CORPS OF ENGINEERS: CLIMATE CHANGE AND THE COLUMBIA RIVER BASIN

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“The views, opinions and findings contained in this report are those of the authors(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation.”
Outline

- Corps of Engineers Nation Climate Change Plan
- Completed work in the Columbia Basin
- Future work in the Columbia Basin
Federal Government Climate Preparedness and Resilience (CPR)

- EO 13514 (2009): Begin adaptation planning (but mostly mitigation); superseded by EO 13653
- President’s Climate Action Plan (2013)
- EO 13653 (2013): Prepare the US for the impacts of climate change (mostly adaptation)
- EO 13677 (2014): International climate preparedness and resilience
- Priority Agenda (2014)
- EO 13690 (2015): Update EO 11988 to reflect future climate risks and develop federal flood risk management standard
Sea Level Rise: ER 1100-2-8162

“Guidance for incorporating the direct and indirect physical effects of projected future sea level, change across the project life cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects.”

1) Use online sea level calculator to determine low, intermediate, and high rates of sea level change.

2) “…determine how sensitive alternative plans and designs are to these rates of future local mean SLC, how this sensitivity affects calculated risk, and what design or operations and maintenance measures should be implemented to adapt to SLC to minimize adverse consequences while maximizing beneficial effects…”

Calculator and User Manual updated in Sept. 2015

http://corpsclimate.us/ccaceslcurves.cfm
USACE Climate Hydrology Policy and Guidance

- ECB 2014-10: *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects*
- ETL1100-2-2: *Appropriate Application of Paleoflood Information for Hydrology and Hydraulics Decisions*

Two guidance docs being routed for signature

- ECB 2014-10 guidance update, expected August 2016
ECB 2016-XX
(Update to ECB 2014-10)

Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects

“…applies to all hydrologic analyses supporting planning and engineering decisions having an extended decision time frame.”

“This ECB helps support the interpretation and use of climate change information for hydrologic analyses supporting planning and engineering decisions through a qualitative assessment…”
“…the qualitative analysis is not expected to alter the numerical results of the calculations made for the other, non-climate aspects of the required hydrologic analyses.

However, the qualitative analysis can inform the decision process related to future without project conditions, formulation and evaluation of alternative plans, and other decisions related to project planning, engineering, operation, and maintenance”
Tools and Resources Supporting CPR Policy and Guidance

- **Existing:**
  - Tools should shift emphasis from data management to analyzing potential risks and adaptation
  - Sea level calculator
  - Nonstationarity detection tool, released March 2016

- **Two tools in prep based on archive of climate and hydrology data:**
  - ECB 2014-10 update tool released May 2016
  - Annotated bibliography of nonstationarity, EndNote expected May 2016, web app later FY 2016
  - Sea level tracker, expected FY2016

- **Three guidance docs in prep**
  - ECB 2014-10 guidance update, in review May 2016
  - ETL 1100-2-4, total water levels for coastal analyses, expected CY2016
Tools: Regional Information Produced in 2015

- Regional climate literature syntheses for the 21 USGS Watershed Regions
  - Mid-Atlantic Region: 02
  - South Atlantic-Gulf Region: 03
  - Great Lakes Region: 04
  - Ohio Region: 05
  - Tennessee Region: 06
  - Upper Missouri Region: 07
  - Lower Mississippi River Region: 08
  - Souris-Red-Rainy Region: 09
  - Missouri River Region: 10
  - Arkansas, White and Red Rivers Region: 11
  - Texas Gulf Region: 12
  - Rio Grande Region: 13
  - Upper Colorado Region: 14
  - Lower Colorado Region: 15
  - Great Basin Region: 16
  - Pacific Northwest Region: 17

http://www.corpsclimate.us/rccciareport.cfm
### Primary Variable

<table>
<thead>
<tr>
<th>PRIMARY VARIABLE</th>
<th>OBSERVED</th>
<th>PROJECTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Trend: ↑, Consensus: (6)</td>
<td>Trend: ↑, Consensus: (3)</td>
</tr>
<tr>
<td>Temperature MINIMUMS</td>
<td>Trend: ↑, Consensus: (1)</td>
<td>Trend: ↑, Consensus: (1)</td>
</tr>
<tr>
<td>Temperature MAXIMUMS</td>
<td>Trend: ↑, Consensus: (1)</td>
<td>Trend: ↑, Consensus: (3)</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Trend: ↘, Consensus: (6)</td>
<td>Trend: ↑, Consensus: (5)</td>
</tr>
<tr>
<td>Precipitation EXTREMES</td>
<td>Trend: ↘, Consensus: (3)</td>
<td>Trend: ↑, Consensus: (3)</td>
</tr>
<tr>
<td>Hydrology/Streamflow</td>
<td>Trend: ↘, Consensus: (5)</td>
<td>Trend: ↑, Consensus: (5)</td>
</tr>
</tbody>
</table>

**NOTE:** Trend variability was observed (both magnitude and direction) in the literature review for Observed Precipitation Extremes. Trend variability (both magnitude and direction) was observed in the literature review for Projected Precipitation and Projected Hydrology.

### Trend Scale

- **↑** = Large Increase
- **↑** = Small Increase
- **=** = No Change
- **=** = Variable
- **↓** = Large Decrease
- **↓** = Small Decrease
- **=** = No Literature

### Literature Consensus Scale

- **=** = All literature reports similar trend
- **=** = Low consensus
- **=** = Majority reports similar trends
- **=** = No peer-reviewed literature available for review

(n) = number of relevant literature studies reviewed
Progress: Hydrologic Nonstationarity

From this......

To this......
Detecting Trends

Looking for:

**Consensus** – Agreement between multiple statistical methods that detect the same type of nonstationarity

**Robust** – Agreement between multiple statistical methods that detect different types of nonstationarity

**Magnitude** – The size of the change in the streamflow before and after the detected nonstationarity

Cochiti Canyon Flood
Dixon’s Apple Orchard

August 22, 2011
Essentially, all models are wrong, but some are useful.

-Sir RA Fisher quoted in George E.P. Box 1987

It’s impossible, irresponsible even, to be more precise than you can be accurate.

-Paul Kalanthi, New York Times 26 Jan 2014
The Columbia River Treaty has no specified end date

In 2024 flood risk operations change

10 years prior written notice is required for either country to terminate the treaty

Recommendation to U.S. State Department from U.S. Entity delivered December 2013
  - flood risk management
  - hydropower
  - ecosystem based function
Previous Climate Change Work

- RMJOC-I
- CRT 2014/2024 Review
RMJOC-I

- RMJOC – BPA, USACE, BOR
- Used IPCC 2007 GCM data
  - 2020’s & 2040’s
  - Med (A1B) & Low (B1) Emission Scenario
  - Statistical Downscaling
    - Hybrid-Delta/BCSD
    - Transient
    - Delta
- Calibrated VIC hydrology model to PNW
  - 13 locations
  - Modified flows
- System monthly reservoir model studies
  - 6 projections for 2020’s & 2040’s
  - C, MW/W, LW/W, MW/D, LW/D, & MC
RMJOC-I Outcomes

- Produced 4 multi-agency reports
  - http://www.usbr.gov/pn/climate/planning/reports/
  - Finished 2011
- Provided data for CRT 2014/2024 Review
- Provided valuable lessons learned for future work
- Was used as a FYI study
CRT 2014/2024 Review

- RMJOC-I data
  - Improved bias correct data
  - Bookend Study
- Improved Forecasts
- Daily Spring FRM modeling
CRT 2014/2024 Review

- FYI Study
  - Schedule, resource, and guidance issues
  - Greatest benefits: increased understanding and technical competence for future work
  - Primary conclusion: adaptive management required in a future Treaty
CRT 2014/2024 Review – Climate Change Results

Key Findings:
- High winter flows increased risk to winter flooding
- Reduction in summer flows
- Harder to balance all reservoir objectives

Outcomes:
- Further model improvements required for future work, BiOp and winter FRM
- Better defined vulnerabilities, but difficult to apply to CRT defined decisions
Future Work – RMJOC-IIPNW datasets

- IPCC 5: ~180 datasets
  - University of Washington/Oregon State team
  - 2 RCPs, 4.5 (Med Low) & 8.5 (High)
  - Glacial modeling
  - Multiple downscaling methods
  - Multiple Hydrologic models
- Available end of 2016
Real-time Realities

- BiOps in the Columbia River Basin need to include updated climate change analysis

- Currently scoping modeling analysis
  - RMJOC modeling team members
  - Monthly modeling
RMJOC-II Study

- New UW datasets are being created as a RMJOC-II study
- Year-round modeling with forecasts
  - Flood Risk Management
  - Hydropower
  - Environmental
- Modeling to start FY2017, finish FY2019
- Significant interest by Tribes, stakeholders, States, other Federal agencies
CRT 2024 Implementation

- Follow on from RMJOC-II work
- Results will be used for BiOp and NEPA
- Results should be used in Treaty Updates
  - Treaty could go to 50 or more years
  - Modify reservoir operations for climate change
  - Complete a vulnerability assessment
  - Adaptive management is a top priority for Treaty Updates
  - Likely to be one of the first major studies used for implementation
Question/Discussion

Sauvie Island, February 1996,