IRRIGATION DEMAND AND SUPPLY: THE BENEFITS OF USING AN INTEGRATED MODEL APPROACH

Richard Brunton[1], Bas Veendrick[1]
[1] Pattle Delamore Partners Ltd

Aims

Large scale irrigation schemes have become a vital part of developing New Zealand's pastoral productivity. Assessing the benefits and potential environmental effects of large scale irrigation schemes is critical. Traditionally, when assessing the effects of large scale irrigation schemes several different analyses (and computer programmes) are needed to assess performance of each of the many components of such schemes. This traditional way of evaluating the effects of irrigation storage schemes often requires data to be transferred between several software programs which can be time consuming and inefficient. This paper describes the methodology of a model developed in MATLAB which integrates hydrology with irrigation demand and supply. This paper describes the methodology to integrate hydrology with irrigation demand and supply within a single shell model, eliminating the need for transferring data between different software packages and allowing rapid assessments of irrigation reliability and environmental effects. To demonstrate the benefits of an integrated model this paper also investigates the effects of Interdecadal Pacific Oscillation (IPO) on irrigation supply and demand. IPO is a cyclical change in the Pacific ocean-atmosphere system which affects New Zealand's climate resulting in variations in rainfall and river flows.

Methods

The computational model developed for this paper is constructed in MATLAB, an advanced programming and visualization environment used in R&D in many high tech industries. The model contains two key components. The irrigation component estimates the daily irrigation demand of the scheme area based on land use, soil type, evapotranspiration, rainfall and the history of irrigation water supplied during the preceding days. The supply component of the model calculates the availability of run–of-river supply and the storage requirements based on measures for irrigation reliability of supply. It also provides clients with the ability to quickly look at the effect of several different options such as irrigation area or storage reservoir size and to assess effects from variations in climate inputs.

In order to demonstrate the advantages of using an integrated model and to assess the reliability and environmental effects of a large scale irrigation scheme a MATLAB model was developed for Waimakariri Irrigation Ltd (WIL).

Results

The WIL scheme has approximately 18,000 ha of mixed land use located north of the Waimakariri River in Canterbury. The scheme supply is primarily run-of-river with some small on-farm storage. An additional 8 Mm^3 of on-plains storage is proposed to be constructed. The following results were observed from the MATLAB model:

- MATLAB model resulted in full simulation run time of six seconds based on mean daily data from 1967 to 2012, all post processing outputs one to five second run times;
- Average scheme reliability with proposed on-plains storage: 95.3 %;
- Scheme reliability during negative phase IPO reduced by 3% and increased by 3% for positive phase IPO.

Conclusions

The immediate benefits of an integrated approach using MATLAB are:

- Interaction between the hydrological and irrigation components occurs within model simulations avoiding the need for information transfer between different programs, which is both computationally inefficient and limiting;
- Efficient code;
- Flexible post processing;
- Ability to exploit linkage between different components of model;
- Once the code is developed for the particular scheme components it is very easy to run and evaluate different options.

IPO has a significant impact on reliability. It can be expected that the next 10 - 20 years are in a negative phase IPO (MFE 2008) resulting in reduced reliability. Improved reliability of supply can be expected in the next positive IPO phase.

References

Ministry for the Environment (2008). Climate Change Effects and Impact assessment. A guidance Manual for Local Government in New Zealand. 2nd edition. Prepared by B.Mullan, D.Wratt, S.Dean, M.Hollis (NIWA); S.Allan, T.Williams (MWH NZ Ltd); G.Kenny (Earthwise Consulting Ltd), in consultation with Ministry for the Environment. Report ME 870