CONTEXT SUMMARIES OF ARY VAN DER LELY REPORTS

1972 - Rice Field Hydrology – Aspects of Land Suitability

This report is a first attempt in the MIA to describe the deep percolation factor from rice. The methodology involves firstly, the water balance method of a rice field by which percolation is deduced from water applied less water lost due to drainage and evapotranspiration. The second method relies on direct measurement of percolation using infiltration rings.

Management of rice land suitability subsequently became dependent on a difficult to define relationship between soil texture and hydraulic conductivity, in which the low permeability of the immediate subsoil is important.

Whilst this was important work, the groundwater levels continued to rise despite the introduction of criteria to define land suitability.

1973 - Winter Water Table Surveys in the MIA

This report is of historical value mainly. The IREC Deep Drainage Committee had been concerned with high groundwater levels in horticulture since 1939 and the WC&IC had instituted annual water table surveys in horticultural farms. These surveys became a habit rather than being useful, so after this report of results was written up the practice was stopped, saving considerable resources.

1974 - Hydraulic Conductivity in Horticultural Soils

Subsurface drainage in horticulture was linked to measurement of hydraulic conductivity measurements to the tune of one per acre prior to determining drain spacings and depth. This report is a quite detailed statistical evaluation of the relationship between soil type and hydraulic conductivity. By comparing with subsurface drainage criteria, the extent to which farms may be under drained or over drained as a result can be discussed.

1976 Infiltration and Water Movement in Soils Used for Rice Growing

This paper with Tjeerd Talsma of CSIRO reports infiltration features of a range of soil associations used for Rice growing. Particularly it reports variation over the growing season. It follows on from other work on infiltration and percolation studies. A key feature is that duplex soils have the restriction for downward movement near the surface, whilst with swelling clays it depends on the compaction by the overburden at about 2 metres and more.

1976 – Infiltration and Water Movement in Swelling Soils

This work with CSIRO Tjeerd Talsma reports on a detailed study in a rice field with measurement of soil swelling characteristics, water movement and percolation over time, and matric potential changes in the profile. The complexity introduced by the swelling characteristics of the clay minerals present stands out. The overburden deeper in the profile reduces hydraulic conductivity and this is a factor when determining the suitability of these soils for rice growing.

1977 – Artificial Sub Surface Drainage in NSW

Several years of investigations into design criteria for both horizontal and vertical groundwater drainage are summarised in this paper. The design criteria developed in the 1950's for tile drainage were discussed and evaluated on effectiveness. This depends on the speed of the water table between drains being drawn down by the installed tile lines. With vertical drainage some pump test data were analysed to determine the area of effectiveness of individual tube wells.

1978 – Groundwater Accessions in the Coleambally Irrigation Area

The rapid rise of groundwater in the CIA in the 1970's is being reported, and the causes evaluated considering groundwater balances. Rice growing was found to be the main factor responsible. A total of 100,000 ML/year was involved in recharge, which was about a quarter of total water use.

1978 - South Hanwood Pump Effectiveness Analysis

This tube well was protecting about 50 hectares of horticultural land from water logging, the method being an alternative to tile drainage as an aquifer traverses the area. This review looks at the data re groundwater levels, and considers pump testing as a means to find aquifer parameters. Comments are made as to the beneficial effect of this site.

1979 – Causes and Effects of Deep Percolation Losses in the MIA

This report looks at typical values of percolation and compares it to the leaching requirements which keep the soil profile salinity free. It is found that these requirements are exceeded by significant amounts.

1980 – Tile Drainage Effluent Studies in the MIA

This quite comprehensive report by David Hoey, but in which I had much involvement, considers the salt loads which were being discharged by tile drainage in the 1970's, with projections beyond. It was found that about 14% of all irrigation and rainfall was discharged in those days and that 10 times more salt was discharged than put on by the irrigation water. At the time about 27,000 tonnes per year was discharged but it was expected to decline over time. The studies consider drainage channel salinity, installations over time and more detailed monitoring on 7 farms.

1980 – Water and Salt Movement in Transitional Mallee Soils of the Wah Wah District

About 1980 there was a move to commence rice growing on these soils and the concern was that these soils contain a lot of salts in the sub surface horizons. Some measurements are reported together with consideration of the prospects into the future.

1980 – Soil Moisture Loss from Soils subjected to High Water Tables. Discussion based on a Drum Experiment.

Capillary rise is an important feature in these soils, with Transitional Red Brown Earths reporting 0.2 mm/day and Self Mulching Clays up to 2 mm/day when water tables are within 0.8 metres. However it was found that significant moisture loss happens due to vapour movement near the surface, and it was also found that the heat balance in the soil over a cycle of heat wave conditions followed by a cool change had an effect of about 3.8 mm total.

1983 – Salinity Control Problems associated with Irrigation Areas in NSW

This paper to a conference in Utah presents the Wakool, Berriquin and Murrumbidgee Irrigation areas/districts and the Sub-surface and surface drainage schemes being implemented there.

1983 – Use of an Electromagnetic Induction EM38 instrument to map Soil Salinity in the MIA

This method became popular at the time and a methodology was developed to map spatial salinity variation of farms in the Benerembah Irrigation District reasonably rapidly, involving one day field work per farm. The calibration of the instrument is discussed.

1983 – Salinity Control in the USA

This study trip report found that disposal of saline effluent was fairly common in the USA. Overal the study tour was very interesting and worthwhile. As the Wakool sub-surface drainage scheme was already in operation this prompted a lot of studies in the MIA to investigate feasibility. These studies resulted in reports which are not part of this list as the print quality was too poor for scanning. However, the 1994 Water Control Options report does refer extensively to the options that were being considered. Integrated drainage and salinity control was a big deal at the time!

1987 – Groundwater Hydrology of the Coleambally Irrigation Area

This is an update of the 1980 report but much more comprehensive with graphs, tables, and water balance considerations. Rice still was the main factor responsible for groundwater rise. A specific concern, what happens to the salts being leached from the top 20 metres of profile into deeper aquifers, which are being used for groundwater exploitation is getting special attention.

1988 – Problems with Wheat Growing in High Water Table Areas

This report with Heather Percy and supported by Wayne Meyer uses steel drums with the main clay soil types in the MIA and, in a lysimeter, measures the effect of capillary rise on potential problems into the root zone of wheat crops. The rate of upward salt movement was much higher in the self-mulching clay soils relative to transitional red brown earths. A very high water table therefore would be an issue in the former but not so much in the latter. The possibility of using sub-surface drainage is discussed, but the recommendation is more towards having a rotation of crops including rice and wheat/other crops, to prevent the salts of building up in the first place.

1988 – Environmental Management – Rice Growing Controls

This report is the culmination of 18 years of work on percolation from rice and lateral flow between fields considerations. The objectives are discussed, and the potential of soil factors to be used to control sustainable management. When it comes to high groundwater levels, the lateral flow aspect is the most important. Here the quantitative values of the aquifer transmissivity, the superficial clay layers characteristics, gradients and the proportion of the landscape under rice are critical. The criteria used and the principles underlying them are presented. It was found it is desirable that in most of the MIA no more than 25% of the landscape should be under rice.

1988 - Wakool - Subsurface Groundwater Models to assess Seepage from Evaporation Areas

A landholder claimed damages due to seepage from the evaporation areas of the sub-surface drainage scheme. I was nominated to develop a groundwater model to reflect the true situation on behalf of the defence. It was the most challenging project for me up to that time. Two models were developed, a numerical one and an analytical one. All physical factors were simulated, seepage, the interceptor drain, tube wells, rice fields, weather over 12 years. This was the first model ever used in a court case which produced enough plausibility to in the end win the case, which was then settled.

1990 External Sources of Tile Drainage

These include channel seepage, downslope seepage, flow from adjacent land or rice fields, aquifer movement and upward groundwater gradients. These factors and their effect on a horticultural farm are discussed in this paper.

1990 – Management of Environmental Impacts on Rice Growing in SE Australia

This is another version of the 1988 report below focussing on the same factors affecting sustainability. The lateral flow between farms gets special attention.

1990 – Water and Salt Movement – Modelling

The physical factors involved in groundwater and salt movement are discussed in the conference overview paper, the theories involved and the modelling methods that were available at the time. The difficulties to link the unsaturated soil profile with the groundwater system is mentioned.

1992 – Water and Salt Balance for the MIA and Benerembah

A spreadsheet model underlies a monthly model representing all factors involved in the fairly complicated MIA supply and drainage system. The various sources of drainage and salt load are included in the respective parts of the system, as well as the effects on the downstream users. This study was a precursor of the Benerembah Surface Drainage scheme EIS, which required the prediction of its impact.

1993 – Horticulture on Large Area Farms – Groundwater Issues.

In the early 1990's horticulture on large area farms became popular. As rice still very much dominated the irrigation industry and average groundwater levels very high, about 1.2 – 1.5 metres in many places, the issue of potential impacts needed to be addressed. This report discusses those issues.

1994 – Coleambally Irrigation Area LWMP – Regional Options

As part of the Land and Water Management Plan the regional options needed to be developed. The report describes the issues. This include water balances, groundwater trends, and trends in soil salinity. Future salinity trends in a no plan scenario and with plan scenario became the key criterion for the selection and optimisation of control options. For each option the beneficial effect in terms of reducing groundwater accessions was evaluated and this was entered in the soil salinity evaluation model. This is a lengthy report as part of a lot of other work carried out

1994 – Groundwater Factors affecting the Productive Use of Saline Land

This conference paper describes how irrigation disturbs the natural groundwater system and how this can lead to salinity on a smaller or larger scale. Groundwater flow factors play a role in the severity of the impacts. These should be determined by establishing the soil salinity trends using an acceptable methodology. The solutions may be to lower hydraulic loading, or other options such as rotation management or abandoning small parts of the landscape.

1994 – Water Table Control Options – MIA

In a landscape with a lot of rice growing, high groundwater levels and a risk of increasing soil salinity, key question were; what can we do about this? This report is a precursor to the MIA LWMP and examines the models to evaluate the water balance and the soil salinity trends (a methodology was developed for this). It then looks at engineering control options such as tube well drainage and horizontal drainage, effluent disposal, whether they are feasible and their costings. The benefits are related to the extent the soil salinity trend was estimated to be reduced into the future.

1995 – Development of the MIA LWMP Preferred Plan Scenario

This major report follows on from the WT Control Option report but includes all options for the plan, describes targets for each sub-district, and describes the methodology used to determine the optimum combination of options to achieve the desired salinity targets. The optimisation process was based on multi factor analysis and optimisation using Excel Spreadsheets. The degree by which each option needed to be implemented was found by this analysis. This was then later modified slightly by the LWMP Management Committee.

1996 – Jemalong Soil Salinity Assessment

This report for the Jemalong LWMP makes an assessment of the soil salinity trends with and without a plan scenario. The complication relative to the MIA was that for Jemalong far fewer groundwater data are available and there are large parts of the district not used for irrigation. The method used relies on a relationship between groundwater depth and soil salinity developed elsewhere, so groundwater trends are its basis. The low irrigation loading in Jemalong means future groundwater levels are unlikely to be extremely high but nevertheless, an assessment of the likely outcome was made.

1996 + 2000, 2001 …. 2008, 2011 – MIA Annual Groundwater Report

After 1996 the MIA was privatised, but the NSW government licence required annual reporting of the groundwater conditions. I was hired to do this for Murrumbidgee Irrigation annually until 2012. These reports describe the groundwater conditions in the four sub-districts as well as for the MIA as a whole. The 1996 report is a kind of baseline, with rice growing still very much dominating conditions.

The subsequent reports become more and more detailed in the analysis and a water balance model was introduced to determine the main factors describing groundwater level change. Towards 2010 the predictive capacity of this model became better as dry conditions caused groundwater levels to fall, and model optimisation with a larger range in the data set improved accuracy.

In summary, average groundwater levels were estimated from weather data, various irrigation enterprise and rice area data and factors such as effective porosity. The optimisation was for the coefficients on each of these data sets to find the recharge and discharge volumes to the groundwater every six-month period for up to 12 years. This in turn produced the groundwater trend which was compared with observed data, and the sum of square root of the differences. A by-product was the relative contribution from rice, whilst the contribution from summer crops relative to winter crops (in spring) was also examined.

This groundwater model became one of the three model simulation of the groundwater hydrology in the MIA (see below).

1997 – Pooginook – Groundwater Effects from Coleambally

This short report examines one instance where a landholder felt the CIA was having an impact on his farm by groundwater movement. This was found to be the case, but the impacts were found to be small to negligible as groundwater levels remained below 3 metres.

1998 – Coleambally Outfall Drain Groundwater Report

This brief report examines the effect of Coleambally and seepage from the Outfall Drain on groundwater conditions in the area. It may be seen as a follow up of the CIA LWMP.

1998 – MIA LWMP Draft Report

This report is the plan as it was published, with minor modifications and signed by Wal Hood and John Bonetti. It contains all the information compiled from many contributors.

1998 – MIA Soil Salinity Survey

This report reflects the methodology used at the time to get a regional and sub-district impression of the status of soil salinity in the MIA. Data and spatial factors are discussed.

1999 – Lower Tarim and Kongque Rivers Floodplain Groundwater Processes

A consultancy tour to Xin Jiang Provence, China produced this brief report on the effect of lower river flows on vegetation in the lower reaches of this river.

1999 – Groundwater Studies of the Kaidu and Kongque River Systems

During a consultancy to Xin Jiang Provence in China I was requested to review a model prepared for the irrigation areas of this system. It proved an interesting task and I was able to use the methodology in the MIA, after significant modification and alteration. See the 2013 report.

1999 – Coleambally Soil Salinity Survey Results

At the time it was felt important to, as part of the LWMP, to keep check of the soil salinity status of the area. To that end a sampling strategy based on the grid system was developed and samples taken at each location. The analysis was based on 1:5 soil/water suspensions. The methodology and results are discussed, together with shortcomings and discussion.

1999 – Lowbidgee Groundwater Update.

This very short report describes groundwater conditions in the Lowbidgee area in 1999. Some comment on the (minor) effect of flooding is being made.

1999 – Rice Hydraulic Loading Perspectives

The proportion of land under rice affects the areas in between, by groundwater movement. Crop rotational management may reduce the deleterious effects by salting. The report recommends the use of salinity surveys on a district scale to determine trends. In the MIA such surveys had been carried out on three occasions up until 1998. The results of these surveys are shown in the report.

2001 – Response Times in Dryland Salinity

During my time in Wagga working on dryland salinity it was noticed that many dryland salinity problems relate to catchments in which a linear hilly ridge over a distance exists with groundwater discharge to each side of the divide into a creek or stream. With a groundwater mound beneath such a mound the drop of the water table over time after and between rainfall events indicates aspects of for instance the nature and permeability of the rocky strata. That theory was applied to a catchment in the Yass area, indicating response times of 4000 days (drop to 1/e of initial value) and transmissivities in the order of 10 m2/day. Using this information, a longer period (say 50 years) could be modelled showing the main peaks and lows of the groundwater mound. The salinity discharge at the foot of the hills would vary correspondingly.

2001 – Assessment of Dryland Salinity and Optimisation of Benefits based on Management Options Combinations

This follows the 2001 report on groundwater response times in catchments which exhibit dryland salinity symptoms. Various options may applied to reduce groundwater recharge and thereby the groundwater recession curve. These include better pastures, forestry options etc. If the beneficial effects of each option can be quantified (and some data are available in that respect), the outcome for a With Plan scenario may be compared to a No Plan scenario and the benefits compared to costs. Optimisation of options maybe possible and this is being reported. Note: whilst the local economist was quite enthused about this project, the DLWC Parramatta Technical Unit virtually ignored it.

2002 - MIA Soil Salinity Survey

Murrumbidgee Irrigation decided to follow on from previous surveys as part of its irrigation licence and this report reflects the results. The data, the methods, advantages, and shortcomings of this survey are discussed. Rather than having a broad scale survey over the whole district in this survey there was a special focus on about 10 farms where more detailed monitoring was carried out.

2003 Groundwater Salinity Report

This report reflects the sampling from piezometers in the MIA over several decades. The data are summarised, maps are presented and trends in groundwater salinity are being discussed. These trends have been downwards by about 10% over 22 years, however for deeper aquifers and some areas the trend was not equally significant.

2003 – Lake Wyangan Environmental Status Report

This report is a follow on of a report by Annette McGaffery. The various environmental factors relevant for this area are discussed with a special emphasis on the water balance of Lake Wyangan, including its salinity. These are sections 4 and 5 of this report.

2004 Coleambally Soil Salinity Survey Report.

This is a follow up of the 1998 report, including a new data set. It is shown the data sets are very skewed, and that there have been very small changes to soil salinity since 1998. The soil acidity pH was found to be quite low in significant areas

2005 - Murray Valley Groundwater Trends and Balances

A study was conducted to examine whether average groundwater depth behaviour of irrigated districts and sub-districts in the Murray Valley could be explained as a function of the various contributing recharge and discharge factors. To this end average groundwater depths of shallow and deep aquifers were calculated and compared with irrigation delivery data, the areas of rice, climatic data, groundwater pumping data, and other contributing factors such as channel seepage, lateral flow, tree uptake and groundwater evaporation where appropriate. The period considered was 1990 to 2004. The results show that a groundwater model as used in the MIA showed very good predictions of average groundwater depth versus observed data. The contribution of each factor to the average groundwater depths prediction lines varied. Deep leakage appears to be significant, in the order of 10-20mm/year for every 10 metres down gradient. Accessions from rainfall are significant, with the winter season usually contributing more than the summer season.