United States Army Corps of Engineers
Inland Hydrology Climate Change Adaptation
Engineering Construction Bulletin 2014

Advisory Committee on Water Information
Subcommittee on Hydrology

February 7, 2014
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Inland Hydrology Climate Change Adaptation

Bottom Line Up Front

Use the information that we know about observed and projected climate changes to reduce vulnerability and increase resilience.

1) ECB 2014 – Require **Qualitative Analysis** of climate change impacts to inform Planning and Engineering Design that is contingent on inland hydrology.

2) Layout framework for **Quantitative Analysis** that “hedges” known hydrology in direction that reduces vulnerability. Specific project type guidance to be issued as appendices in updated guidance beginning Summer 2014 for flood risk reduction.
ECB Development Process

Future Activity

Conceptual Development

Current Process Milestone

Completed Milestone

Winter 2013 ECB

Fall 2014 Additional Project Guidance

Summer 2014 FRM Guidance

2015 – 2016 Completion of additional guidance for H&H Project Types

Milestone

Draft ECB developed

Outreach Federal partners (Reclamation / FEMA).

Outreach Internal

Draft ECB developed

USACE Review

Outreach Internal
- ECB Currently in review / signing USACE HQ
- Anticipate Release Winter 2013
Qualitative Analysis

- No direct quantitative change to hydrology.
- Always required. Level of detail and use intended to be scaled to the decision.
- Collect readily available information from peer reviewed literature and data.
- Assess potential impacts and vulnerabilities to project goals and engineering designs.
- Information available during alternative selection and engineering design.
Qualitative Analysis Example
Flood Reduction Project - Levee

Potential Alternatives

Qualitative Climate Change Information

Hydrology - FDA

Selection
Qualitative Example
What Does It Mean to Your Project?
ECB 2013 – Provides Example In Appendix C

• Initial Assessment – Determine climate change relevancy.

• If Climate Relevant – More in-depth literature review to identify climate threats and potential impacts to your project goals and designs.

• When Quantitative Analysis Online – Identify available data, methods, and models that can support Quantitative Analysis Steps.
Quantitative Analysis

- Directly alters hydrology information informing planning and engineering design.
- Alteration of hydrology always done in direction of “hedge” to reduce vulnerability to climate change.
- Amount of alteration dependent on evidence of current and future climate change impacts.
- Amount of alteration always within current assessment of uncertainty of hydrologic inputs.
Quantitative Analysis Example

Flood Reduction Project - Levee

Potential Alternatives

Qualitative Climate Change Information

Climate Hedged Hydrology - FDA

Selection
Discussion - Quantitative Evaluation Process Steps

1) Detect (Yes / No) and Attribute Hydrologic Changes (Yes / No)
   • This is the PAST

2) Will available projections of change alter hydrology (Yes / No)
   • This is the FUTURE

<table>
<thead>
<tr>
<th>Detect and Attribute Change from Observed Hydrology</th>
<th>Projected Change from Climate Change Simulated Hydrology</th>
<th>Hydrology Adjustment</th>
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<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>High</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Medium</td>
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<td>No</td>
<td>Yes</td>
<td>Low</td>
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<tr>
<td>No</td>
<td>No</td>
<td>0% (Business as Usual)</td>
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3) Adjust inputs to USACE methodologies within uncertainty estimates currently available. (HEDGE USACE Decision)

4) Conduct analysis per existing USACE guidance
Next Steps

• FY 2014 – Work with USACE Planning Community to develop joint EC

• Continue Development of Quantitative Adjustments for Project Specific Types.
  o Flood Risk
  o Water Supply
  o Dam Safety
  o Levee Safety
  o Ecosystem Restoration
  o Navigation
  o Hydropower
  o Recreation
Next Steps
Quantitative Analysis Development

• Determine Quantitative Adjustments
  o Locally Relevant
  o Reasonably reflect evidence of climate change within uncertainty of hydrologic analysis
  o First in development is for flood risk reduction projects. Input is analysis of flood frequencies and internal team evaluating adjustment factors between 5 and 45%.
Summary
Technical Implementation

• Qualitative Analysis
  • Synthesis of Available Literature
  • Potentially First Order Statistical Analysis

• Quantitative Analysis
  • Statistical Analysis for Detection of Change
  • Statistical Analysis or literature synthesis for Attribution of Change
  • Future Climate Projections
  • Hydrologic Simulation Including Future Climate Projections
  • Translation into Engineering Process
Implementation Support

- USACE in process of developing and deploying the tools to support implementation of qualitative and quantitative analyses.

- Many of the tools being developed have been done so collaboratively with Reclamation and others.

- Both under auspices of CCAWWG and directly.
HUC 2 Literature Synthesis

Contents:

• Observed and Projected Changes

• Impacts by Business Line

• Consistent Graphics of Change Projections for each HUC2
HUC 2 Literature Synthesis

Leverage Existing Literature
Apply to USACE Geography
Peer Reviewed Literature with Impacts Identification Goal

1. USACE RCC Pilot Reports
2. National Climate Assessment Documents
   • Regional Synthesis
   • Technical Input Report
3. Federal Agency Synthesis Documents (CCAWWG)
   • Reclamation
   • EPA
   • NOAA Regional Climate Trends and Projections
Detection and Attribution Literature Review
Application Specific Change Detection and Attribution Guidance
Future Climate Projections

Downscaled CMIP3 and CMIP5
Climate and Hydrology Projections

• Multiple Generation of Climate Models
  • CMIP3
  • CMIP5

• Multiple Statistical Downscaling Methodologies
  • Bias Corrected Spatially Downscaled (BCSD)
  • Bias Corrected Constructed Analogs (BCCA)

http://gdo-dcp.ucar.gov/downscaled_cmip_projections/dcpInterface.html
Hydrologic Projections

USACE Activities

- Inland Hydrology Guidance Implementation
- Sedimentation Analyses
- Vulnerability Analyses
- Drought Contingency Plans

http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html
Hydrologic Projections
Phase 1 Complete
(Example) HUC 0509 – Middle Ohio
Hydrologic Projections
Phase 2 Ongoing
(Example) HUC 0509 – Middle Ohio
Discussion FDA Analysis

Beth Faber developed adjustment tool – May 2013

SPK Example Summary Output

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<th>Stream Name</th>
<th>Damage Reach Name</th>
<th>Beginning Station</th>
<th>End Station</th>
<th>Bank</th>
<th>Index Location Station</th>
<th>Description</th>
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<table>
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<th>Without+15%</th>
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<th>Without+25%</th>
<th>Without+30%</th>
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Target Stage Annual Exceedance Probability

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Conditional Non-Exceedance Probability by Events

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<th>2.0%</th>
<th>1.0%</th>
<th>0.4%</th>
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Climate Change Adaptation Training

Hydrologic Impacts Under Climate Change Training Class (Pilot January 15-17, 2013).

Crop Irrigation Requirements (CIR) under Climate Change Training Course (Pilot March 5-7, 2013)

Additional training being developed.

Sedimentation Impacts Analysis
Ecological Impacts Analysis
Discussion