RECLAMATION

Managing Water in the West

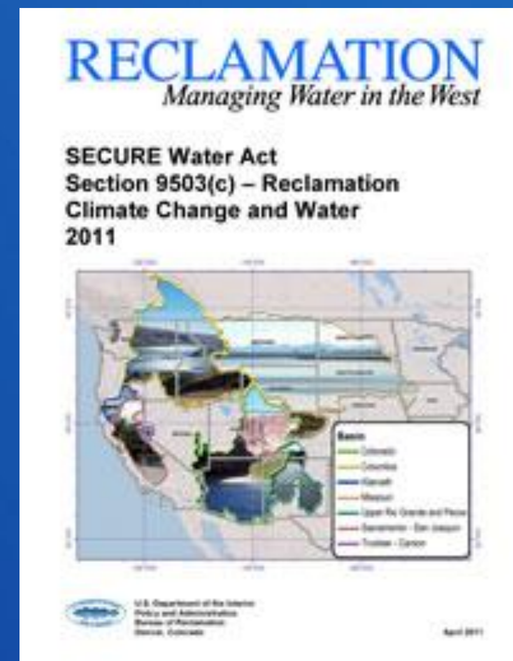
WaterSMART

U.S. Department of the Interior
Bureau of Reclamation

Basin Study Program

SECURE Water Act Section 9503

- Directs the Secretary to establish a climate change adaptation program which includes
  - *Assess risks* to water supply
  - *Analyze the impacts* of changes in water supply on a variety of demands
  - *Develop mitigation strategies* in consultation with non-Federal participants



Basin Study Program

WWCRA

- Baseline Assessment of risks and impacts
- Determine Imbalances in Water Supply & Demand

Basin Studies

- Stakeholder engagement
- Develop adaptation strategies

SECURE Studies

- SECURE Special Studies
- SECURE Feasibility Studies
- SECURE Guidance Development

Landscape Conservation Cooperatives

- Understand risks in a landscape context
- Applied science tools
- Supporting resource managers

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Basin Study Program Activities

- **West-Wide Climate Risk Assessments (WWCRA)**
  - Apply a consistent approach throughout the west to assess impacts of climate change to water supplies, demands and operational risks

- **Basin Studies**
  - Reclamation works on a cost-shared basis with state and local partners to develop potential adaptation strategies to meet future demands in light of imbalances in supply & demand

- **SECURE Special Studies and Feasibility Studies**
  - SECURE Special Studies
    - Small scale panning studies to provide a path forward to further develop adaptation strategies
  - SECURE Feasibility Studies
    - Support state and local partners to determine feasibility and impacts to ecological resiliency of adaptation strategies identified in Basin Studies

- **Landscape Conservation Cooperatives**
  - Partnerships to develop applied science tools to help resource managers address landscape-scale threats.
  - Provides a forum to share information developed through the Basin Study Program and to benefit from complementary activities by other agencies

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West Wide Climate Risk Assessments

- Include projections and assessments of risks and impacts to water supplies, demands, and Reclamation’s operations due to climate change

- Key baseline assessments leading towards more in-depth analyses performed through future Basin Studies

- Streamflow Projections Website
  http://gisweb.usbr.gov/Streamflow_Projections/
  - Provides future streamflow and water supply information at 195 locations across the west

Basin Studies

- **Reclamation works *collaboratively with non-Federal partners* to evaluate current and future *water supply and demand imbalances in a changing climate* and *identify adaptation strategies* to meet future water demands.**

- **Eligible applicants include States, tribes, water districts, cities, and other local governmental entities with water delivery or management authority located in the 17 Western States**

- **Require 50/50 cost-share**

- **Not Financial Assistance**

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Basin Studies – 2014 Selection Process

- Fiscal year 2014 selection process expected to be initiated by the end of November 2013
- President's budget request includes approximately $2 million in funding for Basin Studies
- Studies are selected through a 2 step competitive process
  - Step 1 – Letters of Interest
    - Letters of Interest are submitted to Reclamation regional offices
    - Regional offices select which Letters of Interest will move forward to step 2 of the selection process
  - Step 2 – Proposals
    - Applicants work with Reclamation to develop a joint study proposal to submit to Policy and Administration
    - Proposals are reviewed and scored based on identified evaluation criteria by an application review committee made up of Reclamation staff

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Basin Studies

- **4 Required Elements**

1) Projections of water supply and demand, including the risks of climate change

2) An analysis of how existing water and power infrastructure and operations will perform in response to changing water realities

3) The development of adaptation and mitigation strategies to supply adequate water in the future

4) A trade-off analysis of the strategies identified, and findings and recommendations as appropriate

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Funded Basin Studies

19 Basin Studies funded since 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**

2013
- **San Diego Watershed**
- **West Salt River Valley**

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Klamath River Basin Study

- Selected in fiscal year 2010
- Bureau of Reclamation, Oregon’s Water Resources Department, and California’s Department of Water Resources are partnering to conduct the Klamath River Basin Study
- Stakeholder involvement in the Study includes a broad spectrum of Klamath tribal governments, water user groups, agriculture associations and environmental interests
- Total cost is approximately $1.85 million

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Sacramento-San Joaquin Rivers Basin Study

- Selected in fiscal year 2012
- Partnership between the Bureau of Reclamation, California Department of Water Resources, California Partnership for the San Joaquin Valley, Stockton East Water District, El Dorado County Water Agency, and the Madera County Resources Management Agency
- Study area encompasses the entire Central Valley of California with an area of more than 22,500 square miles from the Tehachapi Range in the South to the Klamath Mountains in the north
- Involves stakeholders from throughout the Sacramento and San Joaquin basins including agriculture interests, City and County water agencies, water user associations and environmental interests
- Total cost is $2.4 million dollars

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SECURE Special and Feasibility Studies

- First selection process expected to be initiated fall of 2013
- Competitive process similar to Basin Studies
- Must have participated in a completed Basin Study to be eligible
- 50% non-Federal cost share required
- Not financial assistance
- FY 2014 funding - $400,000 for SECURE Special Studies and $500,000 for SECURE Feasibility Studies

SECURE Special Studies

- Must be completed within 2 years
- Up to $200,000 in Federal funding
- Intended to provide an opportunity to further explore and refine adaptation and mitigation strategies
  - Which strategies within a suite of strategies will be most effective
  - Different ways to implement a specific strategy
  - Other analysis that may be need to advance implementation of strategies

SECURE Feasibility Studies

- Must be completed within 3 years
- Up to $1.5 million in Federal funding (max $500,000 per year)
- Reclamation does not intend to seek Congressional authorization or appropriations for construction, except in very limited circumstances
- Will provide stakeholders the opportunity to advance the implementation of feasibility scale projects

Landscape Conservation Cooperatives

- Reclamation co-leads 2 LCCs with FWS that encompass the Colorado River Basin
  - *Desert LCC* and *Southern Rockies LCC*
  - *Reclamation provides funding for applied science grants in these two LCCs*

- *LCCs in California include:*
  - *Desert*
  - *California*
  - *North Pacific*
  - *Great Basin*

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WaterSMART Grants

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WaterSMART Grants

- **Provide financial assistance for the following types of projects:**
  - **Water and Energy Efficiency Grants:**
    Seek to conserve and use water and energy more efficiently, increase the use of renewable energy, protect endangered species, or facilitate water markets
  - **System Optimization Reviews:**
    Broad look at system-wide efficiency focused on improving efficiency and operations of a water delivery system, water district, or water basin
  - **Advanced Water Treatment Pilot and Demonstration Projects:**
    Address the technical and economic viability of treating and using brackish groundwater, seawater, impaired waters, or otherwise creating new water supplies within a specific locale
  - **Grants to Develop Climate Analysis Tools:**
    Development of tools to more efficiently manage water in a changing climate

Water and Energy Efficiency Grants

- **Require a minimum 50% non-Federal cost-share contribution**
- **Selected through a competitive process**
- **Must be completed within two to three years from funding date**
- **2 Funding Groups**
  - Funding Group I – up to $300,000
  - Funding Group II – up to $1.5 million (over three years)
- **Grants are available to:**
  - States
  - Indian tribes
  - Irrigation & water districts
  - Other entities with water or power delivery authority

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Water and Energy Efficiency Grants

- **FY 2013:**
  - **Received 182 applications requesting more than $111 million in Federal funding**
  - **Selected 35 new projects for a total of approximately $17.2 million in Federal funding**
    - **25 Funding Group I projects (up to $300,000)**
    - **10 Funding Group II projects (up to $1.5 million)**

- **FY 2014:**
  - **Funding Opportunity Announcement posted on November 14, 2013**
  - **Proposals due January 23, 2014**
  - **President's budget request includes $12 million**

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Sacramento – San Joaquin Rivers Basin Study

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The Sacramento-San Joaquin River Basin Study is a partnership between the California Department of Water Resources, California Partnership for the San Joaquin Valley, Stockton East Water District, El Dorado County Water Agency, the Madera County Resources Management Agency and the Bureau of Reclamation. Utilizing broad partner and stakeholder involvement, the Basin Study will recommend adaptation strategies in response to climate change.

The Sacramento-San Joaquin Rivers Basin Study encompasses the entire Central Valley of California with an area of more than 22,500 square miles from the Tehachapi Range in the South to the Klamath Mountains in the north. Approximately 7 million people reside in the Central Valley and it has been one of the fastest growing regions in the State. The Study area includes 3 major basins which are the Sacramento on the north, the San Joaquin in the central portion, and the Tulare Lake Basin on the south. A portion of the Trinity River Basin in Northern California is also included due to water exports from the Trinity River to the Sacramento River. The study area covers extensive areas of national forests, parks and wildlife refuges, irrigated agricultural lands, and many rapidly growing urban areas. The Sacramento and San Joaquin Rivers converge in the Sacramento-San Joaquin Delta which has become a focal point for local, regional and national discussions on environmental protections for the fragile delta ecosystem.

The Sacramento-San Joaquin Rivers Basin Study will assess potential climate change impacts to the Basin's water supplies and demands and will specifically evaluate potential changes to agriculture and urban water supplies, flood control, hydroelectric power generation, recreation, fisheries, wildlife and their habitats, water quality and water-dependent ecological systems. Where negative impacts are found, the Study will identify mitigation or adaptation strategies to address these impacts. The Study will involve a broad spectrum of stakeholders from throughout the Sacramento and San Joaquin basins including agriculture interests, City and County water agencies, water user associations and environmental interests. The Study will also explore potential opportunities for collaboration with the San Joaquin River Restoration Program which was identified as one of two top priorities in California in the America's Great Outdoors 2011 50-State Report. The total cost of the Sacramento-San Joaquin Basin Study is $2.4 million dollars with a 50/50 cost share between Reclamation and the non-Federal Partners.

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Klamath River Basin Study

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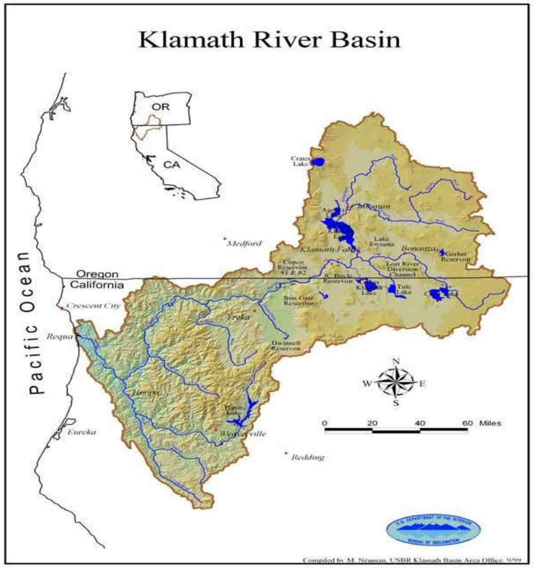

Bureau of Reclamation, Oregon's Water Resources Department, and California's Department of Water Resources are partnering to conduct the Klamath River Basin Study to identify strategies to meet current and future water demands in the Basin. The Klamath River Basin straddles the boundary between the states of California and Oregon and covers approximately 12,100 square miles. The basin originates east of the Cascade Mountain Range in Oregon and extends southwest into California where the Klamath River flows into the Pacific Ocean. The Klamath River Basin has become a focal point for local, regional, and national discussions on water management and water scarcity due to imbalances between water supplies and demands.

Employing broad stakeholder involvement, the Klamath Basin Study will accomplish the following objectives:

- Evaluate supply and demand imbalances in the basin which may be exacerbated by climate change;
- Identify possible impacts to the Basin's agricultural water requirements, hydroelectric facilities, recreational facilities, fish and wildlife habitats, flood control facilities, and water storage and distribution facilities; and
- Develop both structural and non-structural adaptive strategies to balance supplies with demands.

Stakeholder involvement in the Study includes a broad spectrum of Klamath tribal governments, water user groups, agriculture associations and environmental interests. The total cost of the Klamath Basin Study is $1.85 million with a 50/50 cost share between Reclamation and the States of California and Oregon.

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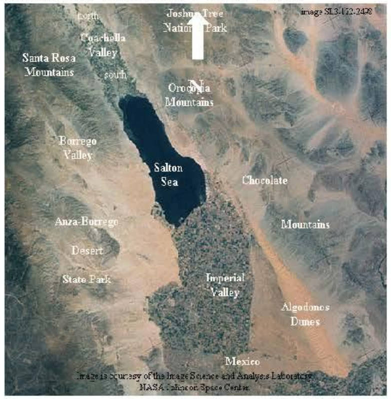
Southeast California Regional Basin Study

Contact: Bill Steele, So. California Area Office, Ph. (951) 695-5310
Jerry Rolwing, Borrego Water District Ph. (760) 767-5806

The Southeast California Basin Study (Study) is a collaborative effort between the Bureau of Reclamation and the Borrego Water District (District), which is authorized under the Secure Water Act (Title IX, Subtitle F of Public Law 111-11). Imperial Irrigation District, Coachella Valley Water District, and the San Diego County Water Authority will also participate in the study. The Study will begin in January of 2011 and will be completed within 2 years.



The region consists of 5,199 square miles and is home to over 750,000 people. The study area includes three irrigation districts, four Indian Tribes, 10 cities, and the Salton Sea. The region's water interests include agricultural demand, environmental concerns, municipal/industrial demand, and land and water based recreation. Affects from prolonged drought, population growth, and climate change will be thoroughly assessed by the study and adaptation strategies will be developed to help deal with this region's future water supply and water quality demands.

The Study will:

- characterize current regional water supply and demand;
- assess risks to regional water supplies, including those due to climate change;
- identify potential strategies and options to resolve water supply and demand imbalances;
- identify potential legal and regulatory constraints and potential impacts to water users; and
- prioritize identified strategies and options for potential future actions.

The study will enable competing interests to partner with Reclamation and investigate existing water resources management practices, system components, and evaluate management mechanisms to optimize water resources in alternative scenarios. The total cost of the study is $850,000, with a 50/50 cost-share.

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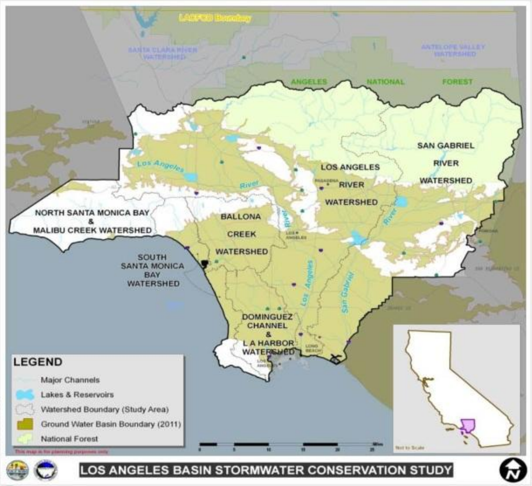
Los Angeles Basin Stormwater Conservation Study

Contact: Amy Witherall, awitherall@usbr.gov, 951-695-5310

The Los Angeles Basin Stormwater Conservation Study (Basin Study) is a partnership between the Los Angeles County Flood Control District (LACFCD) and the Bureau of Reclamation, Southern California Area Office. The Basin Study encompasses 1,900 square miles and includes the Los Angeles River, San Gabriel River, North Santa Monica Bay, South Santa Monica Bay, Dominguez Channel/Los Angeles Harbor, and Ballona Creek watersheds. The Basin Study area is home to over 10 million people, over 25% of the state's population. Water usage exceeded 1.6 million acre-feet in water year 2010-2011[1], and local regional planning efforts project a potential 800,000 acre-feet/year shortfall by 2025[2]. This shortfall could be exacerbated by climate variability as the area is affected by changes in ocean temperatures and currents that occur over months, years or decades as evidenced by phenomena such as the El Nino and La Nina cycles.



The purpose of the Basin Study is to identify alternatives, conduct trade-off analyses and develop recommendations for bridging the gap between current and future water supply and water demand in the Basin Study watersheds. The Basin Study has two objectives. The first is to evaluate the long-term potential of existing LACFCD flood control dams, reservoirs, spreading grounds, and other interrelated facilities to conserve increased amounts of stormwater for water supply. The second objective is to analyze the potential for new facilities and operational changes to capture increased stormwater volumes for water supply. Each objective will be met through detailed scientific, engineering, and economic analyses.

The Basin Study is estimated to cost $2.4 million dollars. The LACFCD and 21 local project partners will contribute approximately $1.4 million dollars towards completion of the Basin Study, and Reclamation will fund up to $1 million dollars, subject to funding availability.

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[1] MWD Calculations, IRPSIM Sales Model Projection 20a2, January 2012.
[2] Greater Los Angeles County Integrated Regional Water Management Plan, 2006, pg. 2-18, http://www.ladpw.org/wmd/irwmp. Metropolitan's Integrated Resources Plan proposes that its member agencies develop projects to increase local water production and conservation, and further suggests that financial incentives can facilitate some of those projects to fill the gap.

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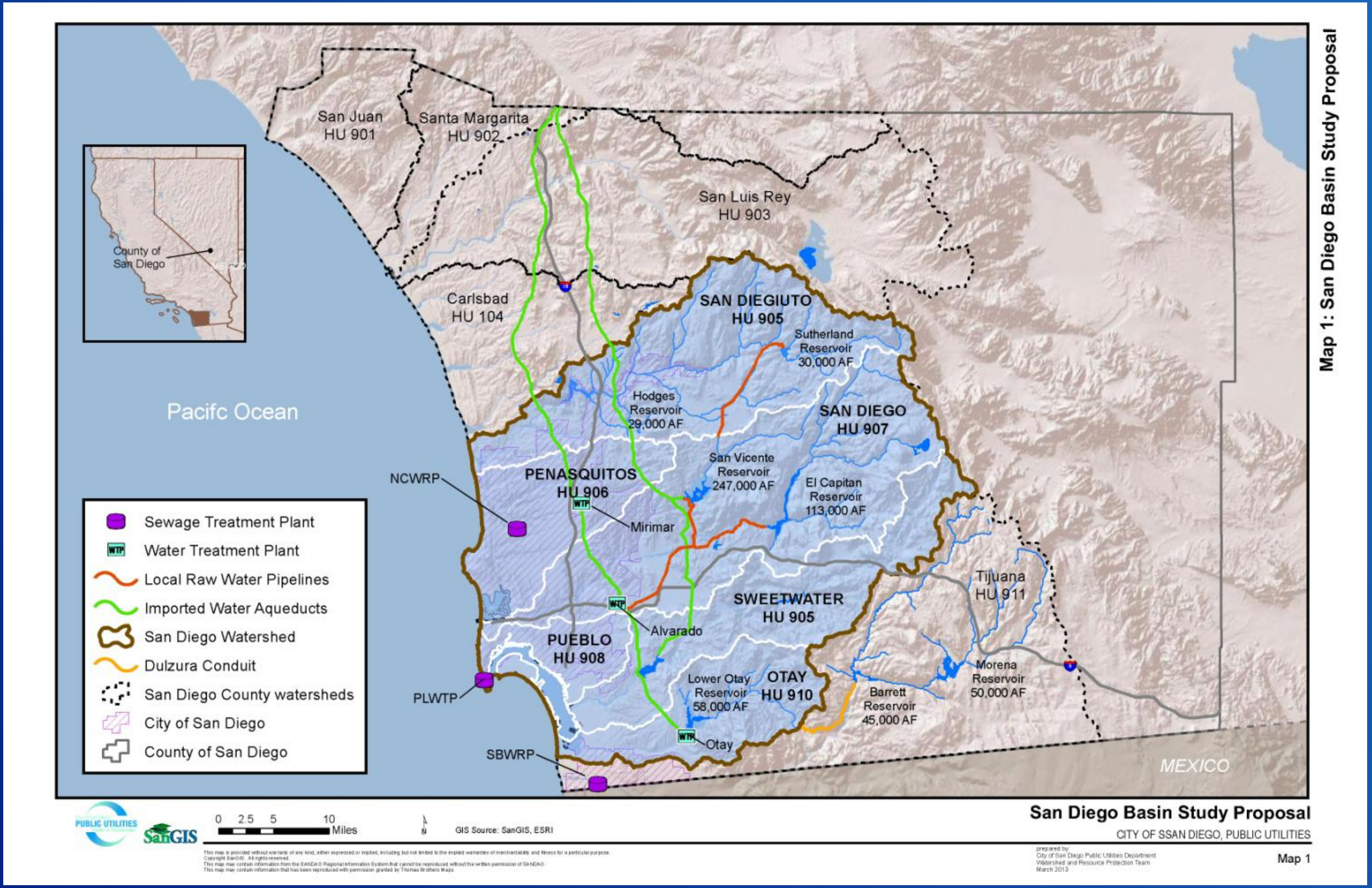
San Diego Basin Study



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Santa Ana River Watershed Basin Study

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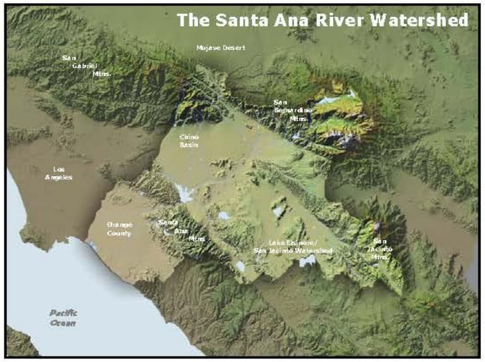
Mark Norton, P.E., SAWPA Water Resources, Ph. (951) 354-4221

The Santa Ana River Watershed Basin Study is a collaborative effort by the Santa Ana Watershed Project Authority (SAWPA) and the Bureau of Reclamation, which is authorized under the Secure Water Act (Title IX, Subtitle F of Public Law 111-11). The study will be initiated in the fall of 2010 and will be completed in 2012. The study focuses on SAWPA's integrated regional water resources management planning process and will refine the region's water projections, and identify potential adaptation strategies, in light of potential effects of climate change.



SAWPA is a joint powers authority that represents five major water resource agencies. SAWPA's membership includes over 350 water, wastewater and groundwater management, flood control, environmental, and other non-governmental organizations. These entities work together collaboratively and focus on the region's Integrated Water Resources Management plan called the "One Water One Watershed" (or the OWOW) Plan.

The Santa Ana watershed is home to over 6 million people within an area of 2,650 square miles. In light of climate change, prolonged drought conditions, growth, and population projections, a strong concern exists to ensure there will be adequate water supplies to meet future water demand. The Basin Study will update the OWOW Plan, address the impacts of climate change and identify potential adaptation strategies, assess increased energy demand, and ensure that future water quality and supply needs are met. Goals of the study include: incorporating existing regional and local planning studies within the watershed; sustaining the innovative "bottom up" approach to regional water resources management planning; ensuring an integrated, collaborative approach; using science and technology to assess climate change and greenhouse emissions affects, conducting watershed adaptation planning; and expanding outreach to all major water uses and stakeholders. Over $2 million dollars has been committed to the Basin Study, with a 50/50 cost-share.

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Santa Ana Watershed Basin Study: Report

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Summary Report

Santa Ana Watershed Basin Study

U.S. Department of the Interior
Bureau of Reclamation

September 2013

Climate Change Analysis: Impacts Assessment

- Will surface water supply decrease?
- Will groundwater availability be reduced?
- Is Lake Elsinore in danger of drying up?
- Will the region continue to support an alpine climate and how will the Jeffrey Pine ecosystem be impacted?
- Will skiing at Big Bear Mountain Resorts be sustained?
- How many additional days over 95°F are expected in Anaheim, Riverside and Big Bear City?
- Will floods become more severe and threaten flood infrastructure?
- How will climate change and sea level rise affect coastal communities and beaches?

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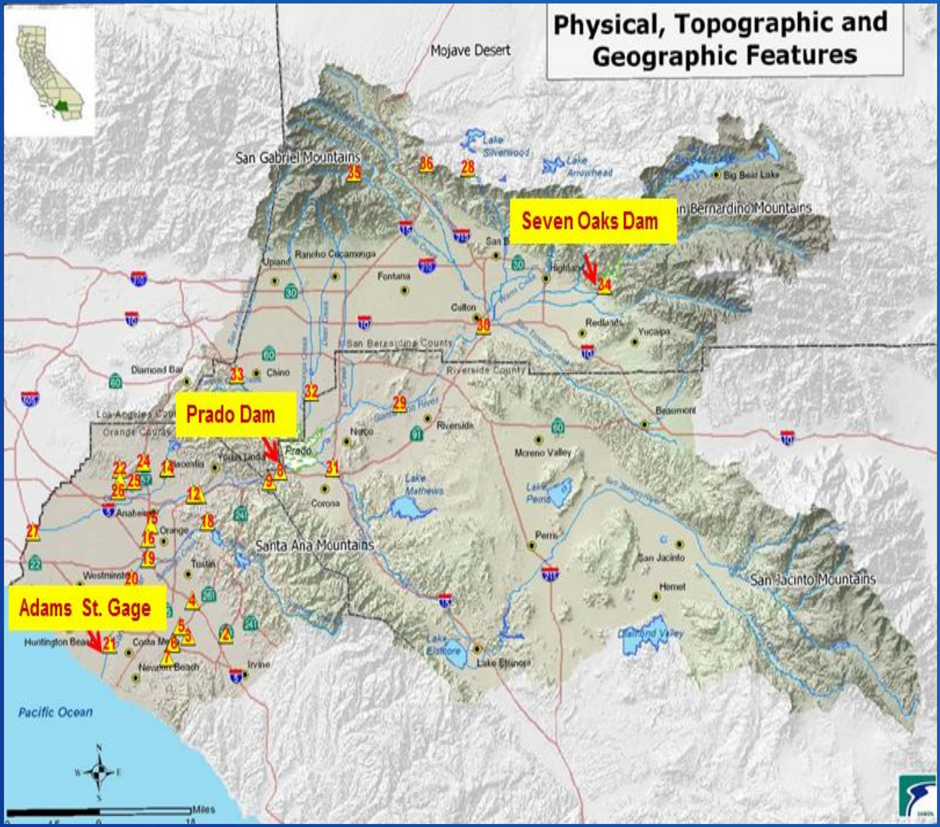
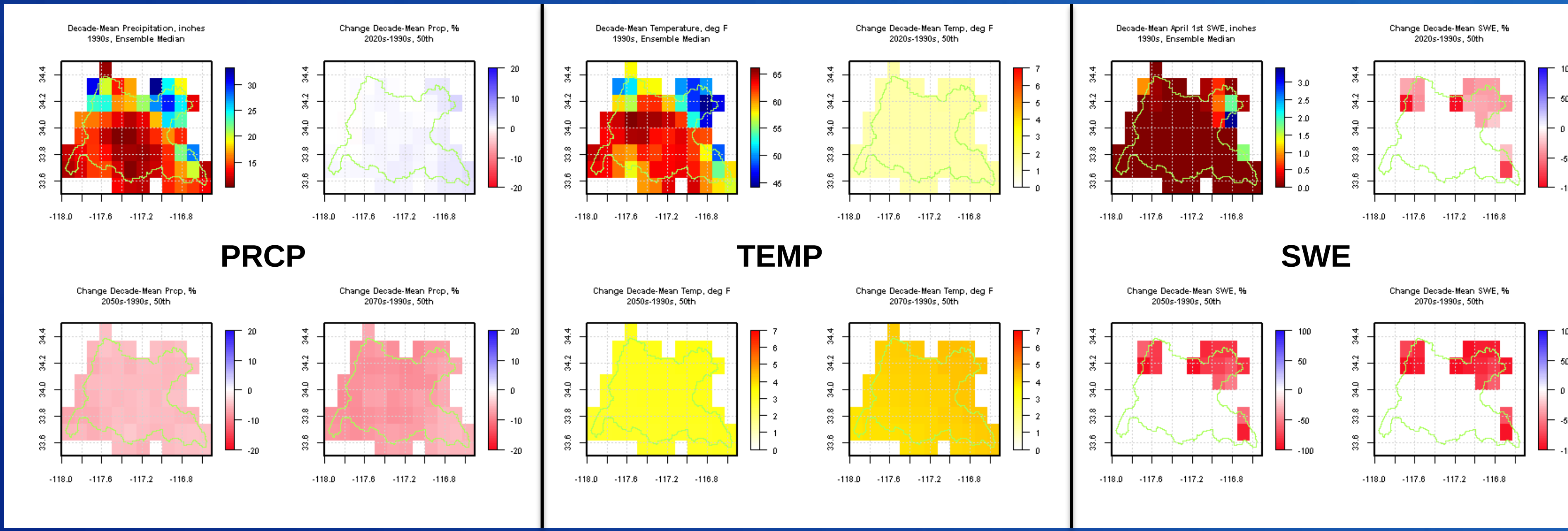
Climate Change Analysis: Tasks

- **Climate Projections to Hydrology Projections**
- **Projections:**
  - **Hydroclimate (precipitation, temperature, surface water supplies)**
  - **Water Demand**
- **Decision Support Using Climate and Hydrology Projections (examples of impacts assessment):**
  - **Temperature Trends**
  - **Flood Frequency**
  - **Groundwater Management (decision support tool)**
- **Tool Development:**
  - **Groundwater Screening Tool**
  - **GHG Emissions Calculator for the Water Sector**



Climate Change Analysis: Hydroclimate Projections



Hydroclimate Metric (change from 1990s)	2020s	2050s	2070s
Precipitation (%)	0.67	-5.41	-8.09
Mean Temperature (°F)	1.22	3.11	4.1
April 1st SWE (%)	-38.93	-80.4	-93.07

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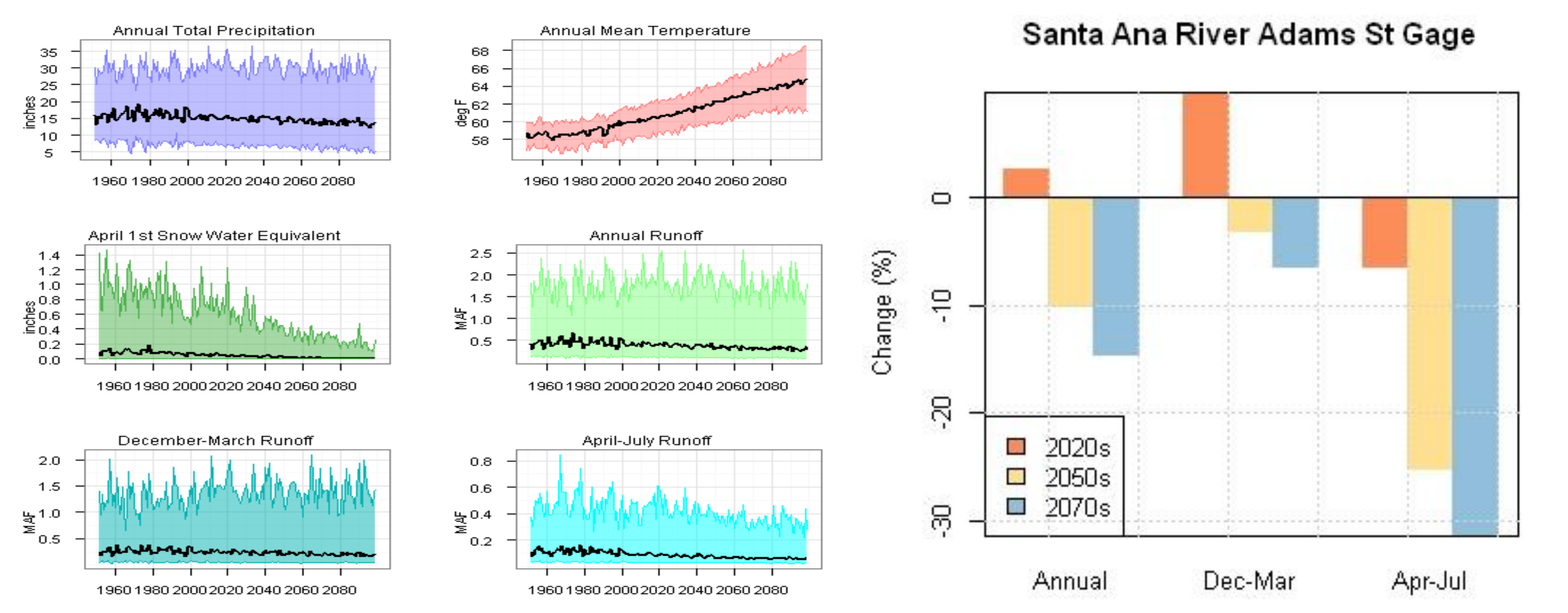
Climate Change Analysis: Hydroclimate Projections



Hydroclimate Metric (change from 1990s)	2020s	2050s	2070s
Annual Runoff (%)	2.6	-10.08	-14.61
Dec-Mar Runoff (%)	9.82	-3.01	-6.38
Apr-Jul Runoff (%)	-6.35	-25.24	-31.39

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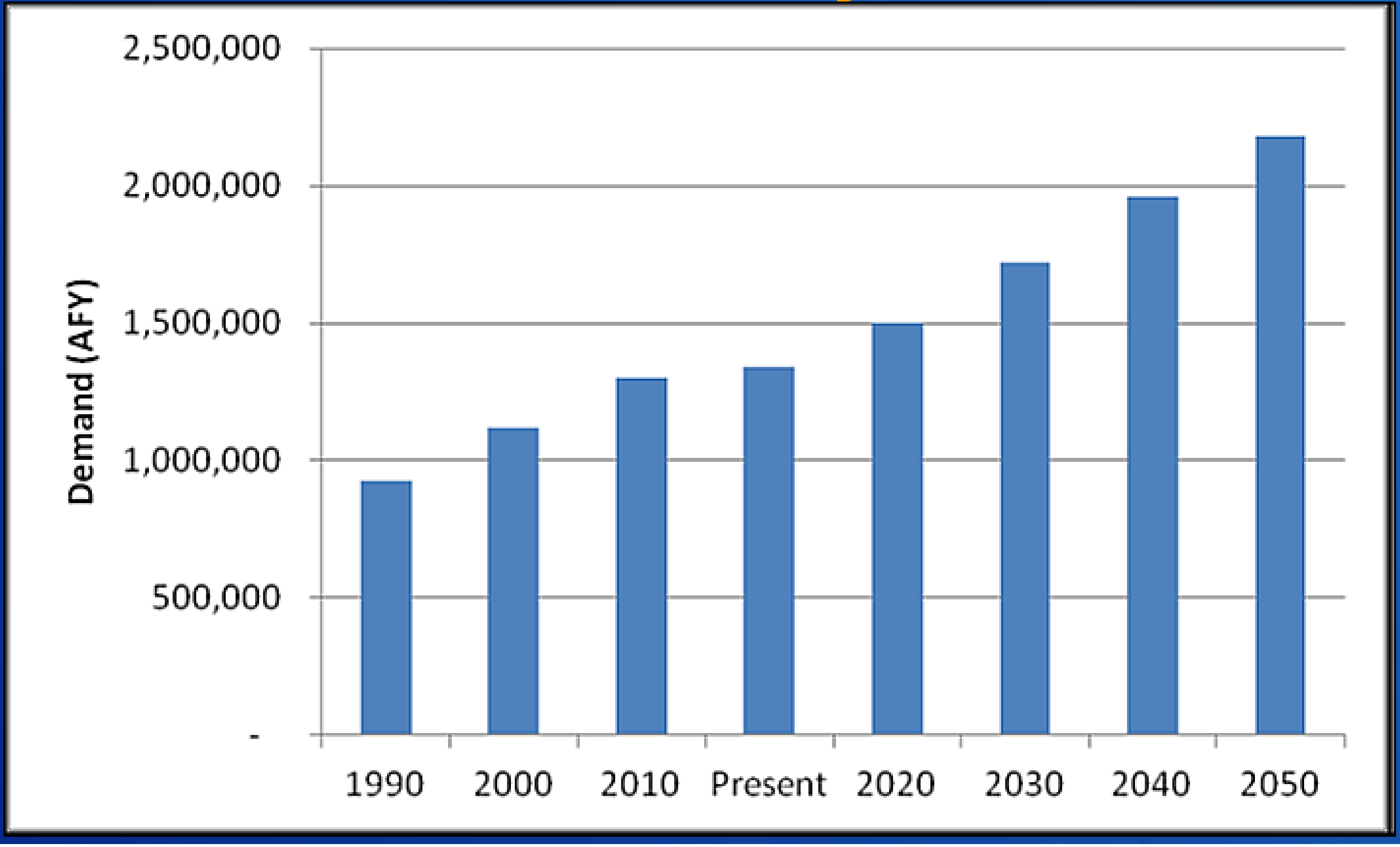
Climate Change Analysis: Demand Projection



	1990	2000	2010	Present	2020	2030	2040	2050
Demand (MAFY)	0.924	1.121	1.298	1.339	1.503	1.723	1.958	2.178

Climate Change Analysis: Impacts Assessment

- Will surface water supply decrease?
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- Is Lake Elsinore in danger of drying up?
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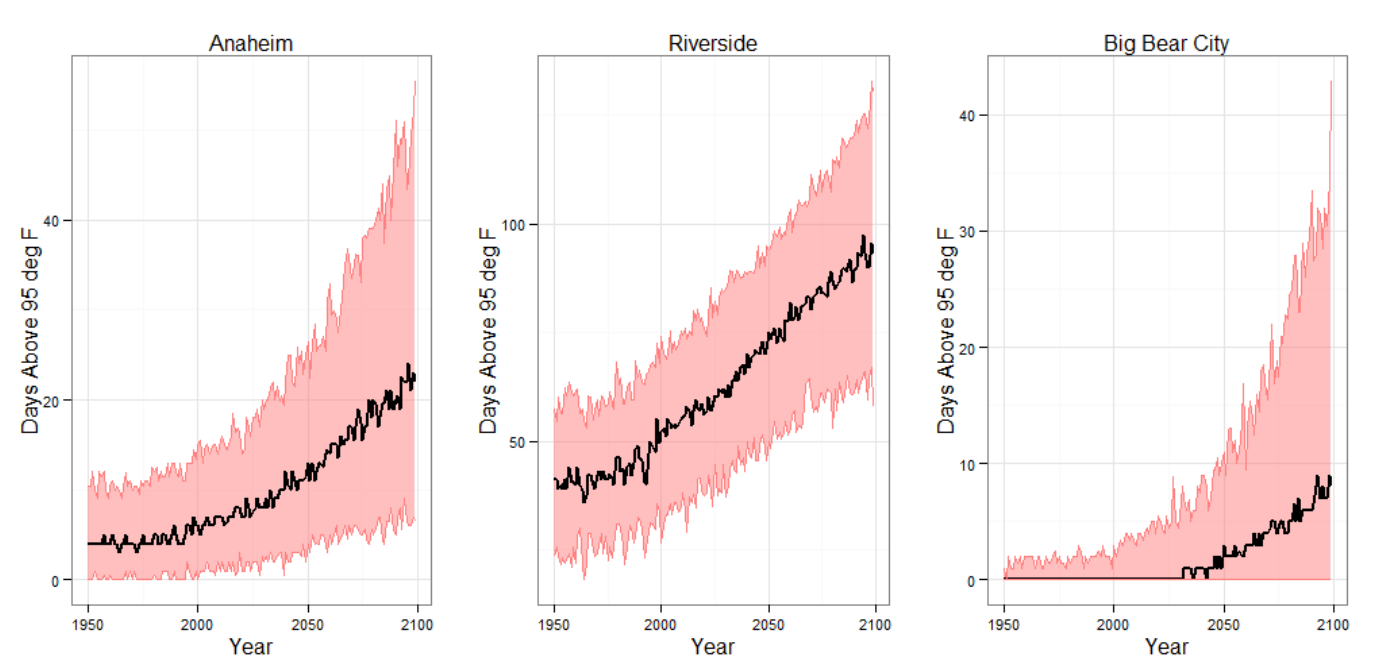
Climate Change Analysis: Impacts Assessment



	Historical	2020	2050	2070
Anaheim	4	7	12	16
Riverside	43	58	72	82
Big Bear City	0	0	2	4

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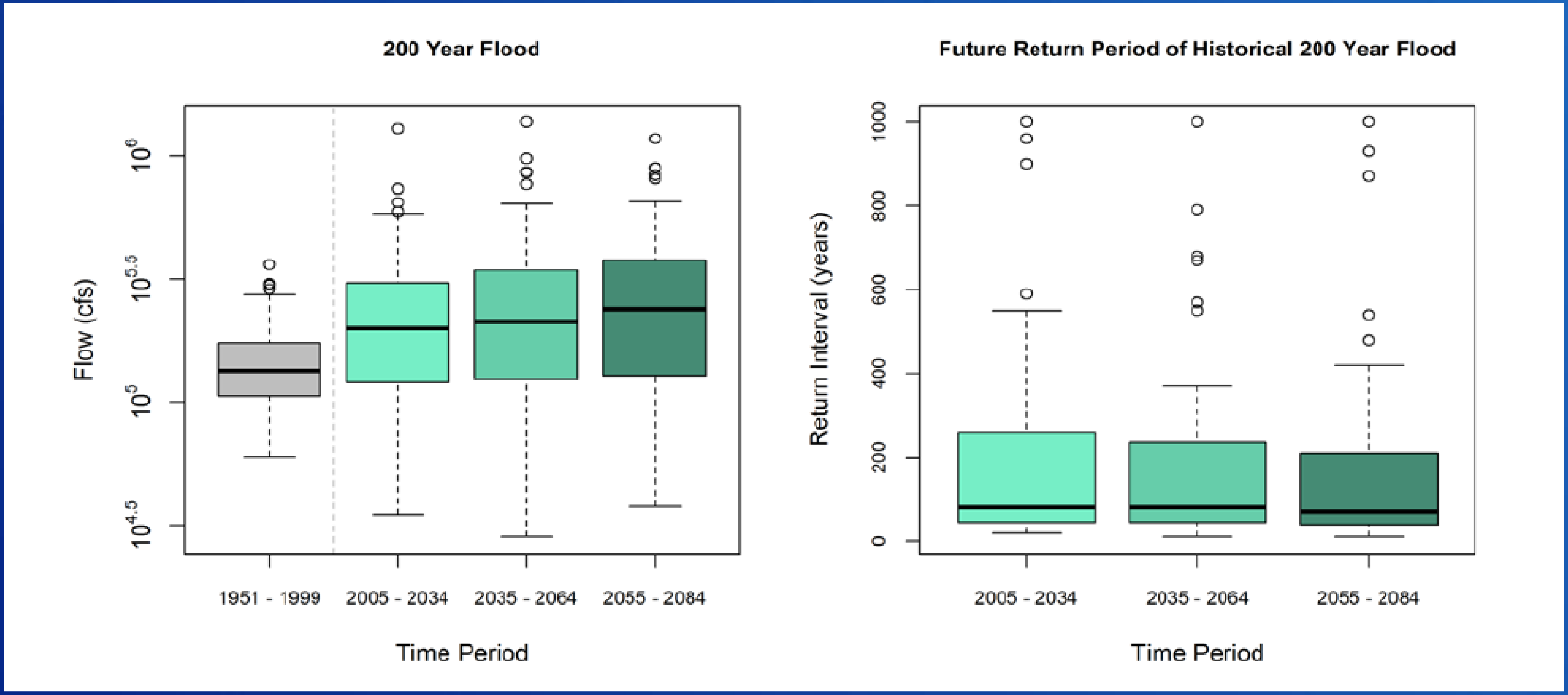
Climate Change Analysis: Impacts Assessment



Station	Time Period	Percentile		
		25%	50%	75%
Prado Dam	Historical	106,289	134,170	174,018
	2020	120,616	199,623	302,401
	2050	124,369	212,392	335,621
	2070	129,706	239,359	377,660

A 200 year historical event is likely to be closer to a 100 year event in the future.

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SAWPA Frequently Asked Questions:

Climate and Flood Frequency in the Santa Ana River Watershed

SAWPA

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Results

Will floods become more severe and threaten flood infrastructure?

Key Findings

- Simulations indicate a significant increase in flow for 200-year storm events in the future.
- Similarly the likelihood of experiencing what was historically a 200-year event will nearly double (i.e. the 200-year historical event is likely to be closer to a 100-year event in the future).
- Findings indicate an increased risk of severe floods in the future.
- There is large variability between climate simulations.
- Although there are clear trends in the median values, the range of flows is also large.

Additional Considerations

- Results are demonstrated for the Prado Dam gage but they can be easily replicated for other locations.
- Future work should expand this analysis to consider floods of different return periods as well as longer flood durations.
- Pearson Log III distributions were fit for this analysis. However, other extreme value functions may also be relevant (e.g. distributions with time varying parameters).

Link to full technical report: www.u

Climate and Forest Ecosystems

SAWPA

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Key Findings

- Warmer temperatures will likely cause Jeffrey pines to move to higher elevations and may decrease their total habitat.
- Forest health my also be influenced by changes in the magnitude and frequency of wildfires or infestations.
- Alpine ecosystems are vulnerable to climate change because they do not have the ability to expand to higher elevations.
- Across the state it is projected that alpine forests will decrease in area by 50-70% by 2100.

Additional Considerations

- The rate of climate change determines how quickly ecosystems must adept, and influences the total impact.
- There is significant uncertainty about the role of increased CO_2 levels on forest productivity.
- In general predictions about forest productivity are uncertain and will rely mainly on future precipitation.
- Most available research has focused on the state of California as a whole and no studies explicitly consider the future of Jeffery pines or alpine ecosystems within the SAWPA area.

Results

Projected climate change impacts on forest ecosystems:

While there is significant variability between climate change scenarios, all projections include increased temperature and increased levels of atmospheric carbon dioxide. As a result, the following general trends are predicted:

- Warmer temperatures will cause trees to move northward and to higher elevations
- Changes in total forest cover for California are projected by one study to range from a 25% decrease to a 23% increase by 2100 (Lenihan et al., 2008)
- Species with the smallest geographical and climate ranges are expected to be the most vulnerable to change
- Extended droughts and earlier snowmelt could cause fire seasons to start earlier and last longer (California, 2010)
- Temperature increases may change the frequency and magnitude of pest infestations such as the pine beetle

Alpine/Subalpine Forest, Conifer Forest, Mixed Evergreen Forest, Mixed Evergreen Woodland, Grassland, Shrubland, Desert; PCM1-A2, GFDL-B2, GFDL-A2; Change in Total Cover (%)

Figure 1 - Fig. 4 from Lenihan et al. 2008. Percent change in total land cover for vegetation classes by 2100 for three climate change scenarios predicted using the MC1 Dynamic Vegetation Model.

How will the Jeffrey pine ecosystem be impacted?

The Jeffery pine is a high altitude coniferous evergreen tree that can occupy a range of sites and climate conditions (Moore, 2006). Based on the general trends noted above it is likely that the Jeffery Pines will migrate to higher elevations and some lower elevation forest area will be lost. Several studies predict that warming temperatures will result in the displacement of evergreen conifer forests by mixed evergreen forests across California (Hayhoe et al., 2004; California, 2010). However, no study has explicitly considered the migration of the Jeffery pine. Given its versatility it is possible that impacts to the Jeffery pine may be less than some other species.

Will the Region continue to support an alpine climate in the local mountains?

Alpine ecosystems are particularly vulnerable to increased temperatures because their habitat range is already limited and they cannot shift to higher elevations. One study projects that Alpine and subalpine forests will decrease in area by 50-70% by 2100 (Hayhoe et al., 2004).

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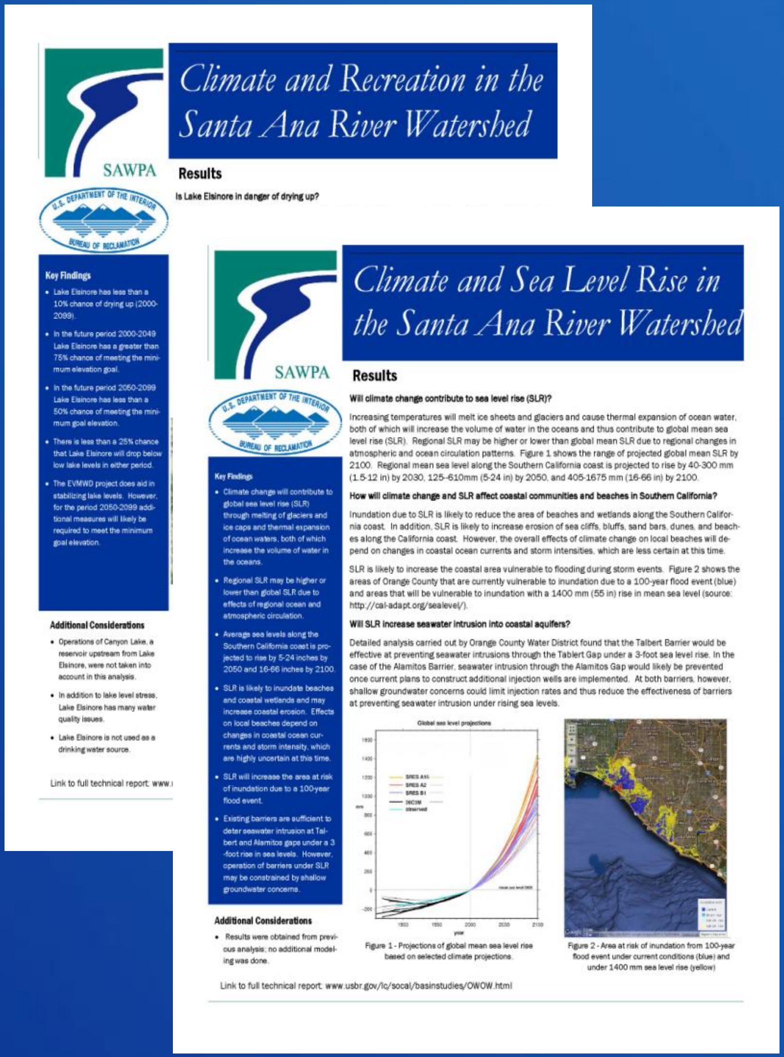
Moore, L. M. 2006. *Jeffrey Pine Plant Guide*. United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)

Link to full technical report: www.usbr.gov/lc/socal/basinstudies/OWOW.html



Climate and Recreation in the Santa Ana River Watershed

SAWPA

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Results

Is Lake Elsinore in danger of drying up?

Key Findings

- Lake Elsinore has less than a 10% chance of drying up (2000-2099).
- In the future period 2000-2049 Lake Elsinore has a greater than 75% chance of meeting the minimum elevation goal.
- In the future period 2050-2099 Lake Elsinore has less than a 50% chance of meeting the minimum goal elevation.
- There is less than a 25% chance that Lake Elsinore will drop below low lake levels in either period.
- The EVMWD project does aid in stabilizing lake levels. However, for the period 2050-2099 additional measures will likely be required to meet the minimum goal elevation.

Additional Considerations

- Operations of Canyon Lake, a reservoir upstream from Lake Elsinore, were not taken into account in this analysis.
- In addition to lake level stress, Lake Elsinore has many water quality issues.
- Lake Elsinore is not used as a drinking water source.

Link to full technical report: www.

Climate and Sea Level Rise in the Santa Ana River Watershed

SAWPA

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Key Findings

- Climate change will contribute to global sea level rise (SLR) through melting of glaciers and ice caps and thermal expansion of ocean waters, both of which increase the volume of water in the oceans.
- Regional SLR may be higher or lower than global SLR due to effects of regional ocean and atmospheric circulation.
- Average sea levels along the Southern California coast is projected to rise by 5-24 inches by 2050 and 16-66 inches by 2100.
- SLR is likely to inundate beaches and coastal wetlands and may increase coastal erosion. Effects on local beaches depend on changes in coastal ocean currents and storm intensity, which are highly uncertain at this time.
- SLR will increase the area at risk of inundation due to a 100-year flood event.
- Existing barriers are sufficient to deter seawater intrusion at Talbert and Alamitos gaps under a 3-foot rise in sea levels. However, operation of barriers under SLR may be constrained by shallow groundwater concerns.

Additional Considerations

- Results were obtained from previous analysis; no additional modeling was done.

Results

Will climate change contribute to sea level rise (SLR)?

Increasing temperatures will melt ice sheets and glaciers and cause thermal expansion of ocean water, both of which will increase the volume of water in the oceans and thus contribute to global mean sea level rise (SLR). Regional SLR may be higher or lower than global mean SLR due to regional changes in atmospheric and ocean circulation patterns. Figure 1 shows the range of projected global mean SLR by 2100. Regional mean sea level along the Southern California coast is projected to rise by 40-300 mm (1.5-12 in) by 2030, 125-610mm (5-24 in) by 2050, and 405-1675 mm (16-66 in) by 2100.

How will climate change and SLR affect coastal communities and beaches in Southern California?

Inundation due to SLR is likely to reduce the area of beaches and wetlands along the Southern California coast. In addition, SLR is likely to increase erosion of sea cliffs, bluffs, sand bars, dunes, and beaches along the California coast. However, the overall effects of climate change on local beaches will depend on changes in coastal ocean currents and storm intensities, which are less certain at this time.

SLR is likely to increase the coastal area vulnerable to flooding during storm events. Figure 2 shows the areas of Orange County that are currently vulnerable to inundation due to a 100-year flood event (blue) and areas that will be vulnerable to inundation with a 1400 mm (55 in) rise in mean sea level (source: http://cal-adapt.org/sealevel/).

Will SLR increase seawater intrusion into coastal aquifers?

Detailed analysis carried out by Orange County Water District found that the Talbert Barrier would be effective at preventing seawater intrusions through the Tablert Gap under a 3-foot sea level rise. In the case of the Alamitos Barrier, seawater intrusion through the Alamitos Gap would likely be prevented once current plans to construct additional injection wells are implemented. At both barriers, however, shallow groundwater concerns could limit injection rates and thus reduce the effectiveness of barriers at preventing seawater intrusion under rising sea levels.

Global sea level projections; SRES A1B, SRES A2, SRES B1, 20C3M, observed; year

Figure 1 - Projections of global mean sea level rise based on selected climate projections.

Figure 2 - Area at risk of inundation from 100-year flood event under current conditions (blue) and under 1400 mm sea level rise (yellow)

Link to full technical report: www.usbr.gov/lc/socal/basinstudies/OWOW.html

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Frequently Asked Questions Cont.:

Climate and Snowpack at Big Bear

SAWPA

U.S. DEPARTMENT OF THE INTERIOR — BUREAU OF RECLAMATION

Results

Will skiing at Big Bear be sustained?

Key Findings

- Simulations indicate significant decreases in April 1st snowpack that amplify throughout the 21st century.
- Warmer temperatures will also result in a delayed onset and shortened ski season.
- Lower elevations are most vulnerable to increasing temperatures.
- Both Big Bear and Snow Summit lie below 3,000 m and are projected to experience declining snowpack that could exceed 70% by 2070.

Additional Considerations

- Downscaled climate variables can be biased and there is significant variability between projections. For example, note that the low sensitivity low emissions scenario in Figure 2 projects only a 20% decrease in snowpack by 2070 while the other scenarios project greater than 70% decreases.
- The grid resolution for both methodologies is 1/8th degree which is much larger than either ski area. Therefore, results have been averaged over the ski area in addition to surrounding areas at lower elevation.

Link to full technical report: www.

Climate and Temperature in the Santa Ana River Watershed

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Results

How many more days over 95°F are expected in Anaheim, Riverside and Big Bear City?

Figure 1 shows the distribution of the annual number of days above 95°F from 1950-2099 for each city for all 112 climate projections. As shown here, there is a clearly increasing trend in the number of days above 95°F for all three locations. Riverside has the most days followed by Anaheim. Big Bear City has the least number of days with a median of zero for all years prior to about 2030. The red shading in Figure 1 shows the range of the 112 climate projections and demonstrates a large spread in projected results. Table 1 summarizes the median number of days above 95°F for each location for the historical time period (1951-1999) and three 30-year future time periods centered around 2020, 2050 and 2070. As shown in Table 1 the number of days increases for all stations as you move further into the future. Changes are quite significant; for example, the median value for Anaheim quadrupled from 4 to 16 days between the historical time period and 2070. Similarly the median value for Riverside nearly doubled between the historical time period and 2070, going from 43 to 82 days.

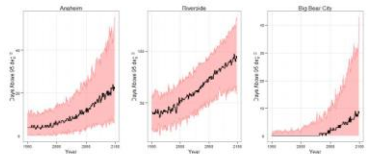

Figure 1 - Projected annual number of days above 95°F. Solid black line is the median and the red shading denotes the 5th and 95th percentile bounds

	Historical	2020	2050	2070
Anaheim	4	7	12	16
Riverside	43	58	72	82
Big Bear City	0	0	2	4

Table 1 - Median annual number of days above 95°F for one historical (1951-1999), and three future (2005-2034, 2035-2064, 2055-2084) time periods

Key Findings

- All the climate projections clearly demonstrate increasing temperature trends.
- Increasing temperatures will result in a greater number of days above 95°F in the future.
- The number of days above 95°F progressively increases for all stations as you move further into the future.
- By 2070 it's projected that the number of days above 95°F will quadruple in Anaheim and nearly double in Riverside. Big Bear City is projected to increase from 0 days historically to 4 days in 2070.
- Although there are clear trends in the median values, the spread of results (shown by the red shading in Figure 1) is also quite large.

Additional Considerations

- Results are shown for the single grid cell where the city is located. Additional analysis could consider regionally averaged temperature trends.
- Downscaled climate variables can be biased. Reported temperature values were not bias corrected to match projected historical values to local temperature gages.

Methods

Daily maximum temperature values came from the BCSD-CMIP3 archive for 112 climate projections. Each projection has 1/8° x 1/8° (~12 km x 12km) grid cell daily forcings that start on January 1, 1950 and run to December 31, 2099. For this analysis the location of each city was matched to the single grid cell that contains it. Results summarize temperature trends for all 112 projections from 1950 to 2099 for the selected grid cell.

Link to full technical report at: www.usbr.gov/lc/socal/basinstudies/OWOW.html

Climate and Water Supply in the Santa Ana River Watershed

SAWPA

U.S. DEPARTMENT OF THE INTERIOR — BUREAU OF RECLAMATION

Results

Will surface water supply decrease?

Key Findings

- Annual surface water is likely to decrease over the future periods.
- Precipitation shows somewhat long-term decreasing trends.
- Temperature will increase, which may cause increased water demand and reservoir evaporation.
- April 1st SWE will decrease.

Additional Considerations

- VIC was an existing model and no refinements were made for this analysis.
- The model is calibrated to reproduce monthly to annual runoff in large sub-basins.
- These models have biases, and are best used for relative change.

Link to full technical report: www

Climate and Groundwater Supply in the Santa Ana River Watershed

SAWPA

U.S. DEPARTMENT OF THE INTERIOR — BUREAU OF RECLAMATION

Results

Will climate change reduce groundwater availability in the Santa Ana watershed?

Future groundwater availability in the Santa Ana watershed will depend on future recharge from precipitation, stream seepage, and managed infiltration facilities, as well as future groundwater withdrawals to for municipal, industrial, and agricultural uses. A groundwater screening tool was developed to evaluate changes in basin-scale groundwater conditions under climate change. Projected increases in temperature and decreases in precipitation will result in increased water demands and decreased groundwater recharge, respectively. Management actions will be required to protect groundwater resources under projected future climate conditions.

Figure 1 illustrates the observed range of basin-averaged groundwater levels in the Orange County groundwater basin for 1990-2009, along with simulated groundwater levels under projected climate conditions. In the absence of groundwater management actions, groundwater levels are projected to decline significantly over the 21st century. It should be noted that projected declines are not constrained by the physical limits of the aquifer—i.e., projected declines may exceed the actual amount of usable groundwater in the basin.

The groundwater screening tool can be used to evaluate potential deficiencies in future supplies and to develop sustainable management alternatives. As an example, potential actions to avoid projected water level declines in Orange County are listed below. Each alternative listed will protect against groundwater declines through 2060. The groundwater screening tool can be used to develop and compare additional management alternatives.

Projected Impacts of Climate Change on Orange County

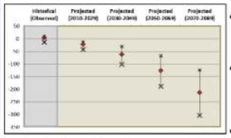

Figure 1 - Range of observed and simulated basin-averaged groundwater elevations for 1990-2009 and projected groundwater elevations for future periods assuming no management action to avoid groundwater deficits

Groundwater Management Alternatives to Offset Projected Impacts of Orange County Groundwater

- **Reduce M&I demand**
  Gradual reduction of approx. 15% by 2020 (i.e., reduce per capita use from ~175 gpd in 2010 to ~150 gpd by 2020)
- **Increase imports from Colorado River and SWP**
  Gradual increase in water imports from Colorado River and SWP from ~30,000 AF/yr to ~105,000 AF/yr by 2020 (this may not be feasible due to cost, greenhouse gas emissions, or availability)
- **Increase local water supplies**
  Increase local water supplies by ~75,000 AF/yr through increasing recycled water treatment capacity, development of seawater desalination capacity, and increasing stormwater capture efficiency

Key Findings

- Groundwater currently provides approximately 54% of total water supply in an average year, and groundwater use is projected to increase over the next 20 years.
- Projected decreases in precipitation and increases in temperature will decrease natural recharge throughout the basin.
- Management actions such as reducing municipal and industrial water demands or increasing trans-basin water imports will be required in order to maintain current groundwater levels.
- A basin-scale groundwater screening tool was developed to facilitate analysis of basin-scale effects of conservation, increasing imported supply, changing agricultural land use, and other factors impacting basin-scale groundwater conditions.

Additional Considerations

- Basin-scale groundwater conditions are an important consideration in basin management; however, local-scale groundwater conditions must be considered in evaluating individual projects.
- The groundwater screening tool does not reflect physical constraints on groundwater use, including the usable amount of groundwater available and decreases in pumping as groundwater levels decline.

Methods

A basin-scale groundwater screening tool was developed to facilitate evaluation of basin-averaged groundwater elevations under projected future climate conditions. The tool uses a multiple regression approach to estimate fluctuations in basin-averaged groundwater elevations in response to natural and anthropogenic drivers, including climate and hydrologic conditions, agricultural land use, municipal water demand, and trans-basin water imports. The tool allows users to quickly calibrate a regression model for a basin of interest, estimate basin-scale groundwater conditions under future scenarios, and compare management alternatives to protect groundwater resources under climate change.

Link to full technical report: www.usbr.gov/lc/socal/basinstudies/OWOW.html

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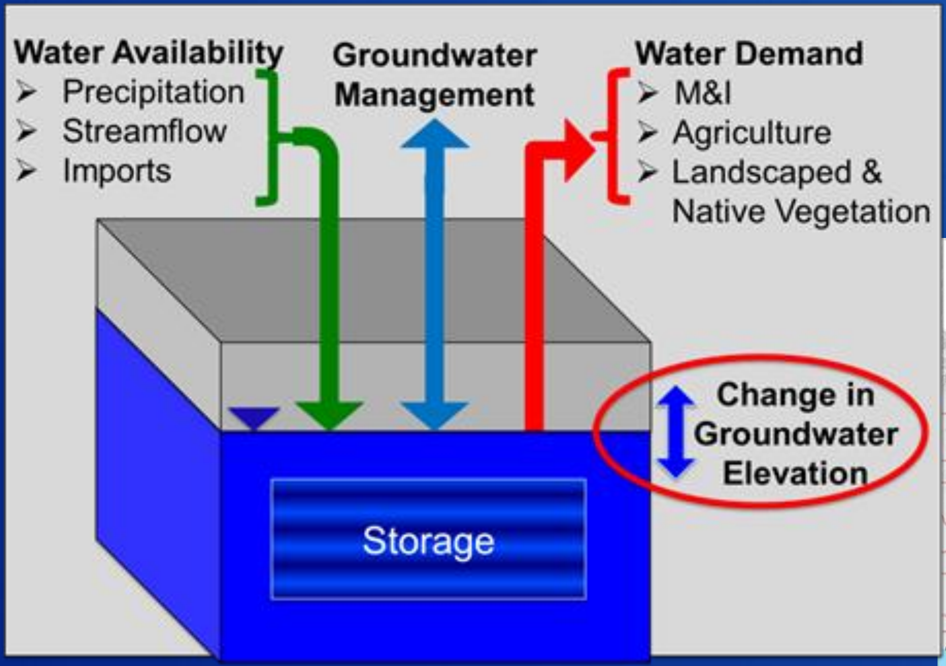
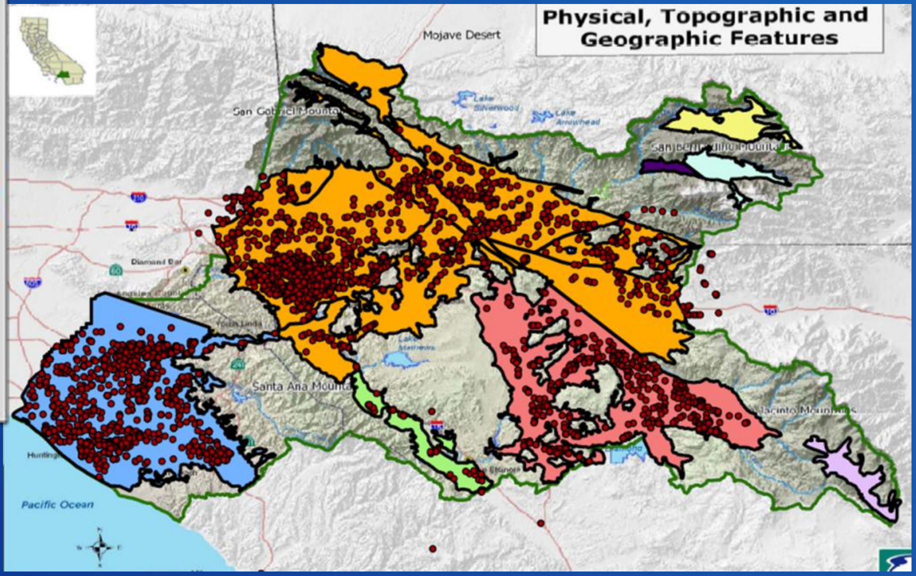
Climate Change Analysis: Groundwater Screening Tool





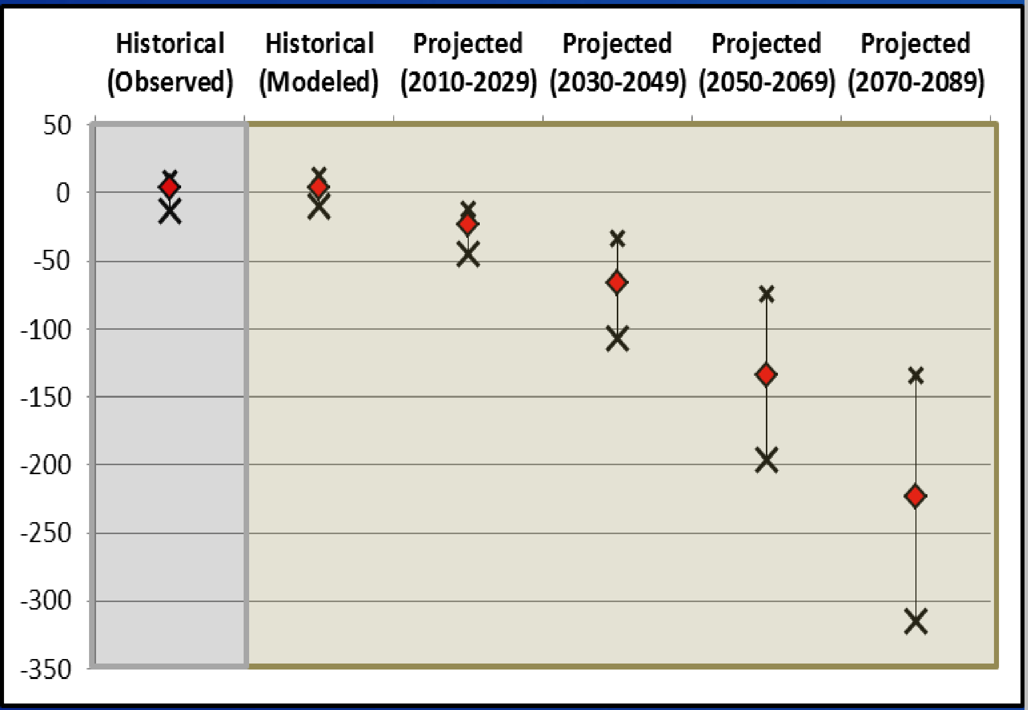
Groundwater Screening Tool:

- **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?**

Groundwater Screening Tool:

Orange County Coastal Plain Groundwater Basin



<u>Conservation</u>

Gradual reduction of approx. 15% by 2020

(reduce per capita use from ~175 gpd to ~150 gpd)

<u>Imported Water</u>

Gradual increase in water imports from Colorado River and/or SWP

(increase from ~30,000 AF/yr to ~105,000 AF/yr

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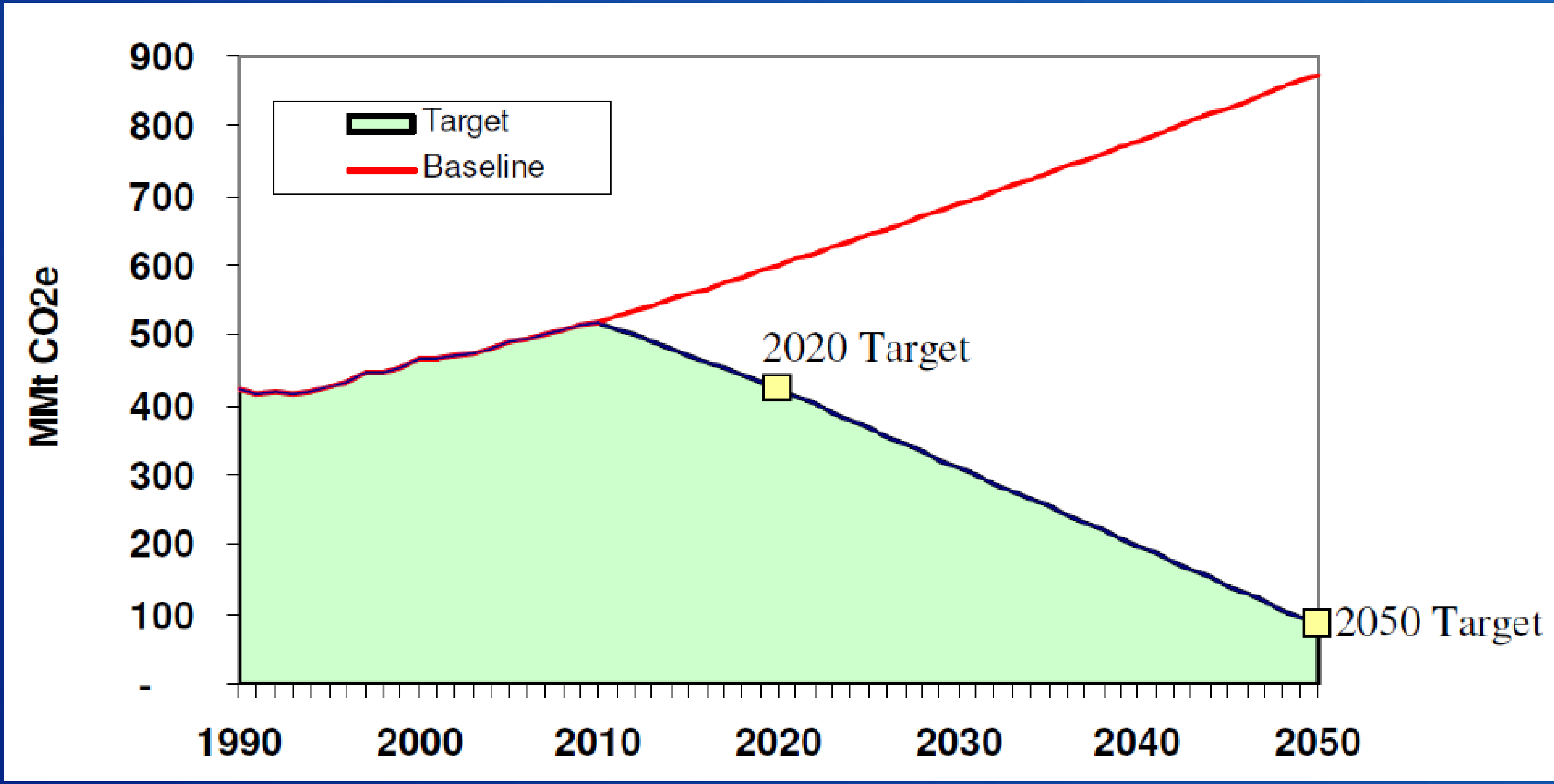
Greenhouse Gas Emissions (GHG) Calculator for the Water Sector:



AB32 legislation to reduce GHG emissions

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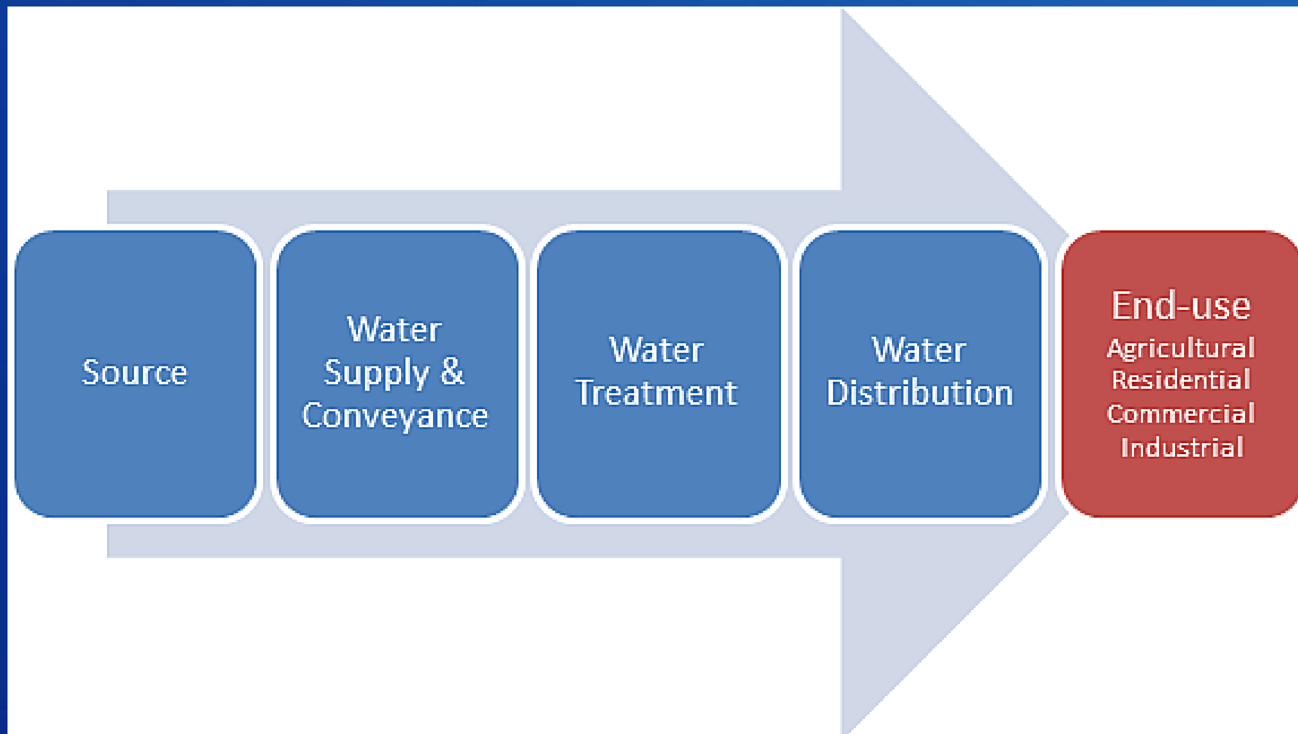
GHG Calculator for the Water Sector:



$$\text{Annual } CO_2e \text{ emissions} = \text{Extraction} + \text{Conveyance} + \text{Treatment} + \text{Distribution}$$

GHG Calculator for the Water Sector:

Final Values for Computation of Total Annual Emissions

	Groundwater (gpd)	Surface Water (gpd)	Groundwater Intensity (KWh/MG)	Supply & Conveyance Intensity (KWh/MG)	Treatment Intensity (KWh/MG)	Distribution Intensity (KWh/MG)	Electricity Emission Factors (kg CO2 eq./MWh)	Annual Groundwater Extraction Emissions (mtCO2e)	Annual Conveyance Emissions (mtCO2e)	Annual Treatment Emissions (mtCO2e)	Annual Distribution Emissions (mtCO2e)	Total Annual Emissions (mtCO2e)
1990	343,504,230	82,441,015	540	8900	496	1200	307.9	20,845	82,454	23,756	57,440	184,495
2000	405,596,183	97,343,084	540	8900	496	1200	307.9	24,613	97,358	28,050	67,823	217,844
2010	428,958,060	102,949,934	540	8900	496	1200	307.9	26,031	102,966	29,666	71,729	230,392
Current	435,443,663	104,506,479	540	8900	496	1200	307.9	26,424	104,523	30,115	72,814	233,875
2020	521,038,724	125,049,294	540	8900	496	1200	307.9	31,618	125,069	36,034	87,126	279,848
2030	561,755,948	134,821,427	540	8900	496	1200	307.9	34,089	134,842	38,850	93,935	301,717
2040	582,194,580	139,726,699	540	8900	496	1200	307.9	35,330	139,748	40,264	97,353	312,694
2050	625,432,500	150,103,800	540	8900	496	1200	307.9	37,953	150,127	43,254	104,583	335,917

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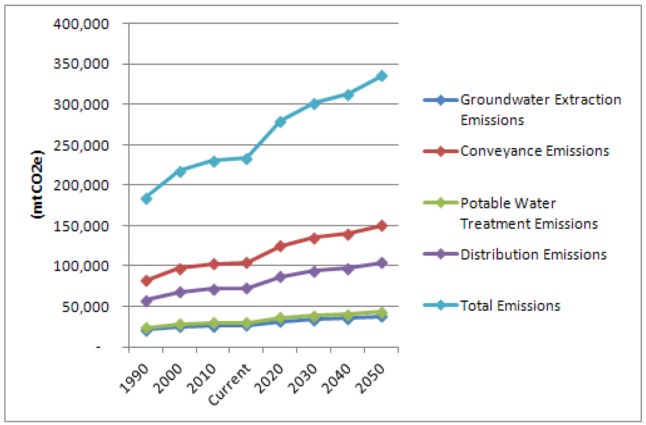

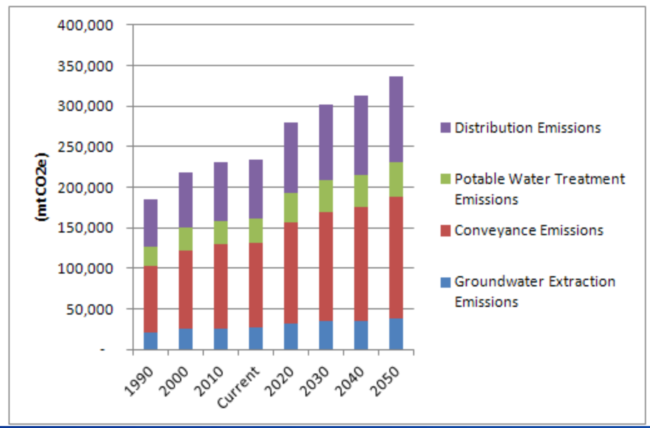

Export Results

Scenario Name: 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 2: Click on export results.

- AB 32 compliance
- Evaluates both supply and demand
- Can be used with any level of data
- Scenario analysis

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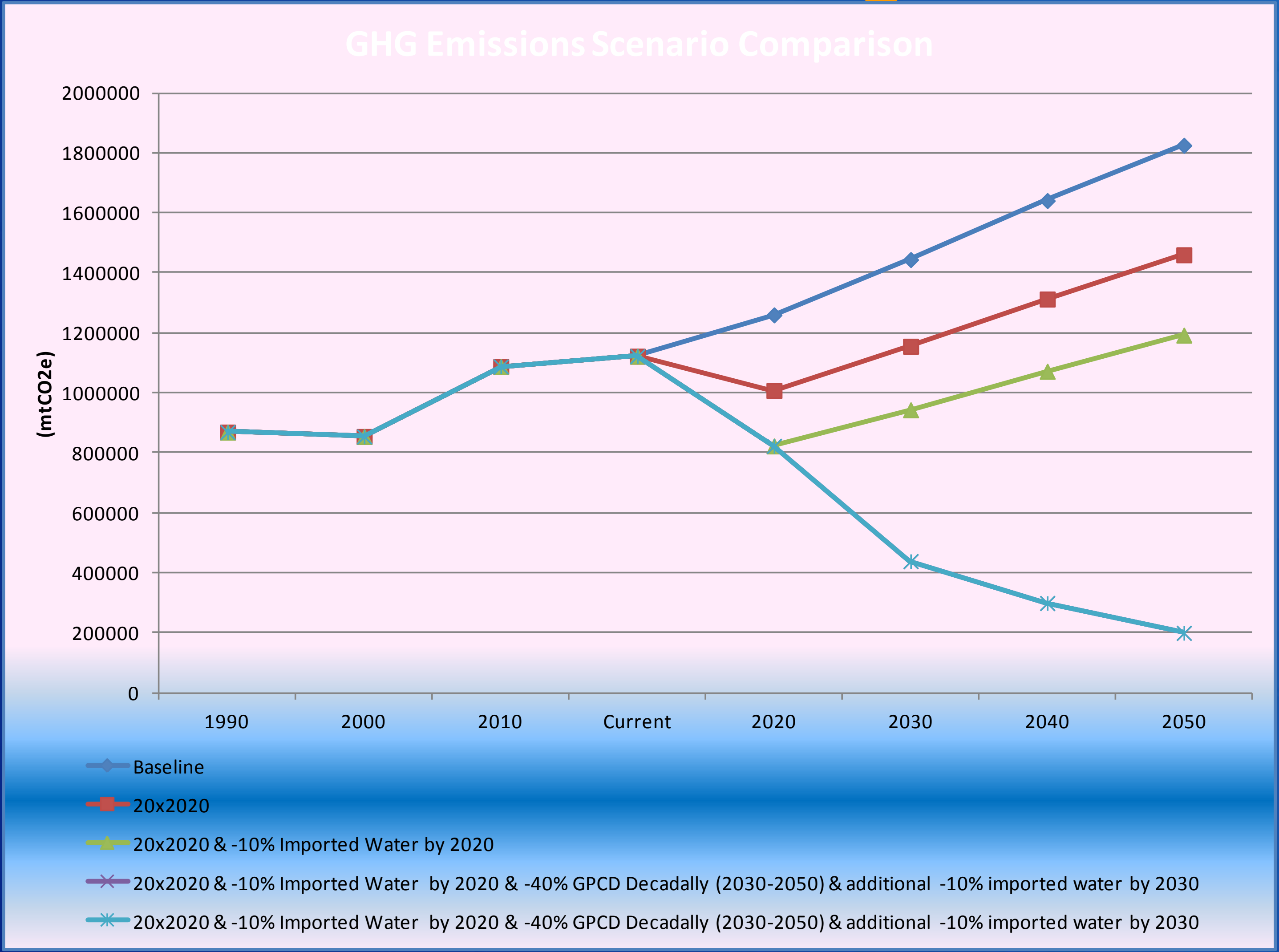
GHG Emissions Calculator Scenario Manager:



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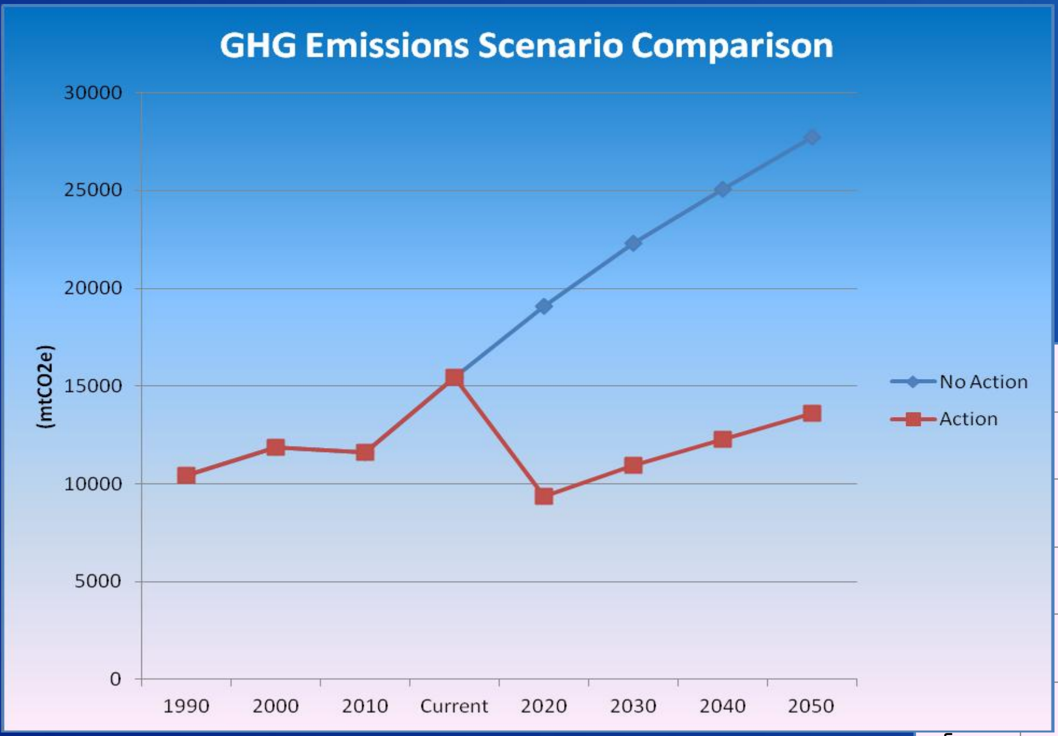
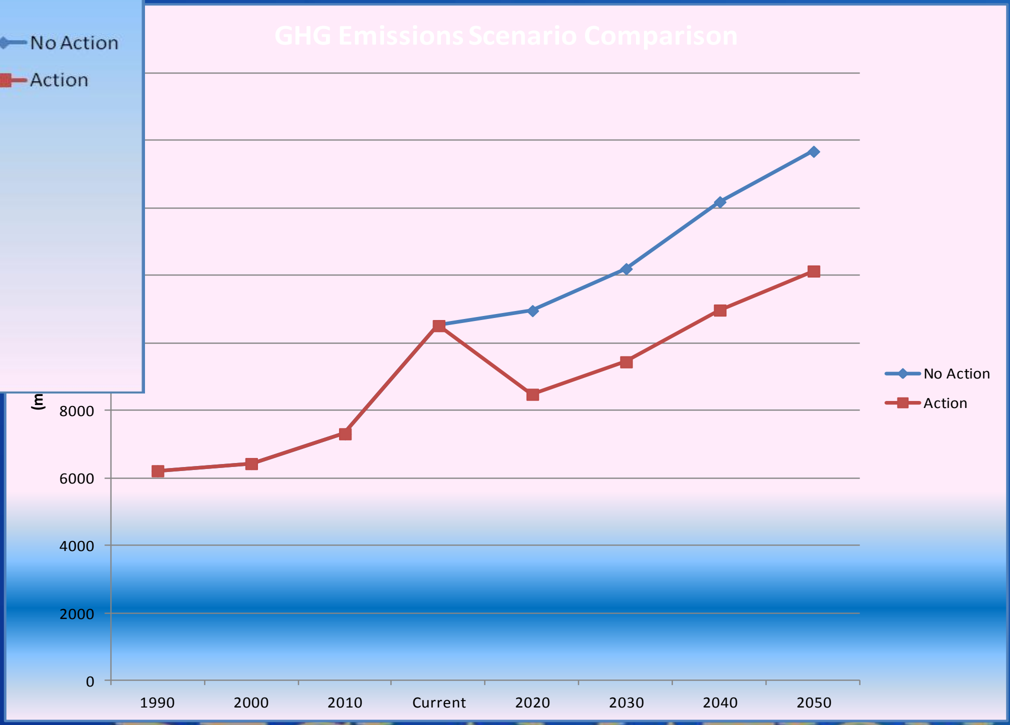
GHG Emissions Calculator
Project Analysis:



Aquifer Recharge Project

Landscape Water Use Efficiency Handbook



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Climate Analysis: Reports

RECLAMATION
Managing Water in the West

Technical Memorandum No. 86-68210-2013-02

Climate Change Analysis for the Santa Ana River Watershed

Santa Ana Watershed Basin Study, California
Lower Colorado Region

U.S. Department of the Interior
Bureau of Reclamation

August 2013

RECLAMATION
Managing Water in the West

Technical Memorandum No. 86-68210-2013-03

Greenhouse Gas Emissions Calculator for the Water Sector: User's Manual

Santa Ana Watershed Basin Study, California
Lower Colorado Region

U.S. Department of the Interior
Bureau of Reclamation

August 2013

Uncertainty Discussions:

- Global Climate Model Forcings;
- Global Climate Model Simulation;
- Climate Projection Bias;
- Spatial Downscaling;
- Watershed Vegetation Changes;
- Impacts Assessment Models; and
- Other approaches to analyzing impacts.

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Thank You!

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