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Senior Technical Leader

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- Power Company Advisory Committee

Teamwork makes the dream work!
Background

▪ Issue
  – Tools to manage water risk require sustained funding to integrate climate-based and regional assessments that inform adaptation and resiliency strategies.

▪ Objectives
  – Facilitate response to emerging water management stakeholder issues
  – Integrate climate assessments into water supply/quality models
  – Give insights on regional climate risks and adaptation strategies to support long range planning
Steps in the Analysis

Evaluate Hydrologic Models

Design Risk Framework

Develop Adaptation Strategies

Linking Research for Strategic Planning and Tactical Outcomes
Step 1a: Evaluate Hydrological Models

- **SWAT**
  - Hydrologic and water quality
  - Detailed representation of actual land uses & mgmt. practices
  - Applicable to many regions
  - Can incorporate land use change in same simulation
  - Can model extreme events
  - Easily available with good support

- **WARMF**
  - Hydrologic and water quality
  - Very good representation of actual land uses
  - Applicable to many regions
  - Can incorporate land use change in simulation in series
  - Can model extreme events
  - Available with good support

- **MIKE SHE**
  - Hydrology
  - Water quality requires additional programming
  - Very good representation of actual land uses
  - Applicable to many regions
  - Need separate simulations for land use change
  - Can model extreme events
  - Available, with a significant monthly fee

Step 1b - Hydrological Modeling
Data Used

- GCMs selected based on best match of historical climate
  - GFDL ESM2 (USA)
  - Hadley GEM2 (UK)
  - MRI CGCM3 (Japan) or Can ESM2 (Canada)

- IPCC projections
  - RCP4.5 (mid-level emissions)
  - RCP8.5 (high-level emissions)

- Downscaling method – Dynamic vs Statistical
Step 2a - Characterize Risk

- Assessment of Risk to Infrastructure
- Assessment of Risk to Operations
- Assessment of Risk to Supply Chains
- Assessment of Water-Related Environmental Regulatory Risk

- Thermal Generating Facilities (coal, natural gas, geothermal)
  - Hydro-electric facilities
- Land-based renewable generating facilities (wind, solar, geothermal)
- Transmission and distribution facilities (e.g., transmission towers, substations, and utility poles)

Qualitative Risk Assessment
- Severity (damage, criticality)
- Likelihood (probability of occurrence)
## Qualitative Risk Identification and Characterization

<table>
<thead>
<tr>
<th>Risk Likelihood</th>
<th>Positive Impact</th>
<th>Low Severity</th>
<th>Medium Severity</th>
<th>High Severity</th>
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</thead>
<tbody>
<tr>
<td>Very Likely</td>
<td>n=0</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Likely</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Moderately Likely</td>
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<td>5</td>
<td>4</td>
<td>1</td>
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<tr>
<td>Less Likely</td>
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<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Unlikely</td>
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<td>1</td>
<td>0</td>
<td>0</td>
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</table>

31 risks identified in total
Step 2b – Quantify Risk

Hydropower example from the San Juan Basin

Cumulative Lost Revenue - Current Residential Rate (FEUS)

Notes:
1. Data from City of Farmington, NM Electric Utility rate study
2. Revenue evaluated at residential rate of $0.10/ kWh
3. Power generation from USACE 2011 FEIS
Step 3a – Identify Adaptation Strategies

1. Biological
2. Physicochemical
3. Geomorphic
4. Hydraulic
5. Hydrologic
6. Socioeconomic

- Bypass to maintain flood control for rare events
- Restricted opening to induce ponding & reduce downstream erosion
- Reduced watt
- Wood structures installed by hand

Pre-project roadside ditch
Post-project stream/wetland
- San Juan River Basin
- Wabash River Basin
- Allegheny River Basin

- Optimization of Existing Storage
- Bankfull Wetlands
- Beaver Reintroduction
- Hand-Placed Logs
Step 3b – Quantify Adaptation Strategies

- **Potentially erosive events**
  - 0.45xO₂

<table>
<thead>
<tr>
<th>Volume (m³)</th>
<th>Cost</th>
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<tbody>
<tr>
<td>~250k</td>
<td>~$1.5M</td>
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<tr>
<td>~1.25M</td>
<td>~$7.5M</td>
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<tr>
<td>~25M</td>
<td>~$150M</td>
</tr>
<tr>
<td>~120M</td>
<td>~$750M</td>
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</table>

- **Bankfull Wetlands** – planning-level excavation cost of ~$6.20/m³ (~$4.75/CY) with free topsoil haul off
  - ~$100k
  - ~$500k
  - ~$10M
  - ~$50M

- **Beaver Reintroductions** – planning-level cost of ~$2,500 per imported colony with each colony creating ~600 m³ (~6 acres ft) of storage
  - ~$15M
  - ~$75M
  - N/A
  - N/A

- **Hand-placed Logs** – planning-level cost of ~$6.75/m³ (~$1.75/CY) with well-trained labor and professional guidance
  - ~$10k
  - ~$500k
  - ~$10M
  - ~$50M

- **Existing Reservoir Optimization** – feasibility and cost will vary by watershed/reservoir
Products - EPRI Reports

- Evaluation of Hydrological Models for Climate-based Assessments (#3002019495) – 2020
- Potential Water-Related Risks to the Electric Power Industry Associated with Changing Surface Water Conditions (#3002017809) – 2020
- Quantifying the Potential Impacts of Water-Related Risks Associated with Climate Change to the Power Industry (#3002021684) - 2022
- Minimizing Risks to the Electric Power Industry from Changing Surface Water Conditions (#3002017808) – 2020
- Conceptual Watershed-scale Opportunities to Minimize Risks of Changing Surface Water Conditions — A Pilot Analysis of Three River Basins (#3002021683) - 2021

Manuscripts in progress
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