**Mixed Population Floods – Regional Analysis and Climate**

**Study Questions** *(questions from Julie Kiang; comments in blue from KKH)*

General questions (if not already done)

1) Are there discernible regional or other patterns to flood-mechanism dominance?

2) Are there differences in the magnitude of floods depending on the dominant mechanism?

(1) and (2) can be demonstrated with what I’ve done already to make a case for (3)

3) How different are frequency curves estimated using mixed populations vs. a single population? (Is this difference a factor in whether consideration of mixed populations is important for regional analysis?)

(3) is a truly intriguing question and strikes me as the central “framing” question of the proposal.

Can we identify conditions that cause the tails to diverge even if the single population curve appears to fit reasonably well?

A case study that indicates this can be done is: *Alila, Y and Mtiraoui, A. (2002) Implications of heterogeneous flood-frequency distributions on traditional stream-discharge prediction techniques Hydrol. Process. 16, 1065–1084 (2002) DOI: 10.1002/hyp.346*
(These authors used data from my dissertation to examine questions similar to (3)

Regional Analysis (4) & (5) = your expertise! – I can provide the mixed data, however there will be only a few tropical storm floods – how small a sample can you work with?

4) Can the mix of floods (or dominant flood mechanism) be used to define subregions in regression analysis? How do results compare to state-wide regressions, or regressions using other methods for defining subregions?

5) Can separate regional regression equations be developed for each flood mechanism and then combined at a single location? Since a single location may not have enough floods of each type, this might entail use of something similar to the “hybrid” method described by Hjalmrason and Thomas (1992) or Sando and others’ (2008) pooled flood frequency for extreme floods.

6) For an ungaged location, how would the mix of floods be determined? Or, how would an ungaged location be placed in the appropriate subregion?

This is an important question; could be address in several ways as multiple working hypotheses:

-- simplest: use mix of location, neighboring or nearest gaged watershed

-- if precip records exist in basin, compare with precip maps for different key storm types in similar or nearby watersheds to determine mix

-- combine the two methods above with detailed info on basin characteristics – regression? Or maybe a decision tree analysis

7) When is it important to consider mixed populations in regional analysis? Can we identify criteria for when it is likely to make a difference? Does it depend on how well we can fit a curve given an assumption of a single population?

Another key question – a central one for operational use – I think we should attempt to identify criteria to determine when it is likely to make a difference – We could contrast a physically based set of criteria with a statistically based set (fit of curve) and compare.

 Does it depend on some threshold of differences among the stations under consideration?

Not sure I understand what you mean here. . . .

**Applicability to Climate Change and Climate Variability**

8) What are climate model projections for the different flood mechanisms in Arizona?

I don’t think we’d be able to get this from model projections, but we could infer them or design a set of alternative scenarios to work from . Could compare with downscaled precip

9) How do we use the (fuzzy) model projections to alter the estimated flood frequency curve?

Another key question – at the exploratory stage on this one. Could compare 3 methods: precip output downscaled, alternative climate change scenarios of different mixes, changing parameters of pdf to simulate climate change (e.g. more skewness, mean shifts up or down, variance changes) all based on known responses to climate variability as seen in sample distributions of gaged records.

10) Could this concept be used to produce different flood frequency curves for the same gage? For example, one for El Nino years, one for La Nina years? Yes – see paper by Alila, Y and Mtiraoui, A. (2002)

**References**

Hjalmarson, Hjalmar W. and Blakemore E. Thomas (1992), New Look at Regional Flood-Frequency Relations for Arid Lands, Journal of Hydraulic Engineering, 118(6), 868-886.

Sando, Steven K. , Daniel G. Driscoll, and Charles Parrett (2008) Peak-Flow Frequency Estimates Based on Data through Water Year 2001 for Selected Streamflow-Gaging Stations in South Dakota, U.S. Geological Survey Scientific Investigations Report 2008-5104, 367 p.

**EXTREMELY ROUGH OUTLINE OF PROPOSAL**

**Title:** Hydrologic Regionalization Based on Flood Hydroclimatology – An Innovative Application for Present and Future Climates OR
 . . . – A Practical Application for Present and Future Climates
Other suggestions?

**Statement of regional, interstate, or multi-state water problem***(include an explanation of need for the project, who wants it, and why)*

-- tie-into one or more **Research Priority Themes:**Best: *“Institutional arrangements for coping with extreme hydrologic conditions”*
**-- Region:** West
**-- States:** Arizona & Colorado ? not contiguous but could be compared in various ways, i.e. contrasting climates, but both challenged with complex terrain, population growth & urban-rural interface encroaching on ungaged basins, both are arid / semi-arid, with flash floods and snowmelt component that may manifest itself in different ways )
**-- Need:** see States (above), plus “no-adverse-impact” concept – but for climate chance and extremes, nonstationarity, ungaged watersheds, developing future scenarios, exploration of alternatives to outdated 100-year flood, etc.

**Statement of results or benefits***(specify the type of information that is to be gained and how it will be used.)*

-- more accurate assessment of regional flood frequency in a framework or methodology that can evolve with a changing climate; nonstationarity issue

 -- benefit to overall watershed planning – balance between water supply, quality, and extreme events disruption of these

 -- riparian ecosystems managers and water supply sustainability – sensitivity of riparian vegetation / ecosystems to timing and seasonality of floods and low flows

 -- benefit to state planners managing development : water supply infrastructure and flood risk at expanding urban-rural interface ( development moving into ungaged basins)

 -- Other??

**Nature, scope, and objectives of the project, including a timeline of activities**

 **-- Overall:** Explore multiple ways of integrating flood hydroclimatology info into regionalization process and evaluate: added value (if any) and usefulness for different types of users
**-- Scope:** need to decide how Study Questions are to be addressed –select a few to keep focused or do all to explore all (or most) angles of the issue ? (probably need 3 –year grant for the latter)
**-- Objectives** – need to decide our scope before we hammer these out – could be closely tied to study questions
-- **Timeline:** minimum 2 year grant, maybe 3? What could we get done ie we streamlined it as a 1-year grant?

**Methods, procedures and facilities***(provide enough information to permit evaluation of the technical adequacy of the approach to satisfy the objectives)*

 **-- Methods**: **UA** -- I can describe flood hydro database development and its use in determining regions hydroclmatically; also its use in developing climate change scenarios
 **USGS**: describe regionalization methods and how mixed flood data would be used
-- **Procedures**: need to develop a collaboration format for our UA-USGS interaction, workshop at some point could be set up to get input, as testbed for ideas, etc. (see Transfer Plan)
**-- Facilities**: will need a boiler-plate description of what we each have to support the research effort , I can cite UA’s [Institute of the Environment (IE)](http://www.environment.arizona.edu/home), [CLIMAS](http://www.climas.arizona.edu/), [Lab of Tree-Ring Research (LTRR)](http://www.ltrr.arizona.edu/) , [Hydrology & Water Resources (HWR)](http://www.hwr.arizona.edu/) , and [Water Resources Research Center](http://ag.arizona.edu/AZWATER/) -- PLUS the campus co-location with the USGS AZ District Office . The UA Cooperative Extension has a [Climate Science Applications Program](http://cals.arizona.edu/climate/index.htm) for stakeholder engagement – planning on inviting Mike Crimmins, Climate Science Extension Specialist, as co-PI. Plus there is a new [Climate Dynamics and Hydrometeorology Cent (CDHC)](http://www.cdhc.arizona.edu/index.html) that is just getting going at UA. Another supporting unit/facility might be [SAHRA](http://www.sahra.arizona.edu/)

 -- Part of the “Transfer Plan” will be to have a user interface where flood hydroclim data can be easily obtained. I had been developing plans to park the data with the [Arizona Hydrologic Information System (AHIS)](http://chubasco.hwr.arizona.edu/ahis-drupal/) and have it available on their [Map Interface](http://chubasco.hwr.arizona.edu/ahis-drupal/map), but that program has been slashed due to state budget cuts. A new possibility is the **UA University Libraries** who are seeking to permanently house digital databases in collaboration with UA units and also agencies external to the UA (like NOAA, USGS).

**Related research***(demonstrate by literature and communication citations the similarities and dissimilarities of the proposed project to completed or on-going work on the same topic)*

-- need review of background and supporting research in both flood hydroclimatology (UA) and the latest approaches to regionalization (USGS)

 -- local /state initiatives, such as Arizona Conservation Science:
 See: <http://azconservation.org/projects/water/>

**Training potential***(Estimate the number of graduate and undergraduate students, by degree level, who are expected to receive training in the project)*

--training of HWR grad students, internships with USGS(?), also the CDHC, which is applying for an [IGERT](http://www.igert.org/) training grant on “A Landmark Program of Education and Research in Terrestrial Hydrometeorology” where this could fit in.

**Statement of Government Involvement***(If a Federal employee will collaborate on the project, provide a detailed description of the role and responsibilities of the Federal Collaborator in the proposed research project.)*

 --Section VI says that USGS collaborators can serve as co-PIs, but not as PIs; no federal funds, no federal sources of matching funds, federal collaborators must prepare a Statement of Government Involvement

**Information Transfer Plan***(Describe the plan for disseminating information on the results of the research and promoting their application. Each plan should define the subject matter and the problems to be addressed, identify the target audience, indicate the strategies to be employed (e.g., workshops, publications), and identify the cooperators (e.g., Cooperative Extension Service).*

-- I am a PI in [CLIMAS](http://www.climas.arizona.edu/) (NOAA-unfunded [RISA](http://www.climate.noaa.gov/cpo_pa/risa/), like [WWA](http://wwa.colorado.edu/index.html), the Colo RISA) -- A companion cross-RISA project could assist with the transfer plan, could have CLIMAS & WWA workshops to engage prospective users , get input, test methods, etc. The UA [Climate Science Applications Program](http://cals.arizona.edu/climate/index.htm) (Cooperative Extension program) will also be ideal for connecting to stakeholders. Also publications, of course.

**Literature Citations/references**

**Investigator’s qualifications***(Include a resume(s) of the principal investigator(s). No resume shall exceed two pages or list more than 15 pertinent publications.)*