	L. WABASH
371	05597000	BIG MUDDY RIVER AT PLUMFIELD	794	BIG MUDDY
373	05599500	BIG MUDDY RIVER AT MURPHYSBORO	2169	BIG MUDDY
374	05597500	CRAB ORCHARD CREEK NEAR MARION	31.7	BIG MUDDY
375	03382170	BRUSHY CREEK NEAR HARCO	13.3	SALINE
376	03382100	SOUTH FORK SALINE RIVER NEAR CARRIER MILLS	147	SALINE
377	03384450	LUSK CREEK NEAR EDDYVILLE	42.9	LUSK
378	03612000	CACHE RIVER AT FORMAN	244	CACHE
379	05594100	KASKASKIA RIVER NEAR VENEDY STATION	4393	KASKASKIA
399	03382530	SALINE RIVER AT GIBSONIA	1062	SALINE

- Suspended sediment samples will be collected on a weekly basis. Daily samples will be collected during storm events and for a period of about 60 to 90 days. Samples will also be collected to determine particle size distribution of the suspended sediments.
- Turbidity will be measured on a selective basis.
- Analyses will be performed to determine seasonal, yearly, periodic, and period-of-record sediment loads.
- Statistical analyses will be performed to determine trends, variabilities, and the influences of external forces.
- Yearly reports will be published and made available to all state, local, and other public agencies and entities.
- Periodic evaluation of the network will be performed to determine the future direction and extent of the network.
- Inputs from DWR, IDOC, IDOA, IEPA, AISWD, SCS, USGS and other interested agencies will be sought to maximize the data collection from the network.

The analyses will also incorporate the various hydraulic, hydrologic, and geomorphic variables of the watershed including physical factors such as geology, soil characteristics, landscape features, slopes, and human influences such as land use.

Support needed for such a program will be as follows:

- One half-time hydraulic engineer
- A Network supervisor
- Four field personnel
- One full time and one half-time laboratory technician
- Equipment such as vans for field data collection, and suspended sediment samplers
- Travel
- Miscellaneous supplies
- Secretarial support

The total yearly cost of such a program will be $275,000 with an additional $110,000 needed in the first year for initiation of the program. This additional money will be needed to purchase essential sediment measuring equipment and field vehicles.

Acknowledgements

Many Water Survey staff members are working on the instream sediment load analyses of Illinois streams and rivers. Special thanks are extended to Al Bonini and Mike Demissie. Appreciation is also expressed to Richard J. Schicht, Acting Chief of the Water Survey; William C. Ackermann, Chief Emeritus of the Water Survey; Glenn E. Stout, Director, Water Resources Center, University of Illinois; Gary Clark of the Illinois Division of Water Resources and other members of the State Water Plan Task Force for reviewing the manuscript of this report. Thanks to Gail Taylor for editing the report, and Becky Howard for typing the camera ready copy.

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