Seasonal Water Forecasting and Prediction

The Seasonal Water Forecasting and Prediction project is developing methods and tools for providing reliable forecasts of seasonal inflows to river and storage systems across Australia.

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Transforming Australia's water resources information

The need to accurately monitor, assess and forecast the availability, condition and use of Australia's water resources is now more important than ever. The past decade of severe drought and recent flood events pose significant challenges to the management of Australia's water resources as we attempt to deal with an ever-increasing demand for water. The Water Information Research and Development Alliance is transforming the way Australia manages water resources, by bringing together the research and development expertise of CSIRO's Water for a Healthy Country Flagship in water and information sciences, and the Bureau of Meteorology's operational role in hydrological analysis and prediction.

Objective

The project aims to develop methods and tools for providing accurate and reliable forecasts of seasonal inflows to river and storage systems across Australia. The forecasts are valuable for many water management decisions including environmental water releases, water supply operations, setting water restrictions, provision of water allocation outlooks, water trading, cropping planning, hydropower operations, and recreational water use.

Key research areas

The project develops both statistical and dynamical modelling approaches to seasonal streamflow forecasting. In 2012-13, the project will evaluate methods to improve the current operational statistical model used by the Bureau of Meteorology for seasonal forecasting, and support the Bureau in developing a dynamical forecasting system and combining statistical and dynamical forecasts. It will also develop technologies for producing ensemble forecasts of monthly time series of streamflows up to 12 months in advance.
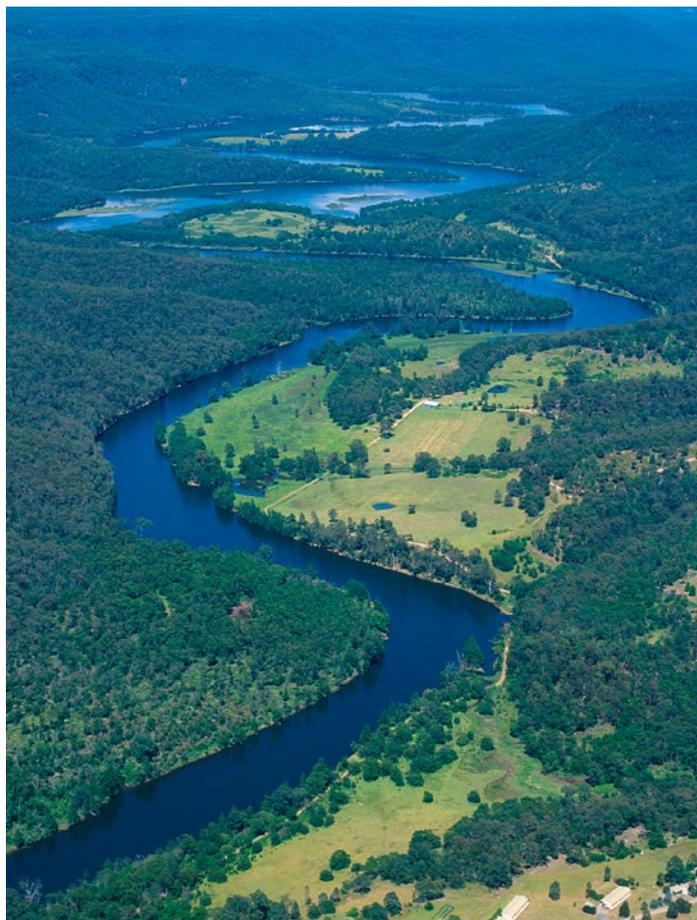
Kangaroo River NSW (Image credit: Greg Heath, CSIRO)

Delivering outcomes

The Bureau's Extended Hydrological Prediction team officially commenced issuing seasonal streamflow forecasts in December 2010. The forecasts, which are available from the Bureau website (www.bom.gov.au/water/ssf), have been produced using the statistical Bayesian Joint Probability (BJP) modelling system developed by the project. Currently the Bureau issues forecasts to the public for over 50 sites and to registered users for an additional 29 sites.

The BJP modelling system consists of three principal components:

* a modelling engine
* a predictor selection approach
* a suite of forecast verification techniques.

a. Modelling engine

The BJP modelling system predicts streamflows using a statistical distribution (specifically a log-sinh transformed multivariate normal distribution). Bayesian methods are used to infer model parameters and their uncertainties, leading to probabilistic streamflow predictions at multiple sites. The modelling engine has the flexibility to handle a wide range of variables, including use of data with missing and non-concurrent records, and intermittent and ephemeral (short-lived) streams.

b. Selection of predictors

The two principal influences on streamflows for the next season are the catchment condition at the start of the forecast period, and the climate during the forecast period. The catchment condition at the time of prediction can be characterised by antecedent streamflows, rainfall or soil moisture. The oncoming seasonal climate can be predicted using indices of large-scale climate anomalies, such as the Southern Oscillation Index. Predictors are selected based on the statistical evidence supporting their inclusion into the forecasting model. Initial catchment condition predictors have been selected for their ability to forecast future streamflows, while the predictors of oncoming climate are selected for their ability to forecast future rainfall.

c. Forecast verification

Several measures are required to assess how well the probabilistic forecasts correspond to observed streamflows. Skill scores provide an overall measure of forecast performance by assessing the reduction in forecast error relative to a reference forecast (commonly a climatology forecast). Graphical techniques are also used to assess forecast event size and whether forecast quality is maintained over time. Current work has focused on forecasting total streamflows for the next three months. Simulations and forecasts from dynamic climate and hydrological models have been used as predictors to represent the climate during the forecast period and the catchment condition in future climates. Future output from dynamic models is likely to be used for operational forecasting. Future work will also seek to produce forecasts of monthly streamflow totals using a combination of output from the Bureau's Predictive Ocean Atmosphere Model for Australia, predictions from rainfall runoff models and the BJP modelling system.

Partners

From 2008 to 2013, the Water Information Research and Development Alliance is delivering the scientific and research innovation required by the Bureau to fulfil its national water information mandate. Through a strategic investment of $50 million over five years, more than 40 researchers are focusing on several challenging areas. These include large-scale information architectures, earth observation, hydrological modelling, water accounting, water resource assessment and water forecasting.

Other partners in the Seasonal and Long-term Water Forecasting and Prediction project include:

* Bureau of Meteorology (Climate and Water Division and Centre for Australian Weather and Climate Research)