National DRYLAND SALINITY Program

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Inspiration, Celebration, Aspiration – an R&D Workshop recognising the achievements of NDSP Phase 2

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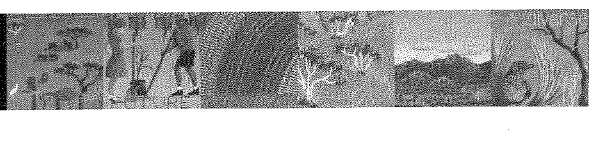

A simple computer program for dryland salinity management Australia-wide: Flowtube (v2.0 ß)

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Workshop Paper

Background

In 1999 the State Salinity Council of WA (SSC) expressed the need to its Research and Development Technical Advisory Group for urgent advice on the impacts of various revegetation schemes. A sub-committee of that group (Hatton George and Clarke, together with Paolo Reggiano, computer expert from CSIRO) was convened.

Given the shortness of time available it was agreed that only one program could model the dozens of sites and hundreds of scenarios: the Funnel program developed by Warrick Dawes and others from CSIRO in Canberra (Dawes *et al.* 1997).

Whilst Funnel proved itself to be extremely versatile and useful it was very hard for hydrogeologists to use. This lead to the development of the simple to use *Flowtube* (v1.1) program based on Funnel by the Department of Agriculture WA and The University of Melbourne (assisted by CSIRO). The NDSP became involved because of the perceived need to extend the use of *Flowtube* to the eastern States. NDSP commissioned Murdoch University to coordinate this development, with in addition to the organisations mentioned above, NSW Department of Land and Water Conservation, Queensland Department of Natural Resources, Victoria Department of Natural Resources and Environment, and SA Department of Primary Industries and Resources.

Flowtube (v1.1) consists of a vertical slice through a catchment which is divided into a series of cells along its length. Groundwater flow between cells is controlled by the 'Boussinessq Equation' (Darcy's Law combined with conservation of mass),

$$S_y \frac{\partial(h-h_b)}{\partial t} = \frac{\partial}{\partial x}\left[K_s \frac{\partial(h-h_b)}{\partial x}\right] + R(x,t) \qquad (1)$$

where h is the water table elevation (Australian Height Datum - AHD) for a cell and h_b is the elevation (AHD) of the impermeable basement bedrock for that cell, S_y is the specific yield of the regolith, K_s is the saturated hydraulic conductivity of the cell, and $R(x,t)$ is the recharge function which was allowed to vary in space and time along the flowtube. The upper end of the flowtube is a no-flow boundary, and the lower end, which is usually coincident with a seepage face or a creek line, can therefore be represented by a constant head boundary. Convergence or divergence in a catchment can be represented in the flowtube by making the vertical walls of the flowtube converge or diverge. Recharge to the flow tube is calculated externally, and it is by varying this parameter that the impact of various treatments can be modelled. When the calculated heads are higher than the surface of the flow tube, the head in the model is set equal to the flowtube surface and the excess volume of water is removed as streamflow. Discharge rate across the flowtube surface is limited and if the calculated discharge exceeds this limit heads are again set equal to the flowtube surface, and the surplus volume redistributed along the flowtube. In either case recharge is set to zero for such cells." (Clarke *et al.* 2001). The results of the SSC modelling are discussed in more detail in George *et al.* (2001).

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Contribution to salinity management

This has resulted in the recent release of an improved version of *Flowtube* (v1.1): *Flowtube* (v2.0 ß). *Flowtube* (v2.0 ß) has all the simplicity and ease of use of the *Flowtube* (v1.1) but has much more functionallity built into it, including the following:

- Flowtubes can now be branched and if the width of the flowtube changes (which could always be done) there is now a screen to view and edit this;
- Hydraulic conductivity values can be changed for the upper pseudo-layer cell by cell;
- The program automatically checks the data entered against the requirements of the conceptual model selected, and
- The program automatically calculates percentage saturated catchment area from the percentage saturated flowtube length using algorithms developed for V, U and broad shaped catchments in WA.

Increased confidence resulting from project

Flowtube (v2.0 ß) will enable much to be done in the battle to halt, or at the very least, slow, the development of dryland salinity.

- It can rapidly assess (at about the same speed you can ask "what if"?) the impact of a wide variety of vegetation treatments.
- It aids hydrogeologists in understanding the groundwater processes operating in their catchments.
- If it is highly parameterised it can be used to replicate hydrographs under treatments, and therefore predict their continued behaviour, and the behaviour of new demonstrations.
- It can be used to assess how near a catchment is to hydrological equilibrium, and its reaction time to treatment.

The unanswered questions

The conversion of percentage saturated flowtube length to percentage of saturated catchment area in *Flowtube* (v2.0 ß) is probabilistic (*ie* it is not 2-dimensionally, spatially distributed). There is therefore an urgent need for a simple to use "point and click" 3-dimensional model to give spatially distributed predictions of saturation, which would complement the 2-dimensional *Flowtube* and the 1-dimensional AgET. The WA Water and Rivers Commission's MAGIC program is a potential program with a realistic combination of simplicity and accuracy.

References

Clarke CJ, George RJ, Argent RM, Hatton TJ, Bell RW (2001) A simple groundwater computer program for dryland salinity management in Australia. In 'Proceedings New Approaches to characterising groundwater flow, 31st International Congress of the International Association of Hydrogeologists, Munich Germany' pp. 279-282 (Balkema: Rotterdam)

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George RJ, Clarke CJ, Hatton TJ (2001) Computer modelled groundwater response to recharge management for dryland salinity control in Western Australia. *Environmental Monitoring and Modelling*, 2(1), 3-35 *http://www.kcl.ac.uk/advances.*

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Project Summary

Project Goal

To research, develop and extend practical approaches to effectively manage dryland salinity across Australia.

Project Purpose

1. Continue the development of the Flowtube model so that it can simulate the eastern states' conceptual models (RIRDC 1998[A]) in addition to those of Western Australia.
2. Carry out thorough testing of the model for both the eastern states and Western Australia by running each of the conceptual models using local data and appropriate/representative treatments.
3. Investigate, for at least some of the conceptual models, how the linear prediction by Flowtube of shallow water table along a flow line in the catchment relates to the area of the catchment that will have a shallow water table as predicted by more complex three dimensional models.
4. Encourage adoption of the model by interested stakeholders in land management agencies by carrying out training in its use.

Project Summary

Dryland salinity is a major problem affecting agricultural production in all Australian states. Much time, effort and money is currently being spent by land managers and farmers on agronomic, tree-based and engineering strategies to ameliorate the problem. Unfortunately there is presently no means of quickly and simply assessing beforehand the spatial impact of these treatments. Development of a simple tool to do this is urgently required. The groundwater computer model Flowtube developed by CSIRO Land and Water (CLW) has the potential to be evolved into such a tool. Modelling on behalf of the WA State Salinity Council using Flowtube investigated the impacts of the treatments recommended in the WA Salinity Action Plan, and after showing these to be inadequate for the task, investigated more effective alternatives. The model proved very effective in the rapid assessment of recharge management scenarios and in modelling the effect of a variety of treatments, but the catchments tested were quite difficult to set up and a computer expert was required to operate it. AgWA has commissioned the University of Melbourne to develop the Flowtube program for the WA type catchments for the development of dryland salinity (RIRDC 1998[A]) so that catchmetns are easy to set up and so that it operates in a Windows type "point and click" environment. This project proposes to do the same for the eastern state catchment conceptual models (RIRDC 1998[A]) and to provide thorough testing of the program for all catchment conceptual models.

Commencement Date

August 2001

Completion Date

February 2004

Policy and Planning Theme