Water Planning in a Future Context: Watershed Specific Climate Data and Tools

SAWPA - 4/11/2013
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Bureau of Reclamation
Background

• Public Law 111-11, Subtitle F (SECURE Water Act, SWA, 2009) § 9503.

• Climate change risks for water and environmental resources in “major Reclamation river basins.”

• Reclamation’s WaterSMART (Sustain and Manage America’s Resources for Tomorrow) program
  1. Basin Studies
  2. West-Wide Climate Risk Assessments (WWCRAs)
  3. Landscape Conservation Cooperatives (LCCs)

SECURE – Science and Engineering to Comprehensively Understand and Responsibly Enhance

8 major Reclamation River Basin
Funded Basin Studies

17 studies have been funded to date starting in 2009.

2009
• Colorado River Basin
• Milk/St. Mary Rivers Basin
• Yakima River Basin

2010
• Niobrara River Basin
• Truckee River Basin
• Santa Ana River Basin
• Henrys Fork of Snake River
• S.E. California Regional Basin

2011
• Lower Rio Grande River Basin
• Santa Fe Basin
• Klamath River Basin
• Hood River Basin

2012
• Upper Washita River Basin
• Sacramento-San Joaquin Rivers
• Republican River Basin
• Pecos River Basin
• L.A. Basin
Santa Ana Watershed
Outline

• Hydrology Projections
  – Surface Water (detail)
  – Groundwater (decision support tool)

• Decision Support Using Climate and Hydrology Projections (examples)
  – Basin-wide Hydroclimate Distribution
  – Seasonal and Annual Flows
  – Flood Frequency
  – Temperature Trends
  – Groundwater Management (decision support tool)
  – ...

• Tool Development
  – Groundwater Screening Tool
  – GHG Emissions Calculator for the Water Sector
Downscaled BCSD-CMIP3 GCM Output and Hydrologic Modeling (Bias-Correction Spatial Disaggregation - Coupled Model Intercomparison Project Phase 3 General Circulation Model)
West-Wide Climate Risk Assessments (WWCRA) - Hydrologic Projections (2011)

SECURE Report to Congress, April 2011 focus on median changes; future reports have broader scope

Analyses of Period-changes in climate and hydrology

Data-service, Reclamation and broader public use


112 Transient Climate Projections...
http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections/dcpInterface.html

112 Transient Hydrologic Projections covering western U.S....

8 “big basin” VIC hydrology model-apps from Univ. of WA...

Online Data Access

http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections
Hydrology Projections
Spatial Distribution of Precipitation (P)

- The ensemble-median change shows some increase in prcp over the basin during the 2020s’ decade from the 1990s’ reference.

- By the 2050s there is decline in prcp from the 1990s reference decade.

- Increased decline in prcp continues through to the 2070s decade from the 1990s reference decade.
Hydrology Projections
Spatial Distribution of Temperature (T)

- The ensemble median change for the 2020s’, 2050s’, and 2070s’ decades relative to the 1990s shows an increasing temperature value throughout the Basin.
Hydrology Projections
Snow Water Equivalent (SWE)

- Spatial distribution of April 1st SWE – persistent decline through the future decades (2020s, 2050s, 2070s) from the 1990s’ distribution.
Hydrology Projections P, T, SWE, Flow

- Temporal trends – solid line is the median, 5th and 95th percentile bounds.
- P – longer-term somewhat decreasing trend
- T – increasing trend
- SWE – decreasing trend
- Flow – longer-term decreasing trend
Hydrology Projections
Flow Impacts

- Annual and seasonal streamflow impacts

- 2020s – increase in annual runoff and winter (Dec-Mar) runoff, decrease in spring-summer (Apr-Jul) runoff from the 1990s reference

- 2050s – decrease in annual, winter, spring-summer runoff from the 1990s reference

- 2070s - decrease in annual, winter, spring-summer runoff from the 1990s reference
### Summary of Impacts
Santa Ana River Adams St. Gage

<table>
<thead>
<tr>
<th>Hydroclimate Metric (change from 1990s)</th>
<th>2020s</th>
<th>2050s</th>
<th>2070s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation (%)</td>
<td>0.67</td>
<td>-5.41</td>
<td>-8.09</td>
</tr>
<tr>
<td>Mean Temperature (deg F)</td>
<td>1.22</td>
<td>3.11</td>
<td>4.10</td>
</tr>
<tr>
<td>April 1st SWE (%)</td>
<td>-38.93</td>
<td>-80.40</td>
<td>-93.07</td>
</tr>
<tr>
<td>Annual Runoff (%)</td>
<td>2.60</td>
<td>-10.08</td>
<td>-14.61</td>
</tr>
<tr>
<td>Dec-Mar Runoff (%)</td>
<td>9.82</td>
<td>-3.01</td>
<td>-6.38</td>
</tr>
<tr>
<td>Apr-Jul runoff (%)</td>
<td>-6.35</td>
<td>-25.24</td>
<td>-31.39</td>
</tr>
</tbody>
</table>

Similar analysis was done for all the 36 sites in the Santa Ana Basin.
Floods – 200-year event, Prado Dam

- More severe floods in the future
- 200 year historical event is likely to be closer to a 100 year event in the future
Days above 95ºF

<table>
<thead>
<tr>
<th>Location</th>
<th>Historical</th>
<th>2020</th>
<th>2050</th>
<th>2070</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaheim</td>
<td>4</td>
<td>7</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Riverside</td>
<td>43</td>
<td>58</td>
<td>72</td>
<td>82</td>
</tr>
<tr>
<td>Big Bear City</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
SAWPA Groundwater Screening Tool

- **Supply (Inflows):**
  - Precipitation
  - Streamflow
  - Imports

- **Demand (Outflows):**
  - M&I
  - Agriculture
  - Evap. Demand

- Change in Water Table Elevation

**Storage**
SAWPA Groundwater Screening Tool

[Map showing physical and geographic features of a region, with various color-coded areas and points of interest labeled.]
Exogenous Variable:
Optional input that allows user to represent additional driving variables that are not included in default model.

Examples:
- Dewatering operations (e.g., Chino basin)
- Injection operations (e.g., Orange Co.)
- Recycled water
- Many other variables may be considered.
SAWPA Groundwater Screening Tool

– Key Features (*what the tool does*)

• Estimates impacts of climate change on basin-scale groundwater conditions

• Facilitates comparison of alternatives to protect groundwater resources under climate change

• Can be used by SAWPA member agencies and stakeholder to support basin planning decisions
SAWPA Groundwater Screening Tool

- Limitations *(what the tool does not do)*
  
  • Does *not* reflect detailed physical properties of groundwater aquifer (geometry, porosity, permeability, etc.)

  • Does *not* provide direct estimate groundwater deficit or surplus, which depends on aquifer properties

  • Does *not* provide estimate of local-scale impacts, only considers basin-scale groundwater budget
SAWPA Groundwater Screening Tool

- Will a 10% reduction in M&I demand offset the impacts of climate change in my groundwater basin?

- What is the projected deficit in groundwater storage in my basin by 2050 due to climate change?
SAWPA Groundwater Screening Tool

- Example:
  Orange County Coastal Plain Groundwater Basin

Estimated decline in basin-averaged groundwater levels due to climate change without management actions to reduce impacts
SAWPA Groundwater Screening Tool

Example:
Orange County Coastal Plain Groundwater Basin

Scenario Comparison: Management alternatives to offset projected impacts on groundwater in Orange County

<table>
<thead>
<tr>
<th>Conservation</th>
<th>Imported Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradual reduction of approx. 15% by 2020</td>
<td>Gradual increase in water imports from Colorado River and/or SWP</td>
</tr>
<tr>
<td>(reduce per capita use from ~175 gpd to ~150 gpd)</td>
<td>(increase from ~30,000 AF/yr to ~105,000 AF/yr)</td>
</tr>
</tbody>
</table>
Greenhouse Gas Emissions Calculator for the Water Sector

Final Values for Computation of Total Annual Emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>Groundwater (gpd)</th>
<th>Surface Water (gpd)</th>
<th>Groundwater Intensity (KWh/MG)</th>
<th>Supply &amp; Conveyance Intensity (KWh/MG)</th>
<th>Treatment Intensity (KWh/MG)</th>
<th>Distribution Intensity (KWh/MG)</th>
<th>Electricity Emission Factors (kg CO2 eq/MWh)</th>
<th>Annual Groundwater Extraction Emissions (mTCO2e)</th>
<th>Annual Conveyance Emissions (mTCO2e)</th>
<th>Annual Treatment Emissions (mTCO2e)</th>
<th>Annual Distribution Emissions (mTCO2e)</th>
<th>Total Annual Emissions (mTCO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>334,504.230</td>
<td>82,441.015</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>20,845</td>
<td>82,454</td>
<td>23,756</td>
<td>57,440</td>
<td>184,495</td>
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<tr>
<td>2000</td>
<td>465,596.183</td>
<td>37,343.084</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>24,612</td>
<td>97,358</td>
<td>25,850</td>
<td>67,823</td>
<td>230,892</td>
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<tr>
<td>2010</td>
<td>428,958.060</td>
<td>102,949.924</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>26,021</td>
<td>103,966</td>
<td>29,666</td>
<td>71,729</td>
<td>233,875</td>
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<tr>
<td>Current</td>
<td>435,443.663</td>
<td>104,506.479</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>26,424</td>
<td>104,523</td>
<td>30,113</td>
<td>72,814</td>
<td>233,875</td>
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<tr>
<td>2020</td>
<td>521,036.724</td>
<td>129,049.294</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>31,018</td>
<td>129,069</td>
<td>35,034</td>
<td>87,126</td>
<td>239,868</td>
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<td>2030</td>
<td>561,755.948</td>
<td>154,821.427</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>34,089</td>
<td>154,842</td>
<td>38,850</td>
<td>93,935</td>
<td>241,717</td>
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<tr>
<td>2040</td>
<td>582,194.580</td>
<td>139,726.659</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>35,330</td>
<td>139,748</td>
<td>40,264</td>
<td>97,353</td>
<td>312,684</td>
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<tr>
<td>2050</td>
<td>625,432.300</td>
<td>150,103.800</td>
<td>540</td>
<td>8900</td>
<td>496</td>
<td>1200</td>
<td>307.9</td>
<td>37,958</td>
<td>150,127</td>
<td>43,254</td>
<td>104,583</td>
<td>335,017</td>
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</tbody>
</table>

Scenario Results: Baseline

Instructions

Step 1: After completing data entry according to instructions, name your scenario in yellow box above and hit enter.

Step 2: Open GHG Scenario Manager, then return to this worksheet.

Step 3: Click on export results.
Greenhouse Gas Emissions Calculator for the Water Sector

- Addresses AB 32

- Evaluates both supply and demand

- Can be used with 3 levels of data
  - Required Data: population data for 1990, 2000 & 2010
  - Suggested Data: water supply portfolio, per capita water use, projected population, etc.
  - Detail Data: monthly or annual energy and flow data can be entered for each category

- If data is not available So Cal defaults will be used
GHG Emissions Calculator

• Uses
  – Compute total annual CO2e emissions for the water sector from 1990-2050
  – Determine emission breakdown from groundwater, conveyance, treatment, distribution, and wastewater
  – Compute projected future water demand
  – Evaluate scenarios for GHG emission reduction by altering either supply or demand

• Limitations
  – Accuracy of results is dependent on input data
Greenhouse Gas Emissions Calculator Scenario Manager

GHG Emissions Scenario Comparison

Population
Default Data
Baseline
conservation
Increased GW

(mtCO2e)

0 100000 200000 300000 400000 500000 600000 700000 800000 900000 1000000 1100000 1200000

1990 2000 2010 2020 2030 2040 2050
Uncertainty Discussions

- Global Climate Forcings
- Global Climate Simulation
- Climate Projections Bias
- Spatial Downscaling
- Watershed Vegetation Changes
- Hydrologic Model

- ...

- Other approaches to analyzing impacts
I. Decision-Makers: “Keep it simple.”

II. Climate Information Providers: “Here’s the info… use it wisely.”

III. Technical Practitioners: “Keep it Manageable.”
In summary, data selections and method choices are throughout the analysis...

I. Decision-Makers:  
“Keep it simple.”

II. Climate Information Providers:  
“Here’s the info... use it wisely.”

III. Technical Practitioners:  
“Keep it Manageable.”

... choices carry uncertainties, we need to understand those uncertainties, and address them in the planning process.
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