Workshop on Nonstationarity, Hydrologic Frequency Analysis, and Water Management

Dates: January 13-15, 2010  
Location: Millennium Harvest House, Boulder, Colorado

Background
The assumption behind traditional hydrologic frequency analysis is that climate is stationary. Stationarity means that the statistical properties of hydrologic variables in future time periods will be similar to past time periods. Anthropogenic climate change and better understanding of decadal climate variability present a challenge to the validity of the assumption. The Intergovernmental Panel on Climate Change (IPCC) has said “Climate change challenges the traditional assumption that past hydrological experience provides a good guide to future conditions” (Bates et al, 2008). Although there have been academic articles criticizing the assumption of stationarity, it is not apparent what if any alternative methods should be used as a replacement. The workshop will present and discuss proposed operational alternatives to the assumption of stationarity in hydrologic frequency analysis that can be used in a transitional period by water managers and planners, as well as a new generation of methods that could be developed. Limitations of the alternatives will also be presented and discussed.

Meeting Objectives
- Discuss whether there is a need for new ways to model nonstationary processes for hydrologic frequency analysis and if current approaches are not working.
- Present a range of potential alternatives for dealing with non-stationarity in hydrology both in the near term, as well as for the next generation of analytical tools that could be developed.
- Compile workshop proceedings based on invited papers and minutes from the meeting.
- Initiate mechanisms for a continuing dialog between water managers and scientists on methods to deal with climate uncertainty.
- Formulate an ‘Action Plan’ for next steps to develop practical guidance for water managers to deal with climate uncertainty.

Proposed Topics and Draft Agenda

Wednesday, January 13, 2010

Introduction (8:00 – 8:45 a.m.) Moderator: Reagan Waskom  
8:00   WELCOME and Introductions

Problem of Non-Stationarity in Water Management – Three Perspectives  
8:15   Robert Hirsch, U.S. Geological Survey (confirmed)  
8:35   Jerry Webb, U.S. Army Corps of Engineers (confirmed)
Gene Stakhiv, UNESCO-International Center for Integrated Water Resources Management (ICIWaRM) (confirmed)

**Current Methods** (9:05 a.m. – 9:40 a.m.) Moderator: Reagan Waskom
9:05 Current Methods for Hydrologic Frequency Analysis
Beth Faber, USACE Hydrologic Engineering Center (confirmed)
9:20 Current Methods for Water Resources Planning
Rolf Olsen, USACE Institute for Water Resources (confirmed)

**BREAK** (9:40 a.m. – 10:05 a.m.)

**Nonstationarity and water management** (10:05 a.m. – 10:45 a.m.) Moderator: Julie Kiang
An example of non-stationarity in the annual flood record for the Red River of the North will be discussed, along with the implications of nonstationarity for dam safety. Water managers will discuss the questions that they need answered.

10:05 **Nonstationarity and Dam Safety**
Nate Snorteland, USACE Institute for Water Resources (confirmed)
10:25 **Red River of the North Flood Frequency Estimation**
Pat Foley, USACE St. Paul District (confirmed)

**Statistical Analysis of Hydrologic Data and Estimation of Future Hydrologic Variability**
“A number of researchers have proposed alternative probabilistic techniques that allow for nonstationarity in flood event distributions. The most common adaptation approach is to allow the parameters of an assumed distribution to vary with time; nonparametric techniques have also been proposed. In general, additional research is required to establish the most suitable methods for treating nonstationarity in flood-risk evaluations for the United States. An alternative is that flood risk be evaluated using a more limited set of recent observations, but extrapolating the probability of infrequent events from a short record is fraught with uncertainty. Furthermore, for long-term evaluations of flood risk, it might be questioned whether any of the instrumental record can be used to portray future flood risk.”

“Furthermore, while the magnitude of a trend may be relatively easy to quantify, its statistical significance may be more ambiguous because of natural climate variability and long-term persistence, which can cause oscillatory patterns in long-term hydroclimatic records (Cohn and Lins, 2005).”
(Excerpts from Circular 1331, Brekke et al, 2009)

**Statistical Methods – Data analysis** (10:45 – 12:15) Moderator: Julie Kiang
10:45 **Problems with trend analysis**
Harry Lins and Tim Cohn, USGS (confirmed)
11:10 **Hurst-Kolomogorov processes and uncertainty**
Demetris Koutsoyiannis, National Technical University of Athens, Greece (confirmed)
11:35 **Analysis of the stationarity of flood peaks in the U.S.**
Gabriele Villarini, Princeton University (confirmed)
12:00 **Discussion**

**LUNCH** (12:15 p.m. – 1:15 p.m.)
Statistical Methods – Frequency Analysis (1:00 p.m. – 3:20 p.m.) Moderator: Beth Faber
1:15  Jery Stedinger, Cornell University (confirmed)
1:40  Balaji Rajagopalan, University of Colorado (confirmed)
2:05  Taha Ouarda, Institut national de la recherche scientifique (INRS), Canada (confirmed)
2:30  Nonstationarity in Precipitation Frequency-Duration Estimates
      Geoffry Bonnin, NOAA National Weather Service (confirmed)
2:55  Discussion

BREAK (3:20 p.m. – 3:45 p.m.)

Panel Discussion - U.S. Federal Agency Perspectives on Flood Frequency Analysis and
Nonstationarity (3:45 p.m. – 5:00 p.m.) Moderator: Dave Raff
The proposed panel will include Federal agency members of the Advisory Committee on Water
Information, Subcommittee on Hydrology, Hydrologic Frequency Analysis Work Group. The
goal of the Work Group is to recommend procedures to increase the usefulness of the current
guidelines for Hydrologic Frequency Analysis computations and to evaluate other procedures for
frequency analysis of hydrologic phenomena. The panel will discuss their perspective on the
need for nonstationary frequency methods, what alternatives could be considered, and constraints
on options. The panel will interact with the audience to discuss how water managers should deal
with trends and non-stationarity in the hydrologic record.

Potential Panel Members:
- Tim Cohn, U.S. Geological Survey (confirmed)
- Beth Faber, U.S. Army Corps of Engineers (confirmed)
- John England, Bureau of Reclamation (confirmed)
- Nancy Steinberger, Federal Emergency Management Agency (confirmed)
(~5-minute speaking slots – reserve time mostly for discussion.)

Thursday, January 14, 2010

Future Climate and Hydrologic Variability – Interpreting Climate Model Information
(8:00 a.m. – 10:10 a.m.) Moderator: Harry Lins
“Several studies have recently attempted to derive future climate probability distributions from
climate projection information (Murphy and others, 2004; Tebaldi and others, 2004; Dettinger,
2005b), sometimes involving the preconditioning or weighting of climate projection information
based on the relative skill among the climate models used to generate projections (Tebaldi and
others, 2005; Brekke and others, 2008). However, there are several difficulties with these
approaches. Tebaldi and Knutti (2007) point out that climate models are not independent, since
models have similar resolution and must parameterize the same processes. Stainforth and others
(2007) state that the effort to weight models is futile: “relative to the real world, all models have
effectively zero weight.” They argue “there is no reason to expect these distributions to relate to
the probability of real-world behavior” (Stainforth and others, 2007).”
(Excerpt from Circular 1331, Brekke et al, 2009)

8:00  Model ensembles to distributions
      Levi Brekke, Bureau of Reclamation (confirmed)
8:25  Possible changes to flood populations, inferred from climate projections
      Mike Dettinger, USGS, Scripps Institute (confirmed)
8:50  Flood frequency based on climate projections
      David Raff, Reclamation (confirmed)
9:15  Difficulties in calibrating GCMs and deriving forecast probabilities / Estimating
      uncertainty in future climate projections
      Dave Stainforth, Tyndall Centre, United Kingdom (confirmed)
9:40  Discussion

BREAK (10:10 a.m. – 10:35 a.m.)

Decision-making Challenges with Nonstationarity (10:35 a.m. – noon) Moderator: Karen
      Metchis
Climate uncertainty will affect both economic analysis and engineering design. Water managers
may need to recognize that their estimates for the likelihood of future hydrologic events are very
uncertain and designs based on the estimate of future probabilities may not be reliable. Water
managers may need to change planning methods that recognize this uncertainty and adopt
alternatives that perform well for many possible future scenarios.

10:35  Engineering with unreliable frequency estimates
       Casey Brown, University of Massachusetts (confirmed)
11:00  Robust decision making
       Robert Lempert, Rand Corporation (confirmed)
11:25  Nonstationary water planning methods
       Marc Waage, Denver Water (confirmed)
11:50  Discussion

LUNCH (12:20 p.m. – 1:20 p.m.)

Approaches to Nonstationarity (1:20 p.m. – 2:35 p.m.) Moderator: Evan Vlachos
This session will review activities that are being conducted internationally on how water
managers are dealing with non-stationarity.
1:20  Planning Hydrology based on Blends of Instrumental Records, Paleoclimate, and
      Projected Climate Information
      Jim Prairie, Reclamation (confirmed)
1:45  Precipitation Nonstationarity Effects on Water Infrastructure and Risk Management
      Jeff Yang, Environmental Protection Agency (confirmed)
2:10  United Kingdom Climate Change Adaptation
      Nigel Arnell, Walker Institute, University of Reading, United Kingdom (confirmed)
2:35  Discussion

BREAK (3:00 p.m. – 3:25 p.m.)
Breakout sessions (3:25 p.m. – 5:00 p.m.) Moderator: Kate White
The participants will be divided into several groups of individuals with different backgrounds to discuss how water managers should deal with potential future non-stationarity. The breakout groups should initially address what water managers should do in the near term. The groups then can address what are future analytical tools that could be developed. Breakout groups should also recommend what are the next steps that should be pursued. (Need to formulate list of questions.)

Friday, January 15, 2010

Workshop wrap-up and Next steps Moderator: Kate White

Report back from breakout sessions (8:00 – 8:45 a.m.)

Panel Discussion: International Perspectives on Nonstationarity (8:45 a.m. – 9:45 a.m.)
Moderator: Gene Stakhiv
The panel can synthesize what they heard in the workshop and provide recommendations for what are the next steps that could be pursued. What are the opportunities to cooperate internationally on developing practical alternatives for how water managers should deal with climate uncertainty in operations and planning?
Possible panel members:
World Bank representative: Ken Strzepek (confirmed)
Zbigniew W. Kundzewicz, Research Centre for Agricultural and Forest Environment, Polish Academy of Sciences, Poland (confirmed)
Kuniyoshi Takeuchi, International Center for Water Hazards and Risk Management (ICHARM), Japan (confirmed)
(~5-10-minute speaking slots – other time for discussion.)

BREAK (9:45 a.m. – 10:10 a.m.)

Panel Discussion: Workshop summary (10:10 a.m. – 11:10 a.m.) Moderator: Rolf Olsen
The speakers will synthesize the results of the workshop and make recommendations on how water managers can deal with climate uncertainty in current operations and planning. The speakers will be asked to write a paper with their conclusions.
   Dennis Lettenmaier, University of Washington (confirmed)
   Richard Vogel, Tufts University (confirmed)
   Gerry Galloway, University of Maryland (confirmed)
(~10-minute speaking slots – other time for discussion.)

Action Plan for Next Steps (11:10 - noon)
Organizing Committee

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   Rolf Olsen, Beth Faber, Kate White, Gene Stakhiv (USACE)
   Julie Kiang, Phil Turnipseed, Harry Lins, Tim Cohn (USGS)
Levi Brekke, Dave Raff, Chuck Hennig (Reclamation)
Reagan Waskom, Evan Vlachos (Colorado State University)
Pedro Restrepo (NOAA)
Karen Metchis, Jeff Yang (EPA)

References
Brekke, L.D., Dettinger, M.D., Maurer, E.P., and Anderson, M., 2008, Significance of model credibility in estimating climate projection distributions for regional hydroclimatological risk assessments: Climatic Change, v. 89, nos. 3–4, p. 371–394. (Also available online at http://www.springerlink.com/content/1586u015g87v8754/.)