Update on Precipitation Frequency Estimates and Questions of Stationarity

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Topics

• Updates to NOAA Atlas 14
  - *Performed by:*
    NWS
    Office of Hydrologic Development
    Hydrometeorological Design Studies Center

• Semantics of Precipitation Frequency

• New Analysis of Exceedances
  - *With assistance from:*
    • Michael Yekta
    • Sanja Perica
    • Kazungu Maitaria
California Project Status

- **Data collection, formatting, initial QC; Complete**
  - *Station numbers:*
    - 1,681 stations; 1-day through 60-day
    - 667 stations; 1-hour through 12-hour
    - 350 stations; 15-minute and 30-minute
  - *Included snow depth data for stations > 3000 feet*
  - *Added semiarid CA to recheck Vol 1*

- **Initial regionalization; Complete**

- **Spatial interpolation; Begin in mid-March**
  - *Analysis of means by OSU PRISM Group*
California Project Schedule

- Complete regionalization and statistics
  - *Expected end of March*

- Peer review
  - *Expected to begin in April 2010*

- Web publication
  - *Expected in September 2010*
Alaska Project

- Data collection (U of Alaska, Fairbanks (UAF))
  - Complete pending three minor data sources
  - 15 data sources collected
    - 819 daily stations
    - 684 hourly stations
    - 38 15-minute stations

- Data formatting (UAF); In Progress
  - 11 data sources completed
  - Resolving issues in 4 data sources
• Under-catch bias correction (UAF)
  - Requires information on stations with Alter shields
  - Researching alternative approach if accurate information is unavailable

• Data quality control (UAF)
  - NWS will extract AMS and provide QC tools

• Data Collection, QC & Bias Correction
  - Behind schedule by 3-4 months

• Web publication due September 2011
Southeastern States Project

- **Data collection; Complete**
  - *Identified 39 potential data sources*
    - 23 data sources may not be used:
      - *Stations have less than 10 years of data*
      - *Duplicated data from another source*

- **Data formatting; In Progress**
  - *Completed 8 data sources*

- **Data QC; In Progress**
  - *Examined co-located NCDC stations for*
    - Consistency & duplicate records

- **Web publication expected May 2012**
Midwestern States Project

• Data collection; Complete
  – *Identified 49 potential datasets*
  • 11 data sources may not be used:
    – *stations have less than 10 years of data*
    – *duplicated data from another data source*

• Data formatting; In progress
  – *Completed 17 data sources*

• Data QC
  – *Examined co-located NCDC stations for*
    • Consistency & duplicate records

• Web publication expected May 2012
Climatology Semantics

• “It is likely that the frequency of heavy precipitation events ... has increased over most areas.”

• “Groisman et al. (2005) found significant increases in the frequency of heavy and very heavy (between the 95th and 99.7th percentile of daily precipitation events)”
  – IPCC AR4 Working Group I

• These and similar statements in the literature define terms such as
  – “heavy”, “very heavy”, or “extreme” precipitation
  – Sometimes differently!
• Groisman et al 2005
  – “… we define a daily precipitation event as heavy when it falls into the upper 10% and/or 5% of all precipitation events; as very heavy when it falls into the upper 1% and/or 0.3% of precipitation events; and extreme when it falls into the upper 0.1% of all precipitation events.”
  – “The return period for such events … varies, for example, from 3 to 5 yr for … very heavy precipitation events.”

• Generally consider just daily durations
• Use precipitation frequency estimates
  – average annual exceedance probabilities (AEP)
  or
  – average recurrence intervals (ARI)

• Heavy, very heavy, and extreme rainfall:
  – generally subjective terms
  – but their meaning can be construed

• Use many durations; not just daily
  – NOAA Atlas 14 provides 5 min through 60 days
### Example Civil Eng Design Criteria

**Type of structure** | **Return period (years)** | **ELV**
--- | --- | ---
**Highway culverts** | | |
- Low traffic | 5–10 | | |
- Intermediate traffic | 10–25 | | |
- High traffic | 50–100 | | |
**Highway bridges** | | |
- Secondary system | 10–50 | | |
- Primary system | 50–100 | | |
**Farm drainage** | | |
- Culverts | 5–50 | | |
- Ditches | 5–50 | | |
**Urban drainage** | | |
- Storm sewers in small cities | 2–25 | | |
- Storm sewers in large cities | 25–50 | | |
**Airfields** | | |
- Low traffic | 5–10 | | |
- Intermediate traffic | 10–25 | | |
- High traffic | 50–100 | | |
**Levees** | | |
- On farms | 2–50 | | |
- Around cities | 50–200 | | |
**Dams with no likelihood of loss of life (low hazard)** | | |
- Small dams | 50–100 | | |
- Intermediate dams | 100 + | | |
- Large dams | – | 50–100% |
**Dams with probable loss of life (significant hazard)** | | |
- Small dams | 100 + | 50% |
- Intermediate dams | – | 50–100% |
- Large dams | – | 100% |
**Dams with high likelihood of considerable loss of life (high hazard)** | | |
- Small dams | – | 50–100% |
- Intermediate dams | – | 100% |
- Large dams | – | 100% |

Let’s Count Exceedances

- **Thresholds**
  - *Use actual NOAA Atlas 14 thresholds*
    - Not a fixed value or a percentile of a time series
  - *For:*
    - 1 year – 1,000 year ARI
    - Durations: 6 hours – 45 days

- **Use Partial Duration Series**
  - *Complies with ARI definition*

- **Count Number of Exceedances**
  - *For each station*
    - Sum for each year over the all stations in the domain
    - Normalize for varying number of stations each year

- **Linear regression for all ARI/durations**
- **Show slopes as % of expected mean**
Example Trends

Semiarid Southwest 1-Day Exceedances

Semiarid Southwest 6-Hour Exceedances

Ohio Basin 1-Day Exceedances

Ohio Basin 6-Hour Exceedances
Trends and Significance

Generally statistically significant except for 6 hour durations

.05 level, T-test & Mann Kendall
Trends and Significance

- Generally not statistically significant except for daily durations above 2 yr ARI
  - .05 level, T-test & Mann Kendall
Compare with NOAA Atlas 14
Confidence Intervals

• NOAA Atlas 14, 90% confidence intervals
  – +/- 30%
    • sparsely instrumented, shorter record; to
  – +/- 10%
    • more densely instrumented, longer record
Trend in mean

- Green +: Upward trend
- Blue dot: No trend
- Red line: Downward trend
Conclusions

- Climate community statements on trends in rainfall intensity
  - *Do not address frequencies and durations required for civil infrastructure*

- Climate community statements are being misinterpreted

- Historical trends in number of events
  - *Are small compared to uncertainty of IFD values*

- Need better guidance on potential impact of climate change on IFD curves
  - *In range relevant to civil infrastructure*