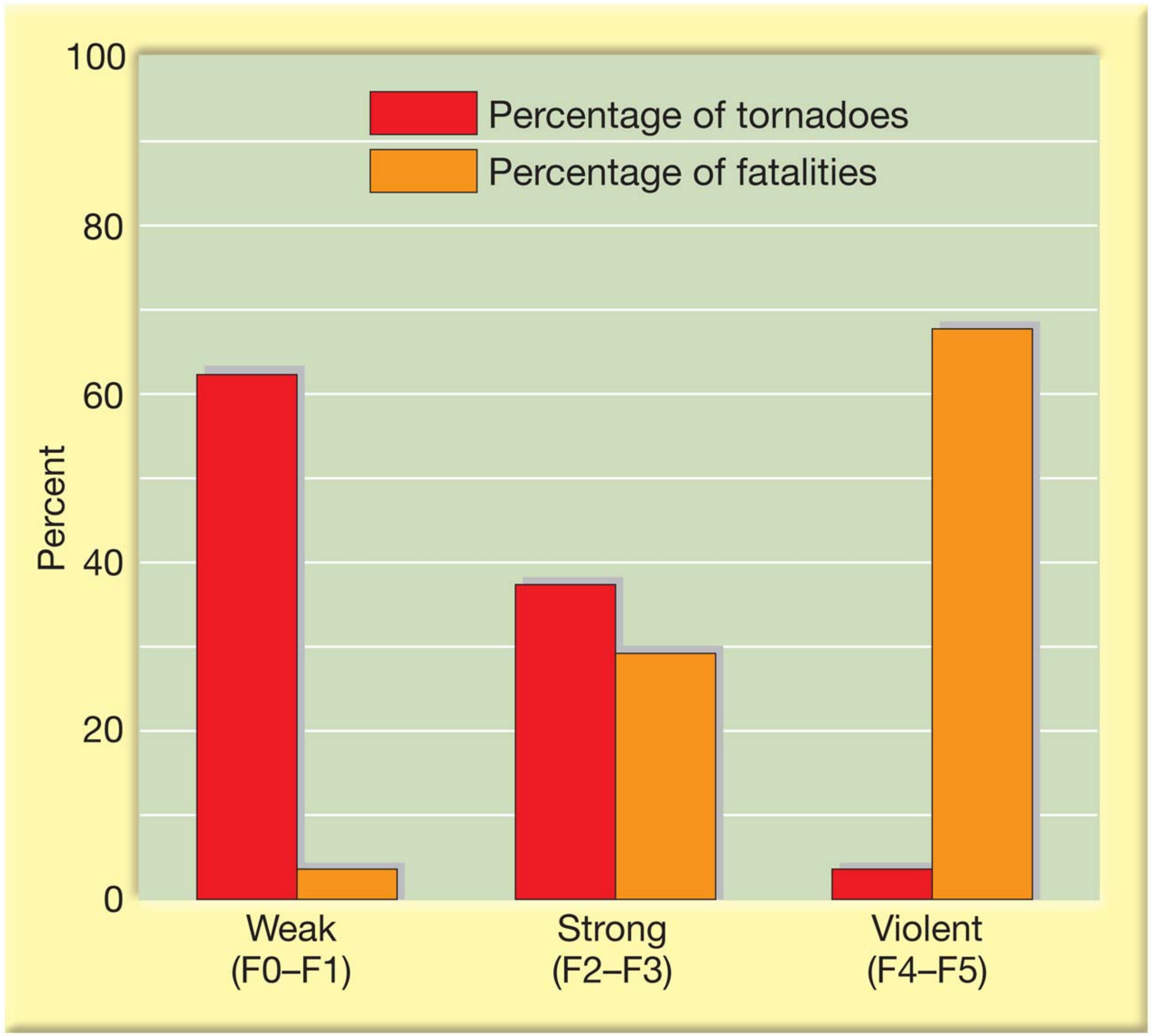
The Red River Valley Flood of 1997:
A Call for Worst-Case Scenario Approaches to Flood Risk Management

Paul E. Todhunter
Department of Geography
University of North Dakota
Grand Forks, ND, 58202-9020
USA

Frequency-Magnitude-Damage Relationships



Extreme Flood Hydroclimatology

- Unique combination of flood-producing processes
- Not sampled in historical record
- Flood Flow Frequency Analysis (FFFA) inadequate to estimate Q_{pk100}

Global Change

- Global climate change
- Global environmental change
- Cultural change
- Assumptions of FFFA not valid

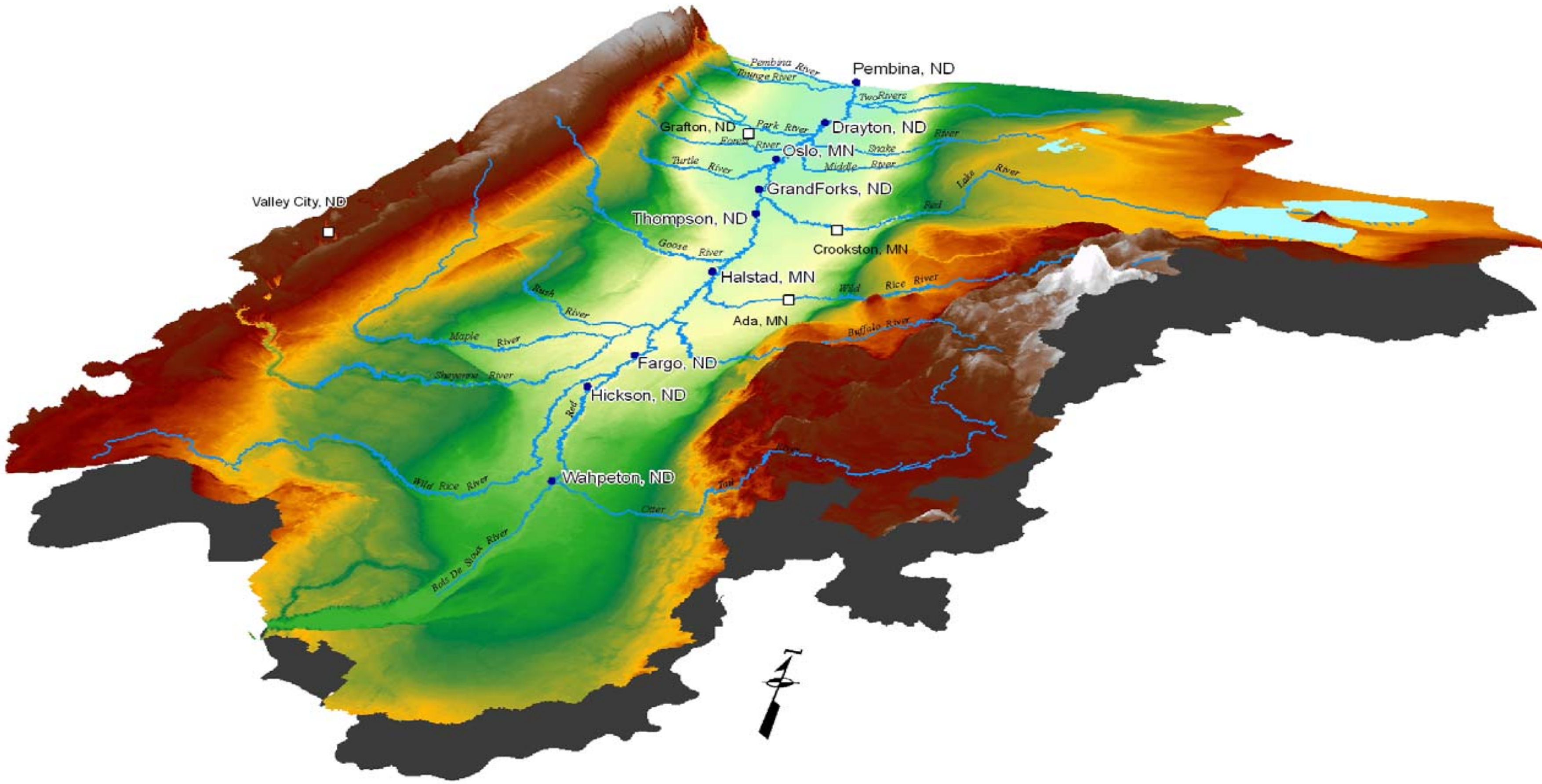
Clark (2005): Worst-case Thinking

- Preemptive resilience as a national disaster mitigation strategy
- Probabilism
- Possibilism

1997 Red River Valley Flood

Grand Forks, ND – East Grand Forks, MN USA

Constant Flood Factors



Source: USGS

Flood Forecast-Response System (FFRS)

(Krzysztofowicz, 1983)

1) Data collection

⇓

2) Flood forecasting

⇓

3) Forecast dissemination

⇓

4) Decision-making

⇓

5) Action implementation

FFRS – Step 1
Data Collection

- United States Geological Survey
- Real-time river stage observations
- Telemetry input to NCRFC
- Required NWSRFS input data


Stream Gage

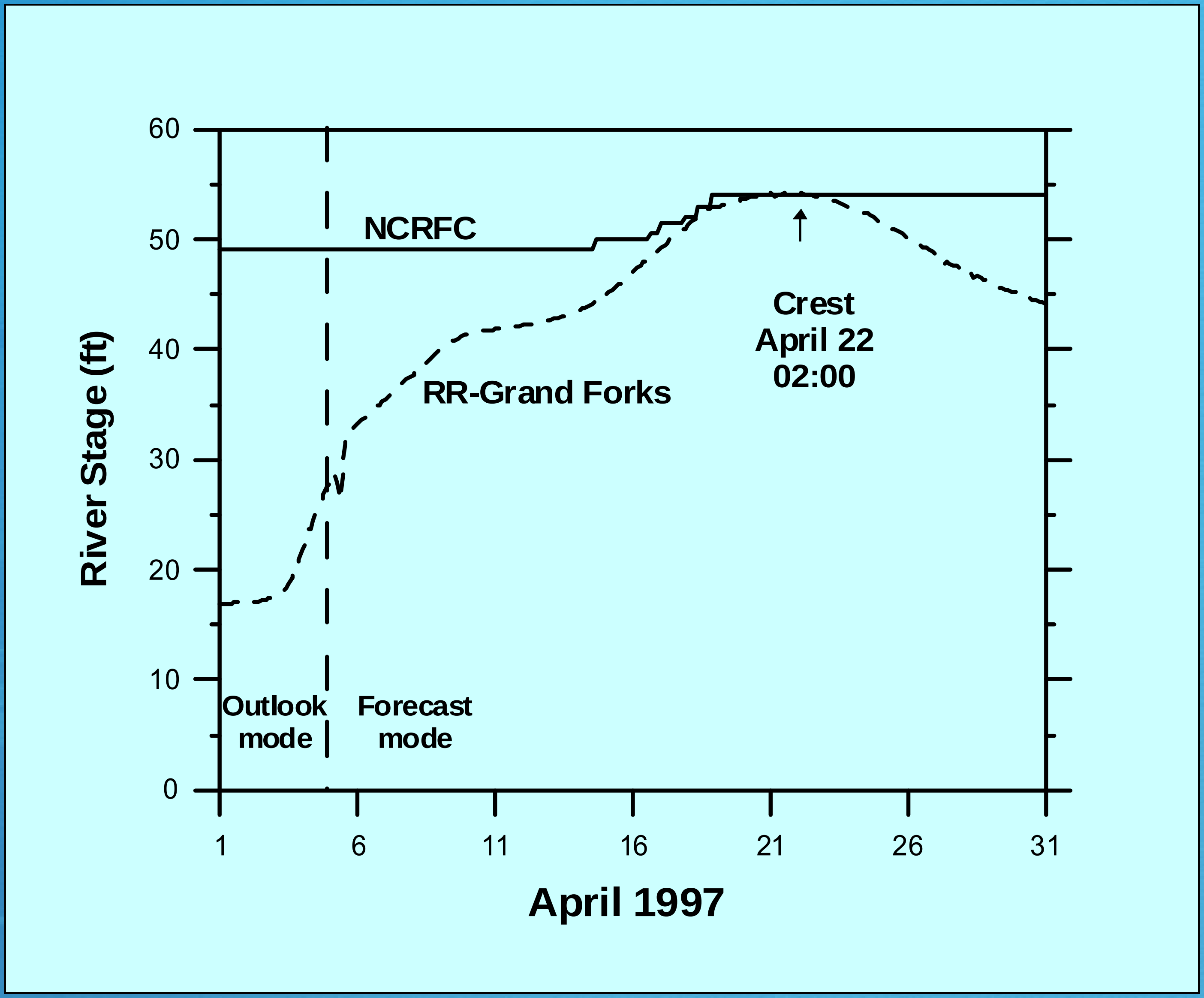
FFRS – Step 2
Flood Forecasting

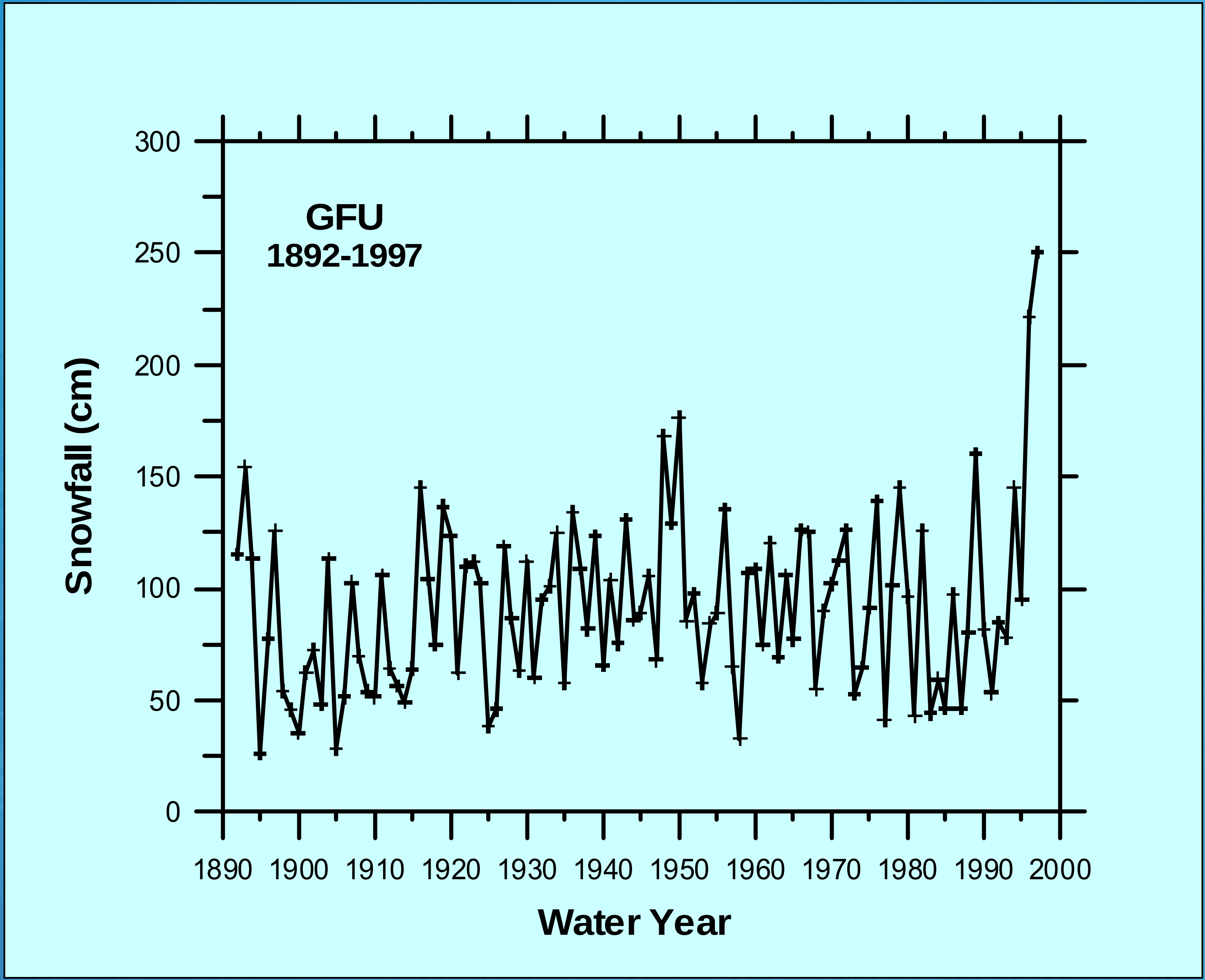
- National Weather Service River Forecast Centers
- NWS River Forecasting System modeling system
- Numerical Outlook – climatological forecast
- Operational Forecasts – NWSRFS for 34 Red River Basin forecast points

Variable Flood Factors

- Long lead time
  - Fall soil moisture
  - Seasonally frozen soils
  - Snow water equivalent of snowpack
- Short lead time
  - Spring thaw
  - Spring rain-on-snow events
  - River ice

“Stair-Stepping”

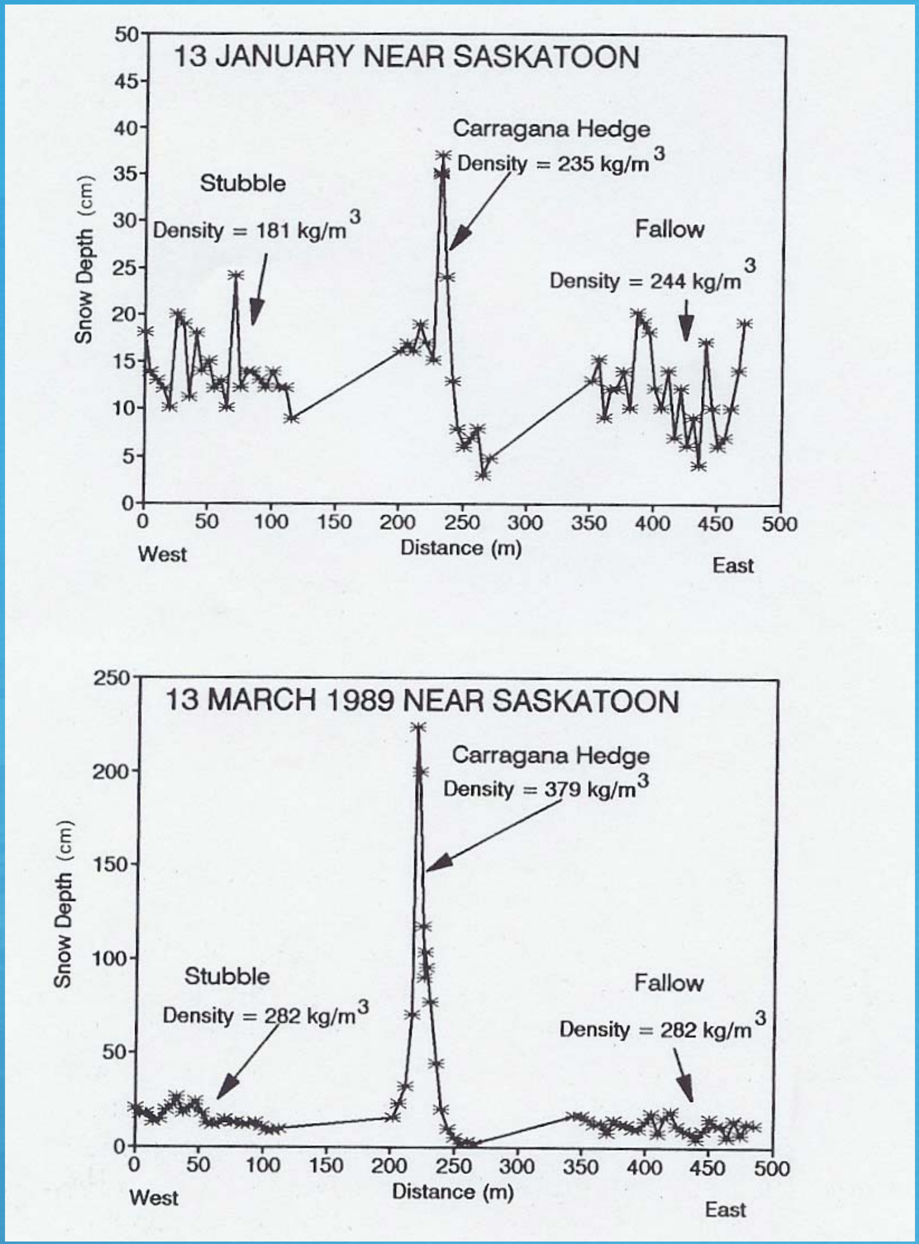


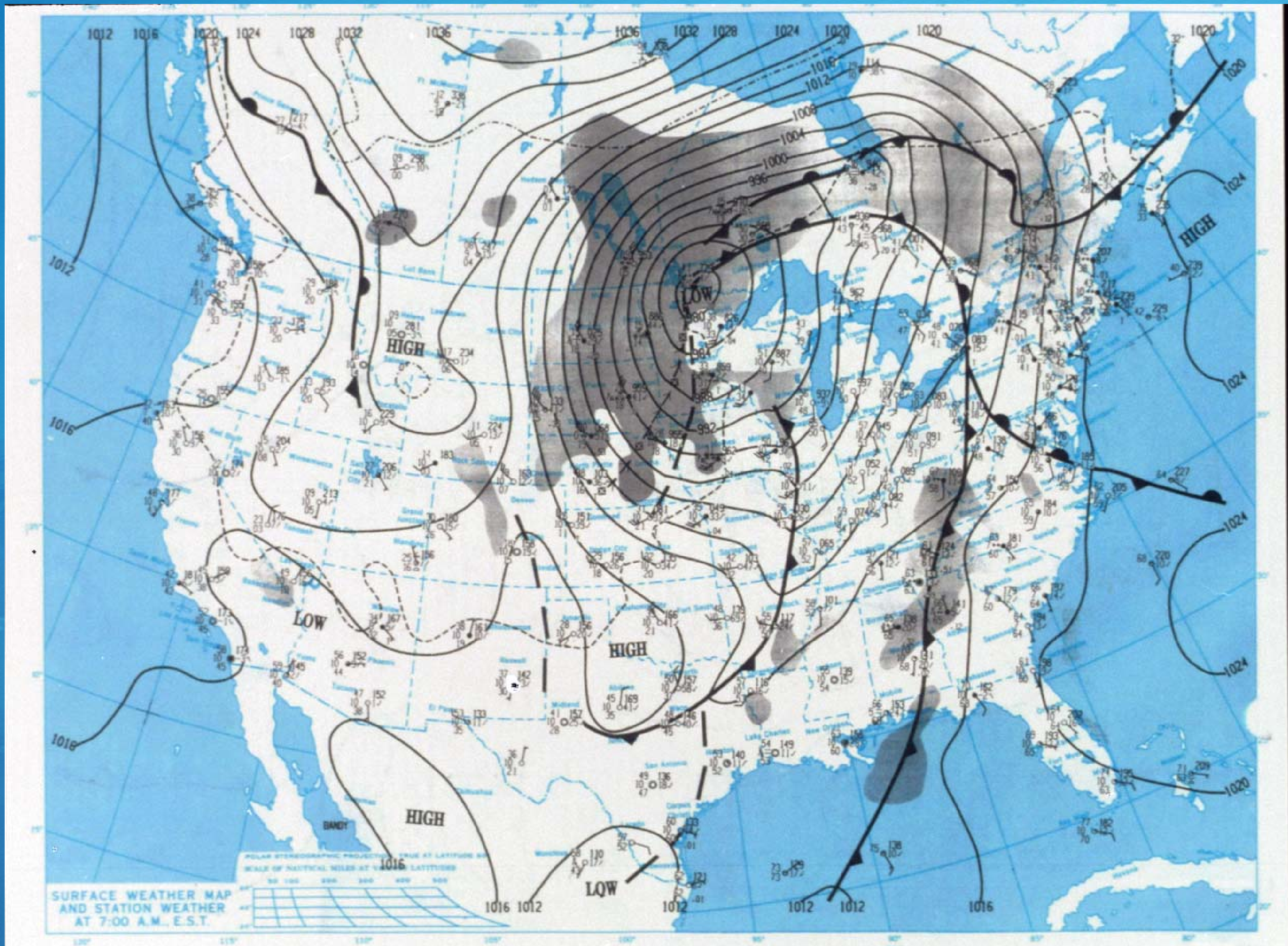


GFU
1892-1997
Snowfall (cm)
0
50
100
150
200
250
300
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Water Year

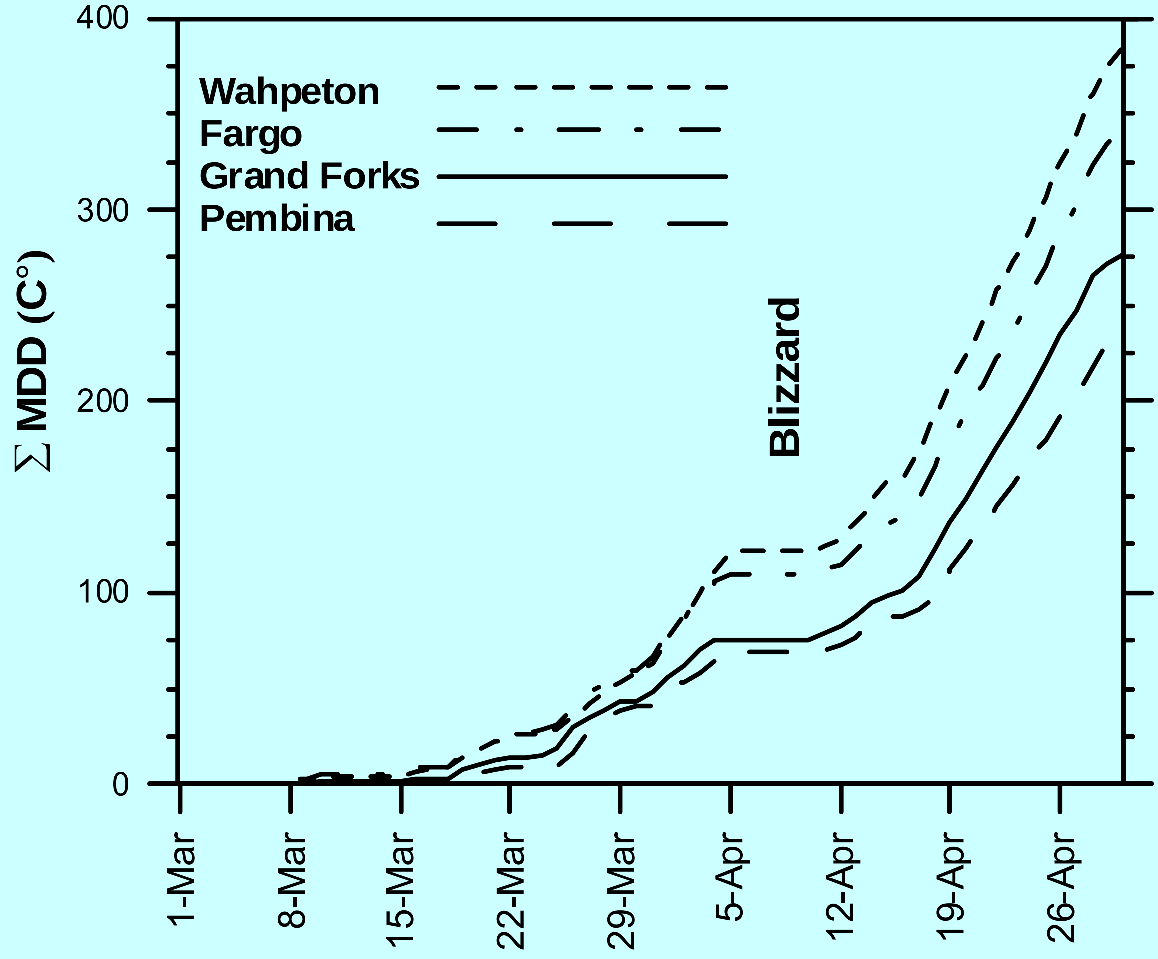
Transect of snow depth and snow density in a prairie snowpack

Pomeroy et al. (1993)



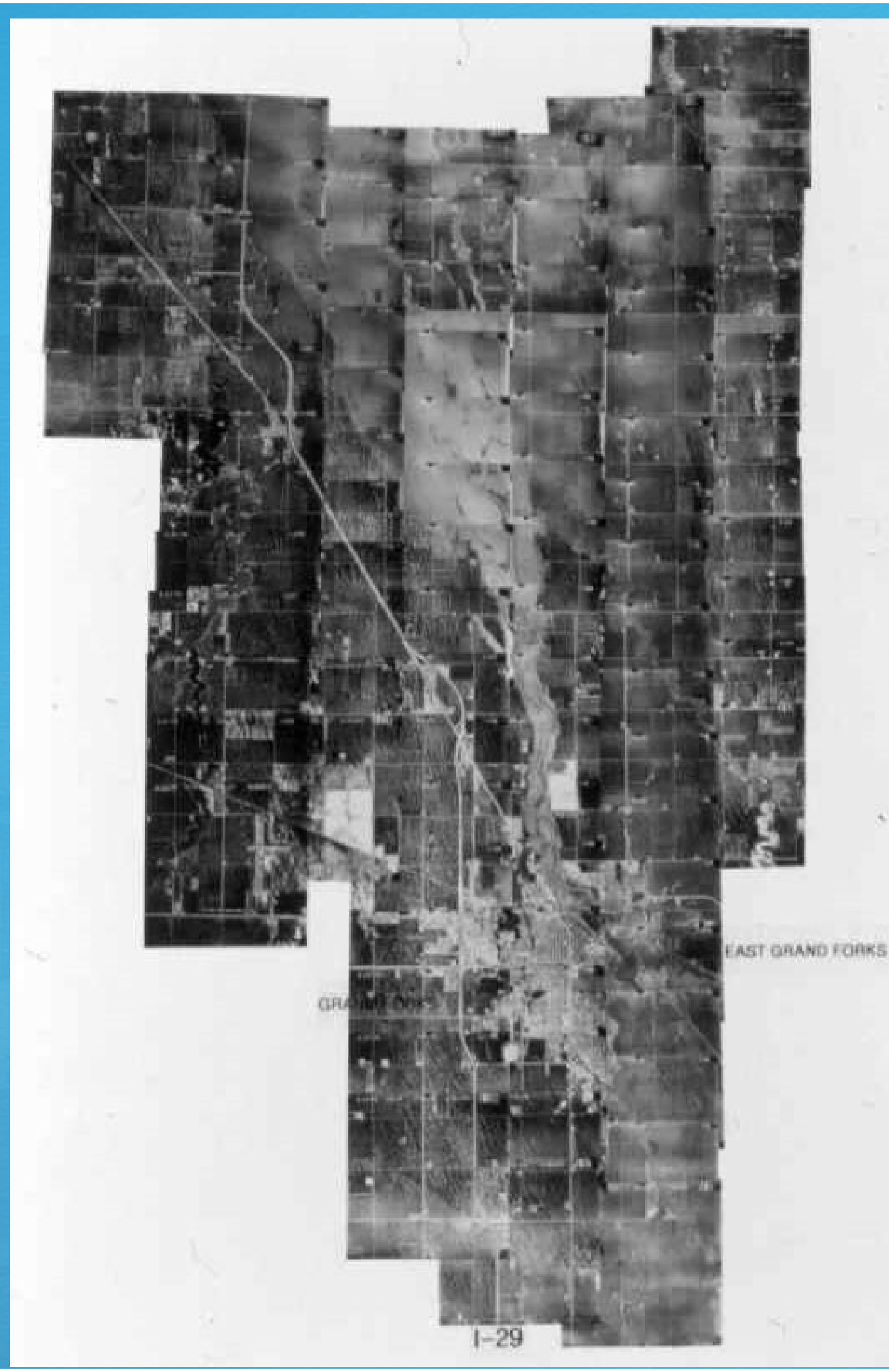


SURFACE WEATHER MAP
AND STATION WEATHER
AT 7:00 A.M., E.S.T.
HIGH
HIGH
HIGH
HIGH
LOW
LOW
LOW
1012
1016
1020
1024
1028
1032
1036
1000
1004
1008
996
992



Wahpeton
Fargo
Grand Forks
Pembina
Blizzard
∑ MDD (C°)
0
100
200
300
400
1-Mar
8-Mar
15-Mar
22-Mar
29-Mar
5-Apr
12-Apr
19-Apr
26-Apr

1979 Flood



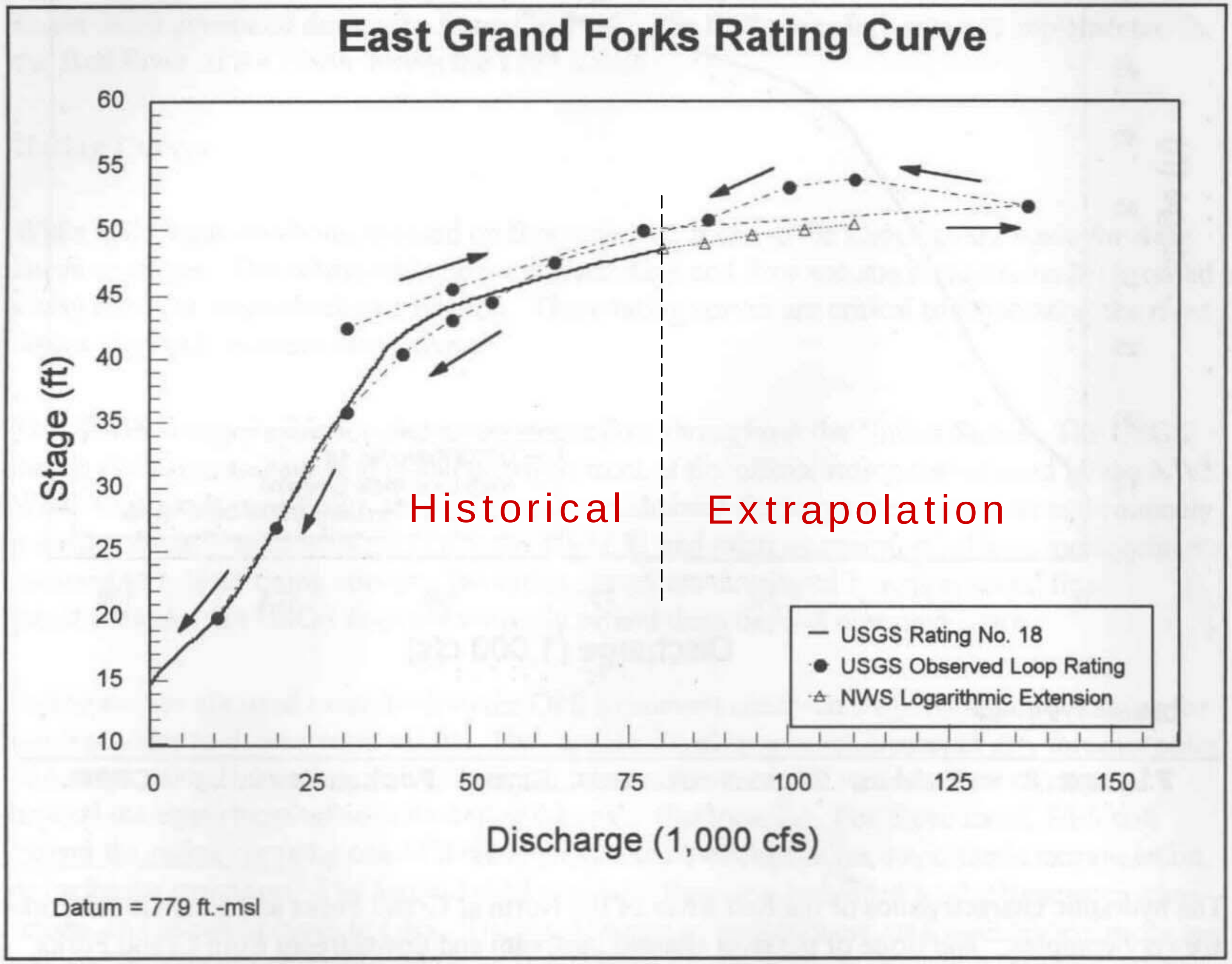


Figure 3 - Loop Rating at East Grand Forks for 1997 Flood.

18 April 1997 Flood Statement, 2008 LST

"This situation is unlike any flooding conditions ever experienced in eastern ND and NW MN. The NWS is working very hard with local, state, and federal agencies to give the public the most accurate information possible."

USA Today, 14 June 1997, NCRFC Head

"… We really didn't have an indication we were going to get 54 feet until all the pieces fell into place and we put the puzzle together."

FFRS – Step 3
Forecast Dissemination

- National Weather Service Eastern North Dakota Forecast Office
- Staff Hydrologist
- Flood Statements addressed hydrological uncertainty to an educated audience

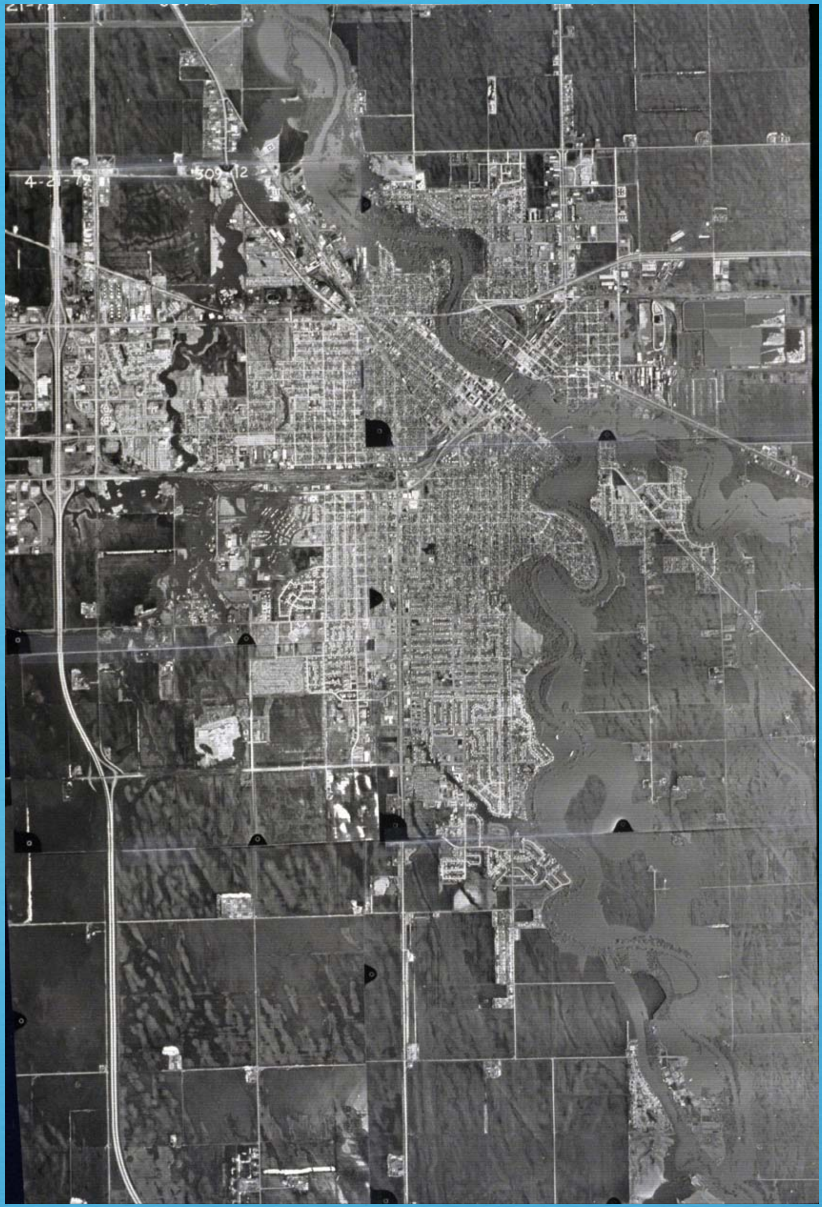
FFRS – Step 4
Decision-Making

- Local governments and agencies
- City Emergency Manager
- City Engineer
- Mayor
- Police, Firefighters, Sheriff, etc.

1997 “The Perfect Snowmelt Flood”

- **1979 Flood: 49 ft**
- **Changes since 1979**
- **Anchoring of perception**

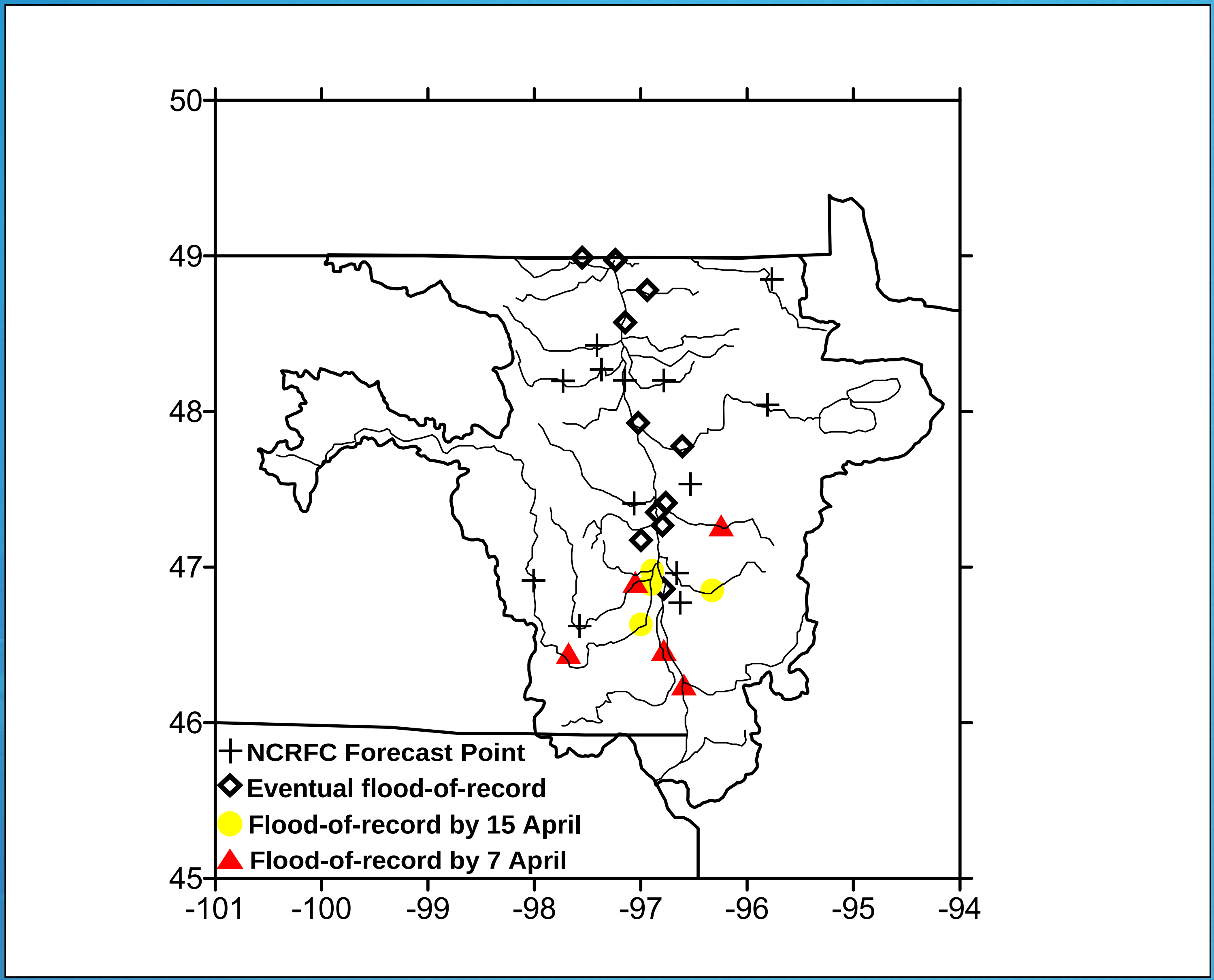
- **Midplaced concreteness**
- **Unfamiliar with NWS products / hydrology**
- **Narrow flood-defense strategy**



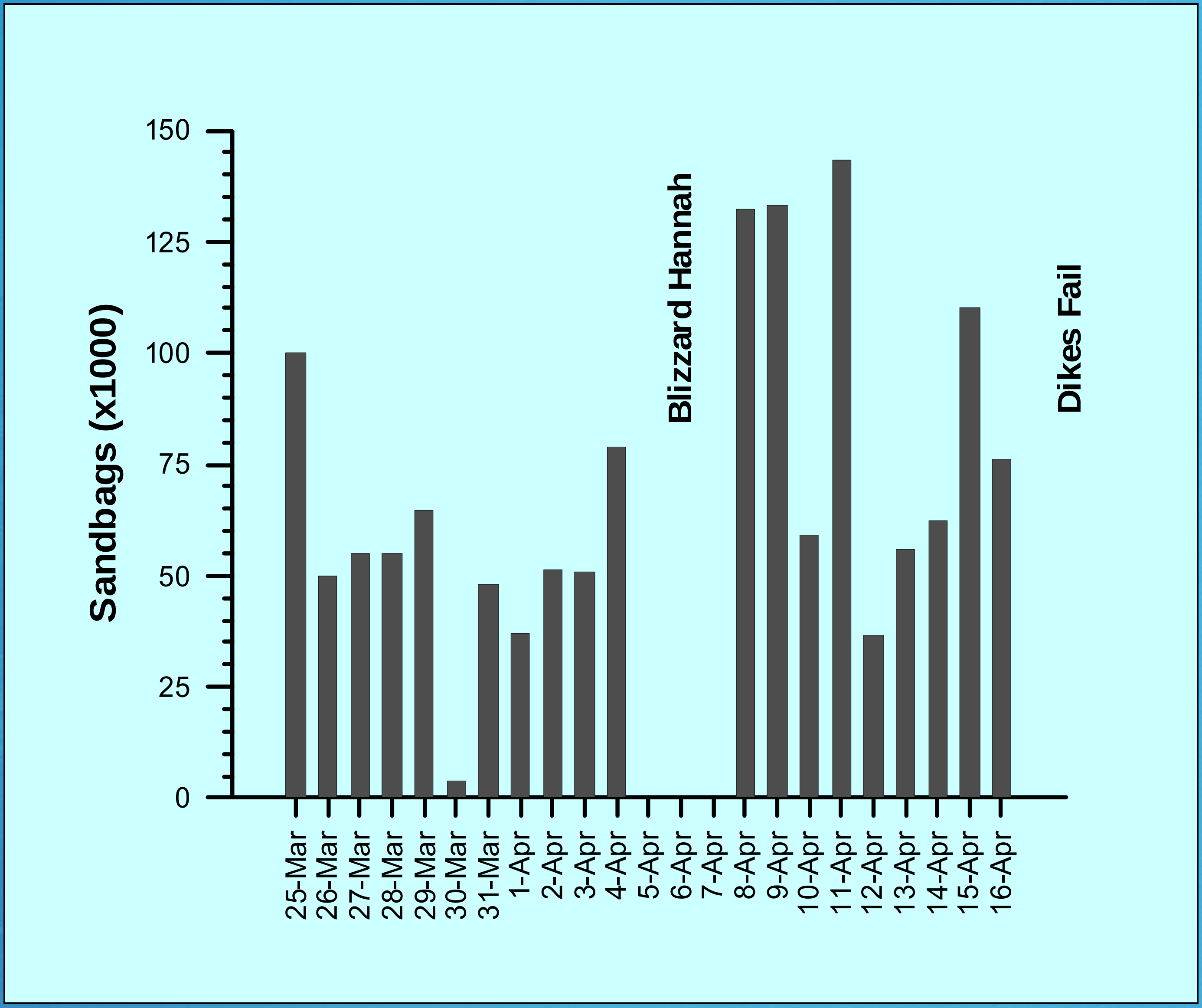
NWSRFC Forecast Point	2nd Numerical Outlook (feet) 14 March 1997	1997 Flood Peak (feet)
Red River – Wahpeton	18.5	19.42
Red River – Fargo	37.5	39.72
Red River – Halstad	39.5	40.74
Red River – Grand Forks	49.0	54.35
Red River – Drayton	44.0	45.60
Red River – Pembina	54.0	54.90
Wild Rice River – Abercrombie	24.5	26.59
Sheyenne River – Lisbon	18.5	19.29
Sheyenne River – Kindred	21.0	22.33
Sheyenne River – West Fargo	22.5	23.30
Sheyenne River – Harwood	894.0	892.0

NWSRFC Forecast Point	2nd Numerical Outlook (feet) 14 March 1997	1997 Flood Peak (feet)
Maple River – Mapleton	14.50	15.50
Pembina River – Walhalla	na	16.20
Pembina River – Neche	22.0	24.51
Buffalo River – Hawley	10.0	10.77
Wild Rice River – Twin Valley	13.5	15.90
Wild Rice River – Hendrum	31.5	33.85
Marsh River – Shelly	na	25.70
Red Lake River – Crookston	27.0	28.40
Snake River – Alvarado	10.0	10.60
Two Rivers River – Hallock	810.0	810.7

NWS NCRFC Forecast Points



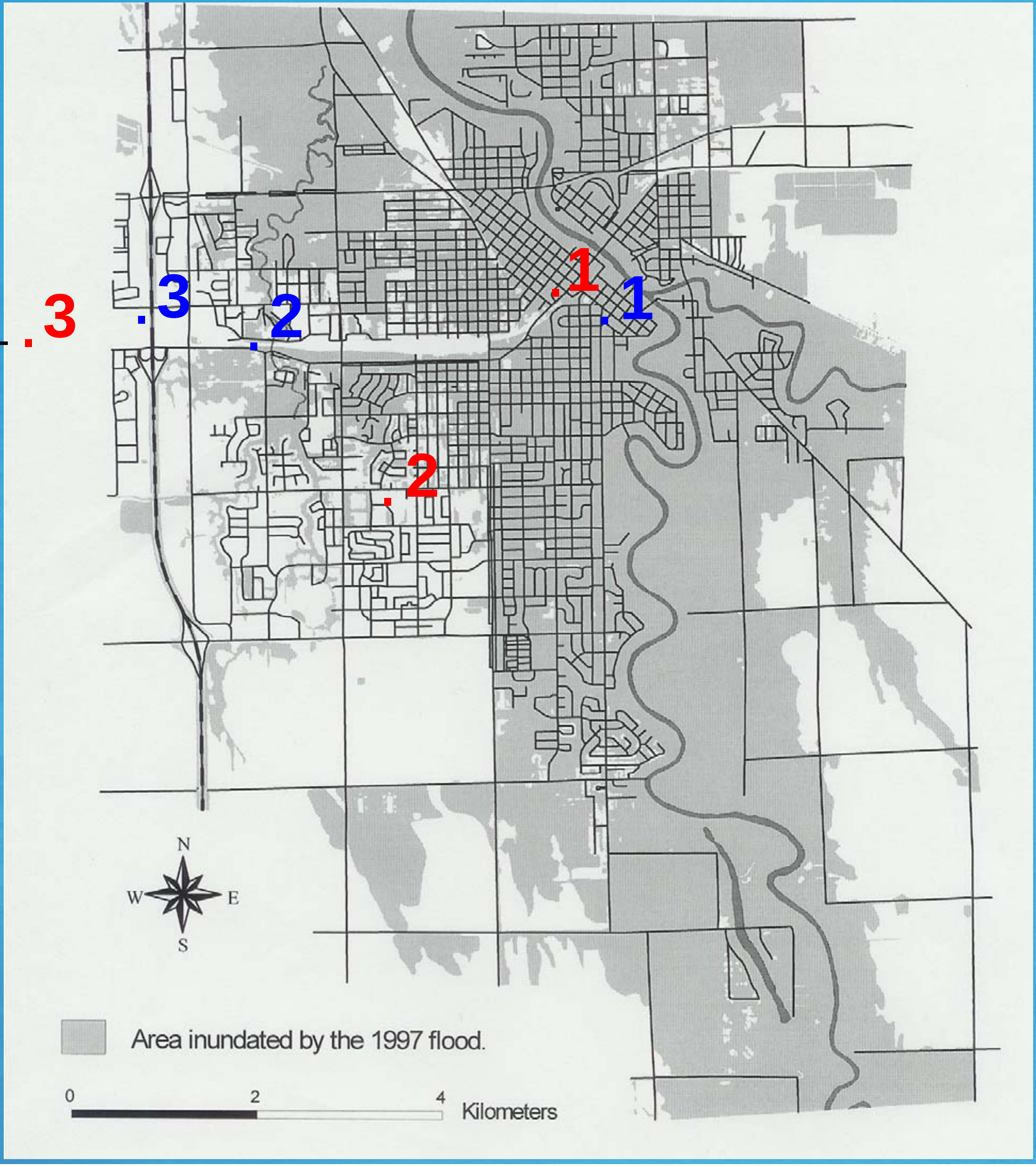
Emergency Sandbagging Operations



FFRS – Step 5
Action Implementation

- Local workers
- Federal workers – National Guard, Army Corps of Engineers, Volunteers

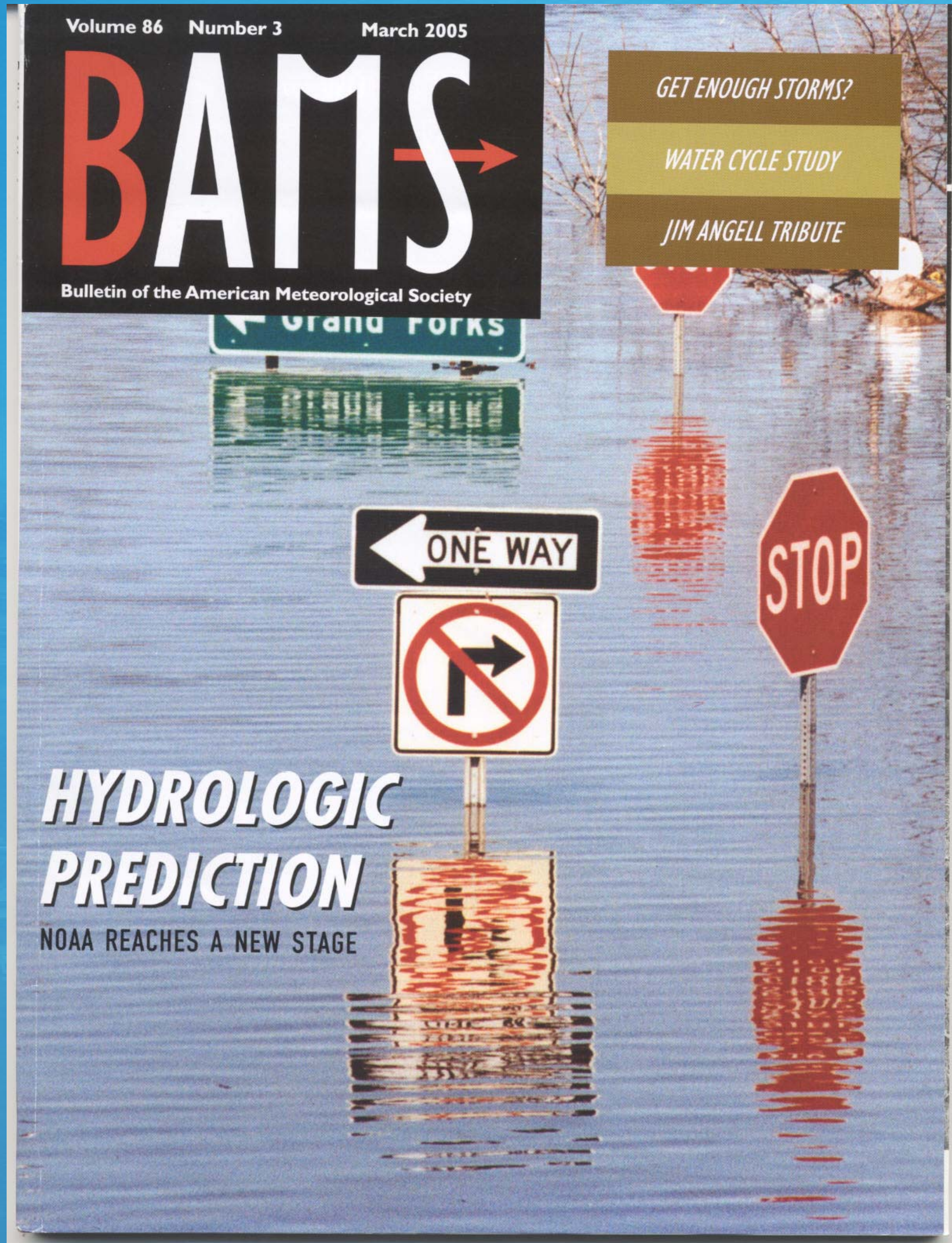
10 km ← .3



Evacuation Sites

Emergency Operations Center

ZZZZZZ
Natural Hazards
OBSERVER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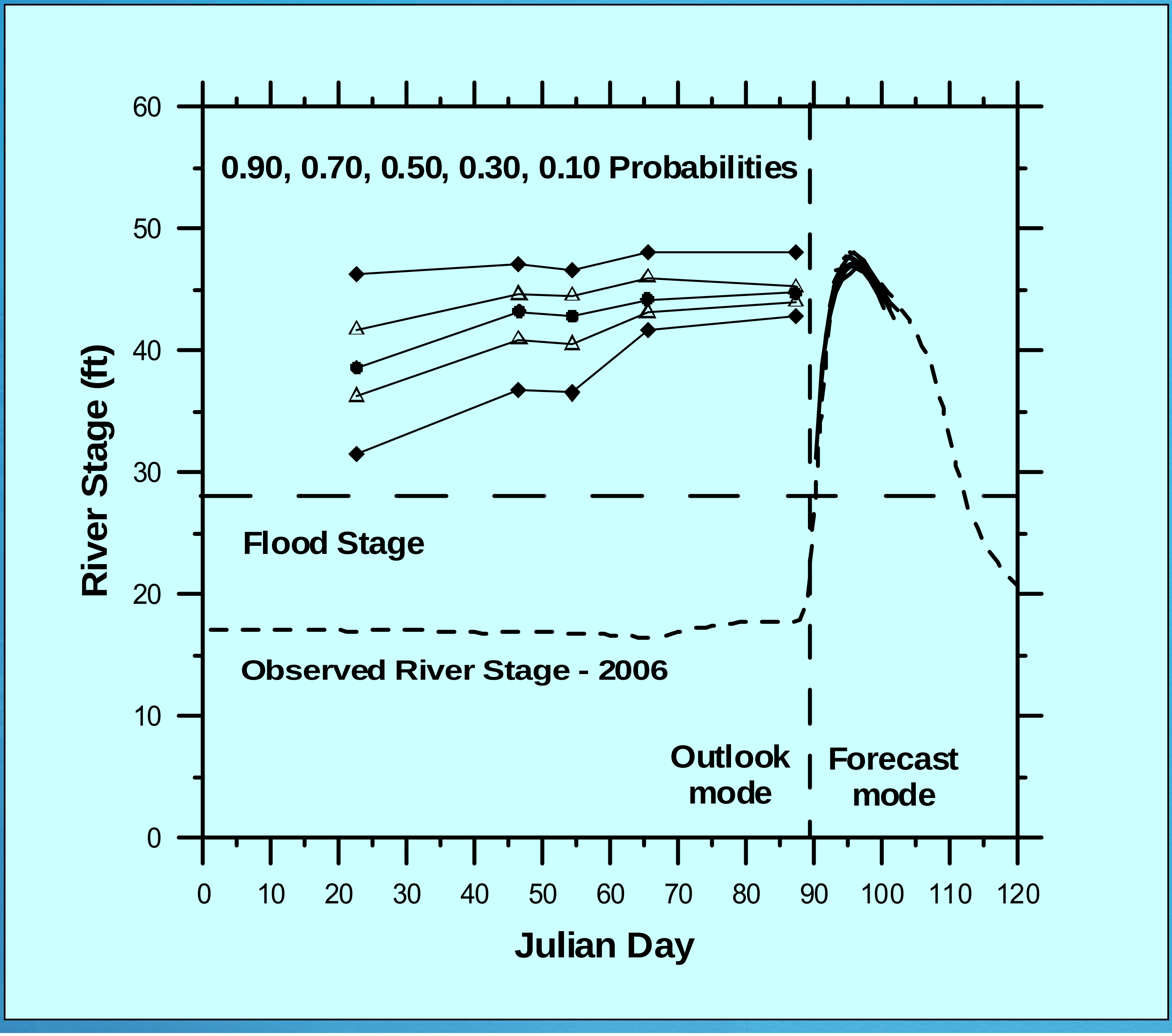
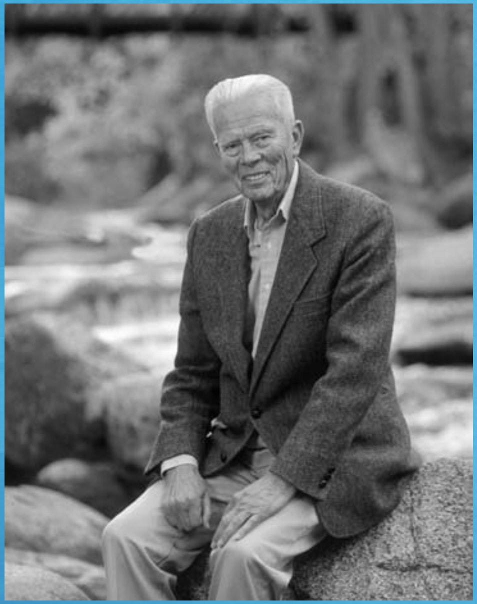
BAMS
Bulletin of the American Meteorological Society
GET ENOUGH STORMS?
WATER CYCLE STUDY
JIM ANGELL TRIBUTE
Grand Forks
ONE WAY
STOP
HYDROLOGIC PREDICTION
NOAA REACHES A NEW STAGE

Advanced Hydrologic Prediction System



Caveant admonitus
(Let the forewarned beware)

Walter M. Kollmorgen (1953) Settlement Control Beats Flood Control.
Economic Geography, 29: 208-215.



Gilbert White
(1911-2006)