Hydrological Newsletter

The Hydrological Society of South Australia No 74

RIVER MURRAY IN FLOOD

Andrew Jessup

THE RIVER MURRAY IS RISING again. This will be the fourth year in five that the river has risen above 'bank - full' and spread out over the floodplain in South Australia.

Lets look at the River Murray's frequency of flooding, the impacts, both good and bad, what has been done to manage this flood and the options for managing in future.

FREQUENCY

The most recent study of flood frequency in the River is *"Flood Frequency Analysis of the River Murray at Morgan"* by EWS 1987. Based on that report, the recent floods had the following probability of exceedance:

Year	Flow Ml/d	ARI
1993	115 000	11
1992	98 500	7
1991	46 800	3
1990	110 000	9
1989	86 000	6

Note:
- o Flow is measured at Overland Corner
- o ARI means average recurrence interval
- o Flow of 115 000 ML/d for 1993 is an estimate

The two largest floods in recent history have been in 1956 and 1931, with ARI of 160 years and 40 years respectively. This shows that we have just experienced an unusually wet sequence of years. The chances of receiving a succession of high flows such as the last 5 years must be quite small. Can any of the statisticians among us hazard a guess as to how small?

SOURCE OF FLOODING

The main source of the flood this year has been tributary rivers in the north - east of Victoria. These include the Goulburn, Broken, Ovens, King, and Kiewa rivers. Very heavy falls of rain occurred over the catchments of these rivers on the long weekend in October. Flooding in these areas was in some cases the highest on record. Major flooding occurred along the River Murray between Echuca and Swan Hill. Downstream from there, flooding has been moderate.

IMPACTS - GOOD AND BAD

There are a lot of people with business and property interests on the floodplain: shacks, stock grazing, houseboats, caravan parks, large floating pleasure craft - to name a few. Many of these activities are affected by flooding.

Sometimes, ferry access is not possible meaning that people wanting to cross the river have to travel to the nearest bridge - and in South Australia, bridges are few and far between - three bridges covering our 650 km of river. As well as the inconvenience to people, economic loss can be large when these activities are interrupted by floods.

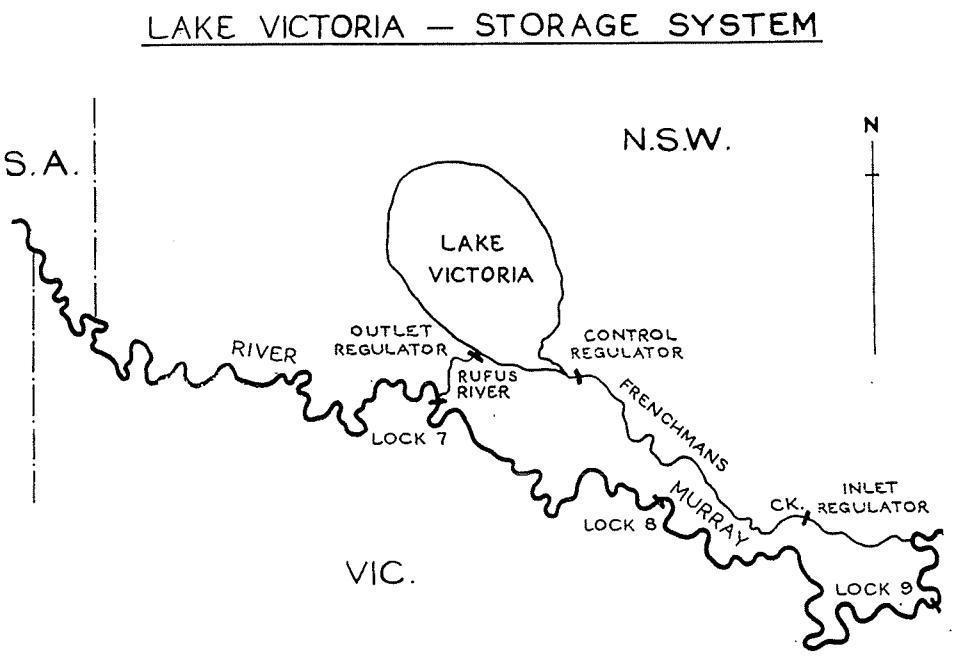
However, there are some very positive benefits. The floodplain and its maze of creeks, ana - branches and backwaters and the trees, fish and animals that live in them rely on periodic flooding for health and survival. Extremely large quantities of salt are flushed from the floodplain during floods. Currently around 8 000 tonnes of salt are being flushed out of the floodplain each day in South Australia.

WHAT HAS BEEN DONE TO MANAGE THE FLOOD THIS YEAR?

When it became obvious that this year's flood would be 150 000 ML/d at Lock 10, it was decided to mitigate the peak of the flood to minimise property damage and economic loss. A particular effort is being to save the Berri to Loxton road.

In this issue:

Lake Victoria, a 680 000 ML off stream storage, located conveniently upstream of the SA border, owned by the MDBC and operated by EWS, was the key. 120 000 ML of 'air-space' was made in Lake Victoria by pre-releases. Up to 12 000 ML/d is being taken into the Lake as the peak passed the Lake inlet. The outlet from the lake is being used to maintain flow in the River downsteam of the lake just below the threshold flow which will flood the Loxton road. These operations will have the effect of mitigating the peak flow to SA by 12000 ML/d, and extending the duration of flow at this mitigated peak. The diagram shows the Lake and its regulators, and the graph shows the modelled operations for the lake.



This amount of mitigation at this flow will have only a small impact on area of the floodplain getting flooded. An estimated 2000 hectares will miss out, compared with about 60 000 hectares which will get flooded. About 80% of the floodplain in SA will be flooded this year. Around 95% of the environmentally important wetland areas at Chowilla will get wet.

WHAT CAN BE DONE TO MANAGE FLOODS IN FUTURE?

It is generally recognised that the frequency of small and medium size floods in the River Murray has been reduced dramatically due to regulation of the river with diversions and large storages. Large floods are able to pass unaffected. Some increased flooding can be achieved using Lake Victoria. The following table shows this clearly:

Flow Ml/d	% of Years When Flow Exceeded		
	Natural	Current	Use LVS
25 000	97	53	63
50 000	77	30	34
75 000	44	13	14
100 000	31	8	10
200 000	2	2	2

Use LVS means that 6 500 ML/d is added to the peak from Lake Victoria. The table shows that Lake Victoria could be used to increase the frequency of flows of 50 000 ML/d from 30 % of years currently, to 34 % of years.

At flows of 50 000 ML/d and more, injection of 6 500 ML/d from Lake Victoria will result in increased peak levels of about 100 mm throughout SA. While this might seem a modest increase in level, it does equate to considerable increases in the area of floodplain getting wet. For example an increase of flow from 50 000 ML/d to 56 500 ML/d results an increase of more than 5 000 hectares of floodplain getting wet.

Community response to this type of enhanced flooding has been mixed. In general, shack owners are against the idea, while others are generally for the enhancement because of the environmental benefits.

EDITOR'S NOTES

Readers are encouraged to submit short articles on their findings to be considered for future issues of *Hydrological Newsletter.* Concise illustrations summarising results are requested. The publication schedule is:

Issue	Items due	Publication
➲Fall	15 Mar	April
➲Winter	15 Jun	July
➲Spring	15 Sep	October
➲Summer	15 Nov	December

Message to the Premier

Hon Lynn Arnold
Premier of South Australia

Dear Sir
re: Water Resources Management in South Australia

I am writing to you on behalf of the Hydrological Society of South Australia to express our concern at the inadequate profile of water resources management in this state. At a recent meeting, Society members decided that this concern should be conveyed to you directly because of the critical importance of the state's water resources to our ongoing prosperity and the perceived lack of consideration of water resources issues in important state planning decisions.

The decision to approach you was not taken lightly. The Hydrological Society of South Australia is open to anybody with an interest in water resources; their management, protection and measurement. The Society has some 200 members, mainly professional and technical staff from educational, research and consulting groups across the state as well as from a number of government and local government agencies. The Society represents the most significant accumulation of expertise in water resources management in the state.

The water resources of this state will be a significant, and in many cases probably the most critical, constraint to economic growth. This is particularly the case with respect to some of the activities and industries that have been identified in your economic statements as crucial to our economic recovery. For example, although the wine grape industry is seen as being an important player in the future economy of the state, there is not one premium wine grape growing area that is not already under threat due to limited water availability. Expansion in this industry will require careful management of the available resources and consideration of the constraints that limited water availability will impose on the planning process.

Similarly the development of industrial and tourism activities outside the greater metropolitan area inevitably is dependent on the availability of suitable water supplies and often may have significant impacts on existing users of local resources or on the local environment. Unless adequate consideration is given to the constraints imposed by water quality and quantity and the options available to modify or mitigate these constraints, the future for the development necessary for the economic recovery of the state is bleak.

As you will be aware there is considerable discussion at the moment regarding the future of water resources management in this state. This has been brought about by a number of factors such as the impending merger between the E&WS Department and ETSA, the formation of an EPA and major reorganisations in several key government agencies.

Although the main question being asked is where the water resources management function should reside, the Society believes that the most important issue is the profile of this function within government. It is considered that water resources management lacks an adequate administrative and political profile in this state despite the significance of water to the South Australian economy.

Unlike other states, there is no Minister of Water Resources or Department of Water Resources. Despite the significance of water to the continued growth and prosperity of this state there is not even a Director of Water Resources, which means that there is no Executive Level officer within government with the sole responsibility to represent water resources issues.

In addition, responsibility for various aspects of water resources management is disseminated across a variety of agencies including the E&WS Department, the Department of Road Transport, the Department of Mines and Energy, Local Government and the MFP. However there is no clear understanding of any responsibility for overall coordination, particularly in relation to some of the emerging issues such as stormwater management and conjunctive use of resources.

If this state is to prosper, the management of our scarce water resources will be critical. It is essential that there be an effective advocate for water resources at a sufficient level within government to ensure water management is adequately resourced and given sufficient profile in broad policy decision making. Further it is important that this advocacy is seen as being independent of the interests of operational agencies and that there is a clear understanding of responsibility for overall coordination of the various activities that make up the water resources management function in this state.

These essential requirements can only be met by establishing a high profile, reasonably autonomous unit within government to coordinate and oversee all water resources policy development and management activities. It is recognised that a new agency may not be appropriate but the establishment of at least a Division of Water Resources within an existing agency would meet most of the critical requirements. Importantly, if this were promoted widely it would provide a clear message to the community that the protection and management of water resources is vital to the future prosperity of this state.

Members of the Society Executive would be pleased to meet with you should you wish to discuss these comments further. I can be contacted during work hours on 226 2502 or after hours on 272 4091.

Yours faithfully

PD Harvey
CHAIRMAN

Copies to D Wotton MP and M Elliott MLC.

Management of water 'horrendous'

The State Government had lost sight of the importance of proper water resource management, the Australian Democrats said yesterday.

Democrat MLC Mr Mike Elliott told State Parliament that the Government must act quickly to rectify the "horrendous" lack of control in this area.

Mr Elliott read from a letter of the SA Hydrological Society chairman, Mr Paul Harvey, which says water will be the most critical constraint to SA's economic growth.

"This is particularly the case with respect to some of the activities and industries that have been identified in (State Government) economic statements as crucial to our economic recovery," Mr Harvey says.

"For example, the wine grape industry is seen as being an important player in the future economy and there is not one premium wine grape-growing area that is not under threat due to limited water availability."

Mr Harvey also says that unlike other States, SA does not have a water resources minister, a water resources department or a water resources director, "which means that there is no executive-level officer within the Government with the sole responsibility to represent water resource issues".

"Essential requirements can only be met by establishing a high profile, reasonably autonomous unit within government to co-ordinate and oversee all water resources policy development and management activities," he says.

– Catherine Bauer

A new era of drainage for the upper South East?

Alan Ockenden

VEGETATION CLEARANCE FOR THE AGRICULTURAL DEVELOPment of a pasture based grazing industry in the western part of the Upper South East has, over time, resulted in a change to the region's hydrology.

The combined effect of elevated groundwater levels from increased rainfall recharge and surface water inundation from wet winters has created an area of land degradation of vast proportions in the Upper South East. Dryland salinisation creeping along the low lying flats of the Upper South East has been described as the largest single expanse of dryland salinity in Australia (Fig 1).

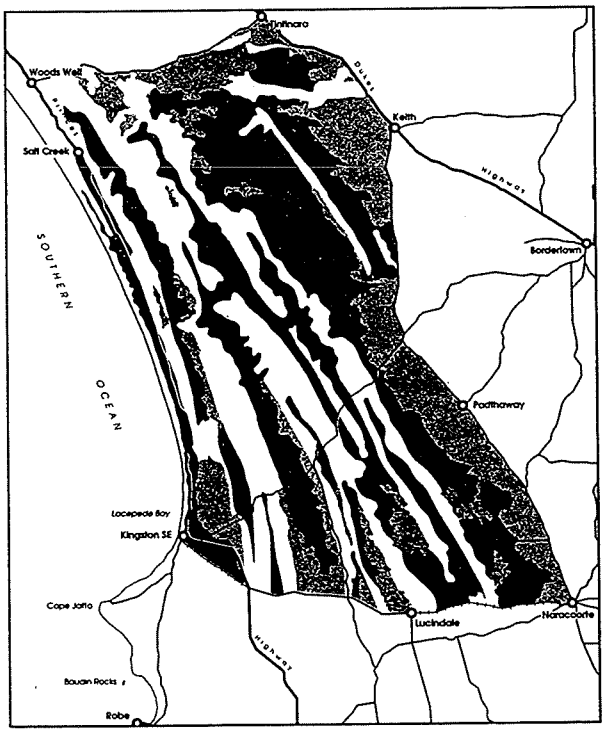
Unless there is some action the productivity of the region's sheep and cattle grazing industry will reduce by almost 50% in the next 25 years representing a long term gross margin loss of $17.7m per annum. Agricultural production is not the only casualty, wetlands and significant areas of remnant vegetation including conservation parks are also being degraded by excessive flooding and the high saline watertable.

Inundation over the flats in winter kills the pastures - particularly the salt tolerant species such as tall wheat grass and puccinellia. During the summer, evaporative discharge of the shallow and saline groundwater fuels the dryland salinisation process across the flats. Over the last five years the problem has become very apparent and the effects have been quite devastating for the region although the economic impact has been somewhat masked by the rural recession.

The problem has recently attracted research funding through the Commonwealth Landcare Partnership program as well as being designated as a core dryland salinity research catchment by the Land and Water Research Development Corporation.

The extent of the problem experienced over the last few years prompted landholders and resource managers to undertake detailed assessments and develop a plan of attack. Through the Natural Resources Council, a peak advisory body to government, an inter-agency multi-disciplinary team was drawn to assist a community based steering committee to put up a management plan. The plan had to be developed with extensive community consultation so that it could be owned and implemented with the support of the local community.

After a great deal of technical work, consultation and deliberation the steering committee finally presented the Upper South East Dryland Salinity and Flood Management Plan to the Natural Resources Council. The Plan was incorporated as a Draft Environmental Impact Statement which literally assessed all the options from the 'do nothing' through to extensive revegetation programs and drainage schemes in a hierarchy that provided detailed economic, environmental and social impacts. In addition to the substantial Draft EIS document some 20 technical background reports were also published to support the technical assessments of the Management Plan.

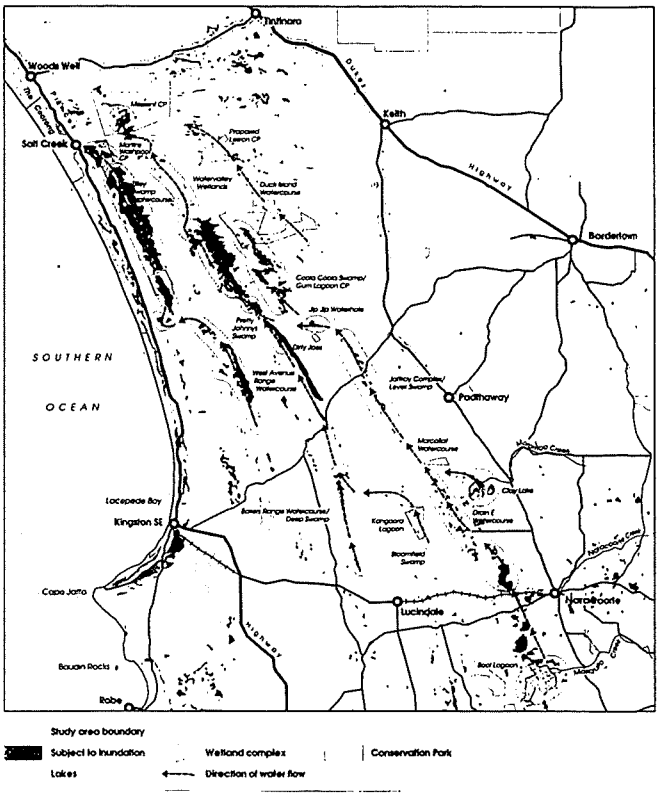


The project was led by Engineering and Water Supply Department and involved very substantial inputs from Primary Industries South Australia, Department of Mines and Energy, South Australian Research and Development Institute and Department of Environment and Natural Resources. Various other agencies assisted as well as several consultants, Eco Management Services, Computational Fluid Mechanics International, South Australian Centre for Economic Studies, RM Herriot & Associates and Lang Dames & Campbell.

The Management Plan combines five key elements to achieve the best possible outcome to the dryland salinity and flooding problems while taking into account the environmental, economic and social concerns. These elements are;

- **surface water and wetland management** (Figure 2)

  Improved surface water management to reduce flooding impacts and utilise water for wetland conservation through a "Wetlands Waterlink". This environmental initiative will enable valuable



remnant wetlands and associated native vegetation to be actively managed to ensure its sustainability. Management of water quantity and quality requirements along with other aspects in consultation with landholders provides the necessary environmental integration to the Plan.

- **coordinated drainage schemes** (refer Figure 3)

  Groundwater levels, excess surface water and associated soil salinisation can be controlled with the construction of a new regional network of groundwater and surface water drains with outlets to the ocean and the Coorong. The integrated network will cost in the vicinity of $36m and can be economically justified on agricultural production alone.

  The steering committee's preferred drainage schemes involve groundwater drains which are essentially designed to lower groundwater levels. The hydrogeology of the area is such that deep drains up to 3 to 4 metres deep will be able to lower groundwater levels up to 2 to 3 km away. Other options involve surface water drains which are typically 1 to 2 metres deep and are designed to manage excess surface water so that saltland agronomy can be established.

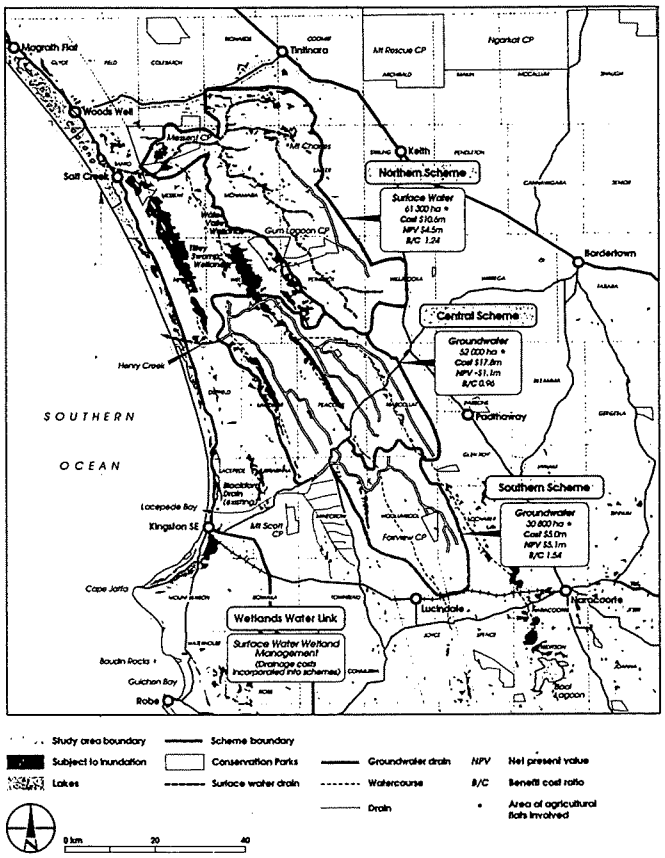
  In all a total of 28 different regional drainage schemes of varying cost, performance and scale are provided in the Draft EIS document. Various outlet options are involved including controversial discharges to the Coorong, inland evaporation basins and a new outlet to the ocean.

- **agricultural production and on-farm measures**

  A pasture redevelopment program utilising salt tolerant and perennial species is proposed to deliver increased agricultural productivity to secure the economic viability of the Plan. With adequate drainage, saltland agronomy (establishing salt tolerant grasses such as puccinellia and tall wheat grass and salt tolerant shrubs) has tremendous potential to improve stocking rates and provide a sustainable agricultural future for the region.

- **revegetation**

  As part of the integrated catchment management approach a major revegetation program is planned to reach a target of 20% cover in the study area. Revegetation is not the primary strategy because of its cost, the very large area required to redress the water imbalance and the lack of potential for it to be financially driven.



- **community ownership and funding.**

  Community ownership of the Plan is essential to achieve the integrated agricultural and environmental components and the funding implications. In economic terms the success of the Plan depends on farmers undertaking the on-farm pasture renovation programs (especially saltland agronomy) which is estimated to involve about $18m over a ten year period.

The Management Plan, when implemented will represent a 'new era of drainage' for the South East. This time drainage schemes will address multiple objectives of agriculture and the environment. The wetlands of the Upper South East are of national significance and this Plan provides the framework to ensure they are sustained along with the remnant native vegetation and the agricultural industry in the region.

Welcome to the first issue of the *Hydrological Newsletter*, formerly the *Newsletter of the Hydrological Society of South Australia.*

HYDROLOGY - TO BE OR NOT TO BE

The role of hydrology as a science is recently being discussed quite vigorously in the Earth Sciences corner of the scientific community, most notably by some top brains in the hydrological establishment. In a nutshell, the questions arise whether hydrology is a science or an engineering hocus-pocus-quick-fix, whether it up to scratch and whether it is of any good at all.

Let us start with the standard definition which says:

Hydrology is the science that deals with the waters of the Earth, their occurrence, circulation and distribution, their chemical and physical properties, and their interaction with the ecosystem, including their relation to living beings.

Because water is the basis and the absolute prerequisite of life on the Earth, it would seem logical that hydrology is the most important science of all. In fact it is. Recognition of this truth, however, is gaining acceptance rather slowly. There is nothing new about it: many early civilisations passed into oblivion through poor management of their water resources, and ours may be just another along the same line. One can read here and there that water wars are looming; and they will be fought with much greater determination than oil wars, for oil is only one of the luxuries of life, whereas water is life. That we have survived so far is not a sign of our brilliant capabilities - for in dealings with water, historically we have displayed mostly, rather brutal ignorance and arrogance - but of the amazing capabilities of the hydrological cycle system to regenerate our supplies - and to cope with much of our abuse...

THE ROLE OF *HYDROLOGICAL NEWSLETTER*

In this magazine we will be presenting local engineering activities and solutions but also will be looking for theoretical considerations on hydrological problems specific to our conditions but without losing sight of the wider perspective. We will cover hydrological, meteorological and geophysical developments in our State and will attempt to present the development of the hydrological thought elsewhere. We will be encouraging contributions from other States and countries: this issue brings articles by our three members on hydrological pursuits in exotic and far-away destinations.

We will present our ideas, seek opinion and communicate with prospective members of our Society, members and leaders of similar groups, government officials, elected or appointed, community groups, key civic, industry or other leaders as well as radio, TV, newspaper and other journalists. A letter written on the behalf of the Society by its immediate past-Chairman to the Premier of South Australia is presented on page 3.

The name of the newsletter is open to change. True, many good names are already in use: *Water South Australia, Water SA, Water News* or *Waterlink* to name only a few. Still, *Water and Land* or *Water and Earth* would probably reflect well our overriding concern for developing a sustainable and harmonious environment. So, please give the Editor a ring and express your opinion.

Your feedback, suggestions and ideas will ultimately decide the shape of this magazine.

Vincent Kotwicki

A little bit of Chile

Steve Barnett

EARLIER THIS YEAR, I had the opportunity to work as a hydrogeologist in Chile for six months for the only groundwater consultants based there, Water Management Consultants. My job was to supervise a drilling program to obtain a water supply for a copper mine under development in the north of Chile on the Altiplano at an altitude of 14 000 feet above sea level. A supply of 750 litres/sec is required over a projected mine life of 70 years.

Needles to say, there were a number of challenges - different language, driving on the other side of the road, volcanic geology that I had never seen before, difficult drilling contractors and acclimatising to high altitude - all led to interesting experiences, not all of them pleasant. The scenery however was majestic and spectacular - chains of snow-capped volcanoes (some still issuing steam), salars with flamingoes, herds of llamas, occasional snow storms and thermal springs with a pH of 2.4.

Chile is one of the boom economies of South America - last year it had a growth rate of 10% with an inflation rate of 12%. I was based in Santiago - a modern bustling city of 4.5 million which is often shrouded in smog. On a clear day, the 8 000 foot high snow-capped Andes made an impressive backdrop. I was surprised by how civilised and westernised Santiago was, and sometimes found it hard to realise I was in South America. I has a very clean and efficient Metro; and expensive shopping centres like North Adelaide. Despite this, there is still a very wide gap between the have and have-nots and very strong class distinction. Restaurant prices are about 30% more expensive than Adelaide, consumer goods roughly the same price and more importantly, beer and wine 30% cheaper. Santiago has a Mediterranean climate very similar to Adelaide's and it is not surprising that horticultural produce has taken over from copper as the biggest export earner, given the abundance of surface water for irrigation from Andean snow melt. The red wine is the most drinkable, being only $3-4.00 in the supermarket, mostly cabernet sauvignon and lighter in style than the Aussie reds.

In my time off, I travelled to the spectacular Torres del Paine in the deep south of Chile in Tierra del Feugo, the Inca ruins of Macchu Pichu in Peru with only 20 other tourists, the headwaters of the Amazon in Bolivia (with piranha for lunch), and the Kakadu-like wetlands of the Pantanal in Brazil. With no great hassle and a relative minimum of fuss. Don't believe all the horror stories about travelling in South America.

There is much ignorance and misunderstanding about groundwater in Chile, especially amongst the mining companies. They don't realise that water has equal value

Continued on page 11

ARTIFICIAL RECHARGE OF STORMWATER

Nabil Gerges

EVERY YEAR, APPROXIMATELY 180 000 megalitres of urban stormwater runoff is discharged into Gulf St Vincent from the Adelaide metropolitan area. This practice represents a terrible waste of a resource which has the potential to supplement, or even replace, existing mains water supplies.

Thankfully in recent times, attitudes to stormwater have changed, and serious attempts have been made to realise its resource potential, particularly in situations where a potable standard is not required.

In conjunction with Hickinbotham Homes, Munno Para City Council and EWS, DME is currently involved in a project to investigate the use of stormwater to irrigate an area of parklands recently developed at Andrews's Farm.

A series of three wetland ponds has been constructed in the parklands, the first of which receives runoff from the adjacent residential catchments. As the newly-planted reed beds become established, sediments, heavy metals, bacteria and other pollutants will be removed from the water as it gradually flows through the network of ponds.

Ultimately, good quality water retained in the third pond will be diverted into the second tertiary aquifer (T2) located 108 m below the surface, and stored underground until the summer months when it can be recovered and used for irrigation.

A promising 6-day trial injection test using mains water was conducted at Andrew's Farm in early August to determine the characteristics of the T2 aquifer, and observed a favourable response to recharge.

A three week trial injection using wetland treated stormwater was officially launched by the local Member of Parliament (Hon. T. Groom) in early November. This was witnessed by over 100 people from a wide range of State agencies and private sector organisations. The launch included a technical presentation by DME and CGS personnel which was very well received by the audience.

Results from this test will be compared to those from the first, in order to assess any changes in performance caused by differences in the quality of the injected water. Of particular interest will be the degree of clogging of the aquifer (if any) caused by fine material suspended in the recharge water. Based on the results of the two tests, a strategy for conducting recharge each year during winter will be devised.

DME drilled several wells into different aquifers and conducted pumping tests at a site in Virginia during early June as part of investigations into the potential for artificial recharge in the Northern Adelaide Plains. The aim was to determine the characteristics of the second Tertiary aquifer (T2) and establish the nature of its interaction with the shallower Tertiary (T1) and Quaternary (Q3 and Q4) aquifers.

Market gardeners in the region rely on water from T2 all year round to irrigate crops, a practice which has lowered water levels over the years, and one which eventually limit supplies from shallow wells. Artificial recharge is regarded as an effective method of returning pressure to the T2 aquifer, and thereby sustaining a resource which is vital to the productivity of the area.

The test program involved pumping water from two wells completed in T2, and monitoring levels in observation wells penetrating Q3, Q4 and T1. Pumping rates ranged from 4 to 10 L/s, and duration of the tests varied from 100 minutes to 24 hours. Following the extraction tests, a seven-day injection test was carried out to determine the aquifer's response to recharge. Initial results indicate that recharge will be effective in raising water levels, but the degree of aeration may restrict the rate of injection. Further work is required to understand the behaviour of the aquifer during recharge, and establish ways of overcoming this problem. Possible solutions include acidisation of the aquifer to improve transmissitivity, and changing the method of injection to minimise aeration.

Members of the public were invited to attend a seminar held at the site in mid June. Groundwater staff explained why water levels in the area have fallen, and described how artificial recharge would repressurise the aquifer and prevent levels from dropping further. It was emphasises that artificial recharge would ultimately benefit all users of T2, and not only those on whose properties it would take place. The response was overwhelmingly positive, and a number of growers indicated their willingness to provide land for use in future research. This may include injection of water from the Gawler River. □

THE PADDOCKS

A report on the two year study of the urban wetlands at The Paddocks, at Para Hills, has recently been released by EWS Department.

The study covers rainfall and runoff, streamflow, water quality, sedimentation and looks briefly at vegetation. The efficiency of the wetland in controlling flooding and improving water quality has been investigated together with the reuse potential of the improved quality stormwater. A full discussion of the study will be presented in the next issue of this newsletter.

Further information about the report or the study can be obtained from Graeme Tomlinson on 226 2493.

Tropical air/sea interactions and climate

Alastair Williams

INTERACTIONS BETWEEN THE TROPICAL ocean surface and the lower levels of the atmosphere were investigated by the Airborne Atmospheric Research Group (AARG) of Flinders Institute for Atmospheric and Marine Sciences (FIAMS) in January and February, 1993.

Establishing a temporary base at Rabaul, on the island of New Britain in northeastern Papua New Guinea, AARG operated their research aircraft over the ocean as part of an international experiment named TOGA COARE. The Coupled Ocean-Atmosphere Response Experiment (COARE) represents a major field phase of the 10-year Tropical Ocean - Global Atmosphere (TOGA) program, focusing on a deeper understanding of the coupled ocean/atmosphere system in the tropical regions, and its role as a modulator of world climate patterns. This program, in turn, forms a major component of the World Climate Research Project (WCRP), aimed at the prediction of climate phenomena on time scales of months to years.

The group's twin-engine Cessna was equipped with a comprehensive suite of fast and accurate meteorological instrumentation, including sensors for the measurement of wind, temperature, humidity, heat and moisture fluxes, and radiation parameters, as well as a weather radar and a video for recording meteorological conditions during the flights. A total of 18 low level missions were flown over the 2-month period, working both alone and in cooperation with larger aircraft and research ships from USA, Australia, France, Japan, China and the United Kingdom. The data obtained will add to that collected by other COARE teams, contributing to the building of an overall picture of the physical processes at work in the western tropical pacific and their impact on world climate patterns.

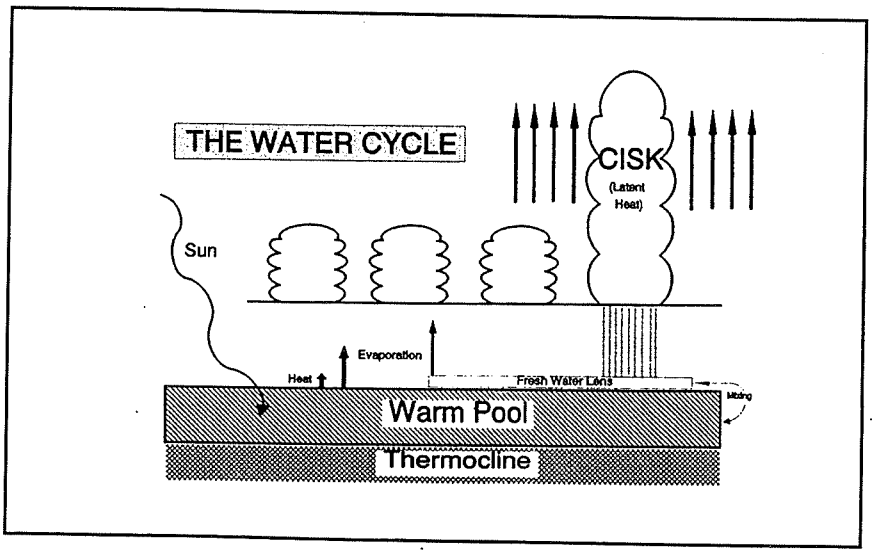
The huge data set produced during TOGA COARE will continue to be analysed for many years to come. In the sections below, various aspects of current knowledge regarding the physical processes underlying the climate machine are described, emphasizing the effects of tropical air/sea interactions and particularly the role of water in both its liquid and vapour forms.

CLIMATE AND THE TROPICS

Atmospheric scientists have long recognised the critically important role which the tropical oceans play in the generation and modulation of climate patterns all over the globe. Sometimes referred to as the earth's "heat engine", strong convective rising motions in these regions drive the Hadley and Walker cells: two fundamentally important large-scale atmospheric circulation patterns. The Hadley cell's corresponding downwards motion is over the mid-latitudes, accompanied by a low-level equator-ward return flow completing the circulation. In the Pacific ocean, most of the upwards motion is usually on the west side, leading to a circulation pattern oriented along the equator. This is called the Walker cell, and has its descending portion over the east Pacific. The Hadley and Walker cells combine to create a generally Westward/equator-ward low-level flow in the tropics, referred to as the "trade winds".

Large-scale general circulation patterns such as the Hadley and Walker cells are essential ingredients defining climate regimes from the tropics well into the mid-latitudes. Although the general form of these circulations are, at least in principal, fairly well understood, there are many more subtle aspects of their behaviour, involving such processes as their interactions with one another and with other geo/bio-physical systems, which can cause significant *modulations* in climate regimes. One example of such a process is the now well-publicised (but still little-understood) *El Niño*/Southern Oscillation (ENSO) phenomenon. ENSO events are triggered by a warming of the surface of the Pacific Ocean along the West coast of South America (*El Niño*) in a rough cycle of about 4-5 years, and have been linked to seasons of flooding in South America, severe storms in America and droughts in Australia and Africa.

Before confident predictions of phenomena such as *El Niño* can be made possible, scientists need to understand more about the physical processes at work in the tropical atmosphere. These processes are extremely complex, and involve many feedback mechanisms and motions on a large variety of time and space scales. In recent years, the role of the interactions of the atmosphere with the surface layers of the tropical ocean has emerged as one of the most important aspects of this system. The ocean responds to atmospheric forcings much faster in the tropics (time scales of weeks to months) than it does in the mid-latitudes (time scales of years), leading to a strong coupling between the atmosphere and the ocean, involving large exchanges of energy (in the forms of radiation, heat, moisture and possibly even momentum) between the two on relatively small time scales. Such interactions result in a very sensitive system, in which small changes can quickly have large effects.



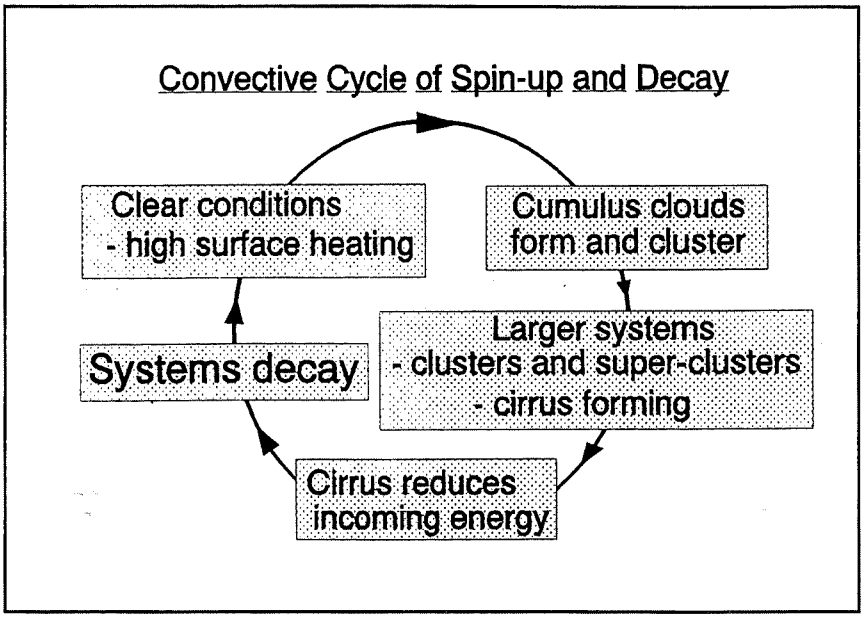
Warm Pools

Little of the sun's radiative energy is absorbed directly by the atmosphere, which is "transparent" to it in the main part. The equatorial oceans absorb most of this energy, and re-emit it to the atmosphere as heat and latent moisture energy (via evaporation). This also happens in the mid-latitudes, of course, but less energy is input (since the sun's rays do not hit the surface directly, but at an angle) and also the energy is re-emitted over much longer time scales. The mechanism by which such huge amounts of energy are re-emitted so quickly in the tropics is one of the key players in the ocean-atmosphere coupling system.

The "tinder box" of the tropics is the Western Equatorial Pacific "warm pool" region. This is the biggest of the tropical warm pools (which in total cover 35-45% of the tropical oceans, or 20% of the entire Earth's surface), and the Sea Surface Temperature (SST) in this region is greater than 28°C throughout the year. During an *El Niño* year, the centre of this pool shifts further to the East, altering the normal pattern of the Walker circulation. The surface temperatures are maintained at such high levels in the warm pool region by several inter-related mechanisms. Convergence of the trade wind flows towards this region causes net down-welling of ocean water along the equator, leading to a deepening of the ocean thermocline. This, and the low wind speeds typical for this region, result in very little colder deep-ocean water being mixed up from below the thermocline, so that the large input of solar energy into the ocean surface layers causes maximum heating.

The Role of Water

With such large SST values in the warm pool regions, one might think that the release of heat energy from the ocean into the atmosphere would constitute a major part of the energy cycle. This is, in fact, not the case. Since the temperature of the tropical atmosphere is very close to the , little heat transfer is possible. Energy is transferred mainly via evaporation. Water vapour carries a large amount of energy in the form of "latent" heat, which is released only when the vapour condenses back to a liquid form. Despite this, the high values play a crucial role as a "catalyst", because evaporation is a strongly non-linear function of temperature, and as the temperature increases, evaporation levels accelerate. At high values, a small change in temperature can lead to a very large change in evaporation.



Once evaporation has occurred, air containing a high water vapour content (and therefore a high buoyancy) accelerates upwards. It cools as it rises (due to dropping pressure), and eventually a height is reached where the air temperature drops below the minimum required to contain the water in vapour form. Clouds begin to form at this level, and as the water re-condenses it releases its latent energy as heat. This heat raises the temperature of the air above the ambient levels, and it once more becomes buoyant and induces a further vertical acceleration. This process is called Conditional Instability of the Second Kind (CISK), and is a principal driving force in the tropical heat machine.

The condensed water falls back to ocean as rain, and little net water transport occurs in the vertical. Yearly precipitation levels in the warm pool regions reach 3-5 m. When it lands on the sea surface, the water has one last part to play in the cycle: it forms fresh water "lenses" on the ocean surface in the presence of low wind speeds, which further increase through stabilisation of the ocean surface layers. This represents a positive feedback mechanism in the system, leading to further augmentation of evaporation rates.

Scales and Spin-up Cycles

Atmospheric motion in the tropics is dominated by the convective processes described above. This convection is organised on a number of interacting scales, indicating the existence of complex spatial dynamical mechanisms in the horizontal plane. Large numbers of single cumulus clouds (size 1-5 km) commonly group into "clusters" or lines with horizontal scales of the order of 10-100 km. On the next scale up, many of these clusters often form into "super-clusters" which now have scales of the order of 1000 km. These scale processes are also directly linked to a temporal cycle of convective spin-up and decay, which is illustrated below.

Starting from sunny, cloudless conditions with high surface heating, mechanisms like CISK and fresh water pooling lead to a build up over a number of days of more and more cumulus clouds, untill large systems have formed with many imbedded cumulonimbus clouds. The highest cumulonimbus clouds reach all the way to the tropopause, and send out great bands of cirrus which eventually cover large parts of the sky, cutting out much of the imcoming solar radiation. Low radiation levels eventually lead to decay of the entire system, representing a very strong *negative* feedback mechanism in the convective cycle. The largest systems (or "super-clusters") are often associated with periods of strong westerly winds at the surface, which cause enhanced mixing of the sea surface layers, dropping levels in a further negative feedback mechanism. □

Dr A.G. Williams is a Research Scientist at Flinders Institute for Atmospheric and Marine Sciences
Flinders University, South Australia

GROUNDWATER DRILLING IN THE OFFICER BASIN

Rick Aldam

THIS REGION, IN THE FAR WEST OF South Australia, is the least known are (geologically speaking) on the continent. It is prospective for hydrocarbons, lead-zinc deposits and evaporites.

To increase the understanding of the subsurface structures, seismic acquisition by Australian Geological Survey Organisation (AGSO) in a joint project with DME commenced on 19 June. This follows separate agreements between Anangu Pitjantjatjara (AP) and the Minister of Mineral Resources (MMR), and between Maralinga Tjaritja (MT) and MMR, enabling operations to proceed within Aboriginal lands.

Field operations, (bulldozing, shothole and water drilling, seismic acquisition) are being carried out with guidance and cooperation from the traditional custodians. For the northern segment a pre-operational onsite induction session for the party was presented by AP anthropologist, Ushma Scales. After this the appointed AP liaison officers and senior custodians, led by Bernard Tjalkarin, took over and remained onsite, or on call, for the duration of the exercise. Their work included twice-weekly visits to the operating area, and supervision and direction of line clearing through sensitive areas to ensure compliance with the agreement. In addition, the AP group arranged cultural excursions including the bush-tucker experience for interested party members on their days off. APs contribution to the successful field practice is greatly valued and augers well for the future exploration.

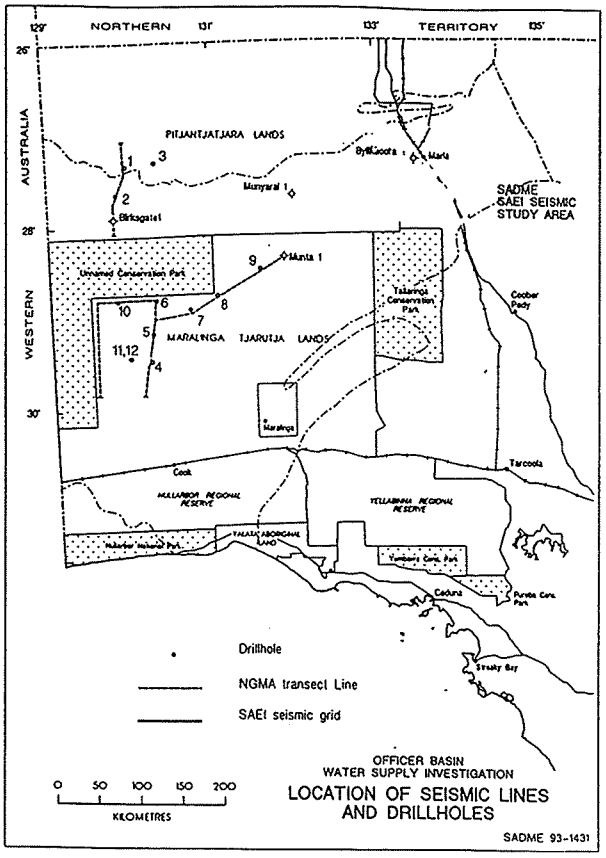
DME Groundwater Division has been involved in the drilling of water supply wells for the seismic transect. Three wells have been drilled in AP Lands and seven in MT Lands. While all 10 were successfully completed as water supply wells, yield and water quality varied considerably.

At the end of the program, the wells will be handed to the Aboriginal people

Of those drilled on AP Lands, Bore 1 near Mount Poondinna intersected potable water, which was pumped at 1 L/s; it is likely to be used as a water supply for the Pitjantjatjara people. Bore 2, the other well drilled on the seismic line, intersected a reliable supply of water suitable for use as a drilling water. Bore 3 drilled for the AP Council also encountered saline water.

All seven wells in MT Lands were successfully completed with adequate supplies of groundwater but none intersected aquifers containing a potable supply. Salinity ranged from 3 600 to greater than 100 000 mg/L. The freshest water was encountered at depth in fine-grained sandstone near the southern boundary of the Unnamed Conservation Park, whilst hypersaline water was encountered near Wyola Lake.

The success rate and spacing of wells has resulted in water for drilling and ablution purposes being within easy reach for the AGSO drilling crews. Drinking water will continue to be trucked into the area. At the end of the program, the wells will be handed over to the Aboriginal people, who then have the option of equipping several with pumps and possibly desalination plants, enabling communities to be established near Mount Poondinna, and north and west of Oak Valley. □



DRAINAGE STUDIES IN PROGRESS

David Kemp and Hugo Van Loon

ONKAPARINGA RIVER FLOODPLAIN MAPPING

The mapping of the Onkaparinga floodplain from Old Noarlunga to the sea, and near Clarendon is in progress. The hydrology for the study was carried out by Trevor Daniell and Peter Hill of the Adelaide University, and the mapping is being carried out by CMPS&F Pty. Ltd. using the unsteady flow model MIKE 11, and an interface to MOSS digital terrain model.

A range of flood recurrence intervals from the 20 year ARI to the Probable Maximum Flood is being mapped to provide information for a range of purposes including planning and emergency response. The study is being managed by a Steering Group including the Bureau of Meteorology, the Noarlunga Council, the E&WS Department and the Department of Road Transport.

ARMAGH CREEK

Armagh Creek is a creek just west of the Clare township that caused flooding to several houses in December 1992 and January 1993, and is within an area being considered for the future expansion of the Clare township. The study will gather data on the recent floods and assessing the magnitude of these. If one of the floods is seen to be approaching the 100 year Average Recurrence Interval, then it will be used as a reference flood for planning purposes. A range of options to mitigate the current flood potential will also be examined, including structural works and flood warning.

Ken Potter is undertaking the study for the District Council of Clare.

PORT LINCOLN

The City of Port Lincoln is currently the subject of a drainage study to determine the future management of stormwater within the township.

Port Lincoln has in the past undertaken the construction of major drainage works, some with the assistance of the Subsidy Drainage Scheme. The purpose of the current study is to review the standard of these and propose an overall drainage scheme to provide a consistent and appropriate standard of protection. Priorities for the construction of the works will be determined.

The study is being undertaken by Kinhill Engineers.

GAWLER RIVER FLOOD MANAGEMENT PLAN

A working party consisting of state and local government and resident representatives has been set up to oversee the production of a flood management plan for the Gawler River, which was subject to several major floods in 1992. The working party has engaged BC Tonkin and Associates to produce the plan in consultation with the working party, and those affected by the flooding.

Bob Williams of BC Tonkin and Associates has spent many hours consulting those affected and Chris Purton has investigated the possible structural flood mitigation measures, including changes to the South Para Dam spillway and a proposed North Para River Dam.

CROSS ROAD DRAINAGE STUDY

The Department of Road Transport is preparing to progressively upgrade and widen Cross Road between West Terrace Highgate and South Road, and the hydrologic and hydraulic assessment of the ultimate stormwater drain requirements under the road to Brown Hill Creek was required prior to reconstruction.

In response to this the Mitcham and Unley Councils have initiated a study which is currently being undertaken by Kinhill Engineers. Experience and analysis has shown that the existing drainage system is inadequate. A ponding basin on Urrbrae School land is one of the measures being investigated to reduce peak flows. This could be developed in conjunction with measures to improve stormwater quality at this location.

FLOODING OF STOCKPORT STUDY

Stockport is a small rural township situated on the Gilbert River, 5 kilometres north of the River Gilbert's junction with the River Light at Hamley Bridge. Several homes have experienced repeated flooding, and a floodplain map with protection measures is required for protection of homes and security for residents.

The District Council of Riverton have engaged Lange Dames Campbell to undertake this study.

Continued from page 6

to gold or copper because the bottom line is NO WATER, NO MINE! Unfortunately, their expenditure does not reflect the importance of groundwater. This ignorance led to unreal expectations, impatience and unnecessary angst on their part which lead to unnecessary pressure being brought to bear on field staff viz a viz, me! However, I take comfort from the fact that Government agencies in the drier States of Australia are excellent training grounds, providing experience exploration hydrogeologists which are in great demand in Chile. By the way, we did find the water. Boreholes with 100 metres of 12 inch sandscreen in unconsolidated volcanic breccias and medium grained ash-fall tuffs, can supply over 100 L/s with 10-20 metres of drawdown and a salinity of 700 - mg/L!

Creeks ain't creeks

or Towards an ecological classification of South Australian flowing waters

John Rolls

WHEN PREPARING RECENTLY for a presentation to the Australian Institute of Geography seminar on *'Human Impacts on Fluvial Systems'* I noted that the impact of European occupation of SA has varied, and continues to vary, according to the nature of individual streams. Pursuing that thought a little further, it is noteworthy that despite the hackneyed characterisation of SA as the *'driest State in the driest continent'*, the State is probably as rich as any other State in terms of the diversity of types of flowing waters represented.

As we move from management of waters for purely anthropocentric purposes to managing within an ecologically sustainable context, the issue of characterisation of waterways becomes of greater significance. After all, the ecosystem which adopts and modifies a surface water has developed to accommodate the natural characteristics of the water body.

The animals and plants must be able to survive and thrive in the pattern of flow variability and of changing water quality. When we change the pattern of flow or of quality variation, then we must reduce the fitness of the water body for the endemic species, and probably favour the occupation of other species.

If we are to develop the body of knowledge needed for ecologically sympathetic management we need to classify our different waters in terms of their flow and other characteristics, and determine the community composition and ecological requirements of the endemic species.

In SA one can distinguish the following types of surface waters, which are probably ecologically distinct:

- **Semi- arid floodplain rivers** with high natural flow variability (the Murray)
- **Arid floodplain rivers** of extreme flow variability (Coopers Creek)
- **Aquifer discharge creeks of low flow variability** (Eight-Mile Creek, Piccaninnie Ponds outflow creek)
- **Temperate lowland creeks of high flow reliability** (the creeks of the South East)
- **Upland permanent streams** of the better watered areas, Kangaroo Island, Fleurieu Peninsula, Mt Lofty Ranges (Onkaparinga River?)
- **Upland seasonal streams** of Kangaroo Island, Fleurieu Peninsula and the Mt Lofty Ranges
- **Seasonal streams** of the semi-arid areas
- **Episodic streams** of the arid regions

This highly tentative classification of SA streams is offered to promote discussion, particularly by limnologists, who would be best equipped to improve on it!

In closing I would like to make two observations.

FIRSTLY, almost all of the work of significance to the determination of environmental flow requirements done so far on SA streams has been restricted to the River Murray, arguably the least typical stream in the State.

SECONDLY, in the context of the Commonwealth Government initiative to protect the country's near-pristine streams, it would be appropriate for streams representative of the different types to be protected. Unfortunately in SA there would be no near-pristine representatives of several of the suggested classifications.

Water called pure H_2O is actually a complicated compound, a mixture of eighteen isotopes and fifteen ions, 33 different substances in all.

Water with the exception of mercury, has the highest surface tension of all common liquids and in its natural state has a tensile strength close to that of most steels.

Bandung Belly

Claus Schonfeldt

THERE ARE 13667 ISLANDS IN Indonesia and in the middle of August, in the space of five days, I visited all but 13666 of them. To be more precise I went to Bandung, a small city of about 2 million people on the island of Java, to participate in a final seminar of the German-Indonesian Collaborative Project, *Water Quality Management for Optimisation of the Citarum River Basin*.

My participation was by invitation from the German Federal Ministry For Research and Technology, who wanted an Australian scientific expert to participate in the seminar to present a paper on an Australian example of water quality planning and implementation to improve river water quality.

The general objective of the project was to support the development and implementation of a regional river water quality management system for the Citarum River Basin, which may be applied to other river systems both in Indonesia and other South-East Asian countries.

The project ran from July 1989 to August 1993 and concluded with the Final Project Seminar.

So what was it all about? Indonesia has recently embarked on a *Clean Rivers Program* aimed at addressing the river water quality problems evident in Indonesia. Water quality problems will no doubt vary throughout the country and, as elsewhere in the world, the severity of the problems will depend on the extent of development within the given river basin.

In the Indonesian context the critical factors are the extent of urbanisation and industrial development, because to a large extent, industrial and urban wastewater is disposed into the river systems with little if any prior treatment. The major water quality concerns relate to bacteriological contamination and high BOD loads, although high turbidity levels and, in some locations, heavy metal concentrations are also potentially of concern.

Sewage treatment as we know it, is relatively uncommon. Domestic sewage may be treated in single chamber infiltration septic tank systems, but these are not used in all homes. Even where they are, the effluent is chanelled through an open drain collector system throughout the city, for final disposal to the river. On the way all manner of urban refuse gets disposed into these drains. Bandung has an important textile industry, and downstream of the factories, the colour of the water in the drains depends on that day's dye colour. I saw a vivid blue drain become a dark black drain as it passed another factory outlet. Downstream of this a family was using the drain as a water source for washing clothes and dishes.

In the Citarum river basin there are 2550 industries, of which the largest 225 are registered. Only 19 of these have treatment plants, although another 198 are having them built. The rest discharge their wastewater directly to the river.

Naturally, when this hits the river, it imposes a very high BOD load. At the time that I was there, which admittedly was the dry season, the river just upstream of the first major water storage, had zero oxygen content. And this would be the case for most of the dry season.

To improve river water quality, management plans targetting the main pollution sources and establishing programs to reduce their pollution contribution into the stream and river systems are being developed.

However, whilst the main causes of the water quality problems are self evident and there seems to be a recognition, through the instigation of the Clean Rivers Program, that water quality needs to be improved, some guidance is needed on how to go about this process in a systematic way.

In this context the Citarum River Basin project was only a beginning both for the Citarum River Basin itself and as a pilot and demonstration of an approach which could be used in other river basins in Indonesia.

Similar projects, also supported by foreign aid programs, have been commenced in Sumatra and elsewhere in Java and presumably others will also be commenced. It seems unlikely however that, at least in the short term, the Indonesian government will fund such projects. It is more likely that they too will be established as collaborative projects based on foreign aid and of course the foreign project team would come from the collaborating country supplying the foreign aid.

There are clearly opportunities for Australian involvement in these projects; we have all the relevant expertise and could certainly emulate the initiatives of the German project team. However, any involvement would be dependent on funding from the Australian government through its overseas aid programs.

I was grateful for the opportunity to participate in this seminar and to experience something of Indonesia. There are certainly many wonderful things to experience, but for me, the climate and particularly the air pollution in the big cities, were not a drawcard. The friendliness and courtesy of the people was however exceptional. And yes, I did succumb to the dreaded gastric problems of travel in South East Asia. Thankfully Bandung belly only hit me on my return to Australia and it only took a week to clear out. □

CAPITALISING ON COINCIDENCE

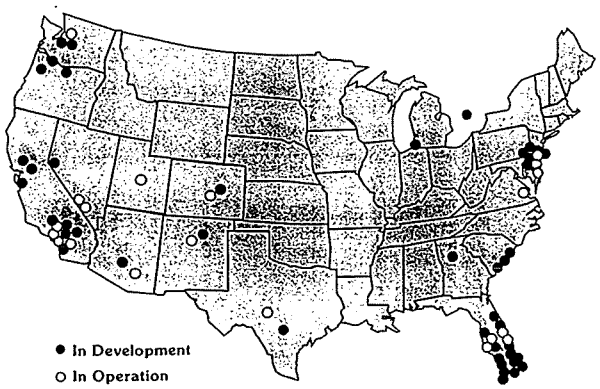
Gordon Mc Intosh

BIG IS THE OPERATIVE WORD IN DEscribing many of the features observed in the United States. For instance, big cities, big supermarkets, big freeways, big automobiles and big urban expansion projects. They also have big problems. In particular, the control of pollution and provision of adequate water supplies to the burgeoning population centres in the warmer southern States.

During a recent visit to participate in the 6th International Conference on Urban Stormwater Drainage at Niagara Falls and the 66th Annual Conference of the American Water Environment Federation at Anaheim, the opportunity was taken to explore some of innovative responses being developed, particularly in the fields of constructed wetlands, aquifer recharge and effluent re-use.

Perhaps, one of the most coincidental and influential factors impinging on water resource management is the increasing focus on improving the quality of waste discharge to the natural environment. The American Clean Water Act was, until recently, primarily directed towards point sources of pollution. In 1990, it was strengthened to incorporate control over some diffuse sources. ie stormwater from urban areas with populations exceeding 100 000 and storm runoff from construction sites and industrial premises. The nett result is, that increasing volumes of improved quality 'wastewaters' are becoming available at a time when the demand for limited conventional water resources is growing.

In a relatively few years, it has become the rule in some areas of California and Florida, that a significant proportion of treated sewage effluent is re-used directly as a second class water supply. Uses include toilet flushing in high rise buildings, irrigation of vines, root vegetables and citrus trees, irrigation of nature strips, playing fields and urban open space and the maintenance of environmental wetlands/community lakes. In some situations, constructed wetlands were used to further 'polish' the treated sewage effluent to achieve standards suitable for sustaining environmental flows in sensitive watercourses.



INDICATIVE EXTENT OF ASR PROJECTS IN THE US [1993]
Ref CH2MHill

It was also observed that whilst the use of wetlands to treat urban stormwater appeared to be an accepted procedure, the highly variable yield from surface retention ponds largely precluded extensive re-use schemes. Instances were observed where some irrigation of lawns adjacent to the ponds was accomplished, but usually on a small scale. The primary purpose of the wetlands appeared to be more directed toward environmental protection and improved urban amenity.

Indirect re-use schemes have also being increasingly introduced in recent years. In it's most basic form, treated wastewaters are directed to rapid sand filters or infiltration basins from whence the underlying aquifers are recharged. The end result is that intentionally or unintentionally, the groundwater is then used as a storage basin and subsequently re used at a later date to provide for a range of demands including drinking water.

The direct 'pipe to pipe' re use of treated sewage effluent for drinking purposes has not been implemented on an operational basis as yet but experimental facilities are exploring the potential. Cost is a major factor reflecting the high level of treatment required and negative consumer attitudes have been encountered. By comparison, attitudes tend to be relatively subdued in circumstances where the history of the drinking water is not so obvious. Consumers in the downstream reaches of large river systems into which municipal sewage is disposed are very likely to be drinking water which has already been through 2 to 3 sets of kidneys before being delivered to the tap.

The threshold of public resistance to treated sewage effluent reuse schemes for drinking water purposes is under assault as the implications of shortfalls in conventional water supplies are grasped and confidence is gradually gained in the reliability of natural treatment systems and emerging water treatment technologies. For instance, undiluted treated effluent is now being directly injected into groundwater aquifers in Orange County California for the first time and extractions for drinking water purposes permitted from wells within 600 metres of the recharge point.

The concept of ASR [Aquifer Storage and Retrieval] is fast becoming an accepted form of water management in some areas. Consultants, CH2M Hill have been very active in promoting this concept. They assess that there are 20 operational schemes throughout the US [September 1993] with a further 45 under development. A water treatment plant at Cocoa, Florida which utilises ASR techniques was visited. Source water for this plant is from underground aquifers and they have

found it more economic to maintain a fairly unsophisticated pumping program and store excess treated water back underground during periods when supply exceeds demand.

The urgency with which some of these re-use schemes have been introduced can also be attributable to the increasingly restricted and oft times expensive options which have to be contemplated. When asked how the City of Cape Coral could afford to install a sewage effluent recycling scheme for the widely dispersed urban area, the reply was 'retirees and other sun seekers are flocking to the area for the lifestyle offered and the only other alternative water supply available is the desalination of salty water'. Under those circumstances, reticulation via a dual system was expensive, but not as expensive as the alternative.

The coincidence of increasing environmental pressures and water supply shortfalls have combined to create a 'waste not, want not' focus for water resource management in those areas visited. In many cases the focus also embodied the concept of a catchment approach to natural resource management and recognised the important role o· community participation.

Many of the water resource initiatives being investigated in South Australia are similar to those being implemented in the United States. A fundamental difference lies in the urgency with which the initiatives are being pursued. This 'dry State', South Australia, is largely perceived to have access to adequate water resources to meet most Metropolitan Adelaide and regional centre water demands for the foreseeable future. Groundwater stresses are being brought under control in irrigation areas. By comparison, the shortfalls in California and Florida are real in some areas and pose a direct threat to State development and living standards.

Perhaps our sense of urgency will move up a gear when the new EPA increases the pressure for environmental protection and the results of current technical investigations and planning studies clarify the future cost effective role of alternative water resources in helping to meet the full range of future water demands. □

CONFERENCE UPDATE

Claus Schonfeldt

Water Down Under 94

First there was John Martin's Christmas pageant. Then there was the Grand Prix. Now there is **WATER DOWN UNDER '94**.

Planning for **WATER DOWN UNDER '94**, the combined conference of the 25th Groundwater Congress of the International Association of Hydrogeologists and the International Hydrology and Water Resources Symposium of the Institution of Engineers Australia, is well advanced.

This bigger than Ben Hur event is happening in Adelaide from 21-25 November 1994 and should round off a month of festivities very nicely.

Chris Wright has done a splendid job organising major and minor sponsors for the conference, giving a total sponsorship to date which is most encouraging. This will help to stabilise budgets and keep registration costs to a minimum, whilst ensuring a first class conference.

Six keynote speakers have been confirmed for the conference;

- Mr Don Blackmore, Australia
  Integrated catchment management
- Prof Wolfgang Kinzelbach, Germany
  Solute transport modelling
- Prof Christine Shoemaker, USA
  Modelling to prevent groundwater contamination
- Prof Fernandez-Rubio, Spain
  Impact of mining on water environment
- Prof David Stephenson, South Africa
  Water supply in developing countries
- Dr Michael Hudlow, USA
  Hydrometeorology and flood forecasting

Five invited speakers have also been confirmed and Prof Bill Williams, from the Adelaide University will be delivering the MUNRO ORATION on Water Resources and Hydrology.

Close to 400 abstracts have been received and the organising committee is going through the selection process at the moment to provide for about 250 papers in five or six parallel streams.

Complementing these formal sessions, there will be several high quality, pre-conference workshops as well as a number of interesting mid and post conference tours. An entertaining social program is also well advanced.

The organising committee expects to have the registration papers available in mid February 1994. So keep a look out for them and make it a date in your diary NOW!

TO LIGHTEN YOUR DAY - JUST ADD - 'IN THE CATCHMENT'

Many Society members have been lookin for that 'spark' of inspiration as they commence their daily work. Well, look no more - than the daily quotation on the bottom of your Desk Calendar od Diary - and add the magic words **'in the catchment'** to get you started.

Here are just a few examples:

*Everything has its beauty, but not everyone sees it - **in the catchment.*** -Confucius

*It is always the season for the old man to learn - **in the catchment.*** - Aeschylus

*Do as we say, and not as we do - **in the catchment.*** Giovanni Boccaccio

*Not what they want but what is good for them - **in the catchment.*** - Oliver Cromwell

*Facts do not cease to exist because they are ignored - **in the catchment.*** - Aldous Huxley

*No road of flowers leads to glory - **in the catchment.*** - Jean de la Fontaine

*The golden rule is that there are no golden rules - **in the catchment.*** - George Bernard Shaw

*It is much easier to be critical than correct -**in the catchment.*** - Benjamin Disraeli

*So little done, so much to do! - **in the catchment.*** - Cecil John Rhodes

*Silence is the virtue of fools - **in the catchment.*** - Francois Bacon

1993/1994 EXECUTIVE COMMITTEE

Name	Position	Telephone	Fax	Institution
Steve BARNETT	Chairman	274 7583	274 1239	Department of Mines and Energy
Trevor DANIELL	V-Chairman	303 5454	303 4359	University of Adelaide
Bill LIPP	Treasurer	343 2508	343 2547	Department of Road Transport
Chris PURTON	Secretary	223 5583	223 5237	BC Tonkin & Associates
Steve PUGH	Elected 1992	274 7696	274 1239	Department of Mines and Energy
Stuart RICHARDSON	Elected 1992	226 0498	231 5849	Department of Primary Industries
Glen WALKER	Elected 1992	303 8713	303 8750	Centre for Groundwater Studies
David KEMP	Elected 1993	343 2534	343 2747	Department of Road Transport
Andrew LOVE	Elected 1993	274 7602	272 7597	Department of Mines and Energy
John ROLLS	Elected 1993	226 2530	226 2161	Engineering & Water Supply

Newsletter items, cartoons, 'Quotable quotes', personal anecdotes relevant to the role of the Society or its members would be greatly appreciated. So put pen to paper, (finger to keyboard) and look through your filing cabinets and dig out those interesting or humourous articles and send them in to:

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