THE HYDROLOGICAL SOCIETY OF S.A. INC.

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Can we afford environmental protection?

C Schonfeldt

We are presently in the throes of a sustainability debate of quite some significance to the future well being of Australia and the world.

Too often the debate is polarised between the environmental purist and the economic rationalist as though one and only one of these extremes would lead to survival. In the meantime the 'silent majority' keeps itself comfortably detached.

The irony of this is that by and large we have the knowledge, the technology and the wealth for development without degradation. However some radical as well as straightforward changes are likely to be necessary.

A fundamental requirement is that we adopt a sustainability ethos; a change in attitude based on an appreciation of the fragility of our natural environment. Education is the key and we need to accept that this is not an overnight process.

In rural catchments we are making great headway. In urban catchments we may need to open our minds to some radical possibilities for infra-structure change. Stormwater management is one aspect offering exciting prospects.

We are lucky in Australia.

Industrialisation and wealth seeking development have not yet wreaked the environmental havoc so evident in other parts of the world.

We are well placed to avoid this.

In tough economic times we tend to sway towards the notion that the demands of the environmental purist are unaffordable; the demise of the Greens in Europe is witness to this.

This is tragic because we are likely to throw the baby out with the bathwater. It will be far less costly to harmonise development and care for the environment now than to suffer degradation and hopefully be able to clean it up later. We cannot however afford to go to extremes. That is neither sensible nor necessary. We must ensure that we use our funds wisely; where they achieve the most beneficial results. At the same time short term economic survival need not and should not require sacrificing of long term environmental aims.

Rather than ask if we can afford environmental protection we should ask if we can afford to forego it.

It is certainly not too late to get it right. Do we have the will?

DRYLAND SALINITY .... IT'S COSTING US THE EARTH

WATER RESOURCES MANAGEMENT

INTEGRATED CATCHMENT MANAGEMENT

[Reporter : C Schonfeldt]

The following article has been reprinted from the ANU/CRES Bulletin, December 1990.

The Aral Sea is a long way from home. Its problems however are typical of those experienced in many locations throughout the world. The message is simple enough ... integrated land and water management policies are the essence of managing our natural resources in a sustainable manner.

Our challenge is to ensure that we achieve integrated land and water management, before the consequences of not doing so overwhelm us.

The lessons are clearly evident and we will not be thanked for ignoring them.

Our institutional framework must be responsive to this and one wonders how much longer it will be before land and water managers are formally integrated, either through a natural resources agency or a body to coordinate the efforts of the separate agencies.

THE DEATH OF A SEA: THE ARAL CRISIS

[F Ghassemi]

Summary : In the past 40 years, diversion of water for irrigation of cotton crops has reduced the level of the Aral Sea by 13 m, its area has decreased by 40 per cent, its volume by 66 per cent, and salinity has more than doubled, wiping out a once-flourishing fishing industry. Between 40 and 150 million tonnes of toxic salts are blown off the former bed annually, and are deposited over 150 000 km², affecting the lives of 36 million people. The total cost of the damage is estimated at US$6 billion. What is to be done?

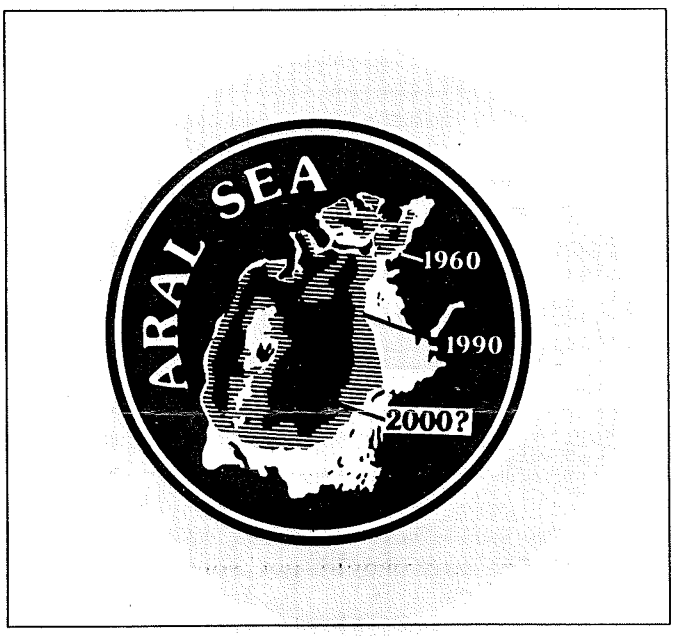
The significance of the Aral Sea problem can in one way be measured by the extent of its effect. It covers an area of 3.5 million km^2 and affects the life of 36 million people.

The Aral Sea is located in Central Asia and its catchment includes two famous USSR deserts, the Karakum and the Kyzylkum. The average annual rainfall of the region is very low and ranges from less than 100 mm to 200 mm, with the exception of the southern mountains which receive more than 1 000 mm. The main rivers discharging to the Aral Sea are the Amu-Darya (2 525 km long, 80.6 km^3 annual runoff) and the Syr Darya (2 190 km long, 31.4 km^3 annual runoff). These rivers have their headwater in the snow-capped mountains bordering Afghanistan, Pakistan and China.

In the late 1950s the central planners of the USSR decided to develop the water and land resources of the region. Their objectives were to increase cotton production for domestic use and for export to earn hard currency, to enhance food production and to raise employment. The development project comprised large reservoirs, hydraulic structures and irrigation-drainage networks. One of the major components of the scheme is the Karakum Canal which was one of the early post-war desert development projects in the USSR. This canal is about 1 450 km long and its maximum intake capacity is 800 m^3s^{-1}. It irrigates an area of about 1 million ha. The waters of Amu-Darya began to flow into the canal in 1956 but it was not until the 1960s that the delicate equilibrium between inflow and evaporation in the Aral Sea fell apart and the sea started to dry up.

Analysis of the water balance component of the Aral Basin in 1987 shows that the total runoff of the Amu-Darya and Syr-Darya was 112 km^3. Another 12.3 km^3 of water was extracted from groundwater reservoirs, yielding a total volume of 124.3 km^3.

On the other hand, demand was about 122 km^3 during the same year, leaving only a minimal volume of water drainage to the sea. Moreover, analysis of the inflow of water to the Aral Sea during the past two decades show that the Syr-Darya failed to reach the sea during this period and the Amu-Darya had no significant flow to the sea, even in wet years. The level of the Aral Sea suffered substantially from this lack of inflow. Its level dropped 12.9 m (from 53.4 to 40.5 m), its area decreased by 40 per cent (from 68 000 to 41 000 km^2) and its volume diminished by 66 per cent (from 1 090 to 374 km^3). Its average depth dropped from 16 m to 9 m and its average salinity rose from 10 to 27 g/L. As the sea shrunk, enormous quantities of salt accumulated on its former bed. These salts (sodium chloride and sodium sulfate) are toxic for almost everything other than the small shrubs, *Haloxylon aphyllum* and *Haloxylon persicum*, which are grown to stabilise the dried sea bed.



The vanishing Aral Sea

One serious problem is the blowing of the salt and dust from about the 30 000 km^2 of exposed sea bed. Between 40-150 million tonnes are blown off annually reaching up to 1 000 t/km^2 in some areas of Karakalpak. Salt is deposited in a vast area of 150 000 to 200 000 km^2.

The fishery resources of the Aral Sea have suffered as well. Once many fish species lived in the Aral Sea. Fishing was a major industry in the region employing 60 000 people and the annual catch was about 40 000 tonnes. Due to the increase of salinity from 10 to more than 28 g/L, all species of fish have disappeared. The major fishing ports of Muyank and Aralsk are now tens of kilometres from the shore. For some time fishermen were using a canal dug to provide them access to the sea. Eventually, even this became useless and fishing ships were subsequently left abandoned in the canal.

The problems of the Aral Sea are not limited to its desiccation, the disappearance of fish from its remaining salty water, the death of the fishing industry and blowing of salt and dust from its dried bed. A number of other problems have developed.

These include the salinisation of irrigated lands and toxification problems resulting from the excessive use of fertilisers and chemicals for cotton and other crop production.

There are also health problems, lack of medical facilities, inadequate drinking water and sewage treatment facilities.

In the Aral Basin, of a total irrigated area of 9.8 mha, about 5.1 mha are cultivated for cotton (52 per cent), followed by fodder, 2.05 mha (21 per cent). Other major crops are rice, wheat, maize, grapes, potatoes, other vegetables and melons.

Secondary salinisation due to the rise of the watertable is widespread in the irrigated areas and about 1 mha of land is lost to salinisation. Agricultural production has also decreased significantly in the remaining salt affected lands.

For decades, huge dosages of chemicals, fertilisers, pesticides and defoliants have been used for cotton and other agricultural production. Consequently, the spread of chemicals in the soil, drainage water and the water supply decreased land productivity and caused poisoning of tens of thousands of inhabitants of the region.

Excessive use of chemicals and environmental degradation resulted in an increase in respiratory, eye, gastro-intestinal, kidney and cardio-vascular ailments, tuberculosis, typhoid, throat cancer and even mental diseases, particularly in the lower part of the Aral Basin and close to the sea. In Karakalpak ASSR, about 83 per cent of the children have serious health problems, 80 per cent of women suffer from some sort of disease, salt content in mother's milk is 3-4 times higher than normal and the rate if miscarriage is high.

The total damage to the nature and economy of the region, estimated by the cost of measures directed to liquidation of the consequences of the Aral Crisis amount to at least 37 billion roubles (approx US$6 billion). This figure does not take into account damage to the health of people and compensation costs.

Any solution of the Aral Crisis should consider the two following aspects of the crisis:

1. To solve health, social, ecological and economic problems resulting from mistakes in agricultural development and unsatisfactory design, building and exploitation of the irrigation system.

2. To preserve the Aral Sea which requires an inflow of about 35 km^3 of water per year.

Although the two aspects of the problem are interrelated, the problem of the Aral Sea preservation is secondary compared to the general problems of the Aral Basin.

Proposals have been put forward for transfer of Caspian Sea water, transfer of part of Volga or Siberian river runoff. Apart from prohibitive costs of such diversion, this would only save the Aral Sea and would not solve the overall problems of the basin.

Proposals relating to changes in the agricultural structure and irrigation system are capable of solving these overall problems and would save enough water to preserve the Aral Sea. These changes include: retiring of salt affected land, decrease in cotton production, decrease in the area used for rice production, crop rotation, introduction of new varieties of plants, reconstruction of the irrigation system, more extraction from groundwater resources, and rational use of drainage water.

In brief, priorities in the region of the Aral Sea can be defined as follows:

a. Short-term measures - Improvement of living and health conditions of the population, providing healthy drinking water, construction of sewage systems, banning the use of pesticides, optimising the use of fertilisers, drastic improvement of medical services and providing the population with high quality foodstuffs.

b. Medium-term measures (2-10 years) - Reconstruction of irrigation systems and water saving, use of drainage water and further use of groundwater, introduction of new varieties of plants, using new technologies in irrigation and agriculture, introduction of new farm and economic management including private farming and water pricing.

c. Long-term measures (more than 10 years) - Solution of demographic problems and diversifying the economic activities in the region.

From last newsletter : The missing symbol was -

88

In this newsletter : What is the missing number?

12
13
14
15
20
22
?
110
1100

DID YOU KNOW The Earth is losing about $7 m^3 s^{-1}$ of water to outer space.

SEVERE THUNDERSTORMS IN SOUTH AUSTRALIA: 22-23 JANUARY 1991

[Reporter: Andrew Watson]
Bureau of Meteorology

Eight severe thunderstorms were identified over the two days. Associated phenomena included large hail, extreme wind gusts and intense precipitation. A tornado was sighted near Pandappa Station and it is suspected damage in two other locations was attributed to tornados.

Damage caused by the storms has been estimated by the Insurance Council of South Australia to be in excess of $26m. More than 95% of the damage value was claimed within the Adelaide metropolitan area. Nearly 8 000 damage claims have been lodged. Of these about 4 500 were for property damage, and the remainder for motor vehicles.

The worst affected areas were Roxby Downs and Andamooka in the northern interior of the State, Port Germein, Jamestown and Pandappa Station in the Flinders Ranges, Kadina, Moonta and Arthurton on northern Yorke Peninsula, and the Adelaide metropolitan area. Minor flooding occurred in Barmera, Waikerie and Minnahill.

Much of the damage in the north of the State and on Yorke Peninsula was caused by strong downbursts. In Adelaide large hail (up to 10 centimetres in diameter) was responsible for the majority of the damage. Many properties suffered water damage during heavy precipitation, particularly those already damaged by wind or hail.

The Electricity Trust of South Australia had to cut power services to several areas after lines and power poles were knocked down or damaged.

Nobody was killed but several people sustained minor injuries.

"ICE FOLLIES"

THE ADELAIDE HAILSTORM 22 JANUARY 1991 - A REMARKABLE EVENT

[Reporter: Jenny Dickins]
Bureau of Meteorology

The severe thunderstorm which hit Adelaide on 22 January 1991 was most notable for the large hail, up to 9 cm across, which smashed roof tiles, shattered car windscreens, broke windows, dented cars and killed seagulls.

The largest hail was generally spheroidal in shape and 7 to 9 cm across on the longest axis. It fell in a narrow swathe 15 km long and just 2 to 3 km wide running SSE from Sempahore Park to Morphettville. Less spectacular hail 2 to 5 cm in diameter fell over a larger area of the southern and south-eastern suburbs as well as in the Meadows and Milang areas.

Large hail like this only forms in what is possibly nature's most violent weather system - the severe thunderstorm. Thunderstorms form from cumulonimbus clouds; bubbling cauliflower type clouds towering to enormous heights (12-18 km) and capped on top by a smooth cirrus cloud shield or anvil.

The cumulonimbus cloud contains strong updrafts, which carry warm humid air from near ground level to great heights where the temperature drops to below -40°C. In a severe thunderstorm, the vertical air currents are extremely strong and persistent, with vertical speeds in excess of 150 km/h having been measured.

This is the environment in which the large hailstone forms and grows. Water droplets get carried into the upper parts of the cloud where the air is well below freezing and they become supercooled - they are below 0°C but have not turned to ice. As soon as these supercooled droplets come into contact with a solid object such as a small ice particle, an unfortunate insect caught in the updraft or an aircraft, they adhere to it and freeze almost instantaneously.

Droplets accumulate to form a small hailstone which will be a bit heavier than the surrounding water droplets and will fall with respect to them (while still being carried upward through the cloud) and will grow further as it collides with more water droplets.

The ultimate size of the hailstone depends on many factors. For really large hail the updraft must be extremely strong and enduring so that the growing stones can be held aloft in the watery part of the cloud for lengthy periods. Hail size also depends on the concentration of water droplets in the cloud and how much melting occurs on the way down. In tropical regions, thunderstorms produce hail often enough but generally it melts before reaching the ground.

One of the largest well authenticated hailstones fell on 6 July 1928 in Nebraska, USA. It was spherical with a diameter of 14 cm and weighed over 650 grams!

Hailstones often comprise several alternate layers of clear and opaque ice (like an onion). This structure develops as the growing hailstone moves through zones of different temperature and water droplet concentration within the cloud.

As the supercooled droplets freeze they release latent heat which warms the hailstone. Sometimes the hailstone warms enough so that the outside layer melts and refreezes slowly to form clear ice. Other times there is no melting; the droplets adhere and freeze virtually instantaneously, trapping air between them. This forms opaque or rime ice.

Many of the stones collected in Adelaide had a layered central core but the outer part was jagged or made up of large lobes or protuberances. This structure develops as the already large hailstone collides with smaller hailstones which partly melt and adhere to it.

Several collected stones were rough on one side but smooth and flying saucer like on the other side. This can happen if a large hailstone falls a reasonable distance without tumbling with melting on the bottom side producing the smooth part.

The last time large hail (>4 cm) fell in Adelaide was 12 November 1976 when a severe thunderstorm produced extreme winds and damaging hail in the north-eastern suburbs.

Weather Bureau records indicate that the hail of 22 January was the biggest seen in Adelaide since European settlement. It was indeed a remarkable event.

OVERHEARD : Conversation between a member of the EWS Department and one of the Department of Road Transport.

DRT - "That news article said your mains water quality is not too crash hot!"

EWS - "Yes, but it is still safer to drink a glass of our water than to travel on your roads!"

DID YOU KNOW

- Φ Evaporation consumes 22% of solar radiation intercepted by the Earth.
- Φ 10% of the globe and 60% of Australia has no outflow to the sea.
- Φ There is about twice as much water in the crust and mantle of the Earth than in the oceans.

MORE NOTES FROM THE BUREAU OF METEOROLOGY

[Reporter : C Wright]

Somehow, after the thunderstorms of late January, all the excitement seems to have missed us in South Australia. No rainfall was recorded in Adelaide for the month of February, exceptional even for us. However they did record 250 mm in 24 hours at Cordillo Downs in the far north! Taking only the last three years, there have been exceptionally heavy falls of rain, all exceeding 150 mm in 24 hours on many occasions, although mostly at remote locations. It is important to remember that meteorologically speaking those severe storms can occur just as easily in Adelaide as in the more remote locations where they were recorded. In 1889 Adelaide received exceptionally heavy rains, Crafers recorded more than 200 mm in 24 hours. Such events will occur again in and around our city.

The very wet conditions in Western Queensland and the Northern Territory have led to flooding in the Cooper and Diamantina Rivers. The volume of the Cooper flood is quite small, much smaller than last years, however the Diamantina flood is large and is expected to make a major contribution to Lake Eyre, perhaps as much as 30% of its volume. The Bureau of Meteorology receives regular satellite pictures of the flooded creek systems. At the time of writing the main front of the flood has passed through Goyders Lagoon and just reached the point where the Diamantina splits into the Warburton and Kallakoopah Creeks.

Claus Schonfeldt was interested to know whether the exceptionally wet conditions that have occurred in the Flinders Ranges and the Leigh Creek area since 1989 are part of a wet cycle, and if so how long will it go on. No one in the Bureau that I spoke to was prepared to speculate. Long term regional weather predictions, produced by the Bureau, which are based on variations in the Southern Oscillation Index (El Nino), are heavily qualified for the area in question.

However a study carried out in 1986 for ETSA by Kinhill/Australian Groundwater Consultants, included a data review of the last 100 years of rainfall records at Beltana. This indicated quite distinct periods of wet and dry seasons with a periodicity of 11 to 15 years, and, at the time of the study, it was predicted that the long series of low rainfall and low flows into Aroona Dam would come to an end. This in fact happened and the dam has spilled on several occasions since then. On this basis it is likely that the last few years have been part of a wet cycle which is probably nearing its end, and we might expect low average rainfalls to occur over the next half dozen years.

The second of 3 pluviometers for the Gammon Ranges Scientific Project was installed in September 1990. The first 3 months of data has been recovered from it, and it indicates that over this period the Gammon Plateau received approximately 50% more rainfall than the adjacent plains area.

Editors Note: We look forward to reporting of the analysis the first two years data from the Gammon pluviometers.

DID YOU KNOW

- Under the conditions that exist today, a bowl of water placed on the surface of Mars would vaporise so quickly it would literally explode.
- Neptune probably has a superheated water ocean some 8000 km deep.
- Tethys, a moon of Saturn, has a radius of 1050 km and consists of pure water ice.
- The total amount of water in human beings is estimated as 700 m^3 and would suffice for only a 1 mm layer over the surface of the Earth.
- 1 gm of AgI_2 provides 2.5 * 10^{15} water condensation nuclei for cloud seeding.

LAST PAGE NEWS

PROGRAM OF HYDSOC MEETINGS

FOR 1991

Feb 14	Water quality of the South East
Apr 18	Probable maximum precipitation
Jun 13	Debate : - Sustainable development ... fact or fiction?
Aug 1	AGM : The Gammons project
Oct 10	Land and water pollution
Dec 5	Murray Darling Basin nutrient management strategy

SEMINAR

Jul 19	Stormwater management

Contributions to the Hydsoc newsletter are welcome and should be forwarded to Claus Schonfeldt

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or by facsimilie to (08) 226 2161

Facts for the Did You Know snippets were provided by Vincent Kotwicki and were researched for his article on Water In The Universe soon to be published in the Journal Of Hydrological Sciences.

CSIRO SEMINAR PROGRAM

FOR 1991

Feb 28	Groundwater Contamination Prof W Kinzelbach
Apr 11	Woolpunda S Barnett, A Herzeg, A Telfer & G Walker State Convention Centre : 10.30
Apr 18	Karst Recharge F Leaney & A Herzeg Flinders Uni. Science Room 103 3.30 pm
Apr 24	Mapping the spatial variability of groundwater recharge P Cook
and	Recent sedimentology of the Lower River Murray system S Barnett Flinders Uni. Science Room 103 3.00 pm
May 2	Modelling microbiological cleanup of contaminated groundwater M Duthy
and	Hydrogeology and hydrochemistry of the Otway basin A Love CSIRO Soils Seminar Rooom 3.00 pm
May 16	Chowilla flood plain study I Jolly, J Hacker & G Walker Flinders Uni. Science Room 103 3.30 pm
Jun 13	Impact of pastoral land use on groundwater quality N Pakrou CSIRO Soil Seminar Room 3.00 pm
Jun 27	Dryland salinity : A comparative study of processes and options J Schuring
and	Isoptope chemistry of acid-saline groundwater in the Dutton River area R Leonard Flinders Uni Science Room 103 3.00 pm