Improved evaluation of bay (and furrow) irrigation

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Summary

Evaluation of irrigation performance is a necessary pre-requisite for performance improvement. This paper describes a new evaluation process for bay irrigation that involves use of the new simulation model SISCO (developed by the CRC IF) and continuous measurement of water depth at a number of locations down the length of the bay. This process overcomes the previous difficulties in evaluating bay irrigation performance.

Introduction

Monitoring and evaluation of bay irrigation practices in Southern Australia is not new. It has been used for a variety of purposes over many years, for example, to evaluate surface irrigation simulation models, for the estimation of soil infiltration characteristics, for the comparison of alternative systems, and to study the water balance of irrigated fields. In no case did the work lead to an assessment of the performance in efficiency terms of bay irrigation or of the opportunities for improvement of performance. This contrasts directly with the experience in the cotton and sugar industries where the focus of evaluations has always been on performance improvement (e.g., Smith *et al*. 2005).

Recent use of the IrriMATE™ evaluation system in Qld and northern NSW has shown the benefits that can accrue from the process of evaluation and improvement. BDA Group (2007) estimated that the application of IrriMATE™ in the cotton industry has so far saved 400 GL over a 16 year period or 28.5 GL/annum and has contributed to industry improvement in WUE of 10%, with anticipation of another 10% improvement by 2014.

Attempts by Smith *et al.* (2009) and Gillies *et al.* (2010) to apply IrriMATE™ system to bay irrigated pasture were less successful. Consequently, a new evaluation process was required that involved new simulation software and a new field procedure.

The IrriMATE™ evaluation system

The present IrriMATE™ evaluation system is both a set of measurement and simulation tools, and a process that involves: (i) monitoring of an irrigation event(s); (ii) inverse solution from the measured irrigation advance and other data to give infiltration parameters prevailing during the measured irrigation; (iii) simulation of the measured irrigation as a means of calibrating the simulation model and calculating the performance parameters for the measured irrigation; and (iv) the conduct of 'what if' simulations to determine the flow rate and time to cut-off to give the best or preferred irrigation performance.

The volume balance model currently used for the inverse solution can only use data collected before the inflow is cut off and while it usually works well for furrow irrigation, it frequently fails for bay irrigation. Here the varying surface roughness, the large volume of temporary storage on the surface of the bay, and the short irrigation times compared to furrow irrigation combine to make analysis extremely difficult.

Sisco and the new evaluation system

SISCO (*Surface Irrigation Simulation Calibration and Optimisation*) is a simulation model that overcomes all of the problems analysing bay irrigation. It involves solution of the full

hydrodynamic equations for spatially varied flow as described by McClymont (2007). In calibration mode, SISCO estimates the infiltration and roughness parameters from the inflow hydrograph and any combination of the advance, water depth, run-off and recession data. It is able to use data collected at any time during the irrigation and has the further advantage that the same model is used for the calibration and simulation.

The use of data collected after the advance reaches the end of the bay, that is, run-off or flow depth at the downstream end of the bay during the period of runoff, extends the time over which data can be collected. This improves the accuracy of the estimates of the infiltration parameters, particularly the final or steady infiltration rate and enables accurate identification of the usually difficult to quantify roughness parameter. Runoff can be difficult to measure in bay irrigation but the same information can be obtained from water depths at the downstream end of the bay. Devices to continuously measure water depth are readily available and can also serve as advance sensors.

Case studies to test the field procedure

The lead author of this paper was awarded a summer scholarship by the National Program for Sustainable Irrigation (NPSI) to evaluate the data required and hence a field procedure to be used in conjunction with the SISCO model.

Data from previous bay irrigation trials in the GMID by Gillies *et al.* (2010) were available. Further data were collected over the 2010/11 season from furrow irrigations from sites in southern Queensland at St George, Cecil Plains and Jondaryan. In each case the data collected was in excess of that usually collected during irrigation evaluations. In addition to the inflow, water advance was measured using electronic contact sensors positioned at regular intervals down the bay or furrow. In the bay irrigation case each sensor consisted of eight contacts spaced 5 metres apart to capture the uniformity of the advance front across the bay width. Water depth measurements were collected at small time intervals also at regular intervals down the middle of the bay (or furrow) using logged capacitance depth probes.

The SISCO model was used to determine the infiltration and roughness parameters for the each bay or furrow, using the full set of advance and water depth data to give the best estimate of the parameters. It was then used with various reduced data sets to determine the minimum data set required to give a sufficiently accurate estimate of the parameters.

Conclusions

To take advantage of the capabilities of SISCO the new evaluation process will involve measurement of the hydrograph of inflow to the bay and some combination of advance and water depth measurements at locations down the furrow or bay. The work showed that the depths measured at the downstream end of the furrow or bay were the data that contributed most to successful determination of the infiltration and roughness parameters. To provide security in the event of equipment malfunction it is proposed that measurement of the advance or depths be taken at three other locations down the furrow or bay.

References

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