THE HYDROLOGICAL SOCIETY OF S.A. INC.
C/- Water Resources Branch
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GUEST EDITORIAL BY DON ARMSTRONG

LET THE RIVERS RUN FREE

A great deal of scientific and engineering effort coupled with considerable expenditure of public monies is currently being directed towards solving the environmental problems associated with rising salinity in the Murray-Darling drainage basin.

I use the term drainage basin intentionally to highlight the real nature of the complex of rivers, tributaries and land systems which culminate in the majestic River Murray which finds its way to the ocean in South Australia. Since the sedimentary rocks of the Murray Basin emerged from the sea, the river has been the major route through which water, dissolved salts and water borne sediments have drained in the course of maintaining the succession of equilibrium states which shaped the land and drainage system.

Throughout the life of the basin the classical hydrological water balance equation has been in operation.

WATER IN = WATER OUT +/- CHANGE IN STORAGE

Strict observation of this equation determined the configuration of the drainage system including the shape of the major drainage element, the River Murray.

At the time of white settlement the climatic regime with which the system maintained equilibrium resulted in feast or famine, or in hydrological terms, floods and recessions with frequent cessation of flow allowing bank storage and natural groundwaters to drain to the lowest possible level. Saline springs and salty pools in the river bed were often the only signs of water in the otherwise semi-arid Murray Basin. Periodic flooding purged the system of salt accumulations with the posible exception of the deepest "holes" in the riverbed. Despite the excesses and deprivations, fauna and flora appeared to flourish perhaps because they were well adapted to the natural variation.

European settlers, whose cultures evolved in a very different climatic setting, ripped out mallee and planted grain. The European experience of mighty rivers like the Rhine suggested to the settlers that the Murray could become a commercial waterway and the era of the paddle steamer arrived, occasionally ground to a halt as floods receded, and was eventually overtaken by the railway system.

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Nevertheless the river was regulated by a series of weirs and locks which maintain artificially high pool levels to facilitate the non-existent commercial paddle steamer trade and, coupled with large storage dams in the headwaters, to supply water for irrigation close to the river and a back-up supply of water for the city of Adelaide when catchments in the Southern Mount Lofty Ranges do not receive sufficient rain.

The dream of navigation and commerce has been replaced by the realities of irrigation, recreational uses and an endless battle to control the influx of salt which has been exacerbated by the changes wrought in the last 150 years. The river remains, as ever, the sole drain for the entire system but it cannot function in the relatively efficient manner which evolved as the river itself evolved.

Irrigation practices have led to the development of groundwater mounds which displace saline (20,000mg/1) groundwater into the river and the artificial pool levels have propped up groundwater gradients leading to the continuous discharge of saline groundwater into the river in some reaches.

The system is struggling towards a new equilibrium imposed by the man made changes of the recent past but the system is so large that it will be extremely difficult to change the course of events. Our current efforts in the area of salinity mitigation although noble in concept and competently designed and constructed, are little more than a series of bandaids supplied to the most obvious sores to provide some relief in the short to medium term.

Our sales pitch on the political stage centres on telling people how many TONNES OF SALT PER DAY enter the river when in fact the SALINITY of the water is what counts. The river carries its greatest salt load when it is in flood, at which time it has its lowest salinity and is behaving as an efficient drain for the removal of salt from the system.

Our management policies do not permit disposal of water into the river except in certain controlled situations yet the disposal of irrigation excess water down drainage wells results in the formation of groundwater mounds, which displace 20,000mg/1 water into the river. Perhaps it would be less troublesome to dispose of the irrigation excess flows whose salinity may be 2000 to 3000mg/1, directly into the river.

On the environmental front we seem to have forgotten that the original pre-settlement conditions in which the indigenous flora and fauna evolved have long gone and like the hydrological regime within the basin, the biological regime must also move towards a new equilibrium which has as a strong component, the activities of man in both the commercial and recreational fields. It is difficult to decide upon acceptable environmental standards for a natural system which has not yet decided for itself how it is going to adapt to enforced changes. We cannot be certain that all the changes occurring within the Murray Basin are the result of man's activities, but we can say that many of the salt mitigation schemes in place or on the drawing board are "solutions" to problems created by engineering or agricultural activities.

Perhaps we have something to learn from the example of biological controls imported to defeat the prickly pear problem in Queensland, which had as the end product the yet to be controlled cane toad explosion.

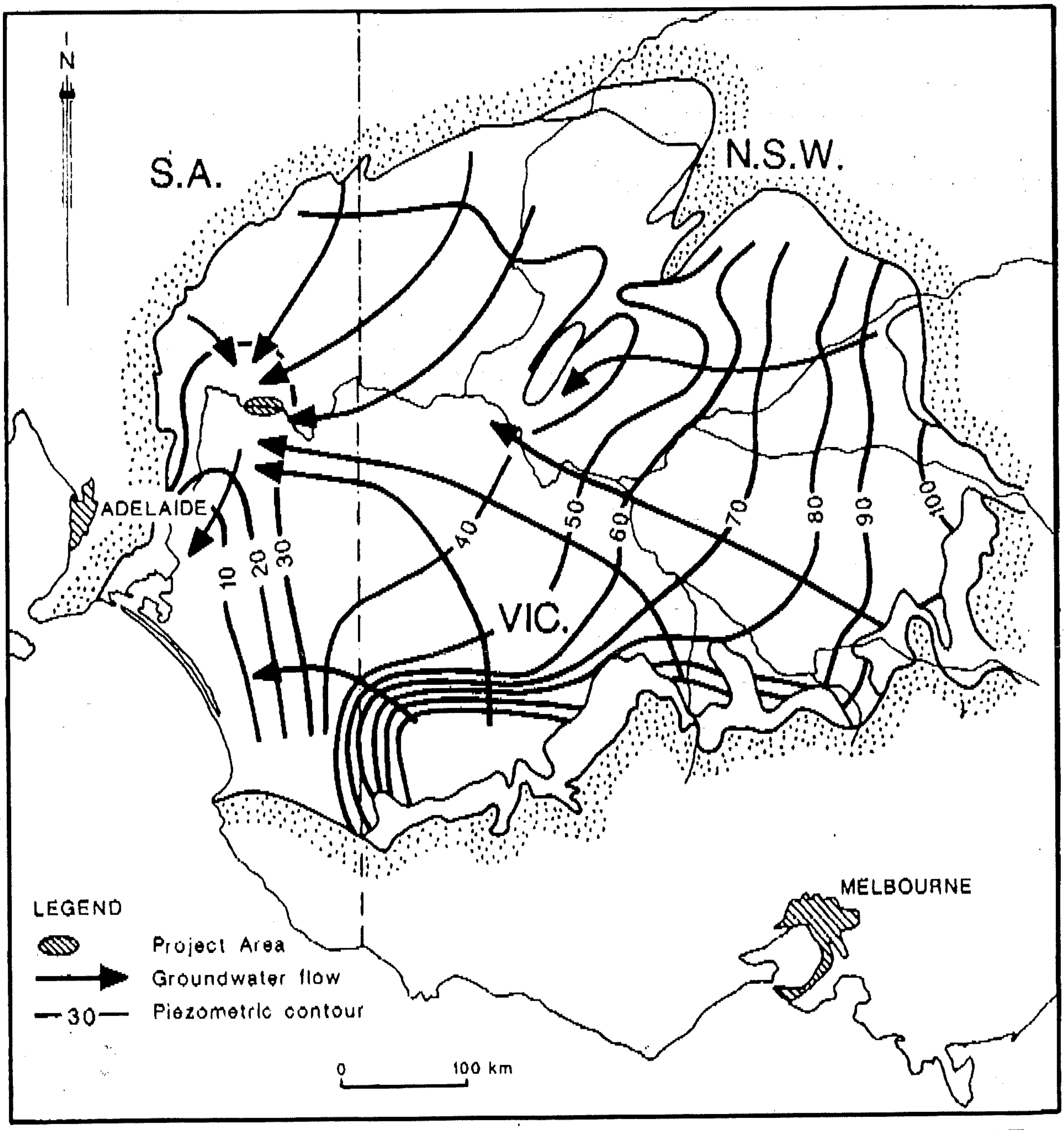
WOOLPUNDA GROUNDWATER INTERCEPTION SCHEME

(contributed by: Andrew Telfer)

The Woolpunda Groundwater Interception Scheme is located adjacent to the River Murray between Waikerie and Overland Corner. The scheme is designed to intercept saline groundwater from the unconfined aquifer which currently discharges into the river. This discharge introduces approximately 180 tonnes of salt into the river per day, and its interception will reduce the average salinity of the river by approximately 49EC.

The groundwater discharge into the river is a natural mechanism. The Murray Basin is essentially a closed groundwater basin. Recharge of the aquifers occurs predominantly at the basin margins, directing groundwater flow toward the western third of the basin. Groundwater can discharge from the aquifers in only two ways:

- evaporative discharge from the water table (which causes dryland salinity),
- groundwater discharge into the River Murray (this is the only mechanism which removes salt from the basin).



PIEZOMETRIC SURFACE AND FLOW LINES OF THE RENMARK GROUP AQUIFER

The Renmark Group aquifer occurs throughout much of the basin. It is unconfined in the east and centre of the basin, but is confined by the overlying Murray Group aquifer in the west. Groundwater in the Renmark Group aquifer flows from the zones of recharge at the basin margins toward the Woolpunda region in South Australia. In this region a combination of factors drives the Renmark Group groundwater upward into the Murray Group aquifer. The factors include a high vertical hydraulic gradient, changes in aquifer thickness and apparent changes in the properties of the confining bed. The chemical composition of the groundwater in the two aquifers discussed above is similar vertically, though varies laterally over a large area. This is hardly surprising when the thickness of the aquifers and intervening aquitard is compared to their dimensions in plan. The dimensions of the basin closely approximate those of a stack of ten sheets of A4 paper. This large surface area to thickness ratio allows the confined aquifer to leak upward into the unconfined aquifer as the groundwater in the confined aquifer flows laterally toward the major discharge zone in the Woolpunda region.

The groundwater leaking upward at the discharge zone then flows in the unconfined aquifer toward the river, and it is this water that the Woolpunda Groundwater Interception Scheme is designed to intercept.

PLUGGING OF OLD ARTESIAN BORES - SOUTH EAST

(contributed by: Fred Stadter)

A large number (>100) of artesian bores which were drilled in the Kingston - Robe area in the early 1960's are allowing good quality groundwter (TDS about 700 mg/L) to leak upwards into the generally poorer quality unconfined aquifer. This leakage is occurring due to the poor bore construction methods used at the time and the continuing casing corrosion problems. It is etimated that about 3000 ML per annum may be being lost from the confined aquifer through this sub-surface leakage.

Over the last two years, SADME have undertaken a bore abandonment programme during which 15 of these old wells have been plugged using cement slurry. The abandonment of some bores has been extremely difficult due to the poor condition of the casing and the presence of cavenous limestone. Various techniques, ranging from pumping cement slurry into the well from the surface to adding lost circulation material to the cement slurry, have been used in order to minimise costs. The average cost, however, for the total programme is still high (in the order of $8000 per bore).

THE AROONA PARADOX

In an interesting aside to the 'Big Wet' reported in the last newsletter, John Vandenberg probes the excesses of the arid zone, and the associated water resource management problems using the last 10-15 years of operation of Aroona Dam as an example. [ed.]

(contributed by: John Vandenberg)

From the mid 1970s to mid 1980s there were no significant inflows to Aroona Dam and at no stage did the dam overflow. With the commissioning of the new coalfield a review of the future water supply for Leigh Creek South suggested that Aroona Dam could not fulfill the town requirements. In 1984 a Reverse Osmosis plant was built and a system of bores established in local aquifers to augment the town's supply. At that stage the dam was extremely low and by late 1986 had reached the critical level at which it was no longer a suitable supply.

The need to implement the reverse osmosis plant was avoided when heavy storms in December 1986 filled the dam and there was a substantial quantity of overflow. Still, there was no need to alter the original expectations of the dam's effectiveness.

However since then there have been several good inflows causing some large overflows and keeping the dam at or near full supply. Three of these events, Feb '87, Dec 88 and March '89, are estimated to have overflowed more than 10,000 Megalitres each or more than twice the capacity of Aroona Dam (last estimate 5,000 Megalitres).

The reverse osmosis plant has still not been made fully operational, but is finding use to filter Aroona water which has been quite dirty in appearance. The question could be asked: is the reverse osmosis plant necessary? If any of the storms in the last few years were of a 5 year to 10 year recurrence interval (or less) then Aroona could possibly have kept Leigh Creek South supplied for at least the expected life of the present coalfield (about 30 years).

Has the town's water supply now been over-designed? Has the dam, spillway been under-designed? What if the Motpena rainfall in "The Big Wet" (340 mm) had occurred in the Aroona catchment which only had about 125 - 150 mm?

The same problem exists for the Highways Dept, Australian National and Telecom. For what sort of event should they allow in building crossings, bridges, etc? [neatest correct answer to John wins a bottle of "Aroona brown", ed.]

ARR WORKSHOP

(contributed by: Chris Wright)

A two-day workshop on the use of "Australian Rainfall and Runoff" (ARR) was held at the Commonwealth Centre on 17th/18th July. The new edition of ARR is a very much updated and expanded guide to the analysis and solution of problems related to stormwater and flood extimation, in both rural and urban situations. The workshop was arranged by a sub-committee of the Hydrological Society, assisted by Paul MacDonald of the IE Aust Civil and Structural Branch. Professor David Pilgrim and Assoc Prof Ian Cordery of the University of New South Wales, both of who are well known to many members of the society, gave the lectures and supervised the Tutorial Sessions.

Sixty four people attended the workshop and were led through each section of ARR. Although constraints on time meant that it was not possible to cover the document in detail, the emphasis was on understanding the principles of rainfall estimation and the process of converting rainfall estimates into runoff. All participants had the opportunity to become familiar with the scope of the document, and had time to work through at least some of the many assignments. Computers were provided, and a range of software was available for rapid calculation of Intensity - Frequency - Duration data, and for Routing Models and Unit Hydrographs.

However the main drive by Pilgrim and Cordery was the understanding of the methods used, leading to an appreciation of the limitations which exist in even the most sophisticated computer model. When Ian Cordery instructed us (somewhat tongue-in-cheek) to throw away all our beloved computer models and work out the problems long hand, he was met with a stunned silence! Any consultant who wants a job in Hydrology always has to demonstrate that he can offer the most up-to-date whiz-bang-model, and be conversant with the right terminology (to Bayes, or Not to Bayes etc). It was certainly sobering to be led by the experts through the potential pitfalls implicit in hydrology in Australia, the margins of error in rainfall estimation, the uncertainties in guessing (!) loss rates, and the weaknesses in the routing models.

We owe a great deal to Ian and David in their dedication to the science (art?) of hydrology, and particularly to their down-to-earth approach, and we thank them for attending the workshop and giving us the best of their time and effort.

GEOSTATISTICS IN HYDROLOGY AND WATER RESOURCES

(editor)

Most environmental variables, such as rainfall, soil and water chemical parameters and groundwater flow properties, vary over an area in a partially random manner. In field investigations the cost of sampling usually limits the number of sample points. The confidence with which specific questions can be answered depends on the sampling programme and the spatial variability of the parameters of interest. For example, the uncertainty of an estimate of total catchment rainfall is reduced when extra rain gauges are installed, or the mass of a contaminant in an aquifer is better defined when new observation bores are constructed and groundwater samples analysed. The tradeoff between estimation error and the cost of a network provides a basis for network design and can be determined using geostatistical methods.

Geostatistics is a catch-word to encompass a suite of quantitative methods for analysing data having a random component which is spatially correlated. Originated in 1951 by a South African mining engineer, Mr D.G. Krige, the techniques were developed by a French mathematician Prof G. Matherson who coined the term "geostatistics" in 1962. They have subsequently been applied extensively in mining and only recently had an impact in hydrology principally in groundwater hydrology.

The two major components of geostatistics are structural analysis and kriging. The first characterises the increase in uncertainty of an estimate with increasing distance from a sampled site. This function is known as a semivariogram. Kriging is simply linear interpolation between data points (using a semivariogram) to estimate values at unsampled points or average values over regions. An appealing feature of kriging is that it also estimates the uncertainty of interpolated values.

Adaptions of kriging allow contouring of data from an irregular array of observations. Kriged estimation uncertainties also may be used to redesign or rationalise monitoring networks (add, relocate or delete sample points) to improve the information/cost ratio. The techniques therefore have value for water resources data analysis and presentation as well as for effective management of data acquisition networks.

A national workshop on Geostatistics in Water Resources (including rainfall/groundwater monitoring network design) will be held in Adelaide on 13th - 17th November 1989 to accelerate the transfer and effective use of these techniques by Australian water resources authorities and consultants. The workshop, which is approved by the Australian Water Resources Council and the National Committee on Water Engineering of the Institution of Engineers Australia, will be conducted by the Centre for Research in Groundwater Processes.

Workshop leaders are Drs Peter Brooker and Peter Dillon with a special contribution by an international guest lecturer, Dr Shakeel Ahmed.

The world-class computer-aided-teaching suite (Sun 3/50 workstations) in the University of Adelaide Faculty of Engineering, will give participants hands-on experience and enable them to apply geostatistics to data sets with which they are familiar. Take-home PC software will also be provided. A registration form is attached.

FROM THE SECRETARY...

The June copy of the Newsletter on the Big Wet proved to be of great interest to members and to a wider circulation. Reprints are available from the Secretary on request (at cost!!).

On 15th June, John Argue and Nara Somaratne addressed the Society on the possibilities of using shallow wells for disposal of suburban stormwater. A research project is underway to test the rate at which these wells can dispose of stormwater from roof drainage. The wells - 2.4 m deep and 0.9 m in diameter, are formed using a standard concrete pipe, and were constructed in a variety of soil types. It was demonstrated that even in heavy clays a major portion of direct runoff from a house roof can be absorbed by the well. If the project can be developed for general use it has the potential for:

- a reduction in the required capacity of urban stormwater drainage,
- replenishment of the groundwater aquifers beneath urban areas,
- reduction in the stormwater pollution load off shore.

John is away on study leave for six months, working at the Hydraulics Research Institute in Wallingford, on his return we will no doubt hear more about this work.

The ARR workshop was held on 17/18 July, and a report is included in this newsletter.

The AGM is coming up, on 10th August, nominations have been received for all posts on the committee for 1989/90. The meeting will be addressed by Dr Graeme Dandy, on the efficiency of pumping systems and implications of pumping policy. Please come along, it should be interesting.

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The cutoff date for contributions to the next newsletter is September 22nd.