



eWater Source

At the Workshop on Modern Tools and Techniques for
Water Resources Assessment and Management

16-17 September 2014, Imperial Hotel, New Delhi

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www.toolkit.ewater.com.au



The Source IWRM Platform

‘Catchment to Estuary’ water system modelling capability

Runoff and constituent generation

Transport through regulated and unregulated systems

Urban and rural systems, including newer urban infrastructure options, crop demand and production models

Ecological function (environmental watering demands, response models)

Link with other models and systems, optimisation, the cloud

Resource management, ownership, water markets

Groundwater interaction

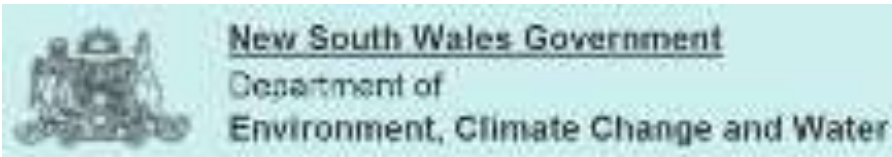
Models are used in developing and monitoring water management policy

“We don’t do policy change without modeling it first

”

...

eWater Ltd – our Current Owners



Department of Sustainability and Environment



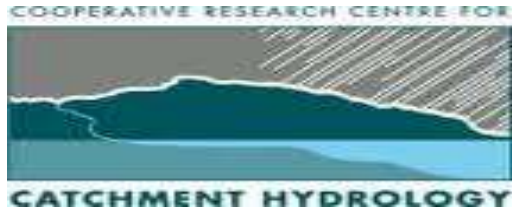
Department of Environment and
Resource Management



Australian Government
Department of the Environment



Evolution of eWater

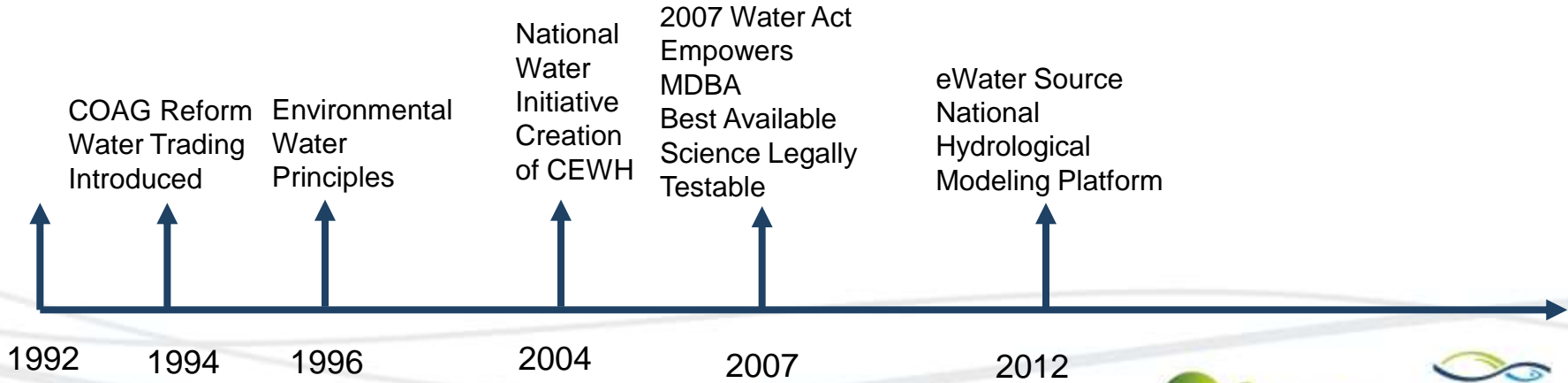


Hydrological Tools & Methods
13 Years, 14 Partners, \$50M



River Ecology & Science
12 Years, 13 Partners, \$50M

Frameworks to manage human and ecological use of water
6 years, 45 Partners, \$160M

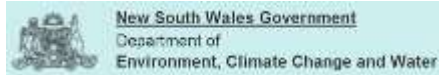


eWater CRC - 34 Industry & 11 Research Partners

PUBLIC INDUSTRY

CORPORATE INDUSTRY

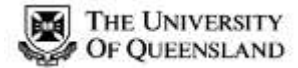
RESEARCH



Department of Sustainability and Environment
Department of Primary Industries
Environmental Protection Agency (EPA)
Victorian Catchment Management Authorities



Department of Environment and Resource Management
Queensland
Primary Industries and Fisheries – Department of Employment, Economic
Development and Innovation



Source and Basin Planning

Stakeholders:



Environment,
People



Urban

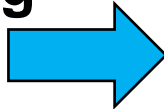


Irrigation



Industry

Understanding the System: Models



Floods &
Dry

Surface
Water

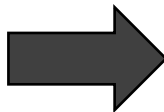
Ground
water

Climate
Change

Water
Quality

Land Use and
Agriculture

Assess Options:



Industry \$

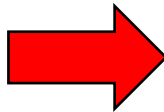
Environment, Services and

Energy Supply

Food Production

Urban

Actions



Policy



Implementation

*Integrated Modelling System
for rural and urban water management*



Ordering

How much water to release from storage to meet downstream requirements. Taking into consideration:

- Delivery time
- The most efficient path
- Supply constraints
- Outlet constraints
- Different supply reservoirs

Based on two passes:

- Constraint pass (top to bottom pass)
- Ordering pass (bottom to top pass)

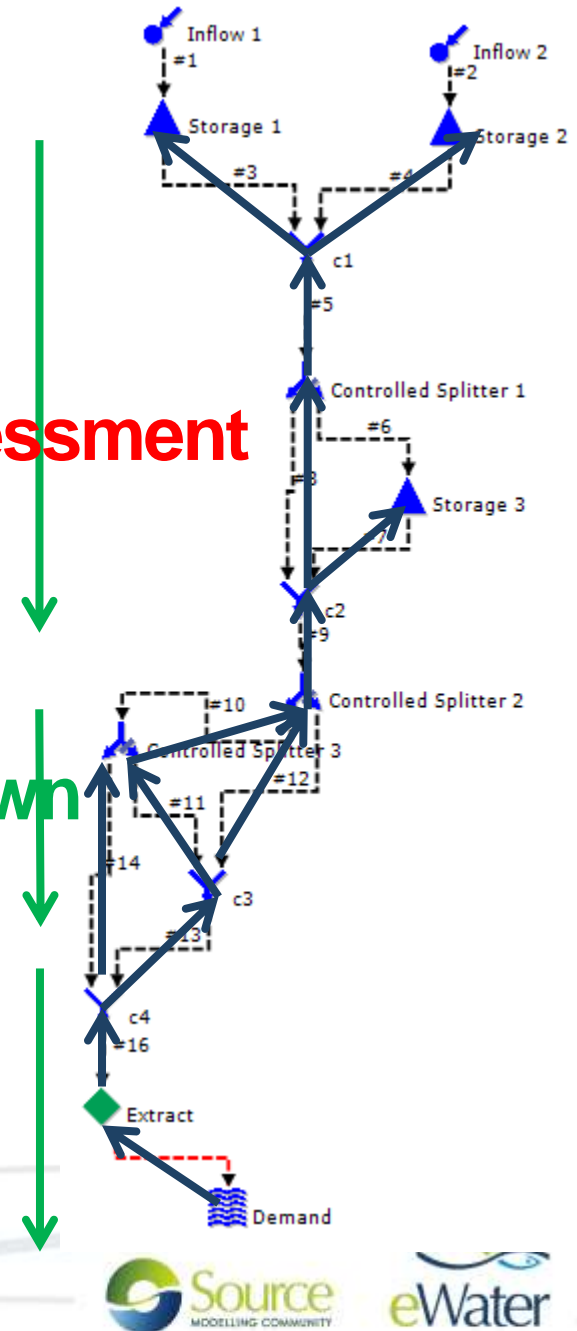
Defined rules or network linear programming (RELAXIV or PPRN).

Resource Assessment

Constraints

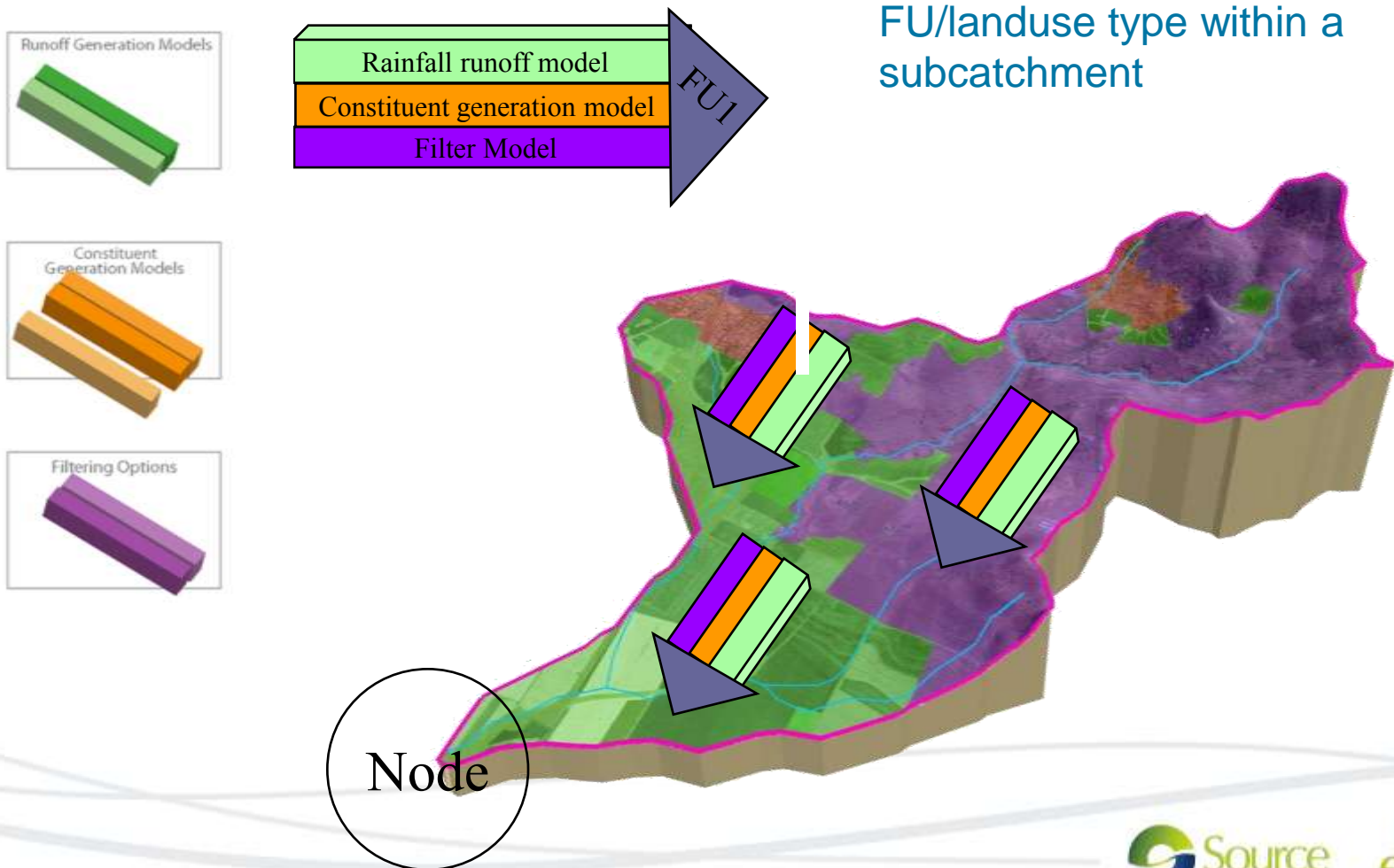
Order Up

Deliver Down



Hydrological framework

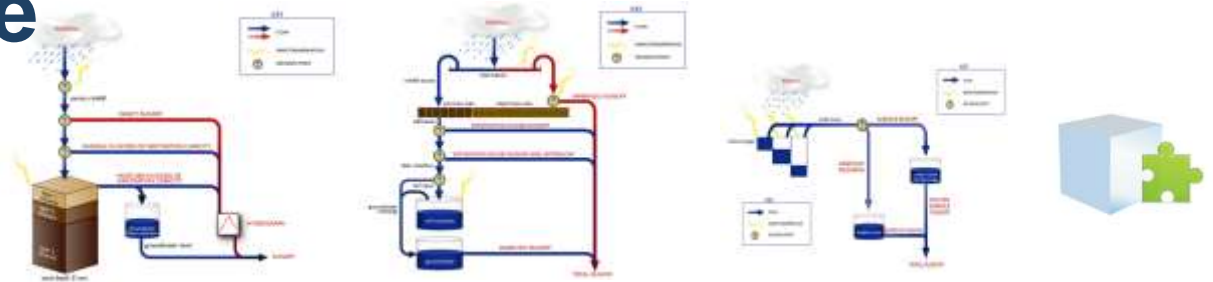
- The combination of processes produces an output for a particular FU/landuse type within a subcatchment



Flexible Structure

Alternate runoff
conceptualisations

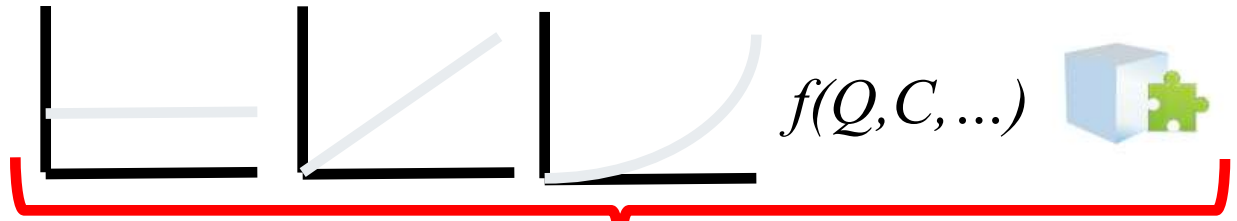
9 models + observed runoff
+ user defined plugins



The screenshot displays the Source (v2.13.1) software interface for a project named 'SC_Demo [SC_Demo_IMS.rproj]'. The interface includes a menu bar (File, View, Edit, Run, Tools, Help), a toolbar with icons for Ownership, Ordering, Single analysis, Configure, and Run, and a Project Explorer on the left. The Project Hierarchy shows a 'Catchment' folder containing 'Desert', 'Forest', and 'Total' sub-folders. Under 'Total', there are nine 'SC #' entries (SC #1 to SC #9) and an 'Urban' entry. The Parameters panel on the left lists various flow and storage components, such as 'Mass Balance (1 instances)', 'Outflow (1 instances)', 'Quick Flow (1 instances)', and 'Slow Flow (1 instances)'. The main window displays a map of a catchment area with a network of flow paths and a red arrow pointing to a specific location. The status bar at the bottom indicates 'Recording Estimate: Eastings: 575748.6875 Northings: -3046169.5' and 'Active scenario: Base Case'.

Constituent Generation

Catchment export methods to suit data availability



The screenshot shows the Source (v2.13.1) software interface. The main window displays a map of a catchment area with a network of flow paths. A context menu is open over the map, listing the following export methods: EMC/DWC, EMC/DWC, Export rate, Nil Constituent, Power Function, and Power Function (flow). The left sidebar shows the Project Hierarchy with a tree structure including Catchment, Desert, Forest, Total, and various SC #10 through SC #9. The Parameters panel on the left lists various flow models such as Mass Balance, Outflow, Quick Flow, and Slow Flow. The bottom status bar indicates the active scenario is 'Base Case'.

Node Types

Nodes representing management functions, key structures, points of interest



Source (v2.13.1) - SC_Demo [SC_Demo_IMS.rproj]

File View Edit Run Tools Help

Ownership Ordering Single analysis Configure Run

Project Explorer [Base Case]

Project Hierarchy:

- Catchment
 - Desert
 - Forest
 - Total
 - SC #1
 - SC #2
 - SC #3
 - SC #4
 - SC #5
 - SC #6
 - SC #7
 - SC #8
 - SC #9

Parameters:

- Mass Balance (1 instances)
- Outflow (1 instances)
- Quick Flow (1 instances)
- Quick Flow Added From Local System (1 instances)
- Quick Flow Removed From Local System (1 instances)
- Slow Flow (1 instances)
- Slow Flow Added From Local System (1 instances)
- Slow Flow Removed From Local System (1 instances)

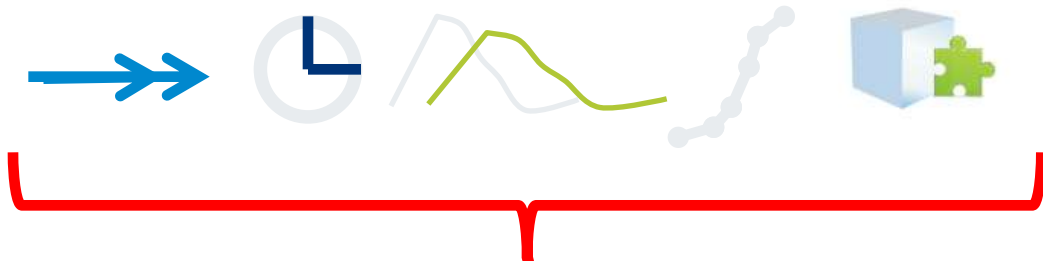
Recording Estimate: Eastings: 575748.6875 Northings: -3046169.5

Recording Manager

Active scenario: Base Case

Hydrological Routing

Alternate transport representations for flow, water quality constituents and ownership



Source (v2.13.1) - SC_Demo [SC_Demo_IMS.rproj]

File View Edit Run Tools Help

Ownership Ordering Single analysis Configure Run

Project Explorer [Base Case]

Project Hierarchy:

- Catchment
 - Desert
 - Forest
 - Total
 - SC #10
 - SC #2
 - SC #3
 - SC #4
 - SC #5
 - SC #6
 - SC #7
 - SC #8
 - SC #9
 - Urban

Parameters:

- Mass Balance (1 instances)
- Outflow (1 instances)
- Quick Flow (1 instances)
- Quick Flow Added From Local System (1 instances)
- Quick Flow Removed From Local System (1 instances)
- Slow Flow (1 instances)
- Slow Flow Added From Local System (1 instances)
- Slow Flow Removed From Local System (1 instances)

Recording Estimate: Eastings: 575748.6875 Northings: -3046169.5

Recording Manager

Active scenario: Base Case

link routing models

- Straight-Through Routing
- Lagged Flow Routing
- Laurenson Flow Routing
- Laurenson Lag Flow Routing
- MockStorage
- Muskingum Flow Routing
- Storage
- Storage Routing
- Straight-Through Routing
- Straight-Through Routing
- TestControlledStorage
- Test Storage

Constituent Filters

Export filters to represent
land management actions
(7 filter models)



The screenshot displays the Source (v2.13.1) software interface. The main window shows a map of a catchment area with a network of lines representing flow paths. A red arrow points from the top-right corner of the map area to the 'SC #10' entry in the Project Hierarchy tree on the left. The Project Hierarchy tree is expanded to show the following structure:

- Catchment
 - Desert
 - Forest
 - Total
 - SC #10
 - SC #2
 - SC #3
 - SC #4
 - SC #5
 - SC #6
 - SC #7
 - SC #8
 - SC #9

The Parameters panel on the left lists various flow models, including Mass Balance, Outflow, Quick Flow, and Slow Flow, each with a radio button and a plus sign icon. The bottom status bar indicates the active scenario is 'Base Case' and provides Eastings: 575748.6875 and Northings: -3046169.5.

Instream Decay

Decay of constituents
instream or within
reservoirs 3 models



The screenshot displays the Source (v2.13.1) software interface. The main window shows a network diagram of a catchment area with various nodes and flow paths. A red arrow points from the icons above to a specific node in the network. The interface includes a Project Explorer on the left showing a Project Hierarchy with nodes like Catchment, Desert, Forest, Total, and SC #1 through SC #9. Below the Project Explorer is a Parameters panel with various model settings. The bottom status bar indicates the active scenario is 'Base Case' and provides Eastings and Northings coordinates.

Demand Models

- Represent demand as a time series, a recurring pattern or with a model.
- Cultural flows
- Ecological demands



Source (v2.13.1) - SC_Demo [SC_Demo_IMS.rproj]

File View Edit Run Tools Help

Ownership Ordering Single analysis Configure Run

Project Explorer [Base Case]

Project Hierarchy:

- Catchment
 - Desert
 - Forest
 - Total
 - SC #1
 - SC #2
 - SC #3
 - SC #4
 - SC #5
 - SC #6
 - SC #7
 - SC #8
 - SC #9
 - Urban

Parameters:

- Mass Balance (1 instances)
- Outflow (1 instances)
- Quick Flow (1 instances)
- Quick Flow Added From Local System (1 instances)
- Quick Flow Removed From Local System (1 instances)
- Slow Flow (1 instances)
- Slow Flow Added From Local System (1 instances)
- Slow Flow Removed From Local System (1 instances)

Recording Estimate: Eastings: 575748.6875 Northings: -3046169.5

Recording Manager

Active scenario: Base Case

Options for Customising Source

1. Functions

Powerful math and logic language built into Source (MS Excel-style formulae)

2. Custom Functions

User defined extensions to the Function Manager

3. Plugins!

Open ended system for changing the algorithms, user interface or operation of Source

...

Options for Customising Source cont.

4. External Scripting

Batch runs, calibration, uncertainty analysis, links to other systems – models, FEWS

5. Optimisation

Multi-objective optimisation, trade-off analysis

6. Run-time Configuration Changes

Scenario analysis

Functions

Ability to calculate mathematical expressions within Source using system variables

Has similar syntax to Excel

Large set of common used functions (trigonometric, statistical, logical)

Piecewise Linear, Patterns and Time of Evaluation

Custom Functions

Extend the language of the expression editor

Reuse common logic

Written in C# and loaded as a plugin

Functions

The screenshot shows the 'Function Editor' window with a tree view on the left containing various function categories like 'End', 'Now', 'Start', 'Inflow', 'Power_Station', 'Power_generation', 'Rice_demand', 'Rice_usage', 'Storage_release', and several '\$DV' and '\$Min' functions. The main editor area displays the function definition for '\$Min_Power'.

```
min($Min_Power,0.188352*$Power_generation.head*min($Power_generation.discharge_rate,max($DV_Min_target_power_release*2/86.4,$DV_Annual_rice_entitlement/7/30/86.4)))
```

Configuration options on the right include:

- Result Units: megawatt
- Initial Value: 1000000000000
- Force Evaluation: ON
- Time of Evaluation: End of TimeStep

Buttons for 'OK' and 'Cancel' are visible at the bottom right.

$\min(\$Min_Power, 0.188 * \$Power_generation.head * \min(\$Power_generation.discharge_rate, \max(\$DV_Min_target_power_release * 2 / 86.4, \$DV_Annual_rice_entitlement / 7 / 30 / 86.4)))$

Plugins

- Replacement component models (demand, runoff, routing, etc)
- Provide a tailored user interface
- Automate repetitive tasks, such as data pre processing, output report generation
- Written in a .NET language such as C# or Visual Basic
- Basic development tool set free of charge from Microsoft

Toolbox

General

There are no usable controls in this group. Drag an item onto this text to add it to the toolbox.

```

QisCIA.QisCIA
reset()

/// Set all the stores to their full state as defined by parameter Store.
/// Required by all RainfallRunoffModels
/// </summary>
public override void initStoresFull()
{
}

/// <summary>
/// Run a single time step of the model.
/// Required by all RainfallRunoffModels.
/// </summary>
public override void runTimeStep()
{
    //double intensity = rainfall / _timeStepInSeconds;

    RunoffCIA = RunoffCoefficient * rainfall * timeStepInSeconds/86400.0;
    // this.baseflow = 0.0; // maps to slow flow

    runoff = RunoffCIA; // maps to quick flow
    // total flow = baseflow + runoff
}

public override void reset()
{
    base.reset();
}

/// <summary>
/// Mass Balance calculation occurs after each "runTimeStep" is called.
/// </summary>

```

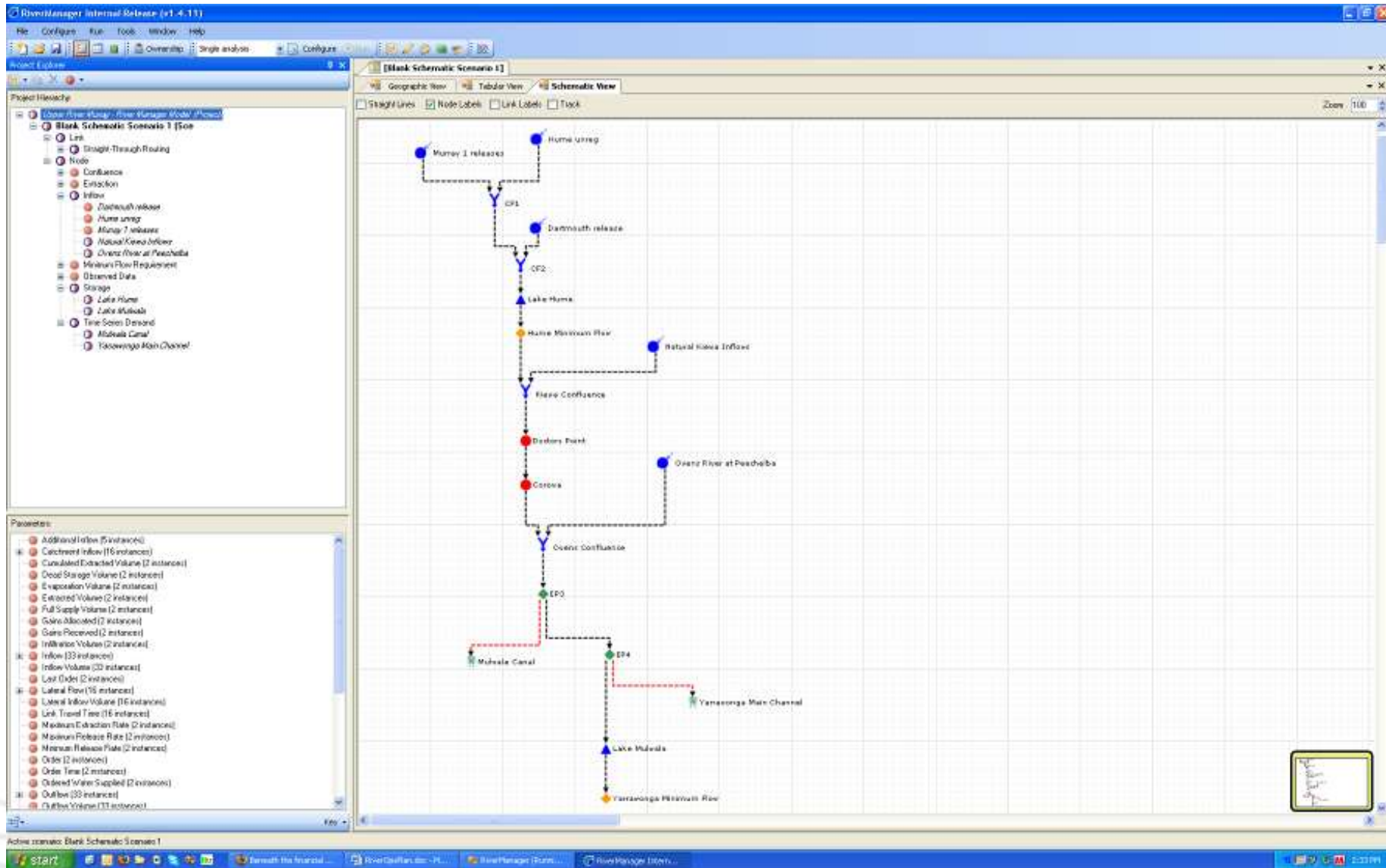
Example Plugin

Error List

31 Errors 0 Warnings 0 Messages

Description	File	Line	Column	Project
-------------	------	------	--------	---------

Planner view



Catchment View

The screenshot displays the RiverManager Internal Release (v1.4.13) software interface. The main window shows a map of a catchment area divided into numerous sub-catchments, each represented by a different color. A network of links and nodes is overlaid on the map, indicating the flow paths. The software's menu bar includes File, Configure, Run, Tools, Window, and Help. The Project panel on the left lists various components: Constituents, Filtering Models, Functional Units, Links, Nodes, Rainfall-Runoff, Demand, Wastewater, and Ownership Configuration. The Demand menu is currently open, showing options for Assign Models..., Input Data..., and Parameters... The Parameters panel at the bottom left lists various parameters with their instance counts, such as Area (945 instances), Catchment Inflow (105 instances), and Inflow (211 instances). The active scenario is identified as 2002 conditions.

Active scenario: 2002 conditions

Managing water supply to competing demands



'Water from dam may be used for Mulshi project'

TIMES NEWS NETWORK

Mumbai: Water from the Mulshi dam, which is used for power generation and irrigation purposes, could be diverted to the new hill city project being planned in Pune's Mulshi taluka. This, however, would depend on permission from the private power company that currently uses the water for its purposes, said the government.

This and several other concessions have been granted to the project by the state urban development. In a notification, it has allowed multiple concessions to the new township based on the reasoning that "in order to promote tourism and orderly development of the land, the modification (to declare the area as a

Pic used for representation only



township) is necessary and should be sanctioned subject to conditions".

The project would have to comply with a set of stringent recommendations made by the Madhav Gadgil committee report on ecological sustainability of the Western Ghats. The state-level expert appraisal committee (SEAC) of the Union ministry of environment and forests (MoEF) has said it will apply the Gad-

gil panel's guidelines to the project mooted by Maharashtra Valley View Private Limited.

"The government has only approved the project in keeping with the guidelines it has put in place for hill station projects. However, until the Gadgil committee's recommendations are applied, it is difficult to say for sure if such projects would be environmentally feasible despite all clearances from the state," said G K Deshpande, acting chairman of the SEAC.

The Western Ghats Ecology Expert Panel report Part II of the Gadgil committee had in August last year said the entire Western Ghats must be considered ecologically sensitive, especially to ensure the sustainability of rivers.

Times of India, Mumbai, 13/6/12

We can model water access rules in different ways

Option 1 – do nothing

Option 2 – use functions to constrain supply

Option 3. Apply allocation system

Use the 'resource assessment' functionality to allocate available resources to different users e.g. on a seasonal basis

The screenshot displays the 'Resource Assessment Explorer' application window. On the left, a tree view shows the following structure:

- Example
 - Resource assessment
 - State 1 Horticulture
 - Account Type 1
 - Horticulture account
 - reassessment
 - reset account
 - Start Of Water Year Trigger
 - State 1 rice
 - Account Type 1
 - rice account
 - reasseement

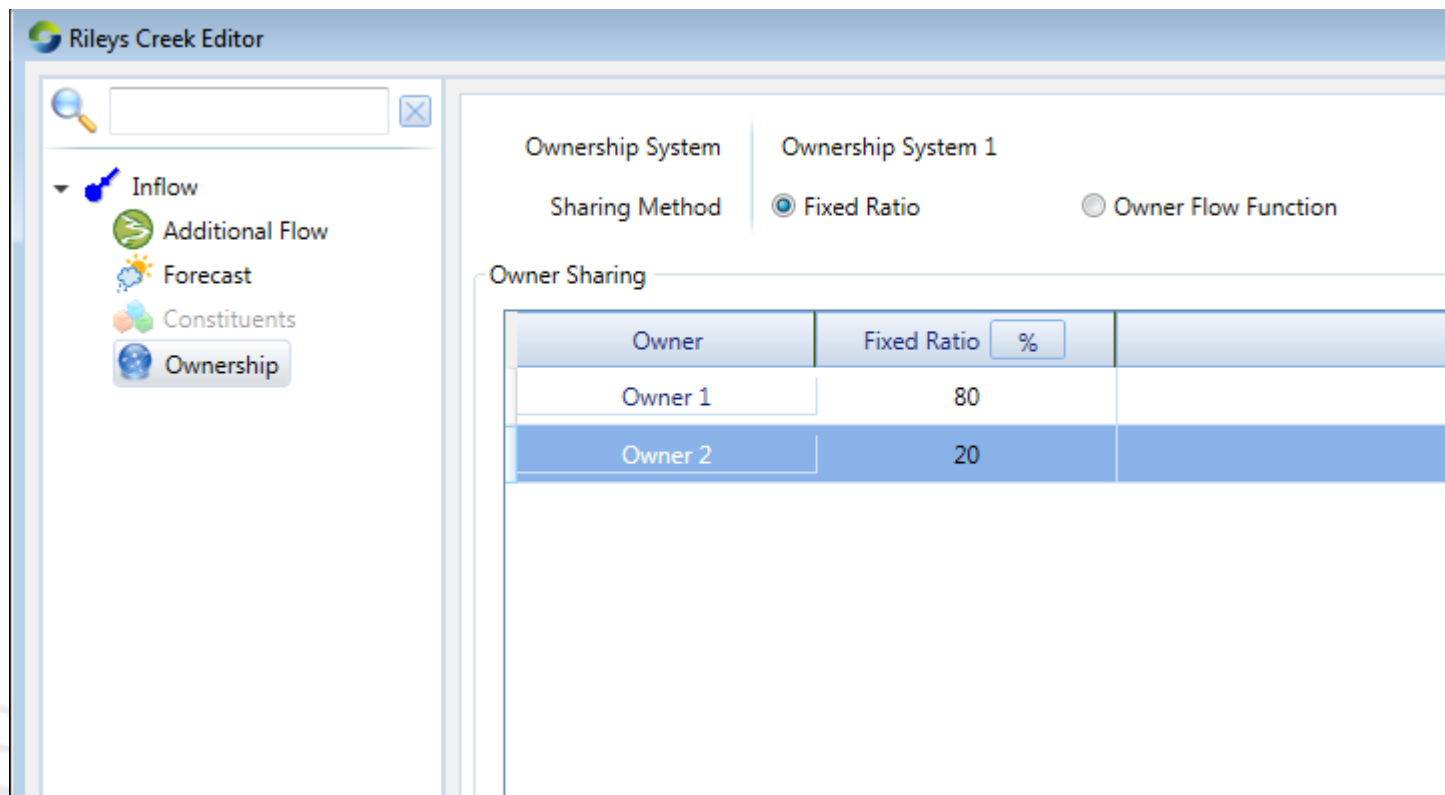
On the right, the 'Trigger Configuration' panel is visible, containing three rows of configuration options:

- Trigger: End Of Water Year
- Execution: Timestep End
- Action: Write Off Accounts

Ways for modelling different water access rules

Option 4. Ownership.

Use the 'ownership' functionality to 'lock in' a users access to a particular quantity or share of water



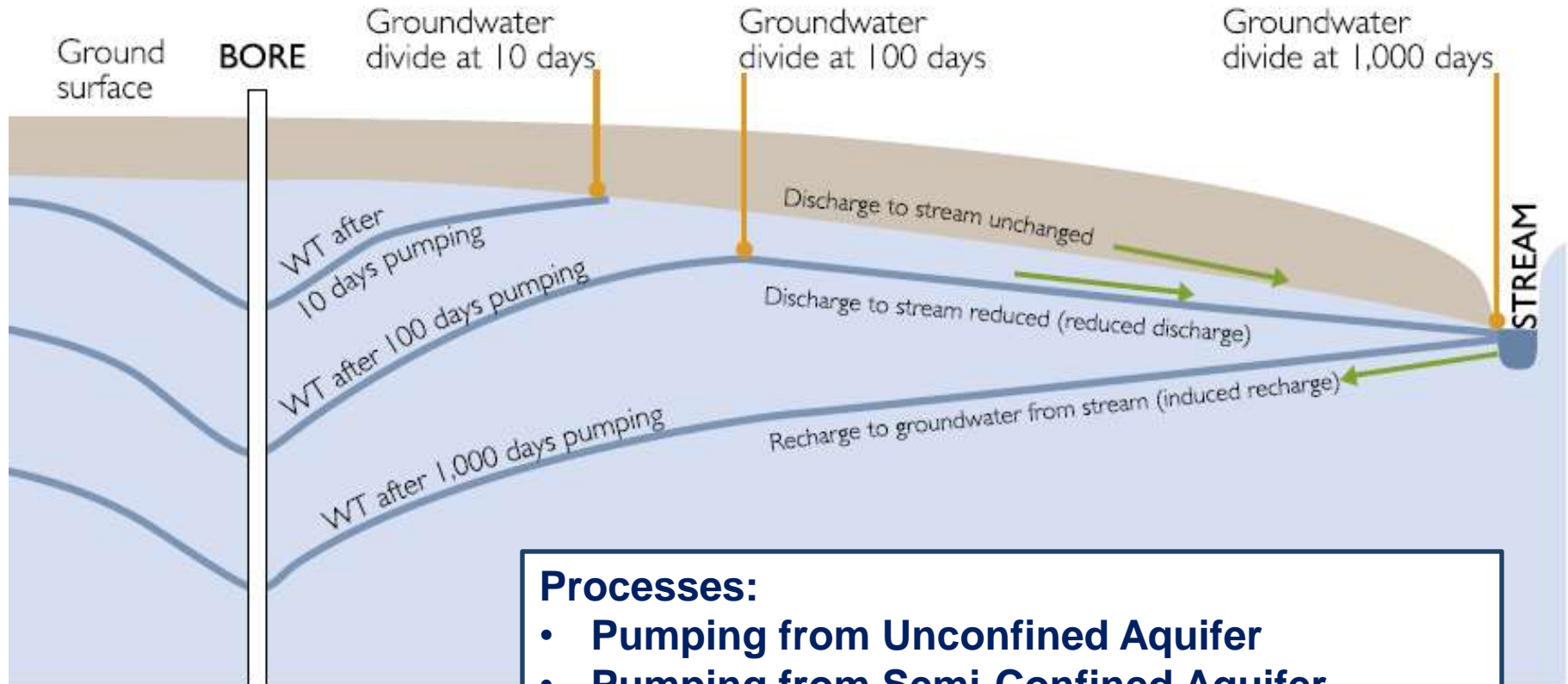
The screenshot shows the 'Rileys Creek Editor' interface. On the left is a navigation pane with icons for Inflow, Additional Flow, Forecast, Constituents, and Ownership. The main area is titled 'Ownership System 1' and shows the 'Sharing Method' set to 'Fixed Ratio' (selected with a radio button) and 'Owner Flow Function' (unselected). Below this is an 'Owner Sharing' table with three columns: 'Owner', 'Fixed Ratio', and a percentage sign in a box. The table contains two rows: 'Owner 1' with a fixed ratio of 80, and 'Owner 2' with a fixed ratio of 20.

Owner	Fixed Ratio	%
Owner 1	80	
Owner 2	20	



Groundwater/Surface Water Interaction

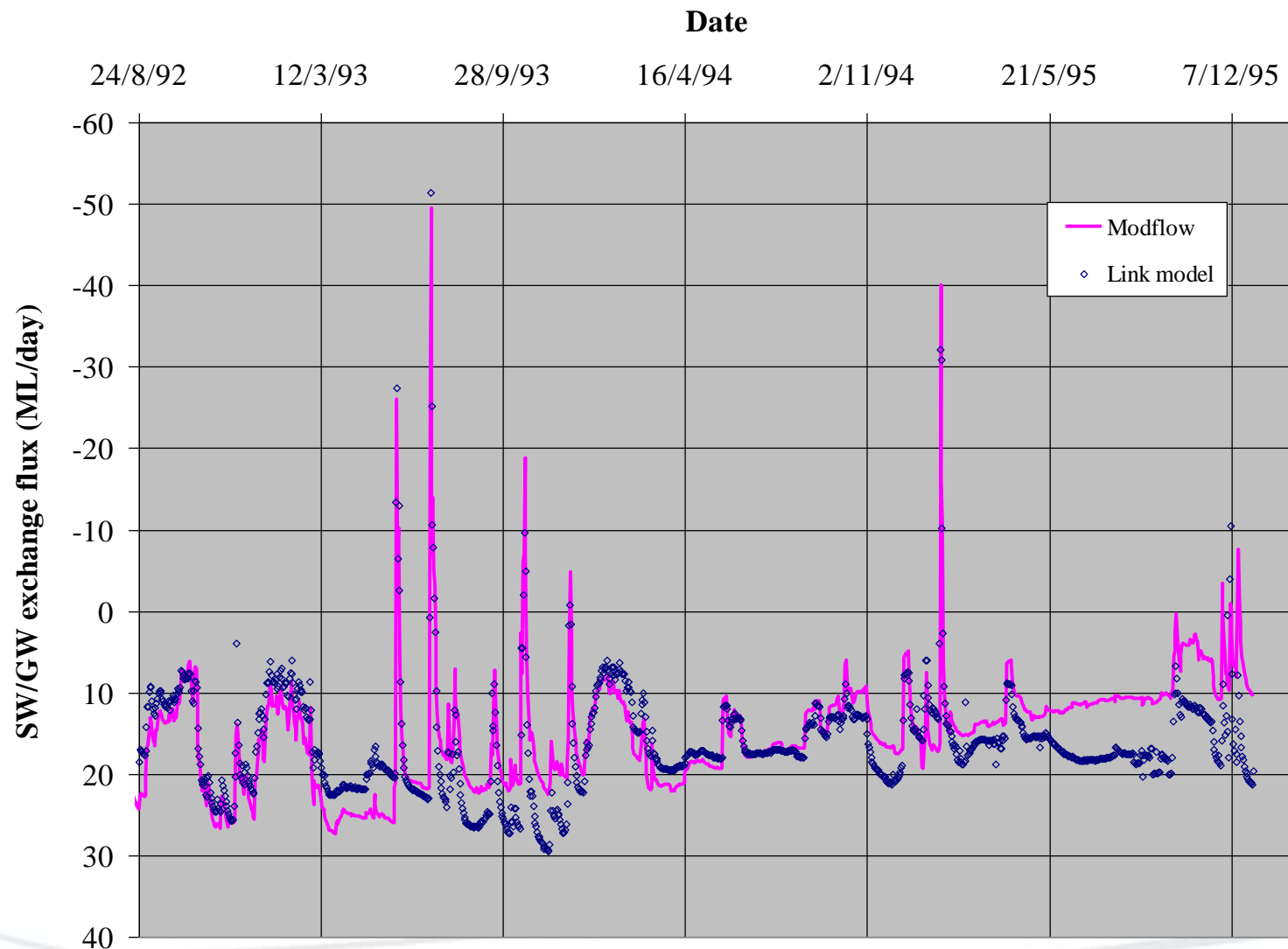
Impacts of groundwater pumping on rivers



Processes:

- **Pumping from Unconfined Aquifer**
- **Pumping from Semi-Confined Aquifer**
- **Irrigation Recharge**
- **Diffuse Recharge**

Groundwater Link Model versus MODFLOW



+ve = Gaining, -ve = Losing

The Source IWRM Platform

- The freely available 'Public Release' is a fully featured IWRM platform
- 330 downloads from 42 countries
- Pricing for the full featured release, which also covers water markets, resource assessment etc. is targeted at commercial use
- Under the Government to Government Agreement we can customise Source to the Indian context
- The Australian Central and State governments are committed to Source. Source is being used for statutory WRM in Australia.



Australian Government

Department of Foreign Affairs and Trade



The Source IWRM Platform

- Quality software engineering
- Extensive unit tests
- Hundreds of regression tests to ensure stability
- User models are added to the regression test suite for assurance
- Readily customisable for specific users – e.g.
 - Glacier, snowmelt
 - Resource assessment
 - Small catchment dams
 - GIS



Australian Government

Department of Foreign Affairs and Trade





Thank You!



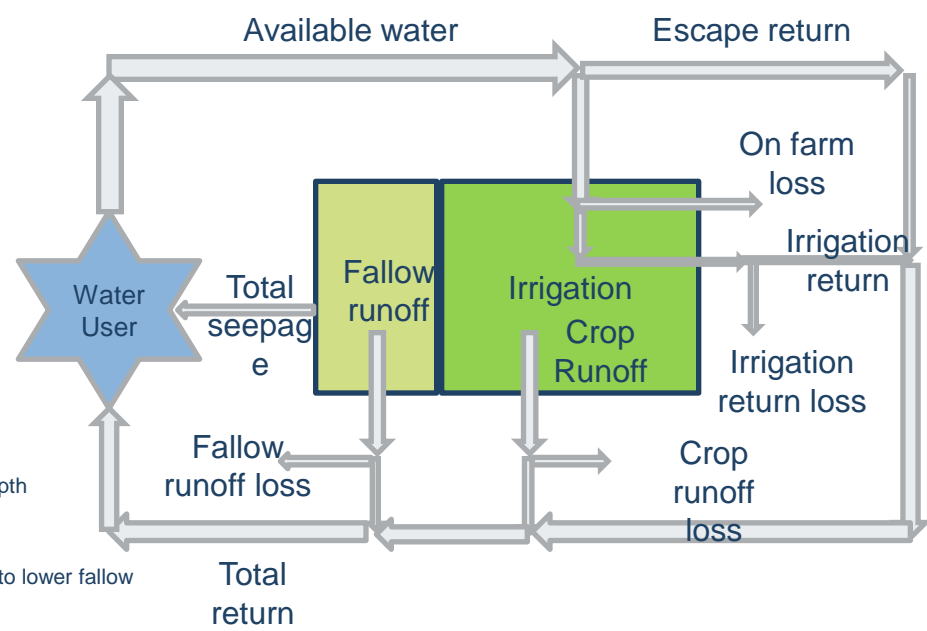
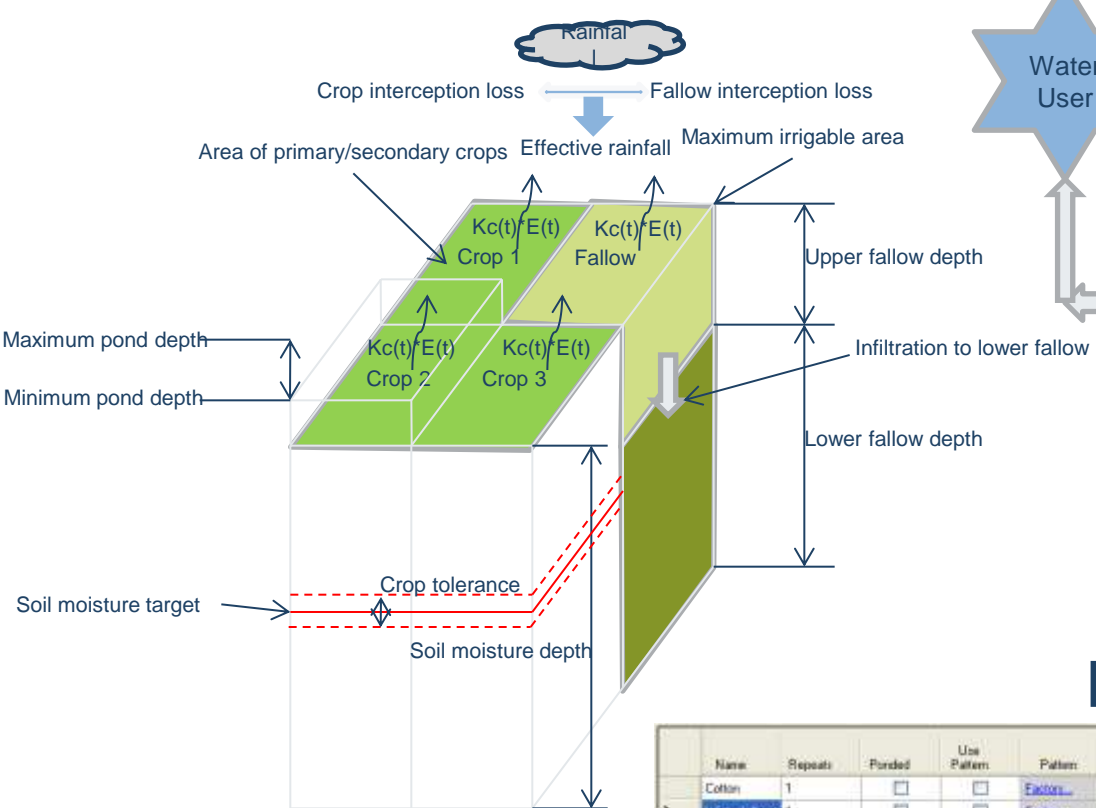
An Australian Government Initiative



CRC
AUSTRALIA



Irrigation Demand



FAO Crop Factors

Name	Repeats	Ponded	Use Pattern	Pattern	Crop Coefficient					Number of growing days				Losses
					Initial	Development	Mid-Season	Late-Season	Maturity	Initial	Development	Mid-Season	Late-Season	
Cotton	1	<input type="checkbox"/>	<input type="checkbox"/>	Factors...	0.4	0.4	1.2	1.2	0.6	30	50	60	95	Losses...
Winter wheat	1	<input type="checkbox"/>	<input type="checkbox"/>	Factors...	0.3	0.3	1.15	1.15	0.3	160	75	60	30	Losses...
Rice	1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Factors...	1.1	1.1	1.1	1.1	0.95	35	40	10	35	Losses...
Pasture	1	<input type="checkbox"/>	<input type="checkbox"/>	Factors...	0.85	0.85	0.95	0.95	0.85	140	60	120	46	Losses...



1000 GI = 1 km³

Storages	Active Capacity
Murray	7498.67 GI
Campaspe	304.65 GI
Loddon	220.08 GI
Bullarook Ck	5.442 GI
Murrumbidgee	2632.895 GI
Menindee Lakes	1555.051 GI
Goulburn	3558.512 GL
Ovens	32.379 GL
Broken	39.653 GL
Snowy	5020.124 GI
Total	20867.46 GI
	20.9 km ³

MDB average long-term annual inflow and water use

Surface water GL

Inflows

Inflows to the Basin	31,599 GL/year	31.6 km ³ /year
Transfer into the Basin	954 GL/year	1.0 km ³ /year
Total	32,553 GL/year	32.6 km ³ /year

Water Use

Watercourse diversions	10,903 GL/year	10.9 km ³ /year
Interceptions	2,720 GL/year	2.7 km ³ /year
Water used by the environment & losses	13,788 GL/year	13.8 km ³ /year
Outflows from the Basin	5,142 GL/year	5.1 km ³ /year
Total	32,553 GL/year	32.6 km ³ /year