

BAUXITE HYDROLOGY UPDATE

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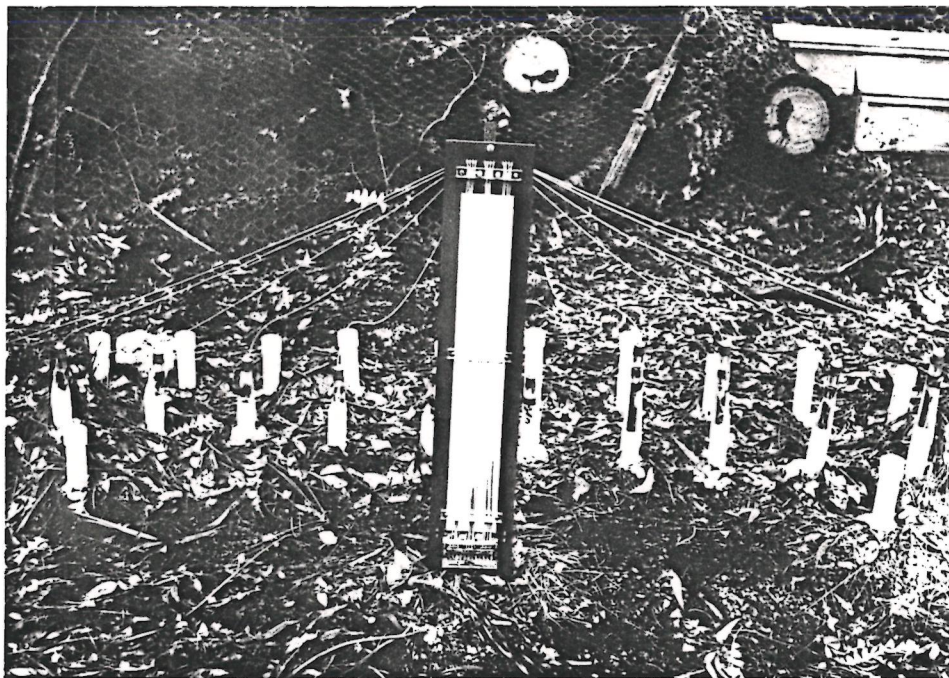
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This newsheet provides a 3-monthly informal update of hydrological research related to bauxite mining in the northern jarrah forest. This research primarily involves the Water Authority of Western Australia, the Department of Conservation and Land Management and Alcoa of Australia.

Hillslope Studies

A hillslope in the Del Park research catchment was selected in 1984 for the purpose of developing methods to assess the impact of bauxite mining and rehabilitation on hydrological processes in the jarrah forest. Instrumentation at the site includes raingauges, throughfall troughs, stemflow gauges, access tubes for the soil moisture neutron probe, mercury manometer tensiometers, gypsum blocks and piezometers. Most of the instrumentation has been monitored 1 - 2 weekly since June 1984. A progress report on the first year's work will be published shortly.



Installation of a mercury manometer tensiometer set at Del Park

The 1985 research programme has seen the continued monitoring of the hillslope instrumentation, further installations near an adjacent ventilated chamber, and some instrumentation development.

The purpose of installations at the ventilated chamber site is to provide a data base for modelling hydrological processes. The site will also act as a control to the hillslope transect study when this area is mined (in 1986?). Equipment installed includes several neutron probe access tubes (one to 18 m), a 12 m profile of gypsum blocks, mercury manometer tensiometers, and a 24 m fixed throughfall trough.

Instrumentation development has involved the incorporation of tipping buckets on some throughfall troughs and stemflow gauges for continuous measurement. Also a capacitance method of logging water level in shallow bores is being investigated in the field. Finally a new method of installing neutron probe access tubes using a rubber packer is being compared to two earlier methods utilizing slurry and a direct tight fit.

A detailed vegetation analysis for a hillslope 'strip' is currently being undertaken by the Department of Conservation and Land Management to assist in the comparison with, and extrapolation to, other sites.

Catchment Studies

The construction of gauging stations for a possible trial mining catchment (Yarrigal North) and the nearby control catchment (Yarrigal East, previously known as 5D) has commenced. The establishment of the Yarrigal North gauging station is near completion while the construction of Yarrigal East gauging station is well underway. It is envisaged that both of these stations will be operating before the end of June 1985. Also, the upgrading of the Forests Department gauging station for the Yarrigal 6C catchment has been completed.

Four sites for temporary rainfall and saltfall gauges on the Yarrigal North catchment have been selected and the clearing of vegetation from these sites has commenced. One site for temporary gauges on the Yarrigal East catchment has been selected. However, problems are being experienced in the selection of a second site owing to the density of the crown cover on the catchment. Nevertheless, it is expected that the six rainfall and saltfall gauges will be operational before the end of June 1985. After a review of the data collected during the winter of 1985, permanent rainfall and saltfall gauging networks will be established on the Yarrigal North and East catchments prior to the winter of 1986.

The preparation of a document detailing a proposed research methodology for the Bauxite Catchment Research Group has commenced. Copies of a draft of the document will be circulated

among members of the Group for comment before it is made available to other interested parties.

Progress has been made in an investigation of the application of stochastic parameter estimation techniques to deterministic catchment models. An optimisation technique based on the method of maximum likelihood has been successfully applied to a simple rainfall-runoff model. Some preliminary results of this work was summarised in a paper presented at the 1985 Hydrology and Water Resources Symposium held by the Institution of Engineers in Sydney (Bates and Townley, 1985). Work will now proceed on the application of this technique to more complex catchment models which can be used to assess the hydrological impact of bauxite mining.

Hydrographic Work

The majority of instruments and associated equipment for the gauging installations at Yarragil North and Yarragil East have been received and their installation will proceed as the construction of the recorder shelters is completed at these sites.

All equipment is now at hand for the installation of pluviometers and bulk precipitation gauges, with the exception of the solid state recording systems for some sites. Installation of all available equipment will proceed prior to the end of June and when the solid state recorders are available they will follow immediately.

Monitoring on a weekly basis has commenced on the recently installed neutron access tubes at the Del park transpiration site. The tubes installed cover depths ranging from six to eighteen metres with a variety of installation methods. A twelve metre profile of gypsum blocks measuring soil moisture potential was installed at this site and monitoring has commenced. Access tubes for the installation of tensiometers and further gypsum blocks have been completed and the equipment will be installed shortly.

The construction of sections of a twenty-four metre throughfall trough at the Engineering Research Station is nearing completion and the recently received tipping bucket system for continuous recording of throughfall is being fitted at present.

Monitoring and maintenance of instrumentation at the Del Park hillslope and all gauged catchments has continued as planned. Annual maintenance at all gauging sites was completed during April. Priority record removed from these sites has been prepared and processed.

Minesite Water Management Activities

Since the start of the new year the MWMG has been very active on both the development of monitoring equipment and the creation of systems to handle the collected data.

The three areas of equipment development are:

1. Production of three CADDAS units and installation of two of these in the field. One at Scarp 6 and the other at the vegetative filter trial at Jarrahdale.

CADDAS is a fully electronic system that uses an optical shaft encoder connected directly to a conventional float and pulley as the waterlevel transducer. There is nothing new in this form of transducer, what is new in the CADDAS system is the great flexibility and reliability that has been built-in. This is due to the extensive use of standard Hewlett Packard and Comsys components plus full environmental housing.

Each CADDAS unit has six water level and three raingauge input channels and three controlled output channels. An office system to upload data to the mainframe computer has already been constructed.

2. Installation of a tensiometer array at Scarp 6 and instrumenting of it for continuous monitoring. This array was installed with the assistance of Martin Hodnett of the Institute of Hydrology. Monitoring is by an automated camera system which photographs the manometer board. The film is developed and the readings are taken manually as it is run through a strip projector.
3. Development of rubber packer neutron probe access tubes and reverse circulation drilling for their installation. To date virtually all installations of neutron probe access tubes in the Darling Range have been done using vacuum drill rigs to make the hole and cement/clay slurry to fill the annulus around the tube.

Irregular hole diameters and unknowns associated with the slurry moisture content are major problems with this sytem.

A small reverse circulation drill rig which is mounted on the back of a Toyota Hi-lux is currently under development. This system appears to be able to produce a neat and accurate 60 mm diameter hole in all lateritic soils. For profiling of the holes, a four point downhole logger is under construction and will be completed shortly.

To replace the slurry, which is used to seal around the tube, an inflatable rubber packer system is under development. This consists of a six metre long rubber sheath around the tube, which is vulcanised onto it at each end. The sheath is

inflated with nitrogen and seals by pressing against the soil. Low inflation pressures of one to two atmospheres are used, so little soil deformation should occur.

As mentioned previously, to complement the above developments in monitoring techniques, considerable effort has been put into creating computer input, storage and analysis systems for handling the collected data. These include:

1. A system to handle surface water flow and quality data from both conventional strip chart recorders and data loggers.
2. A package to handle both tensiometer and neutron probe data. Considerable effort has been expended to ensure that this package is both 'user friendly' and permits accurate checking of the data. It also provides a variety of plotted output for easy viewing of the data.

Transpiration Research

The first phase of jarrah transpiration studies at the ventilated chamber facility on the Del Park Catchment is now complete. The major findings were:

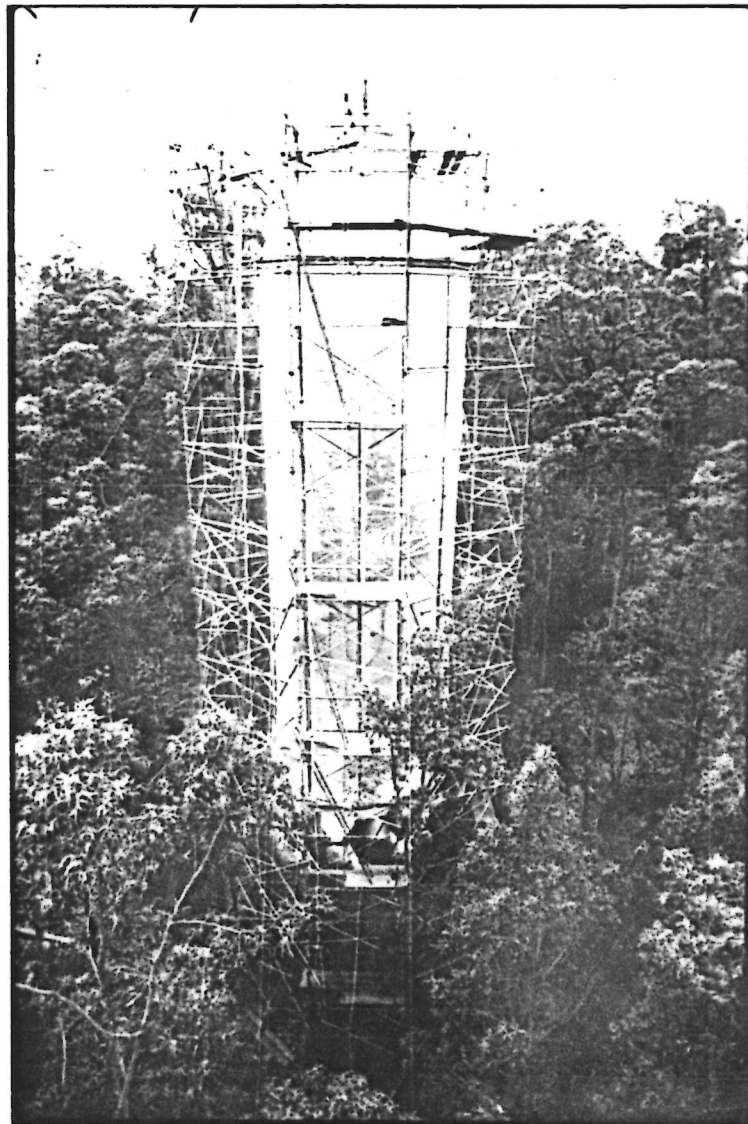
- jarrah showed a quite subdued response to vapour pressure deficit i.e. it can maintain quite high levels of stomatal conductance even under conditions of extreme evaporative demand.
- jarrah conductance showed no response to declining soil water availability through the summer drought period, indicating that jarrah is able to exploit deep soil water storage.

These results confirm previous studies indicating that jarrah is a prodigal water consumer, but go further in quantifying the processes involved. These results are now being prepared for publication.

Before the results can be applied to predicting transpiration over a hillslope or to comparing jarrah performance with potential replacement species, two further areas of work must be completed. They are:-

- leaf area: to convert stomatal conductance (on a per unit leaf area basis) to canopy conductance (on a per unit ground area basis), so that areal predictions of transpiration can be made, will require accurate measurement of leaf area. During the coming winter two rigorous leaf area measurement techniques will be tested and calibrated.
- size of sample to estimate conductance: work to date has been done on a single dominant jarrah. This is too small a sample upon which to base areal prediction of transpiration. The

major source of variation is likely to arise from varying soil water availability between trees, sites and seasons. The relationships between soil water potential, plant water potential and conductance for a range of trees from dominant to suppressed must be defined so that appropriate conductance levels can be selected for the prediction of transpiration for any tree, site or season. This will be done at the ventilated chamber site during the spring to autumn drying period in 1985/86. Neutron probes are being installed to provide data from which soil water potential can be derived. Pressure bombs and porometers will provide plant water potential and conductance data. The chamber will also be used to provide further conductance data.



The ventilated chamber at Del Park

Recent Publications

Bates, B.C. and Townley, L.R. (1985) Estimation of parameters and uncertainty in a runoff routing model. Proceedings of the Hydrology and Water Resources Symposium, Institution of Engineers, Australia, National Conference Publication No. 85/2, pp 48-52.

Editorial Note

It is proposed to hold further 1-day seminars of the type held last July on Hydrological Models Applicable to the Darling Range. The idea of the seminars will be to focus on specific inter-disciplinary and inter-departmental issues which will benefit researchers by presenting and collating diverse material. Areas of future research may also be identified. All researchers will be given the opportunity of presenting a short paper, which will be informally edited and published. Emphasis, however, will be given to discussion. At this stage seminar topics are sought. A couple of examples are 'The role of lateritic caprock in the hydrology and ecology of the jarrah forest', or 'Measures of variability across the jarrah forest'. It is anticipated that such seminars would be an annual event. Please send your ideas to the Editor.

Contributors

Contributors to this update were N. Schofield (Hillslope Studies), B. Bates (Catchment Studies), K. Baldock (Hydrographic Work), J. Croton (Minesite Water Management Activities) and J. Bartle (Transpiration Research).