The Abdus Salam
International Centre for Theoretical Physics

2242-10

Joint ICTP-IAEA Workshop on Uncovering Sustainable Development CLEWS; Modelling Climate, Land-use, Energy and Water (CLEW) Interactions

30 May - 3 June, 2011

Water Evaluation And Planning System

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WEAP

Water Evaluation And Planning System

SEI

WEAP

Water Evaluation And Planning System

- Integrated watershed hydrology and water planning model
- GIS-based, graphical drag & drop interface
- Physical simulation of water demands and supplies
- Additional simulation modeling: user-created variables, modeling equations and links to spreadsheets & other models
- Scenario management capabilities
- Seamless watershed hydrology, water quality and financial modules
- Developed by the U.S. Center of the Stockholm Environment Institute

SEI

WEAP in Planning

- Provides a common framework and a transparent set of data that can be explored by all stakeholders and decision-makers
- Scenarios can be easily developed to explore options for the future
- Implications of various policies can be evaluated

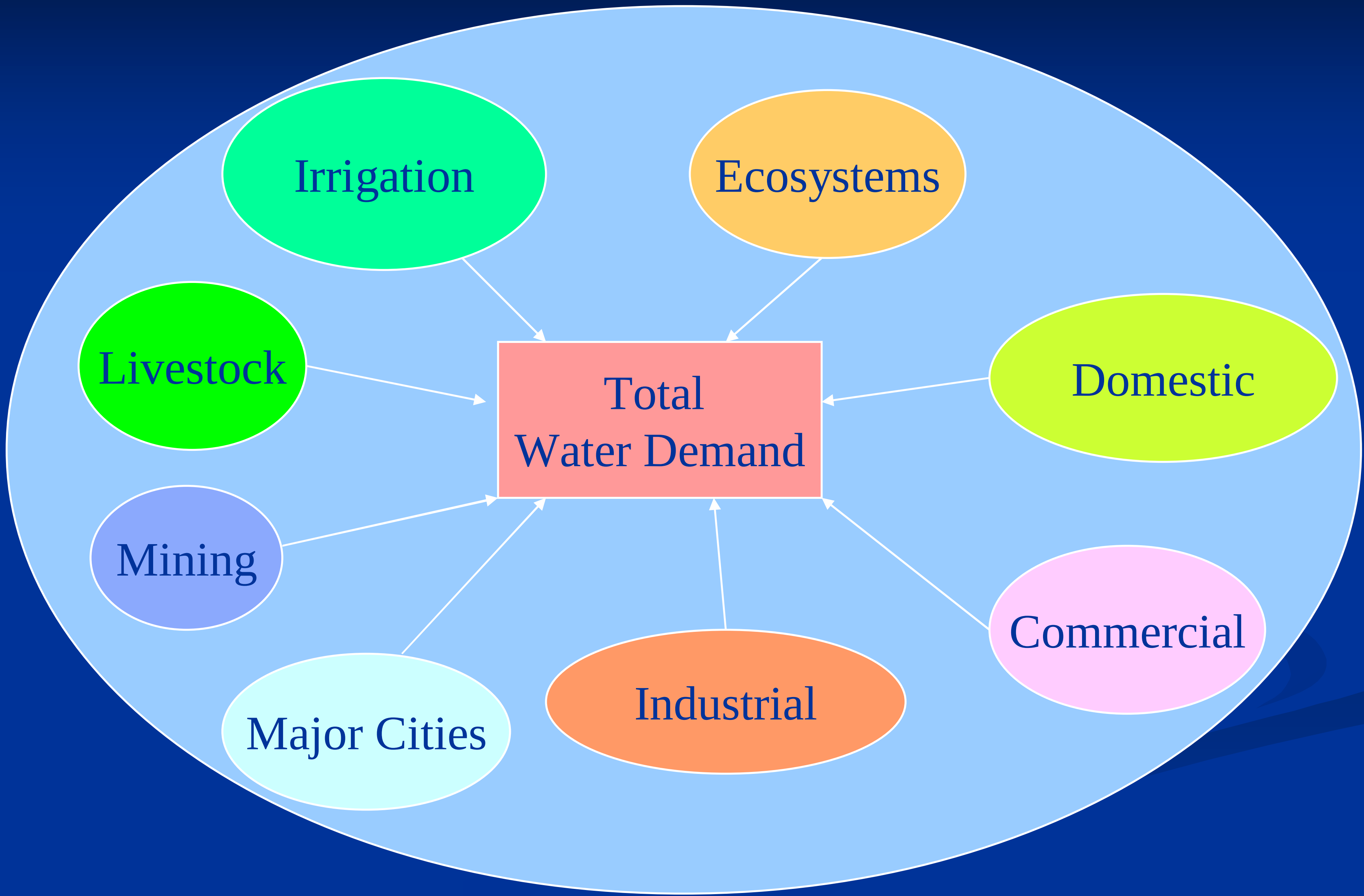
Examples of Analyses

- Sectoral demand analyses
- Land use & climate change impacts on hydrology
- Water conservation
- Water rights and allocation priorities
- Groundwater and streamflow simulations
- Reservoir operations
- Hydropower generation
- Pollution tracking
- Ecosystem requirements

WEAP Applications

- Water Systems Planning
  - Small Reservoirs Project, Ghana/Brazil
  - California Water Plan, California, USA
  - Guadiana River, Spain
- Transboundary Water Policy
  - Okavango River, Angola/Namibia/Botswana
  - Lower Rio Grande, USA/Mexico
  - Mekong River, Thailand/Cambodia/Vietnam/Laos
  - Jordan River, Syria/Israel/Jordan
- Climate Change Studies
  - Sacramento and San Joaquin River Basins, California, USA
  - Massachusetts Water Resources Authority, Massachusetts, USA
  - Yemen Second National Communication
  - Mali Second National Communication
- Ecological Flows
  - Connecticut Department of Environmental Protection
  - Town of Scituate, Massachusetts, USA
- Water Utility DSS Application
  - Case studies in Portland, Oregon; Austin, Texas; and Philadelphia, Pennsylvania.

Sectoral Water Demands



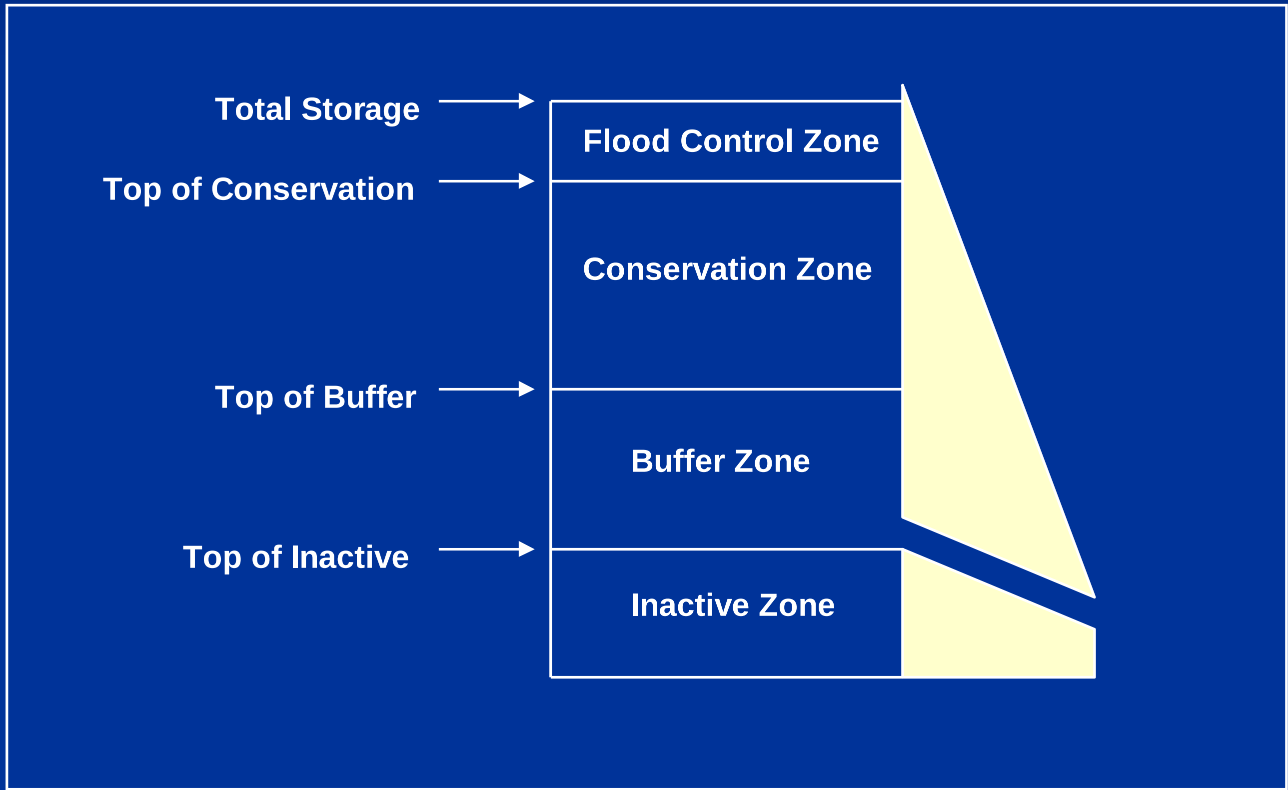
Illustrative Demand Structure

SECTOR	SUBSECTOR	END-USE	DEVICE
Agriculture	Cotton Rice Wheat …	Irrigation …	Furrow Sprinkler Drip
Industry	Electric Power Petroleum Paper …	Cooling Processing Others	Standard Efficient …
Municipal	South City West City …	Single Family Multi-family …	Kitchen Bathing Washer Toilet …

Supplies

- Rivers
- Groundwater
  - storage capacity
  - maximum monthly withdrawal
  - natural recharge
- Diversions (e.g. canals, pipelines)
- Reservoirs
- Other (e.g. desalination)

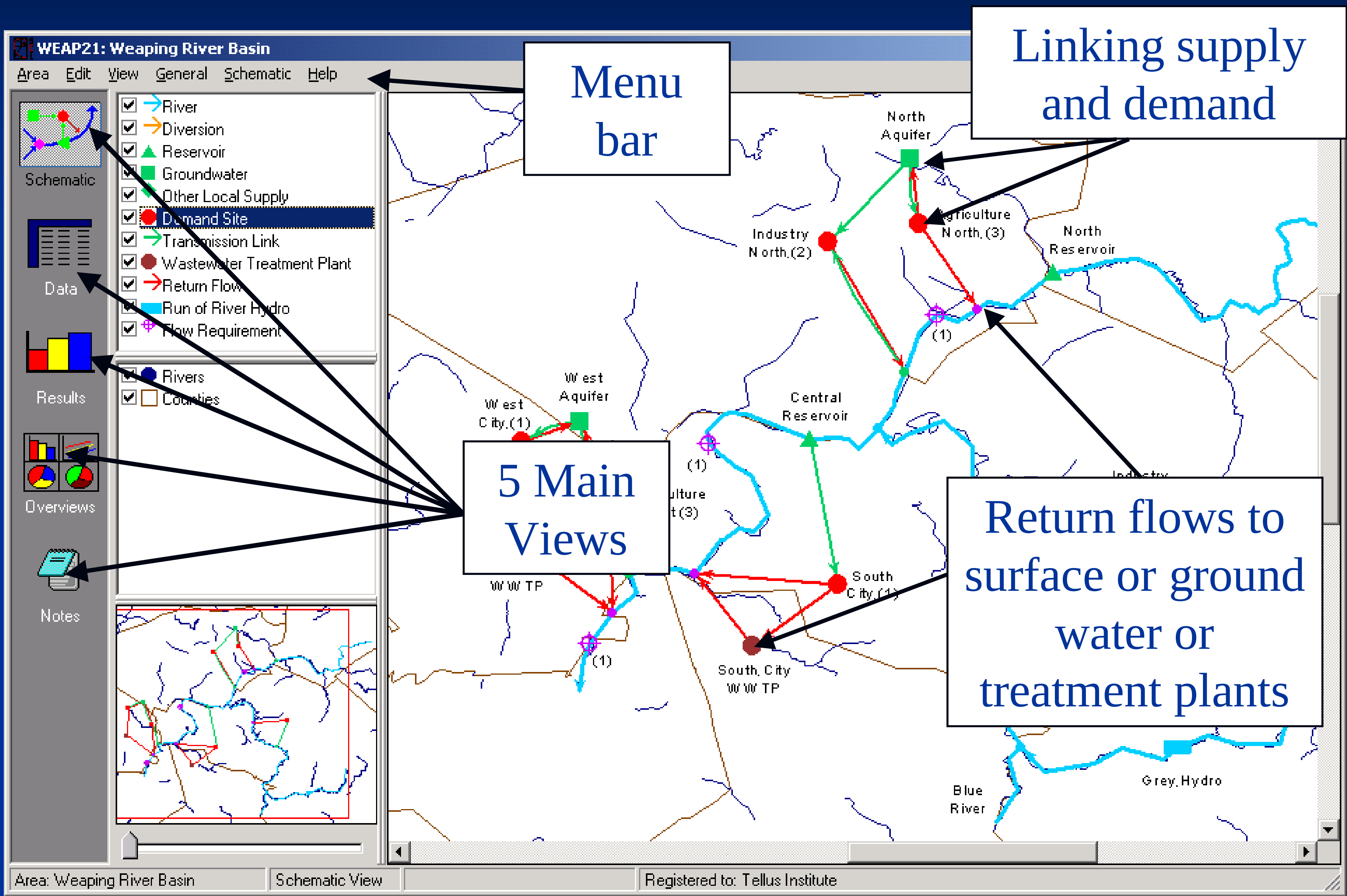
Reservoir Operations



WEAP Capabilities

- **Easy to use interface facilitates learning, data input, and scenario development**
- Water allocation problem is solved based on demand priorities and supply preferences
- Input can be from files or user specified functions
- Multiple scenarios can be run and displayed graphically at one time
- Use of notes allows for internal documentation of scenarios
- Hydrology may be climate driven or from gage data
- Several internal modules to choose from (eg Hydropower generation, Financial analysis, Water quality)
- Dynamically links to other models

WEAP Network Schematic



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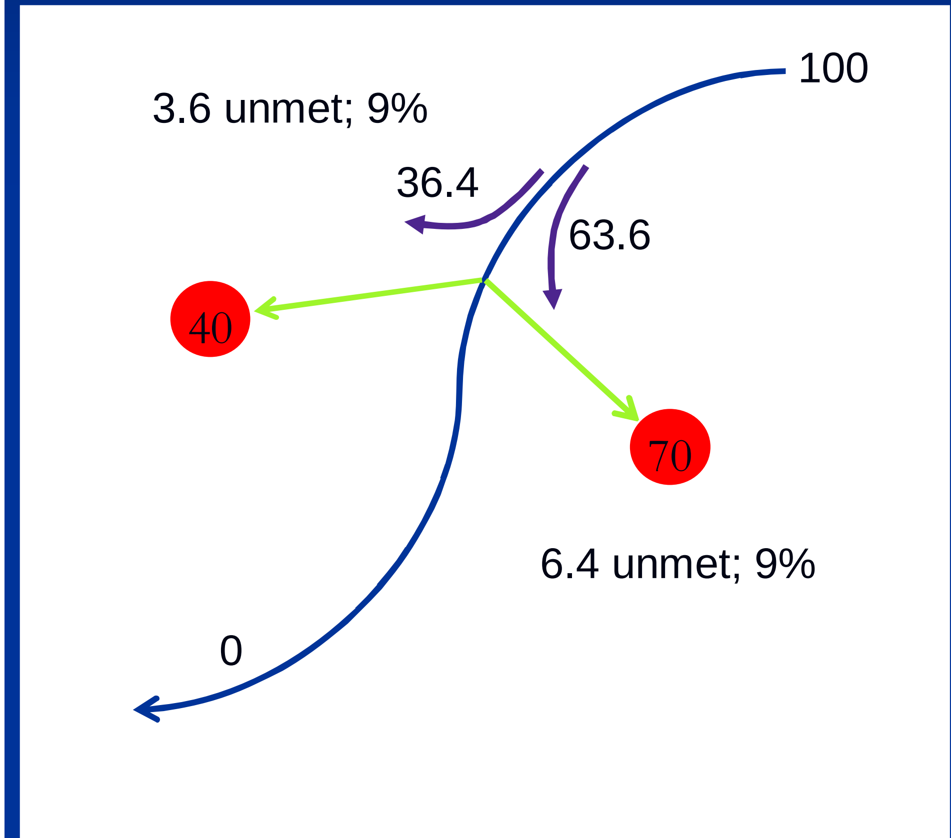
Priority Allocation of Water Resources

- Supply Preferences
- Demand Priorities

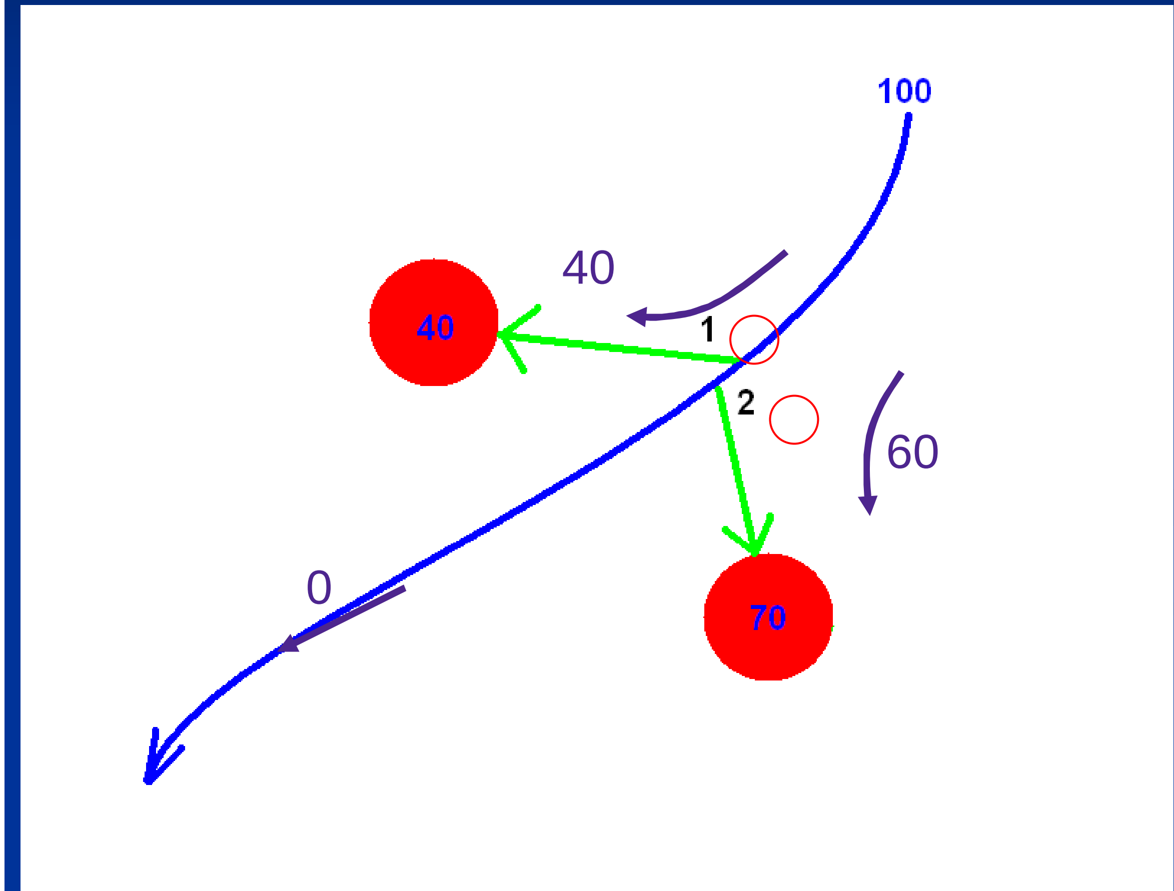
→ Allocation Order

Same Demand Priorities



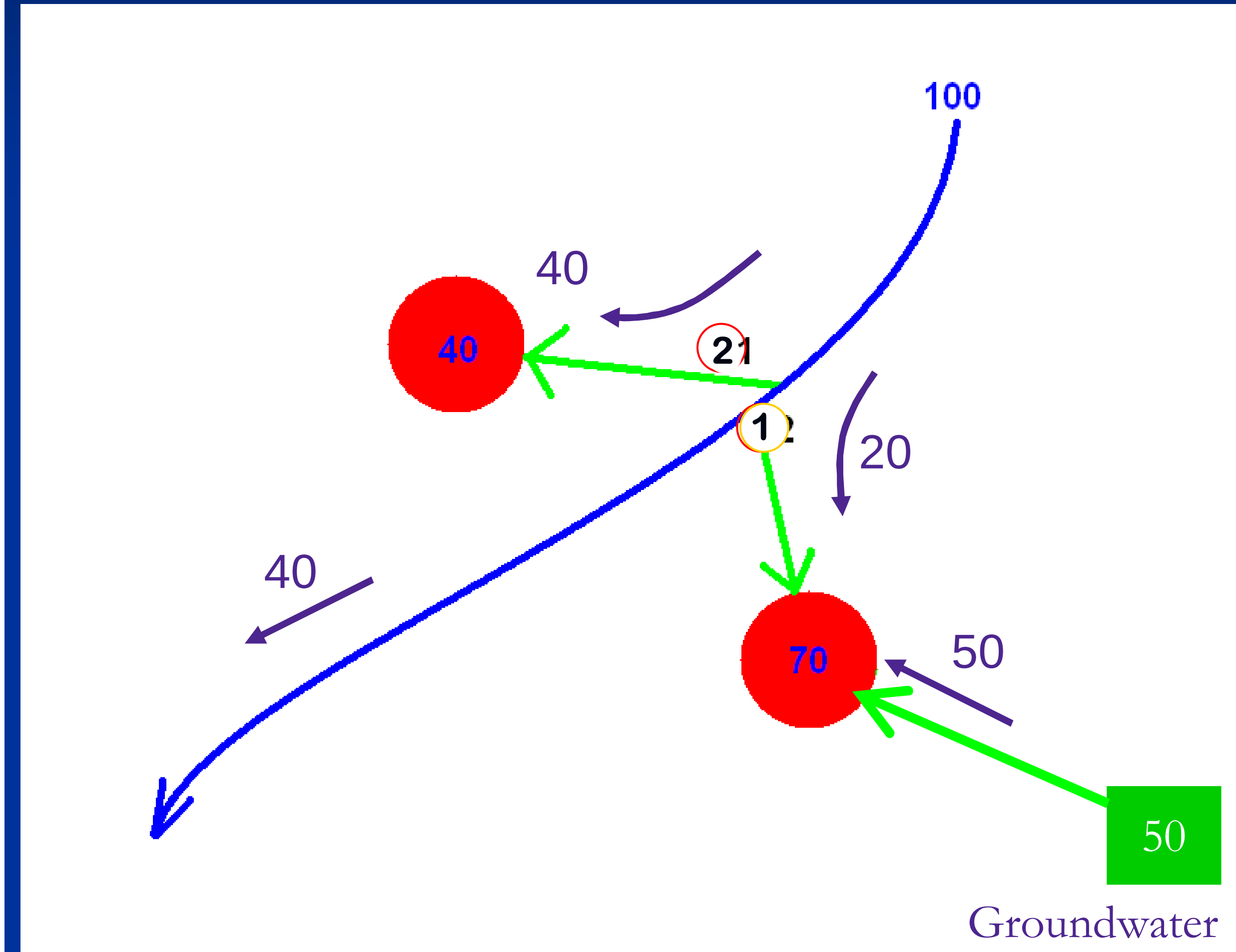
- If there are two demands, both with the same priority and insufficient water to meet their needs fully, WEAP will provide ***equal % of demand to each.***

Different Demand Priorities



- If the priorities differ, WEAP will satisfy the first priority fully before giving water to the lower priority.

Different Supply Preferences



- The large demand (70 units) has higher priority for river water, but has a greater preference for groundwater

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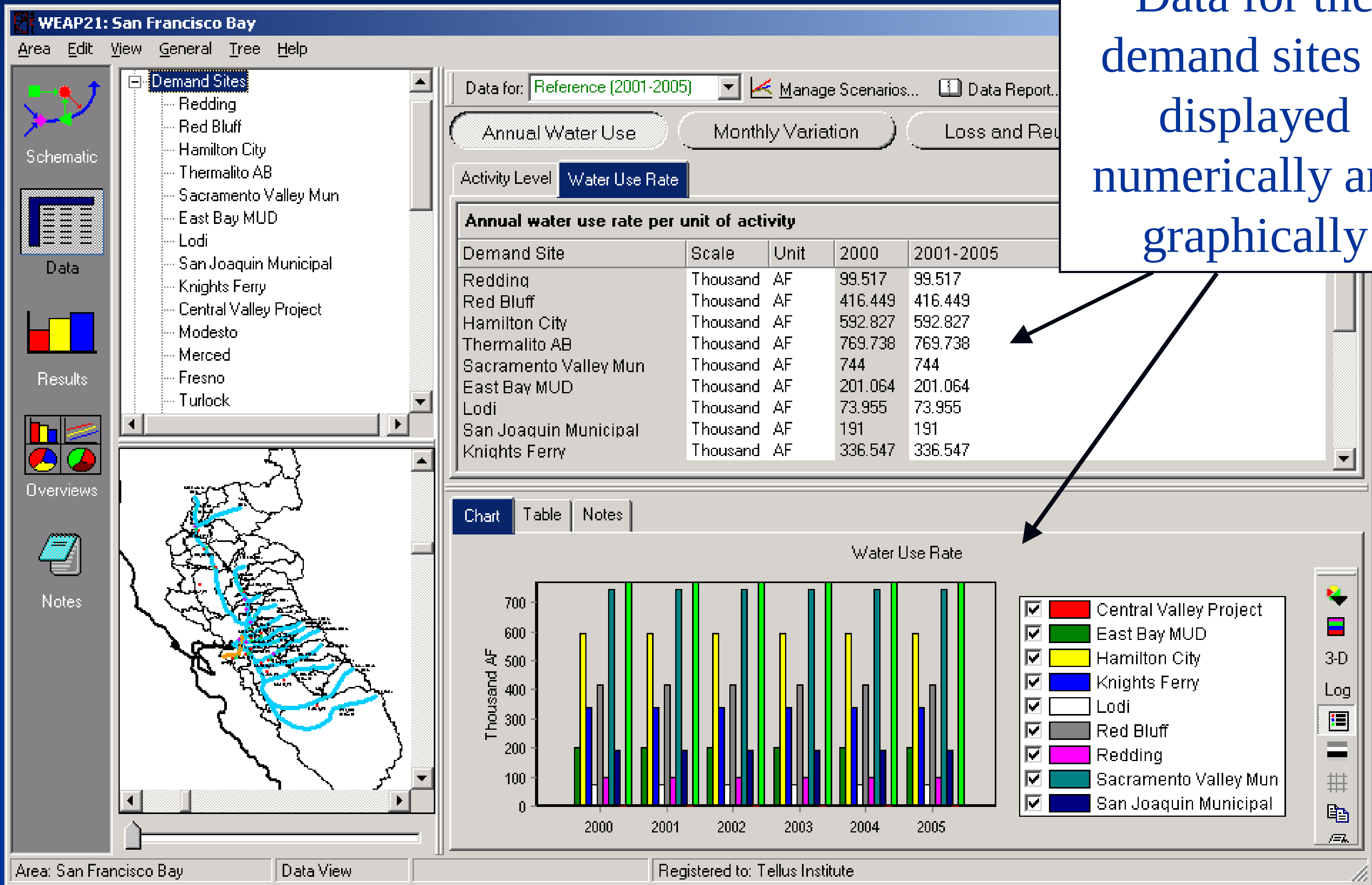
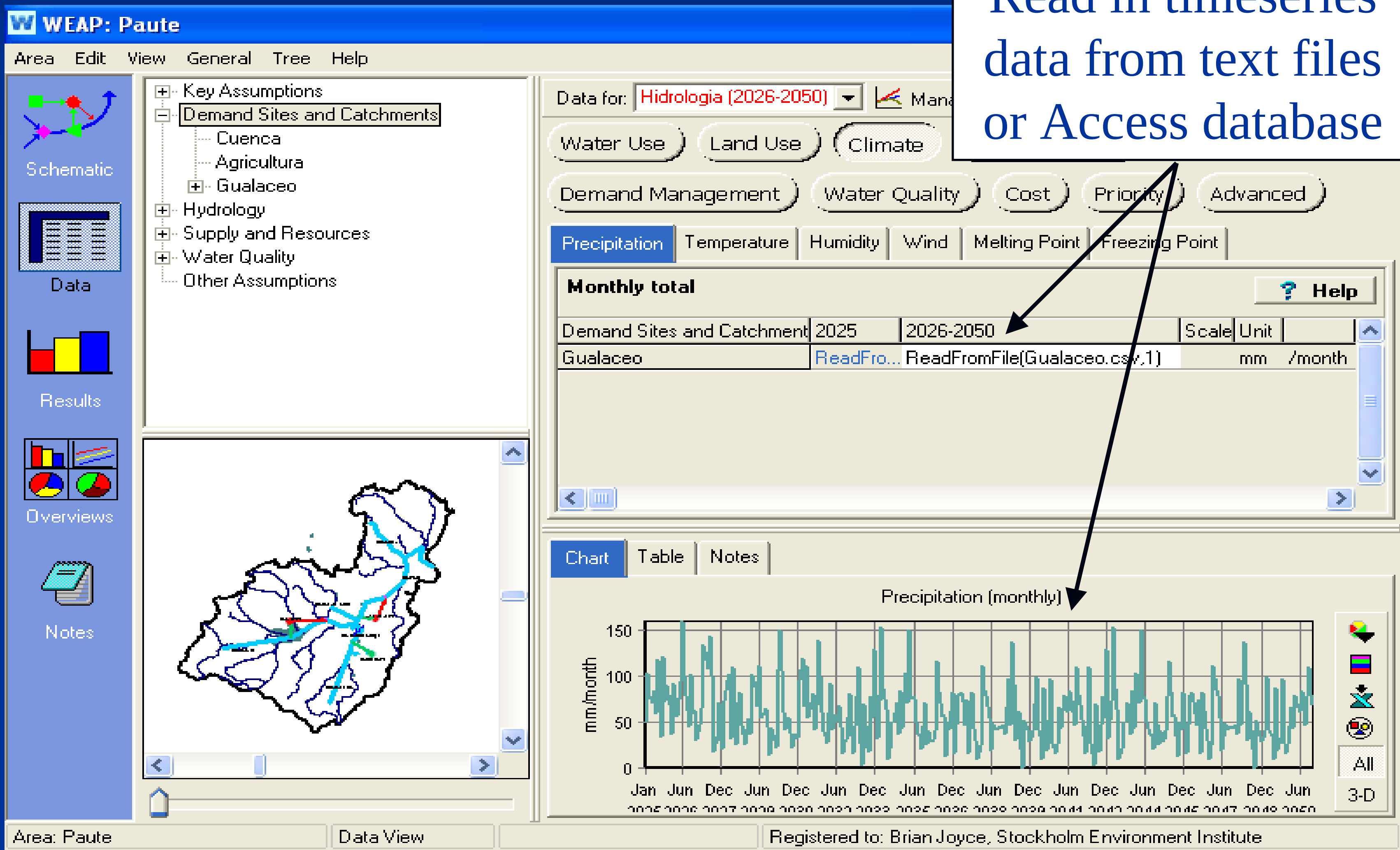
Data View

Data for the demand sites is displayed numerically and graphically



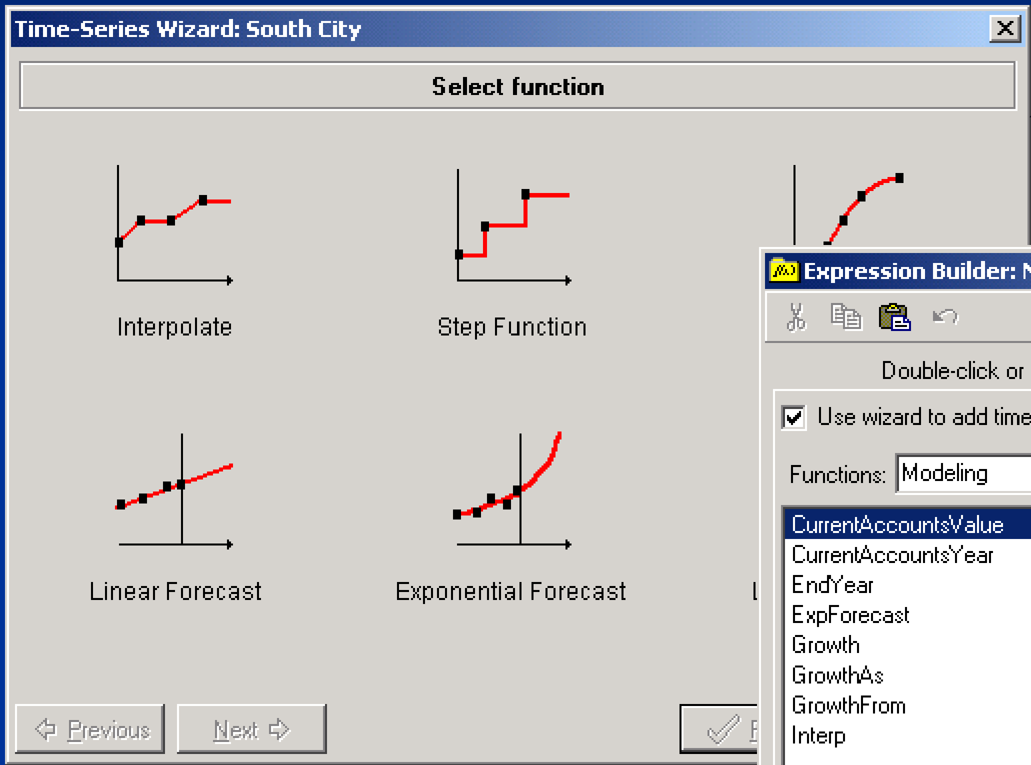
Reading from Files

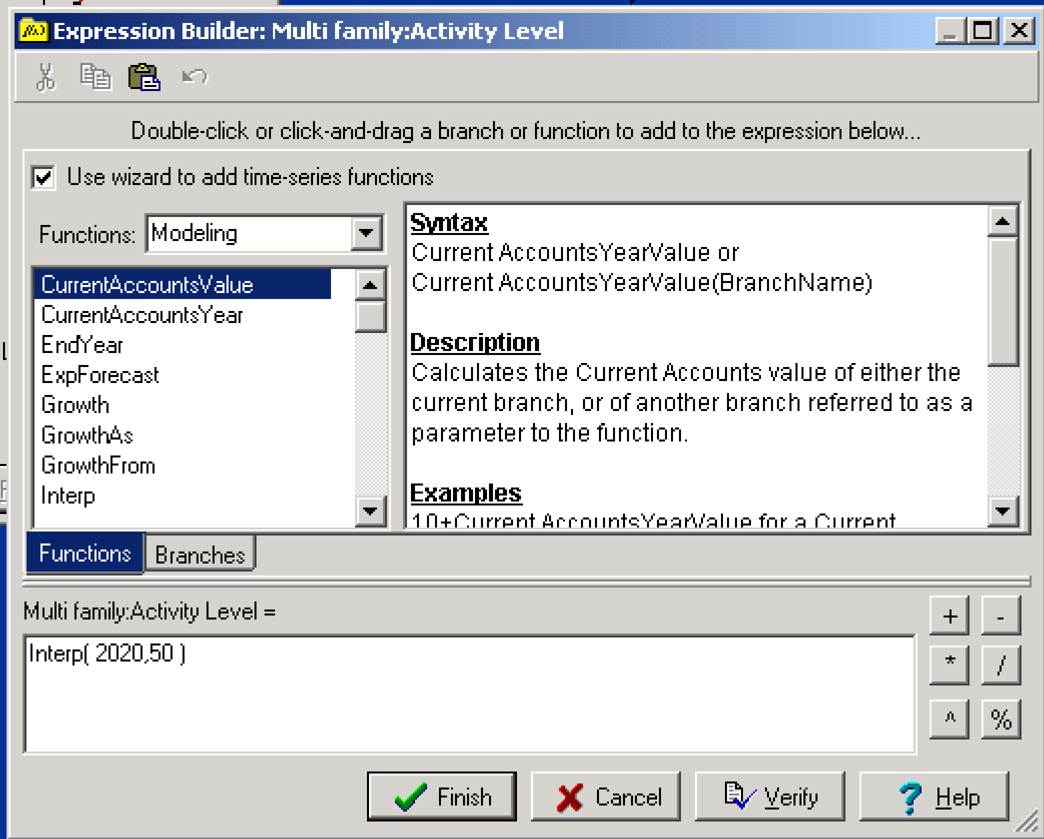


Read in timeseries data from text files or Access database

Building expressions

Use the time series wizard or expression builder





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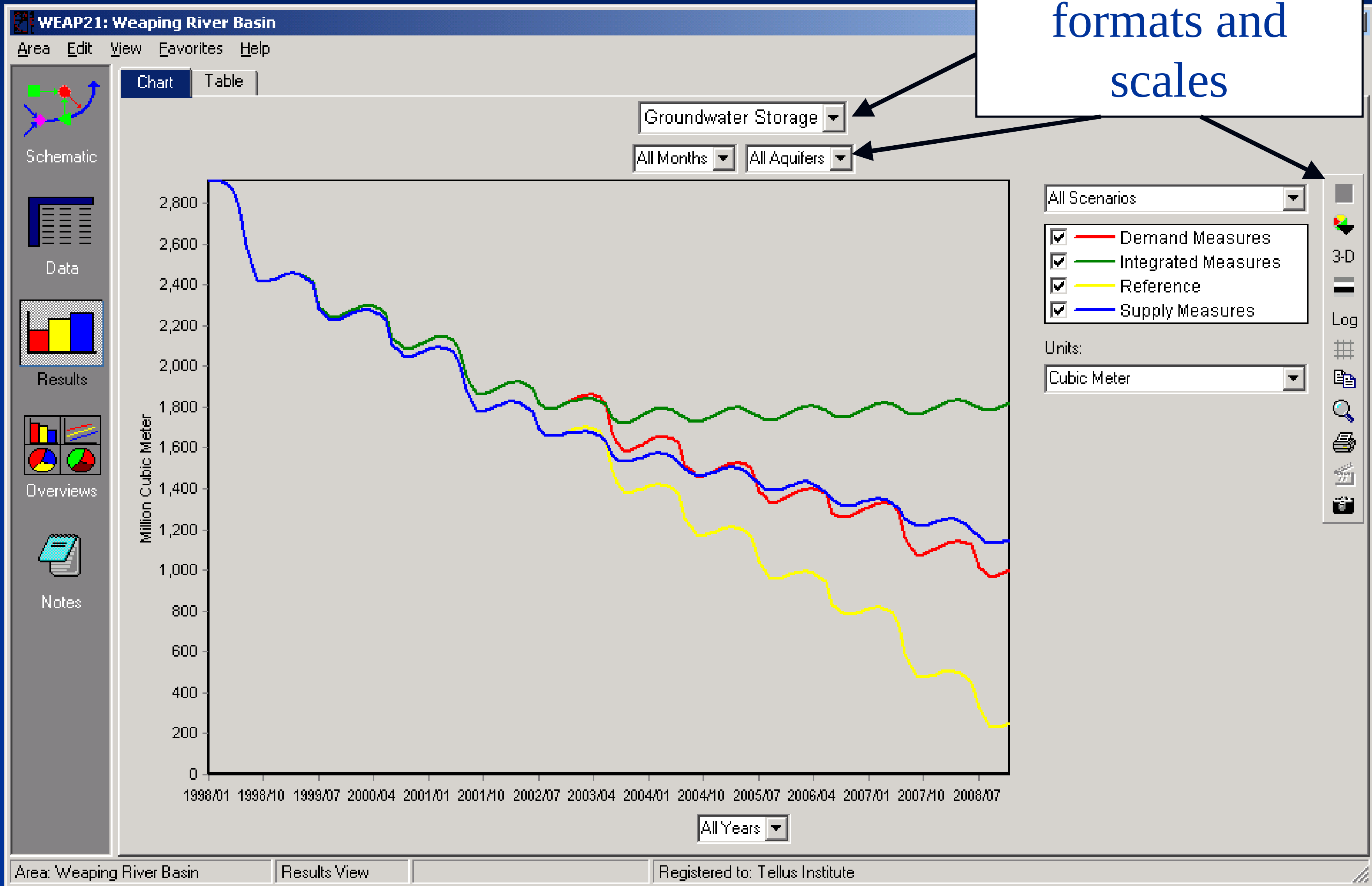
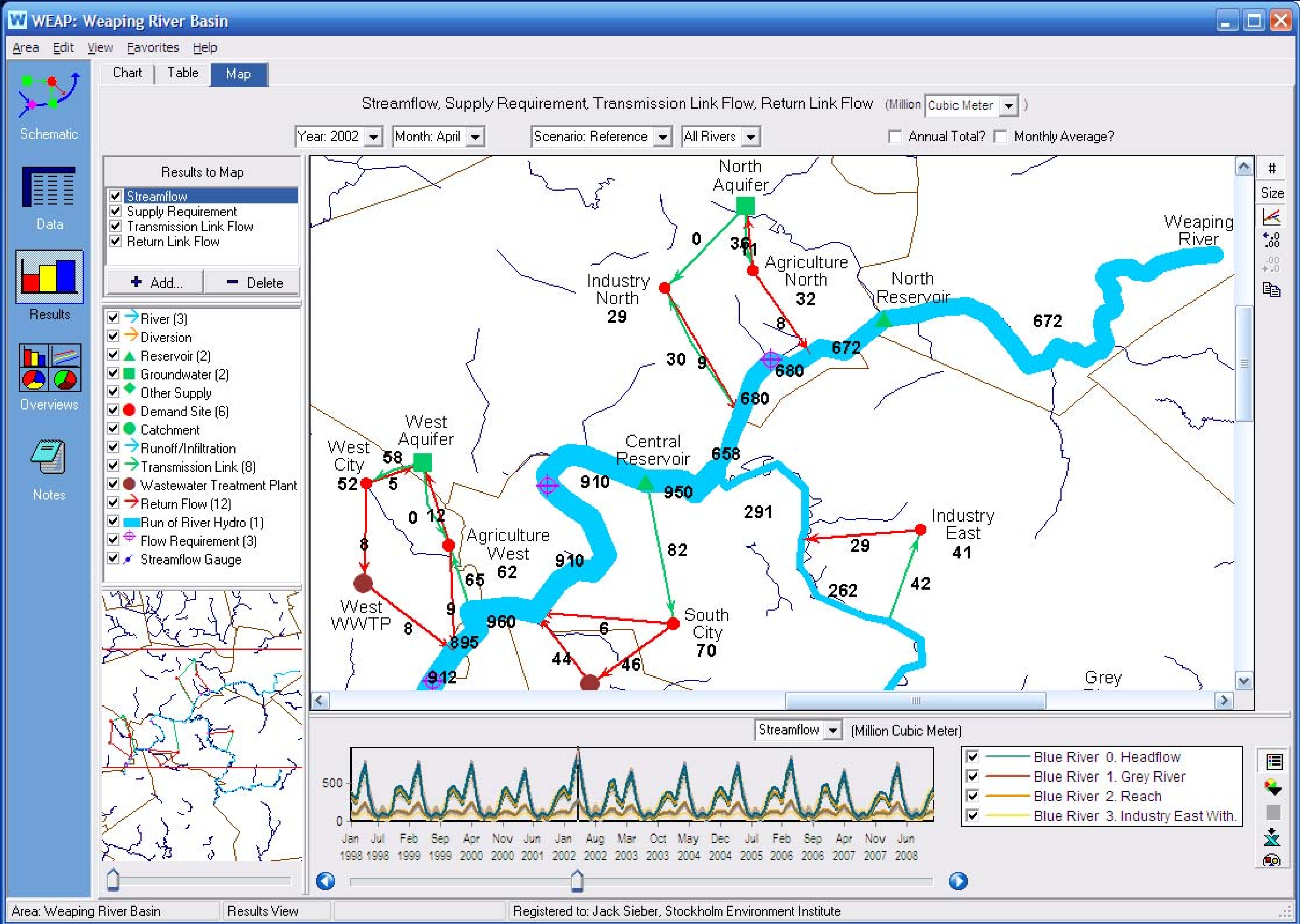
Results View

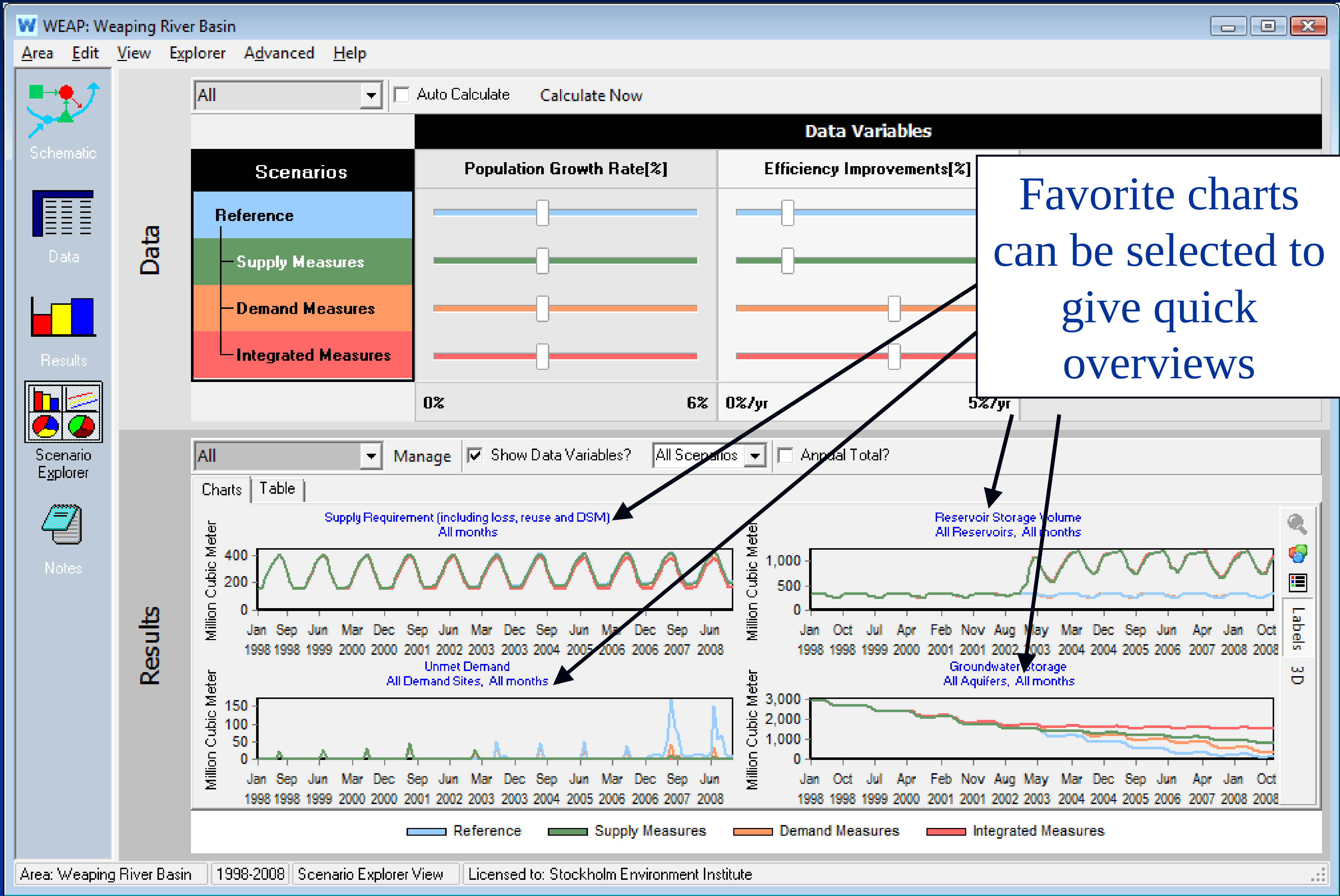
Results can be displayed in a number of formats and scales



Results Displayed on the Map



Scenario Explorer



Favorite charts can be selected to give quick overviews

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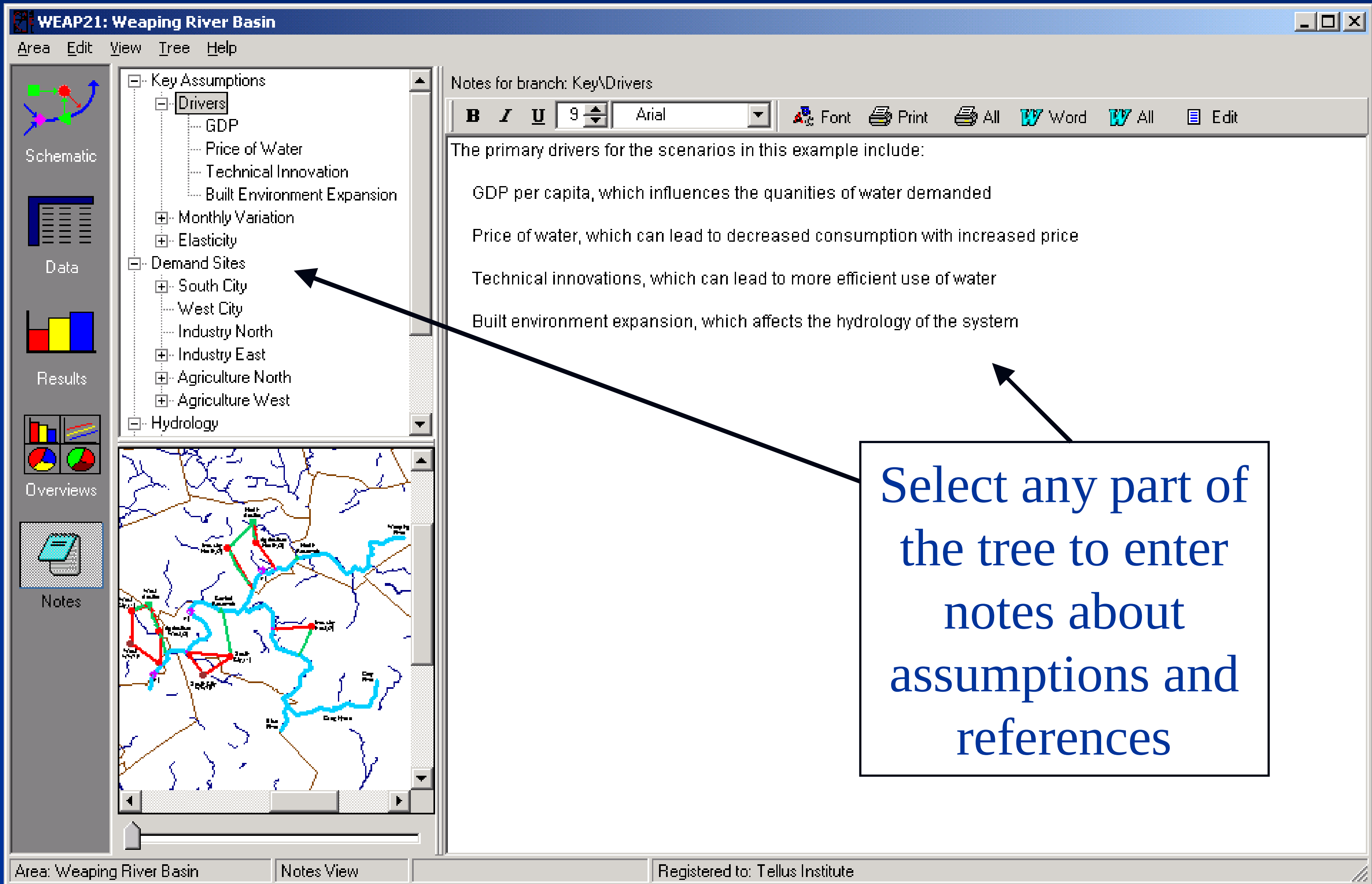
Notes View



Select any part of the tree to enter notes about assumptions and references

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Hydrology

Simplified Water-Year Method

- Describe a series of water year types from very dry to very wet
- Enter the water year sequence

Read-from-file Method

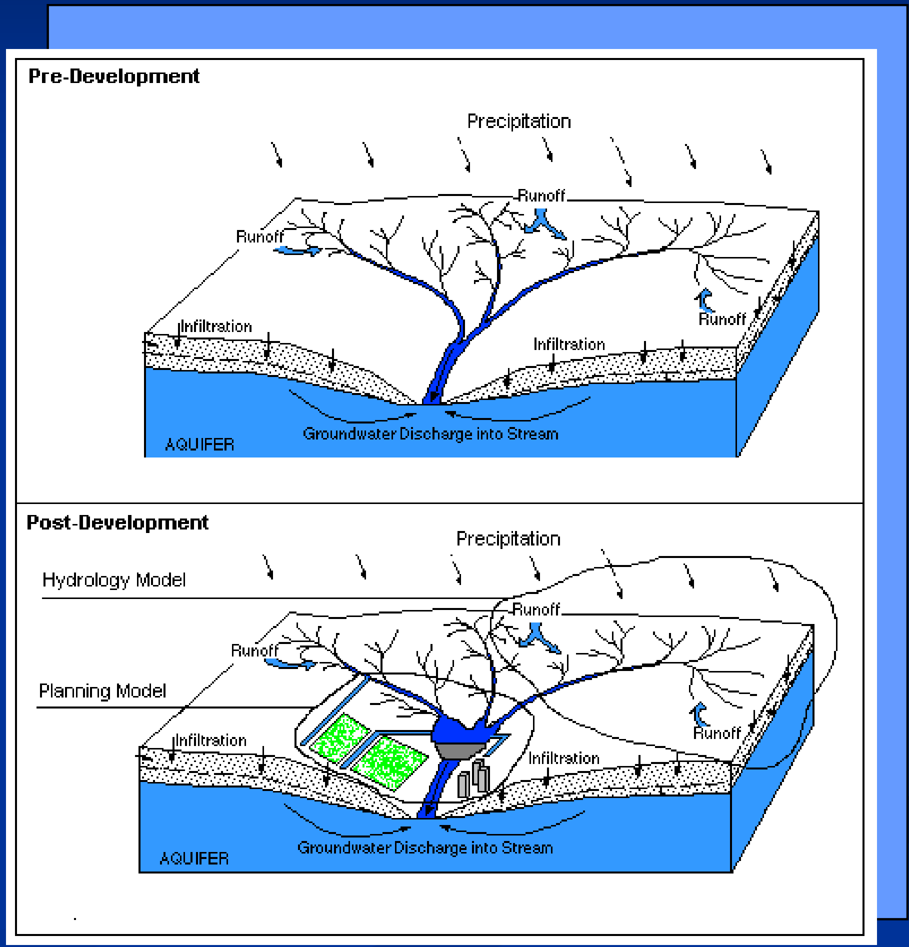
- Historical or synthetic data
- Import from ASCII files

Rainfall-Runoff

- Lumped parameter
- Semi-distributed
- Sub-watershed specific
- Climate input

Hydrology and Management

- WEAP21 advantage: seamlessly integrates watershed hydrologic processes with water resources management
  - Can be climatically driven



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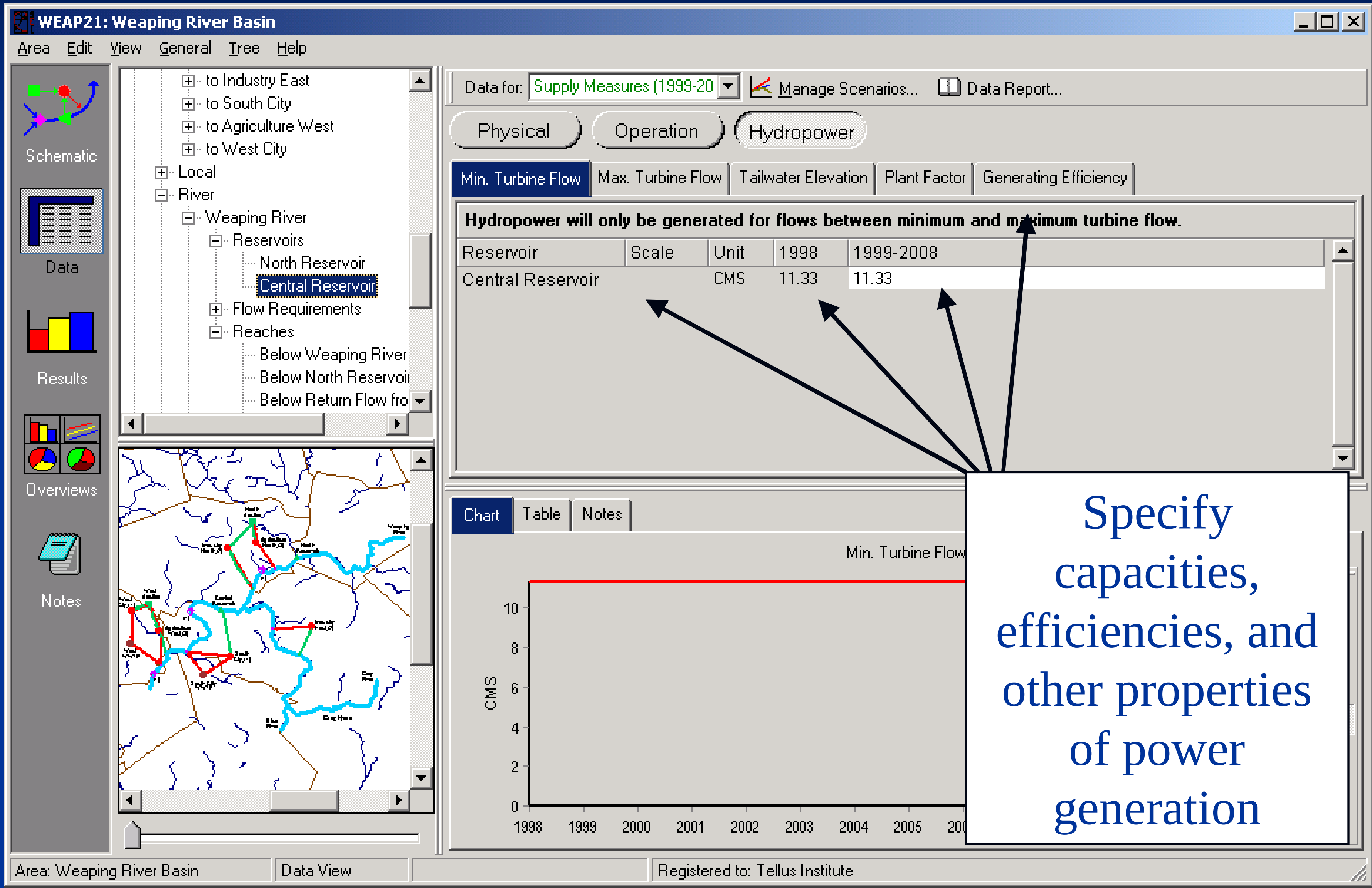
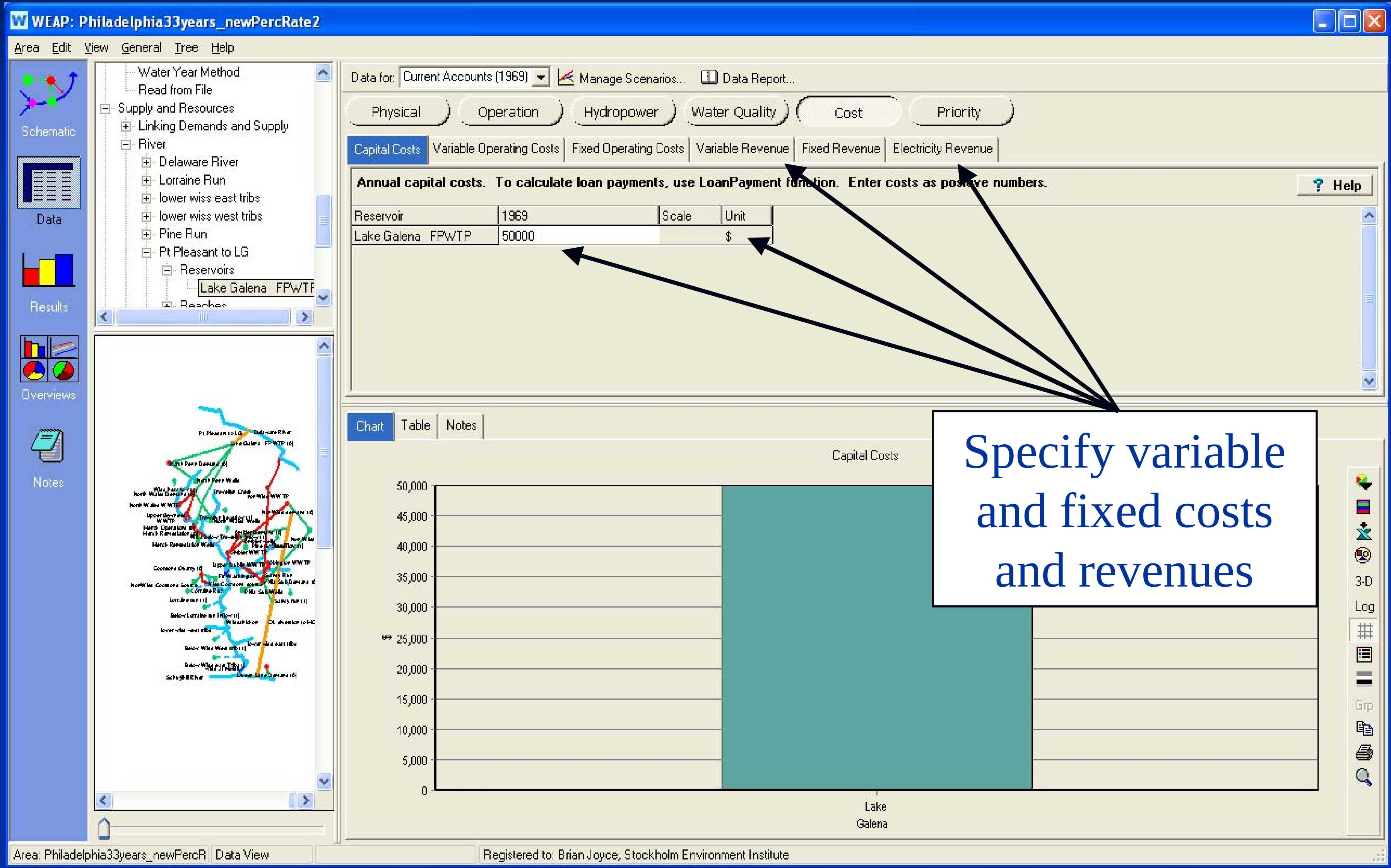
Hydropower

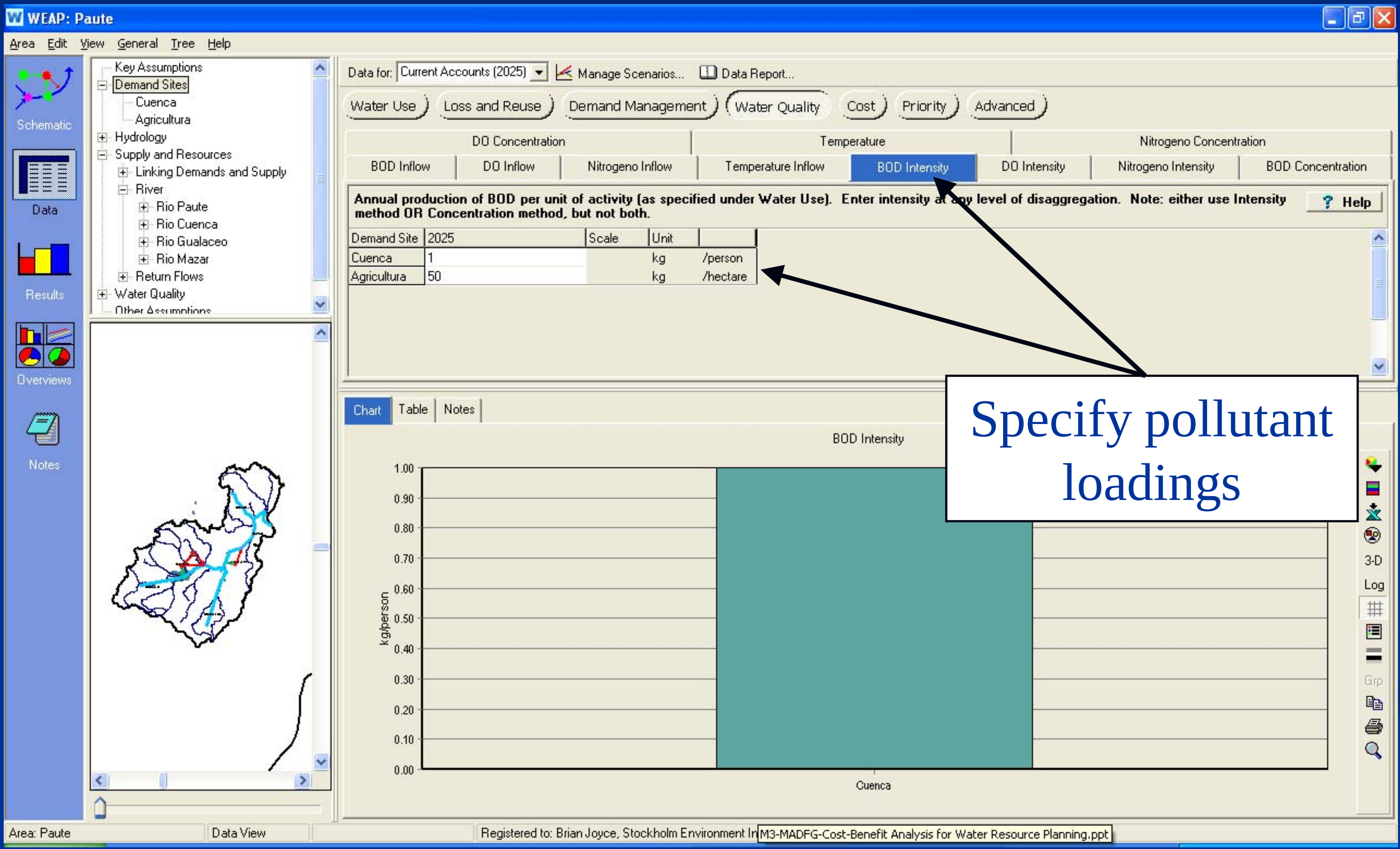

WEAP21: Weaping River Basin
Area Edit View General Tree Help
to Industry East
to South City
to Agriculture West
to West City
Local
River
Weaping River
Reservoirs
North Reservoir
Central Reservoir
Flow Requirements
Reaches
Below Weaping River
Below North Reservoir
Below Return Flow fro
Schematic
Data
Results
Overviews
Notes
Data for: Supply Measures (1999-20
Manage Scenarios...
Data Report...
Physical
Operation
Hydropower
Min. Turbine Flow
Max. Turbine Flow
Tailwater Elevation
Plant Factor
Generating Efficiency
Hydropower will only be generated for flows between minimum and maximum turbine flow.
Reservoir
Scale
Unit
1998
1999-2008
Central Reservoir
CMS
11.33
11.33
Chart
Table
Notes
Min. Turbine Flow
CMS
Area: Weaping River Basin
Data View
Registered to: Tellus Institute
Specify capacities, efficiencies, and other properties of power generation

Financial Analysis



Specify variable and fixed costs and revenues

Water Quality



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- **Dynamically links to other models**

Linking WEAP to Other Software

- Customized/Programmed links
  - Groundwater flow model
    - MODFLOW
  - Surface water quality model
    - Qual2K
- User-defined links to dynamic-link libraries
  - California Department of Water Resources
    - Delta salinity model
  - East-Bay Municipal Utilities District
    - Reservoir operations model
- Call WEAP using application programming interface (API)
  - Scenario analysis
    - CARS (RAND Corporation)
  - Model calibration
    - PEST
  - Sensitivity analysis
    - VB script

WEAP Highlights

- Integrated water resources planning system
- GIS-based, graphical drag and drop interface
- Model-building tool – user-created variables and modeling equations
- Basic Methodology: physical simulation of demands and supplies
- Scenario management capabilities
- Dynamic links to spreadsheets & other models

WEAP Information

- www.weap21.org
  - Downloads
  - Tutorials
  - Educational videos
  - User forum
- Free for non-profit, governmental or academic organizations in developing countries