What does the tool do?

GSWIT is a collection of models and protocols/guidelines that simulate the exchange of groundwater and salt between rivers and the underlying groundwater systems.

In Source Rivers, GSWIT is comprised of the reach-scale Groundwater–Surface Water Link model which determines the exchange flux of water between a river and the underlying aquifer for each link of Source Rivers. The estimated flux accounts for all the interactions between groundwater and surface water along the entire length of the link. This includes the dynamic simulation of floodplain groundwater processes such as bank storage, evapotranspiration, groundwater pumping, and diffuse, irrigation and flood recharge.

In Source Catchments, GSWIT is comprised of a catchment-scale groundwater and salt exchange model (GWlag) for unregulated upland regions.

The GSWIT team is also developing interface protocols and practical guidelines for linking river models to industry-standard groundwater models such as MODFLOW. These can be used for situations where there is high groundwater data availability and significant groundwater management issues that can only be handled by more complex groundwater models.

Why is it needed?

In many of Australia’s river basins, extraction of large volumes of groundwater in close proximity to rivers can reduce stream flows. The issue, often referred to as ‘double accounting’, occurs when surface water and groundwater availability assessments are conducted independently; a discrepancy arises if groundwater extraction has depleted stream flows.

Prediction tools that simulate these complex interactions are needed to assist in the sustainable allocation of water. Groundwater–surface water interactions are handled poorly in existing surface water and groundwater models.

The GSWIT models are focussed on improving the handling of groundwater in the Source Rivers and Source Catchments surface water models, but are not intended to replace detailed groundwater management models. The interface protocols and guidelines are aimed at improving the conjunctive modelling of groundwater management and river planning.
When or where would you use it?

In Source Rivers, the Groundwater–Surface Water Link model will provide groundwater and salt fluxes to/from a river. It will also enable prediction of groundwater fluxes from major floodplains, but only with good data on overbank flooding, soil and vegetation types, and the location of groundwater pumps and their extraction rates. Time series of groundwater heads and fluxes from field monitoring or other groundwater models such as MODFLOW can also be imported into Source Rivers as an alternative to using the Groundwater–Surface Water Link model.

In Source Catchments, the GWlag model will enable prediction of groundwater and salt fluxes (with an emphasis on low flows) from unregulated upland regions, and will be suited to any catchment that has mapping of topography, groundwater flow systems, and soil and vegetation types.

The protocols/guidelines will be useful for any situation where river models are used together with detailed groundwater models. The Namoi will be used as the focus catchment to test the tools. The GWlag model will also be tested in the Upper Murrumbidgee, and the Floodplain Processes model may be tested in the Chowilla Floodplain of the Lower Murray River.

How does it work?

Source Rivers

The Groundwater–Surface Water Link model predicts the exchange of water and salt in Source Rivers links, and these can be either losses from the river to the groundwater or gains from the groundwater to the river. The groundwater exchange may include the following components: (i) continuous exchange fluxes between the river and the aquifer, which is driven by head difference and underpinned by the type of connection (e.g. losing or gaining river); (ii) bank storage exchange fluxes during within-bank flood events; (iii) flux gains due to diffuse, irrigation and over-bank floodplain recharge; and (iv) flux losses due to evapotranspiration of shallow groundwater and groundwater pumping. The fluxes are represented as a total volumetric loss or gain in the link for each time-step in Source Rivers.

Figure 1 shows the conceptualisation of the Groundwater–Surface Water Link model in both a plan view (A) and cross-sectional view (B). Figure 2 shows a 3D plot of predicted pressure head distribution in an aquifer where the impacts of a fluctuating river stage, a groundwater pump, and two recharge sources were combined.

![Figure 1. Conceptualisation of the Groundwater–Surface Water Link model.](image)
Source Catchments

The conceptualisation of the PERFECT-GWlag model in Source Catchments is shown in Figure 3. In an application of the GWlag model, a gauged upland catchment can be subdivided into sub-catchments using terrain analysis of surface topography and knowledge of the scale of the underlying groundwater flow systems. Each sub-catchment can be further divided into Functional Units, which are defined as areas with the same combination of soil, land-use and climate. A 1D water balance model (PERFECT) can be used to generate surface runoff, evapotranspiration, and deep drainage from each Functional Unit and these can be summed to the sub-catchment level. The GWlag model can then take the daily deep drainage, which is split into groundwater recharge and shallow lateral flow. Groundwater response time-scales can then be calculated for each sub-catchment using groundwater flow system parameters to provide a daily output of base flow to the river.
Who is involved in building it?

Project Team: Ian Jolly, David Rassam, Mat Gilfedder, Trevor Pickett and Matt Stenson (CSIRO Land and Water).

Funding Partners: National Water Commission.

Partner staff: Craig McNeilage (NSW Office of Water), Shahadat Chowdhury (NSW Office of Water), Linda Holz (University of Canberra), Chris Ribbons (NSW Office of Water), and Dugald Black (CSIRO Land and Water) from the Namoi focus catchment team. Mark Littleboy (NSW Department of Environment, Climate Change and Water) and Tony Herbert (SA Department for Water) have provided test data for the Upper Murrumbidgee and the Chowilla Floodplain respectively.

The GSWIT Technical User Group: Mike Williams (NSW Office of Water), Chris Ribbons (NSW Office of Water), Carl Daamen (Bureau of Meteorology) and Rick Evans (Sinclair Knight Merz).

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