DCDC's WaterSim

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Simulation Models

- *Simulation*: Imitate the operations of a facility or process (via a computer)
- What's being simulated is the *system*
- To study systems we make assumptions/approximations, both logical and mathematical
- These assumptions form a *model* of the system
- If simple enough, could use mathematical methods to get:
    1) *Exact information* on questions of interest —*analytical solution*
    2) *Approximate information– numerical solution*
- A model is a collection of *Hypotheses*


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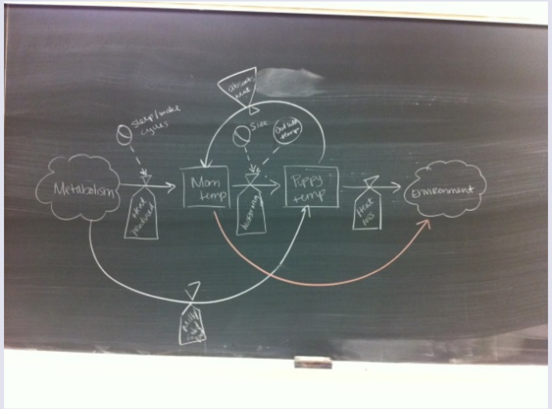
Systems:

- *System*: A collection of entities (people, parts, messages, rivers, urban,…) that act and interact together toward some end (Schmidt and Taylor, 1970)
  - Objectives determine the collection
  - Bounded (physical and logical)
  - Detail often varies
  - Usually a time element – *dynamic* system
- *State* of a system: Variables and their values necessary to describe the system at that time
- *Fluxes*: material movement among states
- *Driver Variables*: impact the rates
- *Auxiliary* Variables (parameters)

Jay Forrester



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Classification

- Classification of simulation models
  - *Static* vs. *dynamic (steady state vs. time-dependent)*
  - *Deterministic* vs. *stochastic (initial conditions give similar results vs. probability distributions)*
  - *Deductive vs. Inductive (Based on theory vs. empirical generalizations)*

WaterSim is dynamic, deterministic, and both deductive and inductive.

Some Terminology

- Parameterization : "fit" the model using empirical data-constants, functions, theory, etc. that enable verification.
- Verification : Do functions, responses, and outputs trend with reality? e.g. linear increases, curve-linear decreases over time, greater, lessor, etc.
- Validation : How well do outputs agree with alternative data? (usually empirical data, but sometimes other model results).

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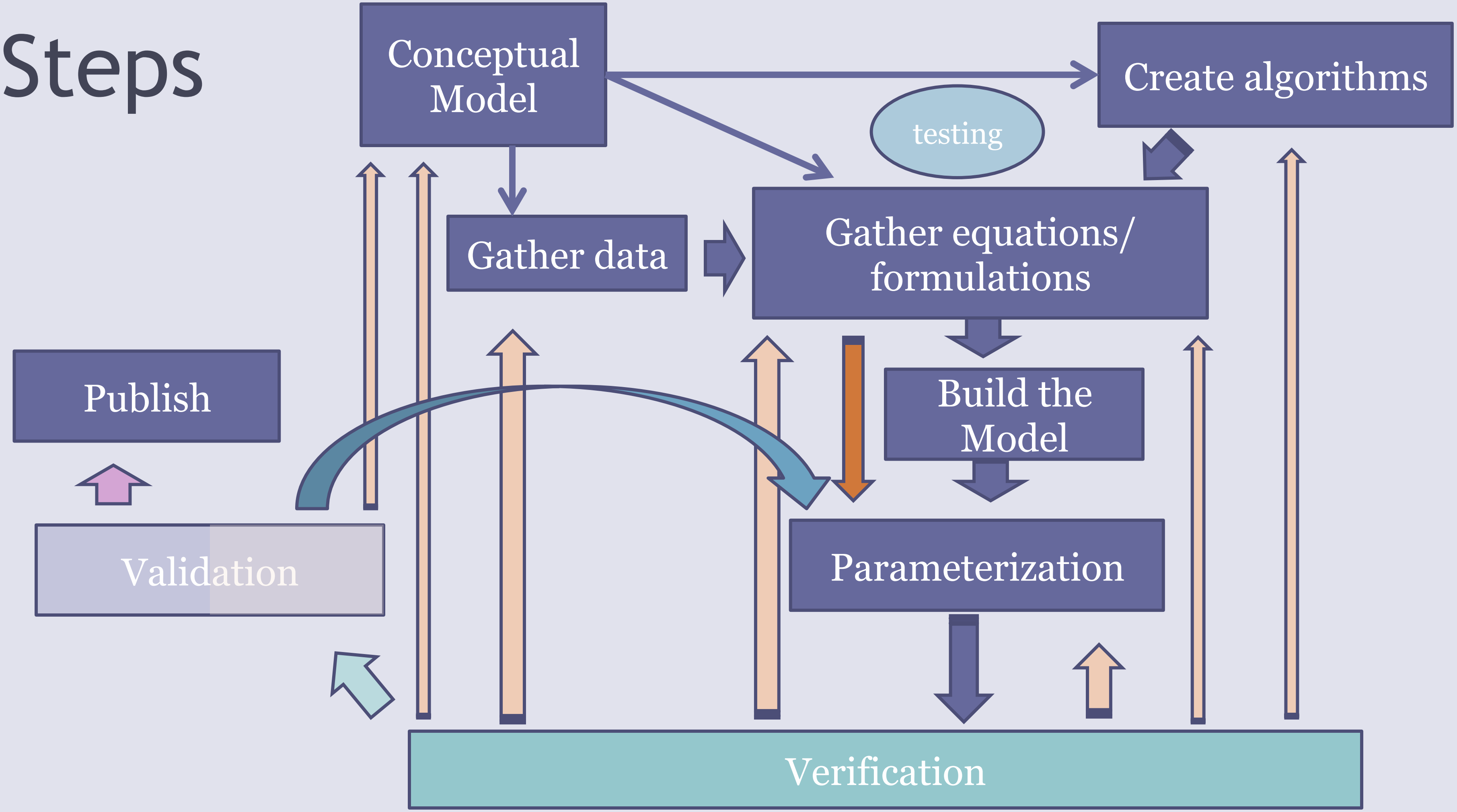
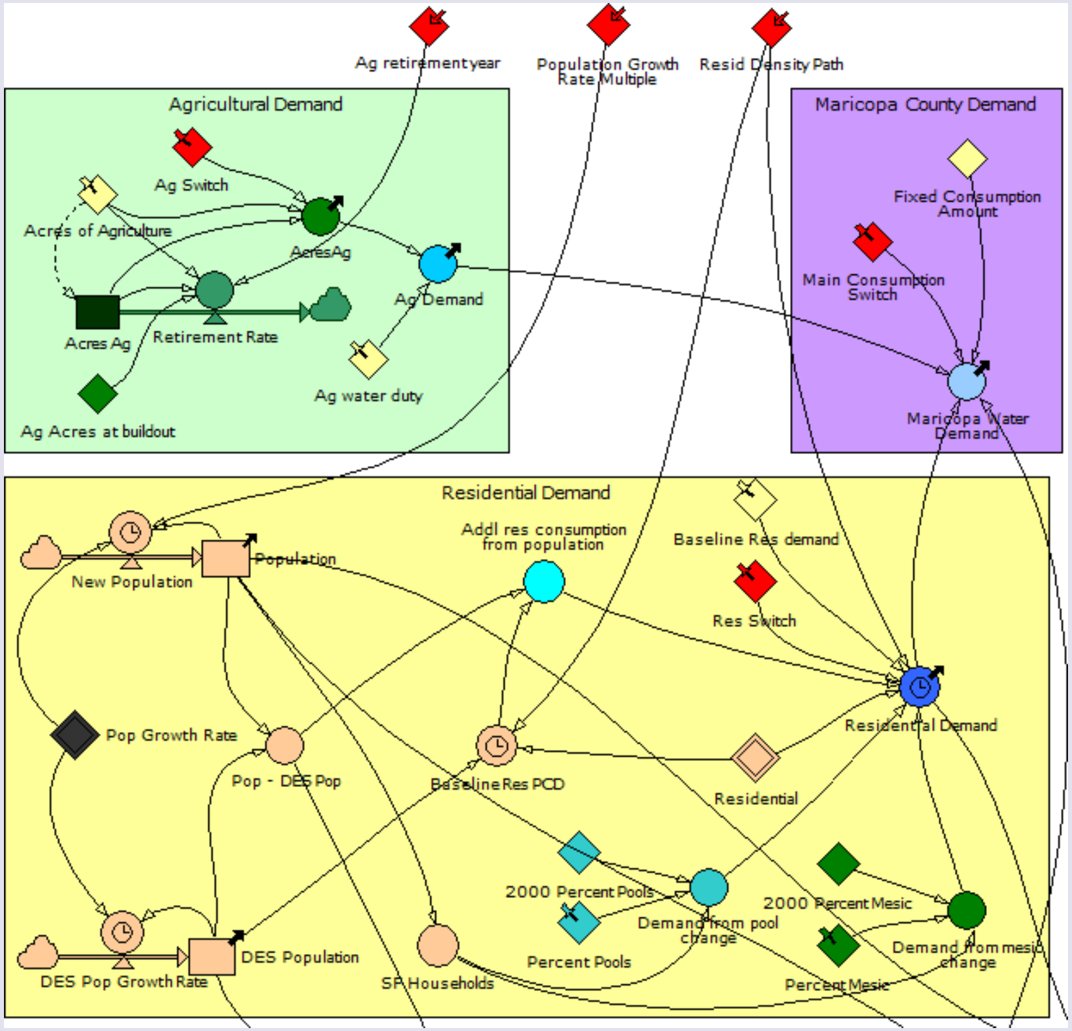
Steps


Conceptual Model
Create algorithms
testing
Gather data
Gather equations/ formulations
Build the Model
Publish
Validation
Parameterization
Verification

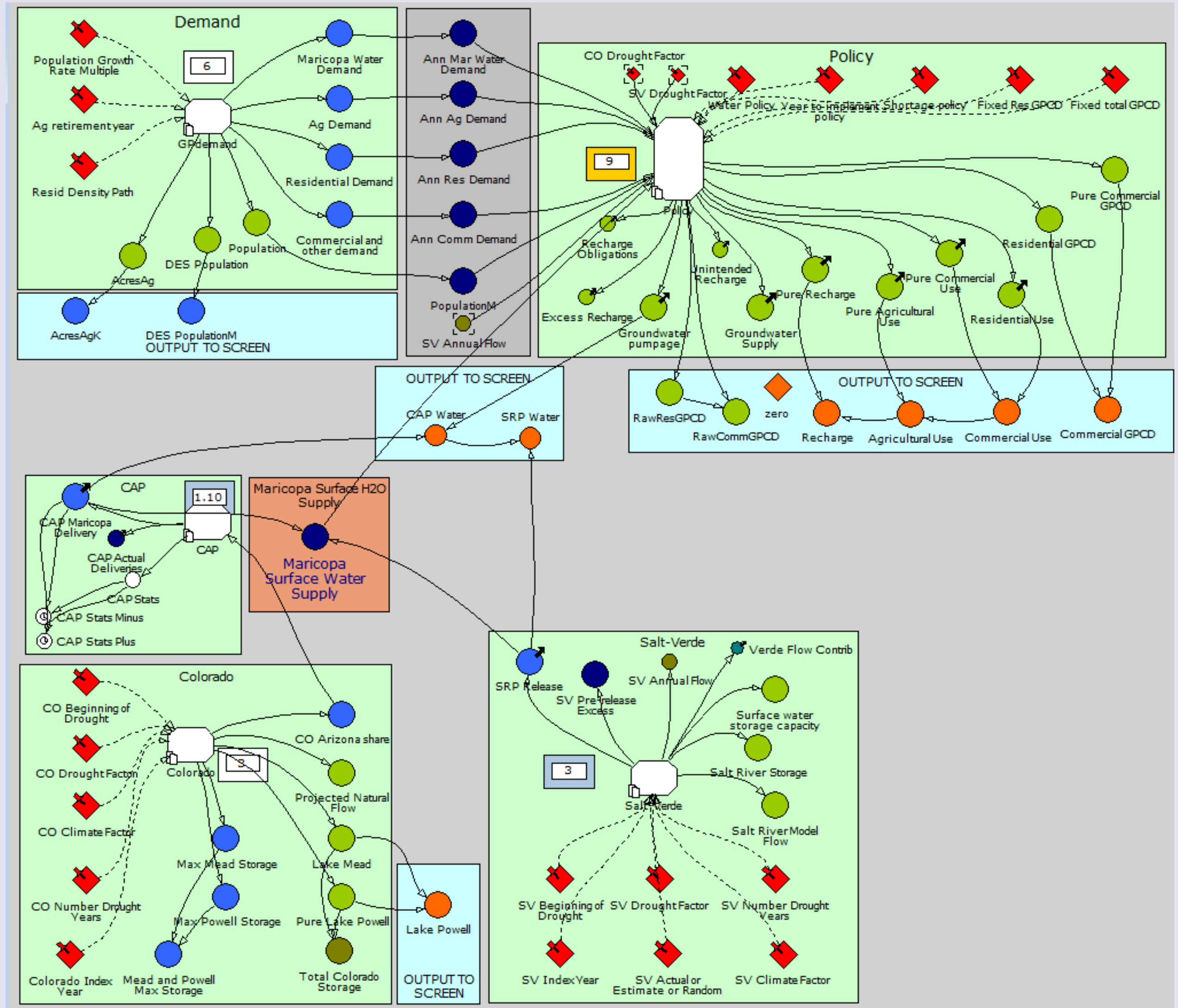
WaterSim 1

- PowerSim®
- County Scale



WaterSim 2

- PowerSim®
- County Scale

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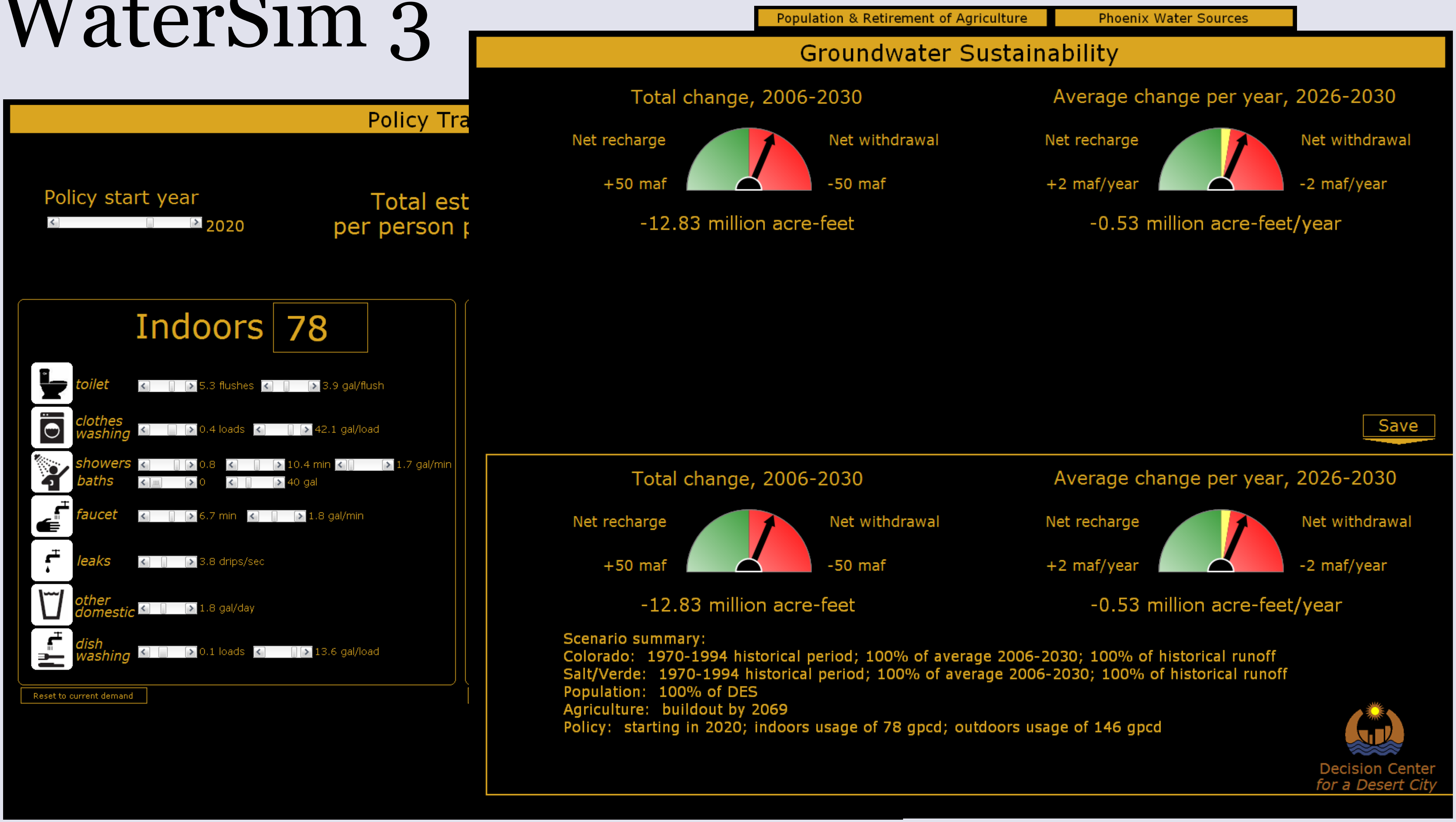
WaterSim 3



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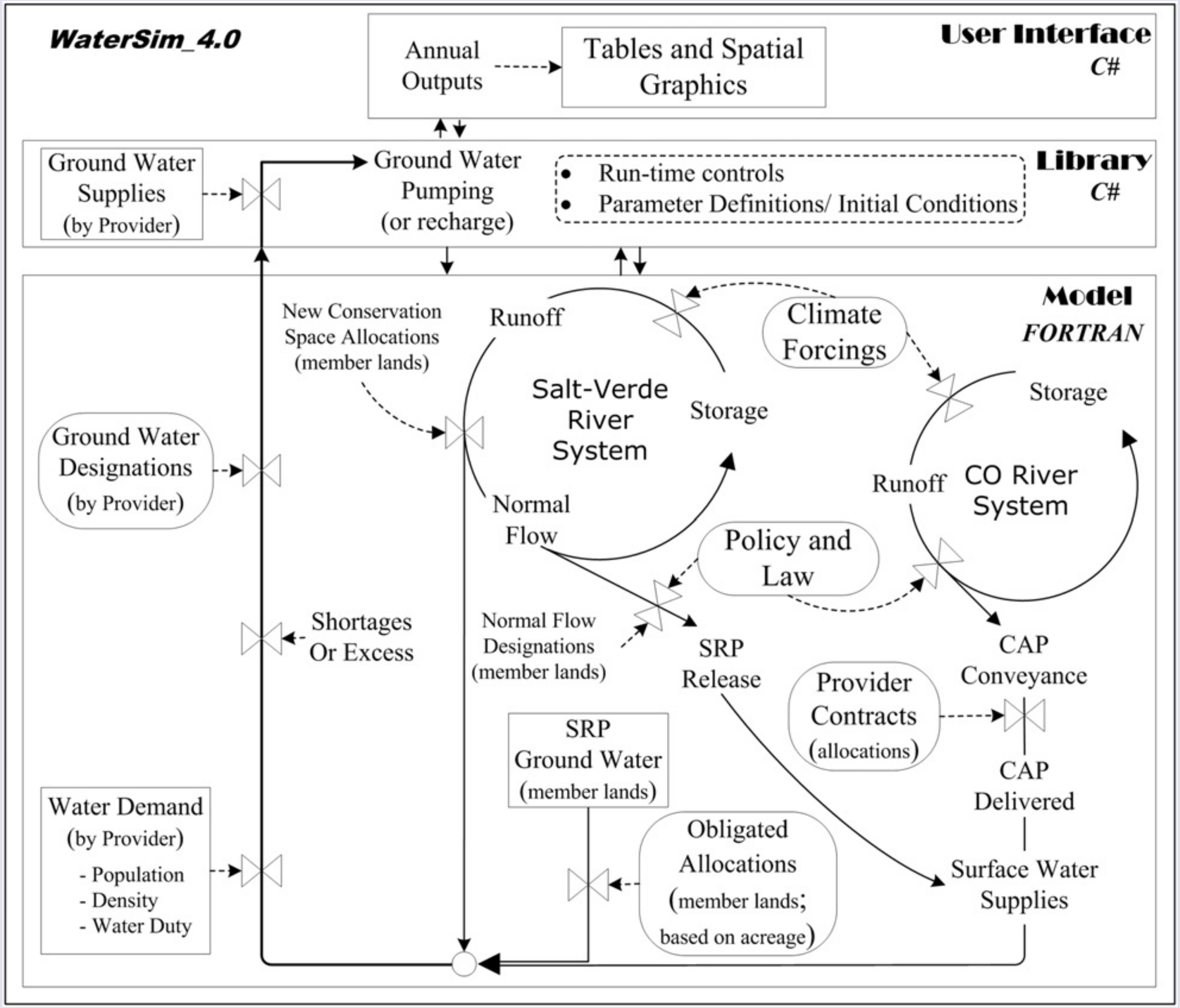
WaterSim 4

Water Supply Model



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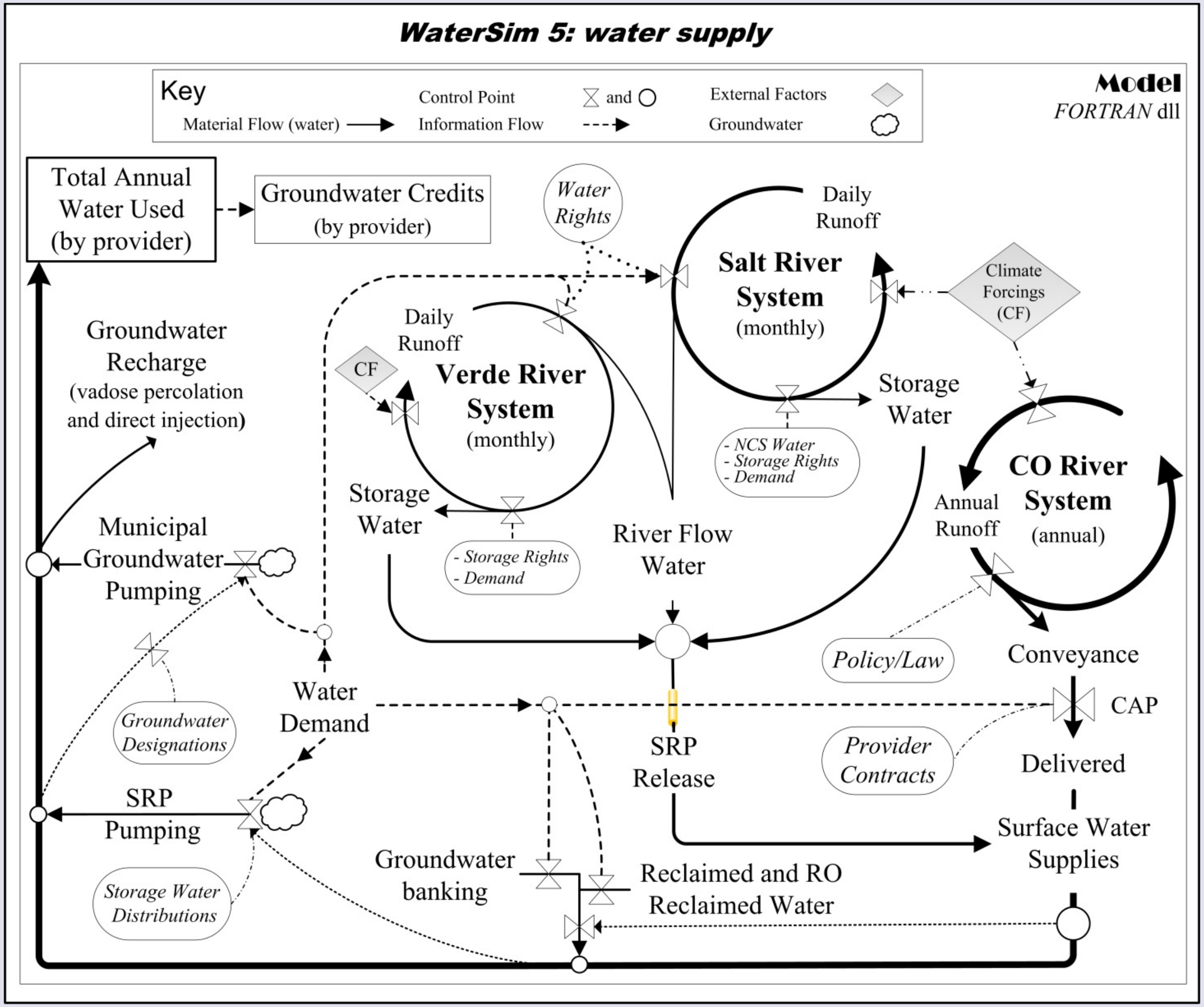
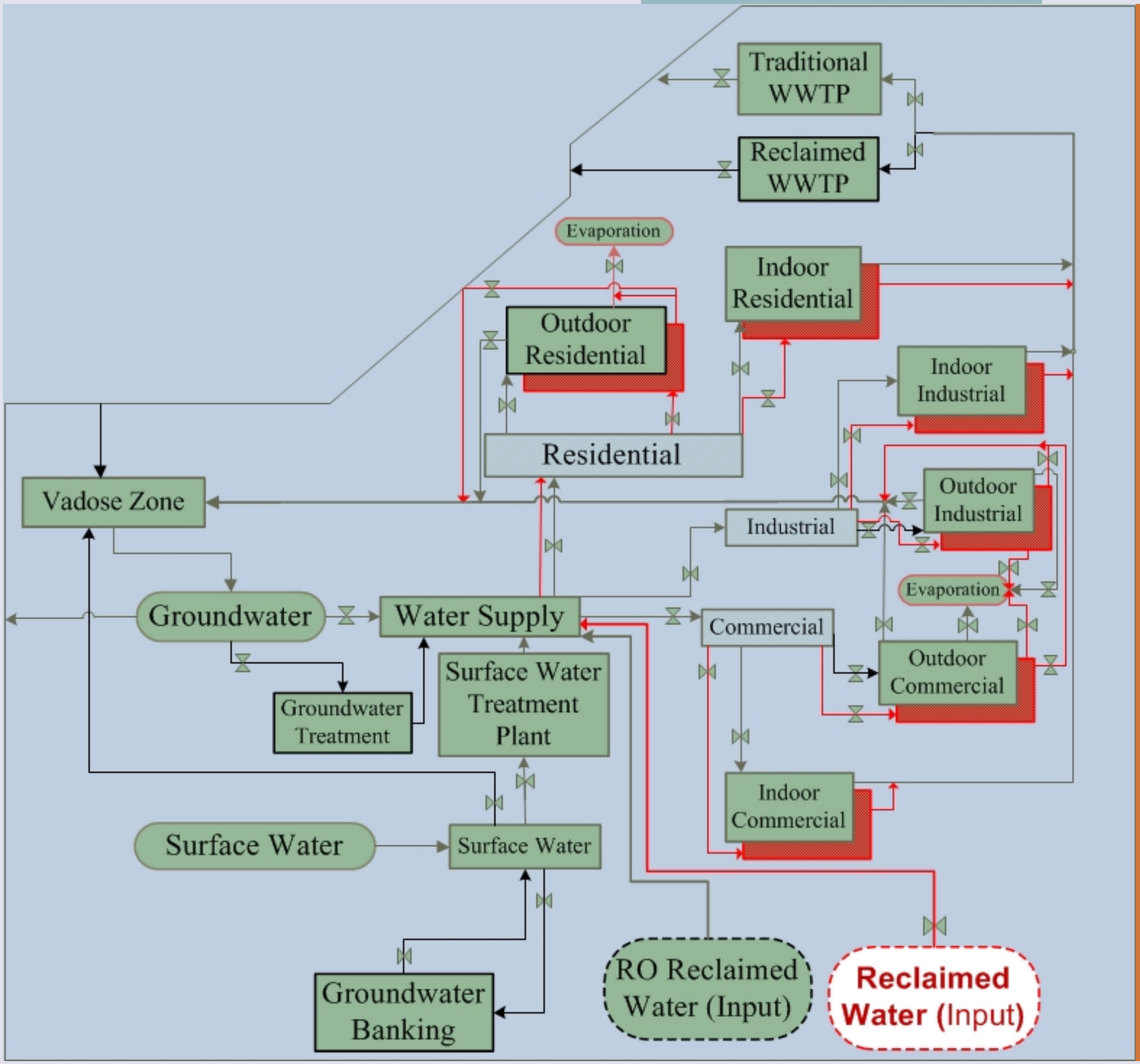
WaterSim 5

Water Demand Model



Water Use Network



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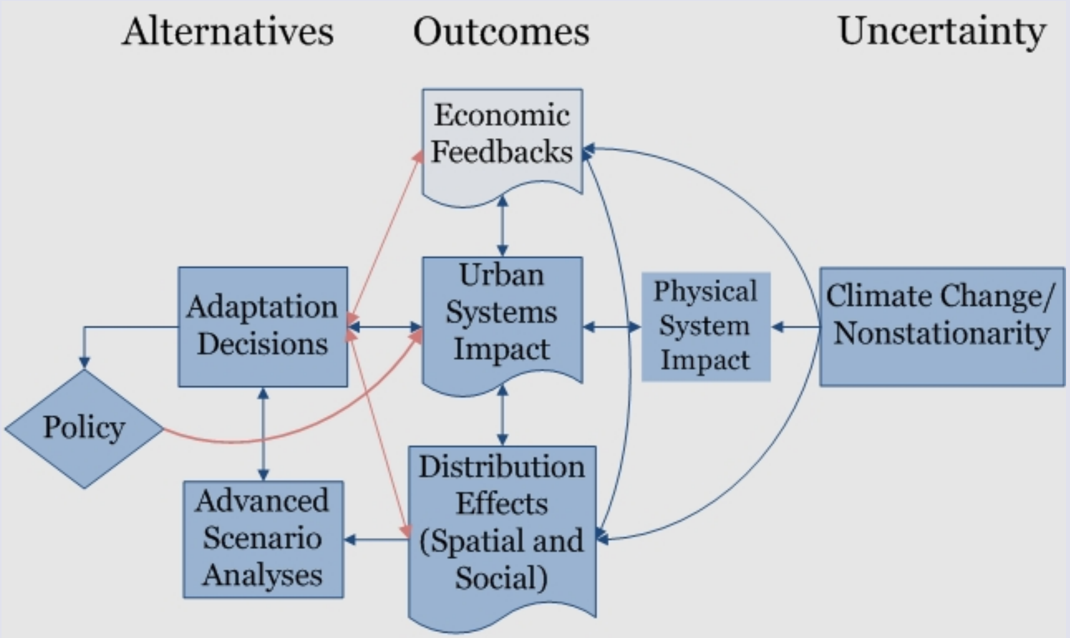
DCDC and WaterSim



Verification and Validation

Is the structure correct and are the outcomes believable?

Do the rules and algorithms follow law?

Are the driving variables, levers, and outputs pertinent?

The Model Must Be:

- ✓ Credible
- ✓ Legitimate
- ✓ Salient

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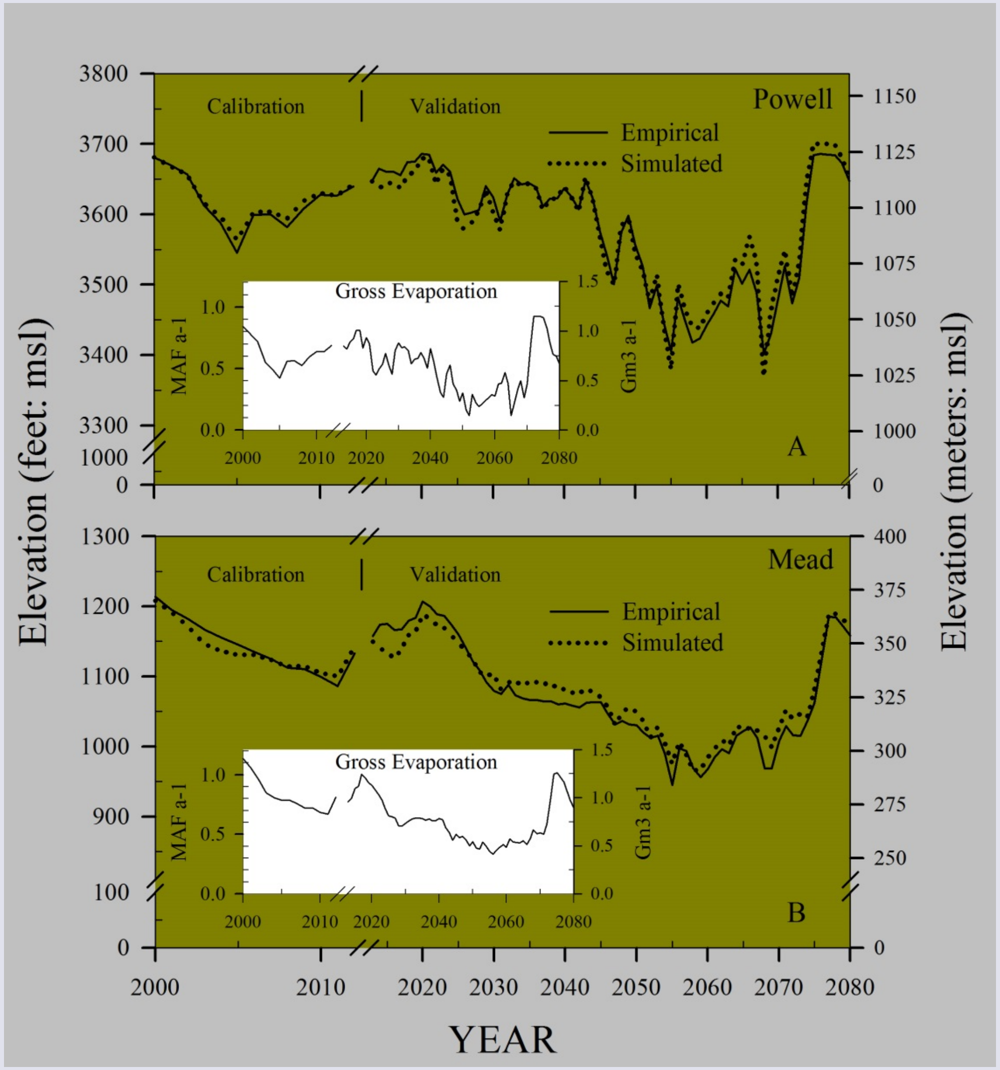
Colorado River



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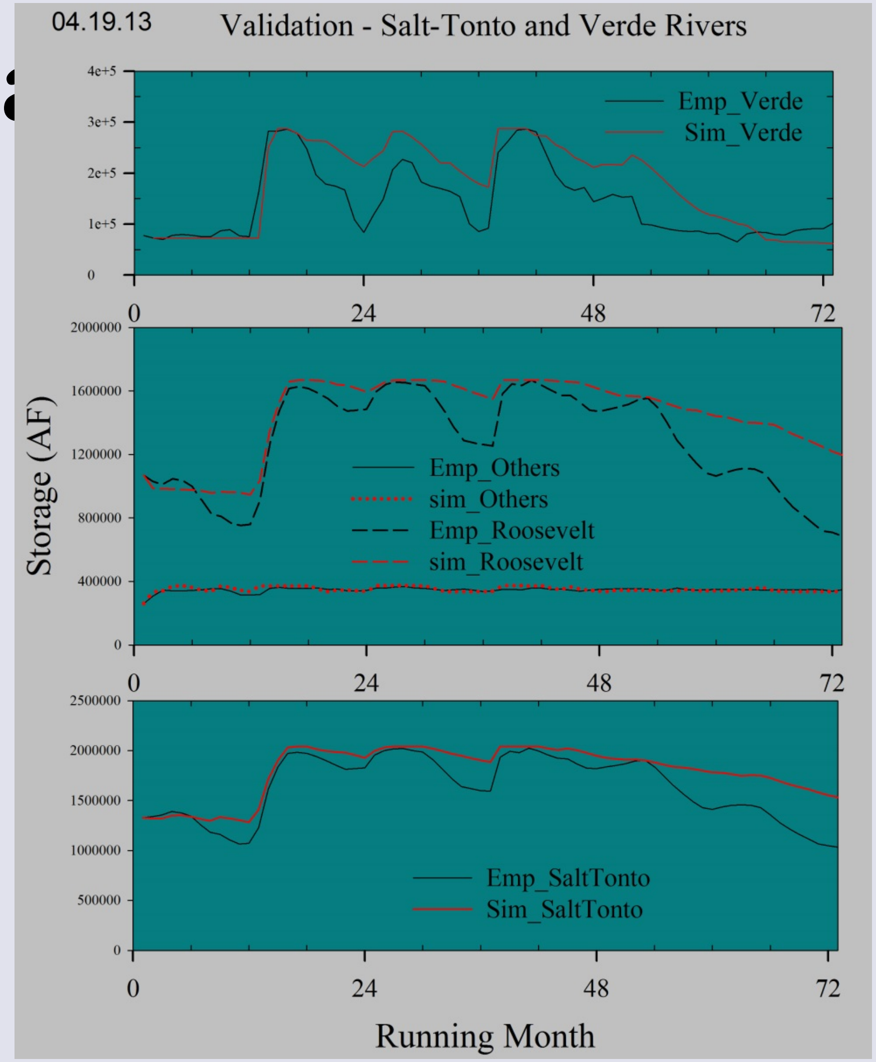

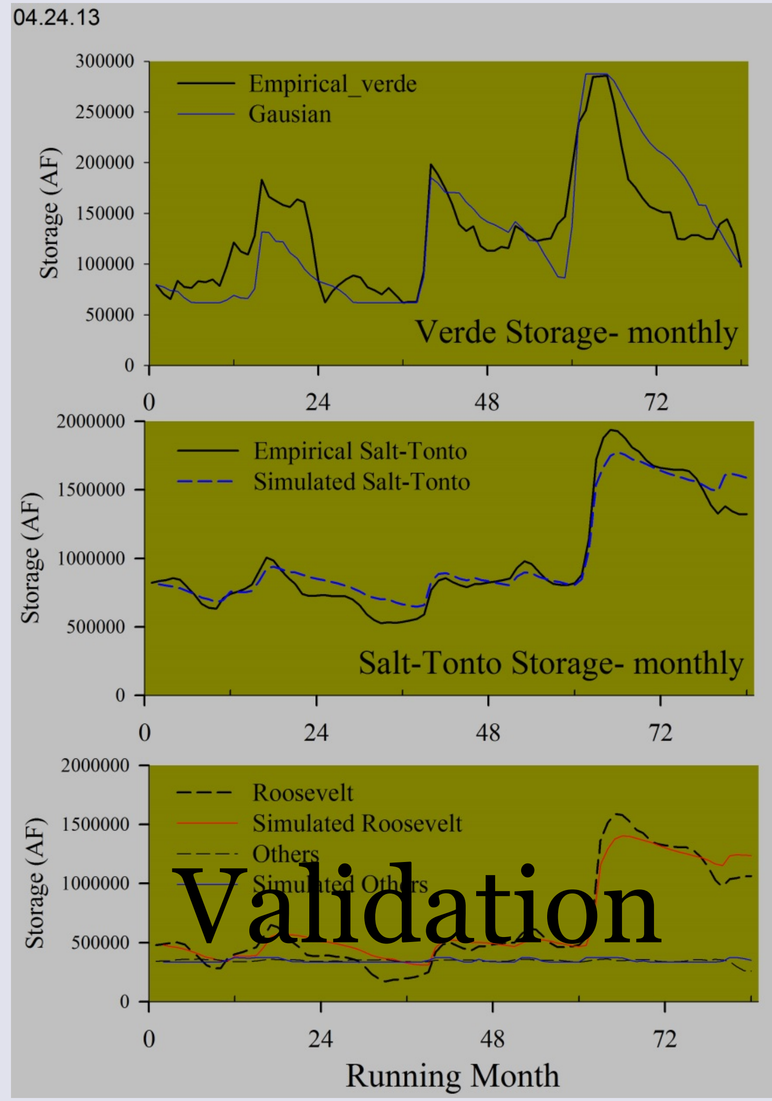

Validation

Water Provider/ Educator Participation

WaterSim Base Data for Phoenix

Item	Description	Units	Current Value	NewValue
Use GPCD	The GPCD that will be used if [Provider Demand Option] is set to Value=4.	GPCD	206	
% Effluent to Reclaimed Plant	The percent of Waste water effluent that is sent to a Reclaimed Plant (versus a traditional plant- see figure 1).	%	1	
% Total Wastewater is Usable Effluent	The percent of Waste water effluent that is used and not discharged into a water course (note: if PCEFFREC [below] is set to 100% no waste water is sent to the traditional WWTP and, so, no effluent will be available for partitioning).	%	81	
% Reclaimed to RO	The percent of reclaimed water that is sent to a Reverse Osmosis Plant (thus becomming potable water for direct injection or potable water for use in the next time-step).	%	0	
% RO to Water Supply	The percent of water from Reverse Osmosis Plant that is used for potable water.	%	0	
% Reclaimed to DirectInject	The percent of reclaimed water that is used to recharge an aquifer by direct injection into an aquifer.	%	0	
% Reclaimed to Water Supply	The percent of reclaimed water that is used to meet qualified user demands (non-potable).	%	100	
% Reclaimed to Vadose	The percent of reclaimed water that is delivered to a vadoze zone recharge basin.	%	0	
% Effluent to Vadose	The percent of wastewater effluent delivered to a vadose zone recharge basin.	%	4	

Communication Avenues

A. Stakeholder feedback
   1) Parameterization
   2) Policy Options (& metrics)
   3) Empirical Comparisons

B. Application Interface
   1) Framework (structure)
   2) Look and feel
   3) Visualization of Outputs

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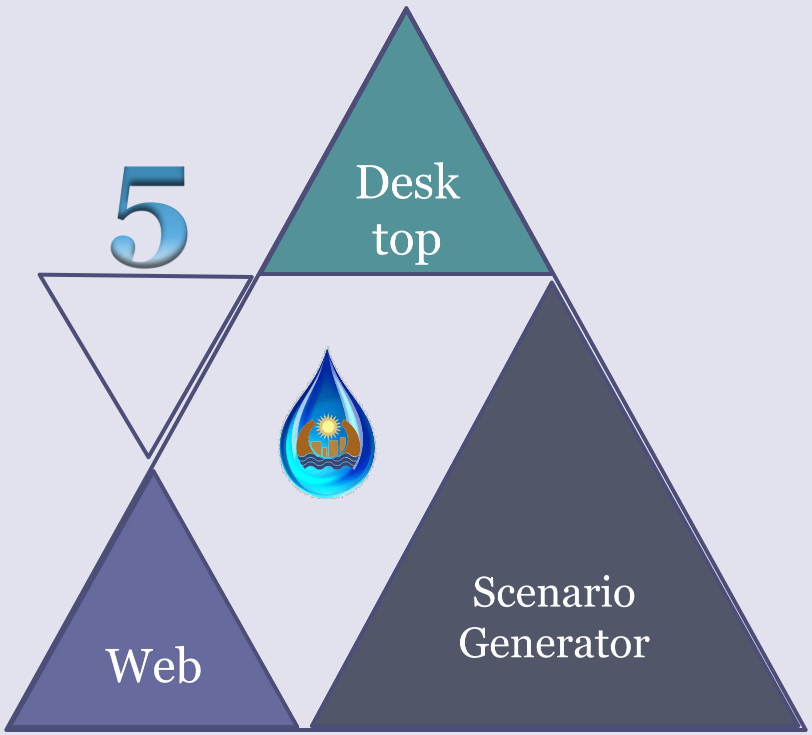
WaterSim Versions

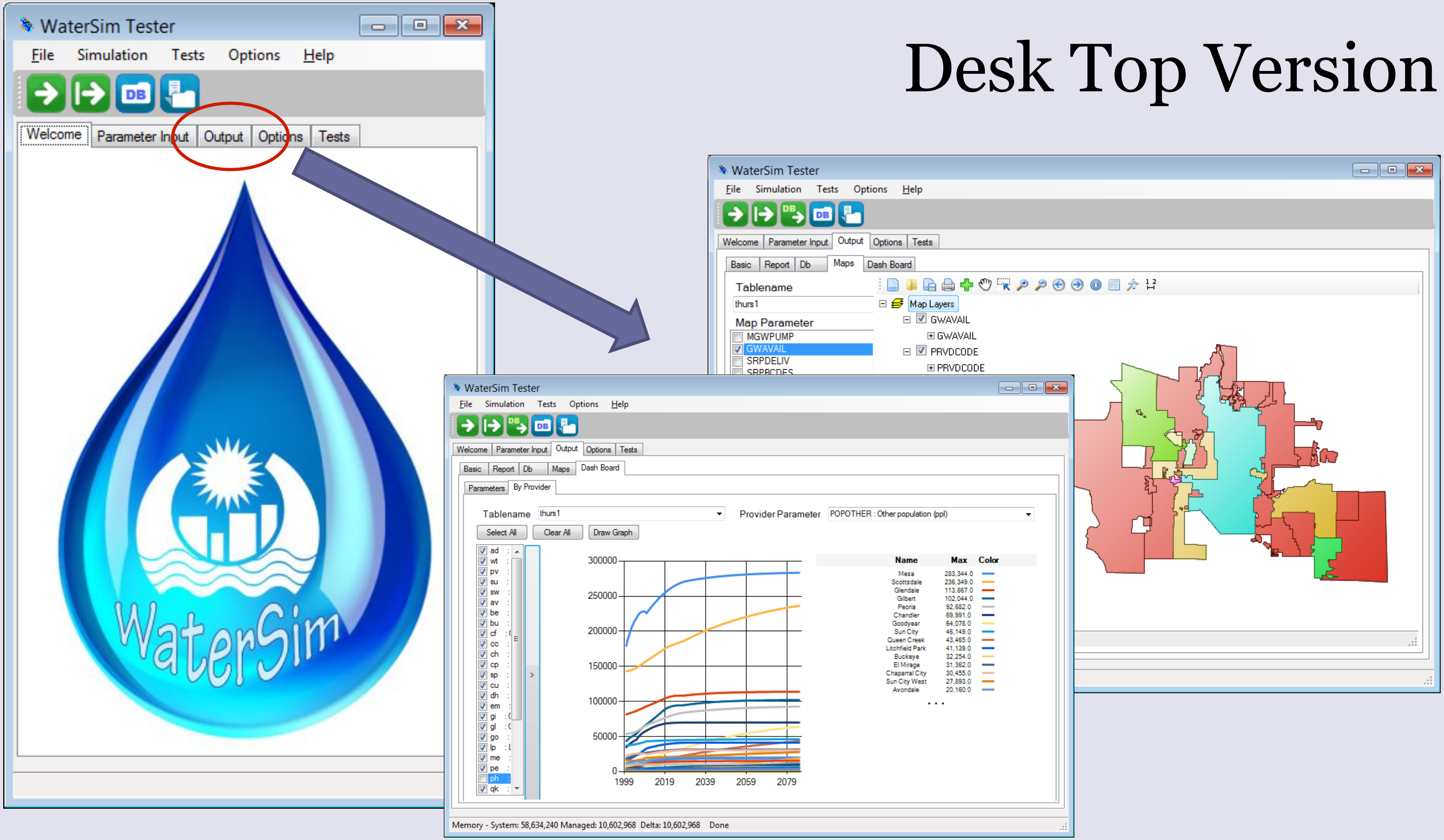


WaterSim is: Evolving water policy and management

- ✓ Physical model of rivers and reservoirs
- ✓ Policy model with management options
- ✓ Urban model with representative city infrastructure

Missing ....

Desk Top Version



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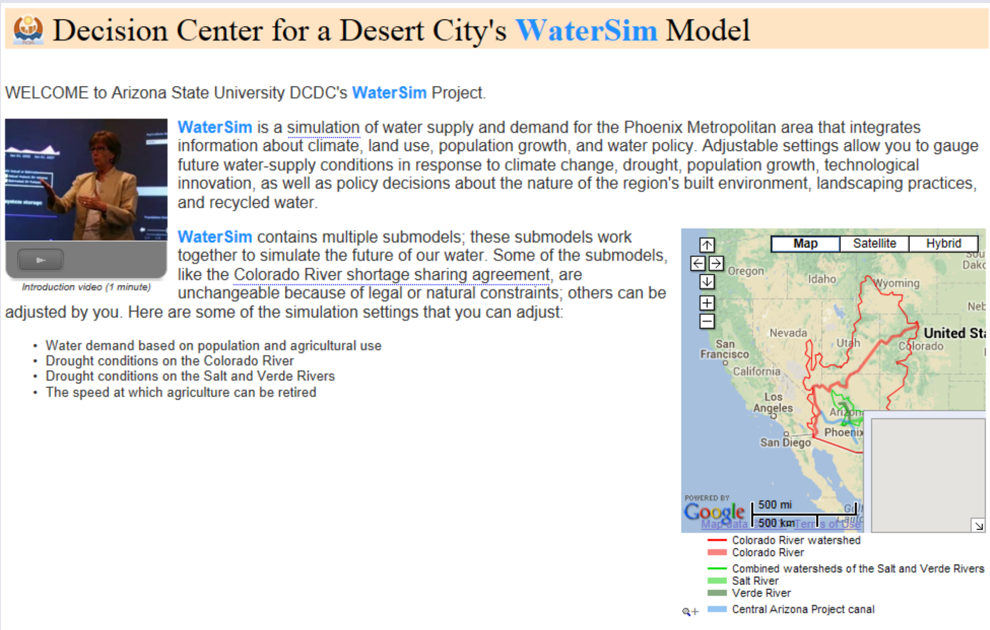
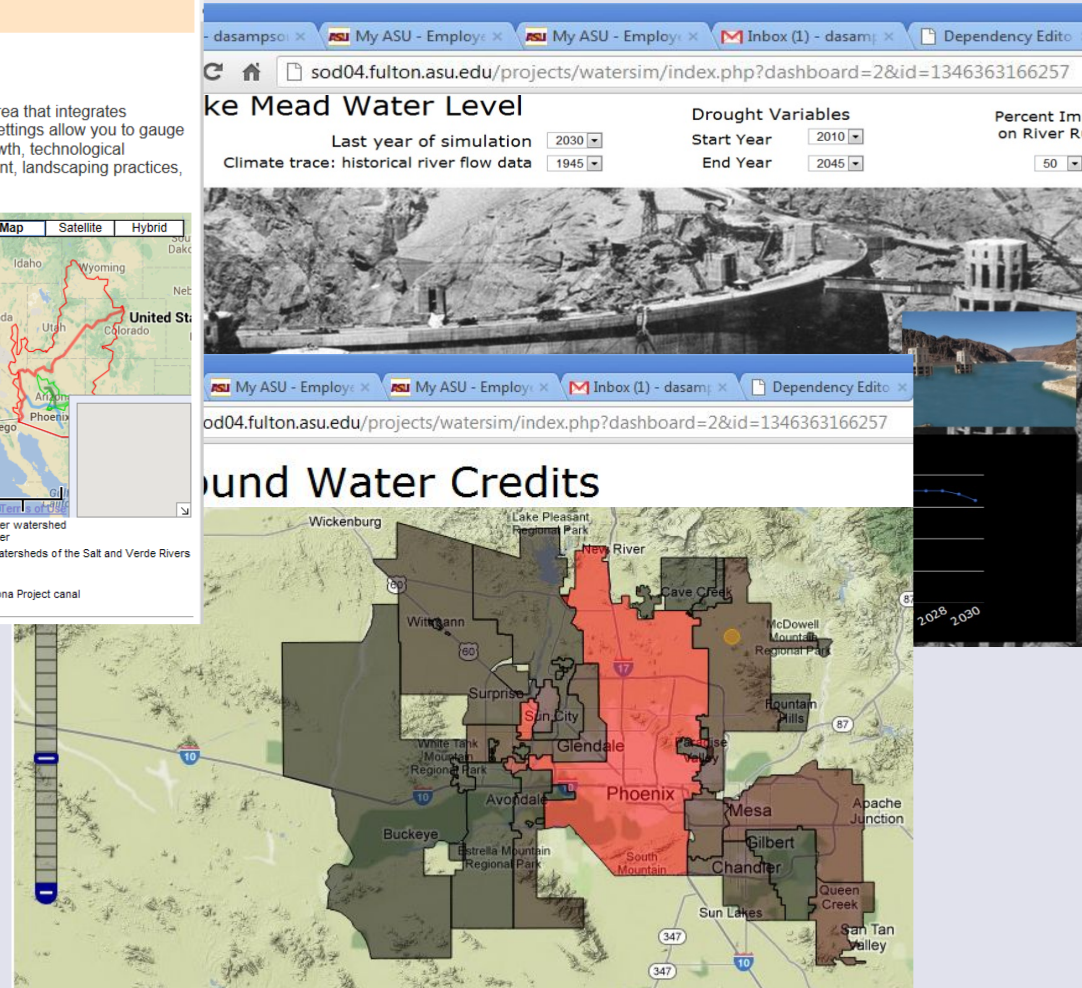
Web Version



Web Beta Version



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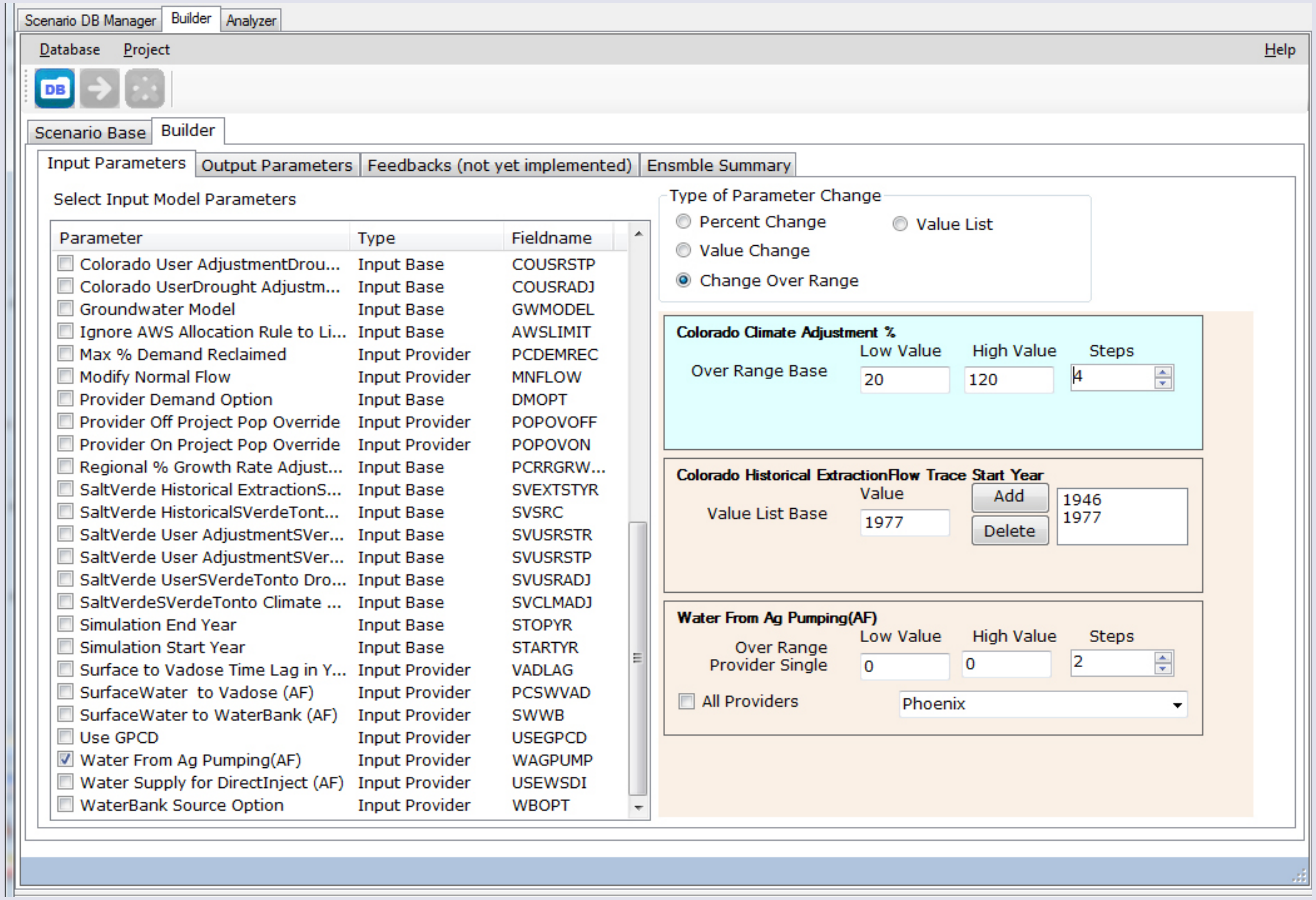
Scenario Generator



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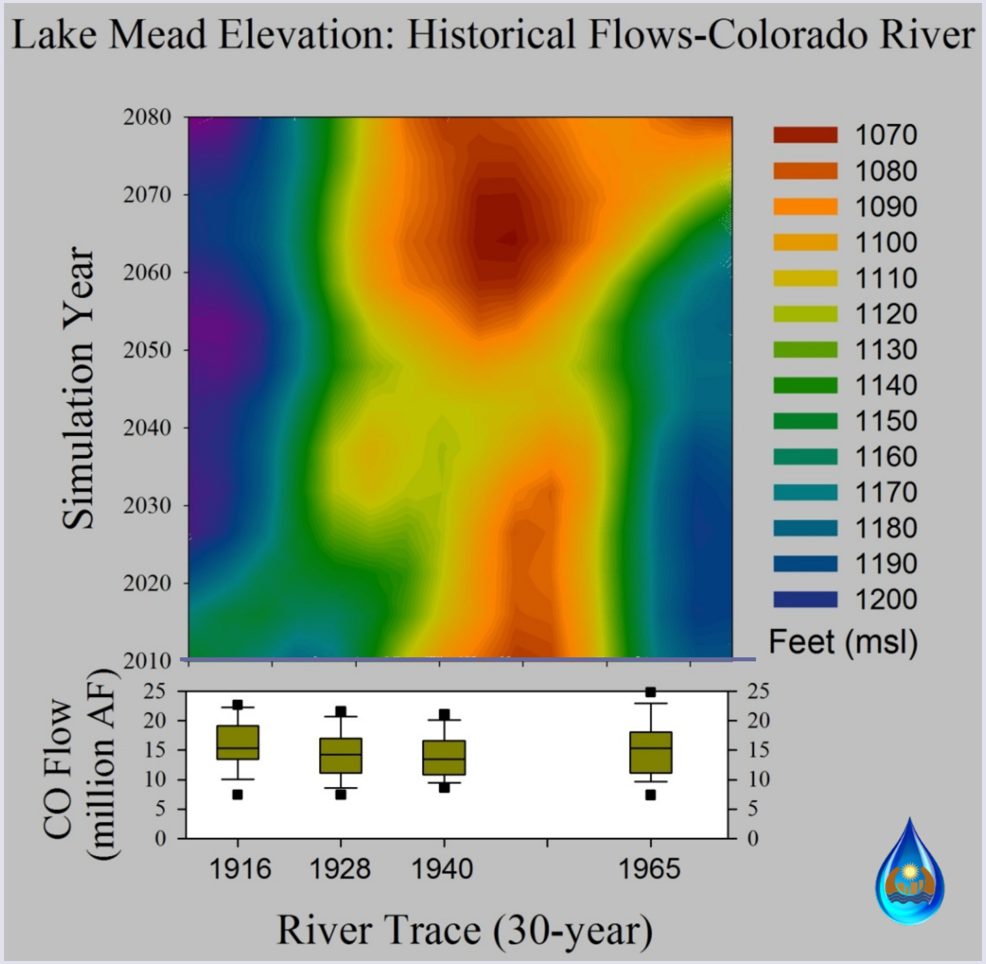
Sensitivity Analysis

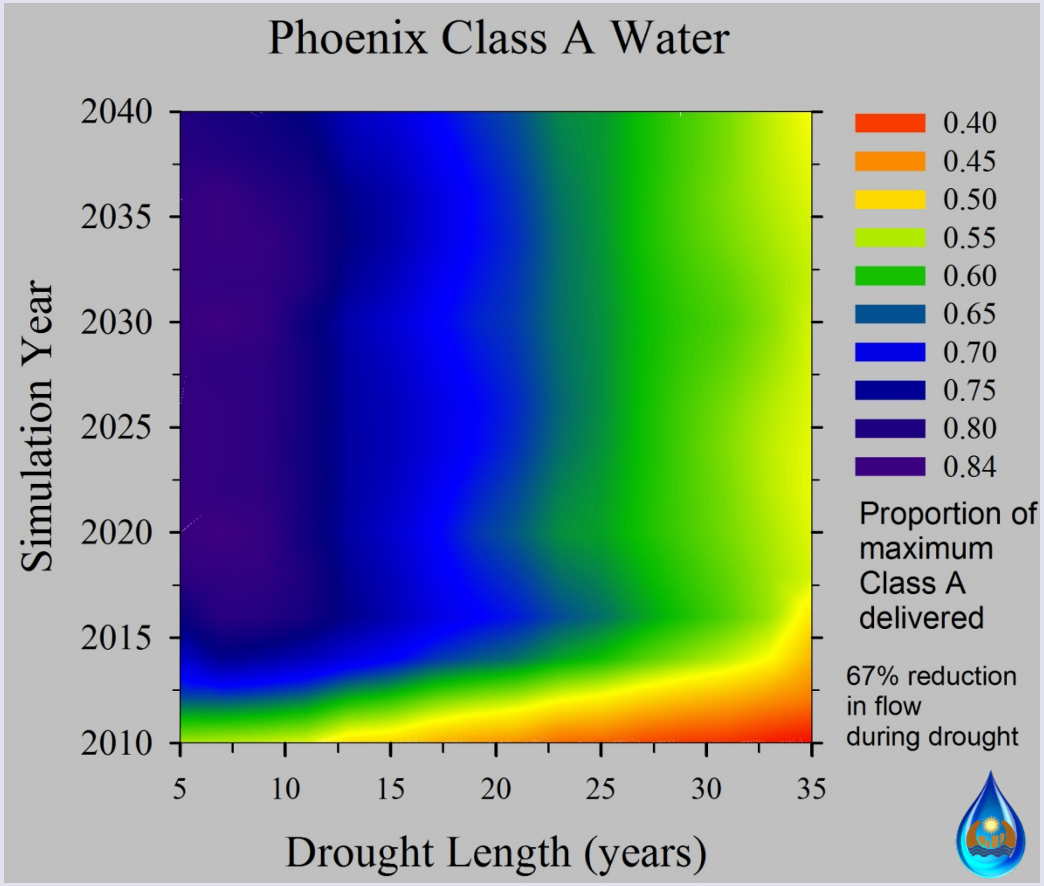
Lake Mead and Shortage Elevations



Trigger Points

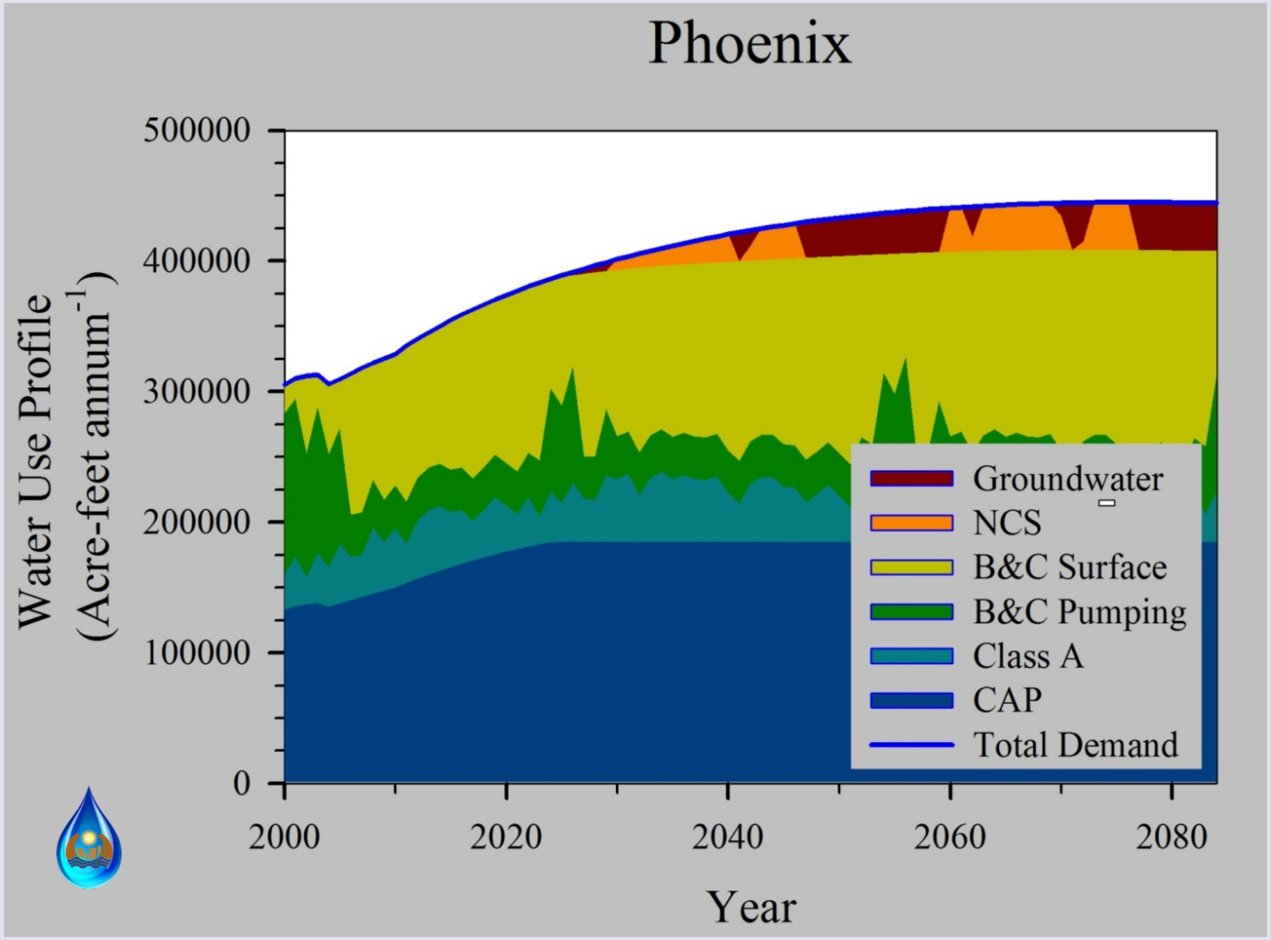
Sensitivity Analysis

Drought and Surface Water



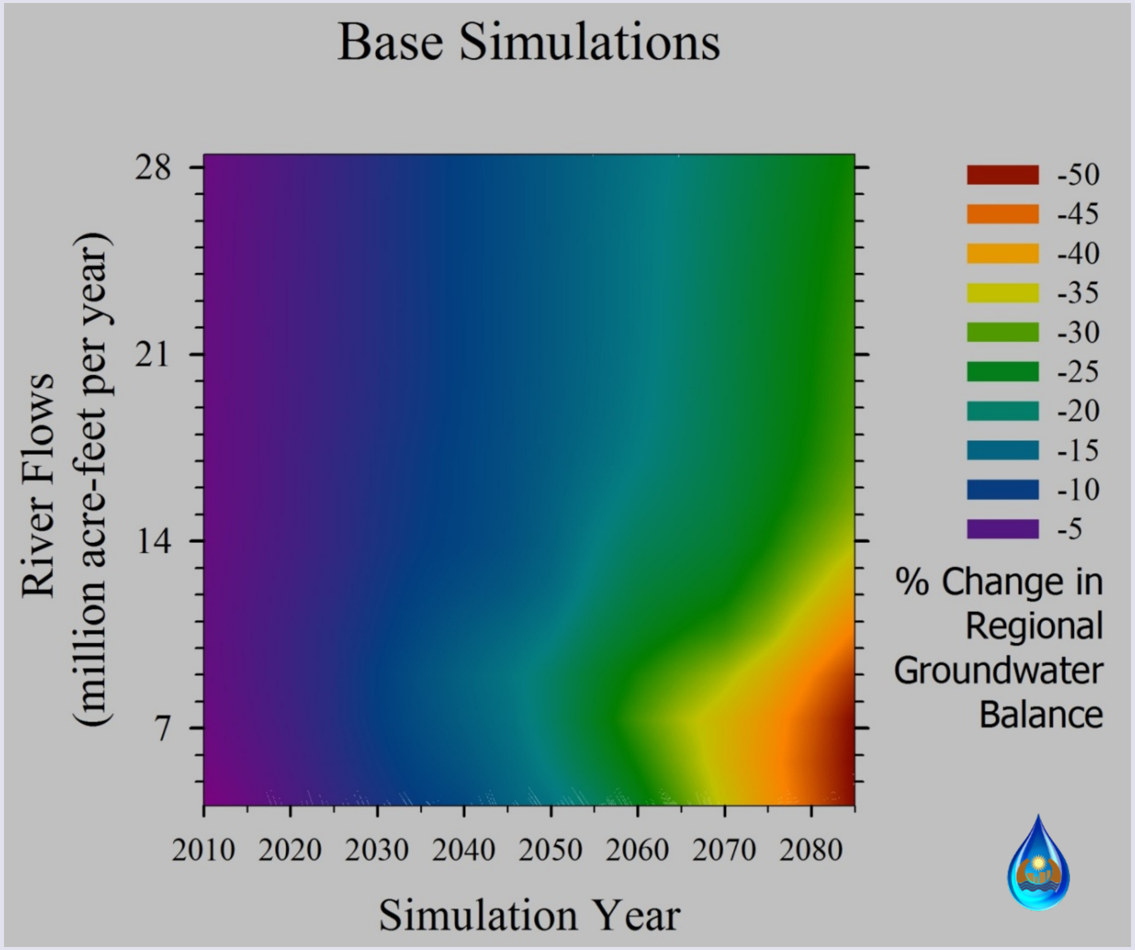
Simulations

Water Profile

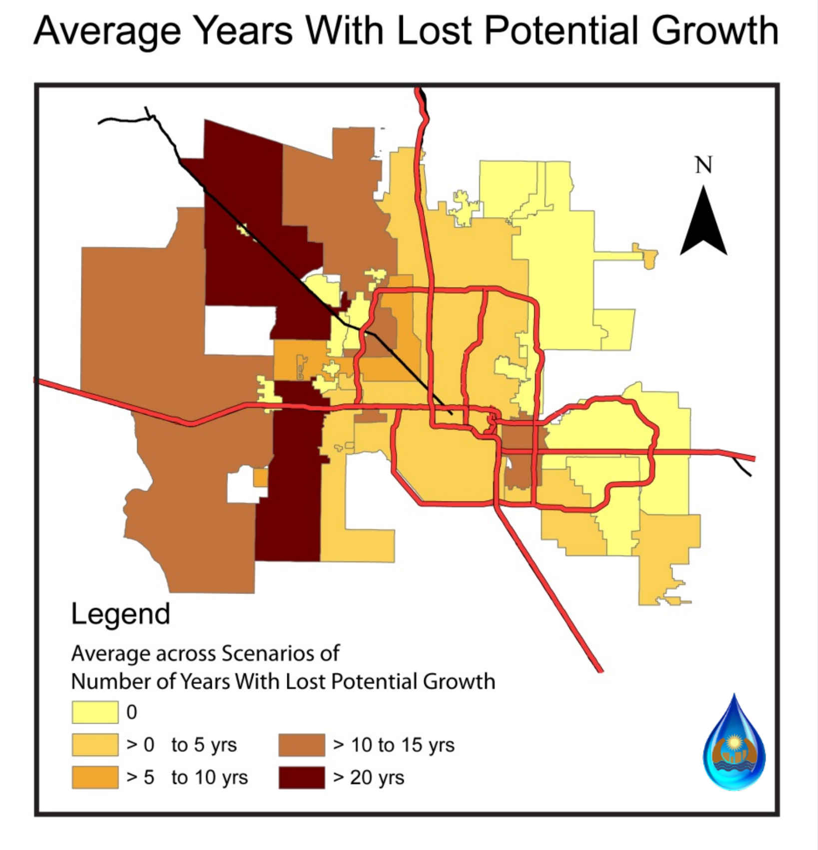


Scenario Analyses

Regional Groundwater



Summary



Open Source Software for:

1) Educators
2) Researchers
3) Water Managers

Future Work:

1) Verify Water Provider Inputs (profile data)
2) Create Interfaces that Water Managers will use
3) Explore Scenarios of Future Water Reality Potentials

Thank-you for your attention!