NCAR

Climate Variability and Uncertainty in Flood Risk Management in Colorado:

An interdisciplinary project on extremes

Rebecca Morss, Doug Nychka

Mary Downton, Olga Wilhelmi, Uli Schneider, Eve Gruntfest, Heidi Cullen, and others

Example: Fort Collins (CO), July 1997

- Over 10” of rain in 6 hours
- 5 dead, 54 injured, 200 homes destroyed

- Much of damage outside 500-year floodplain

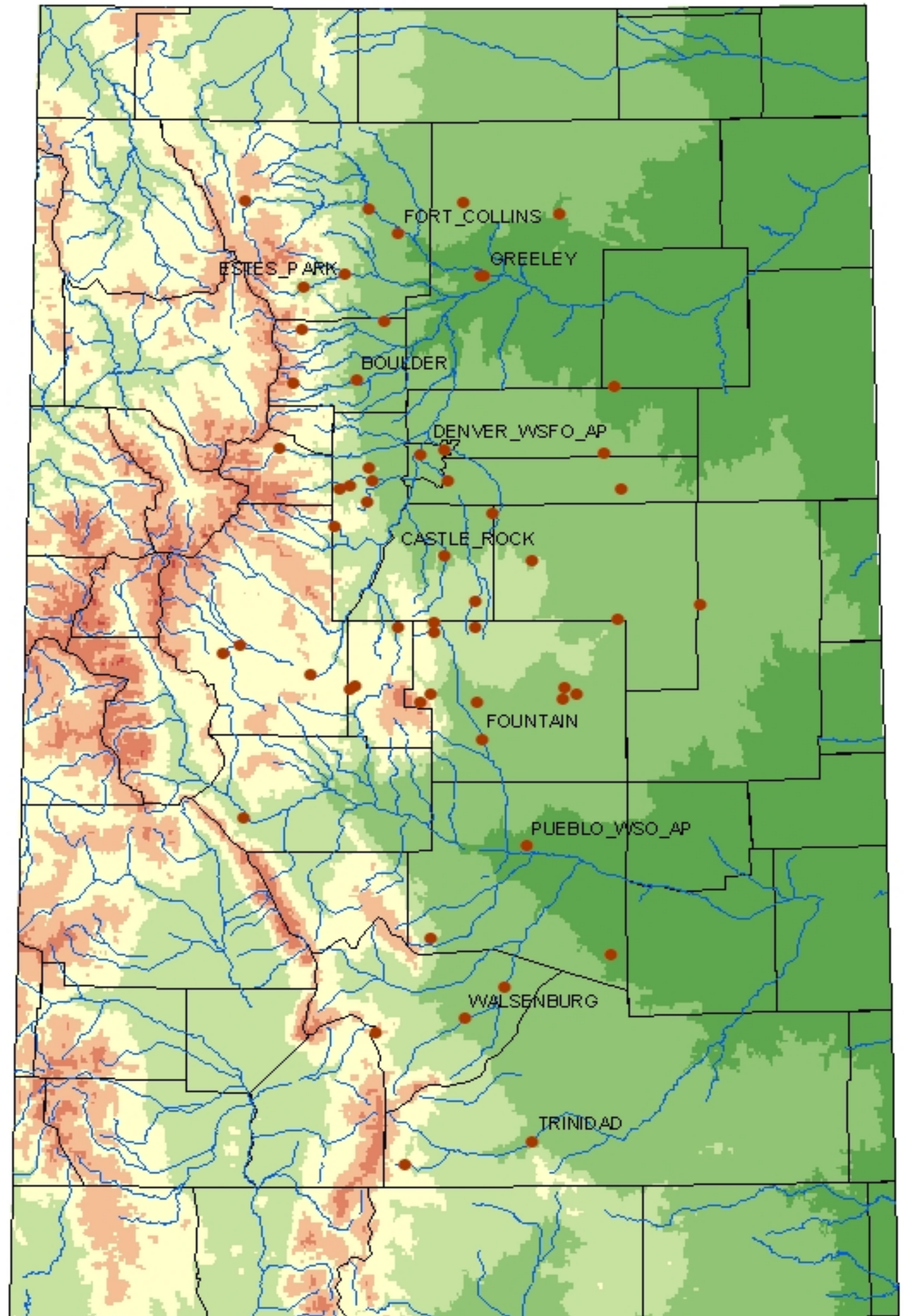
Key Questions

- How is scientific information about extreme flooding used in flood management decision-making?
- How does uncertainty in risk of extreme flooding interact with flood management decision-making?
- What new or improved scientific information about extreme floods could we provide that would benefit flood management?

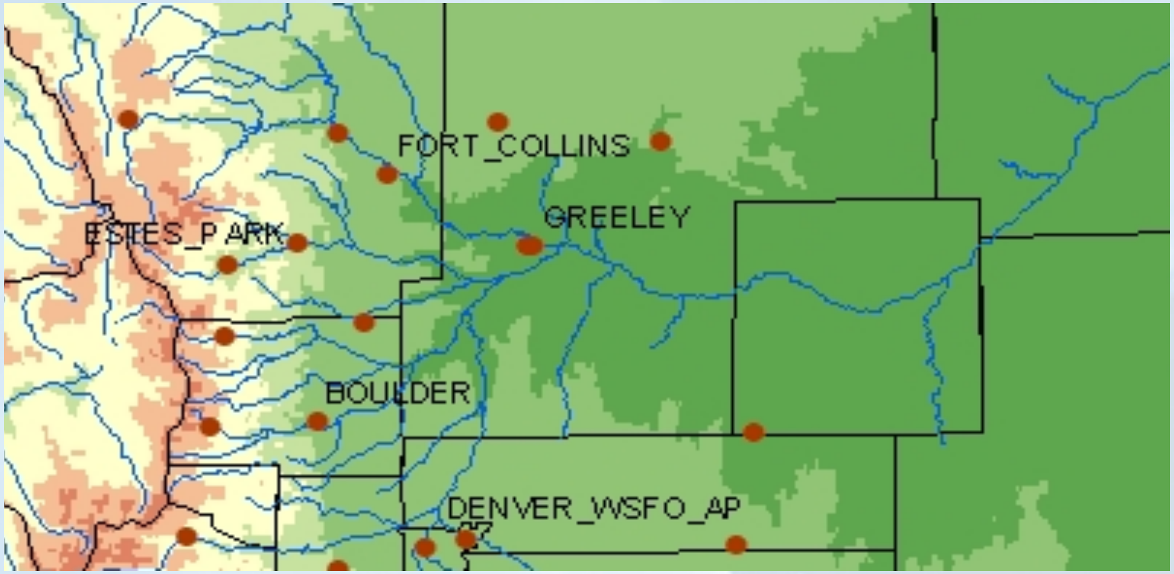
Focus: Colorado Front Range

- Steep topography
- Spatially and temporally variable precipitation
- Limited data
- Growing population

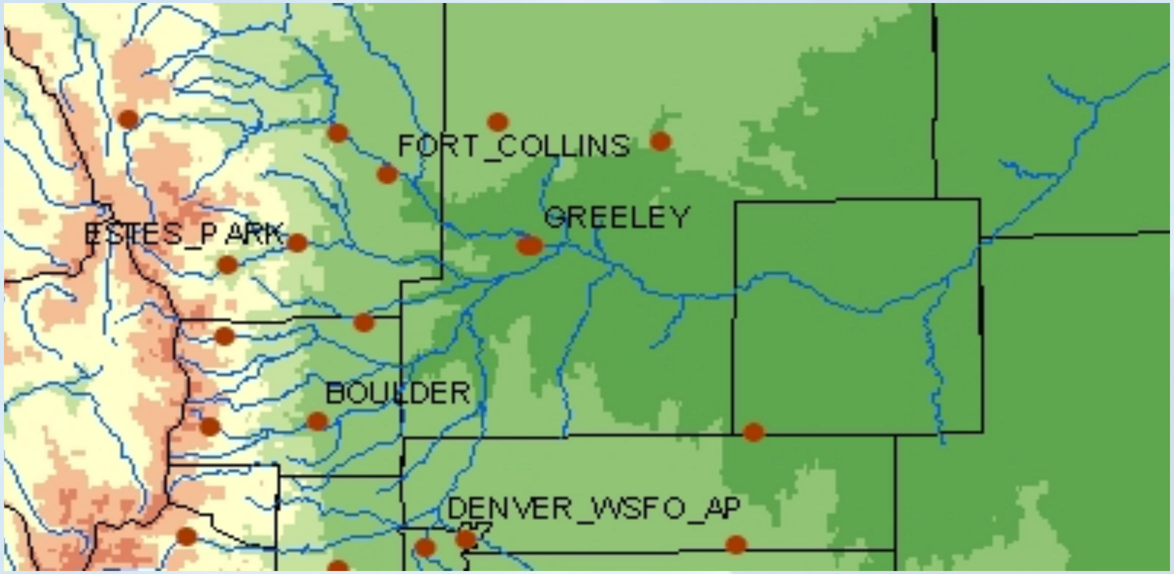
⇒ Flood management important, but flood risk uncertain



Scientific information in flood management

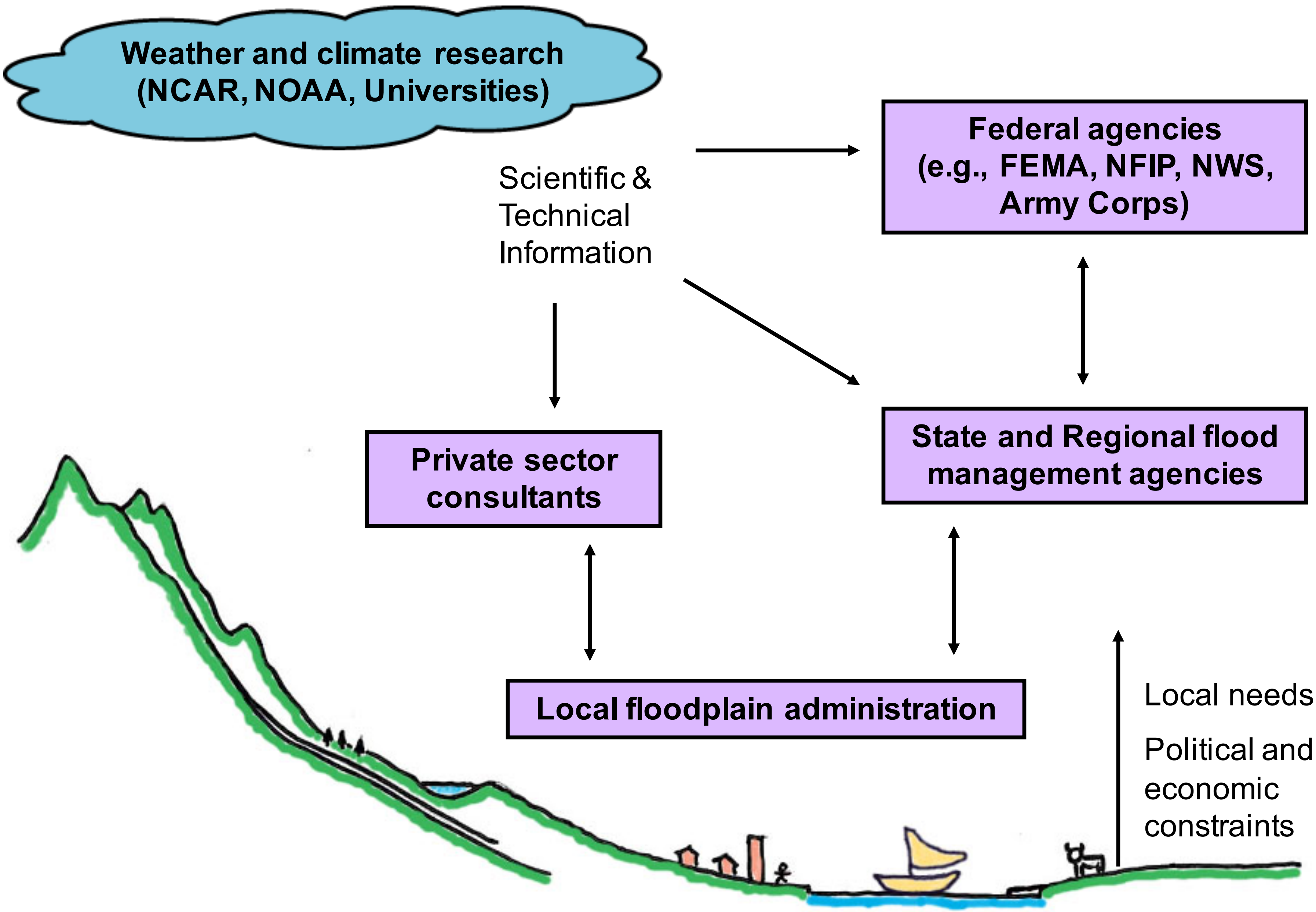


Scientific information in flood management

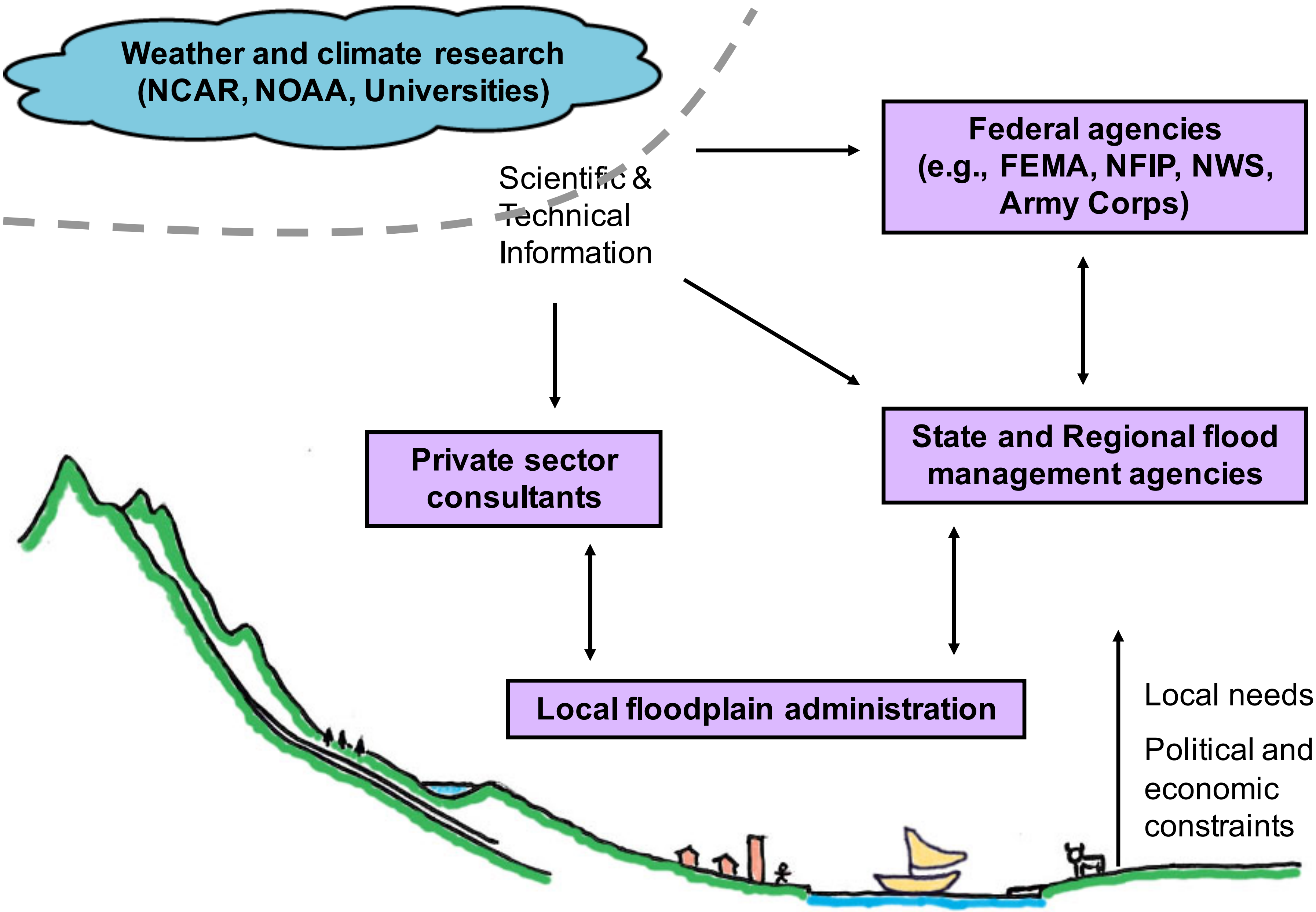


- Meteorology/climatology
- Statistics
- Hydrology
- Engineering
- Decision-making

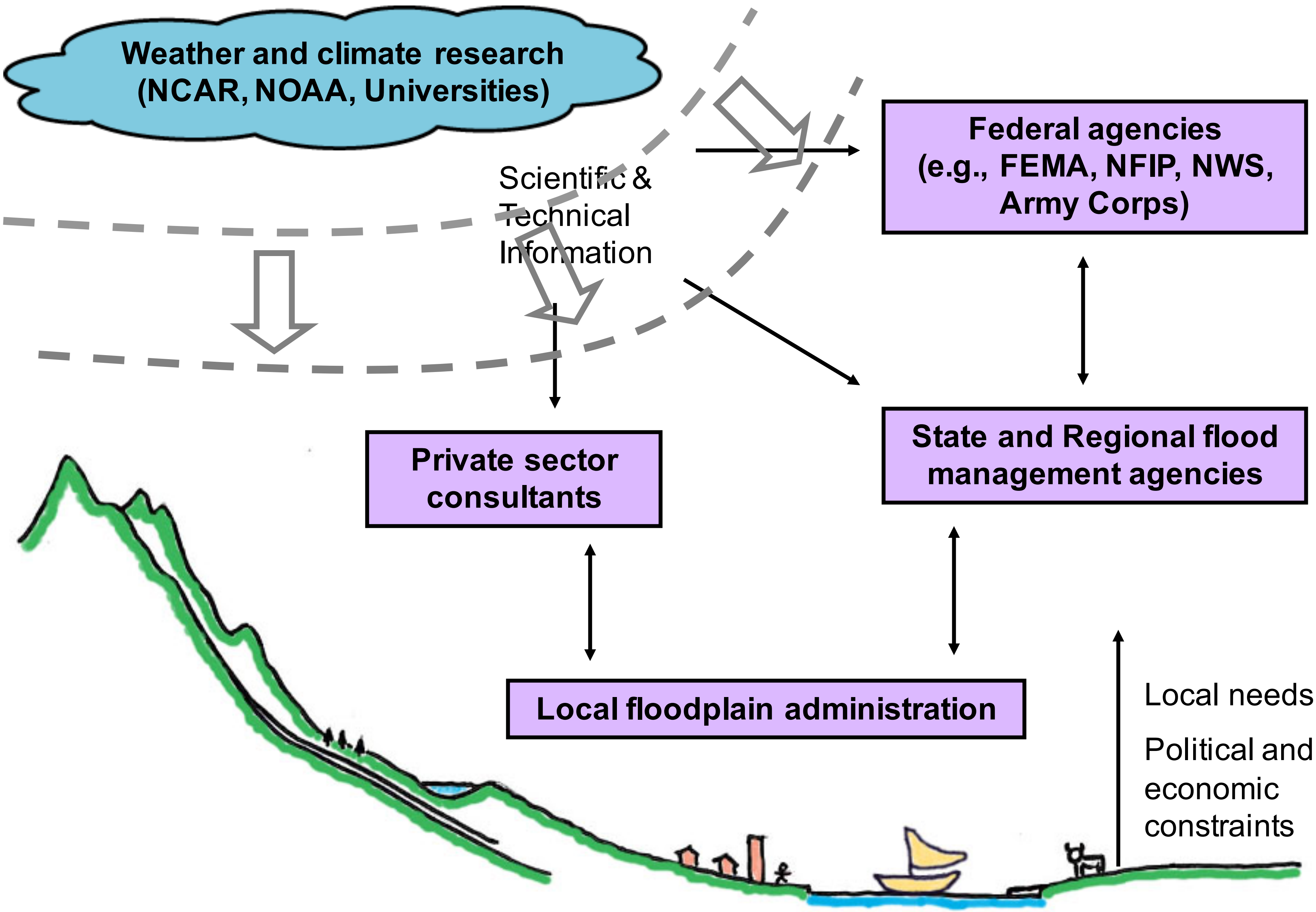
Scientific information in flood management



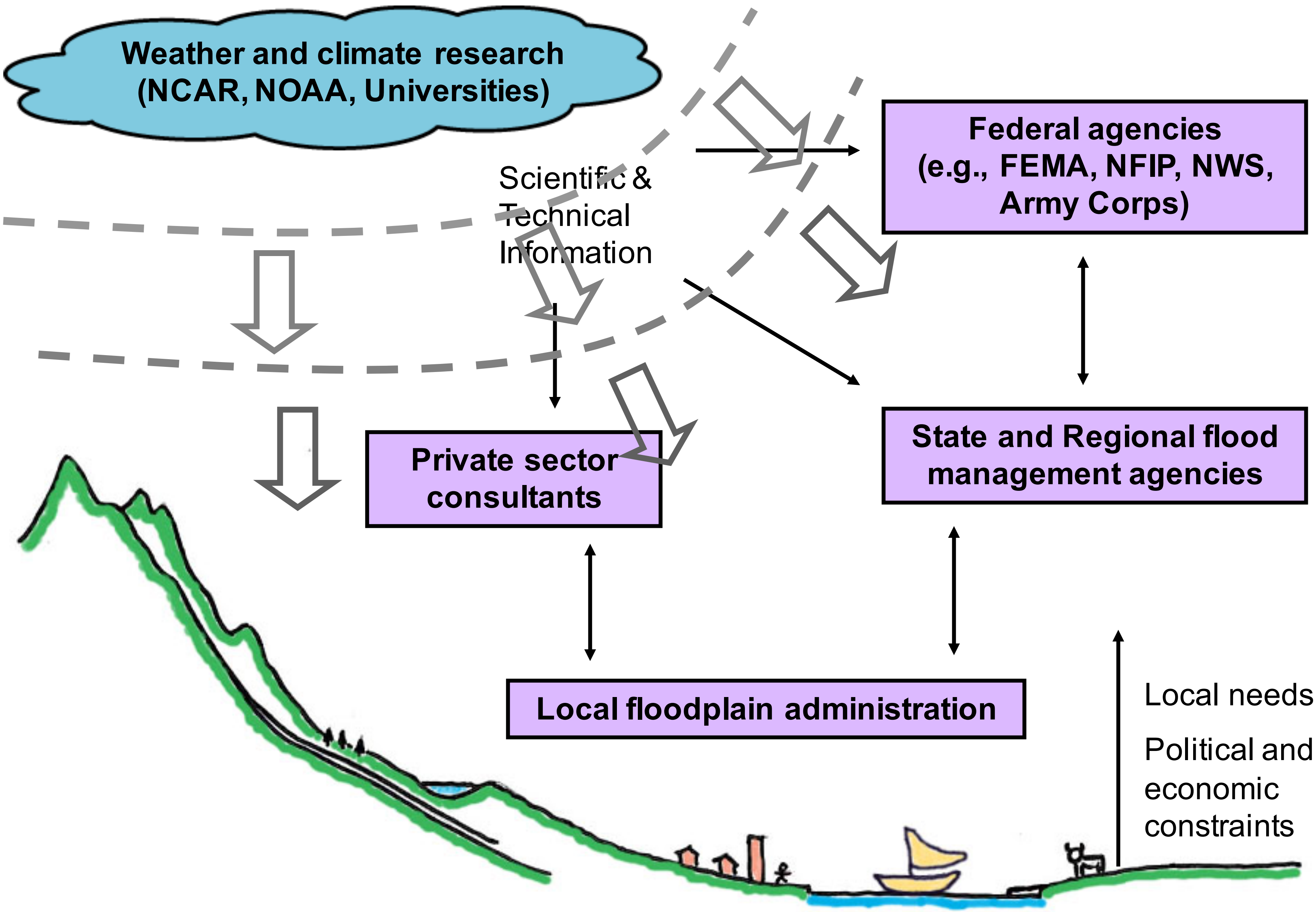
Scientific information in flood management

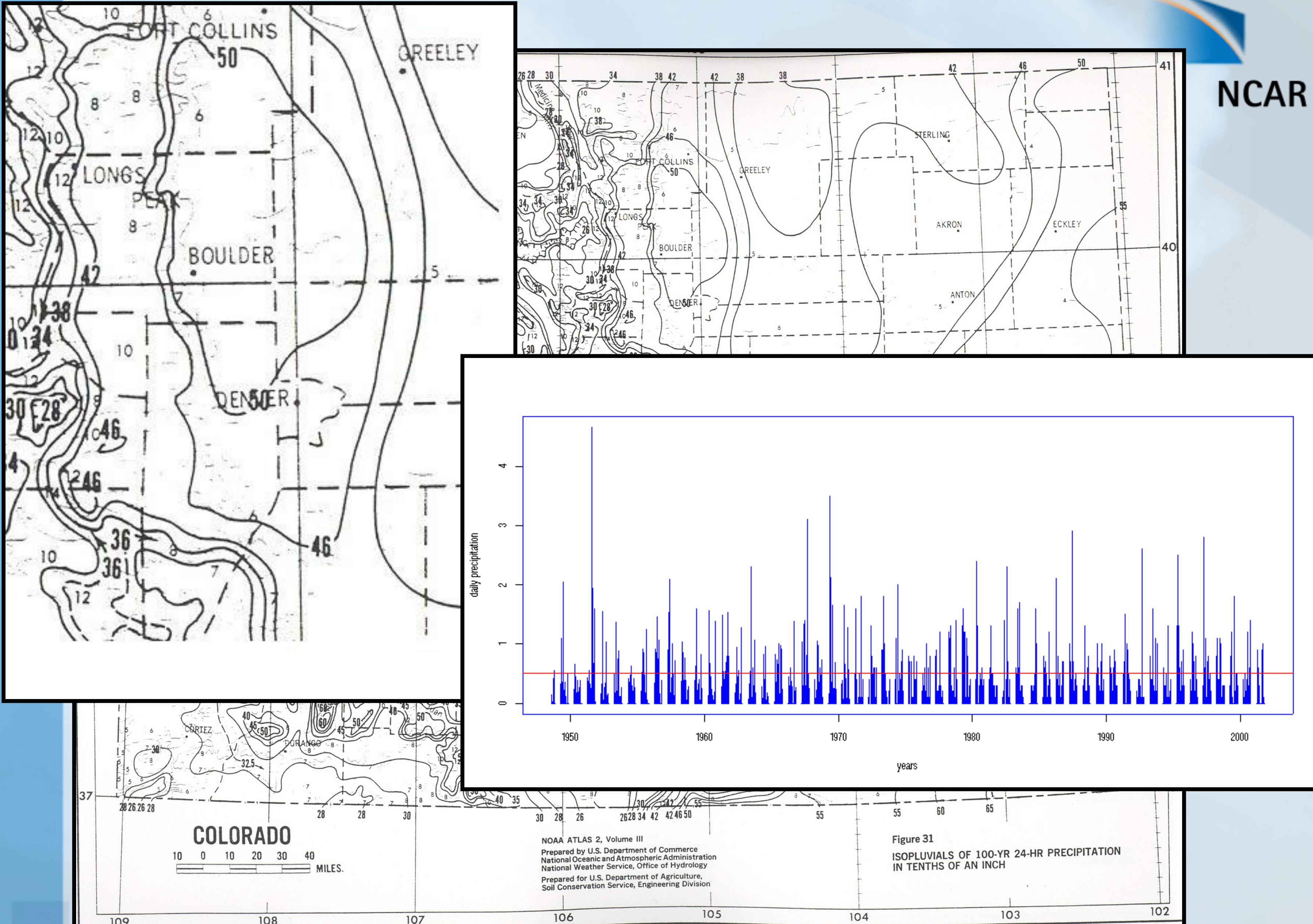


Scientific information in flood management



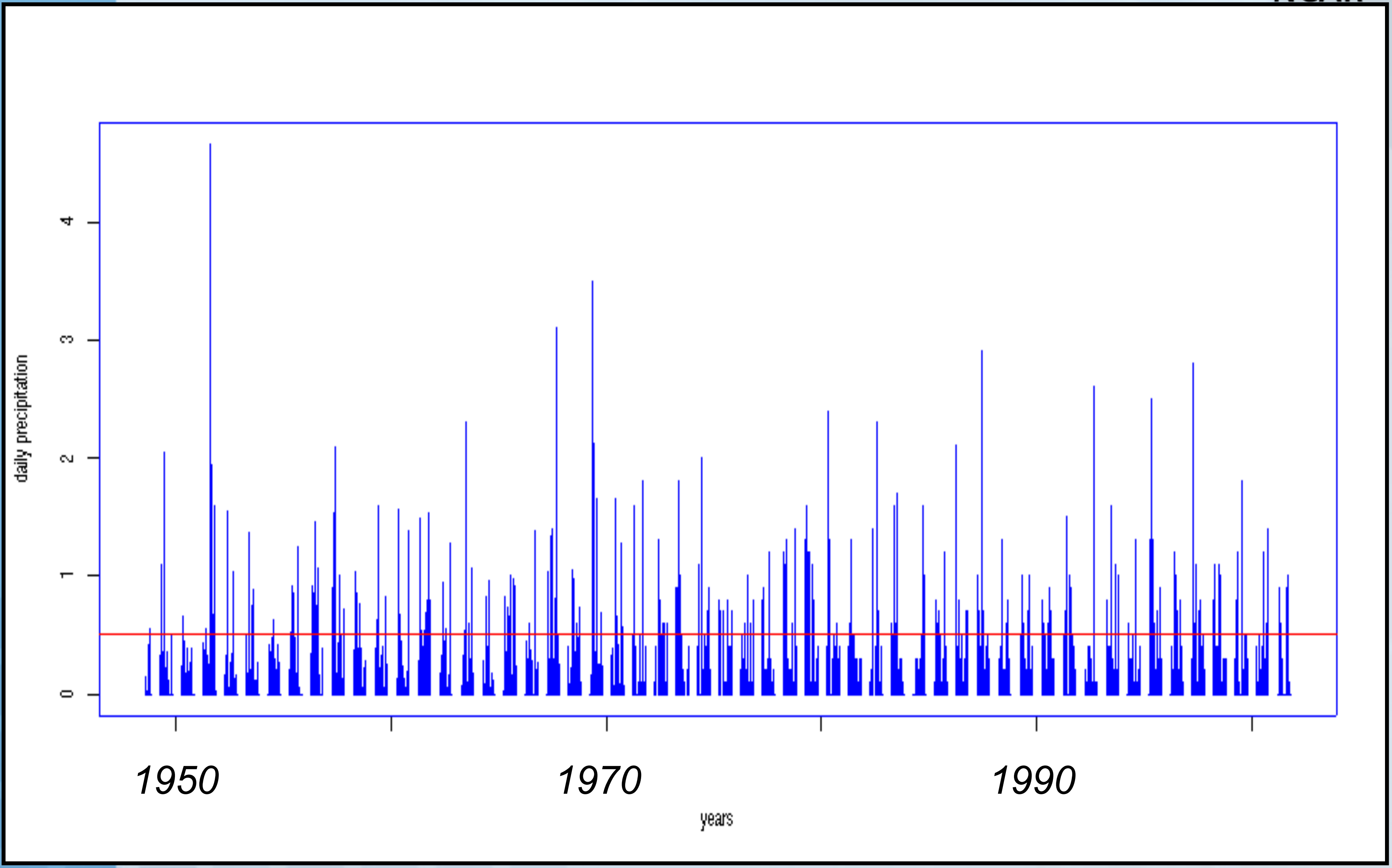
Scientific information in flood management





FORT COLLINS
GREELEY
LONGS PEAK
BOULDER
DENVER
STERLING
AKRON
ECKLEY
ANTON
CORTEZ
DURANGO
COLORADO
MILES.
NOAA ATLAS 2, Volume III
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division
Figure 31
ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION
IN TENTHS OF AN INCH
daily precipitation
0
1
2
3
4
1950
1960
1970
1980
1990
2000
years

Boulder Daily Precipitation



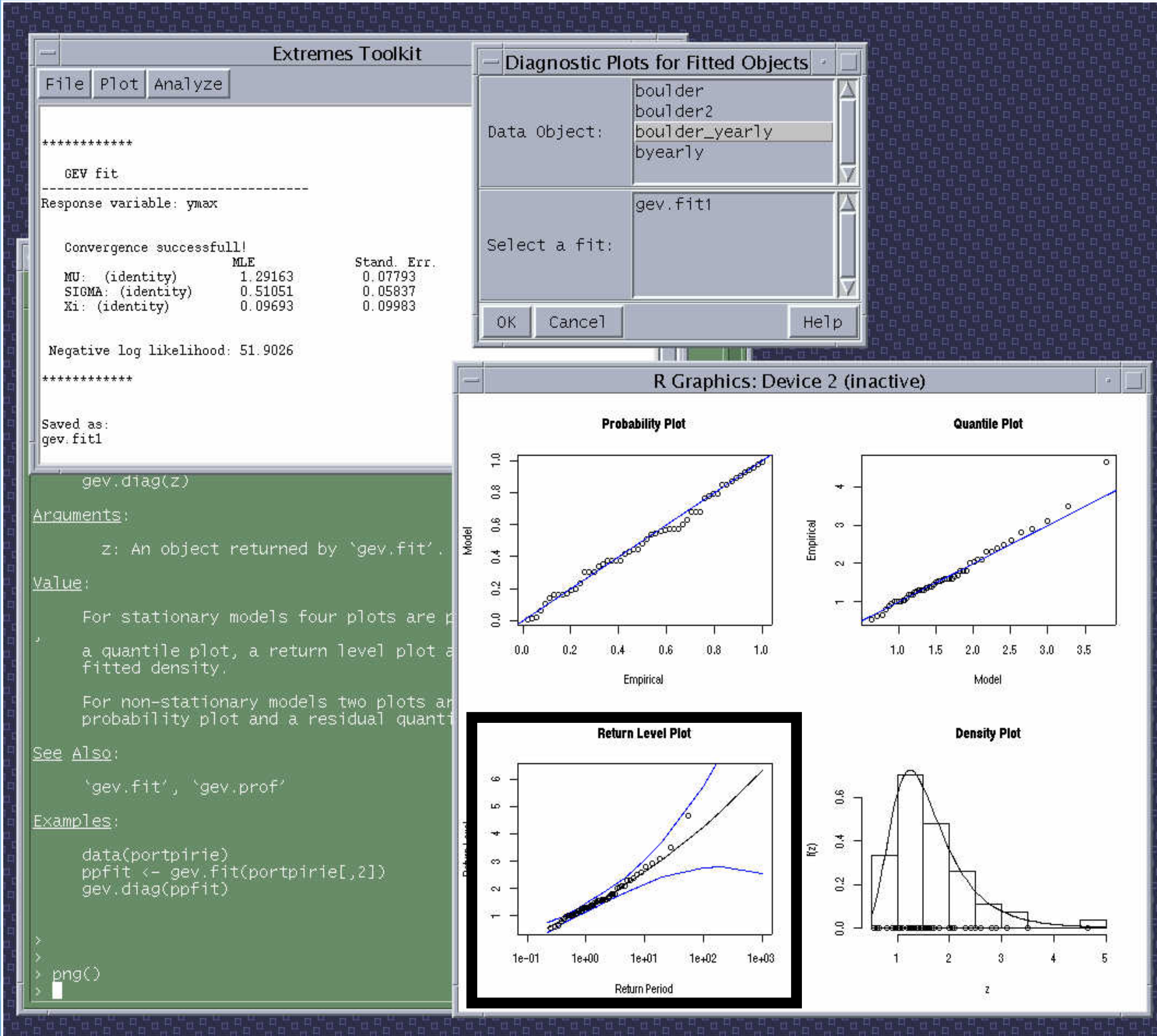
Extremes Analysis of Boulder Daily Precipitation

NCAR

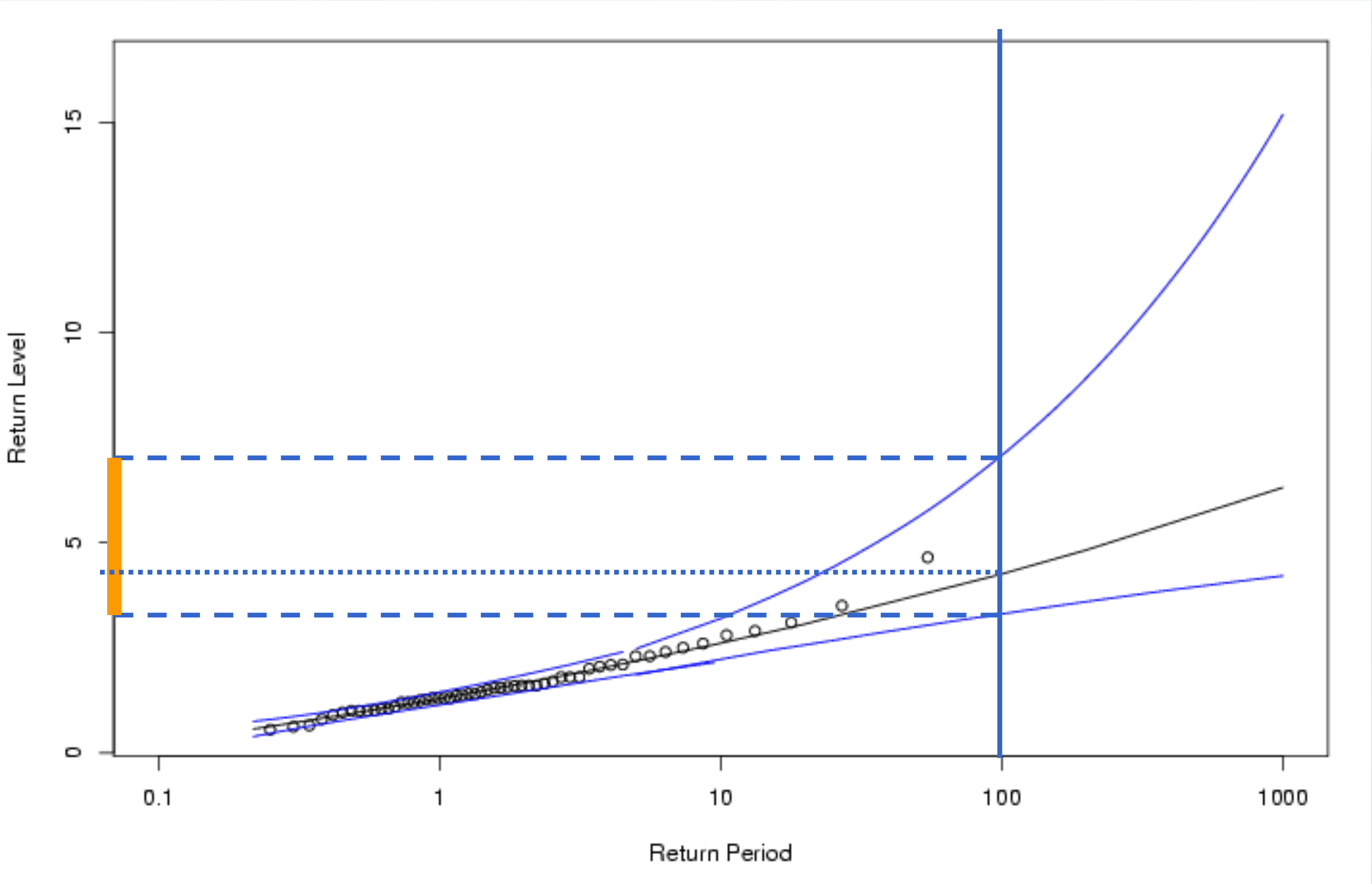
- *Generalized extreme value distribution* can model the annual maxima
- *Generalized Pareto distribution* is an equivalent model for daily data
- Both are characterized by scale, shape and location parameters
- A common summary is the *return time:*

e.g., the 100 year return level has probability .01 of occurring in a given year

Analysis Using *Extremes Toolkit*



100 Year Return Level for Boulder

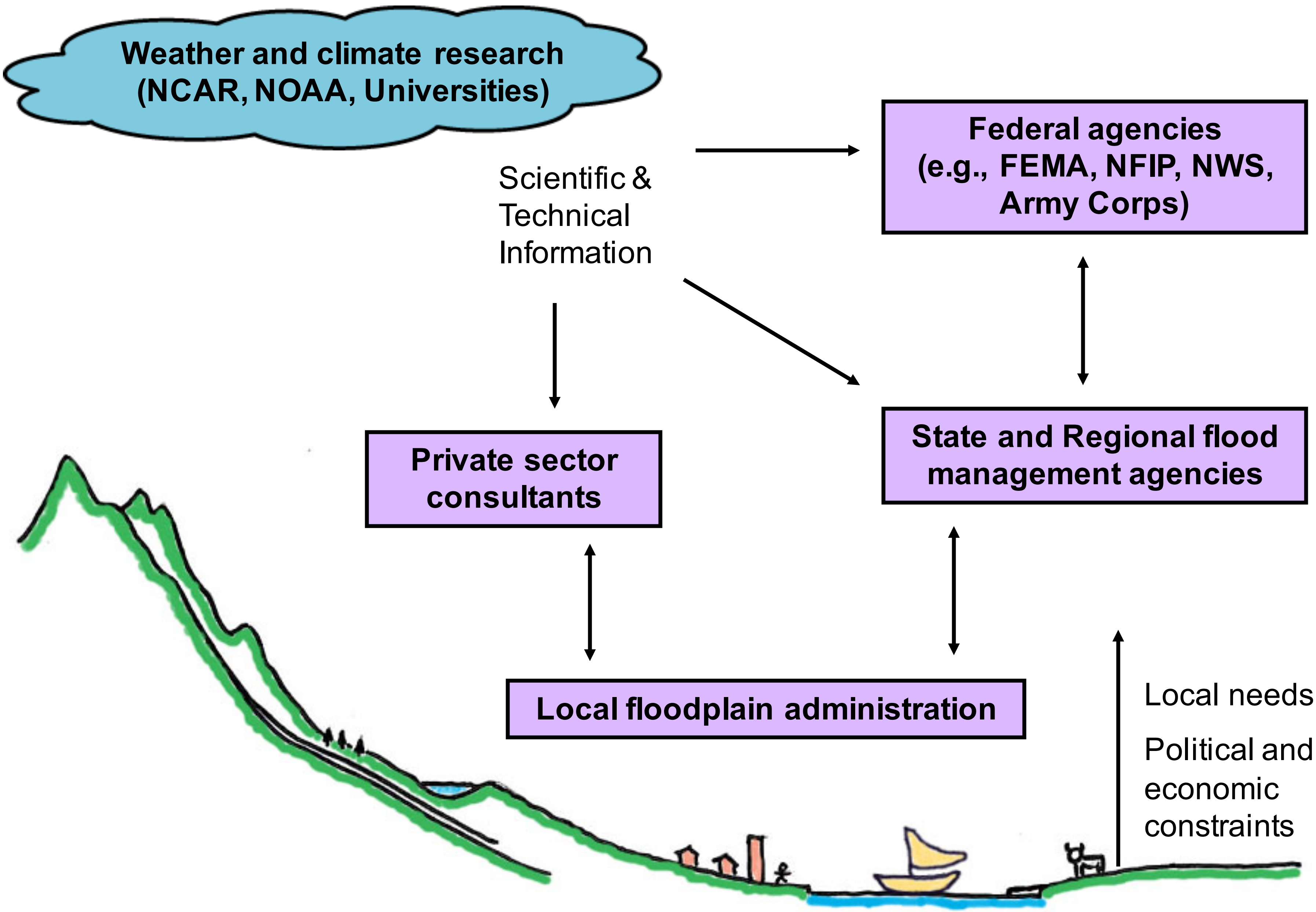


Combining Geostatistics and Extremes

NCAR

- Use (Bayesian) spatial statistical models to extrapolate the extremal analysis to unobserved locations.
- Incorporate covariate information such as elevation, aspect.
- Use ensembles of maps to quantify uncertainty.

Scientific information in flood management

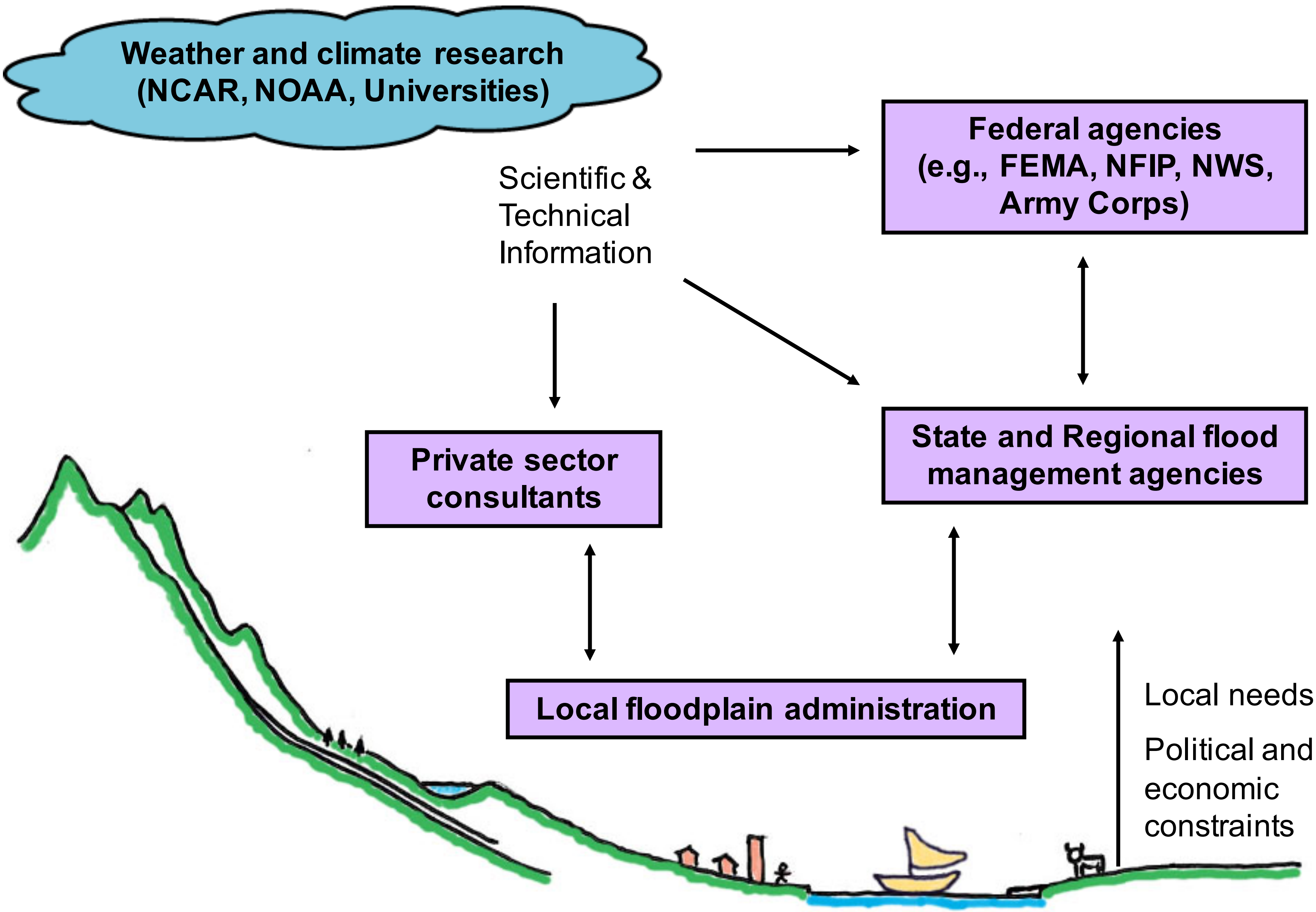


Scientific information, uncertainty, and decision-making: Lessons learned

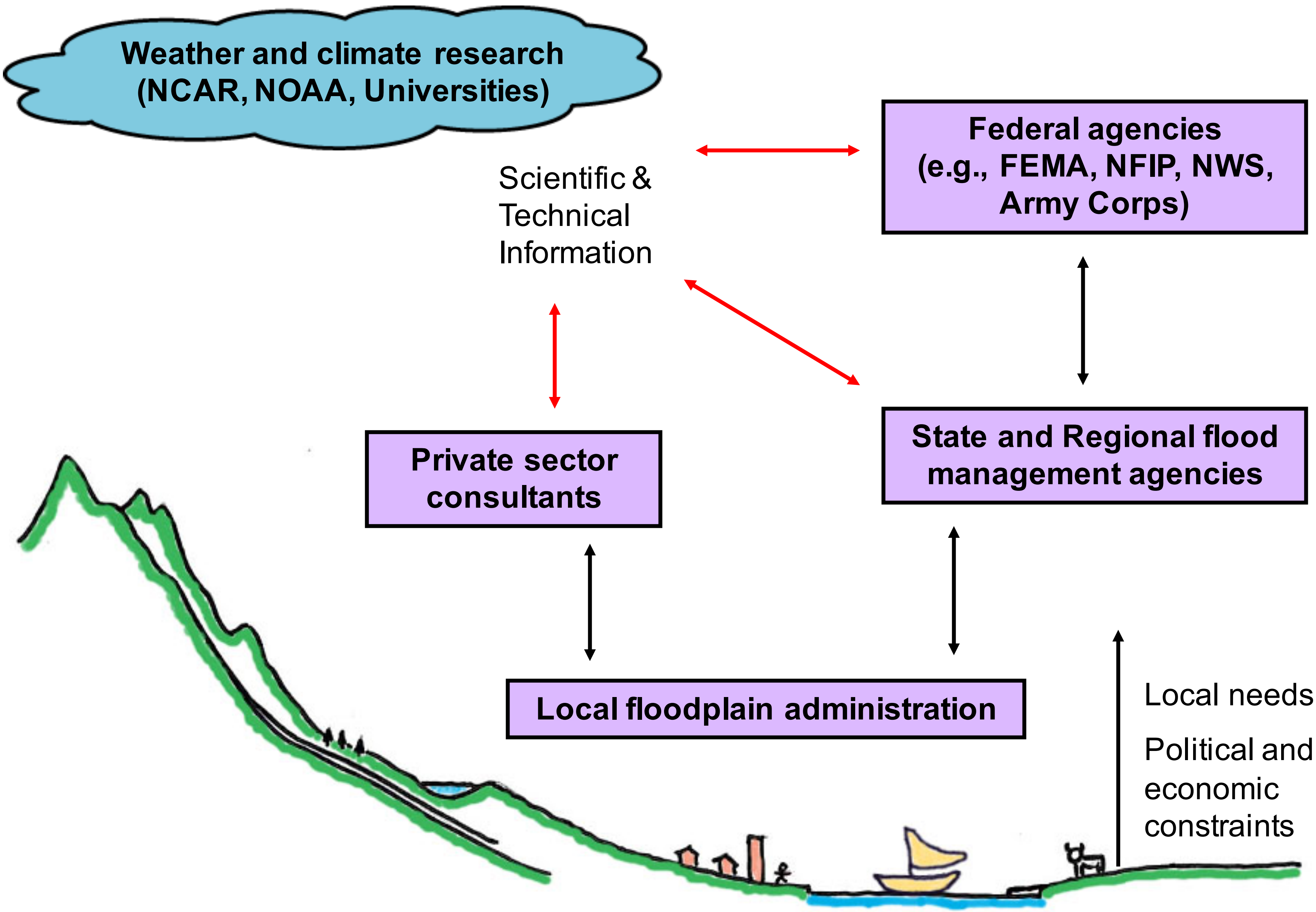
NCAR

- Decision-makers are diverse and interconnected
- Political, technical, and contextual constraints often limit decision-makers' ability and motivation to use new methods and information
- Scientists and decision-makers often perceive of and respond to uncertainty differently
- Assumptions often act as barriers to more useable scientific information

Scientific information in flood management



Scientific information in flood management



Summary

NCAR

- Important to understand, and place information in, decision context
  - For example, quantification of uncertainty is increasingly important in risk-based analysis
- Important to approach producing scientific information from decision-maker point of view, not vice versa
  - Put decision-making at center, iterate between specific flood management practitioners and scientists to co-produce useful information

Key Questions & Answers

NCAR

- How is scientific information about extreme flooding used in flood management decision-making?

  In a more limited fashion than scientists might initially expect, given potential relevance of information

- How does uncertainty in risk of extreme flooding interact with flood management decision-making?

  In complex ways, depends on the specific decision-maker

- What new or improved scientific information about extreme floods could we provide to benefit flood management?

  New statistical approaches for precipitation extremes atlas, as a start

Future Work

NCAR

- Continue developing statistical methods for an improved extreme precipitation atlas — in collaboration with users of the information
- Integrate specific features of flood risk management into more general models of uncertainty and decision-making
- Apply/extend methods developed and lessons learned to other projects on extremes, uncertainty, and decision-making