

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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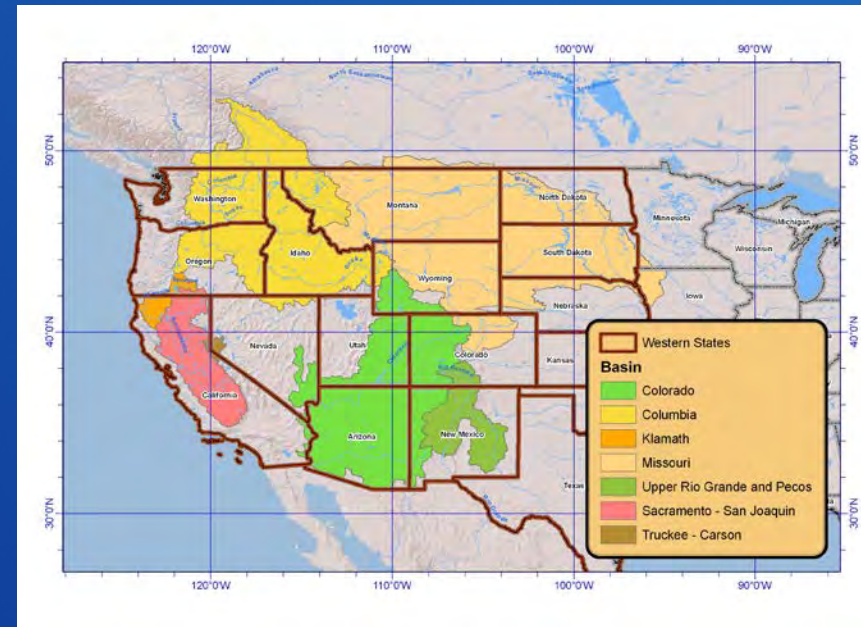
Reclamation Technical Service Center, Denver



**U.S. Department of the Interior
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 (**S**ustain and **M**anage **A**merica’s **R**esources for **T**omorrow) 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

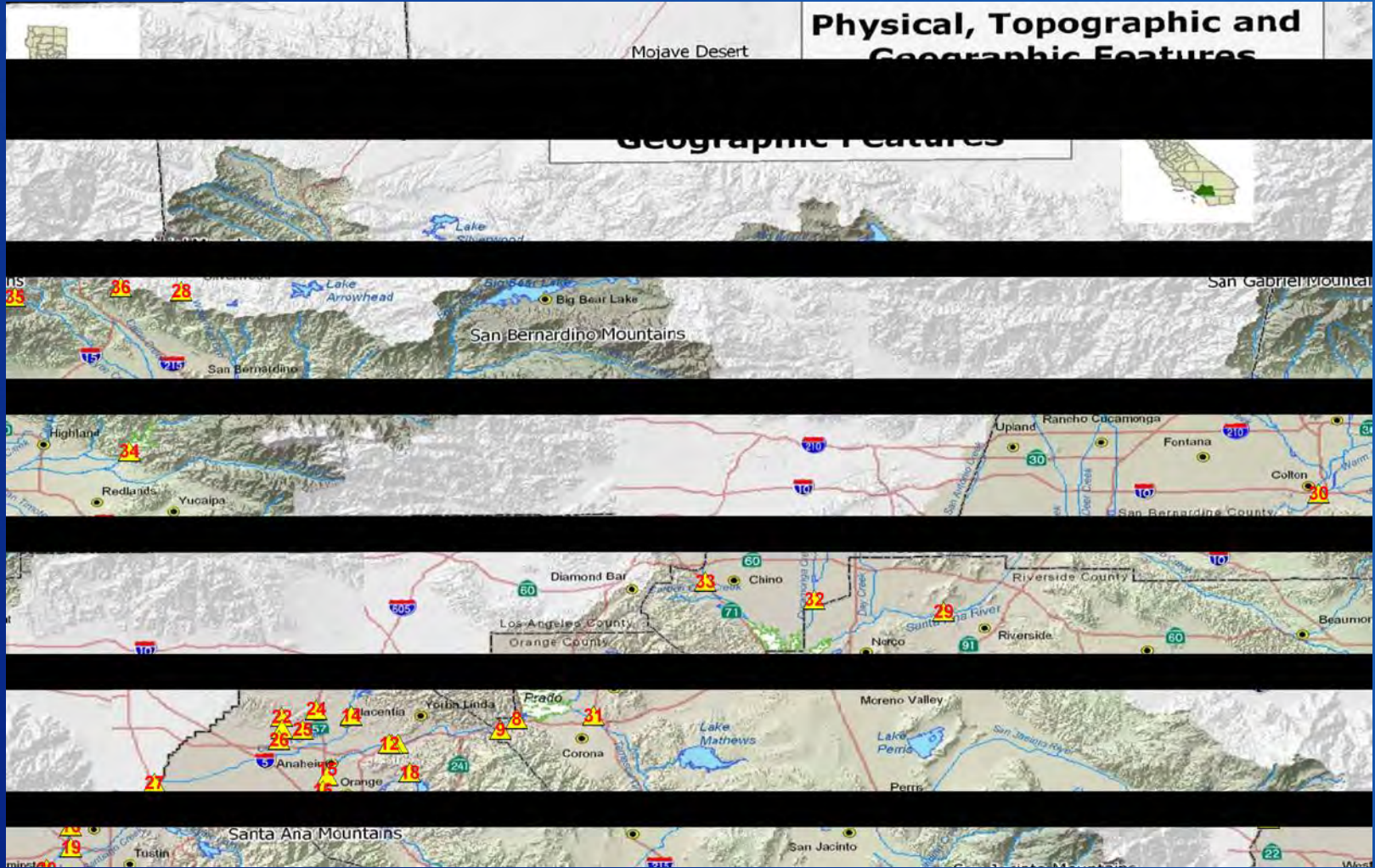
2012

- Upper Washita River Basin
- Sacramento-San Joaquin Rivers
- Republican River Basin
- Pecos River Basin
- L.A. Basin



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Santa Ana Watershed



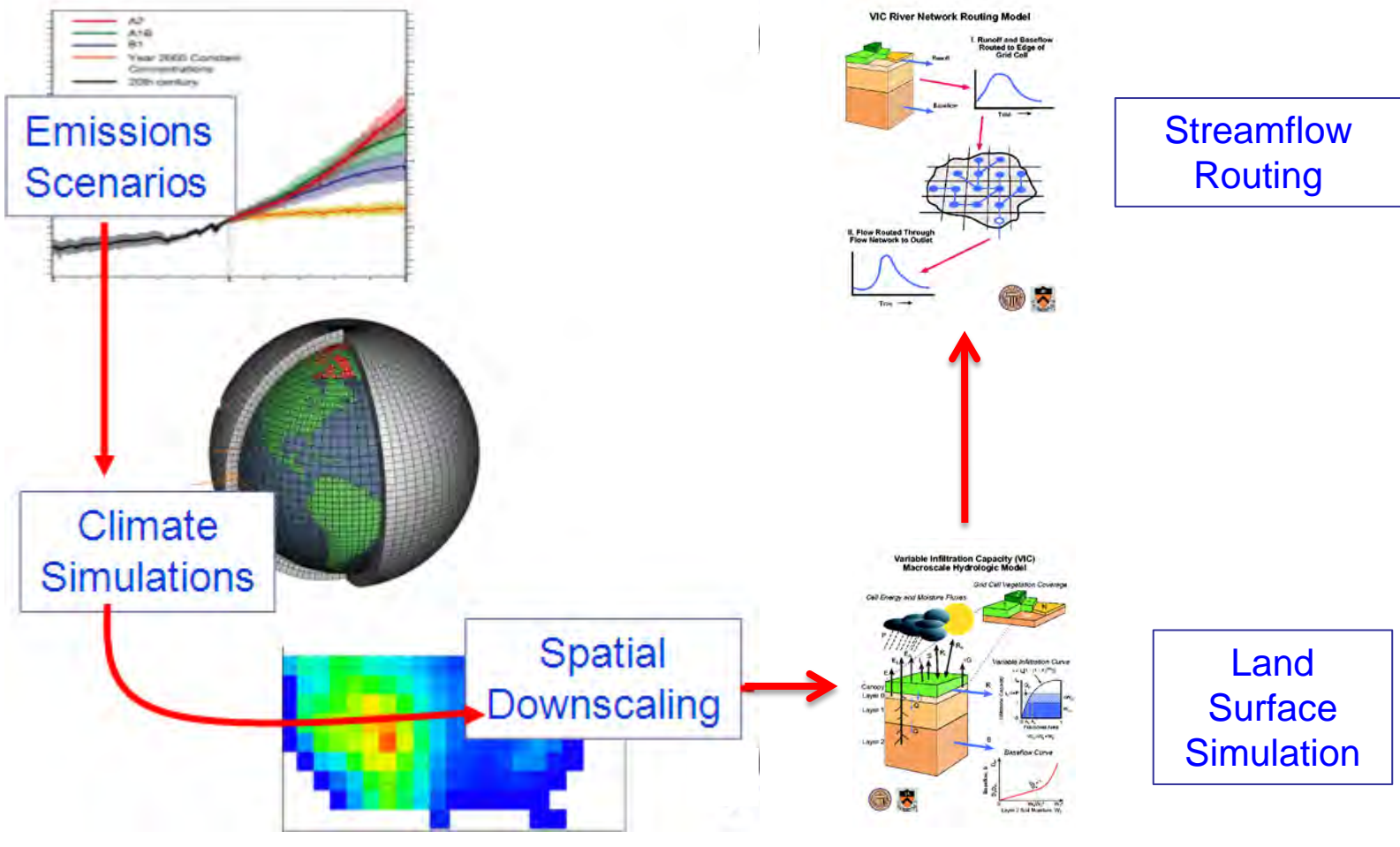
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Outline

- **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...

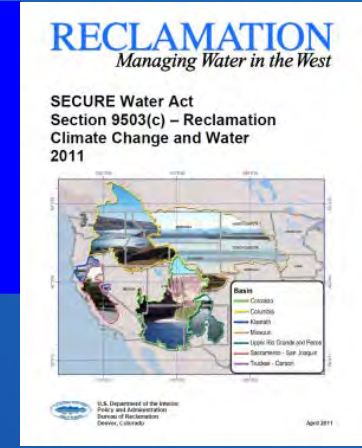
http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections/dcpInterface.html



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

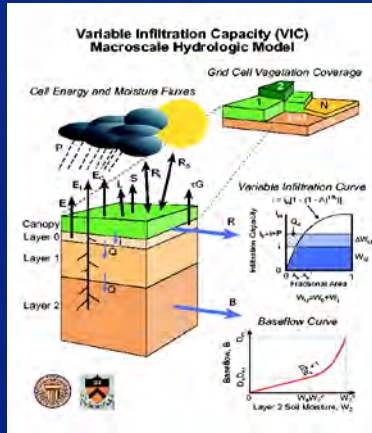


SECURE Report to Congress, April 2011 focus on median changes; future reports have broader scope



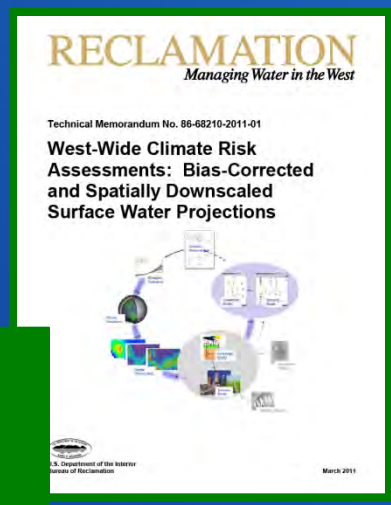
Analyses of Period-changes in climate and hydrology

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



Data-service, Reclamation and broader public use

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

Bias Corrected and Downscaled WCRP
CMIP3 Climate and Hydrology Projections

This site is best viewed with [Chrome](#) (recommended) or [Firefox](#). Some features are unavailable when using Internet Explorer. [Requires JavaScript to be enabled.](#)

Welcome About Tutorials Projections: Subset Request Projections: Complete Archives Feedback Links

Summary

This archive contains fine spatial-resolution translations of:

- climate projections over the contiguous United States (U.S.) developed using two downscaling techniques (monthly BCSD Figure 1, and daily BCCA Figure 2), and
- hydrologic projections over the western U.S. (roughly the western U.S. Figure 3) corresponding to the monthly BCSD climate projections.

Archive content is based on global climate projections from the [World Climate Research Programme's \(WCRP's\) Coupled Model Intercomparison Project phase 3 \(CMIP3\)](#) multi-model dataset, which was referenced in the Intergovernmental Panel on Climate Change Fourth Assessment Report. Please see the "About" page for information on projection development, including the methodology to perform climate model bias-correction and spatial downscaling.

Purpose

The archive is meant to provide access to climate and hydrologic projections at spatial and temporal scales more relevant to some of the watershed and basin-scale decisions facing water managers and planners dealing with climate change. Such access permits several types of analyses, including:

Figure 1: BCSD CMIP3 Monthly Climate Analysis example - Median projected change in average-annual precipitation (cm/year), 2041-70 versus 1971-2000.

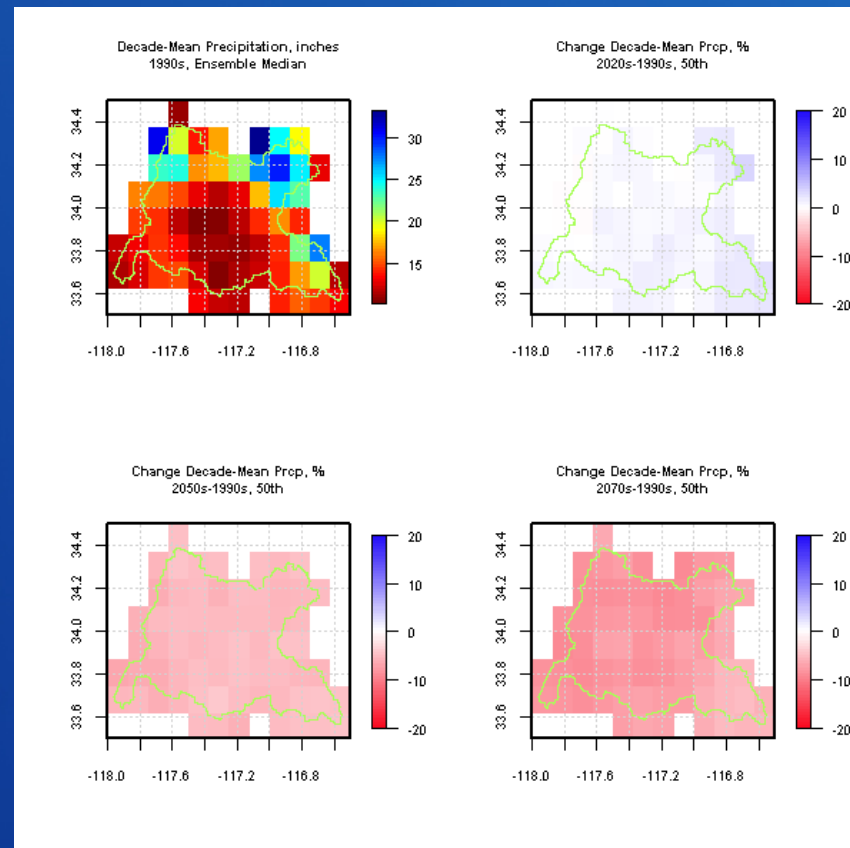
http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections

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.

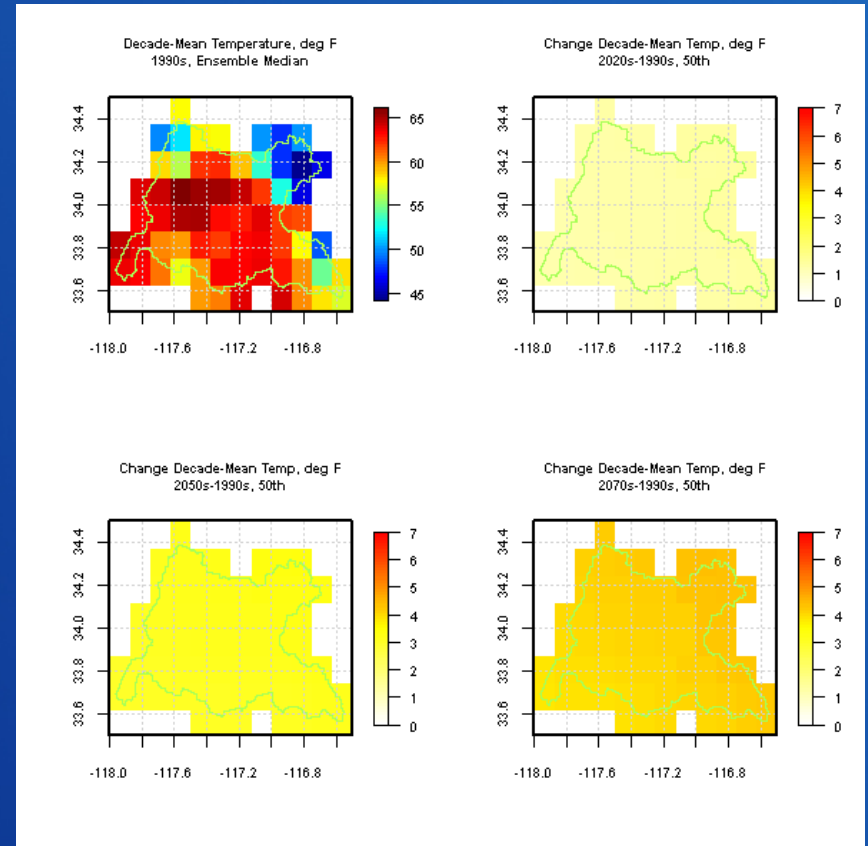


Hydrology Projections

Spatial Distribution of Temperature

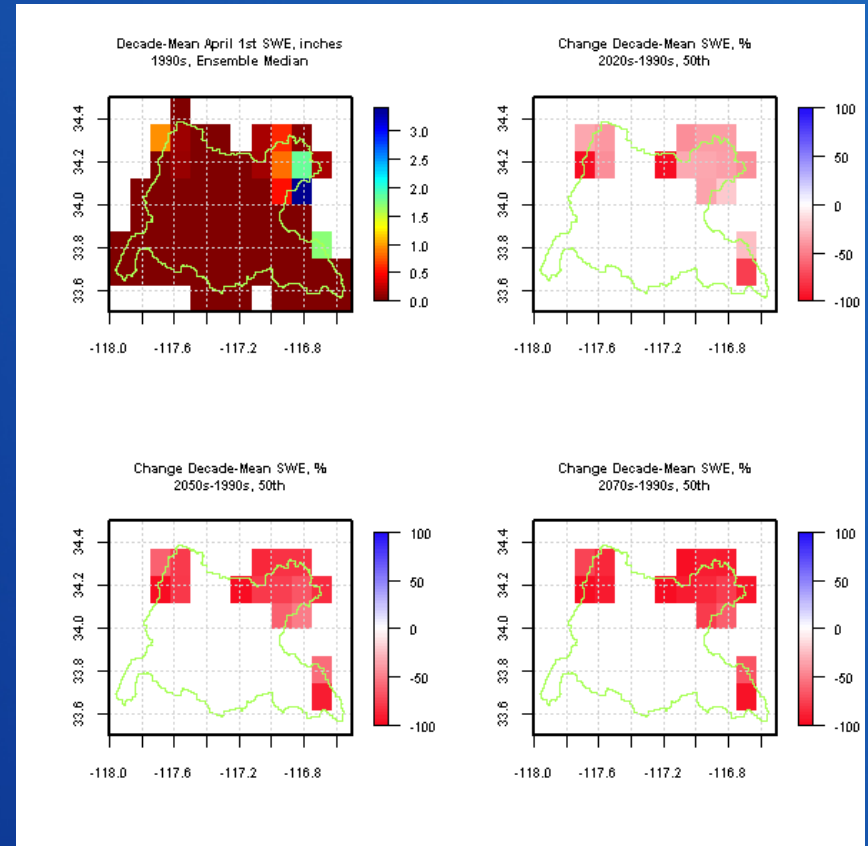
(T)

- 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)

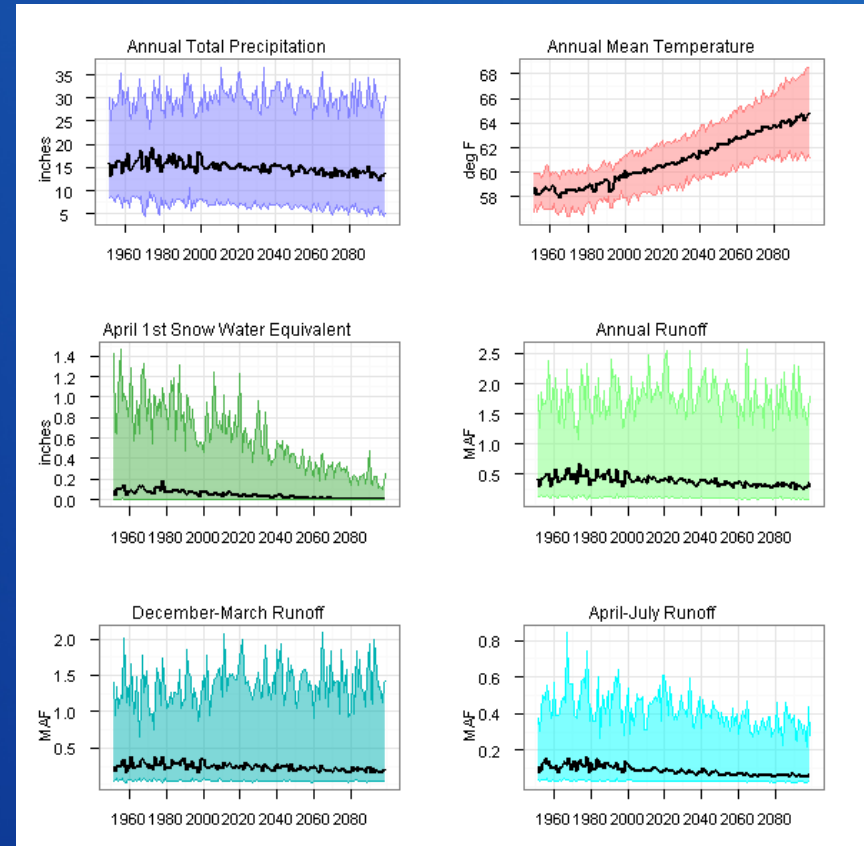
- **Spatial distribution of April 1st SWE – persistent decline through the future decades (2020s, 2050s, 2070s) from the 1990s’ distribution.**



Hydrology Projections

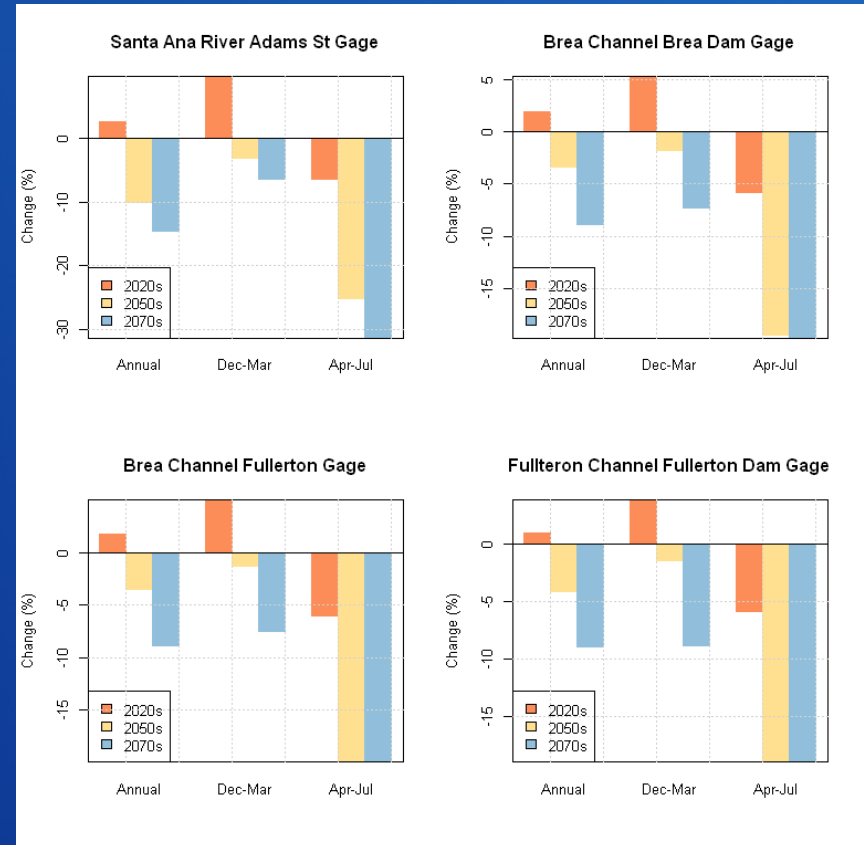
P, T, SWE, Flow

- 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



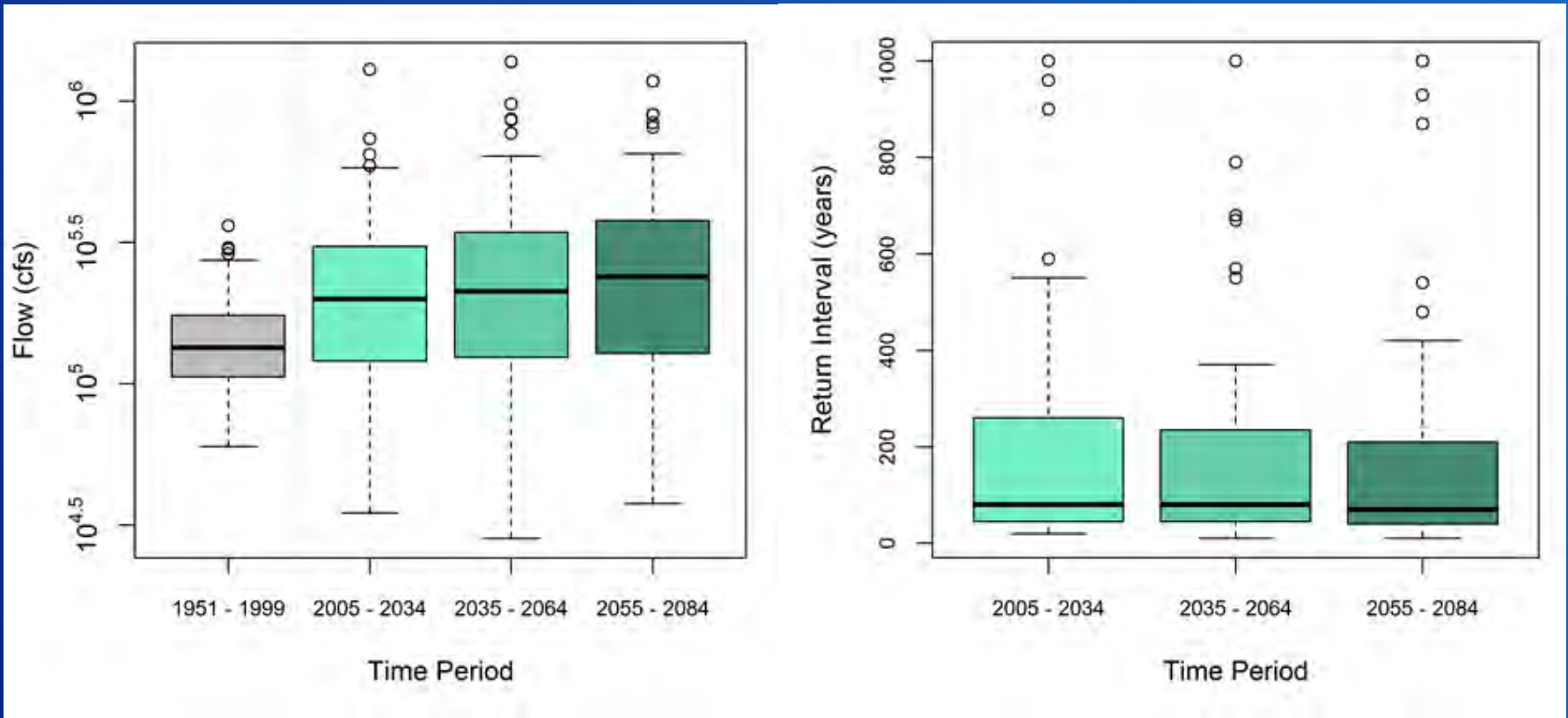
Summary of Impacts

Santa Ana River Adams St. Gage

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

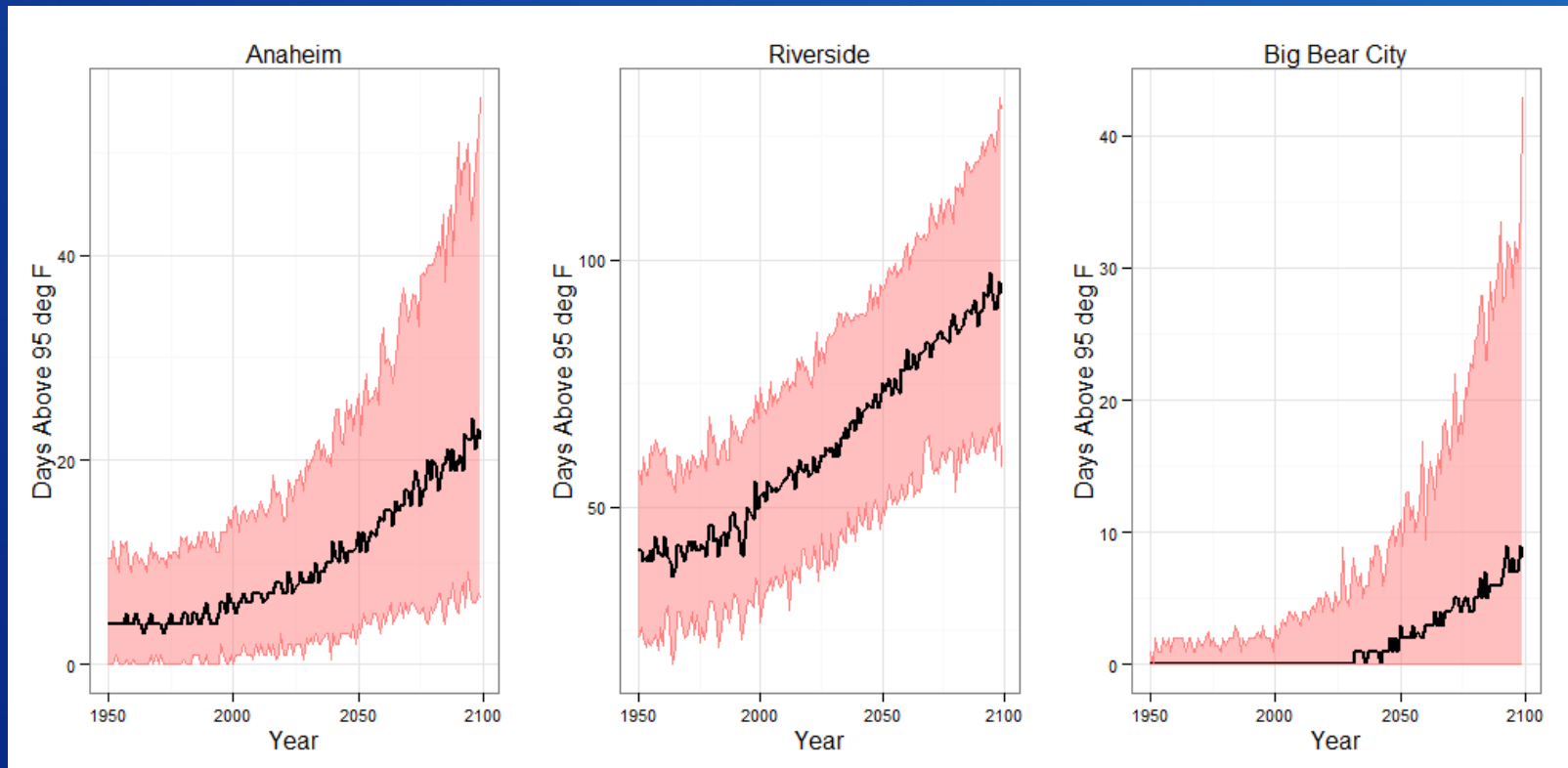
Similar analysis was done for all the 36 sites in the Santa Ana Basin

Floods – 200-year event, Prado Dam



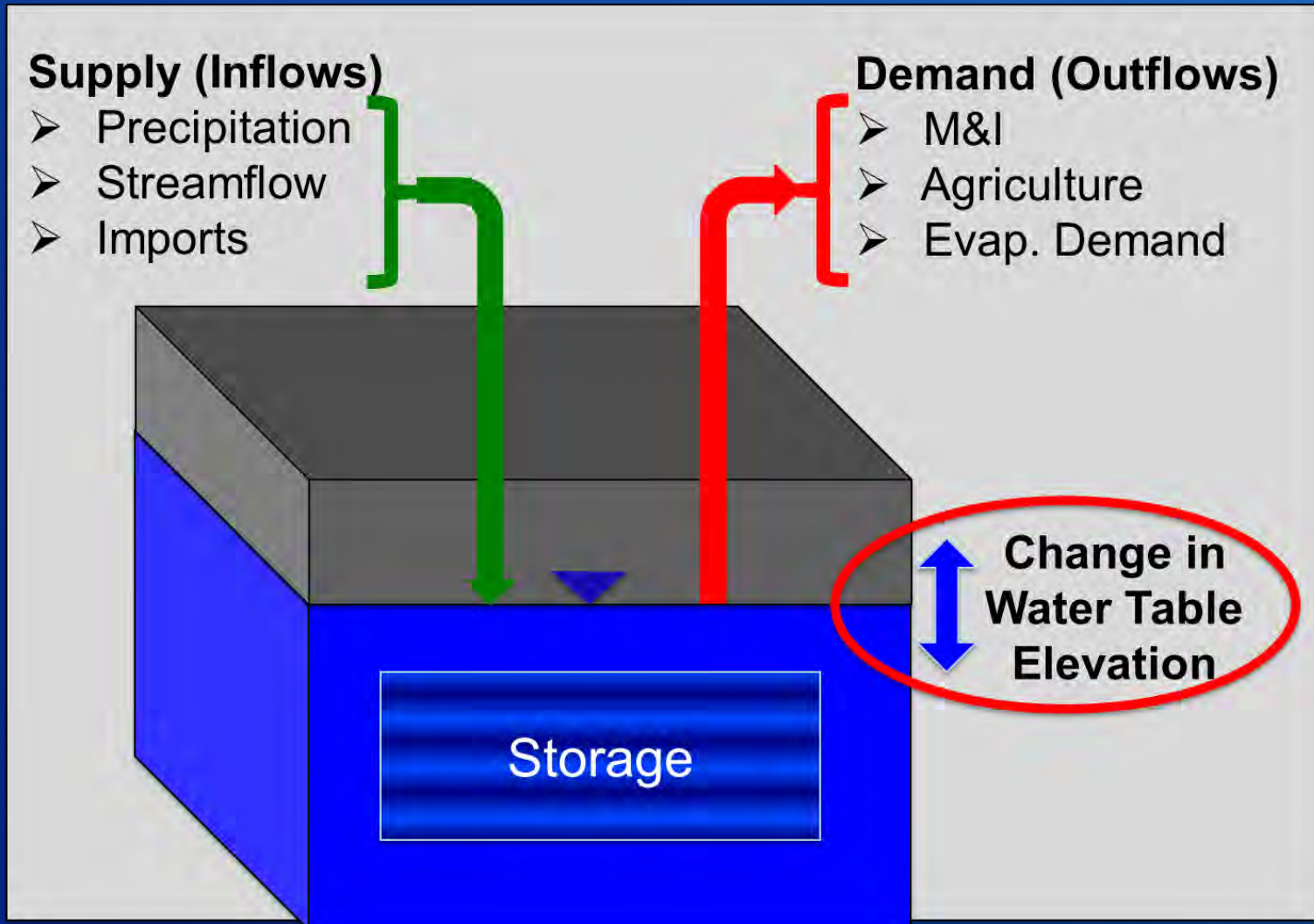
- More severe floods in the future
- 200 year historical event is likely to be closer to a 100 year event in the future

Days above 95°F

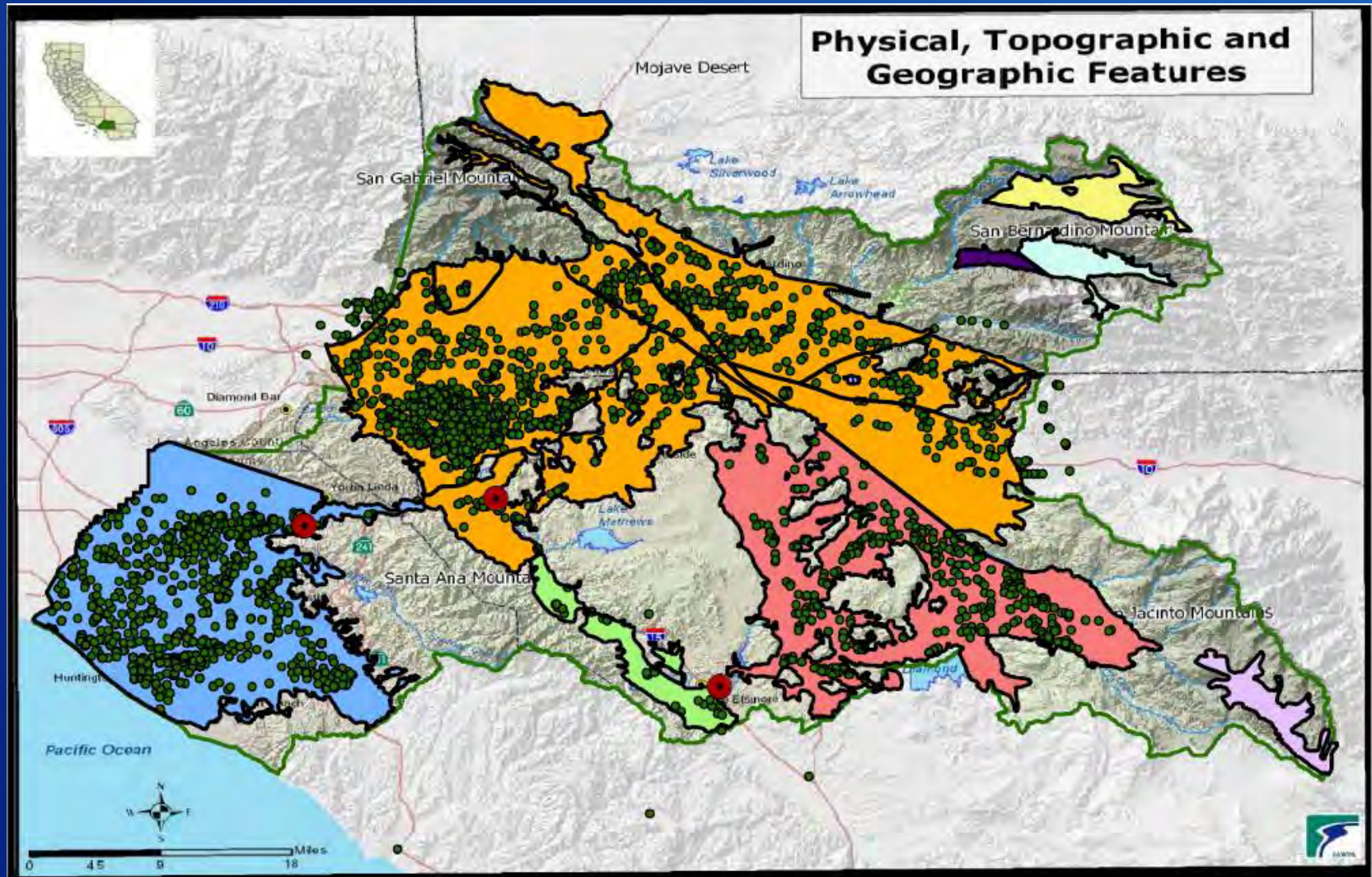


	Historical	2020	2050	2070
Anaheim	4	7	12	16
Riverside	43	58	72	82
Big Bear City	0	0	2	4

SAWPA Groundwater Screening Tool



SAWPA Groundwater Screening Tool



SAWPA Groundwater Tool

The screenshot shows the Microsoft Excel interface for the SAWPA Groundwater Tool. The spreadsheet is titled "GroundwaterScreeningTool_ForScreenShots.xlsm". The ribbon includes Home, Insert, Page Layout, Formulas, Data, Review, and View. The active sheet is "GW_Hist" with a default style of "ObsData.Default".

Simulation Information

Simulation Name	Test 1
Simulation Description	Simulation of groundwater basin 8-1 (Orange County Coastal Plain) using data developed by TSC.

Data Selection: Historical Period (Jan 1990 - Dec 2009)

Variable	Number of Series	Source
Groundwater Elevation	1	ObsData.Default
Precipitation	1	ObsData.Default
Temperature or Potential ET	1	ObsData.Default
Naturalized Streamflow	1	ObsData.Default
Agricultural Acreage	1	ObsData.Default
Population	1	N/A
Per Capita Use	1	N/A
M&I Demand	1	ObsData.Default
Interbasin Transfers	1	ObsData.Default
Exogenous (User Defined)	1	None

Data Selection: Future Period (Jan 2010 - End of Record)

Variable	Number of Series	Source
Precipitation	112	FutureData.Default
Temperature or Potential ET	112	FutureData.Default
Naturalized Streamflow	112	FutureData.Default
Agricultural Acreage	1	FutureData.Default
Population	1	N/A
Per Capita Use	1	N/A
Demand	1	FutureData.Default
Interbasin Transfers	1	FutureData.Default
Exogenous (User Defined)	1	None

Red circles highlight the "Exogenous (User Defined)" rows in both data selection tables. Red arrows point from these circles to the text box on the right.

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?



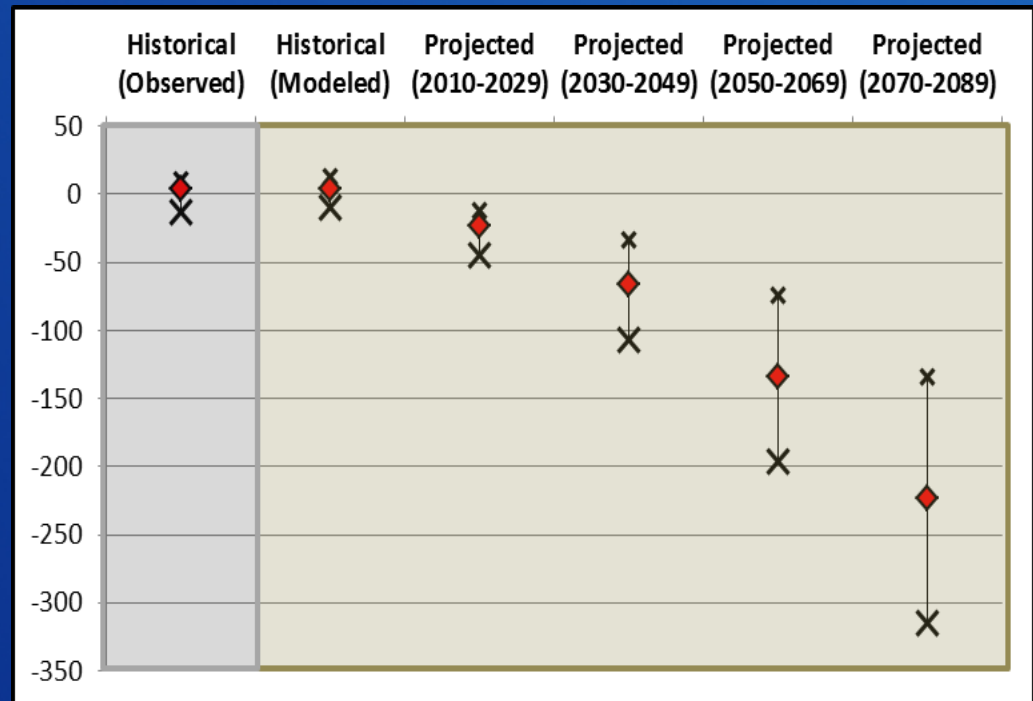
- What is the projected deficit in groundwater storage in my basin by 2050 due to climate change?



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

Conservation

Gradual reduction of approx. 15% by 2020
(reduce per capita use from ~175 gpd to ~150 gpd)

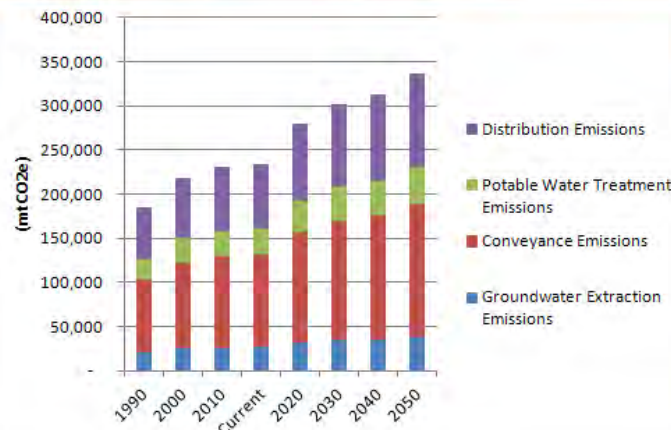
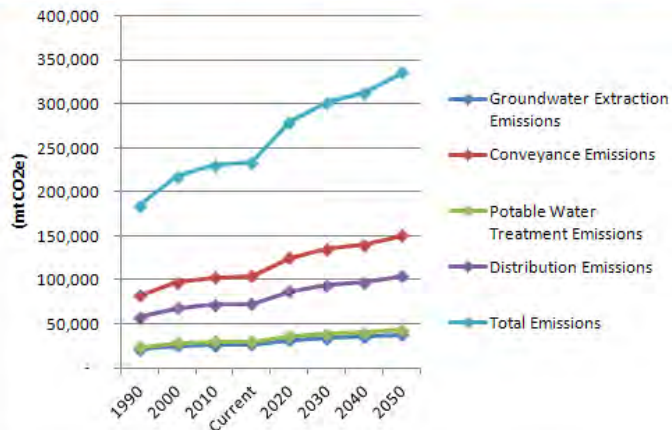
Imported Water

Gradual increase in water imports from Colorado River and/or SWP
(increase from ~30,000 AF/yr to ~105,000 AF/yr)

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



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.

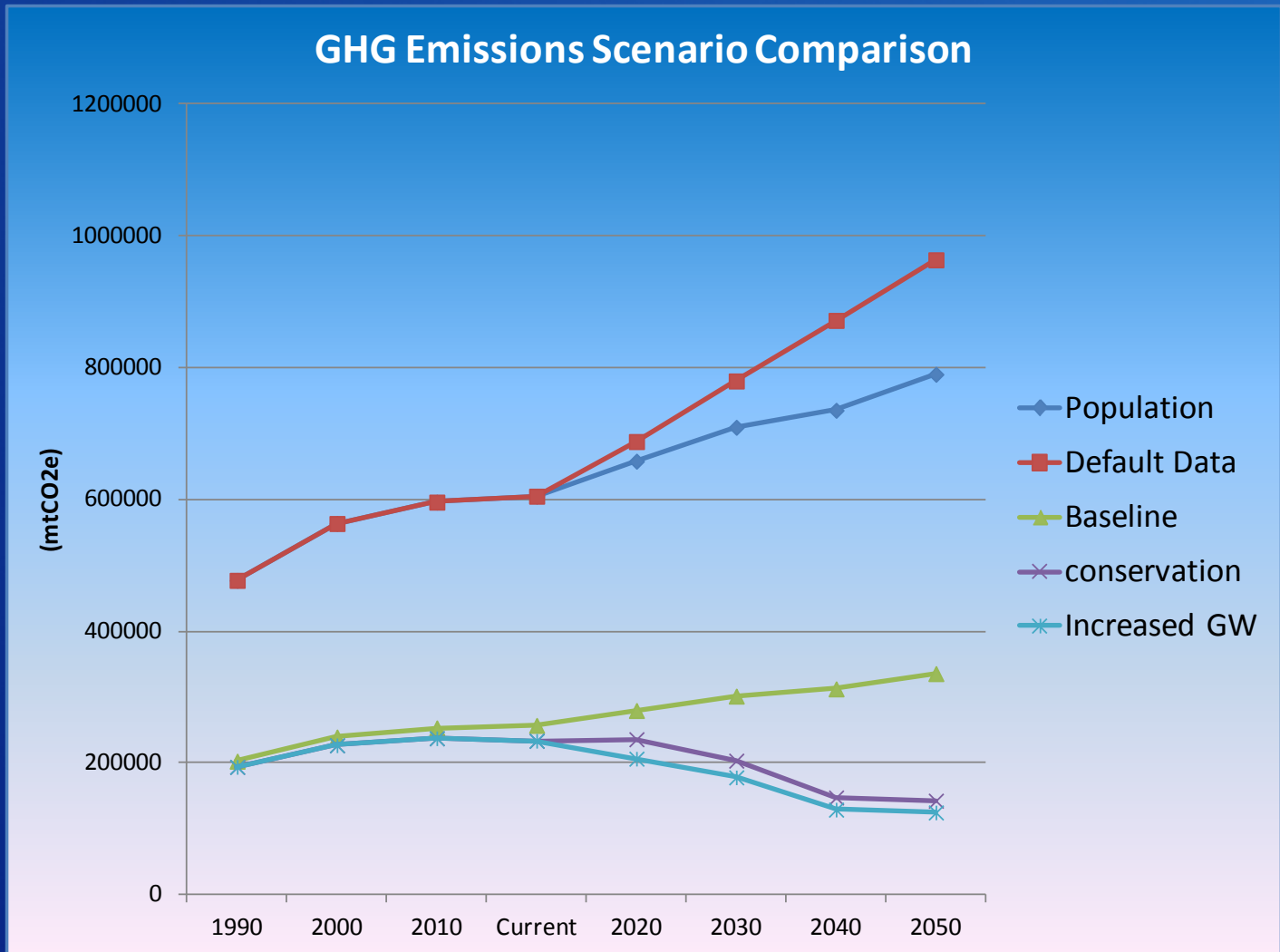
Greenhouse Gas Emissions Calculator for the Water Sector

- 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



Uncertainty Discussions

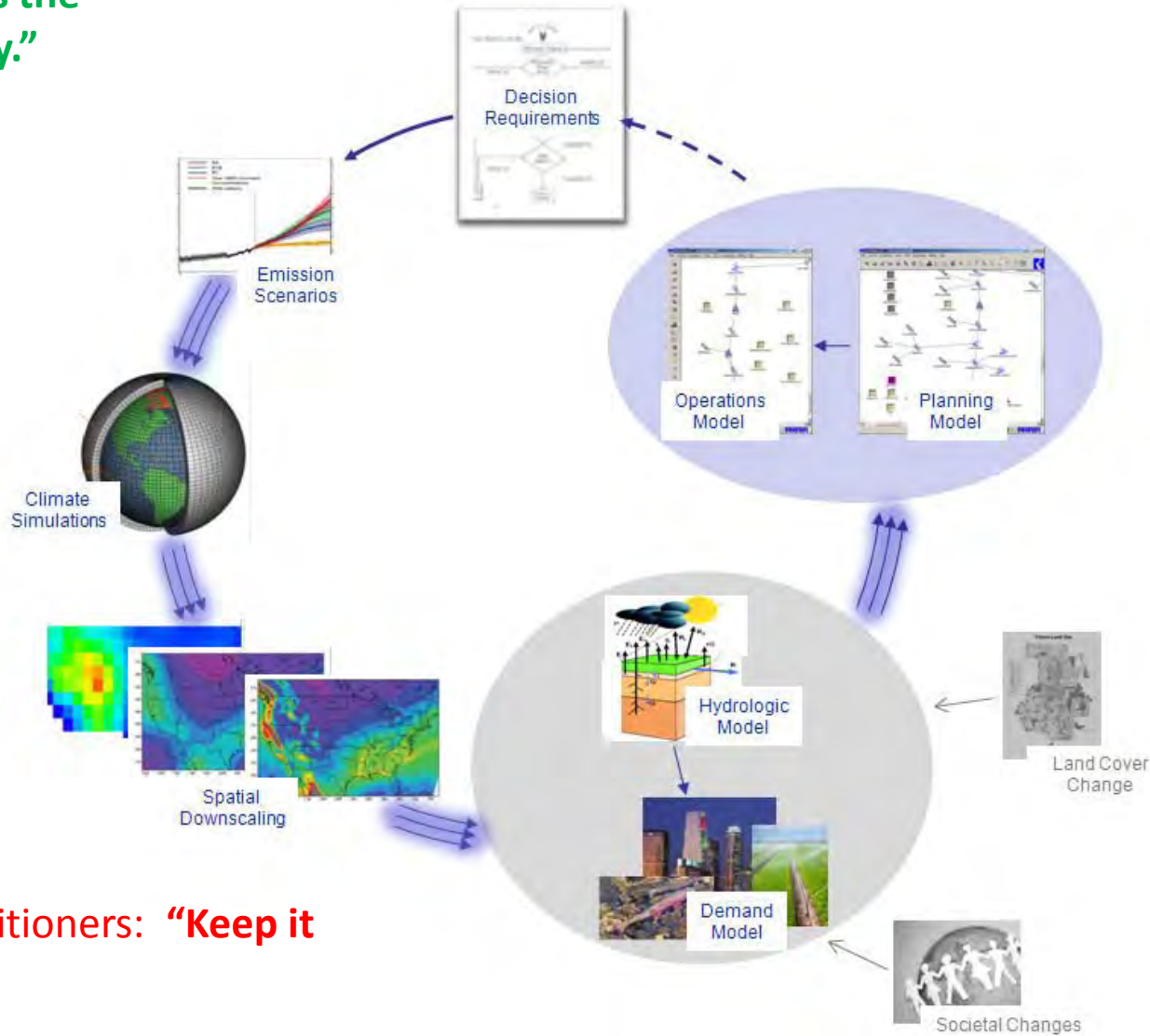
- **Global Climate Forcings**
- **Global Climate Simulation**
- **Climate Projections Bias**
- **Spatial Downscaling**
- **Watershed Vegetation Changes**
- **Hydrologic Model**

- ...

- **Other approaches to analyzing impacts**

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

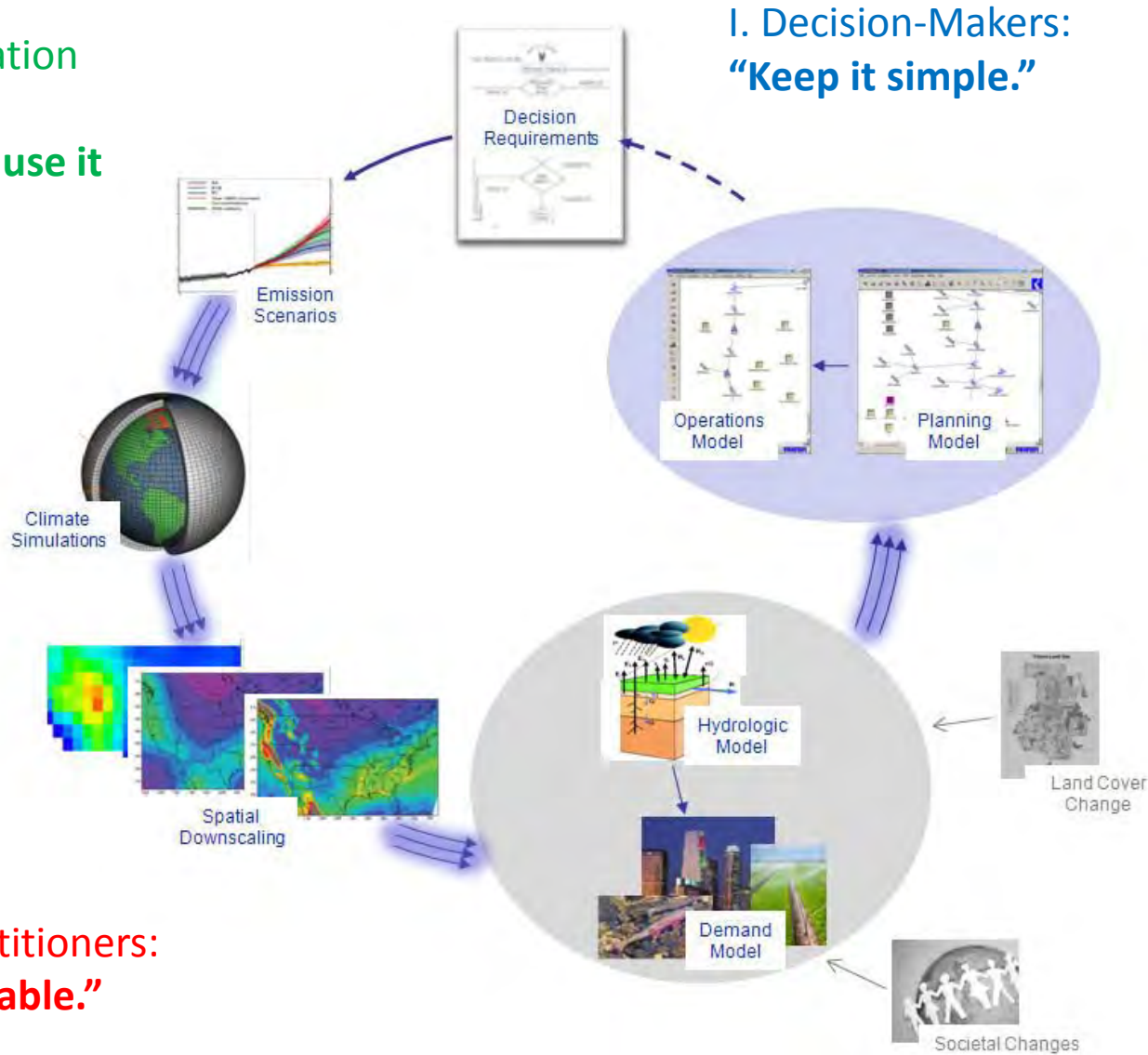
I. Decision-Makers: **“Keep it simple.”**



III. Technical Practitioners: **“Keep it Manageable.”**

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

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 .

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

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