Water modelling

Water is managed by the Northern Territory Government for the benefit of all Territorians. Water resource management focuses on balancing productive use of water with long-term viability of the resource and the ecosystems that depend on it. It is underpinned by water science, monitoring and assessment.

Water modelling is a key tool used in water resource management. This statement clarifies how models are used in the NT.

What are water models?

Water resource models (models) are computerised simulations of dynamic and complex natural water systems. Models use physics and mathematics to represent the flow of water, helping us better understand the resource and predict changes.

Before developing a model, a conceptual understanding of the resource is needed from specialist hydrogeologists, geologists and hydrologists. This understanding is based on real world data and information, which can include:

- measurements from drill cores
- surface water flow and groundwater level measurements
- field tests
- remote sensing and geophysics
- climate observations.

Models vary in sophistication depending on the amount of data to support them, and the complexity of questions we need them to answer. There are two main kinds of models, analytical and numerical.

Analytical models

Analytical models use a mathematical equation to relate known characteristics of a water resource, to a single unknown characteristic. Analytical models are relatively fast to use, but they only give a very simple view of the resource. They cannot take into account dynamic changes and interactions.

We use analytical models to make predictions about rainfall runoff, aquifer drawdown, recharge volumes, and aquifer storage. They provide a rapid analysis but cannot replace the level of certainty provided by numerical models.

Numerical Models

Numerical models also rely on mathematical equations, however they give a more sophisticated view of the resource. They divide the resource into multiple pieces (nodes or cells) to reflect differences in the resource's characteristics. Numerical model simulations take into account differences and interactions between each cell, making numerical models more suited to understanding dynamic, complex systems.

Where our water scientists have identified that surface water and groundwater systems are connected, our surface water and groundwater models can be integrated.

Numerical models require more time and data to build and verify. Complex numerical models often require specialist hardware and software. We develop numerical models to support water planning and flood forecasting.

How models are used

Models are used in multiple aspects of water resource management. This includes in planning and decision making, and as part of adaptive management through announced allocations. Models provide us with data representing resource characteristics. Expertise is needed to check the reliability of the data, and to convert it into useful products that inform resource management.

Natural water balance

The natural water balance describes the storage, inflows and outflows of water in a given area. Numerical models can be used to develop sophisticated natural water balances, including for connected surface and groundwater systems. This approach is used in water allocation planning to understand the magnitude of extraction scenarios compared to the natural flows of the system.

Analytical models can be used to understand parts of the natural water balance outside of water allocation plan area.

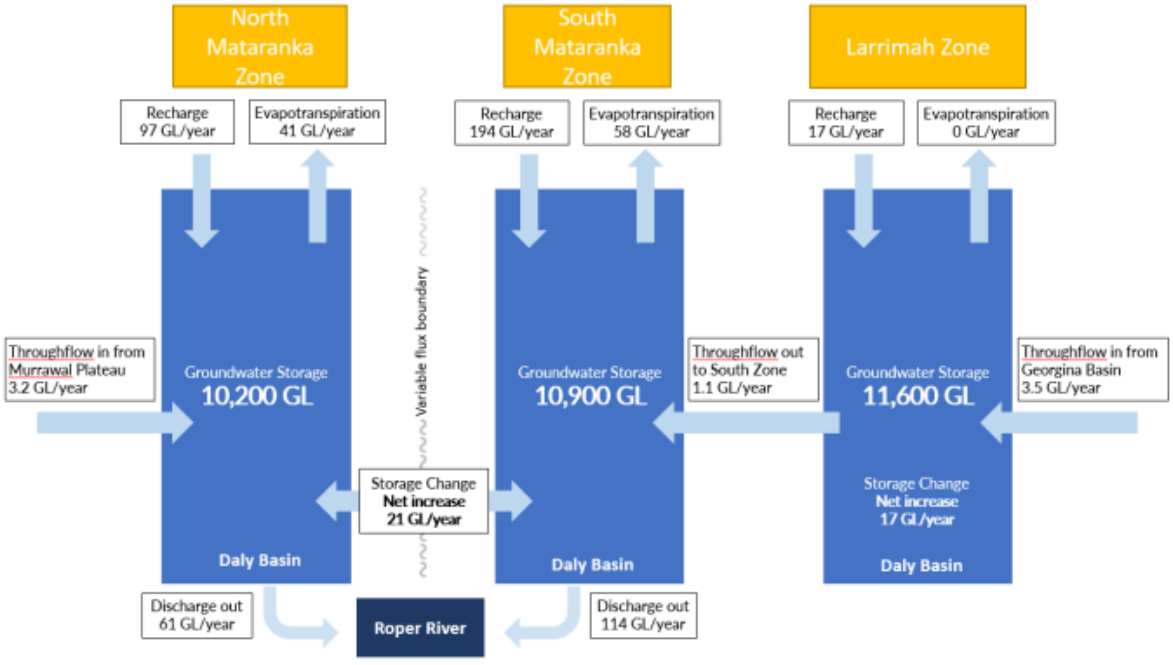

Figure 1: Example natural water balance developed using a numerical model for the draft Mataranka Plan Background Report, 2023.

Predicted water levels

Models can be used to predict how water levels change in response to other factors (e.g. climate cycles or water extraction). Groundwater levels are reported as depth to groundwater, for surface water they are reported as volume of flows.

Modelled water levels support multiple water resource management activities:

- **Water allocation planning:** changes in water levels are tested for a range of extraction scenarios to understand potential impacts on water users, the environment and cultural values. This informs the estimated sustainable yield.
- **Announced allocations:** Water level response to annual wet season rains in addition to licensed water extraction can be tested. Where unacceptable impacts to environmental flow thresholds are predicted, water entitlements can be reduced for the upcoming year.
- **Water licence decisions:** the impact of a proposed bore field on neighbouring users or environmental flow thresholds can be tested.

  Our models are usually developed for a regional scale view of water resources, applicants may need to develop smaller, more targeted models to understand local scale impacts themselves.
- **State of the water resource reporting:** We publicly report predicted and measured water levels in water allocation plan areas to demonstrate that the water resource is behaving as expected.

Analytical models can be used to predict water levels in more straight forward scenarios. For example, understanding how far apart neighbouring domestic bores should be separated.

Setting model scenarios

When testing scenarios for water allocation planning or water licensing we:

- Test a range of volumes including a natural scenario and an existing use scenario.
- Develop existing use scenarios taking into account water for stock and domestic use, and existing licence entitlements (assuming all licence holders extract their full entitlement).

When we report on modelled scenarios, as a priority we show predictions (outputs) for:

- Locations of known drinking water supply (domestic or public water supply extraction points).
- Locations of known ecological, cultural or social importance (e.g. springs or soaks).

Quality control

We implement a range of measures to ensure the quality of our models:

- Our models are peer reviewed by qualified specialists independent of model development. Peer review may be undertaken internally or externally.
- Each of our water models is supported by an operational guideline to ensure consistent application.
- Models are recalibrated on a 5-10 year schedule, incorporating new data and updates to our conceptual understanding of the resource. Timeframes depend on availability of meaningful new data.
- Model recalibration is progressively including sensitivity and uncertainty analyses to identify priorities for further data collection.
- Historic climate data is not widely available throughout Australia, The Bureau of Meteorology (BOM) has developed a consistent dataset using climate models that interpolate across areas where there is a lack of measured data. Rainfall data is available from the early 1900's from this dataset.

Reliable evaporation data is only available from the 1970's onwards. Updated climate data is added to each model annually.

- We do not currently include predicted future climate data in numerical models, as there is a high level of uncertainty in the nature and magnitude climate changes in the future. We continue to monitor climate study literature to understand if this practice should change.

Finding out more

You can find out more about water resource management in the NT online here:
https://nt.gov.au/environment/water/management-security/water-policies-and-guidelines