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

<u>Introduction (8:00 – 8:45 a.m.)</u> 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 (tentative)

8:50 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 Knuuti (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: Evan Vlachos
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 Limits to Predictability and Water Management Adaptation
Suraje Dessai, University of Exeter, United Kingdom (tentative)
11:25 Robust decision making
Robert Lempert, Rand Corporation (confirmed)
11:50 Discussion

LUNCH (12:20 p.m. – 1:20 p.m.)

Approaches to Nonstationarity (1:20 p.m. –3:00 p.m.) Moderator: Karen Metchis
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 Nonstationary Water Planning Methods
Marc Waage, Denver Water (tentative)
2:35 United Kingdom Climate Change Adaptation
Nigel Arnell, Walker Institute, University of Reading, United Kingdom (tentative)

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)
Pavel Kabat, Wageningen University and Research Centre, Netherlands (confirmed)
Kuniyoshi Takeuchi, International Center for Water Hazards and Risk Management (ICHARM), Japan (confirmed)
Johannes Cullman, UNESCO (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.
Peter Rogers, Harvard University (confirmed)
Dennis Lettenmaier, University of Washington (confirmed)
Richard Vogel, Tufts University (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)

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