Miscellaneous Publication 178

Guidelines for a Supplemental Hydrological and Meteorological Database for the 1993 Midwestern Flood

by
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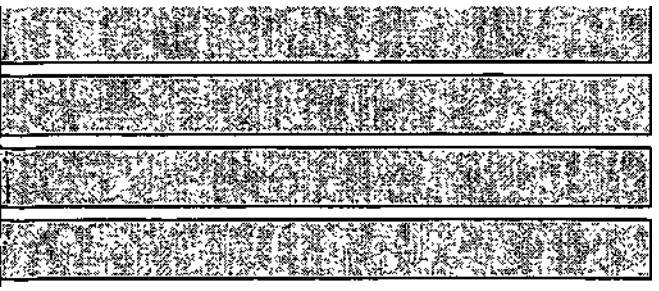
October 1996



Illinois State Water Survey
Atmospheric Sciences and Hydrology Divisions
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A Division of the Illinois Department of Natural Resources

GUIDELINES FOR A SUPPLEMENTAL HYDROLOGICAL AND METEOROLOGICAL DATABASE FOR THE 1993 MIDWESTERN FLOOD

Robert W. Scott and H. Vernon Knapp

NSF Grant EAR-94-12460

Illinois State Water Survey

October 1996

ISSN 0733-3927

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INTRODUCTION

This report contains guidelines for use of a hydrological and meteorological database that has been developed for the 1993 flood in the Midwest. The emphasis is on presentation of difficult-to-access data collected largely by state agencies and, to some extent, by federal agencies across the nine-state area affected by the flood of May-August 1993, one of the most devastating floods ever to occur in the north central United States. Numerous cities located along the major rivers of the nine-state region were inundated by the high waters that broke levees and flooded lowlands, destroying homes, farms, and businesses from central Minnesota to southwestern Illinois. Precipitation recorded at raingage sites of the National Weather Service (NWS) revealed record totals for several consecutive months over wide areas of the Midwest.

This report describes the types and sources of hydrological and meteorological data that were assembled. Many sources are special meteorological and hydrological networks operated by agricultural or research agencies in various states. Some small, dense networks cover only select regions of a state, while other less dense networks cover entire states. In addition, some meteorological networks include not just precipitation, but a full array of weather observations.

The database can be accessed in two ways:

- First, it is on the Internet and accessible on the Midwestern Climate Center's home page (http://mcc.sws.uiuc.edu/) under the title, "1993 Mississippi River Flood Supplementary Data" (see appendix).

- Second, three disks containing the database can be ordered from the Illinois State Water Survey, 2204 Griffith Drive, Champaign, Illinois 61820. Data are on a 3 1/2-inch IBM-compatible disk and are available in table or comma-delimited ASCII format. The cost is $45.

For all sources, data are provided for the period from 1 April to 30 September 1993. However, some data files also include data for portions of 1992, and other files extend to the end of 1993. In addition, for comparison purposes and since hydrologic responses are frequently slower, some hydrological data made available include considerable pre-flood historic data and other data that extend well past the flood. All data are provided for public use, free of charge, other than costs of the data on a disk. We do request, however, that for those data obtained through this source, and which are later used in a technical report or scientific paper, proper acknowledgment and reference be given to the Illinois State Water Survey.

This endeavor has been a result of National Science Foundation Grant EAR-94-12460 and support by the Illinois State Water Survey, a division of the Illinois Department of Natural Resources. The project was done under the direction of Principal Investigators Stanley A. Changnon, Nani G. Bhowmik, and Kenneth E. Kunkel. The authors and P.I.s wish to thank the staff of numerous state agencies who graciously provided the data in this database.

HYDROLOGICAL DATA

Most of the hydrological data are provided in two formats: tabular form using ASCII and a comma-delimited file for easy access by spreadsheet users. A short example of the ASCII format is provided, and the following sections describe each type of data. The data can be downloaded through the Internet from the Midwestern Climate Center's home page (see appendix for the World Wide Web address) under the title, "1993 Mississippi River Flood Supplementary Data," or ordered on three disks.

River Stages at Sites on the Mississippi and Illinois Rivers

River stage information is provided by the U. S. Army Corps of Engineers (COE) for general information purposes only. Verified data may be obtained for the region of the 1993 Midwestern flood from either the Rock Island or St. Louis Districts of COE. A link to these sources appears in on the Midwestern Climate Center's World Wide Web and the Illinois State Water Survey (WWW) display of these data, and the address is also included in the appendix.

In these data, daily river-level gage information is provided for all of 1993 at 11 river gaging stations along the Mississippi River bordering Illinois and for one site on the Illinois River. In addition, data at 6-hour intervals are included at four sites along the Mississippi River during the month of July 1993, the period of highest water levels. Site specifications for each gaging station can be obtained from an Internet link to COE from the Midwestern Climate Center home page (see appendix for address). These descriptions include: an identification number, the river or stream along which each gage is located, gage zero level, flood stage level, date and height of the record river level, latitude and longitude of the gage location, drainage area serviced by the gage, and river mile of the gage as measured north from the confluence of the Ohio River downstream. Additional data may be included at some sites. All heights are provided in feet and drainage areas in square miles.

The daily gaging sites include: Dubuque, Iowa; Camanche, Iowa; Burlington, Iowa; Keokuk, Iowa; Quincy, Illinois; Hannibal, Missouri; Grafton, Illinois; St. Louis, Missouri; Chester, Illinois; Cape Girardeau, Missouri; Thebes, Illinois; and Hardin, Illinois. The four 6-hour sites are Burlington and Keokuk, Iowa; Quincy, Illinois; and Hannibal, Missouri. Examples of the daily (24-hour) and 6-hour river stage data are shown in Tables 1 and 2, respectively.

Table 1. Sample Data Format for the Daily River Stage Data along the Mississippi River at Dubuque, Iowa.

Date	Stage
1/1/93	8.8
1/2/93	9.2
1/3/93	9.3
1/4/93	9.4
1/5/93	9.4

Note: Flood stage = 17 feet.

Table 2. Sample Data Format for the 6-hour River Stage Data along the Mississippi River at Burlington, Iowa.

	Time of Day			
Date	0600	1200	1800	2400
7/1/93	21.62	21.66	21.61	21.61
7/2/93	21.75	21.90	22.03	22.14
7/3/93	22.23	22.31	22.32	22.38
7/4/93	22.40	22.40	22.40	22.42
7/5/93	22.44	22.45	22.49	22.53

Daily Flows of the Mississippi River and Tributaries

Official streamflow data for the 1993 flood are maintained by the U.S. Geological Survey (USGS). No supplemental streamflow data are provided here. However, for completeness of the topic, a WWW link is provided on the Internet display, and the address is in the appendix.

Wetland Reserve Programs

The Wetlands Reserve Program (WRP) is a voluntary program offering payments to landowners for restoring and protecting wetlands. Authorized by the Food Security Act of 1985 (and amended in the 1985 and 1990 Farm Bills), the WRP provides a unique opportunity for farmers to retire marginal lands and reap the benefits of having wetlands on their property. The WRP obtains easements from participating landowners and provides cost-share payments for wetland restoration. Similar to the Conservation Reserve Program, the WRP pays farmers to safeguard certain lands — in this case, wetlands. The WRP is administered by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture, formerly the U.S. Soil Conservation Service.

The Emergency Wetlands Reserve Program (EWRP) is very similar to the WRP, with two differences: 1) land accepted into the program must have been flooded, and 2) appropriations for the program come from emergency disaster relief programs, not the Farm Bill. The EWRP is justified on the basis that it will reduce the money needed to repair or pay for flood damages now and in the future.

The intent of both programs (WRP and EWRP) is to offer landowners the appraised agricultural market value (as is) of their land in exchange for a permanent easement and restoring the land to a wetland. Easements for 30 years also are offered for 50 percent of the appraised value. A link to the Nebraska NRCS office is provided from our WWW display, and the address appears in the appendix.

Data in this report list the total acreage of lands accepted into the WRP and EWRP for several Midwestern states from 1993-1995. Listings have been provided by the state offices of the NRCS. Most of the land accepted into the EWRP program in the years after the flood had been inundated in 1993, but could not be included in the program until additional funds were allocated. Often, this is true also of parcels of land accepted into the WRP program, although it is not required for the land to have been flooded. It is sufficient that these lands are able to be restored to a wetland function or otherwise contribute significantly to wetland values. Table 3 presents a sample format of data in the WRP and EWRP programs from Illinois.

Table 3. Sample Data Format for the WRP and EWRP Programs from Illinois.

WETLANDS RESERVE PROGRAM Illinois Statistics					
County	WRP-1994 (Acres)	EWRP-1994 (Acres)	WRP-1995 (Acres)	EWRP-1995 (Acres)	Total acres
Alexander		197.4		2216.5	2413.9
Bureau		25.9			25.9
Clay	472.0				472.0
Douglas	43.4				43.4
Fayette	547.6				547.6
Greene	69.5				69.5
Jackson			2065.2	1026.0	3091.2

Levees and Drainage Districts

SAST Levee Database - Abridged Text Version

Levee data included were abstracted from the Upper Mississippi/Missouri Rivers Levee Database, developed by the Scientific Assessment and Strategy Team (SAST) of the U.S. Geological Survey, along with cooperation from the U.S. Army Corps of Engineers. The SAST Levee Database was designed using ARC/INFO software, a Geographic Information System (GIS), which provides both a comprehensive vector base map, showing locations of levees, and a table of attribute data for these levees.

The information included here provides easy access to a portion of the database. It was particularly targeted to provide data for those individuals without access to ARC/INFO. Only one minor modification has been made to the SAST data: state and county locations were added in the few cases where such data were missing.

The following attributes (data items) are presented in the accompanying table:

Lev#	SAST levee identification number
St	State in which the levee is located
County	County in which the levee (or its major portion) is located
Name	Name of the levee district
Major Stream	Name of the stream having the main effect on the levee district
Built	Year when levee construction was completed
Lngh	Length in miles of the levee system as determined by field survey
Prot	Level of protection provided by the levee defined by the average expected recurrence interval, in years, of the maximum flood from which protection is provided (expected flood recurrence intervals are determined by analysis of the hydraulic characteristics of the drainage basin).
Acres	Area protected by the levee as measured in acres
Lev Tp	Type of area protected by levee
	A Agriculture
	AR Agriculture and Residential
	E Environmental
	I Industrial
	R Residential
Levee Failure	Levee failure attributes
	? Whether or not the levee district was flooded in 1993
	Date Date that the initial 1993 failure occurred
	#p Number of previous failures in the history of the district

The full SAST ARC/INFO database is available from a link on our WWW display, and the address is also provided in the appendix. ARC/INFO vector coverage can be exported from this site, as well as additional attribute information, described in a Metadata file, and listed below:

SPONSORSHIP	Name of sponsor responsible for maintaining levee
OWNERSHIP	Type of taxing body
UPSTRM_ELEV	Elevation where the upstream end of the MAJOR_STREAM river levee and the upstream tie-back flank levee meet (elevation is measured in feet above sea level or M.S.L. 1929)
UPSTRM_HEIGHT	Approximate height of the MAJOR_STREAM river levee crown at the same location as the UPSTRM_ELEV, measured in feet above the landside ground elevation
DWNSTRM_ELEV	Elevation of the downstream end of the MAJOR_STREAM river levee crown or downstream tie-back flank levee where overtopping is first estimated to occur (elevation is measured in feet above sea level or M.S.L. 1929)

DWNSTM_HEIGHT	Approximate height of the major stream river levee crown in feet above the landside ground elevation, at the downstream end of the MAJOR_STREAM river levee where the DWNSTRM_ELEV was measured
LEVEE_MATERL	Main type of soil used in levee construction
FOUND_MATERL	Main type of soil in the foundation at the base of the levee
PL_84_99	Whether or not the levee district meets PL-84-99 minimum conditions to be eligible for Federal cost- sharing support in the event of levee failure or overtopping
FEMA_CERT	Whether or not the levee district meets the Federal Emergency Management Agency's minimum conditions for certification (the levee must provide at least 100-year level of protection).
CONSTRUCTION	Whether or not Federal funds were used to construct levee
FAILURE_TYPE	Type of failure in 1993
Overtopping	Levee was overtopped before any structural failure occurred
Breach	Levee failed when water level was below the crown of the levee
COST_REP_93	Cost to repair damage due to flooding that occurred in 1993

The SAST places no constraints on the use of the database, however, acknowledgment of the U.S. Geological Survey, U.S. Army Corps of Engineers, EROS Data Center, and the Scientific Assessment and Strategy Team would be appreciated in products derived from these data. For further information about the database and its distribution contact:

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NRCS Data on Levee and Drainage Repairs in Illinois

Attribute information is provided from the National Resources Conservation Service (NRCS) of the U.S. Department of Agriculture on levee damages and repairs in Illinois. The data are provided in tabular form and include the following parameters:

Site Name	Name of levee
County	County in which levee is located
NRCS Exigency	Was the levee break life-threatening (YES or NO)?
Type of Levee	Levees are classified by stream location and ownership Main Stem, Secondary, or Private
Major Stream	Waterway along which levee is located
What is Levee Protecting?	Terrain features protected by levee (cropland, urban area, etc.)
Levee Break Hght	Height of the levee breach from the bottom of the breach to the top of the levee, in feet
Levee Break Lngth	Length of the levee breach, in feet
Number of Breaks	Previous number of breaks for the district
NRCS Cost Constr	Cost to NRCS for reconstruction (a cost of $0 can include levees not repaired or levees repaired using some other source of funding, including federal, state, and local funding).

Water Quality Data and Studies

USEPA Monitoring Activities

In response to the 1993 flood, Congress provided $3.2 million to the U.S. Environmental Protection Agency (USEPA) to support a number of special flood-related water quality monitoring efforts. These studies addressed both immediate concerns for potential contamination of drinking water supplies, and the longer term water quality impacts resulting from the flooding. The results of these studies were presented at a workshop in October 1995, sponsored by the Upper Mississippi River Basin Association. The conclusions and recommendations from the workshop are presented, along with data from selected studies.

A. Workshop Conclusions and Recommendations

The Upper Mississippi River Basin Association-sponsored Flood Monitoring Workshop on the flooding conditions during 1993 along the Mississippi River was held on October 30-31, 1995, in Bettendorf, Iowa. Workshop participants from various state and federal agencies offered the following *conclusions* based on their monitoring studies and discussions:

- The monitoring did not reveal significant flood-related water quality impacts in terms of contaminant concentrations. However, there were substantial increases in contaminant loadings. These increased loadings, particularly the increased delivery of nutrients and herbicides, may have had significant impacts on the Gulf of Mexico.

- There is insufficient information about the dynamics or behavior of the river system to draw conclusions about the longer term impacts of the contaminants that remain in the river system.

- It is not possible to draw conclusions regarding water quality impacts during the pre-peak portion of the 1993 flood due to lack of monitoring data.

- Little or no sampling was done by most water quality researchers during the first pulse of the flood, due in part to lack of funding and pre-event planning, but also due to the inherent difficulty of recognizing the rising limb (i.e., pre-pack) of a flood. The leading edge of a flood is when one would typically expect to see the highest contaminant concentrations.

- The U.S. EPA-funded monitoring studies were focused on direct water quality impacts and did not provide extensive insights into the physical and ecological impacts of the 1993 flood.

- Findings from research funded from other sources, as well as some insights gained through the EPA-funded studies, suggest that the flood may have had significant impacts on the geomorphology and ecology of the river system. However, gaining a basic understanding of these impacts would require a significantly greater study effort. Funding for such work has not generally been available since the 1993 flood.

- Available baseline data frequently do not provide an adequate context for interpreting the results of special event monitoring.

- Although there are good surface water records available in some areas for some parameters, less information is available for sediment or ground water. In general, insufficient baseline data are available to confidently identify long-term trends or isolate the impacts of specific events.

- Monitoring efforts related to the 1993 flood would have been enhanced by a clear articulation of purpose and prioritization of monitoring needs.

- Although several agencies did prepare work statements that addressed the purpose and priorities of their water quality monitoring efforts, this was not universally done.

- Monitoring efforts related to the 1993 flood would have benefitted from interagency coordination of sampling locations, parameters, finances, and personnel.

- The EPA-funded flood-related monitoring studies did not include adequate resources for data analysis and integration.

- Substantial data were generated by the flood-related water quality studies. However, time and money constraints limited scientists' ability to interpret these data and communicate the results. Some researchers also encountered difficulties getting the necessary laboratory support for their work. Data analysis and information dissemination are critical if scientists are to answer the questions posed by resource managers, political leaders, and members of the public.

Workshop participants developed the following recommendations for future flood event monitoring efforts:

- Flood event monitoring efforts should be shaped by answering the following questions:
  - What information is needed?
  - What questions must be answered to get the information?
  - What data are needed to answer the questions?
  - What type of monitoring and analysis will yield the data and quality assurance needed?
- Knowing what is of great concern in terms of human and environmental health .. is essential to well-targeted and cost-effective water quality monitoring during and after a major flood event. An interagency strategic plan for water quality monitoring developed before such an event can help ensure that monitoring efforts are appropriately focused by answering the questions highlighted above. Such a plan must also be sufficiently flexible to respond effectively to the exigencies of a particular event as it unfolds.
- A National Water Quality Monitoring Council should be formed, with a subcommittee established to address data comparability issues.
- It would be quite helpful to have an interagency group, with both state and federal representation, to address monitoring issues at the national level. Such an entity could catalyze regional interagency coordination efforts, in part by providing information and guidance to statewide or watershed-based attempts to develop and implement coordinated monitoring plans. There is currently a proposal to convert the existing Intergovernmental Task Force in Monitoring Water Quality into a National Water Quality Monitoring Council that could serve this purpose. When formed, the Council should place emphasis on addressing data quality and comparability issues.

- The National Water Quality Monitoring Council should promote the use of water quality indicators that are cost-effective and readily transferable.

- Some water quality parameters are difficult and expensive to sample and analyze. For example, laboratory analysis of polychlorinated biphenyls (PCBs) is very expensive, and variability in analytical methods often makes PCB data difficult to replicate and limits the transferability of results. The Council should attempt to identify parameters that measure, or are indirect indicators of, contaminants of concern and that can be sampled and analyzed in a timely manner at a relatively low cost. The selection of these parameters should be based on the likelihood of water quality standard exceedances.

- State and federal agencies and tribal governments should establish mechanisms for at least annual coordination of flood-related monitoring. Coordination should include planning for information dissemination.

- Coordination could greatly benefit those agencies involved in flood-related water quality monitoring by reducing costs, clarifying interagency objectives, avoiding duplication of effort, and facilitating information transfer. In addition, the same mechanism developed to coordinate flood-related monitoring could also serve as a vehicle for coordinating other event-driven monitoring, as well as routine baseline monitoring activities.

- Effective interagency coordination could occur at the same or watershed level. One benefit of state-level coordination is that many key resource allocation decisions are made at the state level, not only by the states themselves, but also by federal agencies. However, state and federal agencies are increasingly looking at water resource issues on a watershed basis. The impacts of events such as floods and droughts often manifest themselves on a watershed basis. Moreover, in large watersheds, such as the Upper Mississippi River basin, taking a watershed approach could greatly facilitate interagency coordination across state lines. Regardless of whether a state- or watershed-based approach is employed, it would be preferable to use an existing entity, such as a state agency or the Upper Mississippi River Basin Association, to facilitate coordination.

- Event monitoring should be designed to enhance systems understanding to the extent consistent with event-specific information needs. It should also be designed in a way that is consistent across agencies to the fullest extent possible given variations in the agencies' objectives.

- Our understanding of how the Upper Mississippi River and its tributaries function as a system is quite limited, which in turn limits scientists' ability to draw conclusions regarding the water quality, physical, and ecological impacts

of the 1993 flood. An enhanced systems understanding would not only enable scientists to explain what has happened, but would also increase their capacity to predict the impacts of future floods. This in turn could allow individuals, managers, and policy makers to take steps to reduce damages from future flood events.

B. Data from Selected Monitoring Studies

As noted above, a variety of monitoring activities were performed. A sample format of a part of one of these activities is presented in Table 4.

Table 4. Impacts of the 1993 Flood on the Illinois and Mississippi Rivers

CORE1 Results: Illinois River at Valley City, IL

	Q	Cyanide	Arsenic	Phenol	Fluoride	Mercury	Chloride	Sulfate	Total Acid	Alka-linity	TKN
Date	(cms)	(mg/L)	(g/L)	(g/L)	(mg/L)	(g/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
12/15/93	1109	.010K	IK	10K	0.23	.05K	36	74	-	214	0.94
12/22/93	976	.010K	IK	10K	0.27	.05K	32	74	-	246	0.29
1/5/94	659	.010K	IK	10K	0.26	.05K	41	58	-	256	1.33
1/25/94	538	.OlOK	IK	10K	0.35	.05K	58	91	-	264	1.40
2/15/94	396	.O10K	IK	10K	0.27	.05K	110	58	IK	192	2.20

Monitoring of Des Moines Water Supply System

During the 1993 flood, the water treatment plant of the Des Moines, Iowa, public water supply was inundated, contaminating the water supply system. In the 20 days that it took to bring the system back on-line, extensive water quality monitoring was required to ensure that the water would be safe for human consumption.

The Des Moines Public Water Supply (DMPWS) received strong leadership and assistance from the Des Moines Water Works (DMWW), the University of Iowa's State Hydraulics Lab (UHL), the Iowa Department of Natural Resources (IDNR), surrounding communities, state agency staff, and the general public. The cooperation of all of these groups facilitated the accomplishment of this task in a remarkably short period of time.

The operational plan was as follows. The city was divided into a grid of 98 one-mile squares. Six samples were collected from each of these squares: four samples for bacterial analyses, one sample for turbidity analysis, and one sample for chlorine residual. In addition, nine grids were selected at random to be sampled for the presence of organic contaminants.

In Phase I, plate counts were performed in an effort to determine the degree of contamination. A total of 350 bacterial samples were collected, and another 169 samples were free of bacteria. Many of the samples that tested positive for bacteria were turbid and dirty. This was particularly true of samples collected at night.

Organic analyses indicated that except for the presence of common herbicides and trihalomethanes (THMs), there was no evidence of contamination of the distribution system. The presence of THMs was expected, given the source of water and the high chlorine residuals. Pesticides, like THMs, were anticipated since the UHL had been monitoring the Des Moines and Raccoon Rivers and knew that pesticide concentrations were elevated.

Phase I monitoring was completed with no compelling evidence of serious contamination of the system. This allowed teams to proceed to Phase II monitoring, a scheme designed to determine whether or not the system could again provide for safe drinking water.

The city of Des Moines, like all other public drinking water systems, has a drinking water sampling network in place. The network comprises 142 locations around the city where routine samples are periodically collected. Locations are representative of the distribution system within five sections of the city. It was decided that samples should be collected from each of these locations, and in addition, from 110 "dead ends" in the distribution system. The system was to be monitored in similar manner in each of the suburbs, in essence, treating the city of Des Moines and the surrounding communities as a single metropolitan area.

Two samples were collected at each location, one for bacterial analysis and one for chlorine residual. The Department of Natural Resources decided that the system could be declared safe for human consumption if: 1) less than 5 percent of the samples tested positive for total coliform bacteria, 2) no fecal coliform bacteria were identified, and 3) an adequate chlorine residual was present.

Absence/Presence tests were used in the Phase II monitoring. A total of 407 bacterial samples were collected in the metropolitan area. Of these, less six tested positive for total coliform bacteria, and no samples tested positive for fecal coliform bacteria. With Phase II completed, just 20 days after the Des Moines Water Works was shut down due to the Flood of 1993, the Des Moines public water supply was declared safe for human consumption.

Tables 5 and 6 provide samples of data gathered from Phase I and Phase II monitoring. Data from these monitoring activities are provided by the Iowa State Hygienic Lab.

EMTC Database

The National Biological Service's Environmental Management Technical Center (EMTC) maintains a great amount of water quality data on the Upper Mississippi River. Much of the data in the EMTC database has been collected through joint ventures between the EMTC and state agencies. A link to these data is available on our WWW display, and the address is provided in the appendix.

Table 5. Phase I Monitoring of the Des Moines Public Water Supply Rejuvenation Project

Sample	Location	Cl (ppm)	Cl (titration	NTU	Coliform
91A	2600 Block Tiffin	>2.20		0.57	<1 cfu/lOOml
91B	Don-Lee & Tiffin	2.16		1.30	<lcfu/100ml
91C	East 30th & Oak Park (dead end)	1.72		4.40	CG or PPT-NS
91D	Arthur-1st hydrant W of Farwell Rd	>2.20		6.00	CG or PPT-NS
92A	East 27 & Garfield	>2.20		42.00	CG-dirty/rust
92B	East 31 Court & Easton	1.41		6.80	<1 cfu/100ml
92C	East 30 Road & University	>2.20		5.00	<1 cfu/100ml Before 0
92D	Hubble & John Patterson	1.71		16.90	dirty After <1 cfu/100ml

Notes: NTU = Nephlometric Turbidity Units
cfu = Colony Forming Units
CG = Confluent Growth of bacteria, making accurate measurements difficult or impossible
PPT = Possible Positive Total coliforms
NS = Non-Sheen (only E. *coli* produces a metallic sheen appearance)

Table 6. Phase II Monitoring of the Des Moines Public Water Supply Rejuvenation Project

Quad.	Sec.	Location	City	Tot. Bacteria	E-Coli P.
3	3	Meredith Middle School	Des Moines	Absent	Absent
3	4	Dahls	Des Moines	Absent	Absent
3	5	Sinclair-Merle Hay & Hick	Des Moines	Absent	Absent
3	6	Quik Trip-3000 Merle Hay	Des Moines	Absent	Absent
3	11	Sears-Merle Hay Mall	Des Moines	Absent	Absent
3	16	Hoover High School	Des Moines	Absent	Absent
3	21	Wards-Merle Hay Mall	Des Moines	Absent	Absent
3	22	Texaco-Merle Hay & Douglas	Des Moines	Absent	Absent

Biological Data

Substantial biological data for the Mississippi River are also maintained by the EMTC. The WWW link noted above is available also for data collected during the 1993 flood on fish, vegetation, macroinvertebrates, and floodplain forests.

Shallow Ground-water Levels

Well-level data are provided for five observation wells. The wells are monitored on a monthly basis by the Illinois State Water Survey, and periods of record date back to 1953. Each of these gages was selected for presentation because of its proximity to the Mississippi and Illinois Rivers. A large amount of historic data is provided for comparison purposes.

Wells #1075, #1076, and #1072 are located in the floodplain of the Mississippi River near St. Louis. The locations of these wells are in areas protected by levees. These wells were not inundated during the 1993 flood. However, in each case, the ground-water level rose to the ground surface elevation.

Wells #1070 and #91 are located in lowland areas adjacent to the Mississippi and Illinois Rivers, respectively. In both cases, the 1993 maximum ground-water level represents the highest level on record. Table 7 provides some attributes of these shallow water wells. Well data are observed approximately monthly. Table 8 shows an example of the format.

Table 7. Attributes of Well Sites along the Mississippi and Illinois Rivers during the Flood of 1993.[1]

Well no.	County	Well name and location[2]	Depth	Land elev.
91	Mason	Near the Village of Snicarte, IL	42	485.0
1070	Madison	Laclede STL, no. 1, Alton, IL	80	430.0
1072	Madison	Olin Math AN-1, Alton, IL	89	413.1
1075	Madison	Corps of Eng, RW-18, Granite City, IL	68	411.0
1076	Madison	Madison Corps of Eng, RW-70, Granite City, IL	58	406.4

Well no.	Additional description of well location
91	TWN 19N, RNG 10W, SEC 11, approx. 5000 ft W, 1000 ft N of SE corner of section
1070	TWN 05N, RNG 09W, SEC 18, approx. 1650 ft W, 1650 ft N of SE corner of section
1072	TWN 05N, RNG 09W, SEC 29, approx. 3000 ft W, 4300 ft N of SE corner of section
1075	TWN 03N, RNG 10W, SEC 14, approx. 2300 ft W, 1000 ft N of SE corner of section
1076	TWN 03N, RNG 10W, SEC 12, approx. 2300 ft W, 3600 ft N of SE corner of section

Notes:

[1]LegencL

Well no.	State water survey identification number of well
TWN, RNG, SEC	Township, range, and section number of well location
Well name	State Water Survey identification name
Location	General location (nearest town to well site)
Depth	Depth of well, in feet
Land elev.	Elevation of land surface, in feet above MSL

[2]Well location is accurate to within 500 feet.

Table 8. Sample of Well Data Reports
for Well #1070.

Date	Observed depth, feet
02/21/1975	381.5
04/03/1975	385.0
04/24/1975	386.8
05/23/1975	390.0
06/20/1975	389.7
07/23/1975	390.2
08/25/1975	389.0
09/24/1975	386.2
10/30/1975	385.2

Flood Damage Estimates

Corps of Engineers

The Corps of Engineers has produced a series of maps for the 1993 flood. These display the types of damages including: acres flooded, emergency expenses, damages to public and private facilities, etc. A link to these data is provided on our WWW display and the address also appears in the appendix.

Illinois Department of Natural Resources

The Illinois Department of Natural Resources, Office of Water Resources (DNR-OWR), is the lead state agency for water resource planning, floodplain management, and monitoring of flood emergency situations in Illinois. A link to the DNR-OWR home page is available on our WWW Flood 1993 display, and the address also appears in the appendix. Data on flood damages were collected during the 1993 flood by DNR-OWR (at that time part of the Illinois Department of Transportation), and are published in the following report: Illinois Department of Transportation, Division of Water Resources, 1994: *River Stages in Illinois: Flood and Damage Data,* Report No. DOWR/SES/94-001. Data include text files of damages reported at various river gage sites along the Mississippi River in Illinois. Attribute data about each site are listed along with descriptive data on damages to specific regions within each district. The following is a sample report:

ILLINOIS RIVER AT BEARDSTOWN
USGS GAGE NUMBER: 05584000
LOCATION: In Cass County, 88.6 miles above mouth, 0.9 miles upstream from State Rt 100 Bridge, 0.3 miles downstream from Burlington Northern Railroad Bridge.
NW 1/4, Sec. 15, Twp. 18N, Rng. 12W
Drainage Area = 24,227 sq. mi.
1993 FLOOD INFORMATION

The Lost Creek Drainage & Levee District sandbags were stacked 3 high on top of the levee. Some crops were lost due to standing seepage water.

Streets in the village of Beardstown collapsed due to surcharged groundwater carrying material into the combined sewer system. Extra pumping and treatment of the flows in the combined sewer system were also required.

Missouri Data

The Food and Agriculture Policy Research Institute (FAPRI), located at the University of Missouri, conducted a survey of Missouri farmers who sustained flood damages in 1993. The survey data contain information on impacts on crop production, repairs, financial effects, and government programs. A WWW page on their data entitled FAPRI Damage and Recovery Survey Report is available on our WWW display, and the address can also be found in the appendix.

METEOROLOGICAL DATA

Cook County Raingage Network

The Cook County raingage network was installed in 1980 to fulfill the requirements of the U.S. Army Corps of Engineers (COE), Chicago District. The data are used to account for the natural input to surface water from precipitation over the city of Chicago, and to determine the immediate impact of heavy rainfall totals on the Lake Michigan watershed. The COE is responsible for administering the proper diversion of water out of Lake Michigan.

In cooperation with the COE and the U.S. Geological Survey, the Illinois State Water Survey (ISWS) in 1989, installed, and has since maintained, an array of 25 weighing bucket raingages across the more urbanized regions of the Chicago metropolitan area within Cook County (figure 1). Gages are arranged in a quasi-regular array with an 8- to 10-kilometer (km) grid spacing between sites. The recording devices are clock-driven and fitted with 24-hour charts. Data are reduced approximately weekly and are archived at ISWS. Additional information concerning the Cook County Network is available (Peppier, 1991).

The data presented in this file, as a supplement to the flood of 1993, are for the entire calendar year 1993. Table 9 shows a sample format of the displayed information. Data are ordered in rows by day with each site presented in columns. Precipitation values are given in inches. As with the hydrological data, both ASCII and comma-delimited files are available.

Imperial Valley Raingage Network

The Imperial Valley raingage network covers a region of Illinois encompassed roughly by Mason and Tazewell Counties (figure 1). Agricultural practices in this region frequently require irrigation due to the predominantly sandy local soils. This places a large demand on the existing surface and ground-water resources in the area. Knowledge of the variability in precipitation within the region is valuable in the management of local water use.

In cooperation with the Imperial Valley Water Authority, the Illinois State Water Survey (ISWS) in 1992 installed and continues to maintain, a 25-site network of weighing bucket raingages. The sites are arranged in lines that run approximately west to east with a station spacing of about 8 km (figure 1). The units are clock driven and are fitted with a 24-hour chart. Gages are serviced every one to two weeks and data are archived at ISWS. Additional information concerning the Imperial Valley Network is available (Peppier and Hollinger, 1994).

The data supplied in this file are for the calendar year 1993 and are ordered in monthly tables with days represented in rows and sites in columns. Precipitation amounts are given in inches. The format is identical to that shown for Cook County in table 9.

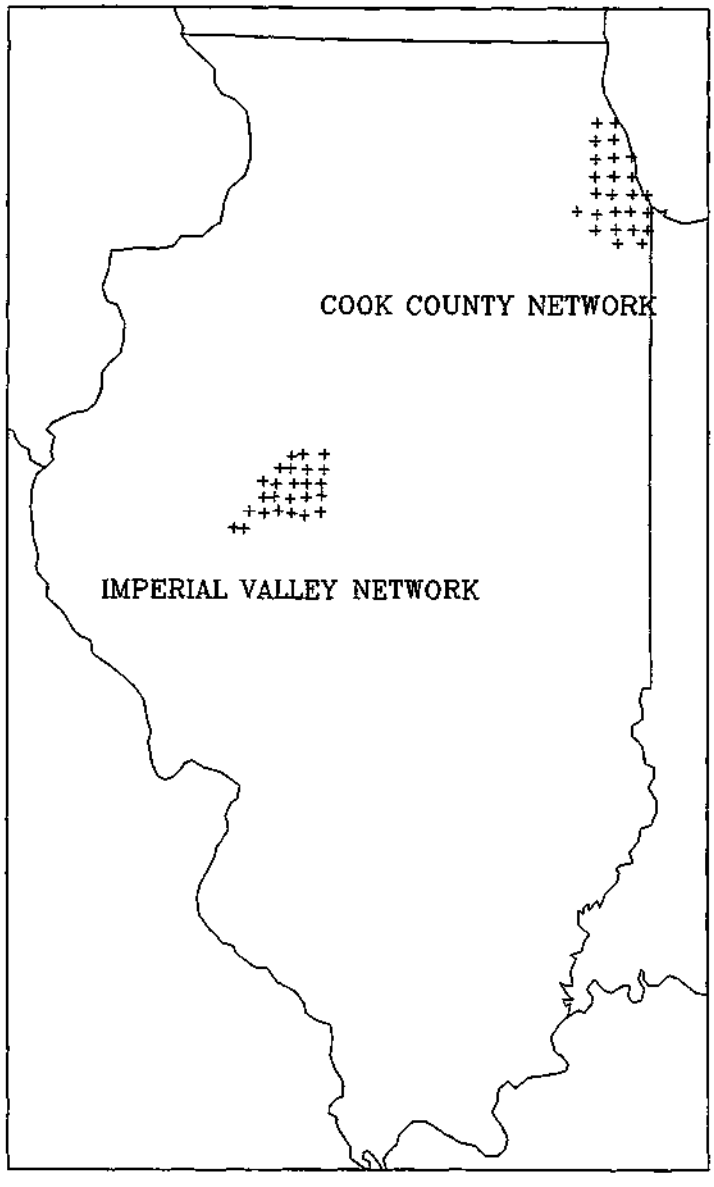

Figure 1. Illinois' high-density raingage networks. Crosses indicate raingage locations.

Table 9. Format of Observed Daily Precipitation (in inches) For the Cook County and Imperial Valley High-Density Raingage Networks.

	SITE NUMBER																								
Day	G 1	G2	G3	G 4	G 5	G 6	G 7	G 8	G 9	G10	Gil	G12	G13	G14	G15	G16	G17	G18	G19	G20	G21	G22	G23	G24	G25
1	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.09	0.15	0.10	0.08	0.12	0.13	0.06	0.11	0.01	0.11	0.07	0.05	0.06	0.15	0.02	0.06	0.12	o.11	0.10	003	0.05	0.09	0.13	0.07	0.04
3	0.15	0.21	0.18	0.24	0.24	0.35	0.23	0.33	0.32	0.26	0.41	0.42	0.33	0.22	0.44	0.53	0.47	0.57	0.44	0.68	0.98	0.57	0.62	0.57	0.44
4	1.10	1.29	1.17	0.88	1.28	1.10	1.28	1.30	1.33	139	128	1.41	1.59	1.39	1.51	1.47	1.33	1.34	1.50	1.57	1.45	1.27	1.31	1.31	1.30
5	0.13	0.00	0.00	0.00	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	000	000	000	0.01	0.00	0.04	000
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.10	0.20	0.12	0.15	0.14	0.10	0.17	0.04	0.08	0.10	0.08	0.08	000	0.00	0.07	009	007	000	0.08	0.09	0.07	0.08	0.03	0.05	0.06
8	0.00	0.00	0.00	0.00	000	0.01	0.00	004	0.05	0.00	. 0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.06	0.00	0.00
9	0.03	0.00	0.04	0.25	0.30	0.31	0.32	0.27	0.43	0.27	0.04	0.03	0.09	0.09	0.19	0.17	0.11	0.03	0.20	0.14	0.16	0.18	0.16	0.14	0.01
10	0.30	0.23	0.23	0.32	0.23	0.41	0.27	0.28	0.41	0.20	0.40	0.11	0.35	0.29	0.14	0.23	0.17	0.05	0.28	0.24	0.29	0.28	0.35	0.27	0.11
11	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.47	0.51	0.51	0.64	0.55	0.58	0.65	0.58	0.63	0.52	0.57	0 57	0.59	0.66	0 54	0.59	0.63	0.66	0.62	0.57	0.68	0.60	0.48	0.60	0.45
13	0 27	0 31	0 29	0.25	0.16	0 28	0.24	0.12	0 25	0.21	0.16	0.20	0.11	0.16	0.16	0.17	0.13	0.06	0.16	0.17	0.16	0.10	0.10	0.09	0.11
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	000	0.00	000	000	000	000	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	000	000	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	000	000	000	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	000	000	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.24	0.26	0.24	0.29	0.26	0.37	0.29	0.26	0.30	0.36	0.28	0.29	0.12	0.34	0.34	0.04	0.29	0.16	0.21	0.25	0.36	0.37	0.15	0.28	0.28
21	0.49	0.47	0.53	048	0.55	0.51	0.48	0.53	0.52	0.53	0.51	0.48	0.49	0.38	0.59	0.70	0.42	0.58	0.46	0.55	0.42	0.46	0.59	0.42	0.42
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	000	0.00	0.00	000	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	000	000	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	000	0.00	000	0.00	000	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	000	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000	000	0.00	000
31	0.00	0.00	0.00	0.00	0.00	0.00	000	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Illinois Climate Network

The Illinois Climate Network is a 19-station array of automated weather-observing sites distributed across Illinois (figure 2). The stations were installed and are operated by the Illinois State Water Survey. Stations are primarily in rural areas and are located typically on the Agricultural Experimental Farms of the University of Illinois and Southern Illinois University, and on the campuses of several community colleges around the state. Site installation began in 1988 and was completed in 1991.

Direct measurements are made of air temperature, atmospheric pressure, soil temperatures at 10 and 20 centimeters of depth, relative humidity, wind speed and direction, solar radiation, precipitation, and potential evaporation. Sites are equipped with an automated datalogger that collects information from each instrument at 10-second intervals. These data are used to compute hourly averages or totals for each parameter. Maximum and minimum extreme values provided are logged daily from the 10-second data. An Illinois State Water Survey computer polls and then downloads data from each station once a day. A full description of the sites and their installation has been reported by Hollinger et al. (1994).

Data files for the flood of 1993 are arranged in tables by station, and provide daily summaries of the following parameters: 1) maximum, minimum, and average values of air temperature, soil temperature, and relative humidity, 2) averages values of vector wind and dew point temperature, 3) maximum wind speed (gust), and 4) totals of solar radiation, precipitation, and potential evaporation. The data begin on 1 October 1992 and continue through 31 December 1993. They are arranged in rows by Julian day with parameters being represented in columns. Table 10 displays a short sample of the data along with a decoding of column headers.

Supplemental Iowa Cooperative Network Data

NWS River Forecast System Data

These supplemental raingage data in Iowa are from the locations (figure 3) monitored at the National Weather Service River Forecast System, and are supplied by the Iowa State Climatologist within the Iowa Department of Agriculture. The data are considered mostly unofficial and are frequently noncontinuous. Many sites report observations only on days with measurable precipitation. Although some of the data are reported to the National Weather Service, quality control in excess of that conducted by NWS has been performed. Thus, these data are likely different than the official *Climatological Data* records.

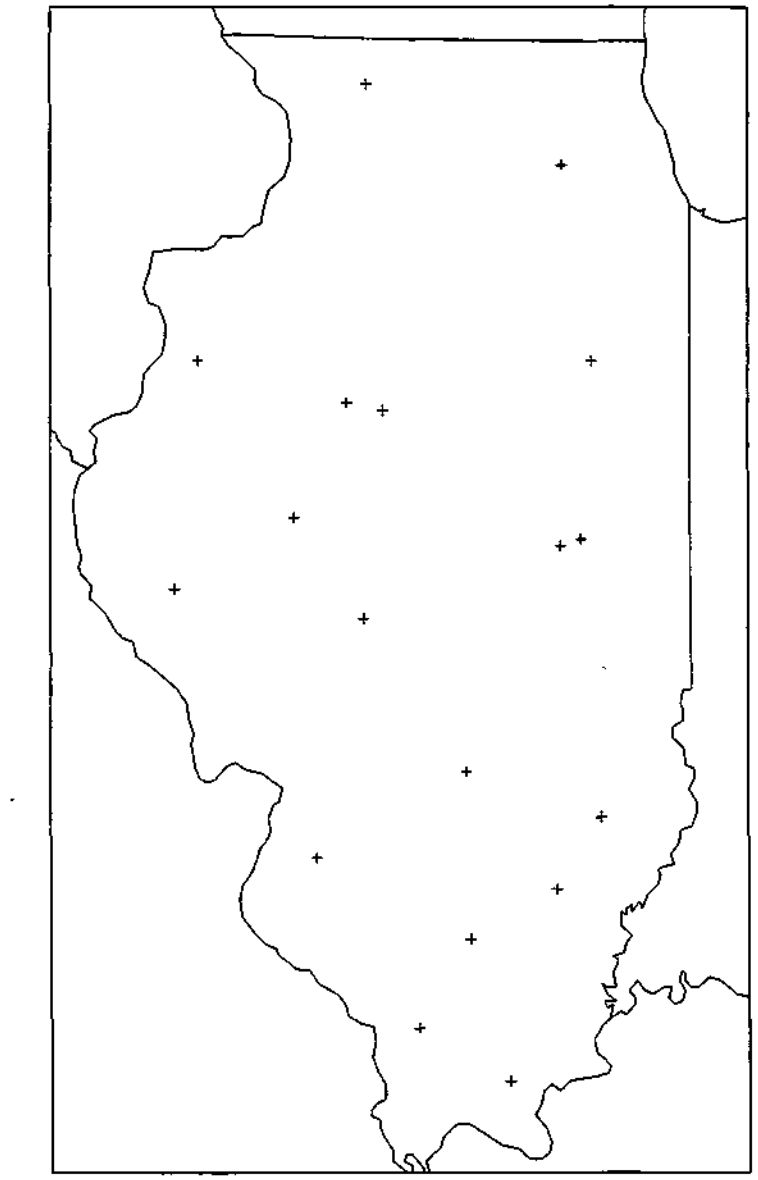

Figure 2. The Illinois Climate Network. Crosses indicate station locations.

Table 10. Sample of Data as Formatted on the ICN Web Page

ID	Year	Jul day	Mx wind gust	Average winds		Mx tmp	Mn tmp	Av tmp)	Mxrh	Mnrh	Avrh	Dp tmp	Sol rad	Precip	Evptrn	Mxst10	Mnst10	Avstl 0	Mxst20	Mnst20	Avst2 0
			(m/s)	(deg)	(m/s)	(deg)	(C)	(C)	(c)	(%)	(%)	(%)	(C)	(mJ/m^2)	(in)	(in)	(C)	(C)	(C)	(C)	(c)	(C)
cmi	1992	275	14.8	184.8	3.2	203.4	23.3	6.1	14.3	96.4	29.9	67.6	7.2	19.62	0	0.16	19.5	14.1	16.7	17.7	14.3	16
cmi	1992	276	18	237.5	4.9	215	25.6	7.3	16.6	97.3	35	67.1	9.5	19.42	0	0.17	20	14.6	17.2	18	14.6	16.3
cmi	1992	277	20.7	241.1	4.3	222.9	27.3	11.4	18.6	93.9	35.1	68	11.8	18.97	0	0.17	20.9	15.6	18.1	18.8	15.4	17
cmi	1992	278	14.1	47.3	2.9	68.6	24.2	11.2	16.7	96.6	53.6	77.3	12.5	12.07	0	0.1	20.3	16.2	18.1	18.6	15.9	17.2
cmi	1992	279	14.3	20.8	3.5	58.9	20.5	8.1	13.5	85.8	35.5	64	6.3	19.93	0	0.15	19.4	15.2	17.2	18.1	15.3	16.7
cmi	1992	280	9.8	133.6	2	129.2	22.1	5.2	12.9	96.4	26.7	66.7	5.6	19.59	0	0.15	19.2	13.8	16.4	17.4	14.2	15.9
cmi	1992	281	19.6	176.5	5.2	167.4	22.6	6.9	14.6	94.3	50.4	77	10.2	14.39	0	0.12	19	14.1	16.4	17.3	14.2	15.7
cmi	1992	282	44.5	194	12.5	197.8	20.9	10.7	14.5	95.6	31.2	70.2	8.5	11.62	0	0.1	18.1	14.9	16.4	16.9	14.8	15.8
cmi	1992	283	30.1	253.8	9.1	239.5	17.4	8.7	12	87.9	50.7	71.2	6.7	9.33	0	0.07	16.7	14	15.2	16.2	13.9	14.9
cmi	1992	284	24.7	269.7	4.8	280.2	20.1	8.9	13.6	91.1	34.7	65.8	6.7	15.78	0	0.13	17.7	13.7	15.5	16.2	13.5	14.8
cmi	1992	285	21.1	289.9	5.3	289.3	17.8	5.2	10.5	93.4	34.7	69.8	4.4	17.17	0	0.13	17	13	14.9	15.7	13.3	14.6
cmi	1992	286	21.4	332.3	6.3	276	20.1	5.6	12.5	82.2	23.4	49.5	1.4	16.22	0	0.13	16.8	12.4	14.3	15.4	12.6	14
cmi	1992	287	16.3	179.2	4.7	179.5	20.6	3.7	13	88.7	19.8	48	0.9	16.98	0	0.13	17	12	14.5	15.5	12.3	13.9
cmi	1992	288	29.3	230.7	11.1	214.7	29.2	17.0 E	22.6	77.5	30 E	52	11.6	15.36	0	0.14	19.6	14.1	16.7	17.3	13.7	15.3
cmi	1992	289	23.3	291.3	5.5	199.4	22.3	14.3	18.6	99.6	58.3	91.5	17.1	7.74	1.38	0.06	19.9	16.4	18.1	18.1	15.5	16.7
cmi	1992	290	31.6	328.3	8	309.5	14.5	4.3	8.5	98.1	51.2	76.4	4.4	9.19	0	0.06	18.8	12.9	15.8	17.9	13.5	15.7
cmi	1992	291	18.7	334.1	2.5	349.8	11.1	0.3	6.4	93.5	33.2	63.3	-0.6	15.56	0	0.1	15.3	11.2	13.3	14.6	11.8	13.2
cmi	1992	292	22.4	326.2	5.9	320.7	8.9	1.2	6.5	84.4	33.4	57.5	-1.7	15.22	0	0.1	14.3	10.6	12.8	13.8	11.3	12.7
cmi	1992	293	12.7	207.4	3.8	165.3	9.1	-2.1	4.2	84.9	30.9	58.9	-3.6	14.72	0	0.09	13	8.8	11	12.4	9.5	11
cmi	1992	294	27.3	230.5	8	205.6	16.5	2.3	9	95.8	61.2	84.7	6.4	11.66	0.15	0.08	13.6	9.6	11.5	12.4	9.7	11
cmi	1992	295	10.3	353.1	2.7	75	18.1	5.9	10.4	99.3	44.5	84.1	7.5	11.66	0	0.08	14.9	10.7	12.5	13.2	10.4	11.7
cmi	1992	296	12.1	203.3	3.3	169.6	26	7.7	15.9	98.2	55.9	83.6	12.8	13.82	0	0.12	17.2	11.1	13.9	14.8	10.8	12.6
cmi	1992	297	25.9	216.6	6.5	223.1	25.9	10.6	18.4	98	50.2	79.3	14.3	11.44	0	0.1	17.7	13.1	15.4	15.6	12.6	14
cmi	1992	298	19.3	352.7	5.5	356.7	20.5	8.3	14.9	94.7	53.8	79.9	11.2	13.98	0	0.11	17.5	14	15.6	15.8	13.3	14.6
cmi	1992	299	10.5	191.5	2.5	169.2	18.8	5.1	11.4	97.1	49	79.4	7.6	14.55	0	0.11	16.6	12.1	14.3	15.1	12.2	13.7
cmi	1992	300	15.8	24.4	5.3	2.2	18.6	8.0 E	12.8	92.6	55 E	73.1	7.8	10.12	0	0.08	16	12.4	14.1	14.6	12.3	13.4

Key:
ID = station identifier
jul day = julian day
mx wind gust = maximum daily wind gust
average winds = average daily vector winds
mx tmp = maximum daily air temperature
mn tmp = minimum daily air temperature
av tmp = average daily air temperature
mx rh = maximum daily relative humidity
mn rh = minimum daily relative humidity
av rh = average daily relative humidity
dp tmp = average daily dew point temperature
sol rad = total daily solar radiation
precip = total daily precipitation
evptm = total daily evapotranspiration
mxst10 = maximum daily soil temperature at 10 cm
mnst10 = minimum daily soil temperature at 10 cm
avst10 = average daily soil temperature at 10 cm
mxst20 = maximum daily soil temperature at 20 cm
mnst20 - minimum daily soil temperature at 20 cm
avst20 = average daily soil temperature at 20 cm
E = estimated data

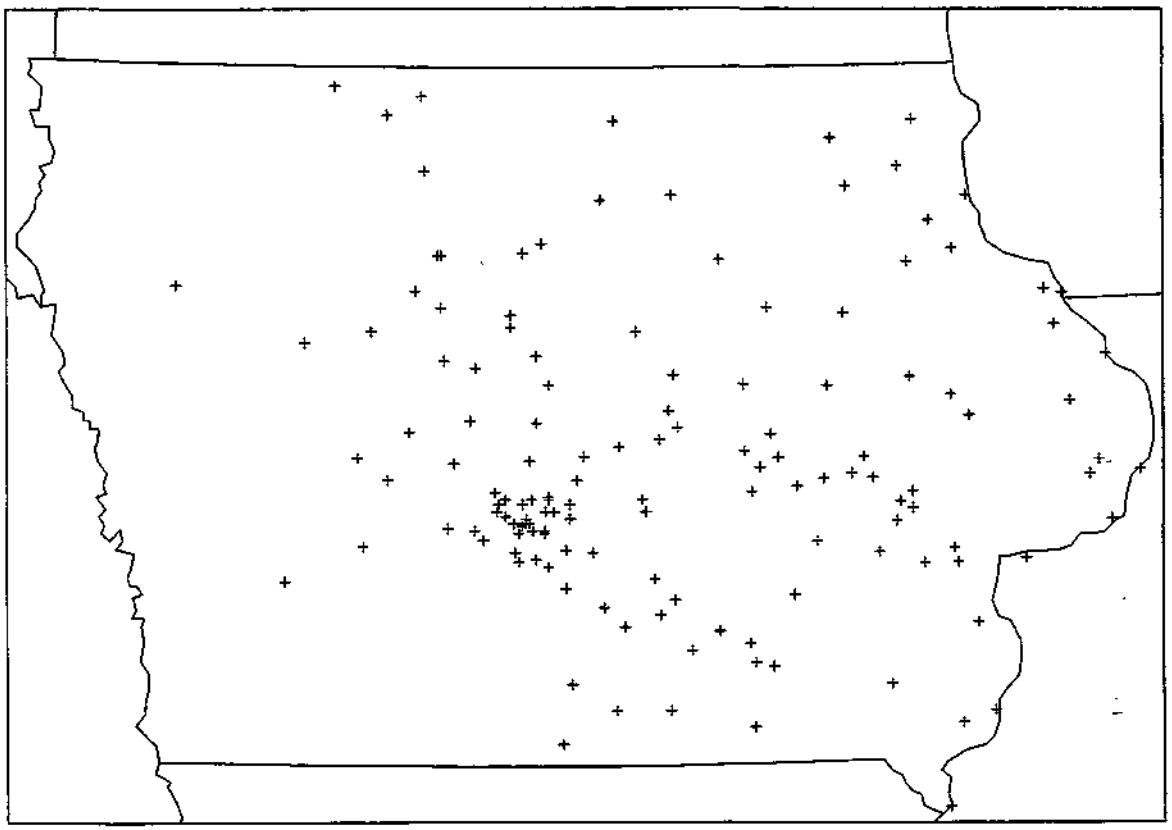

Figure 3. Supplemental Iowa precipitation data. Crosses indicate raingage locations.

The data format approximates TD-3200, a format used by the National Climatic Data Center. This is an ASCII format not available in a comma-delimited form. A sample coded message and decoding of the data are shown below. Some sites have official, six-digit Cooperative Observer identification numbers; others are numbered sequentially with assigned numbers. Data are arranged in monthly reports by station number.

A Sample Coded Message

DLY13002199PRCPHI1993 39999 3110 -99 0 2 0 -99 0 3 0 -99 0 4 0 -99 0 5 0 -99 0 6 0 -99070 -99080 -99090 -990100 -990110 -99 012 0 -99013 0 -99 014 0 -99015 0 -99 016 0 -99 017 0 -99 018 0 -99 019 0 -99 020 0 -99 0210 -99 022 0 -99 023 0 -99 024 0 -99 025 0 -99 026 0 -99 027 0 -99 028 0 -99 029 0 -99 030 0 -99 0310 -99 0

Decoding of the Data

Column	Contents	Meaning
1-3	DLY	record type (DLY = daily)
4-9	130021	station ID (state 13 [Iowa], site 0021)*
10-11	99	99 = regular site, C9 = CAD site, G9 = DCP site
12-15	PRCP	element type (PRCP = precipitation)
16-17	HI	element units (HI = hundredths of inches)
18-21	1993	year
22-23	b3	month (3 = March, etc.)
24-27	9999	not used
28-30	b31	number of data entries to follow (usually number of days in month)
31-32	bl	day
33-34	bO	time of observation (0 = midnight)
35-40	bbb-99	data value (-99 = missing data)
41	b	flag 1
42	0	flag 2 (0 = valid data element)
43-402		repeat of format in columns 31 - 42 for number of records (col. 28)

(b = blank in data example)

* sites that are not NWS Cooperative Observer sites have the state number 93, then are numbered consecutively.

Iowa Cooperative Network Precipitation Data

These data (figure 4) are from official Cooperative Observer precipitation sites published in *Climatological Data* and supplied to the Iowa State Climatologist by the National Weather Service. Copies of the original observer forms were examined in detail in an attempt to resolve questionable values, as well as to fill in some missing precipitation amounts. Thus, some values in the dataset here differ from the official published precipitation totals. However, these data can be considered more authoritative, having been subjected to a more thorough quality control analysis than the observations in *Climatological Data*.

Data are included for a station if any daily value in a month differs from the official precipitation totals published in *Climatological Data* for Iowa. The amounts that differ are marked by the flag "S". The data format is TD-3200, and an example of the decoded data is shown in a prior section. Stations are identified by six-digit Cooperative Observer numbers and are arranged in monthly reports. The period of record is from October 1992 to September 1993.

Minnesota Supplemental Precipitation Data

Data from Minnesota raingage locations (figure 5) are obtained by the Minnesota State Climatologist. This accumulation of 973 raingage sites is from networks organized by the Minnesota Soil and Water Conservation Districts, the Minnesota Department of Natural Resources - Forestry Division, Metro Mosquito Control, and the National Weather Service. Observations were taken manually by volunteer observers.

The data format is TD-3200; a decoded example was provided in an earlier section. Station identifiers are six alphanumeric characters specific to the site owner that were assigned by the Midwestern Climate Center. Data are arranged in monthly reports for the period from April to September 1993.

North Dakota Supplemental Precipitation Data

Supplemental precipitation data for North Dakota are supplied in two files. The data format for both sets of data is TD-3200, a code used by the National Climatic Data Center. Site listings and an example of the decoded data are available. The first file reports rainfall data supplied by the North Dakota State Climatologist, which are extracted from the North Dakota Agricultural Weather Network. This network consists of a series of enhanced weather stations across North Dakota from which data are retrieved automatically by computer each day (figure 6). Data are arranged in monthly reports for the period from April to September 1993. Station identifiers are the standard codes used by the Cooperative Observer Network.

Data in the second file are supplied by the North Dakota Agricultural Research Board (NDARB). The observations are taken across the state by a considerably dense network of

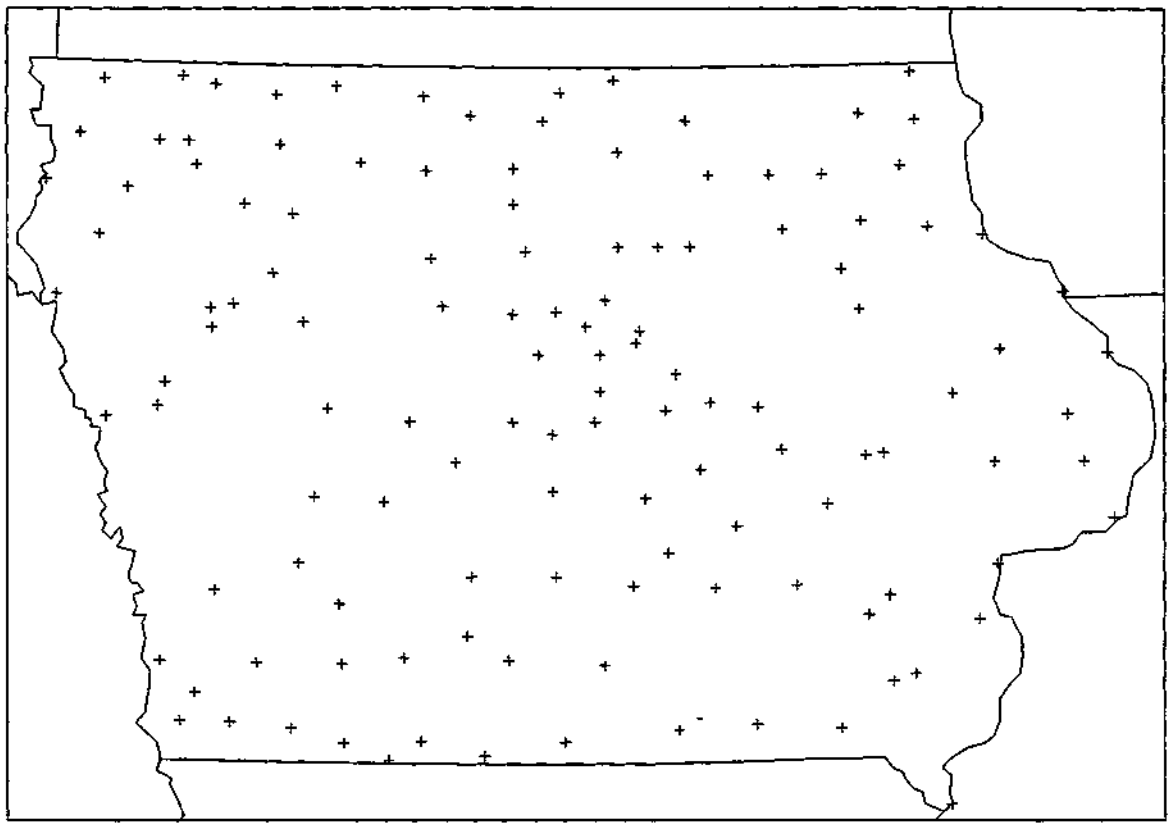

Figure 4. Supplemental Iowa Cooperative Network precipitation data. Crosses indicate raingage locations.

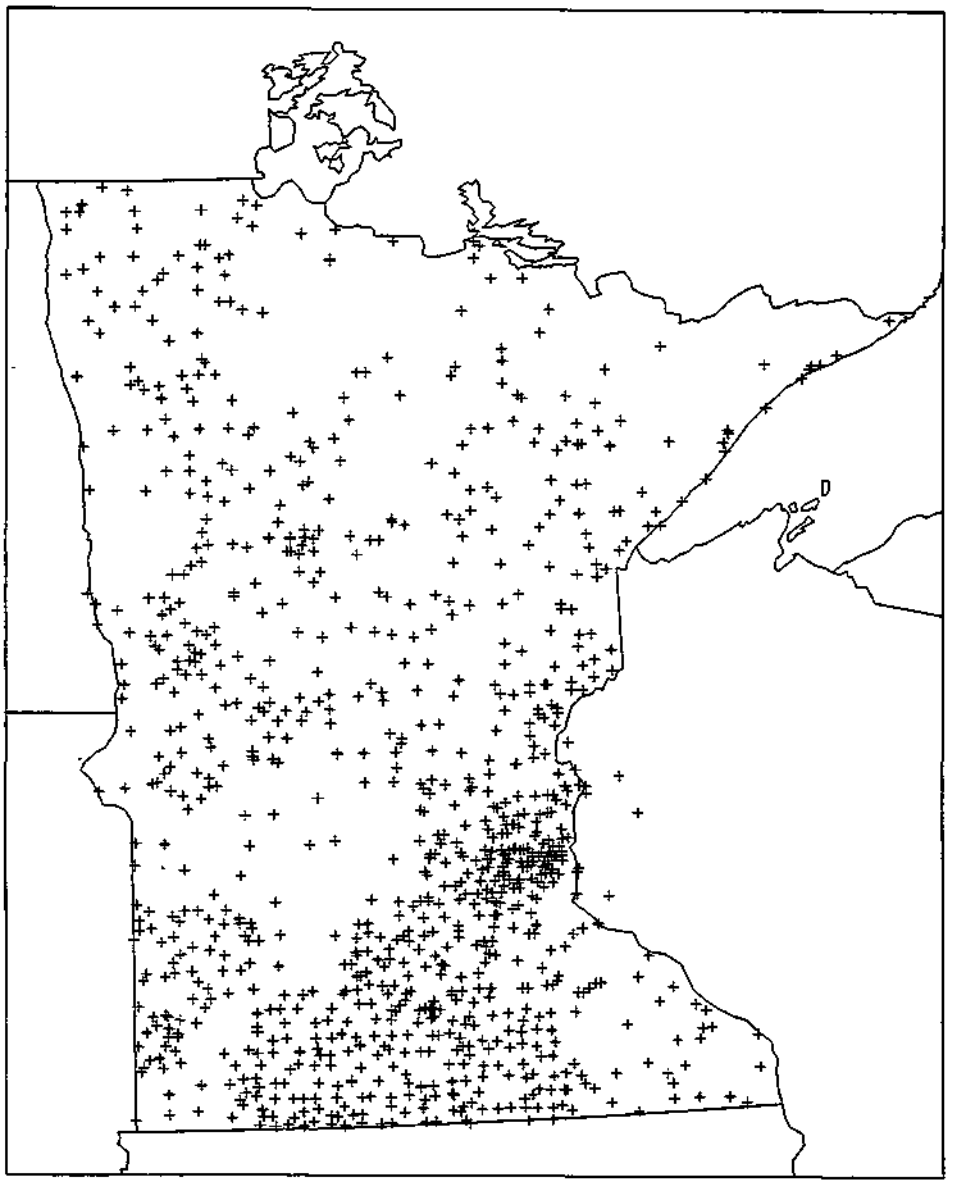

Figure 5. Supplemental precipitation data in Minnesota. Crosses indicate raingage locations.

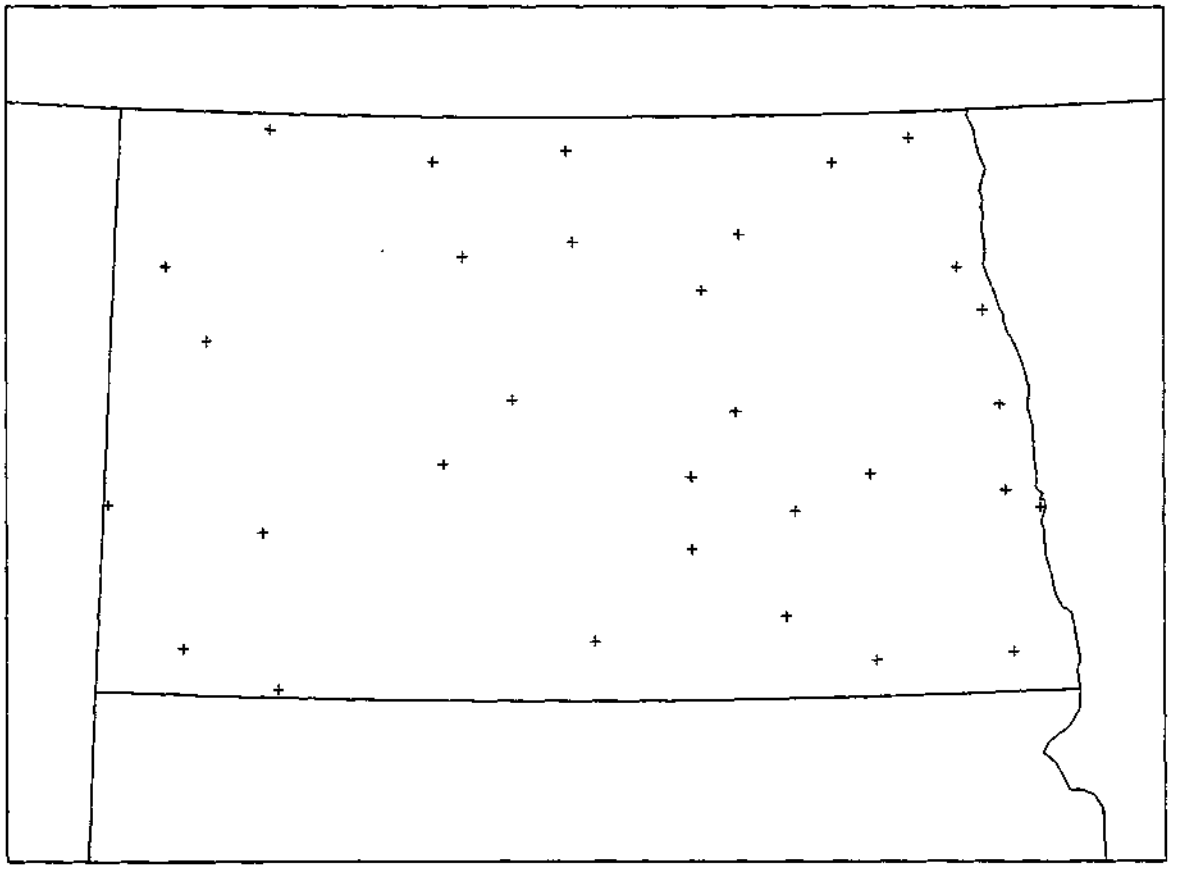

Figure 6. North Dakota agricultural precipitation data. Crosses indicate raingage locations.

approximately 890 volunteer observers using wedge gages (figure 7). The location of each site was calculated by NDARB personnel from township, section, and range information supplied by each observer. Sites were assumed to be placed in the middle of these locations and thus carry with them a potential error of 0.7 miles. Station identifiers are six alphanumeric characters specific to the site owner. Quality control was performed by NDARB personnel. Data are arranged in monthly reports for the period from April to October 1993.

High Plains Climate Center Automated Weather Station Data

The High Plains Climate Center (HPCC) in Lincoln, Nebraska, archives data from an extensive network of automated weather stations at 90 locations over a seven-state area (figure 8). These stations use Campbell Scientific, Inc. equipment. Data are automatically retrieved on a daily basis.

The data provided and available include: daily observations of eight meteorological parameters: maximum and minimum temperature, relative humidity, 4-inch soil temperature, wind direction and speed, solar radiation, precipitation, and potential evapotranspiration. The data are arranged and ordered by state. Stations are identified by six-digit Cooperative Observer numbers, and are presented in monthly reports. The period of record is from October 1992 to September 1993. The data format is TD-3200, a coded format used by the National Climatic Data Center. A listing of sites and an example of decoded data are available.

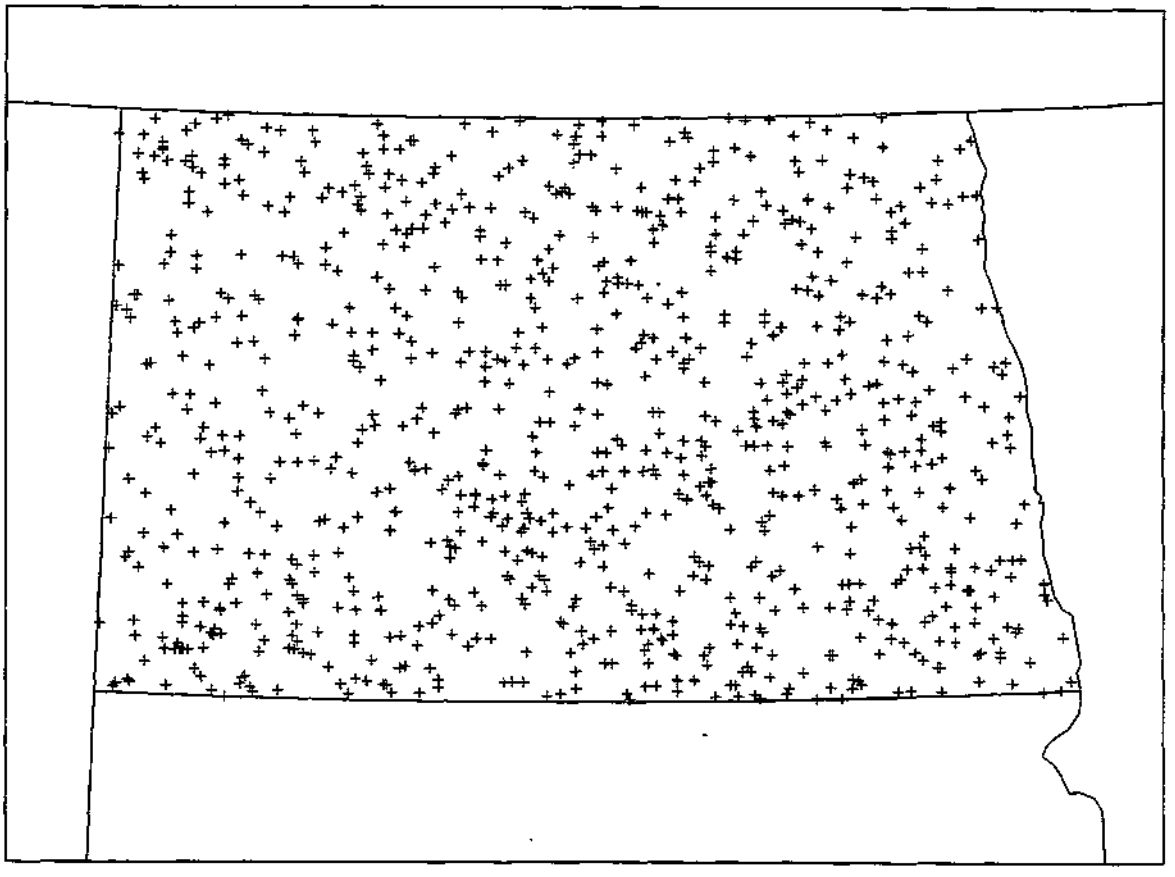

Figure 7. North Dakota supplemental precipitation data. Crosses indicate raingage locations.

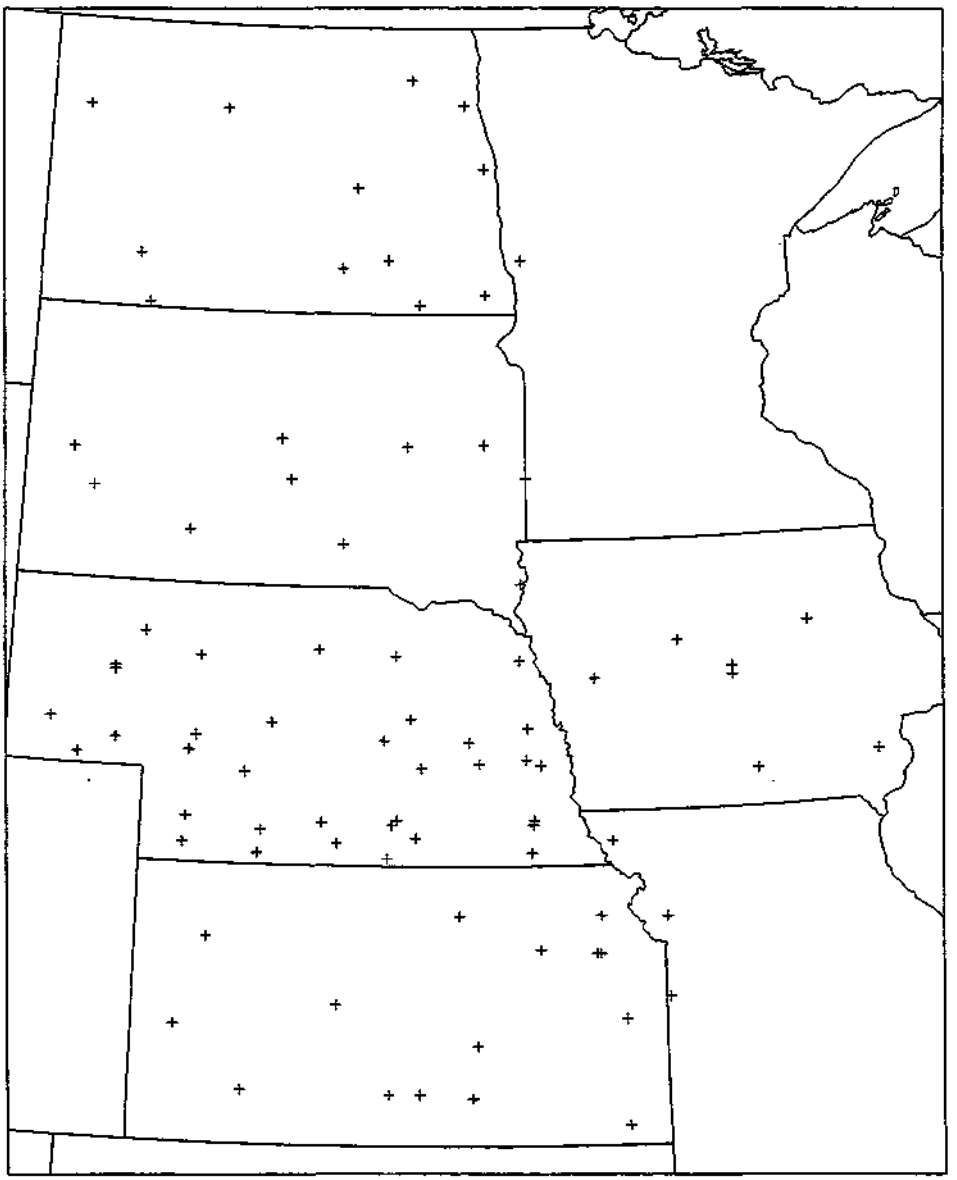

Figure 8. High Plains Climate Center meteorological data. Crosses indicate weather stations.

REFERENCES

Hollinger, S. E., B. C. Reinke, and R A. Peppier, 1994: *Illinois Climate Network: Site Descriptions, Instrumentation, and Data Management.* Illinois State Water Survey Circular 178, 63 pp.

Illinois Department of Transportation, Division of Water Resources, 1994: *River Stages in Illinois: Flood and Damage Data* Report No. DOWR/SES/94-001.

Peppier, R. A., 1991: *Installation and Operation of a Dense Raingage Network to Improve Precipitation Measurements for Lake Michigan Diversion Accounting: Water Year 1990.* Illinois State Water Survey Contract Report 517, 87 pp.

Peppier, R A. and S. E. Hollinger, 1994: *Installation and Operation of a Raingage Network for the Imperial Valley Water Authority, Year One: September 1992 - August 1993.* Illinois State Water Survey Contract Report 575, 59 pp.

APPENDIX

Various additional information on the 1993 Mississippi River Flood can be obtained on the Internet's World Wide Web pages through the following sources:

Midwestern Climate Center - **http://mccsws.uiuc.edu/**
Illinois State Water Survey - **http://www.sws.uiuc.edu/**
Rock Island U.S. Army Corps of Engineers (COE) - **http://ncrbkp.ncr.usace.anny.mil/**
St. Louis COE - **http://lms61.lms.usace.army.mil/index.html**
COE river level gage site descriptions - **http://ncrbkp.ncr.usace.army.mil/docs/gagedesc/**
USGS Historic Stream Flow Data - **http://h2o.usgs.gov/swr/**
Nebraska NRCS - **http://ngp.ngpc.state.ne.us/wildlife/wrp.html**
SAST levee database - **http://edcwww2.cr.usgs.gov/levee.html**
EMTC clearinghouse for data on biological, physical, and spatial data and applications - **http://www.emtcnbs.gov/http_data/emtc_sections/data_clearinghouse.html**
U.S. Army COE 1993 Hood Page - **http://www.wes.army.mil/eI/flood/fl93home.html**
Illinois DNR-OWR home page - **http://dnr.state.il.us/ildnr/ofllces/water.htm**
Food and Agricultural Policy Research Institute Flood Damage and Recovery Survey Report - http://www.ssu.missouri.edu/SSU/FAPRI/reports/theflood/text/intro/titlepg.htm


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