RECLAMATION

Managing Water in the West

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

SAWPA - 4/11/2013

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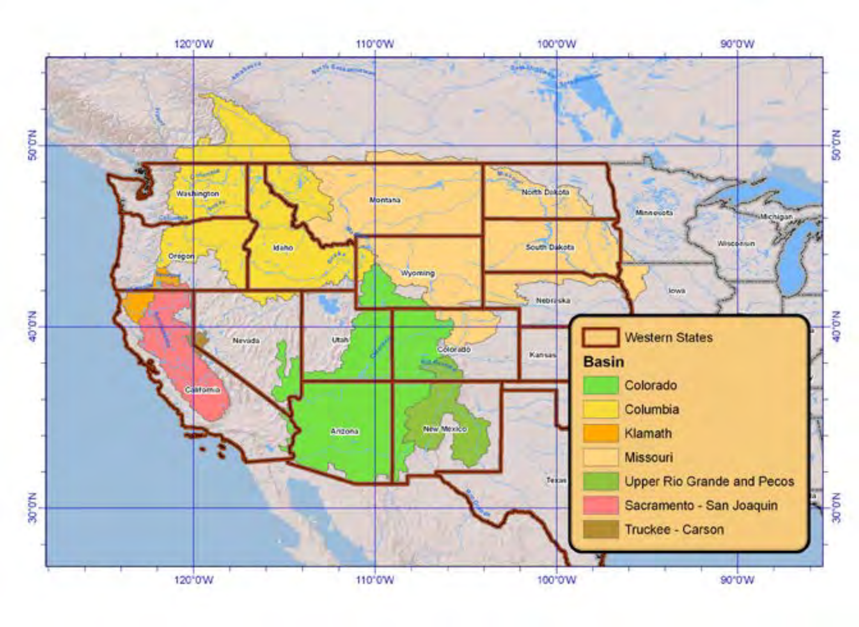
Bureau of Reclamation

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)**



8 major Reclamation River Basin

SECURE – Science and Engineering to Comprehensively Understand and Responsibly Enhance

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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**

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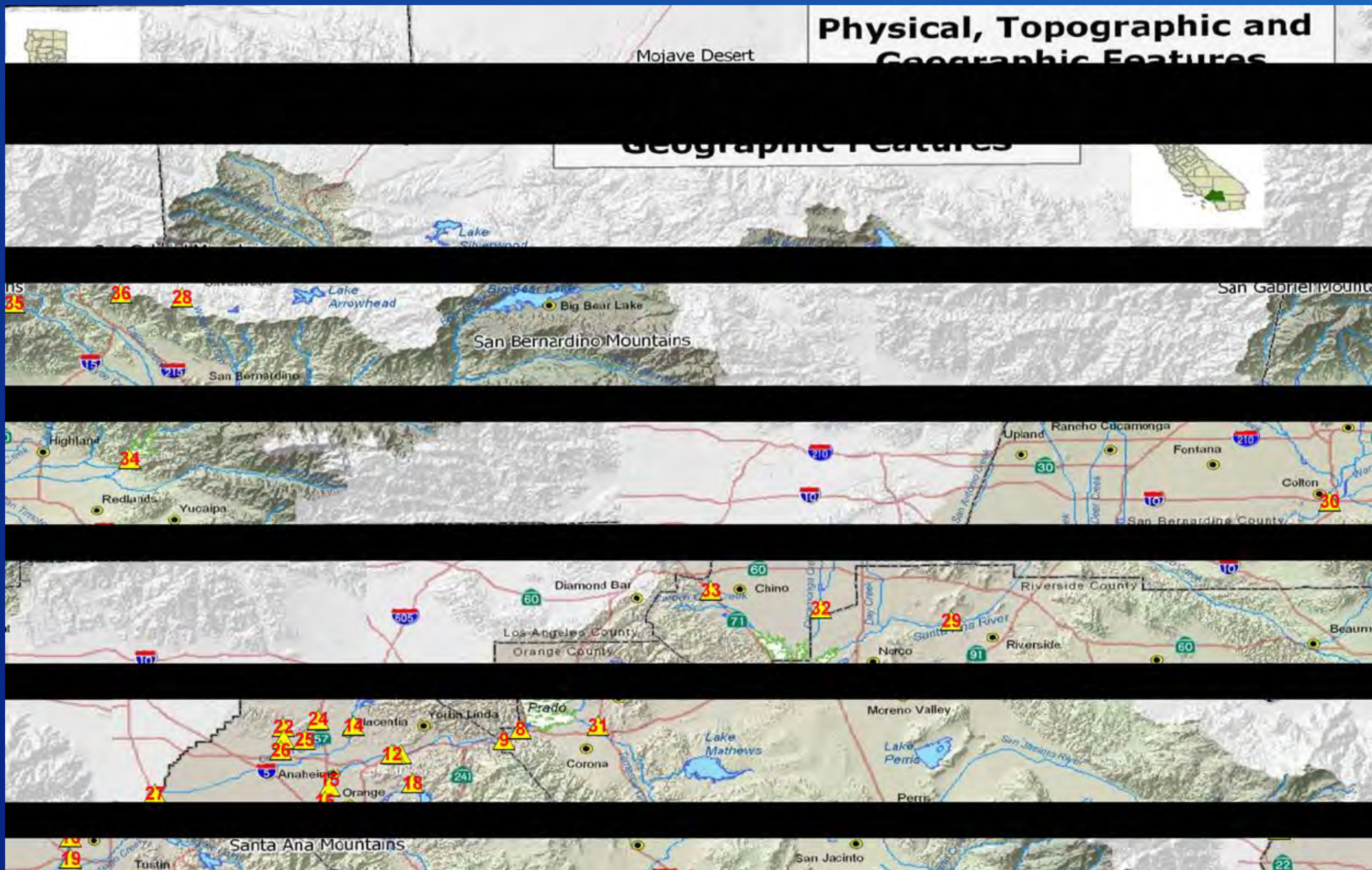
Santa Ana Watershed



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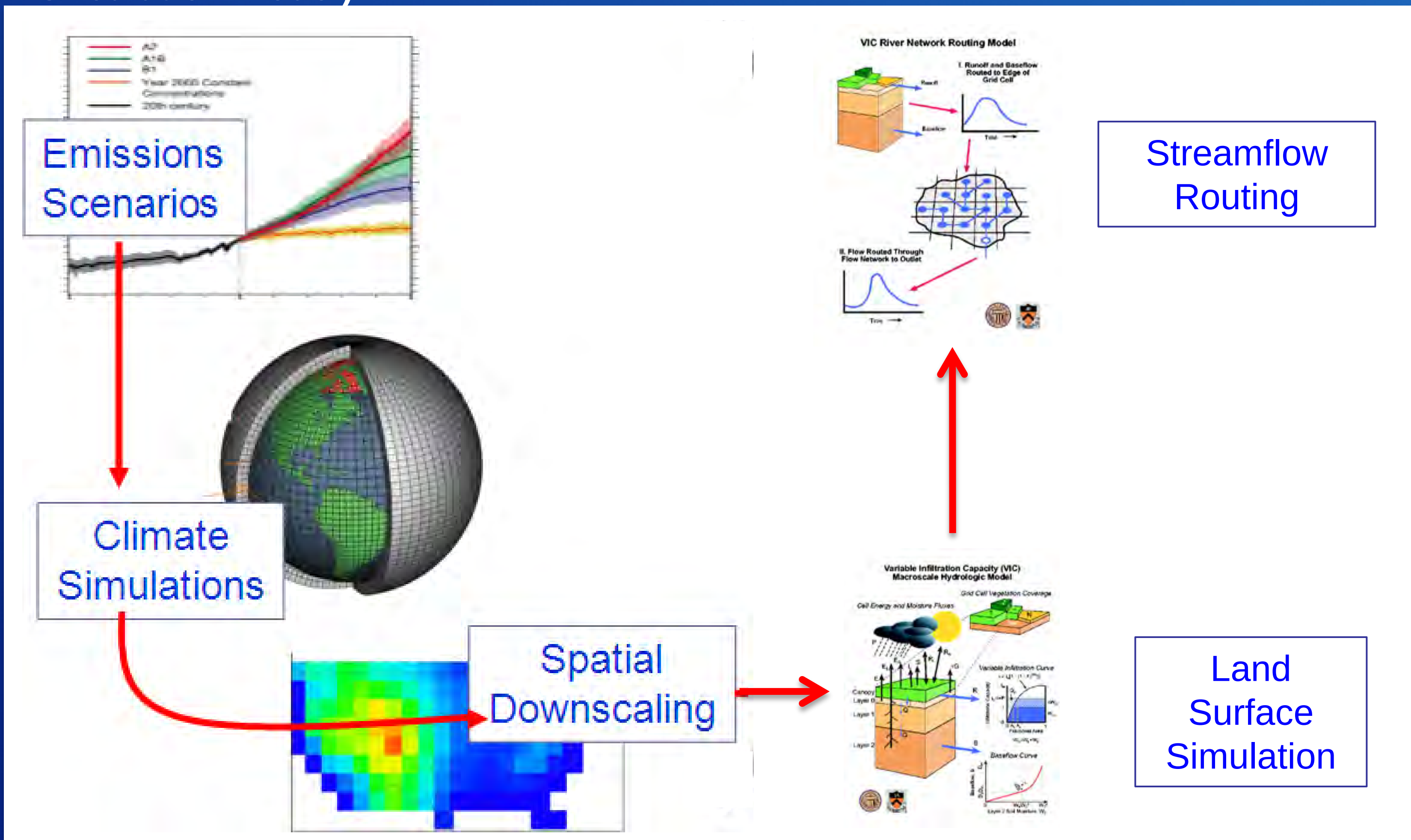
Outline

- 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)

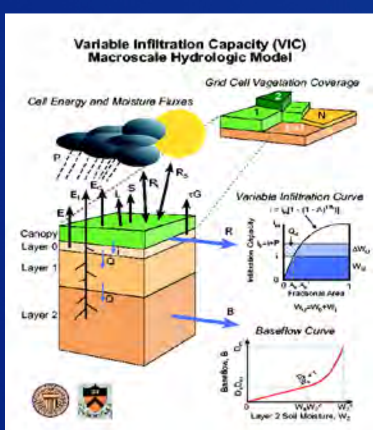


West-Wide Climate Risk Assessments (WWCRA) - Hydrologic Projections (2011)

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

112 Transient Hydrologic Projections covering western U.S.…

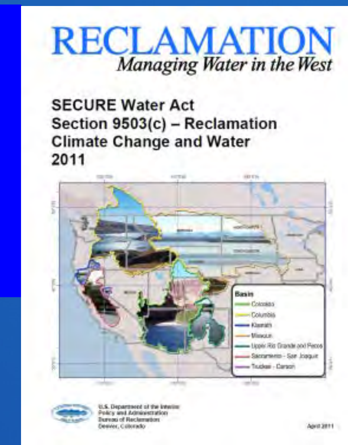
8 “big basin” VIC hydrology model-apps from Univ. of WA…

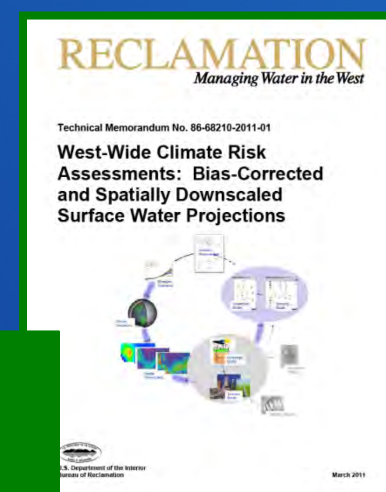


Data-service, Reclamation and broader public use

Analyses of Period-changes in climate and hydrology

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





Technical Report, data-development (TSC 86-68210, March 2011)

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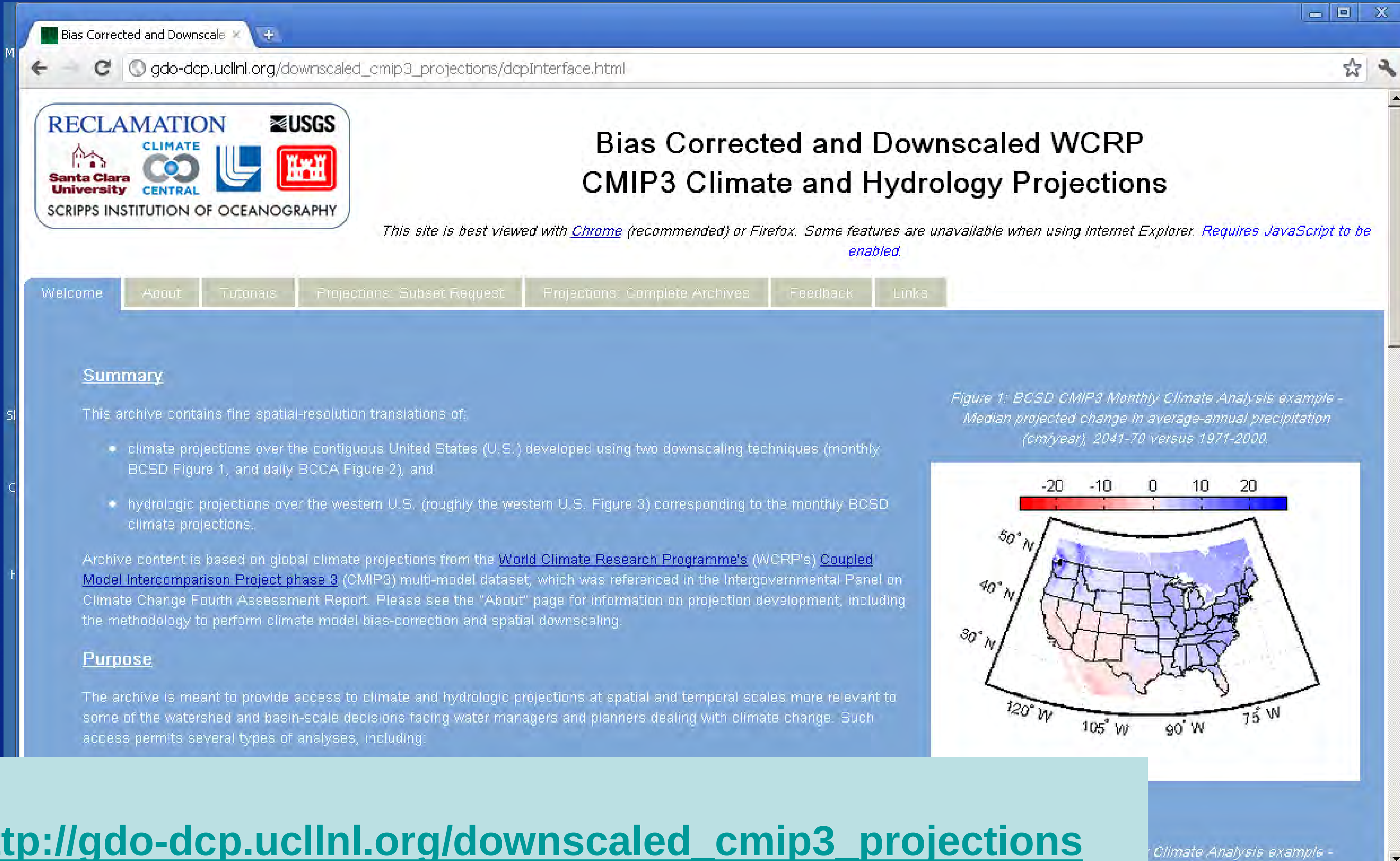
http://www.usbr.gov/WaterSMART/ ; http://www.usbr.gov/climate/

Online Data Access



http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections

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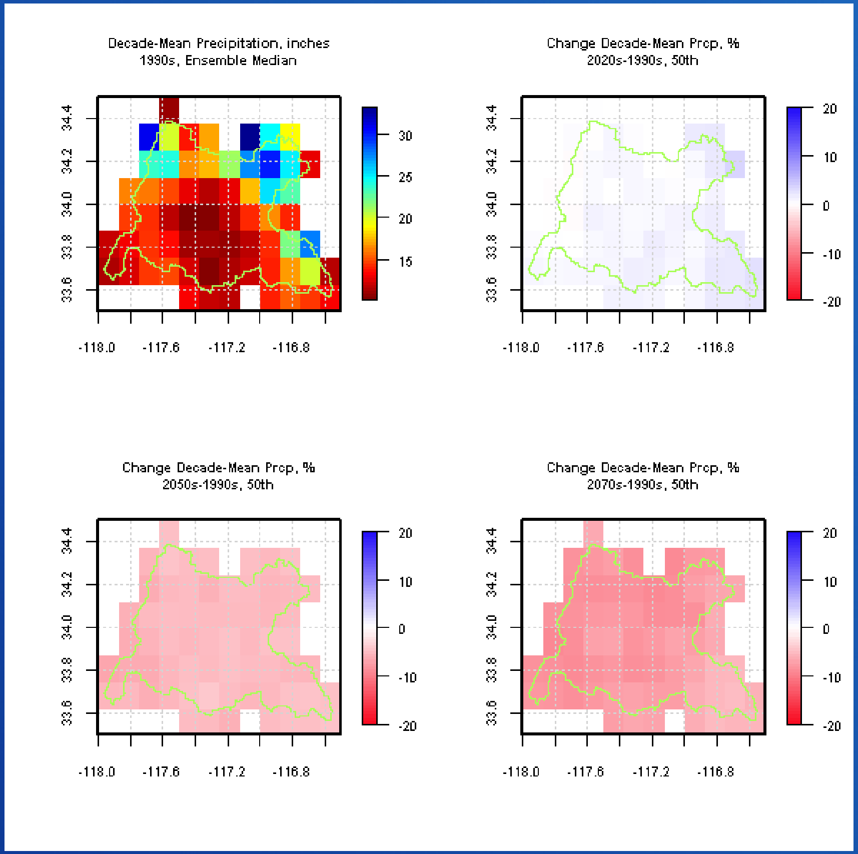
Hydrology Projections
Spatial Distribution of Precipitation (P)

- 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.



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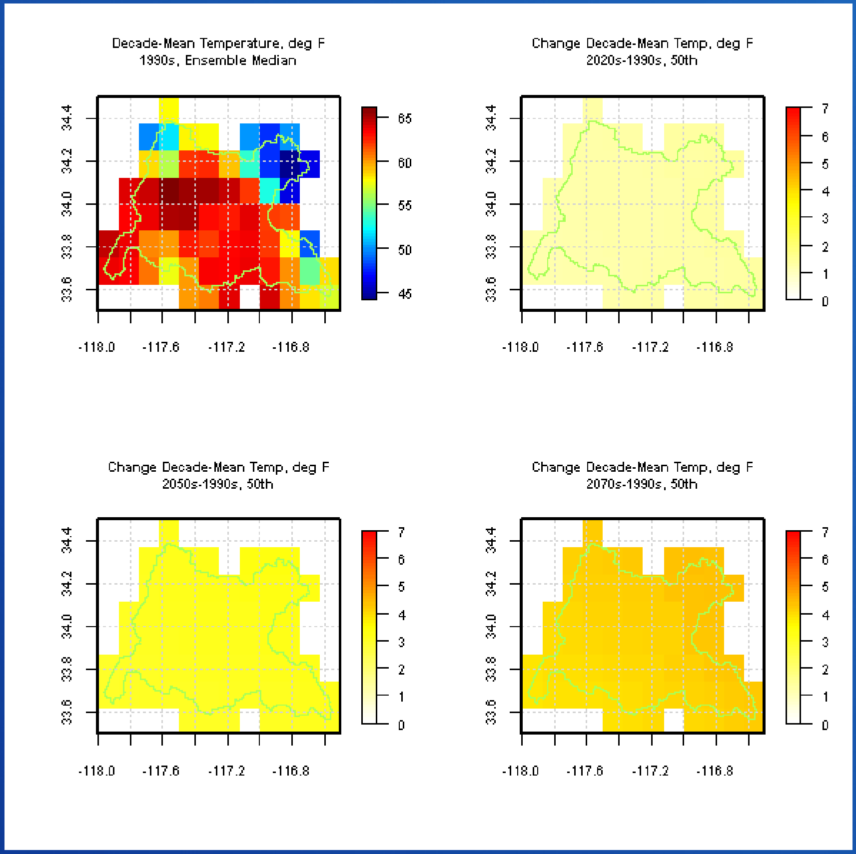
Hydrology Projections Spatial Distribution of Temperature (T)

- **The ensemble median change for the 2020s', 2050s', and 2070s' decades relative to the 1990s shows an increasing temperature value throughout the Basin.**



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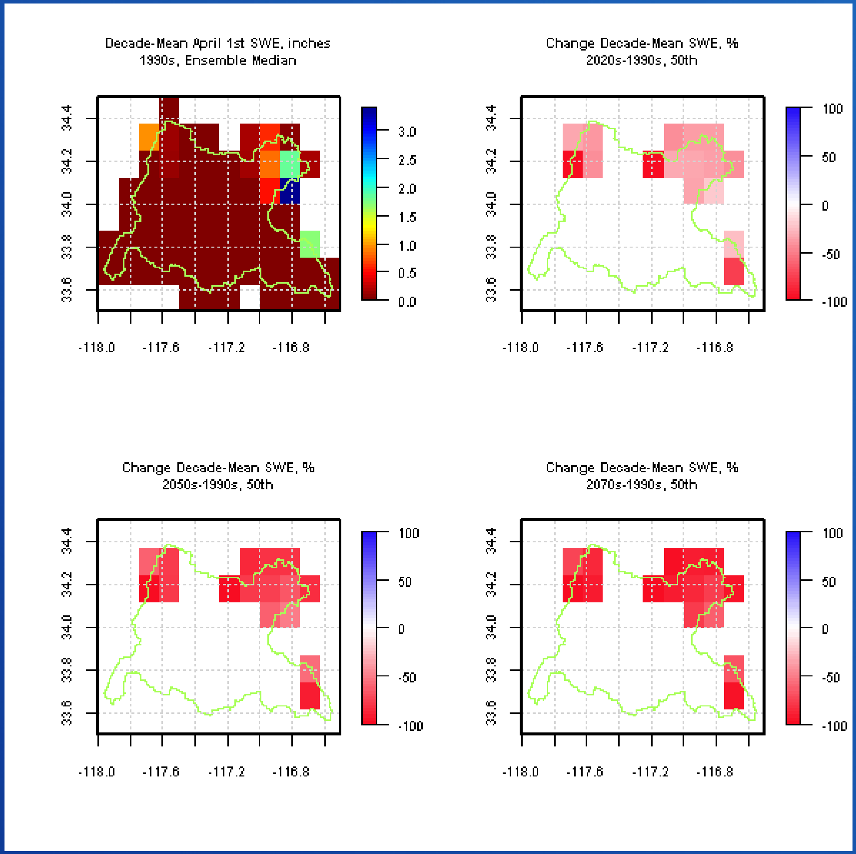
Hydrology Projections
Snow Water Equivalent (SWE)

- **Spatial distribution of April 1st SWE – persistent decline through the future decades (2020s, 2050s, 2070s) from the 1990s' distribution.**



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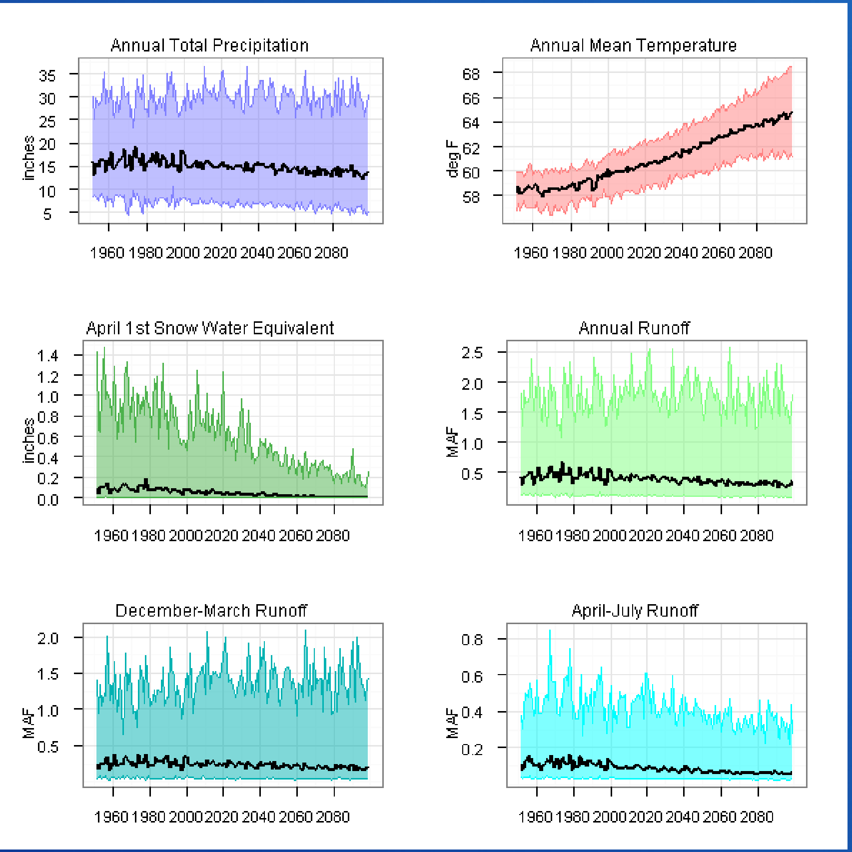
Hydrology Projections
P, T, SWE, Flow

- **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**



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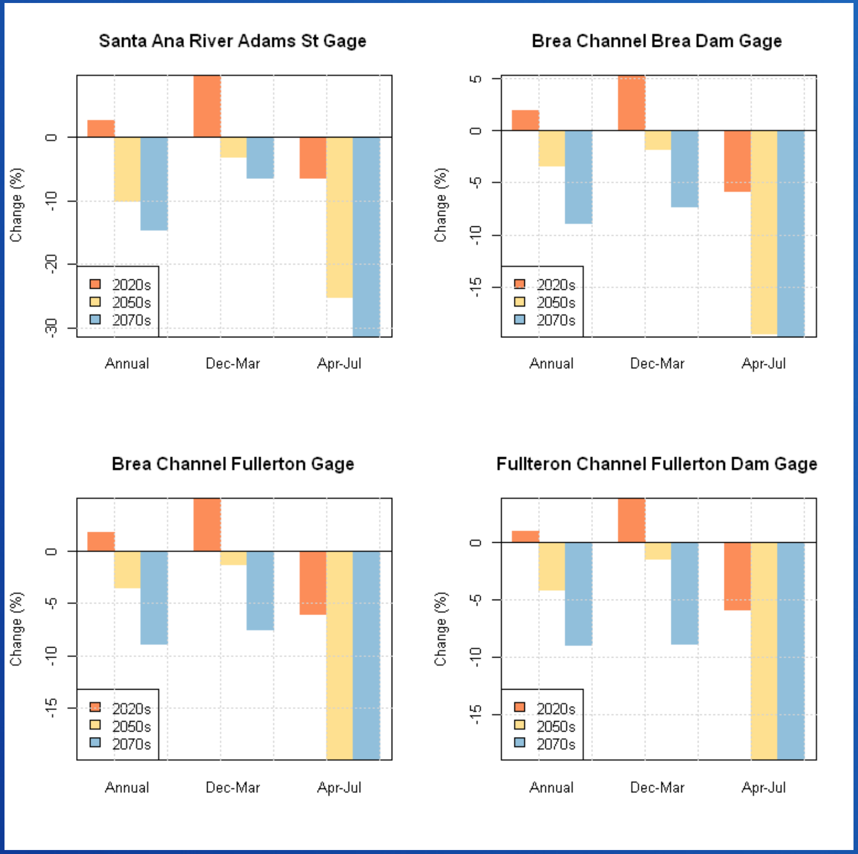
Hydrology Projections Flow Impacts

- 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



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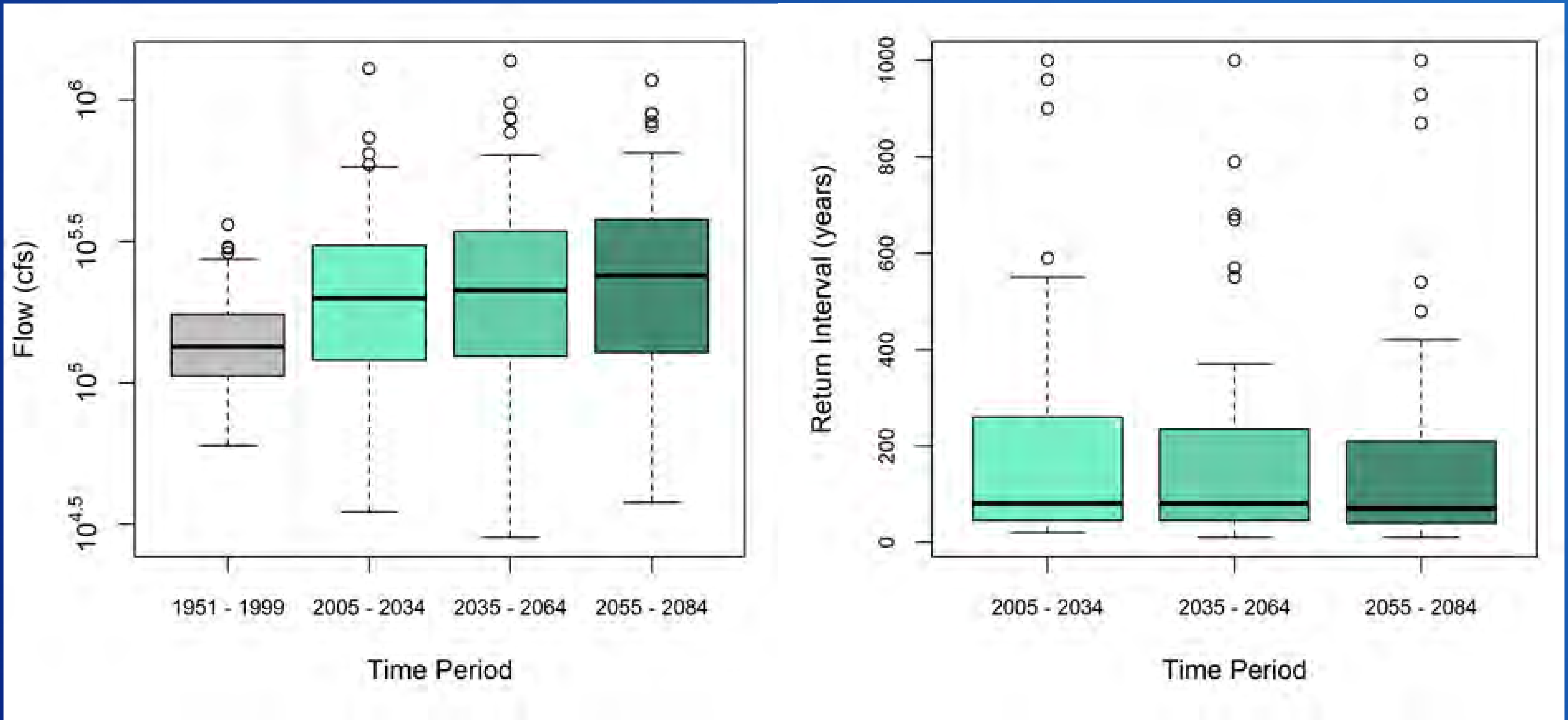
Summary of Impacts
Santa Ana River Adams St. Gage

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

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**

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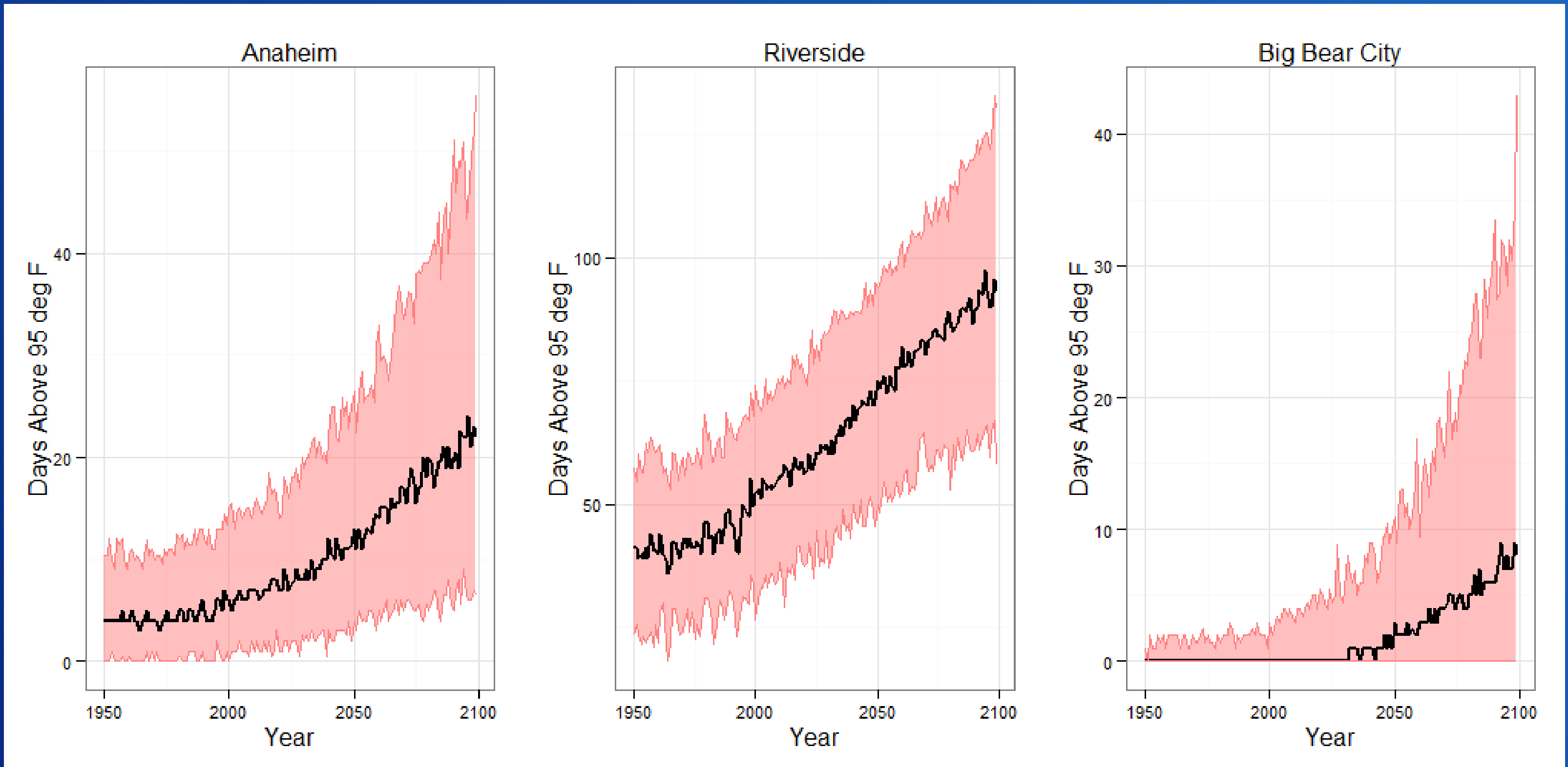
Days above 95ºF



	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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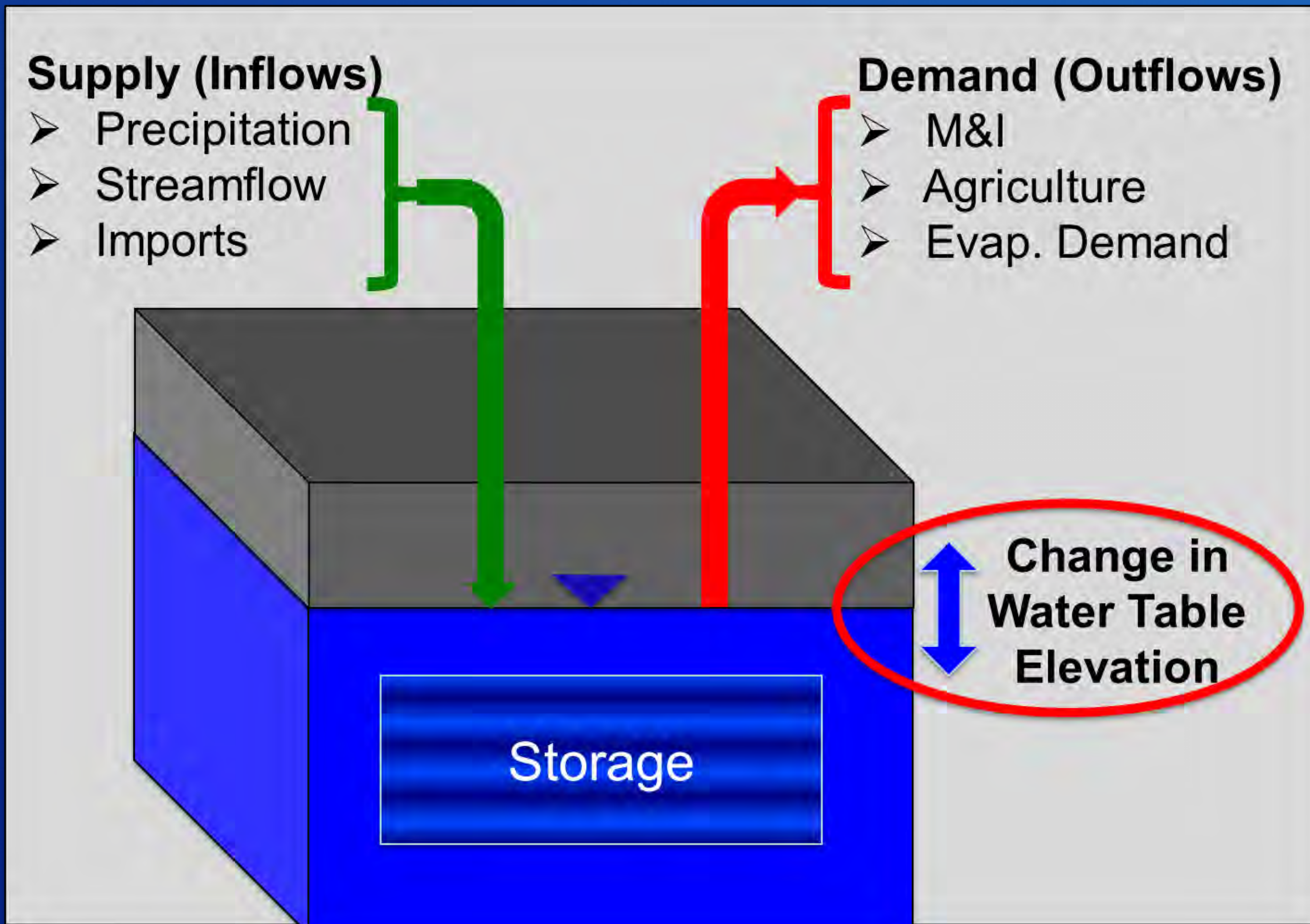
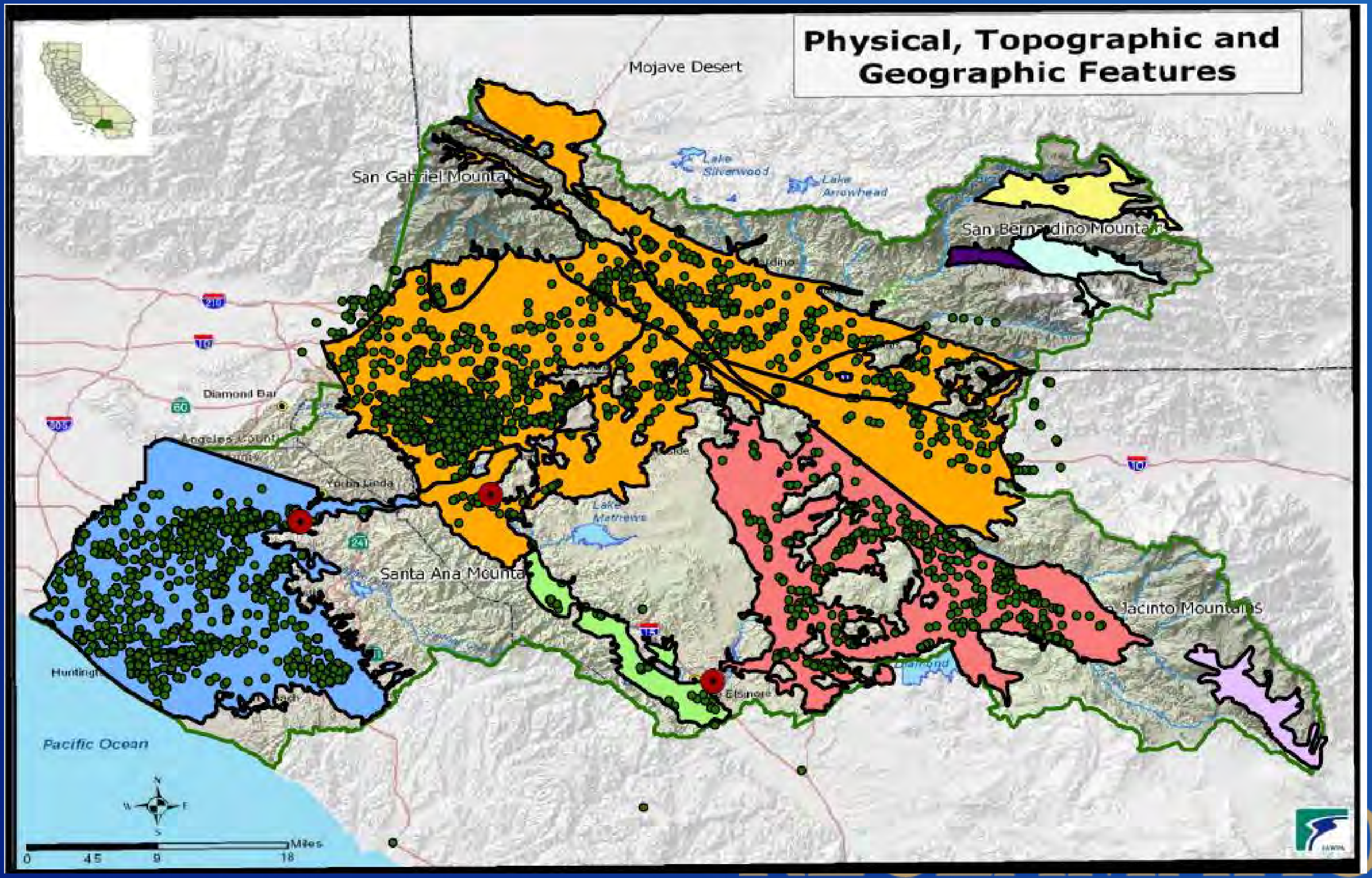
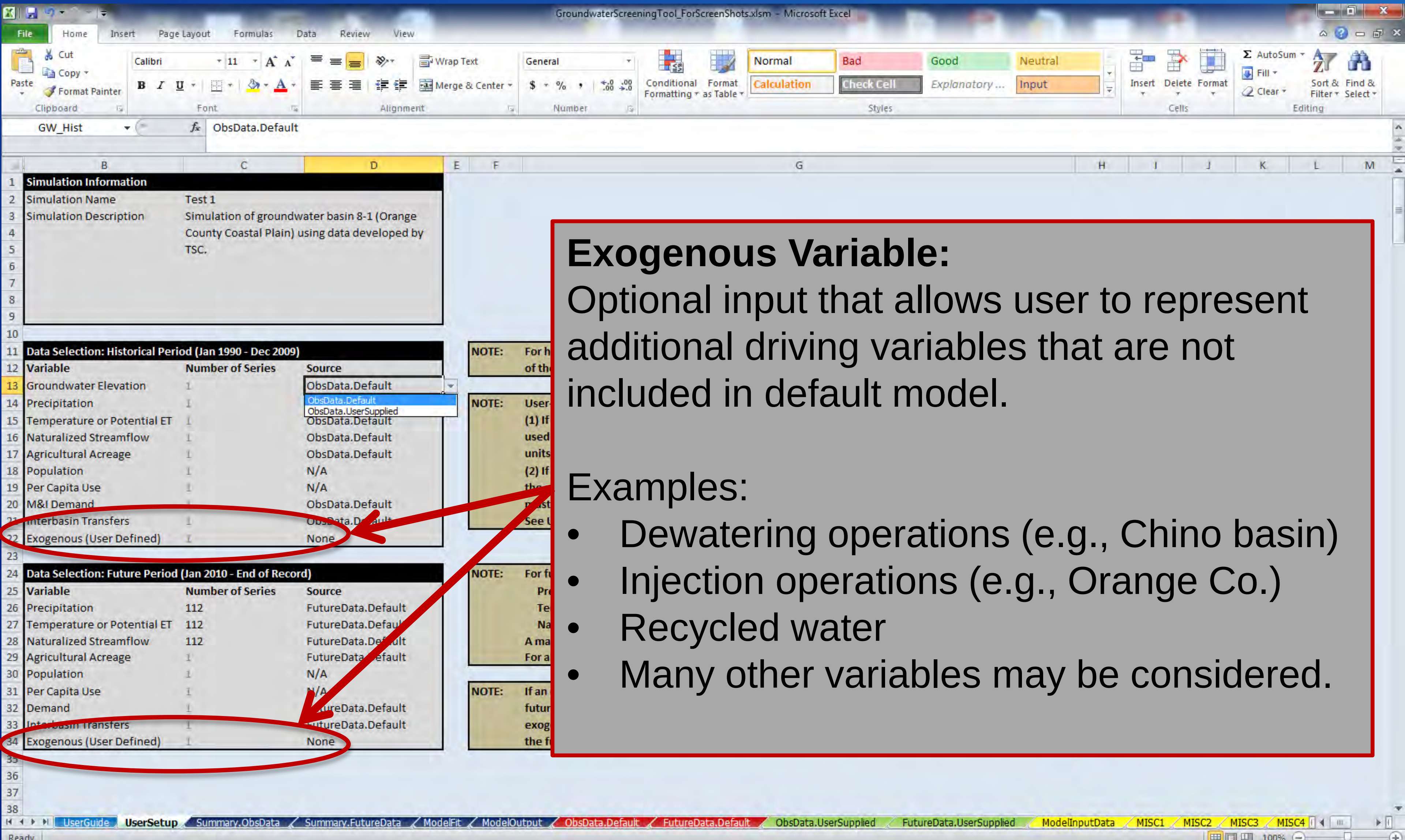
SAWPA Groundwater Screening Tool



SAWPA Groundwater Screening Tool



SAWPA Groundwater Tool



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.

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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 <u>not</u> 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

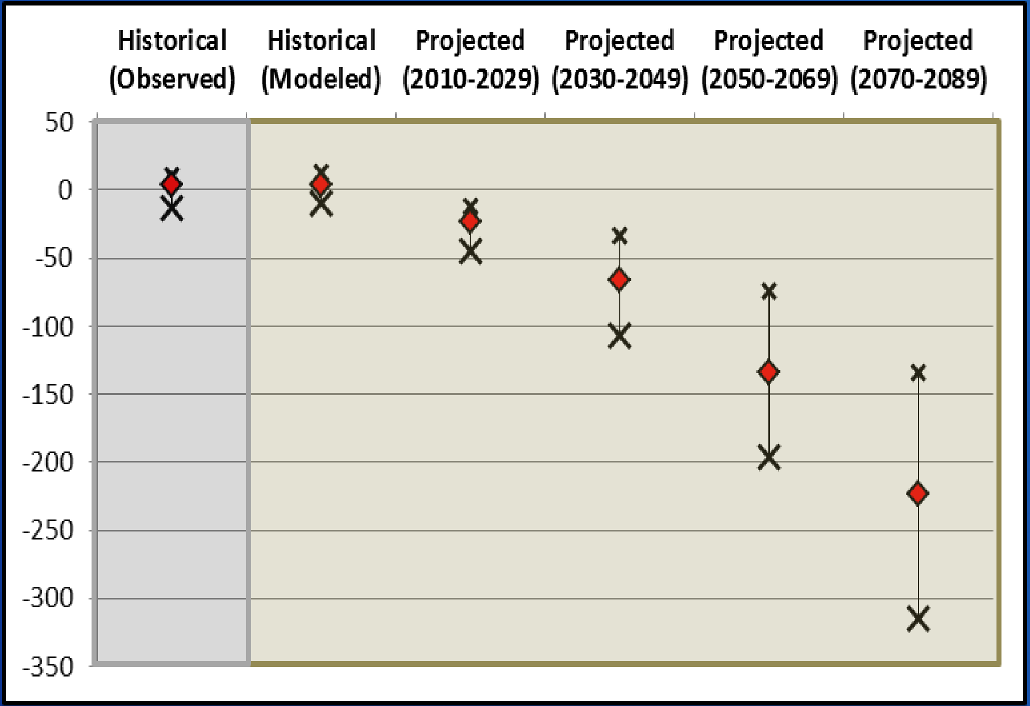
- **Will a 10% reduction in M&I demand offset the impacts of climate change in my groundwater basin?**

- **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***



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SAWPA Groundwater Screening Tool

- **Example:**
  Orange County Coastal Plain Groundwater Basin

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

Conservation	Imported Water
Gradual reduction of approx. 15% by 2020 (reduce per capita use from ~175 gpd to ~150 gpd)	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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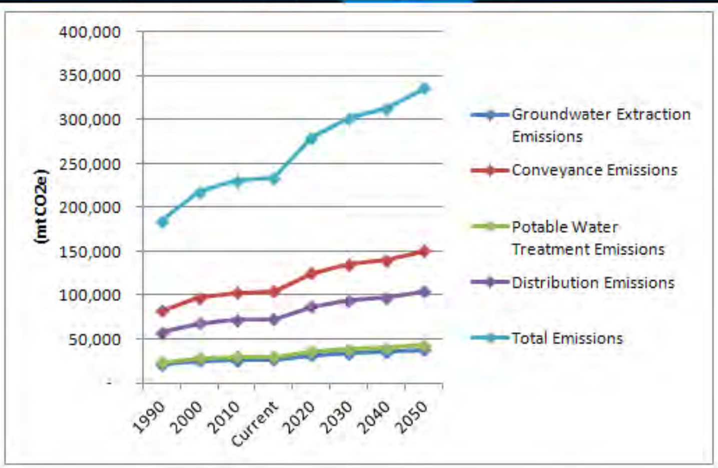
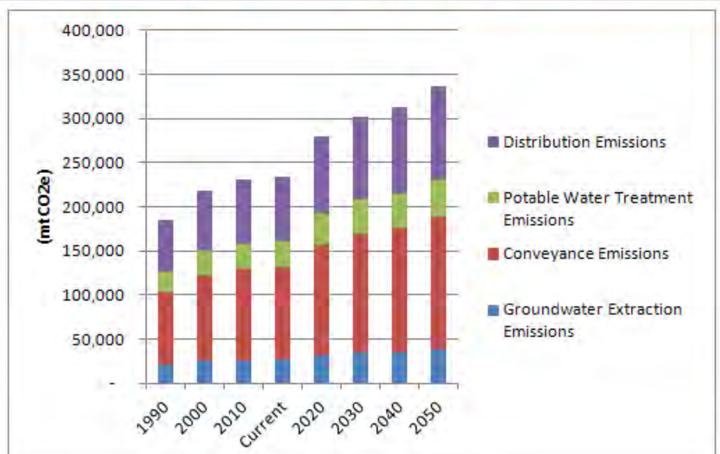
Greenhouse Gas Emissions Calculator for the Water Sector

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.

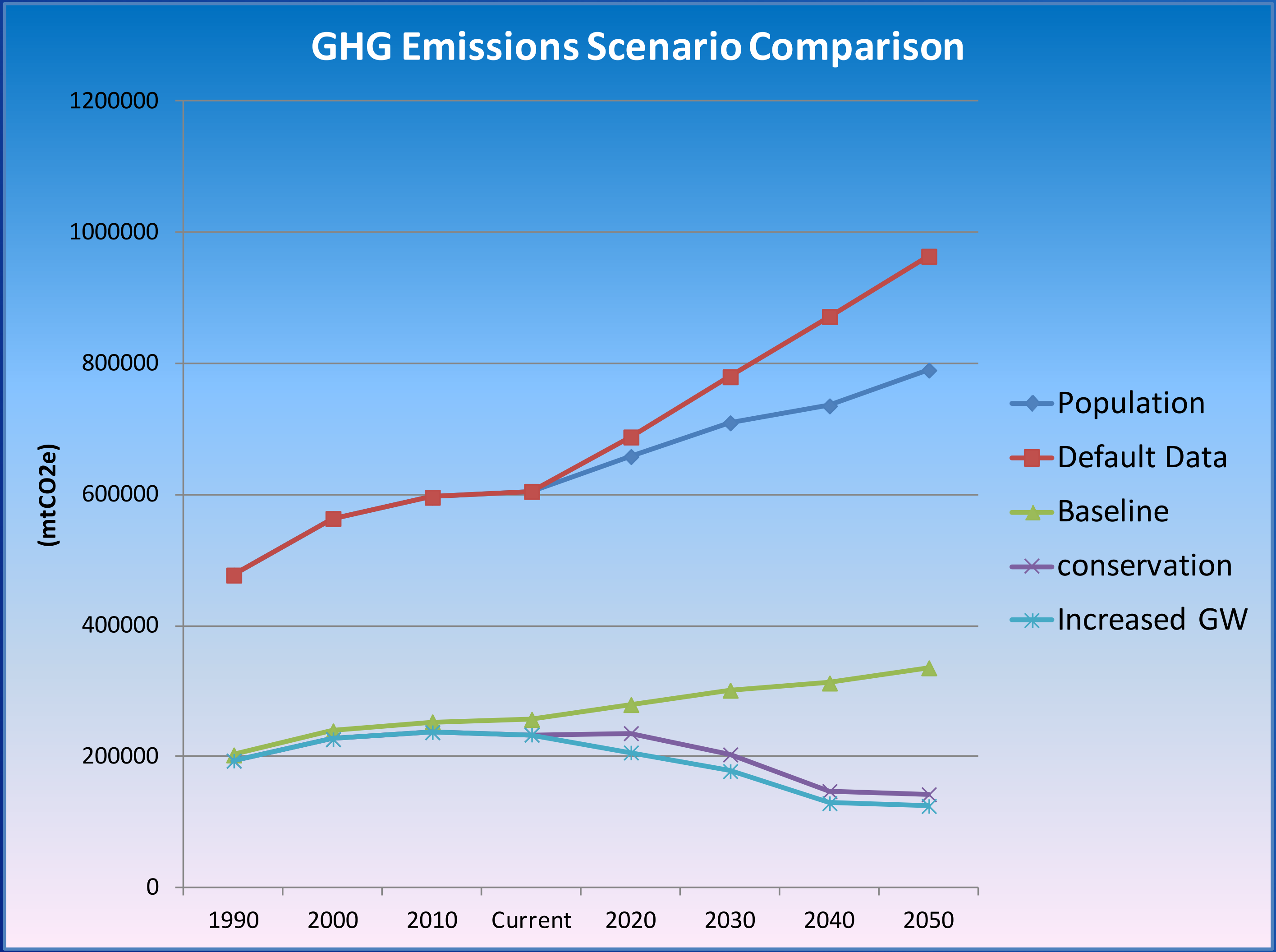
Greenhouse Gas Emissions Calculator for the Water Sector

- 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



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Uncertainty Discussions

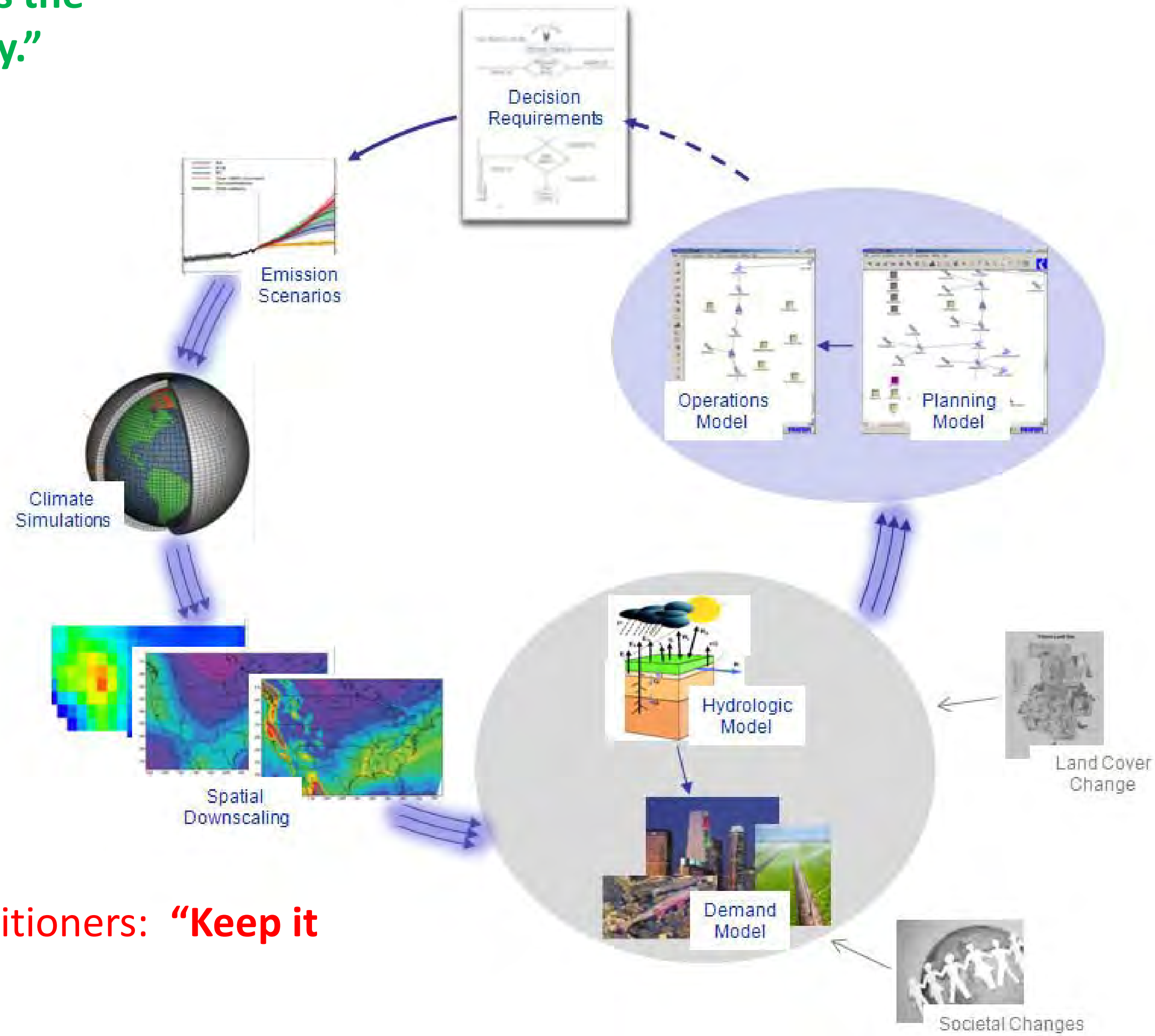
- Global Climate Forcings
- Global Climate Simulation
- Climate Projections Bias
- Spatial Downscaling
- Watershed Vegetation Changes
- Hydrologic Model

- …

- Other approaches to analyzing impacts

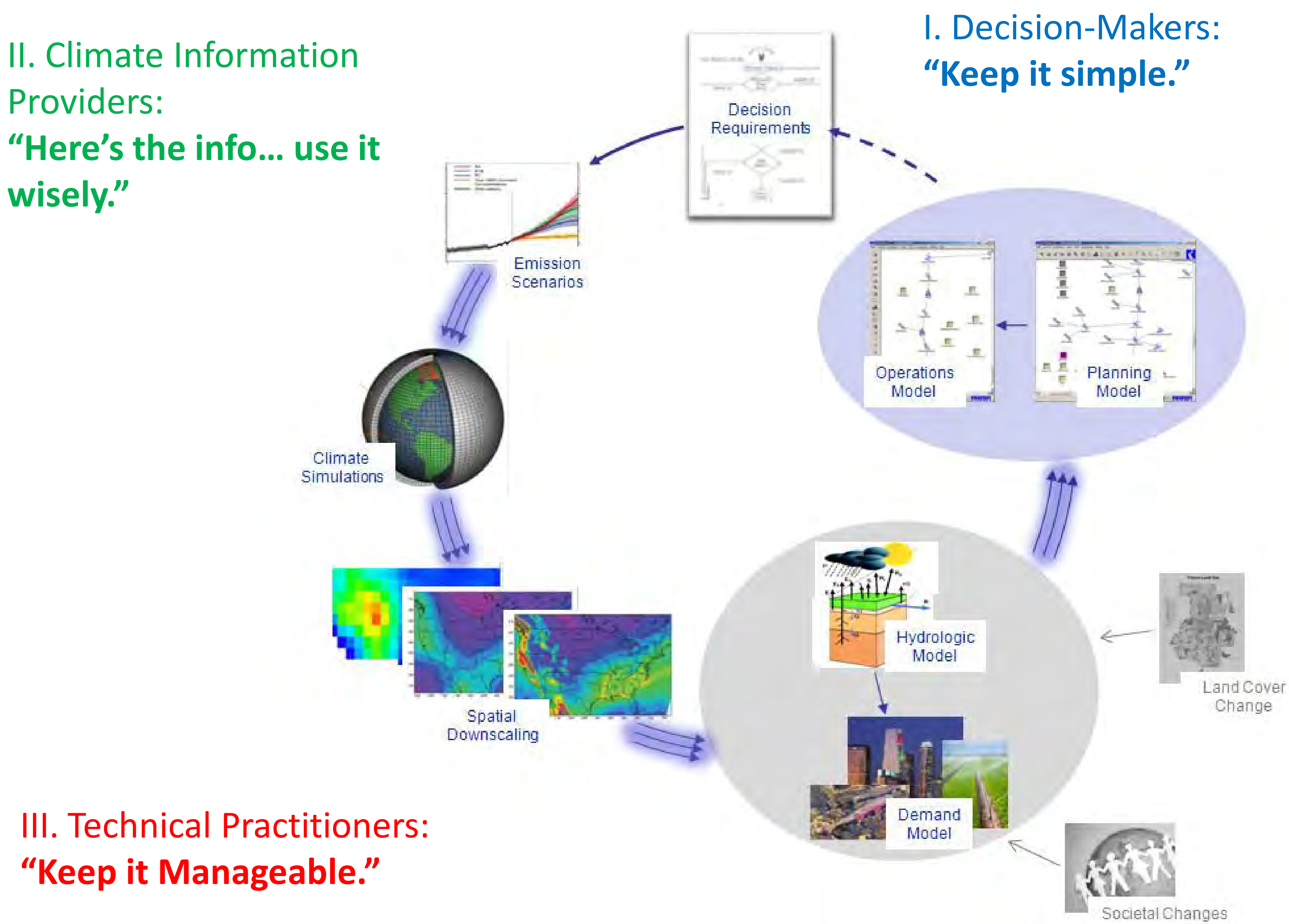
II. Climate Information Providers: **"Here's the info… use it wisely."**

I. Decision-Makers: **"Keep it simple."**



III. Technical Practitioners: **"Keep it Manageable."**

In summary, data selections and method choices are throughout the analysis…



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

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

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