Lessons Learned and Approaches for Climate Change Assessment

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Presentation Overview

- Identify approaches and lessons learned using four projects
  - 20 Watersheds Project, USEPA
  - Climate Change Hydropower Pilot, IFC
  - South Fork Nooksack River Climate Change Pilot, EPA (Nooksack Indian Tribe, supporting partner)
  - Climate Change Assessment, Meacham Creek, Confederated Tribes of the Umatilla Indian Reservation
- Present climate change assessment not just as “studies”, but as tools to support resilient watershed management
General Panel Presentation Framework

Climate Change Vulnerability Assessment

Identify and Prioritize Strategies

Design Resilient Stream Restoration Strategies
Watershed modeling conducted in 20 US Watersheds

- Meacham Creek
- South Fork Nooksack River Assessments
- Hydropower
Evaluated two watershed models:
• HSPF and SWAT

Evaluated different climate scenarios:
• Non-downscaled Global Climate Models
• Dynamically downscaled climate models (NARCCAP)
• Bias-corrected statistical (NARCCAP)

Analysis of:
• Streamflow
• Nutrient (nitrogen and phosphorus)
• Sediment loading

To:
• Plausible mid-21st century climate change
• Urban development scenarios
Changes in forcings -

- The median annual mid-21st century precipitation across climate scenarios is comparable to historic conditions (change varies between -11.6% and +6.5%)
- Median annual temperature increases approximately 3.5° F across climate scenarios

Changes in outcomes:

- Median streamflow volume increase 5% (varies between -8% and +16%)
- Median 100-year peak flow increases by 15% (ranges between -21% and +30%)
- Median TSS increase is 10% (varies between -10% and +24%)
- Median TP and TN decreases 3% and 4% respectively
Outcomes and Lessons Learned

Still significant uncertainty in future precipitation
- Use an ensemble approach
- Consider to be a sensitivity analysis

Products
- EPA's Global Change Explorer: https://20watersheds.epa.gov/
EPA's Global Change Explorer

### EPA Global Change Impacts & Adaptation - 20 Watersheds

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Climate</th>
<th>Stream Attribute</th>
<th>Seasons</th>
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<tbody>
<tr>
<td></td>
<td>Future (ICUS 2050)</td>
<td>Total Phosphorus</td>
<td></td>
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<td></td>
<td>CGCM3/RCM3</td>
<td>Total Nitrogen</td>
<td>Spring (MAM)</td>
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<td></td>
<td>HadCM3/HRM3</td>
<td>Flow</td>
<td>Summer (JJA)</td>
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<td>GFDL/RCM3</td>
<td>7 Day Low Flow</td>
<td>Fall (SON)</td>
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<td>GFDL/GFDL high res.</td>
<td>100 Year High Flow</td>
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<td>Richards-Baker Flashiness Index</td>
<td>Annual</td>
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<td>CCSM/WMRF3</td>
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### EPA Integrated Climate and Land Use Scenarios

**Projections**
- Housing Density
- Housing Density (All Colors)
- % Impervious Surface
- % Impervious Surface (HUC8)
- County Population

**Scenarios**
- A1 Scenario
  - Rapid global economic development
  - Population growth at rapid rate, three times before replacement level
  - Affordability and average US household size decline
  - Births, deaths and net international migration are high
  - Same population projection as the B1 scenario

**Output**
- Display Options
- Print
- Download

### Map

- EPA's Global Change Explorer
- 20 Watersheds
- USDA National Agricultural Statistics Service
- U.S. Geological Survey
- National Oceanic and Atmospheric Administration
- U.S. Forest Service
- U.S. Environmental Protection Agency
IFC Climate Change Pilot for the Kafue River, Zambia
Climate Change Assessment Approach

1. **Climate Change Assessment**
   - Time Periods, GCMs, SRES
   - Downscaled Temperature and Precipitation Data (Zambia and Kafue River Basin)

2. **Operational Risk Assessment**
   - Hydrologic Modeling
   - Reservoir (Energy) Modeling
   - Financial Assessment
   - Financial Performance Indicators

3. **Adaptation Options**

4. **Recommendations**

5. **Flood, Drought, Landslide, Wildfire, Disease Analysis**
   - Future Vulnerability, Risk, Annualized Losses
   - Sectors: Agriculture, Biodiversity/Conservation, Residential, Industrial Analysis
Outcomes and Lessons Learned

Importance of:

• Stakeholder outreach and engagement
• Importance of managing water in an integrated manner
• Use of financial models to understand bottom line

Products

Climate Assessment Objective

• Assess the potential impacts of climate change on stream temperature and stream flow for a TMDL Implementation Plan.
Quantitative Assessment: Modeling Integration, Inputs, Outputs, and Uncertainties

Source: Quantitative Assessment of Temperature TMDL, Washington Department of Ecology, EPA Region 10, Tetra Tech
Quantitative Assessment Modeling Results

Maximum Tributary Stream Temperature 7Q10 Flow Conditions (Pending Publication by EPA)

Current Climate

2080s Climate

Source: Quantitative Assessment of Temperature Sensitivity of the South Fork Nooksack River under Future Climates using QUAL2Kw Draft Report June 10, 2013 by Tetra Tech (Butcher et al.)
Outcomes and Lessons Learned

- Climate change will exacerbate legacy impacts
- TMDL focuses on extreme conditions
- Importance of system potential shading and watershed processes

Resources
- CIG and resources: [https://cig.uw.edu/](https://cig.uw.edu/)

Products (coming soon!)
- SFNR TMDL (Ecology)
- Quantitative Assessment
- Qualitative Assessment
Climate Change Assessment for Meacham Creek

• Focused on the annual maximum of the 7-day average of daily maximum temperatures (7DADMax)

• Used a stream temperature regression model
Climate Change Assessment for Meacham Creek

Used a statistical approach to develop future stream temperature

- A logistic regression approach developed by Mohseni et al. (1998)
- Mantua et al. (2010) used this regression approach in a stream temperature regression model to evaluate water temperature distributions in Washington State under future climate conditions.
- Mohseni models were fit to all 8 monitoring stations along Meacham Creek
Outcomes and Lessons Learned

- Cost effective approach that still provides useful information
- Peak flows are likely to increase about 15-20% by 2065

Resources:
Main Take-Away Points

• Identify local data and tools that can be leveraged
• Good scoping is important - identify parameters, time frame of analysis, methods of analysis
• Can use multiple approaches – from very resource intensive to more efficient to qualitative....doesn’t have to break the bank!
Thank You!

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