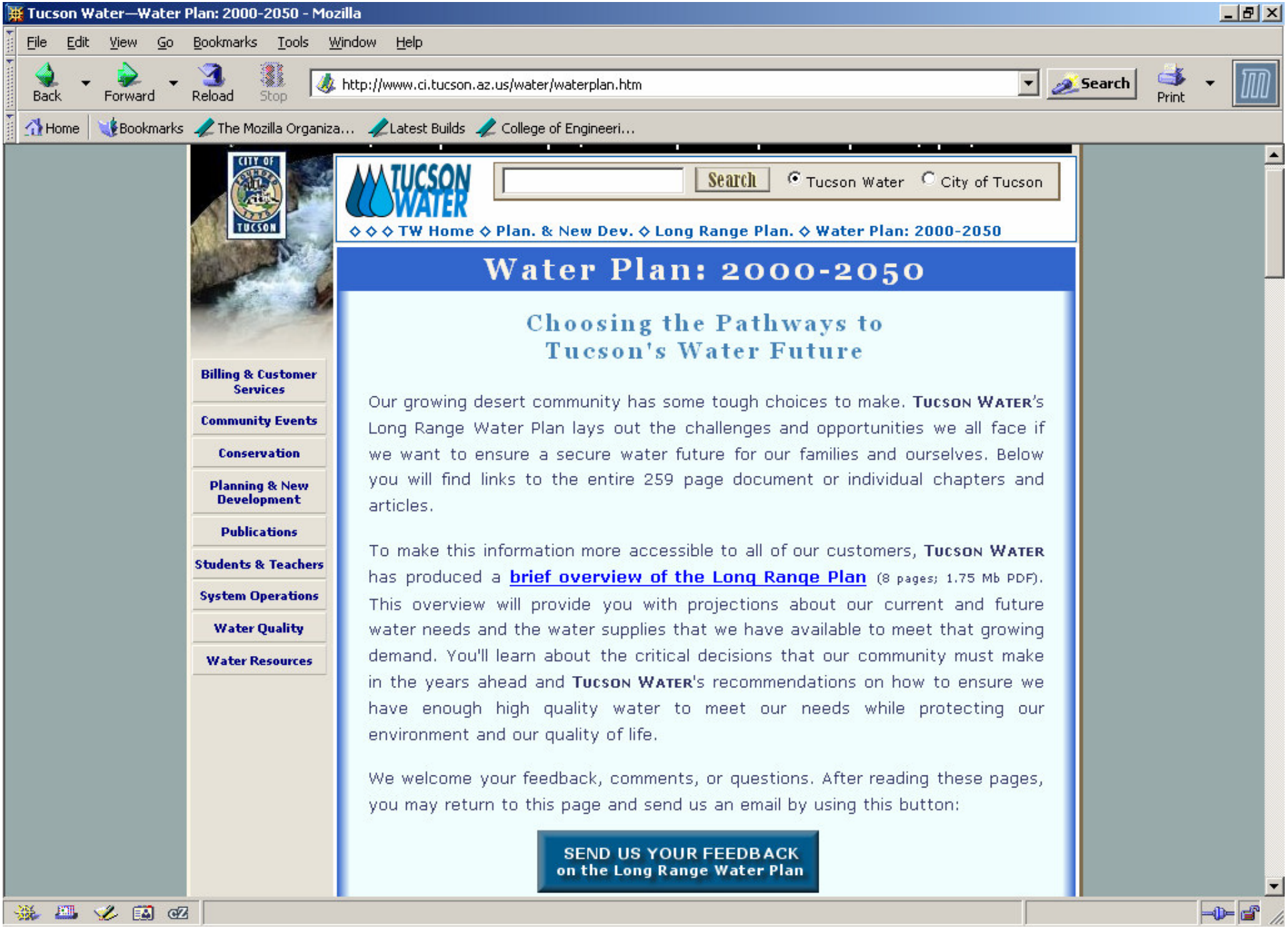
Tucson Water—Water Plan: 2000-2050 - Mozilla
File Edit View Go Bookmarks Tools Window Help
Back Forward Reload Stop
http://www.ci.tucson.az.us/water/waterplan.htm
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TUCSON WATER
Search
Tucson Water
City of Tucson
◇ ◇ ◇ TW Home ◇ Plan. & New Dev. ◇ Long Range Plan. ◇ Water Plan: 2000-2050
Billing & Customer Services
Community Events
Conservation
Planning & New Development
Publications
Students & Teachers
System Operations
Water Quality
Water Resources
Water Plan: 2000-2050
Choosing the Pathways to Tucson's Water Future
Our growing desert community has some tough choices to make. TUCSON WATER's Long Range Water Plan lays out the challenges and opportunities we all face if we want to ensure a secure water future for our families and ourselves. Below you will find links to the entire 259 page document or individual chapters and articles.
To make this information more accessible to all of our customers, TUCSON WATER has produced a brief overview of the Long Range Plan (8 pages; 1.75 Mb PDF). This overview will provide you with projections about our current and future water needs and the water supplies that we have available to meet that growing demand. You'll learn about the critical decisions that our community must make in the years ahead and TUCSON WATER's recommendations on how to ensure we have enough high quality water to meet our needs while protecting our environment and our quality of life.
We welcome your feedback, comments, or questions. After reading these pages, you may return to this page and send us an email by using this button:
SEND US YOUR FEEDBACK on the Long Range Water Plan

A Groundwater-Dynamic Simulation Decision Support System:

Application to the Upper San Pedro Basin

Derya Sumer, Gunhui Chung, Doo Sun Kang, Kevin Lansey

Dept. of Civil Eng. and Eng. Mech.

The University of Arizona

Holly Richter

The Nature Conservancy

Types of Decision Support Systems

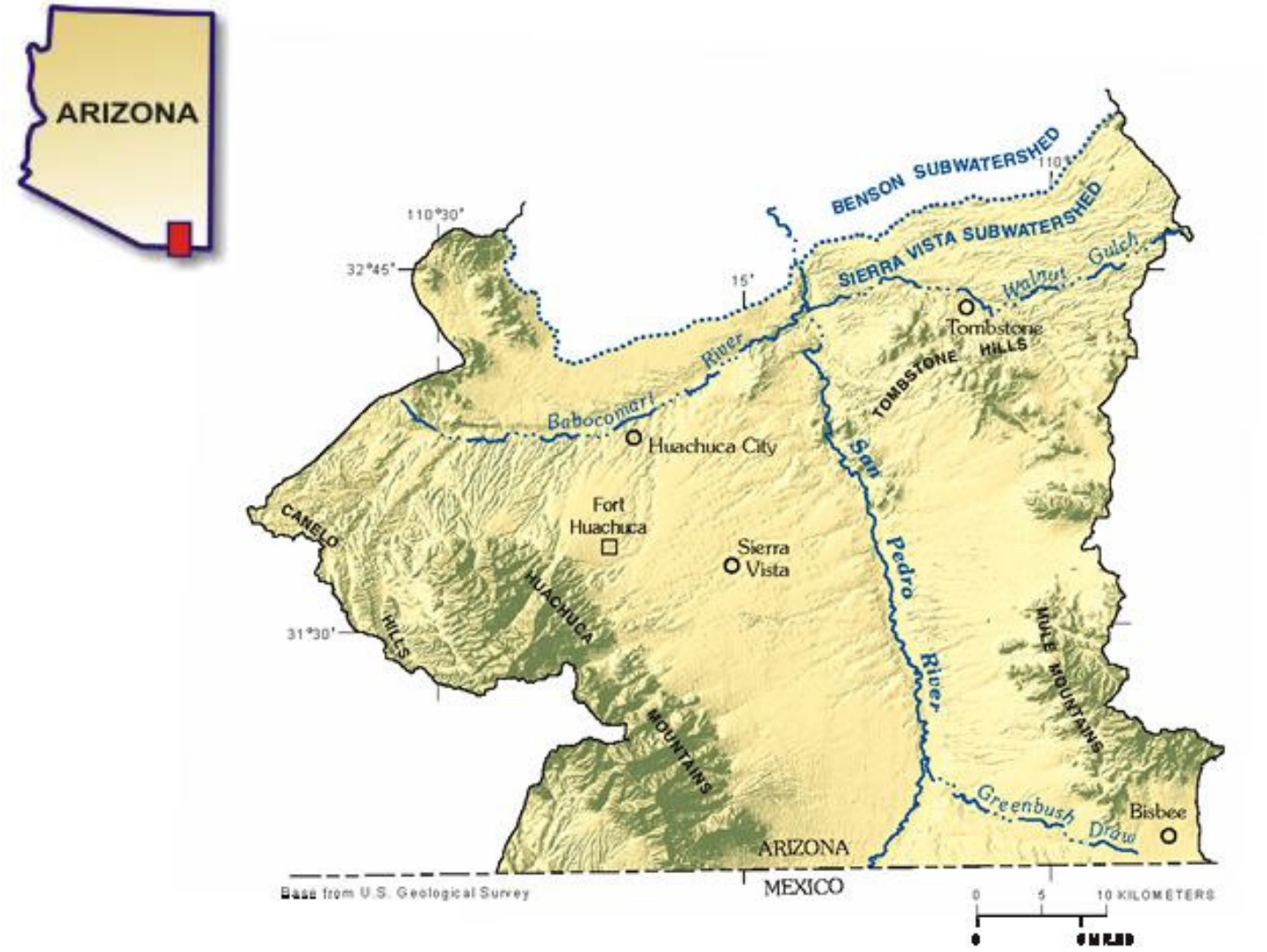
Goal: To provide decision makers information to improve their choices

1) Presentation/visualization of information, particularly spatial data, to understand present and potential future conditions.

2) Prediction of future conditions resulting from a set of decisions and display of one or more evaluation criteria

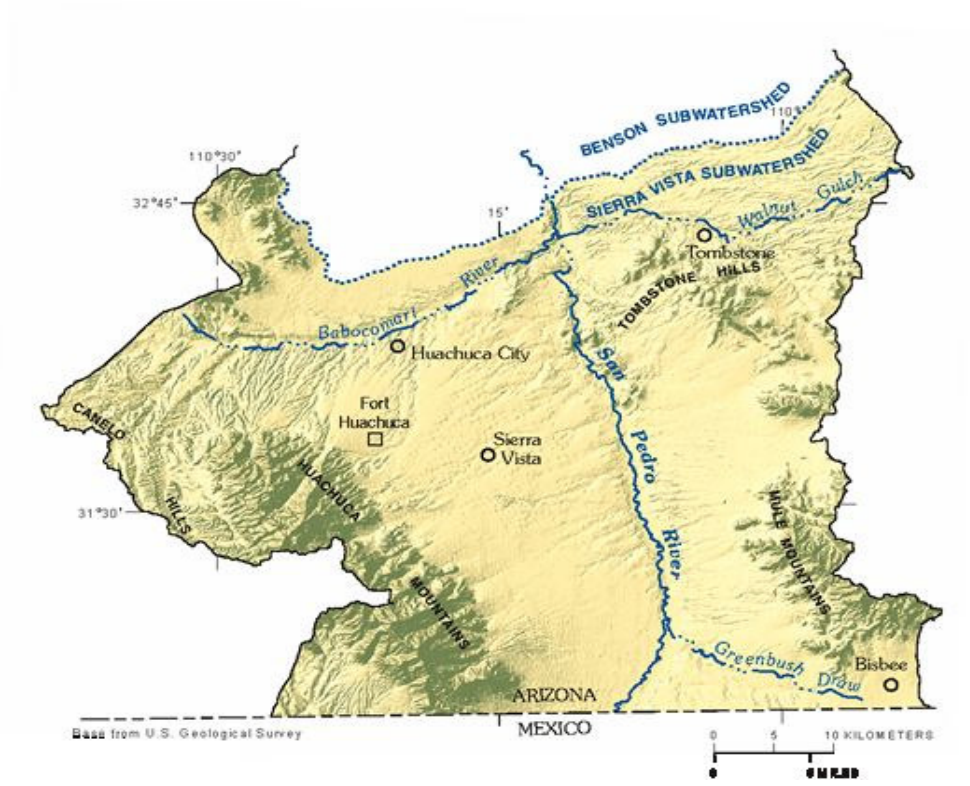
3) Select decisions to optimize one or more criteria – compare solutions and objective function values

Location


ARIZONA
BENSON SUBWATERSHED
SIERRA VISTA SUBWATERSHED
Walnut Gulch
Tombstone
TOMBSTONE HILLS
San Pedro River
Babocomari River
Huachuca City
Fort Huachuca
Sierra Vista
CANELO HILLS
HUACHUCA MOUNTAINS
MULE MOUNTAINS
Greenbush Draw
Bisbee
ARIZONA
MEXICO
110°30'
32°45'
15'
31°30'
Base from U.S. Geological Survey
0 5 10 KILOMETERS

Background

- Five municipalities plus unincorporated county
- Ft. Huachuca military base
- Total population ~ 68000 people (about half in Sierra Vista)
- San Pedro National Conservation Area
- Estimated annual recharge
  ~ 21500 acre-ft
- Groundwater overdraft
  ~ 8400 acre-ft/yr
- SPRNCA requirements
  ~ 7,700 acre-ft/yr

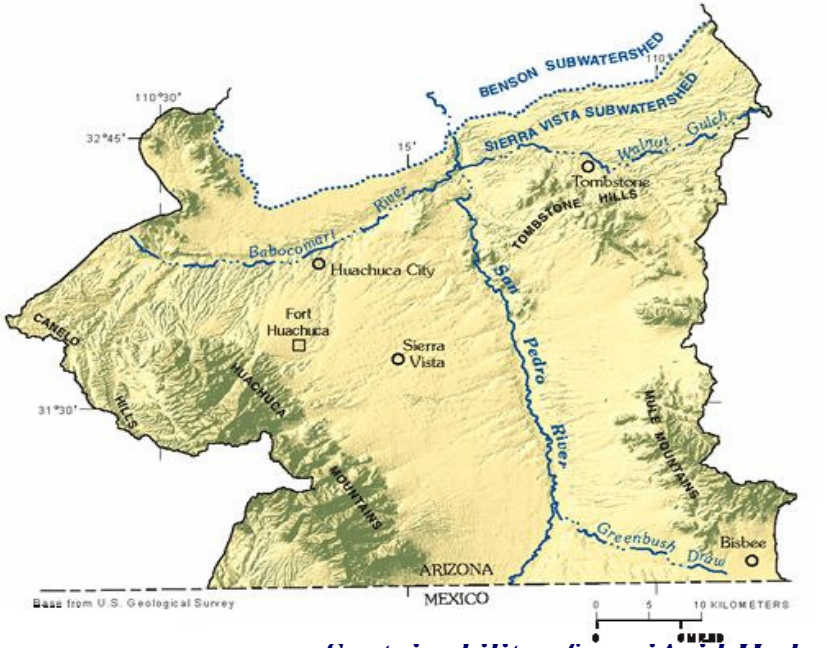


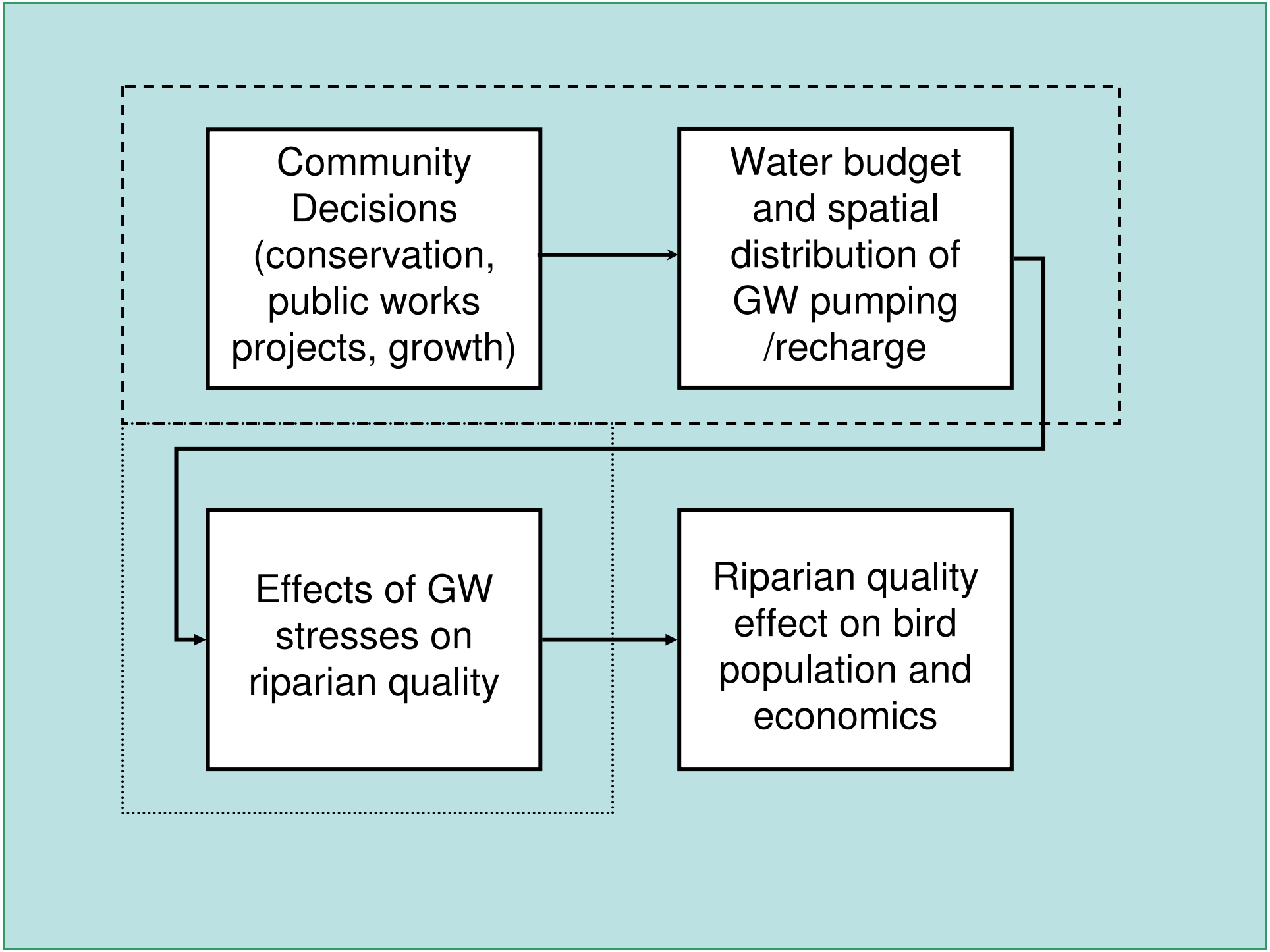
Challenge

- The San Pedro River supports riparian forests that is home to many bird and plant species.
- Freshwater resources in the valley are also shared by nearby cities, a diverse and growing community of users.
- Supplying water needs for the public as well as ensuring the sustainability of the San Pedro River given the wide spectrum of social, cultural and economic values.
- Satisfy recent federal mandate to provide a “sustainable” system

Challenge

- Mountain front recharge from Huachuca Mtns is primary long term water supply
- Sierra Vista pumping occurs between source and river
- Pumping drawdown will eventually affect river flows and GW levels near the San Pedro. However, long travel time from mountains to river and large area.




Community Decisions (conservation, public works projects, growth)
Water budget and spatial distribution of GW pumping /recharge
Effects of GW stresses on riparian quality
Riparian quality effect on bird population and economics

San Pedro Subwatershed Decision Support System

OBJECTIVE:

- To provide a decision making tool for water budget in the subwatershed.
  - Provide basis for understanding impacts of alternative decisions for decision makers and general public
  - Identify cost effective alternative water conservation measures
- Allows users to select among many alternative conservation measures.
- Easy to examine different combinations and to determine if water balance is achieved.

Limitations/cautions

DSS modeling: Generally uses available information and science to develop relationships and model input and presents in way decision makers can use the information

1) DSS computes water demands, consumptive use, and return flows based on demographic data that is calibrated to local records (e.g., turf areas and private well use)
2) Riparian water use taken from Water Needs study
3) Natural recharge agreed upon based on Water Needs and other sources.
4) GW responses developed using recently completed USGS model

MODEL OVERVIEW

- Dynamic simulation software - Powersim
- Simple interfaces
- Web accessible
- Spreadsheet connections
- Public education benefits

PHASE I - AGGREGATED MODEL USING POWERSIM

- Model will include
  - Water demands
  - Population growth
  - Conservation measures
  - Available surface and groundwater resources
  - Development of water use/consumption from micro-level (households) to macro-scale (community)
  - Economic costs of alternative conservation measures

HOW DOES THE MODEL WORK?

- Model divided into several components:

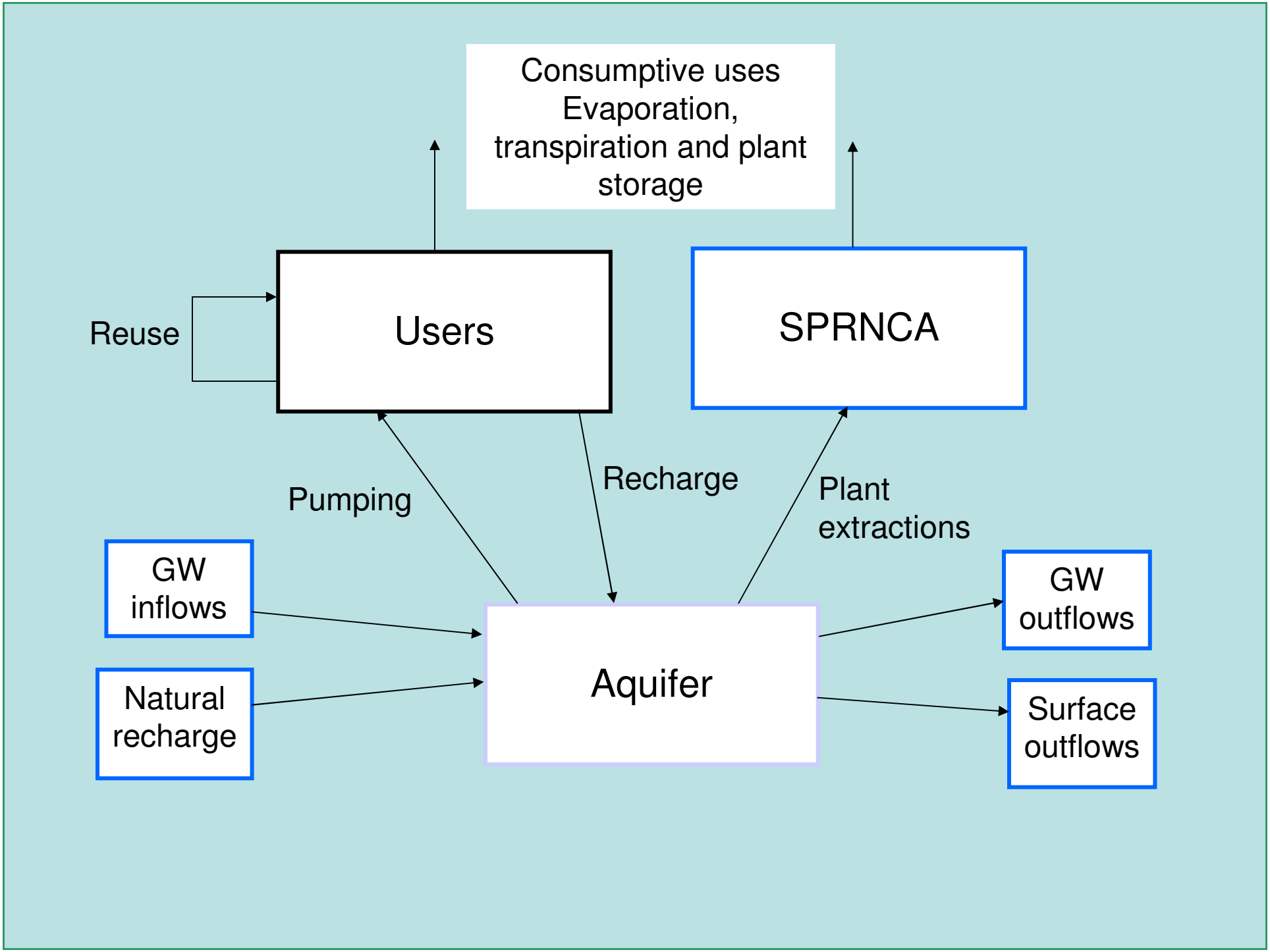
  - Surface water supply
  - Groundwater storage

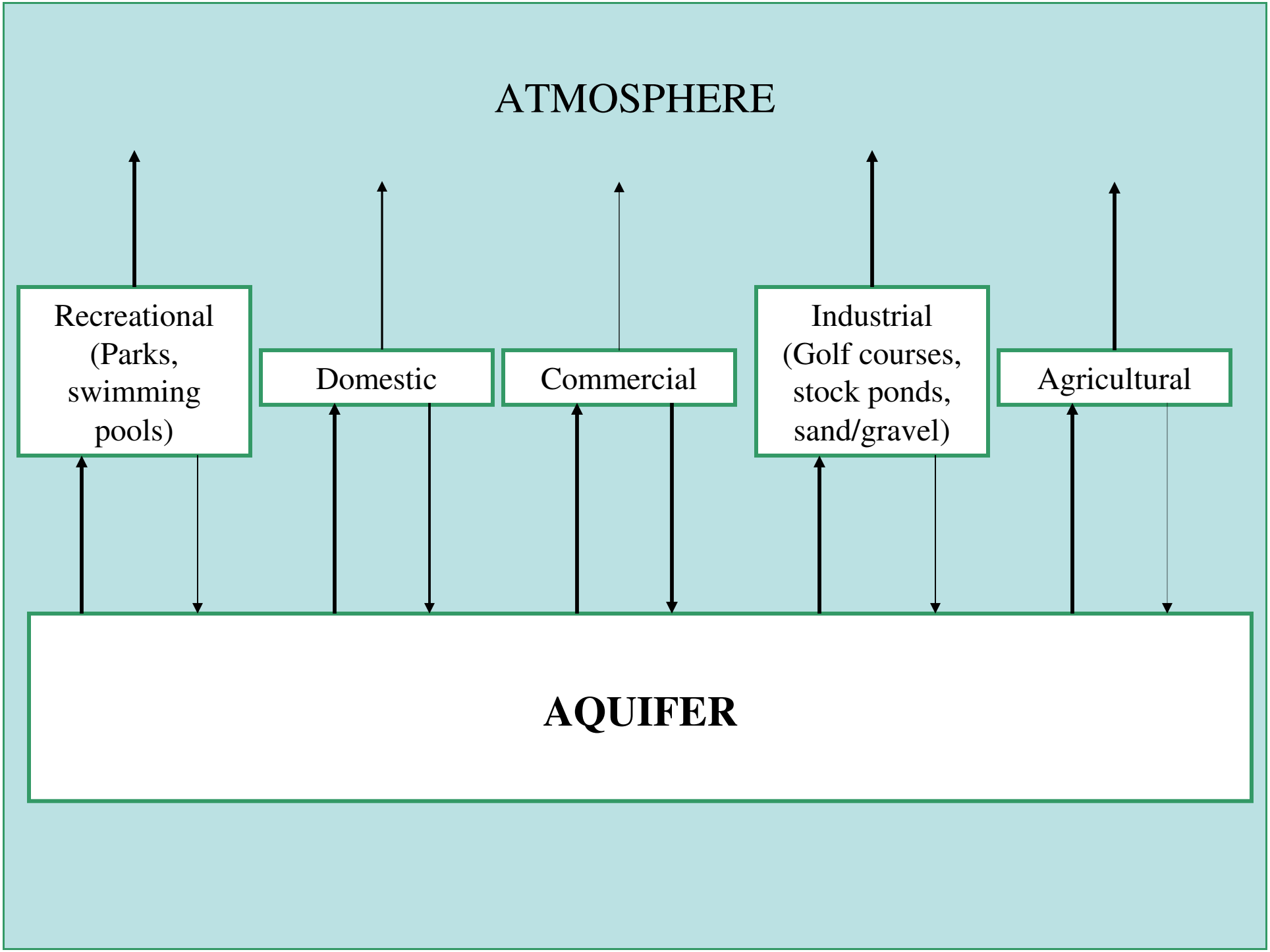
  } **SUPPLY**

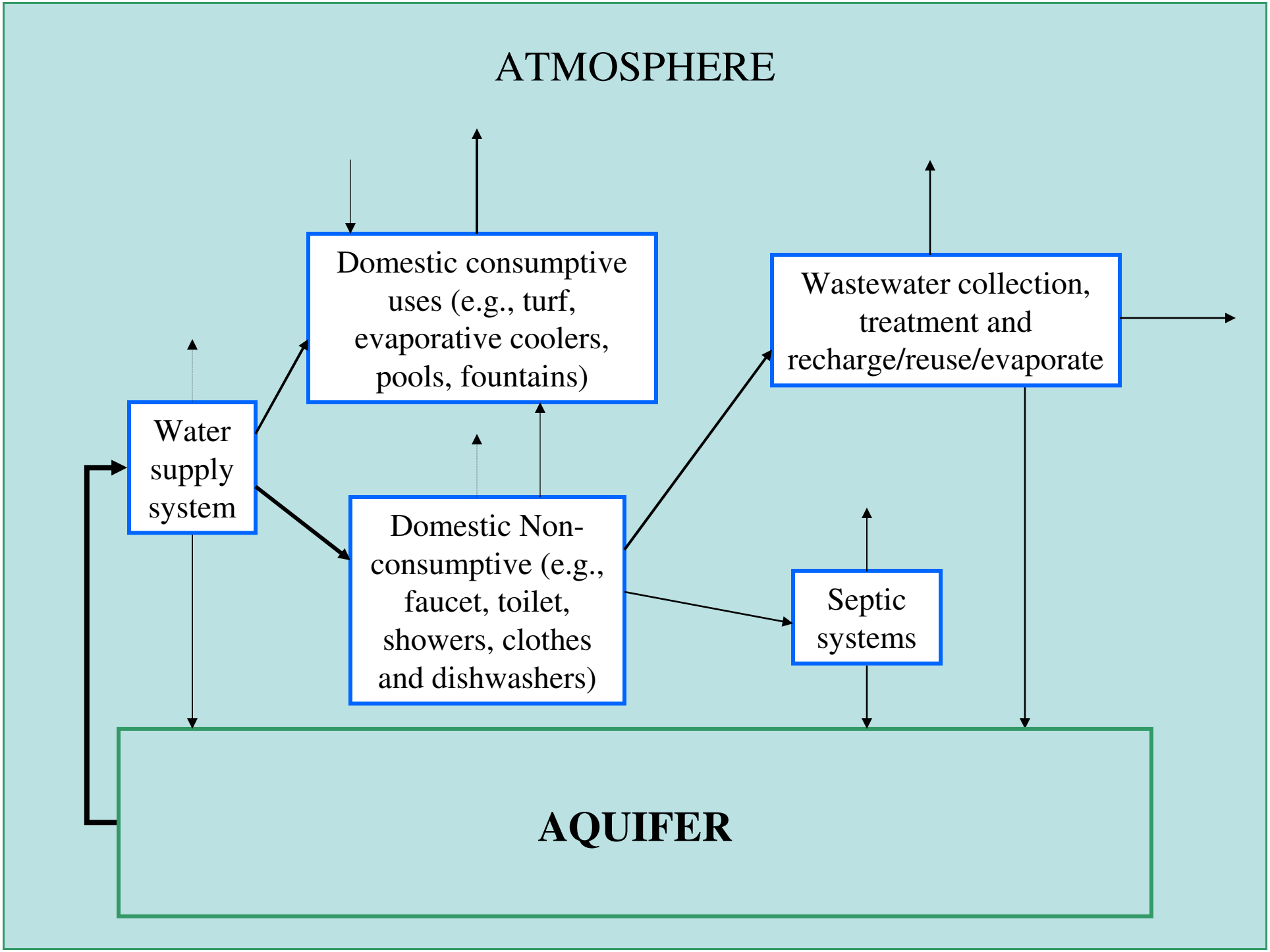
  - Residential uses in each city
  - Commercial uses
  - Irrigated agriculture uses
  - Recreational uses
  - San Pedro National Conservation Area (SPRNCA)

  } **DEMAND**

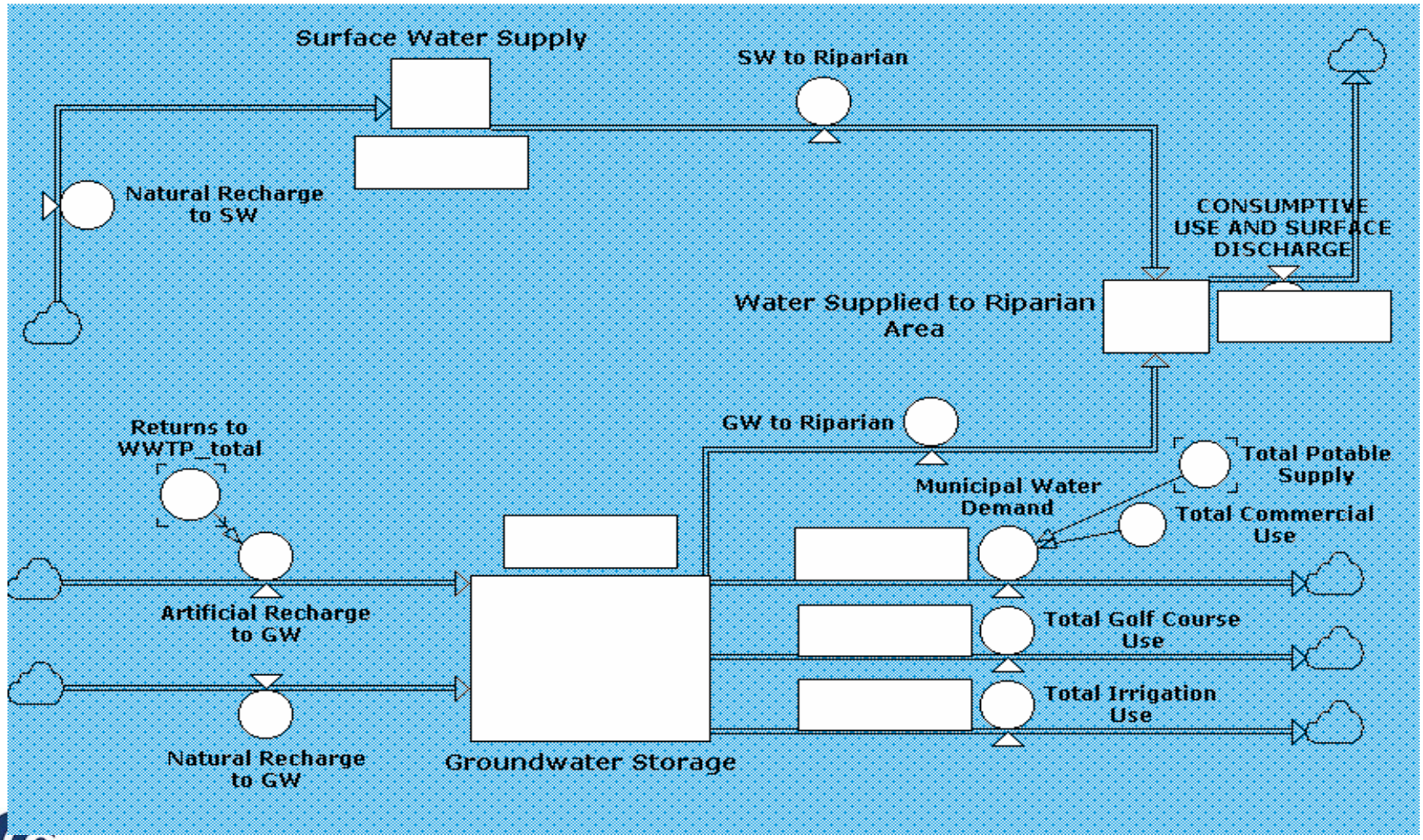
- Possible water conservation methods are modeled within each component (60 potential alternatives)


Consumptive uses
Evaporation, transpiration and plant storage
Reuse
Users
SPRNCA
Pumping
Recharge
Plant extractions
GW inflows
Natural recharge
Aquifer
GW outflows
Surface outflows

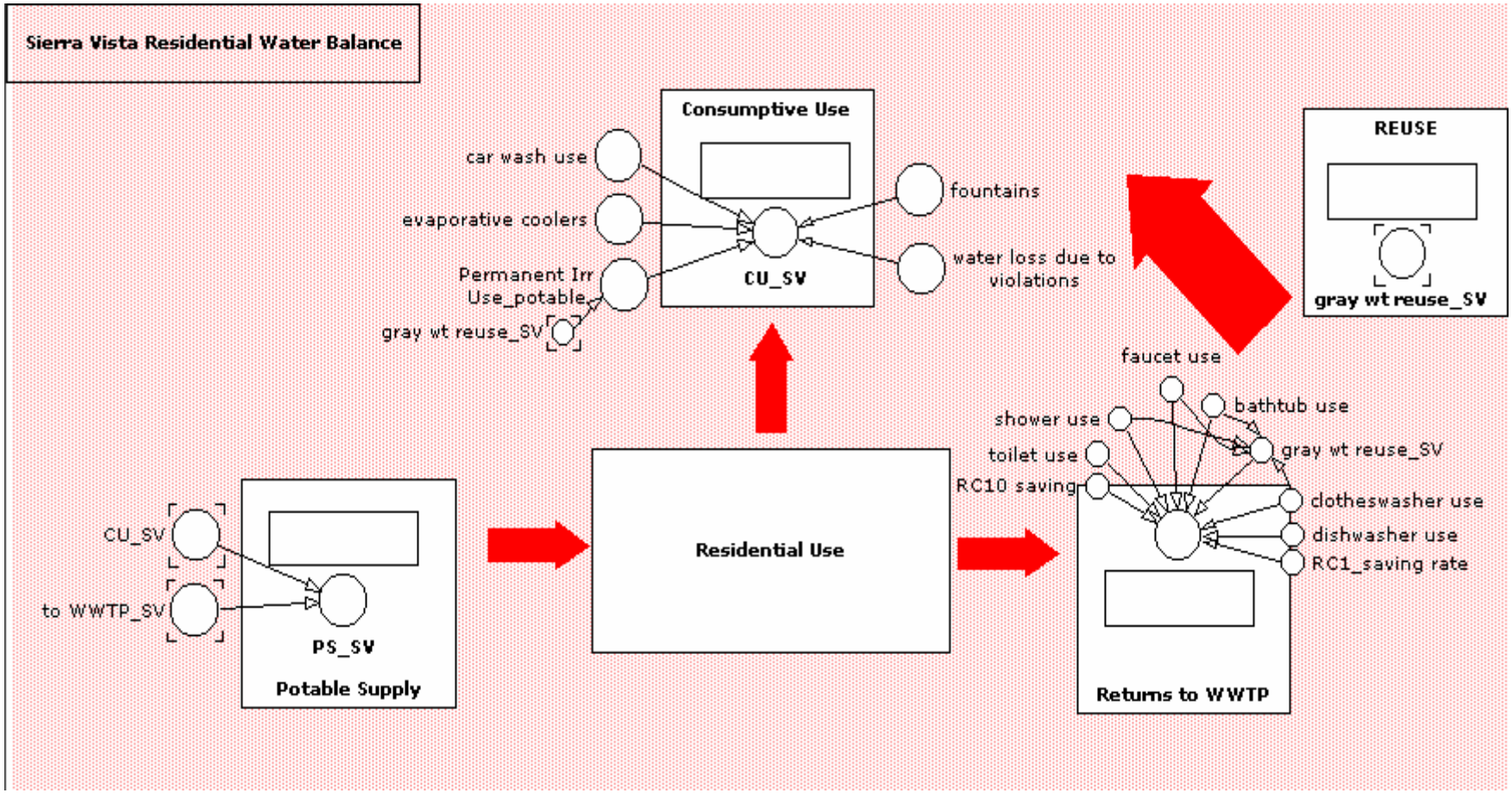

ATMOSPHERE
Recreational (Parks, swimming pools)
Domestic
Commercial
Industrial (Golf courses, stock ponds, sand/gravel)
Agricultural
AQUIFER


ATMOSPHERE
Domestic consumptive uses (e.g., turf, evaporative coolers, pools, fountains)
Wastewater collection, treatment and recharge/reuse/evaporate
Water supply system
Domestic Non-consumptive (e.g., faucet, toilet, showers, clothes and dishwashers)
Septic systems
AQUIFER

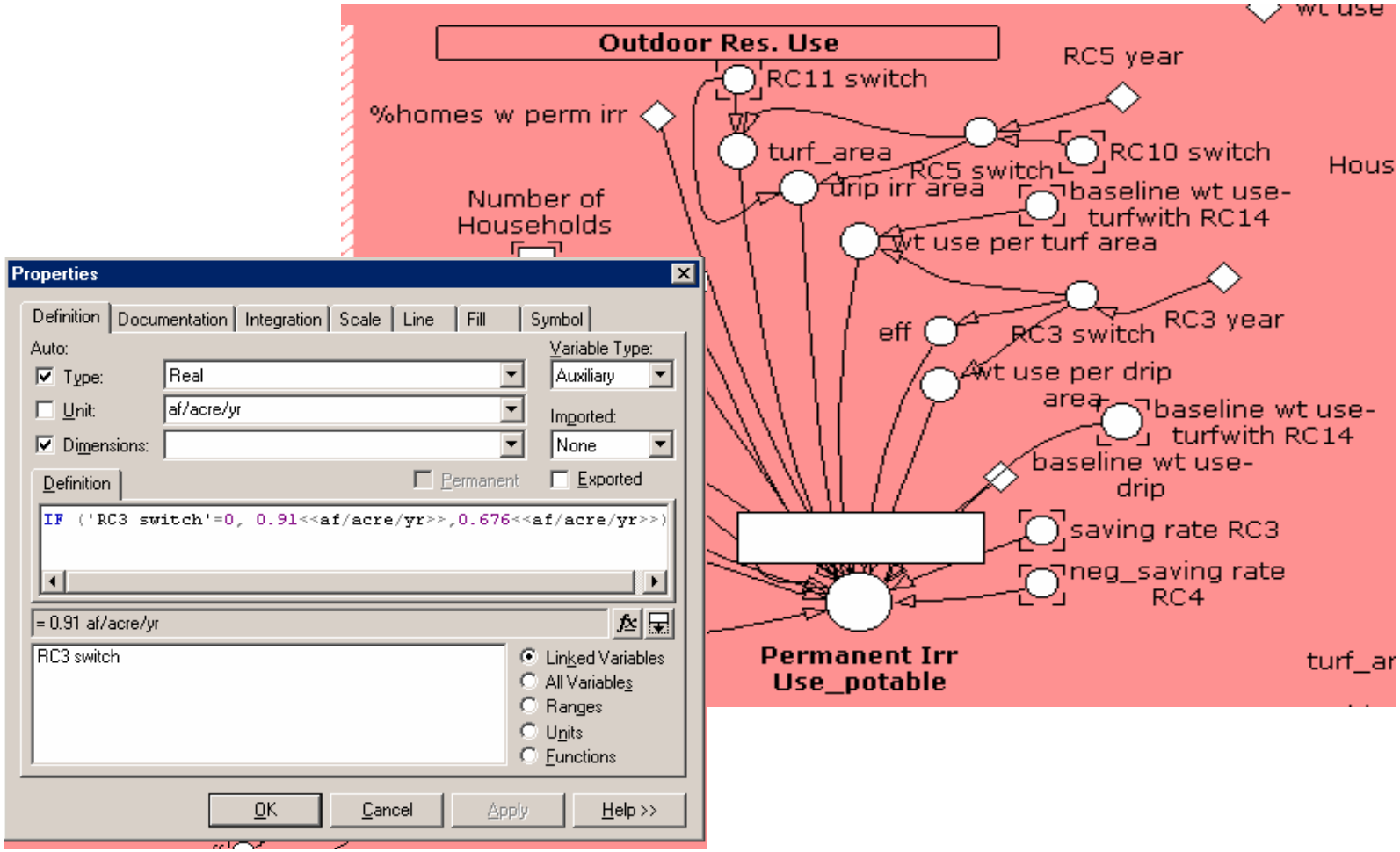
San Pedro Subwatershed Decision Support System



San Pedro Subwatershed Decision Support System



San Pedro Subwatershed Decision Support System



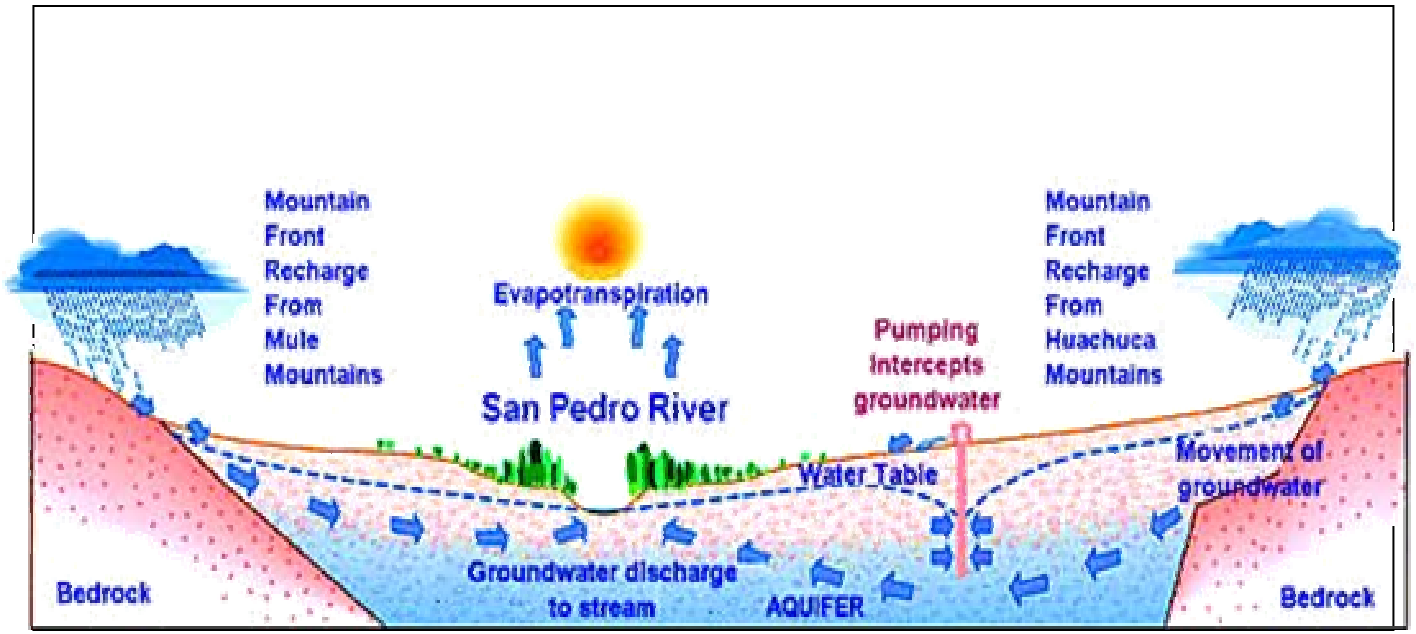
HOW DOES THE MODEL WORK?

- Components are tied to each other to form the water balance in the subwatershed.
- The selection of each conservation measure can be done within a 20 or 50-year simulation period (annual time step).
- Once a scenario is created, the model performs a water balance for 20 or 50 years and a cost analysis.

San Pedro Subwatershed Decision Support System

- Model application

PHASE II MODELING

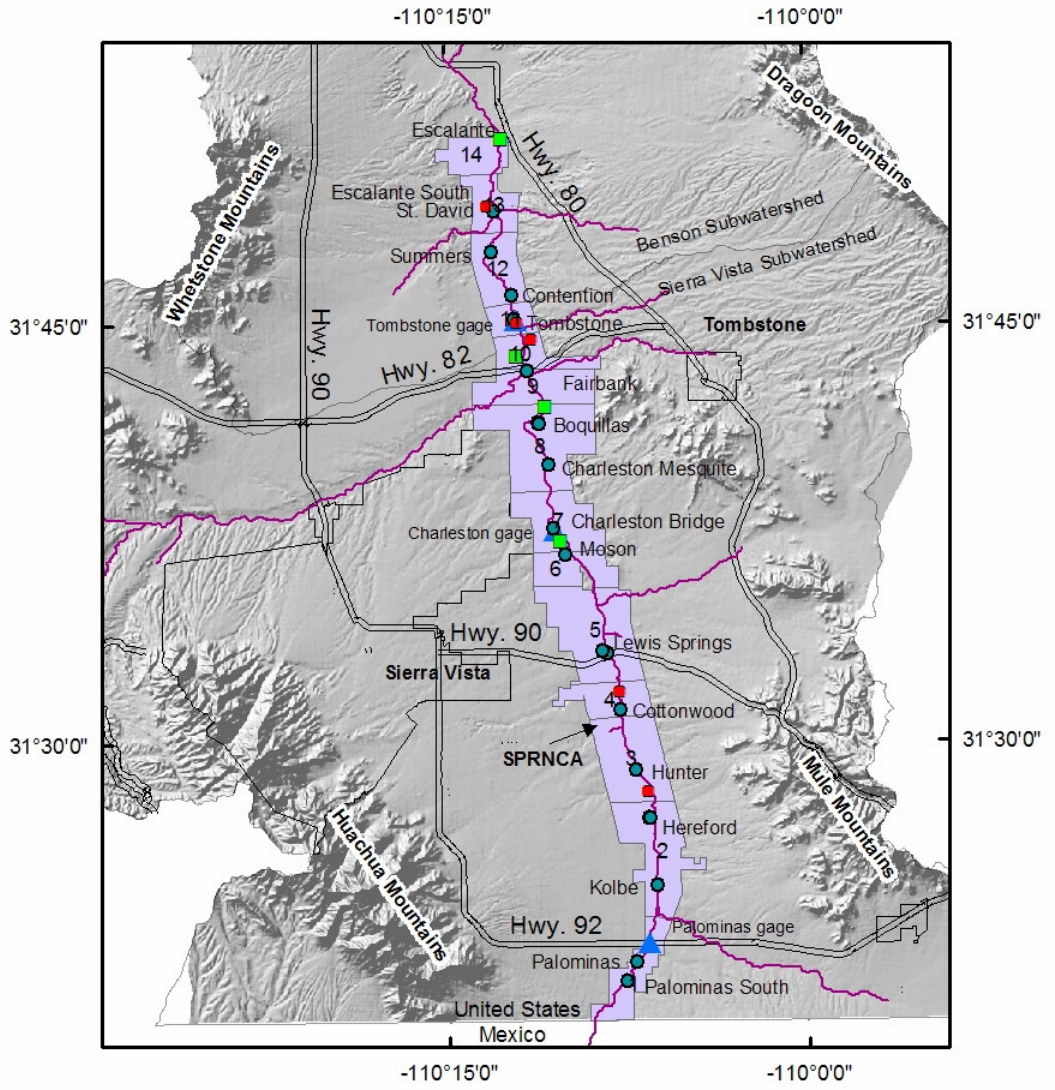


Incorporate groundwater responses within model to provide spatial impacts

San Pedro Subwatershed Decision Support System

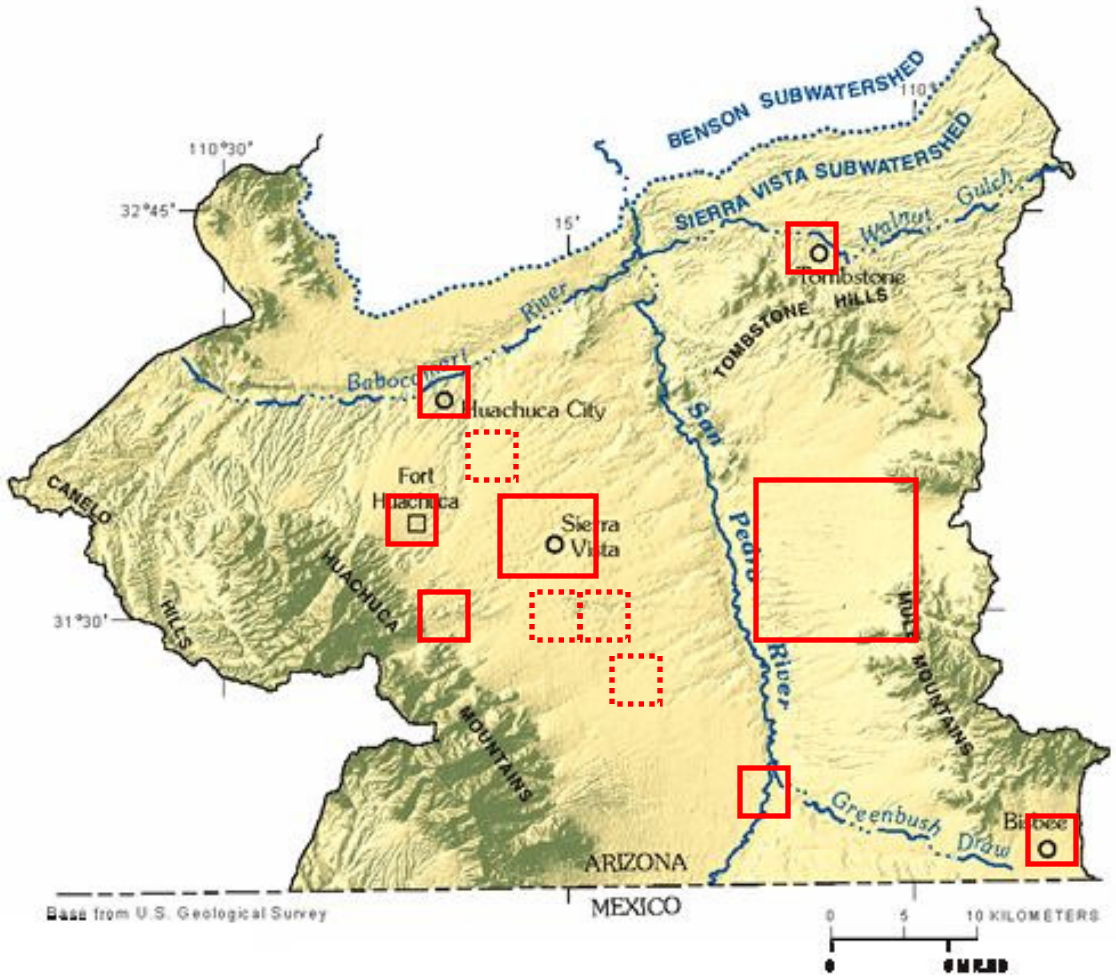
PHASE II MODELING

- Use MODFLOW to develop linear response functions for one or more groundwater models
- Scale functions by extractions or recharge to provide estimate of impact of public works projects within Powersim on a seasonal time step
- Perform more detailed GW modeling off-line



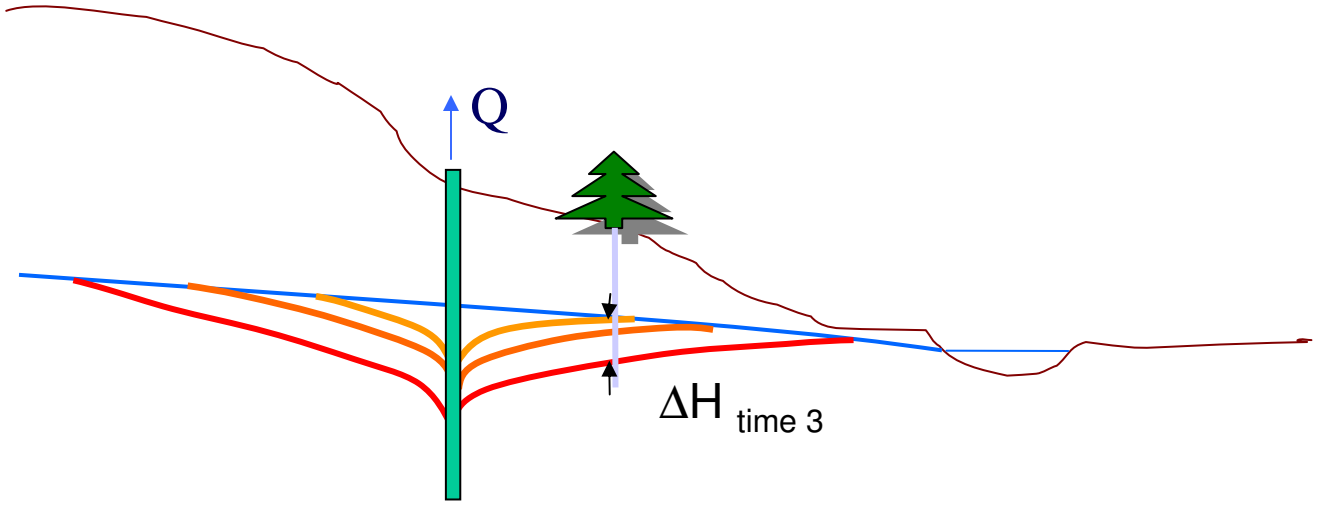
Effects on Groundwater Levels

- Extraction locations



Effects on Groundwater Levels

- Incorporate groundwater responses within model to provide spatial impacts



Effect of pumping at well location on tree location

— Time 1 – very small effect

— Time 2 – some effect

— Time 3 –larger effect

Q: Pumping Rate

Effects on Groundwater Levels

- Change in GW level with respect to a change in extraction rate

$$\frac{\Delta H\,(response\quad time,\ response\quad location\ )}{\Delta Q_{\,ext}\,(pumping\quad time,\ \ pumping\quad location\ )}$$

- Use MODFLOW to develop linear response functions for one or more groundwater models

- Assuming the response for each pumping time is constant, accumulate effects for all pumping locations and pumping times

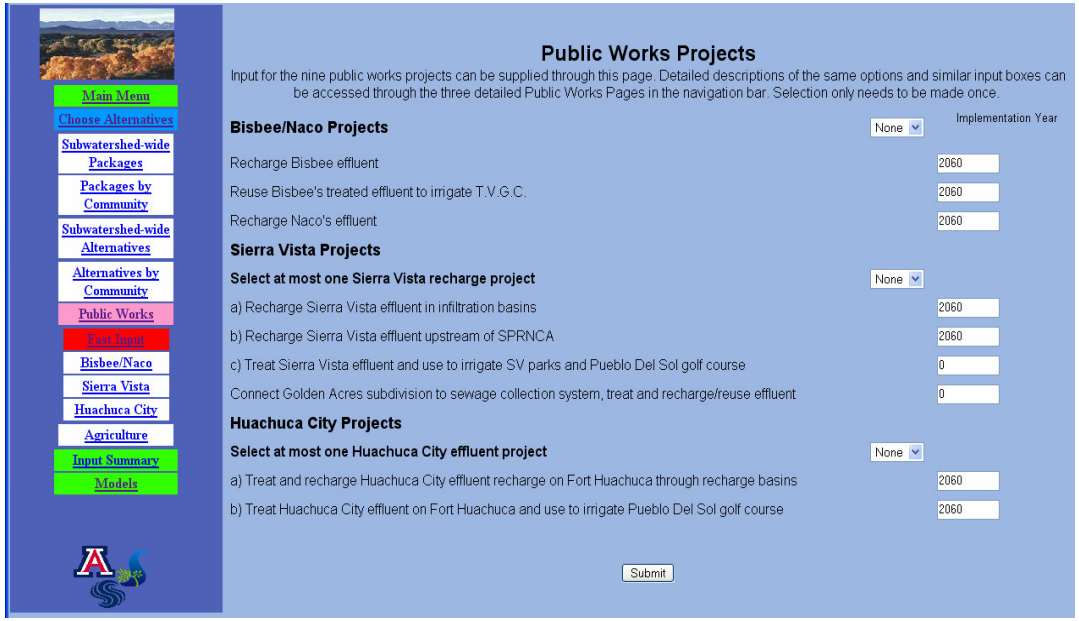
- Scale functions by extractions or recharge to provide estimate of impact of public works projects within Powersim

$$\frac{\Delta H\,(response\quad time\,,\,response\quad location\ )}{\Delta Q_{ext}\,(pumping\quad time\,,\ pumping\quad location\ )}\ Q_{ext}$$

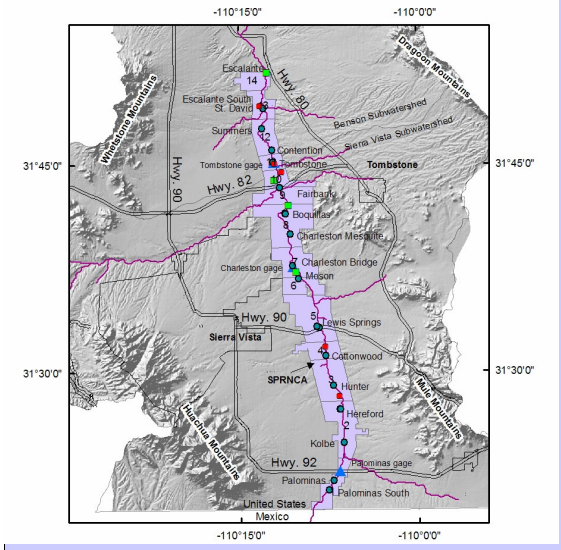
- Perform more detailed GW modeling off-line

San Pedro Subwatershed DSS – Scenario Analysis

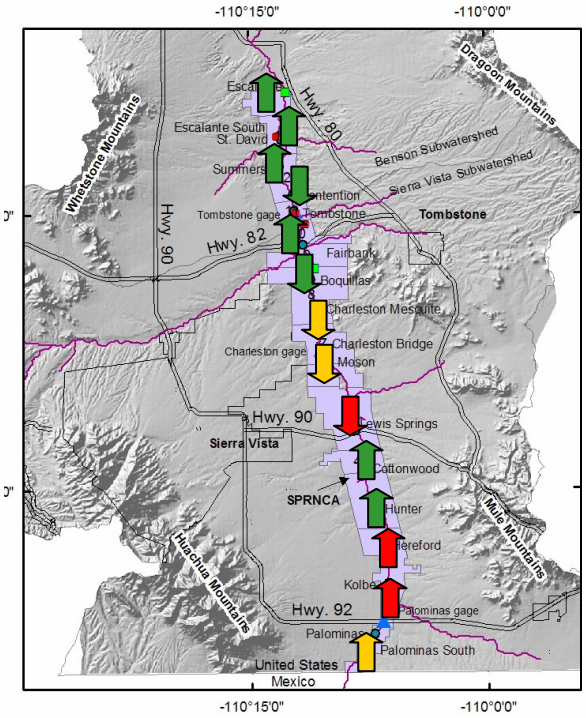
- To evaluate impact of alternative water transfer scenarios or water conservation measures, (1) define timing and magnitude through interface pages



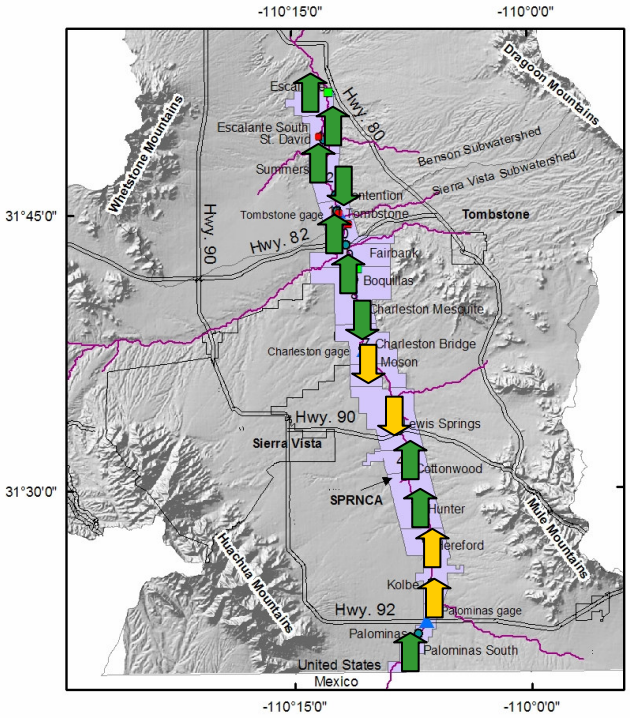
- (2) DSS computes the magnitude and spatial distribution of pumping and recharge.



- (3) Using GW response functions developed from full USGS MODFLOW model computes changes in GW levels for stream segments
- (4) Display can be plots of water level hydrographs or summary page
- (5) If needed, complete full MODFLOW simulation



2010



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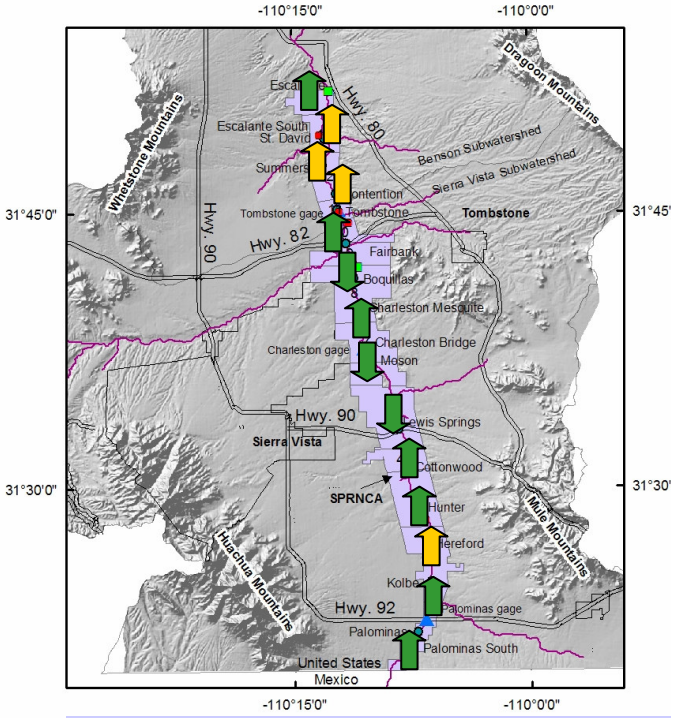

2050

Application Benefits

- Captures physical system
- Rapid alternative evaluation
- Assists in identifying critical factors for decision makers
- Can enhance public awareness possible through web based platform
- Transparent model
  - No hidden numbers/equations
  - Easy to change values
- Collaborative development

Run Management - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://uspp.ce.arizona.edu/webapplication1/ModelSelect.aspx

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Log Out

Plan Management (help)

Your saved plans

test

Load

System plans

Do Nothing

Load

Selected Plan

Plan Description

Edit

Click here to create a new plan Create

Click here to delete the selected plan Delete

Click here to view a printable list of the input parameters of the selected plan Review Input Summary

Click here to process the selected plan Process Run

Click here to go to the results management section Results Management

Done

Slide 1 of 1 Default Design English (U.S.)

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Upper San Pedro Partnership Decision Support System - Mozilla Firefox
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mozilla.org Latest Builds
Main Menu
Choose Alternatives
Input Summary
Models
Help
Upper San Pedro Partnership
Decision Support System
Model's Purpose: To provide decision makers with the technical information needed to assist in selecting the set of conservation measures for long term sustainability of the San Pedro system. This model supports the goal of the partnership -- to ensure an adequate long-term groundwater supply to meet the reasonable needs of area residents and property owners (current & future), and the San Pedro Riparian National Conservation Area (SPRNCA).
Upper San Pedro Partnership
SAHRA
http://uspp.ce.arizona.edu/webapplication1/model/page_53.aspx
Slide 2 of 9
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Upper San Pedro Partnership Decision Support System - Mozilla Firefox

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Main Menu

Choose Alternatives

Subwatershed-wide Packages

Packages by Community

Subwatershed-wide Alternatives

Alternatives by Community

Public Works

Agriculture

Input Summary

Models

Fallow Land in Subwatershed

☐ 2060

Legislative action can be implemented to prohibit of fallow arable land to irrigated agriculture. The benefits of this measure are avoiding future consumptive water use. Presently, the model assumes that no new irrigated agriculture land will be developed. To examine the effect of all arable land (831 acres) be converted to active farmland check the box to the left of this paragraph and enter the year that it will be effective.

Turf area in an average residence

A rough estimalte of the turf average area per residence in the municipal residences was provided by BBC consultants as 600 sq.ft. while homes in the unicorporated county was also 600 sq.ft. These assumptions are highly uncertain. To evaluate the sensitivity of water use to the values, the following slider bars allow input of user defined values.

Bisbee	Huachuca City	Sierra Vista	Tombstone	Unincorporated County
ft^2/house	ft^2/house	ft^2/house	ft^2/house	ft^2/house
2000	2000	2000	2000	2000
1500	1500	1500	1500	1500
1000	1000	1000	1000	1000
500	500	500	500	500
0	0	0	0	0
200	200	500	200	500

Fort Huachuca water

Given the complexities of water use and consumptive use on Fort Huachuca, groundwater pumping, reuse and recharge are input to the model based on historical values and expected changes in the future. Consumptive use is computed as pumping minus recharge. Total use is equal to groundwater pumping plus reuse and demonstrates pumping redu ction due to various conservation measures.

Single values are supplied that are assumed to hold each year in the planning horizon.

1856	Groundwater pumping	245	Water reuse
542	Groundwater recharge	1314	Consumptive use

Increased Recharge

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NUM

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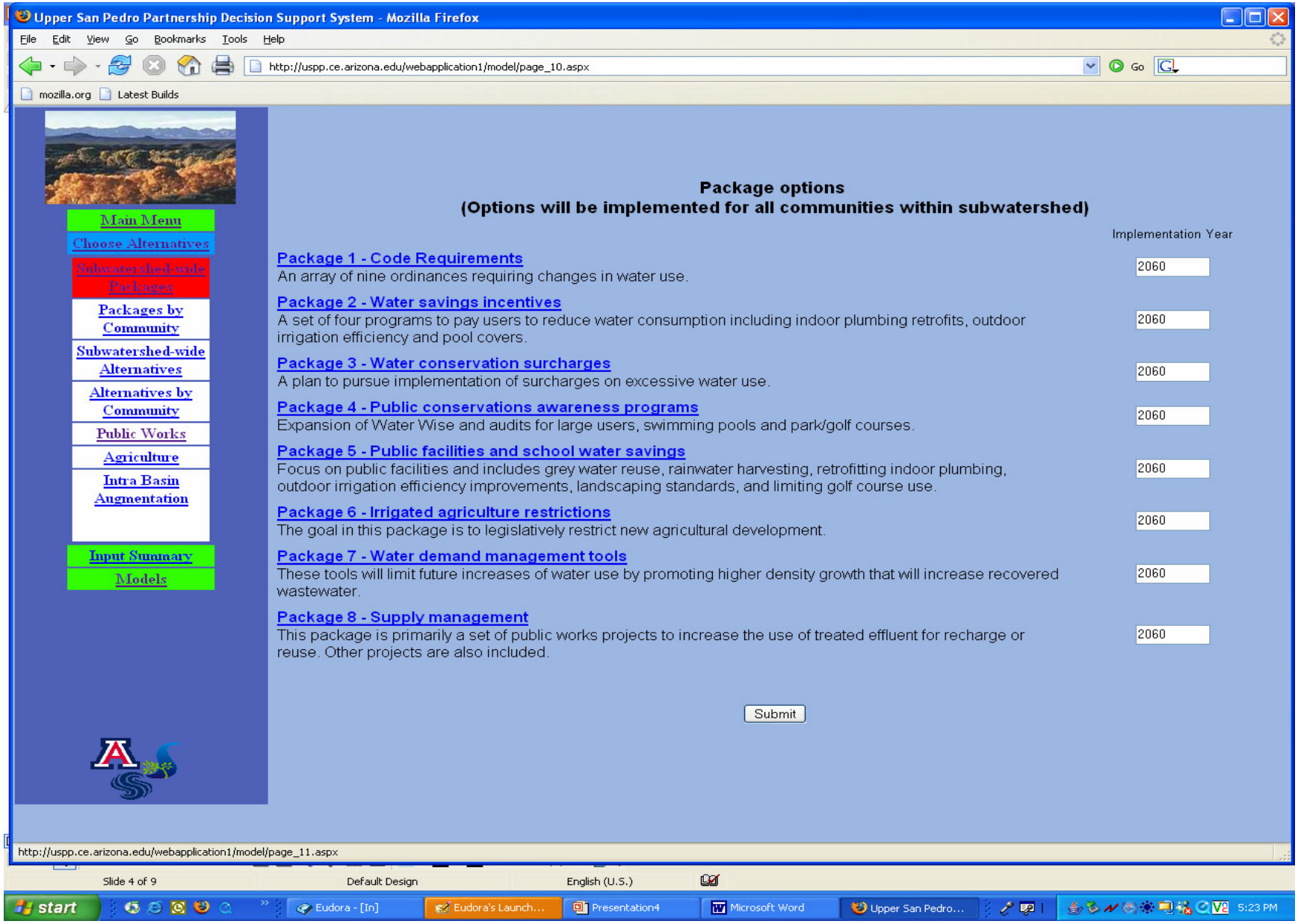
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Main Menu
Choose Alternatives
Subwatershed-wide Packages
Packages by Community
Subwatershed-wide Alternatives
Alternatives by Community
Public Works
Agriculture
Intra Basin Augmentation
Input Summary
Models
Package options
(Options will be implemented for all communities within subwatershed)
Implementation Year
Package 1 - Code Requirements
An array of nine ordinances requiring changes in water use.
2060
Package 2 - Water savings incentives
A set of four programs to pay users to reduce water consumption including indoor plumbing retrofits, outdoor irrigation efficiency and pool covers.
2060
Package 3 - Water conservation surcharges
A plan to pursue implementation of surcharges on excessive water use.
2060
Package 4 - Public conservations awareness programs
Expansion of Water Wise and audits for large users, swimming pools and park/golf courses.
2060
Package 5 - Public facilities and school water savings
Focus on public facilities and includes grey water reuse, rainwater harvesting, retrofitting indoor plumbing, outdoor irrigation efficiency improvements, landscaping standards, and limiting golf course use.
2060
Package 6 - Irrigated agriculture restrictions
The goal in this package is to legislatively restrict new agricultural development.
2060
Package 7 - Water demand management tools
These tools will limit future increases of water use by promoting higher density growth that will increase recovered wastewater.
2060
Package 8 - Supply management
This package is primarily a set of public works projects to increase the use of treated effluent for recharge or reuse. Other projects are also included.
2060
Submit
http://uspp.ce.arizona.edu/webapplication1/model/page_11.aspx
Slide 4 of 9
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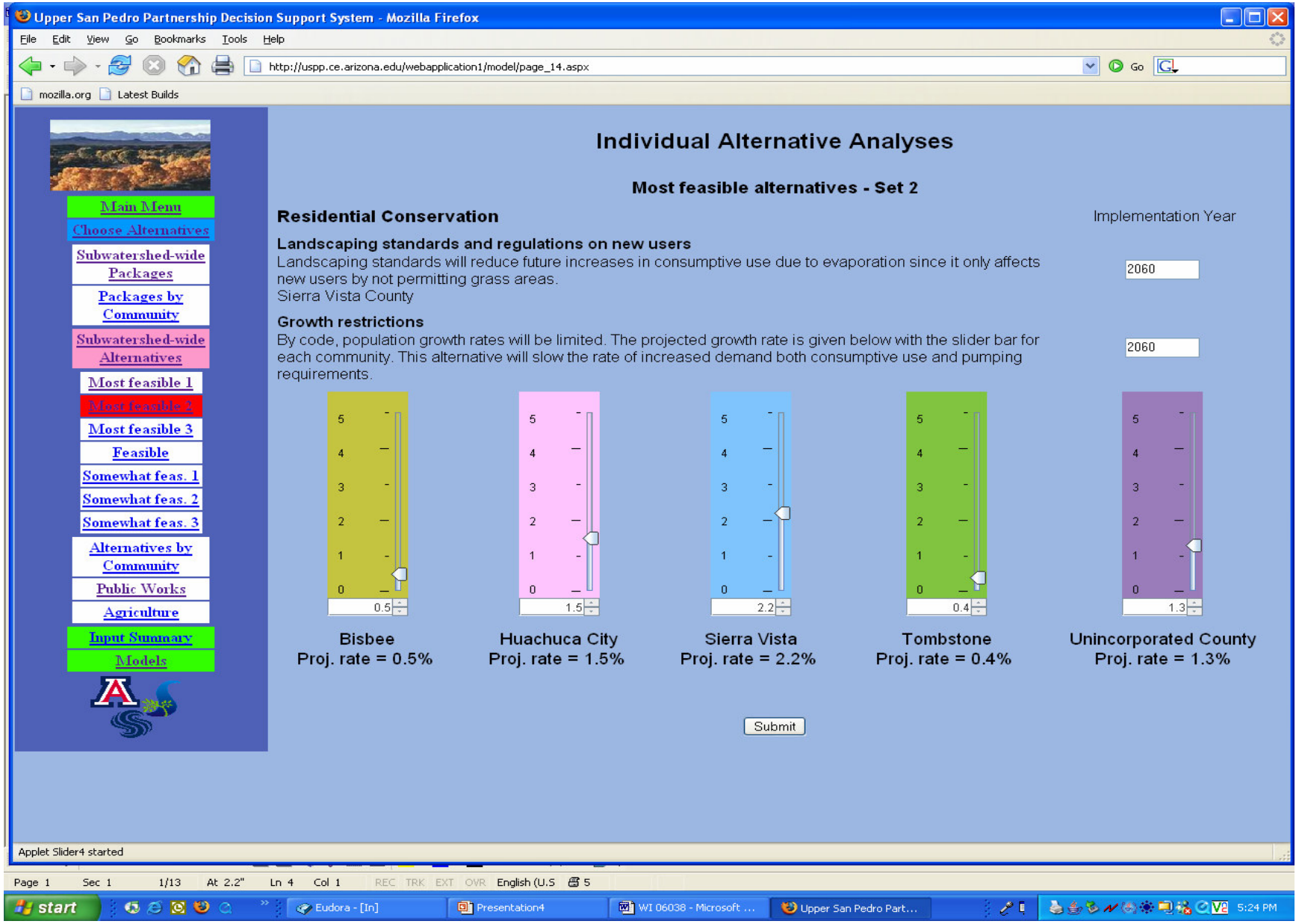
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mozilla.org Latest Builds
Main Menu
Choose Alternatives
Subwatershed-wide Packages
Packages by Community
Subwatershed-wide Alternatives
Most feasible 1
Most feasible 2
Most feasible 3
Feasible
Somewhat feas. 1
Somewhat feas. 2
Somewhat feas. 3
Alternatives by Community
Public Works
Agriculture
Input Summary
Models
Individual Alternative Analyses
Most feasible alternatives - Set 2
Residential Conservation
Implementation Year
Landscaping standards and regulations on new users
Landscaping standards will reduce future increases in consumptive use due to evaporation since it only affects new users by not permitting grass areas.
Sierra Vista County
2060
Growth restrictions
By code, population growth rates will be limited. The projected growth rate is given below with the slider bar for each community. This alternative will slow the rate of increased demand both consumptive use and pumping requirements.
2060
0.5
1.5
2.2
0.4
1.3
Bisbee
Proj. rate = 0.5%
Huachuca City
Proj. rate = 1.5%
Sierra Vista
Proj. rate = 2.2%
Tombstone
Proj. rate = 0.4%
Unincorporated County
Proj. rate = 1.3%
Submit
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Page 1 Sec 1 1/13 At 2.2" Ln 4 Col 1 English (U.S 5
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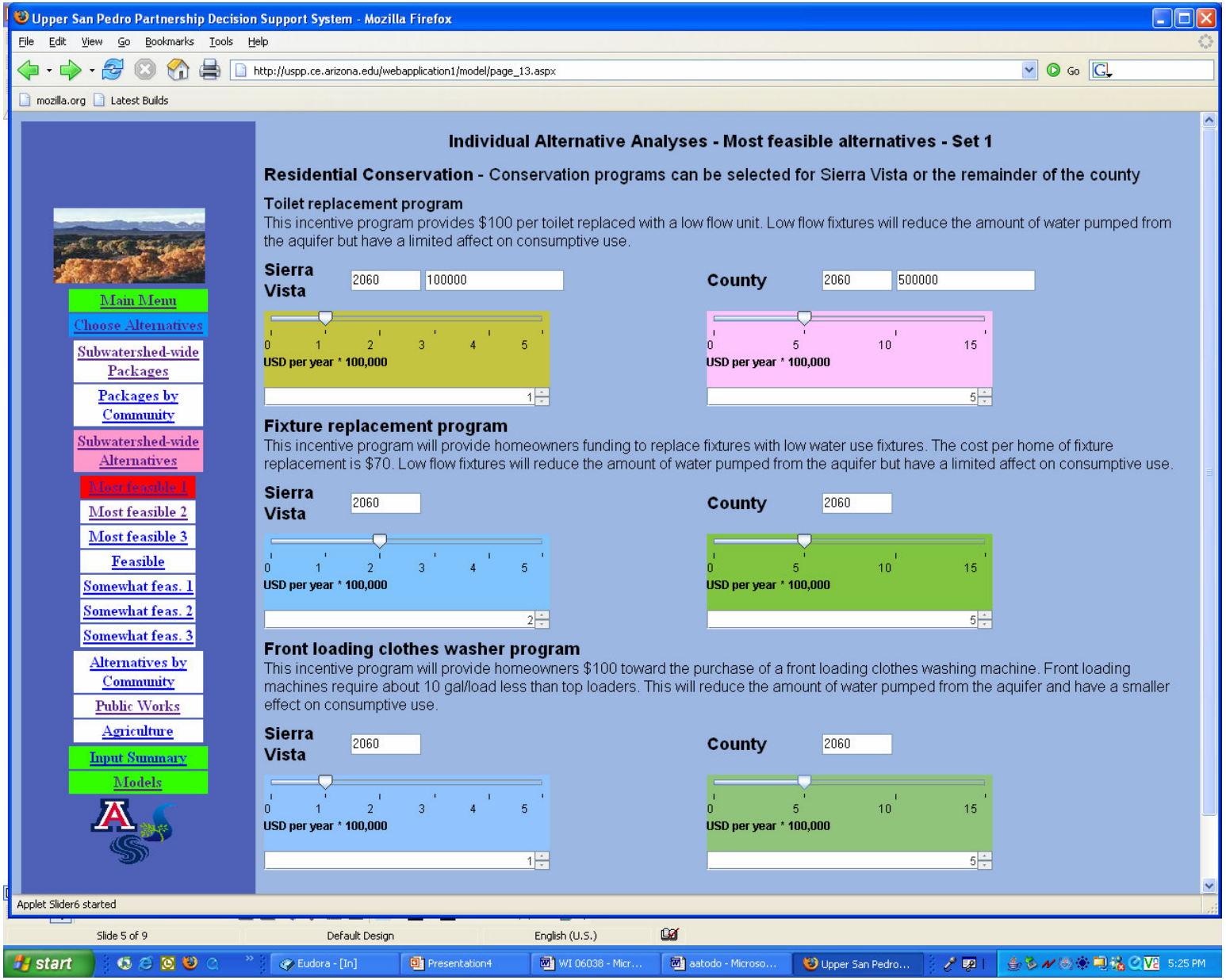
Upper San Pedro Partnership Decision Support System - Mozilla Firefox
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mozilla.org Latest Builds
Main Menu
Choose Alternatives
Subwatershed-wide Packages
Packages by Community
Subwatershed-wide Alternatives
Most feasible 1
Most feasible 2
Most feasible 3
Feasible
Somewhat feas. 1
Somewhat feas. 2
Somewhat feas. 3
Alternatives by Community
Public Works
Agriculture
Input Summary
Models
Individual Alternative Analyses - Most feasible alternatives - Set 1
Residential Conservation - Conservation programs can be selected for Sierra Vista or the remainder of the county
Toilet replacement program
This incentive program provides $100 per toilet replaced with a low flow unit. Low flow fixtures will reduce the amount of water pumped from the aquifer but have a limited affect on consumptive use.
Sierra Vista 2060 100000
County 2060 500000
0 1 2 3 4 5
USD per year * 100,000
0 5 10 15
USD per year * 100,000
Fixture replacement program
This incentive program will provide homeowners funding to replace fixtures with low water use fixtures. The cost per home of fixture replacement is $70. Low flow fixtures will reduce the amount of water pumped from the aquifer but have a limited affect on consumptive use.
Sierra Vista 2060
County 2060
Front loading clothes washer program
This incentive program will provide homeowners $100 toward the purchase of a front loading clothes washing machine. Front loading machines require about 10 gal/load less than top loaders. This will reduce the amount of water pumped from the aquifer and have a smaller effect on consumptive use.
Sierra Vista 2060
County 2060
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Slide 5 of 9
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Presentation4
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Upper San Pedro...
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Upper San Pedro Partnership Decision Support System - Mozilla Firefox
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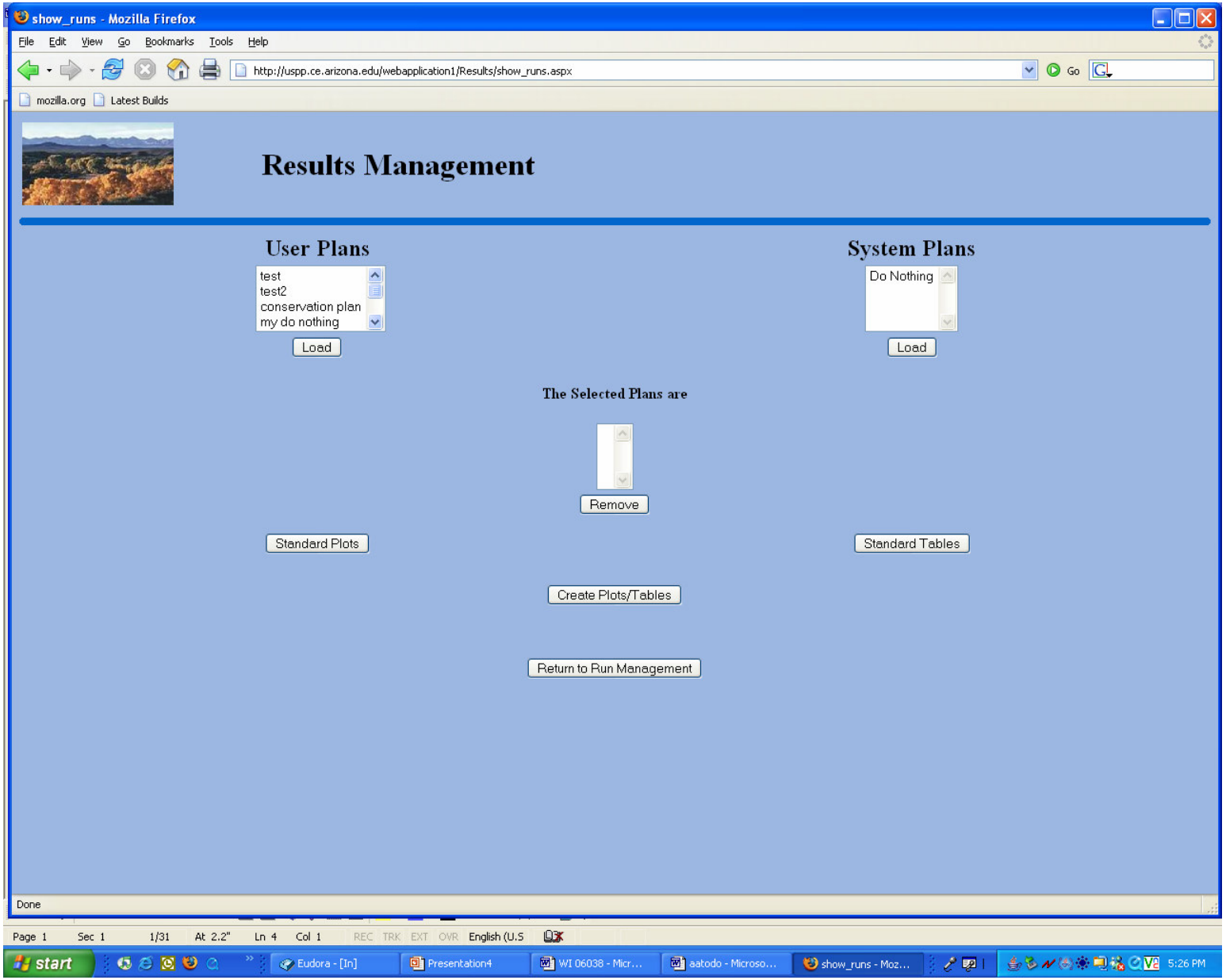
Go
mozilla.org Latest Builds
Main Menu
Choose Alternatives
Subwatershed-wide Packages
Packages by Community
Subwatershed-wide Alternatives
Alternatives by Community
Public Works
Exact Input
Bisbee/Naco
Sierra Vista
Huachuca City
Agriculture
Input Summary
Models
Public Works Projects
Input for the nine public works projects can be supplied through this page. Detailed descriptions of the same options and similar input boxes can be accessed through the three detailed Public Works Pages in the navigation bar. Selection only needs to be made once.
Implementation Year
Bisbee/Naco Projects
None
Recharge Bisbee effluent 2060
Reuse Bisbee's treated effluent to irrigate T.V.G.C. 2060
Recharge Naco's effluent 2060
Sierra Vista Projects
Select at most one Sierra Vista recharge project
None
a) Recharge Sierra Vista effluent in infiltration basins 2002
b) Recharge Sierra Vista effluent upstream of SPRNCA 2060
c) Treat Sierra Vista effluent and use to irrigate SV parks and Pueblo Del Sol golf course 0
Connect Golden Acres subdivision to sewage collection system, treat and recharge/reuse effluent 0
Huachuca City Projects
Select at most one Huachuca City effluent project
None
a) Treat and recharge Huachuca City effluent recharge on Fort Huachuca through recharge basins 2060
b) Treat Huachuca City effluent on Fort Huachuca and use to irrigate Pueblo Del Sol golf course 2060
Submit
Done
Slide 6 of 9
Default Design
English (U.S.)
start
Eudora - [In]
Presentation4
WI 06038 - Micr...
aatodo - Microso...
Upper San Pedro...
5:25 PM


show_runs - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://uspp.ce.arizona.edu/webapplication1/Results/show_runs.aspx
Go
mozilla.org
Latest Builds
Results Management
User Plans
test
test2
conservation plan
my do nothing
Load
System Plans
Do Nothing
Load
The Selected Plans are
Remove
Standard Plots
Standard Tables
Create Plots/Tables
Return to Run Management
Done
Page 1 Sec 1 1/31 At 2.2" Ln 4 Col 1 REC TRK EXT OVR English (U.S
start
Eudora - [In]
Presentation4
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aatodo - Microso...
show_runs - Moz...
5:26 PM

default_plots - Mozilla Firefox

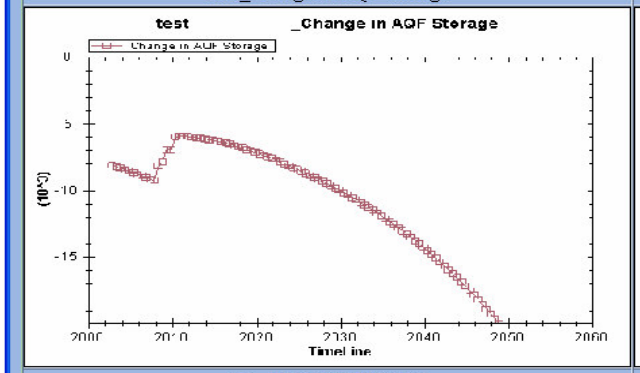
File Edit View Go Bookmarks Tools Help

http://uspp.ce.arizona.edu/webapplication1/Results/default_plots.aspx

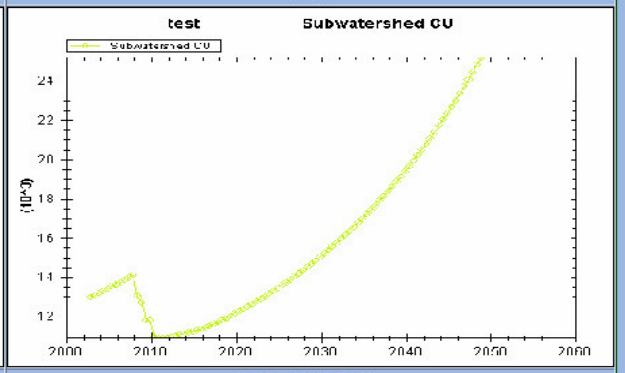
mozilla.org Latest Builds

Standard Plots

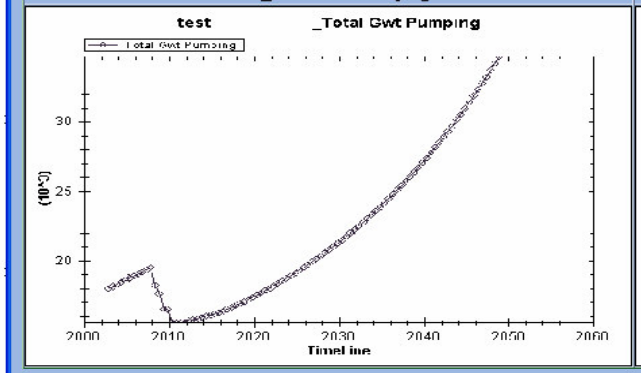
test _Change in AQF Storage



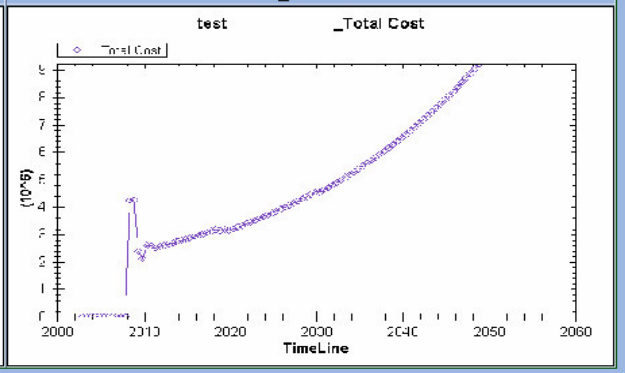
test



test _Total Gwt Pumping



test _Total Cost



Standard Tables

http://uspp.ce.arizona.edu/webapplication1/Results/graphs/graph _5wmswn3lbo0ygza5nlu0tj55_test Change in AQF Storage.jpg

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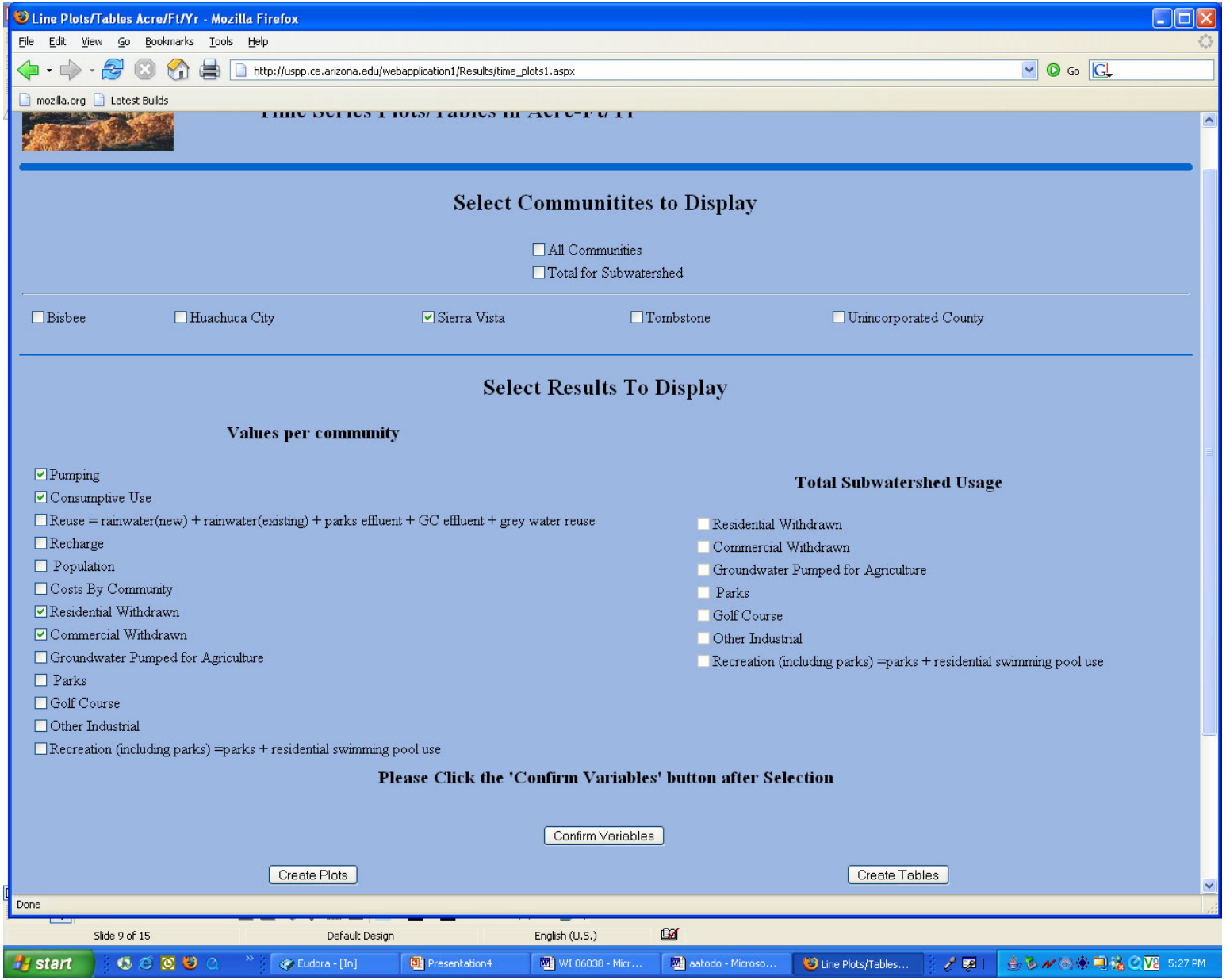
start Eudora - [In] Presentation4 WI 06038 - Micr... aatodo - Microso... default_plots - M... 5:28 PM


Line Plots/Tables Acre/Ft/Yr - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://uspp.ce.arizona.edu/webapplication1/Results/time_plots1.aspx
mozilla.org Latest Builds
Time Series Plots/Tables in Acre-Ft/Yr
Select Communitites to Display
All Communities
Total for Subwatershed
Bisbee
Huachuca City
Sierra Vista
Tombstone
Unincorporated County
Select Results To Display
Values per community
Pumping
Consumptive Use
Reuse = rainwater(new) + rainwater(existing) + parks effluent + GC effluent + grey water reuse
Recharge
Population
Costs By Community
Residential Withdrawn
Commercial Withdrawn
Groundwater Pumped for Agriculture
Parks
Golf Course
Other Industrial
Recreation (including parks) =parks + residential swimming pool use
Total Subwatershed Usage
Residential Withdrawn
Commercial Withdrawn
Groundwater Pumped for Agriculture
Parks
Golf Course
Other Industrial
Recreation (including parks) =parks + residential swimming pool use
Please Click the 'Confirm Variables' button after Selection
Confirm Variables
Create Plots
Create Tables
Done
Slide 9 of 15
Default Design
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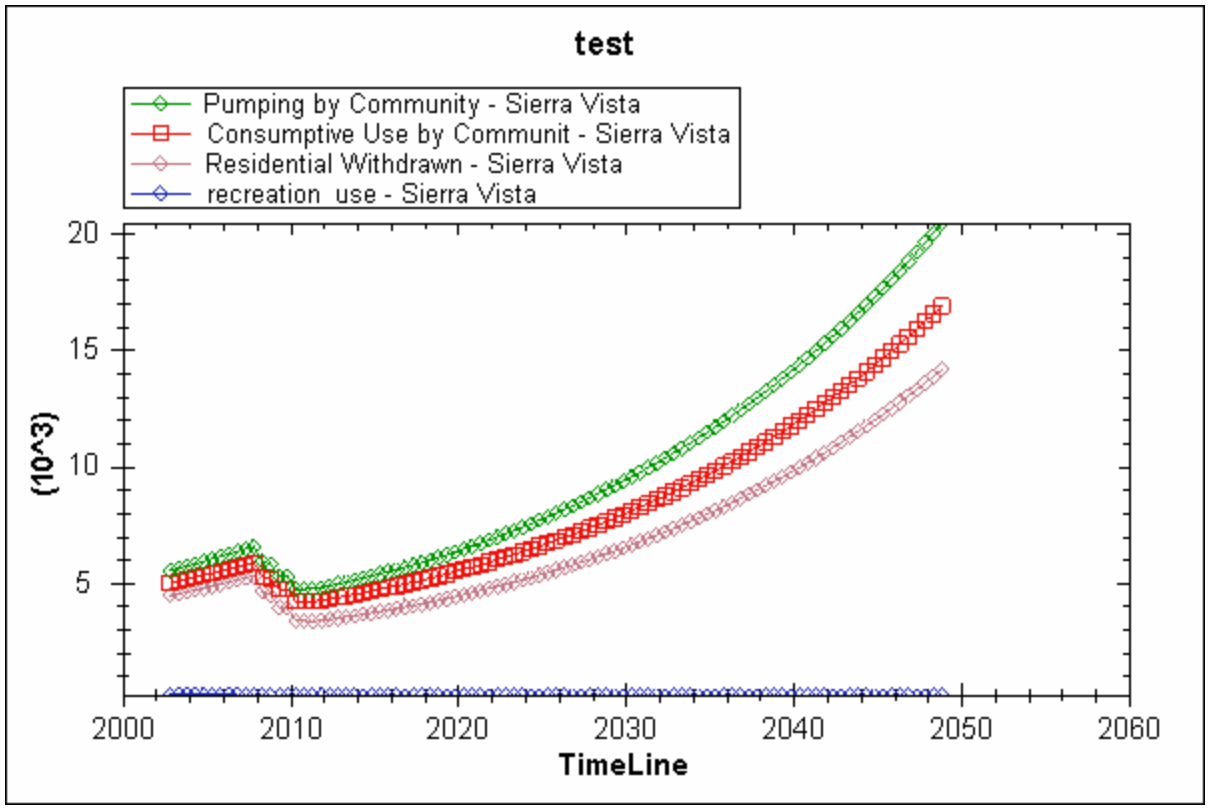
aatodo - Microso...
Line Plots/Tables...
5:27 PM


test
Pumping by Community - Sierra Vista
Consumptive Use by Communit - Sierra Vista
Residential Withdrawn - Sierra Vista
recreation_use - Sierra Vista
20
15
10
5
(10^3)
2000
2010
2020
2030
2040
2050
2060
TimeLine

General Tables

Run Name = test

Time	Pumping by Community - Sierra Vista	Consumptive Use by Communit - Sierra Vista	Residential Withdrawn - Sierra Vista	Commercial Withdrawn - Sierra Vista
2003	5572.54246475213	5026.53326262987	4496.64151707969	861.616547672439
2004	5649.90783745025	5089.97778222288	4557.93320920502	877.69022824523
2004	5749.89455445619	5173.83563225464	4638.68287453594	896.927279920248
2005	5852.0767775978	5259.53453531577	4721.20903250415	916.583345093657
2005	5956.50280801007	5347.11499457292	4805.55076594765	936.667642062421
2006	6069.69047323918	5442.49882588626	4888.34050889401	967.065564345173
2006	6165.93099373873	5522.3108529752	4973.35196015447	978.294633584258
2007	6267.72163230725	5606.99949613099	5060.27759267802	993.159639629232
2007	6375.12092372322	5696.61425198071	5149.15951845243	1011.67700527079
2008	6486.58959361749	5789.75198161107	5240.04077592923	1032.26441768826
2008	6601.38583595068	5885.73443374898	5332.96535040587	1054.13608554481
2009	5938.96936046658	5296.25264646568	4652.84850928563	1071.83645118095
2009	5813.13946754862	5196.91469142211	4503.74159065462	1095.113476894
2010	5315.38138657798	4760.99485328473	3982.08852088411	1119.00846569387
2010	5310.77657030978	4758.60019519576	3953.00911581418	1143.48305449561
2011	4762.22630467279	4237.89329340333	3421.51801668314	1126.42388798965
2011	4767.17984436825	4235.31888869341	3401.42471705592	1151.47072731232
2012	4773.41729245831	4233.73518176861	3382.06005023716	1177.07284222115
2012	4831.12934903934	4278.53817307491	3413.60574765237	1203.23920138697
2013	4909.05449876195	4341.44655627248	3464.78950427454	1229.98059448741
2013	4988.88252119975	4405.8939790808	3517.28926077873	1257.30886042102
2014	5070.65487362848	4471.91393134947	3571.13396916236	1285.23650446612
2014	5154.41412834593	4539.54082421571	3626.35321836676	1313.77650997916
2015	5240.20389572145	4608.80991811722	3682.97724829001	1342.94224743144
2015	5328.06879629302	4679.75729534903	3741.03696410791	1372.74743218511

Done

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start Eudora - [In] Presentation4 WI 06038 - Micr... aatodo - Microso... General Tables - ... 5:28 PM