PART II

OTHER IDEAS

Take the salt out of saltwater

A number of Australians have called the Farmhand Foundation to suggest that desalination, a water treatment process that removes salt from water, is a viable option for harnessing more water when we are a country surrounded by seawater. Dr Ron Smith from Kempsey wrote to the Farmhand *Fencepost* to highlight that desalination should be considered for securing supplementary usable water, though other aspects of water management, such as water tanks, wastewater reuse, reduction of personal use of water and more efficient use of irrigation water must be given current priority.

Desalination essentially separates saline water into two streams: one with a low concentration of dissolved salts (the fresh water stream) and the other containing the remaining dissolved salts (the concentrate or brine stream). The device requires energy to operate and can use a number of different technologies in the separation process.

The world's first land-based desalination plant was installed in the Netherlands Antilles, in 1928. Desalination was used during World War II and the US government funded research after the war through the Office of Saline Water. Its use has gradually grown since then. (Buros, 2000)

More than 60% of the desalination plants in operation worldwide are located in the Middle East, with Saudi Arabia having the largest installed capacity (WAWC, 2000).

There are three methods of desalination: either involving changing the state of water (distillation or freezing), using membranes (reverse osmosis or electrodialysis) or acting on the chemical bonds (ion exchange) (URS, 2002). While over 60% of the world's desalted water is produced using already installed distillation plants (Buros, 2000), more and more new plants are being contracted using reverse osmosis technology (URS 2002).

The largest desalination plant in Australia is at Bayswater Power Station in NSW, which has a 35ML/day reverse osmosis plant installed. This is the world's largest zero-discharge power station water system. (WAWC, 2000)

figure 54 - Solar desalinisation plant
(Solar Energy Systems, 2003)

On Kangaroo Island, a few hours south of Adelaide, the town of Penneshaw supplements their water with a reverse osmosis desalination plant. Historically, Penneshaw residents were supplied from farm dams, but these have become too unreliable and polluted. The desalination plant draws water straight from the ocean and treats 250kL of seawater daily, producing about 100kL of freshwater. The plant cost $3.5 million to build in 1999 and was significantly cheaper than piping mains water from 60km away. (SA Water, 2003 & URS, 2002)

Issues

The exact location and arrangement of a desalination plant will, to a large degree, determine the relevant environmental issues. However, all desalination plants use considerable energy, which could have greenhouse or climate change and air pollution issues associated with it depending on the type of energy

figure 55 - Fresh water made from sea water. The South Australian Water desalinisation plant at Penneshaw, Kangaroo Island (News Ltd)

that is used. Energy requirements for desalination plants depend on the salinity and temperature of the feedwater, the quality of the water produced, and the desalination technology used (WAWC, 2000). Marginal or brackish water require much less processing (and therefore less energy) than seawater.

Research at the Centre for Renewable Energy and Sustainable Technologies Australia at Curtin University has shown that a reverse osmosis desalination system powered by solar power can work (Al-Alawi and Lawrance, 2001).

Marine resources in the vicinity of a desalination plant can be affected by the waste discharge and the way the feedwater is extracted. The range of potential impacts is related to the siting of the plant and pipework and could include disturbance of dune, surf zone and seafloor ecology, disturbance of sea birds and animals and their habitats, disturbance to archaeological resources, erosion and interference with public access and recreation. (WAWC, 2000)

A national review of the economic and technical issues associated with desalination technologies in Australia concluded that there are only limited scenarios in which desalination represented a cost-effective option as a source of fresh water. Desalination would be cost-effective where water is scarce or very costly. (URS, 2002)

Desalination technologies are currently employed to treat water for both industrial and domestic uses.

The costs of desalination varies depending on the feedwater quality, the cost of pumping the water to and from the plant and the cost of electricity. In 2000, the Western Australian Water Corporation estimated that with current technology, the costs for seawater desalination for drinking water varies between about $0.80 per kilolitre and $2.10 per kilolitre (WAWC, 2000). Based on data provided by a study completed in September 2002 and commissioned by the Commonwealth Department of Agriculture, Fisheries and Forestry, the average cost for desalination would be $2.20 per kilolitre or $2,200 per megalitre (URS, 2002 & HWA, 2003).

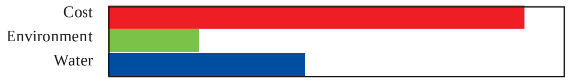
These costs are at the plant before the water is pumped into the water supply systems. There would be extra costs in reconfiguring many of our current water systems in our coastal cities.

It should be noted however, that the cost of desalination plants is reducing and the scarcity and price of water is increasing (as are energy costs), so desalination may have more widespread application in the future.

A final comment...

While desalination uses a lot of energy, it may be cost-effective for drinking water where good quality water is scarce or costly. It is unlikely to be appropriate for irrigation uses due to cost, but could be used as a back-up for domestic use in times of extreme drought.

Build an evaporation channel



Australian inventor Max Whisson has recently proposed that we could build evaporation channels to capture freshwater. The idea first hit the spotlight in the *Weekend Australian* in November 2002, where Max claimed we could be growing tomatoes in the Simpson Desert by next year. (Adams, 2002)

The basic concept of the evaporation channel is like a greenhouse; using the sun's energy to convert salt water into fresh. Aptly named 'MAXWATER', Max's main idea is that seawater is moved inland through ducts 20 metres wide under a transparent cover and the saltwater evaporates. To alleviate the accumulation of salt in the bottom of the channel, Max proposes that the channel does a U-turn and heads back towards the sea where the concentrated water can be disposed of. Water vapour condenses in a thin metal-walled condenser ducts and is distributed to storage tanks and then to areas of need. (Whisson, 2003)

Max acknowledges that it is best to start off small-scale, suggesting that the evaporation channel could be initially 100km long on the round trip with more extensive systems to follow "until the Australian inland has abundant water year in, year out." (Adams, 2002)

Solar Stills

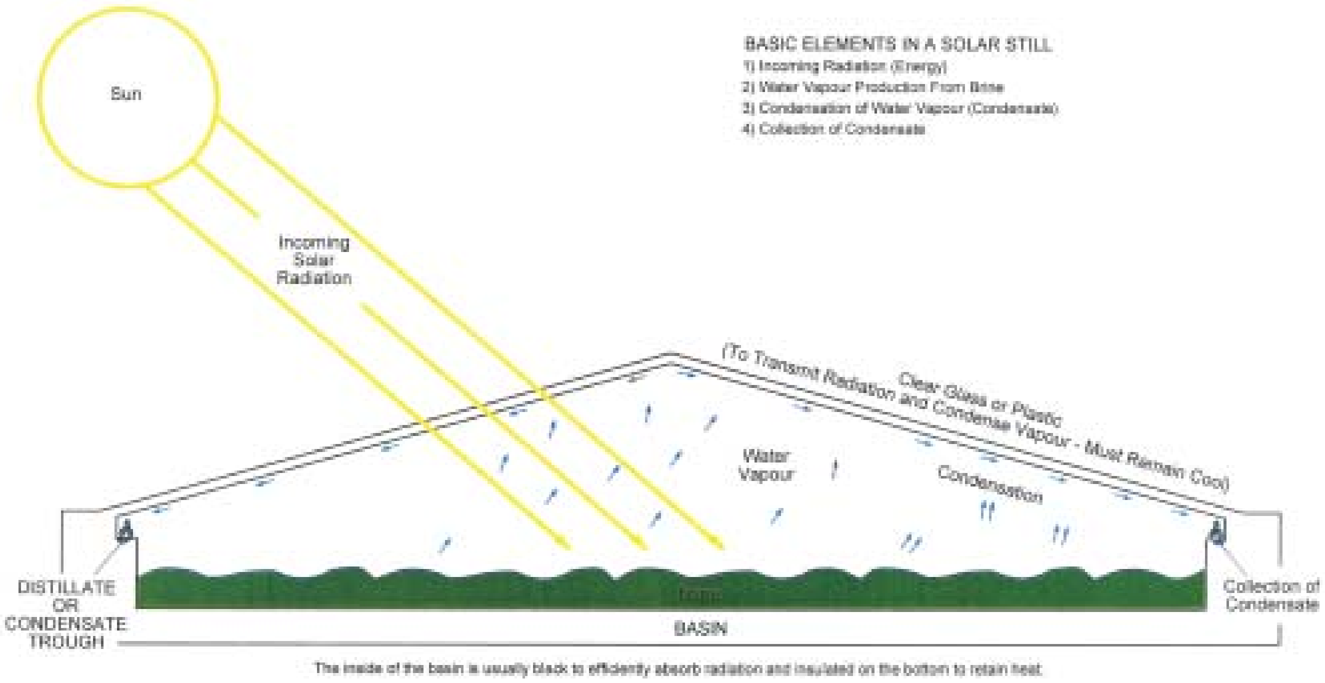
The use of direct solar energy for desalination of water has been investigated and used for some time. 'Solar Stills' operate like a greenhouse - saline water is heated in a basin on the floor, and the water vapour condenses on the sloping glass roof that covers the basin (see figure 56).

During World War II, small solar stills were used on life rafts. This work continued after the war, with a variety of devices being made and tested. Difficulties such as high capital costs, vulnerability to weather-related damage, and the large solar collection area required, have restricted the use of this technique.

Generally, a solar collection area of one square metre is needed to produce four litres of water per day. So for a 4ML/day facility, a land area of about 100 hectares would be needed. (WAWC, 2000)

Any system of producing freshwater needs to be transported to the high point of the coast if it is to reach inland Australia. For Western Australia, where the concept was conceived, this would mean elevating it approximately half a kilometre uphill. According to Max, the main ways that water is moved in the system are tidal power, wind power and the upward flow of air by convection. Other power sources such as photovoltaic electricity generation are proposed where appropriate. (Whisson, 2003)

figure 56 - A solar still (WAWC)



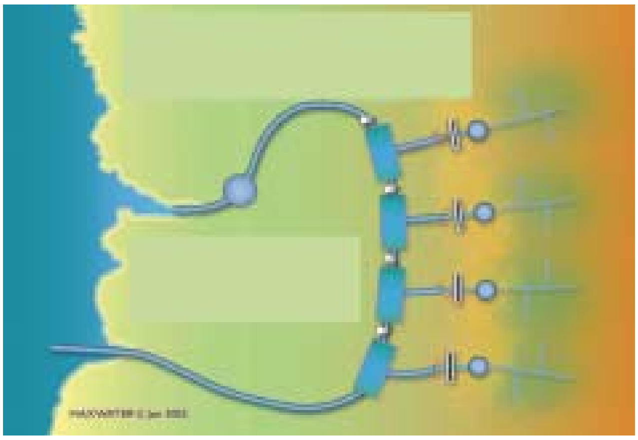


figure 57 - Aerial shot of the proposed Maxwater evaporation channel (Courtesy of Max Whisson)

One such system designed by Max that transports water to a high point can be seen in figure 57. This suggested arrangement uses a tidal seawater intake and hot water vapour collecting ducts leading to hill-top wind-driven compressors to drive the evaporated water up the hill. Cooling ducts expand into compressor chambers signified by the circles. Lower overnight temperatures assist condensation. (Whisson, 2003)

Max acknowledges that each system would be adapted to suit local conditions. Practically, the idea of solar powered desalination could be used on a much smaller scale in our cities and towns. Stormwater channels, carrying water to the ocean, could be covered in places with greenhouses, producing a city source of vegetables without additional water.

Issues

The size of the proposed channel determines the extent of environmental issues. The physical 'foot-print' for this proposal could be significant and could involve land clearing and disruption to wildlife. For a channel 20km wide and 100km long, the surface area footprint would be equivalent to 200 football fields.

Changes to coastal landscape and adjacent inland areas from large-scale channels, pipes, storage of water and associated equipment for power and transport would cause visual impacts that may prove unfavourable for a population who enjoy the beauty of beaches.

The concentrated salt water flushed out of the system may have negative effects on marine and estuary life. Max, having foreseen this potential problem, has proposed a mineral processing plant that could extract the calcium, selenium and metals such as gold from the salt. This plant would either need to be at the point where the channel meets the ocean, or be pumped to a treatment plant nearby.

The transparent cover would presumably suffer from algae problems. An elaborate cleaning system would be required. These maintenance costs could be large. It is unknown whether the proposed power sources of tidal or wind would be sufficient to elevate the condensed water to the high point. If the system is large, it may require pumping which has large energy implications.

Evaporation rates over the majority of Australia are greater than received rainfall (BOM, 2003). Max estimates the amount of water able to be produced, taking a wide variety of day/night temperature and wind conditions into account, would be 400 kilolitres per kilometre per day (Whisson, 2003). This would be the equivalent of the water needs of two average homes per kilometre for a year (HWA, 2003).

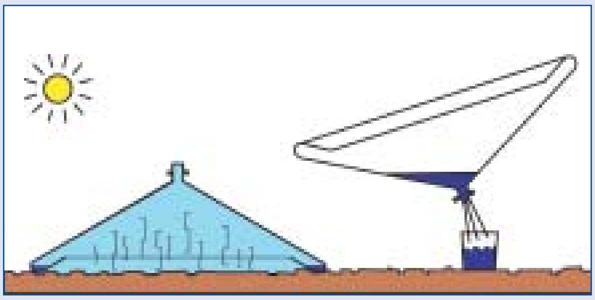
Max's channel would cost about $1.5 billion, depending on the size and the routes taken. The cost of the water would be $42,000 per megalitre. (HWA, 2003)

A final comment...

An evaporation channel would mean big costs for a small amount of water produced. However the concept of harnessing evaporated water from sea water may have small-scale applications.

The Watercone

A German company has an award-winning product that converts salty water to freshwater using the sun's energy. Called the 'watercone', it is a cone made of transparent polycarbonate with a screw cap spout at the operating tip and an inward circular collecting trough at the base. It can produce about one and a half litres of water in a day (Zeltec, 2003).



Make water from air

“The air you breathe is also the air you drink”, according to Mr Hishan who is drinking a glass of water from the ‘Waterfinder’, a machine that produces ‘water from air’. Mr Hishan is the founder of Excel Holdings Inc, one of a handful of US companies who are now marketing and selling such technology, which aims to replace the ubiquitous filtered water dispenser in homes and workplaces. Currently for sale is a small machine for personal use which can produce up to 22 litres of drinking water per day, or an industrial size machine (called the ‘aquasphere’) which can produce up to 45,000 litres per day. (Razali, 2003)

Water molecules are a necessary presence in the air we breathe, playing an active role in much of air’s chemistry. The concept of harnessing the naturally occurring water from air relies on a refrigeration system that extracts the moisture from the air. This works in much the same way as our air-conditioners, which remove moisture before releasing refrigerated air (which is why you often see air-conditioners dripping water on the outside of the building). By condensing and precipitating water particles in air and then passing the water through a filtration system, drinking water can be produced. The efficiency of this process is dependant on the humidity and temperature of the air.

Wally Royal from the Nelson Bay region in NSW alerted Alan Jones to his own homegrown ‘water from air’ innovation. Wally has invented a solar-powered machine about the same size as an office water dispenser, which produces 24 litres of water a day in humid conditions. Currently Australians use 294 litres of water per person per day (ABS, 2000). According to Wally, this technology would be perfect for “mining camps, fishing fleets, outback businesses and homes where water has to be trucked in”. Wally says that the government of Singapore has expressed interest in the technology while Cambodia is potentially ordering 2 million units to sit on the rooftops of homes. The solar-powered unit will sell for approximately $600. More recently, Wally has proposed an industrial sized machine for Australian towns. About the size of a 40-foot container, these machines, powered by diesel, would produce 50,000 litres a day with Wally estimating the cost of 4.7 cents per litre (or $47 per kilolitre). “It’s rainfall-made technologically”, says Wally. (Royal, 2003)

figure 58 - Water from air machine
(courtesy of H_2O Liquid Air Inc., 2003)

A variation on the theory of deliberately producing water from air is the idea of using the water that is produced from our already operating air-conditioners. This water could be used to water the garden, wash the car, run to a water storage tank or top up a pond or pool (ACDA, 2002).

Issues

Generating water from air requires electricity, gas or diesel to power the technology. As yet no studies have calculated how much power it would take to produce. If every water filter dispenser was replaced with a ‘water from air’ machine, the additional requirements to the energy system are likely to be significant. Similarly, adoption of a large-scale ‘water from air’ technology, which works on the same principles as air-conditioners, would be vastly energy intensive.

Air-conditioning units are one of the biggest energy users in the home and workplace. Generating water from air is likely to have similar energy needs and therefore impacts on peak summer loads on the electricity system.

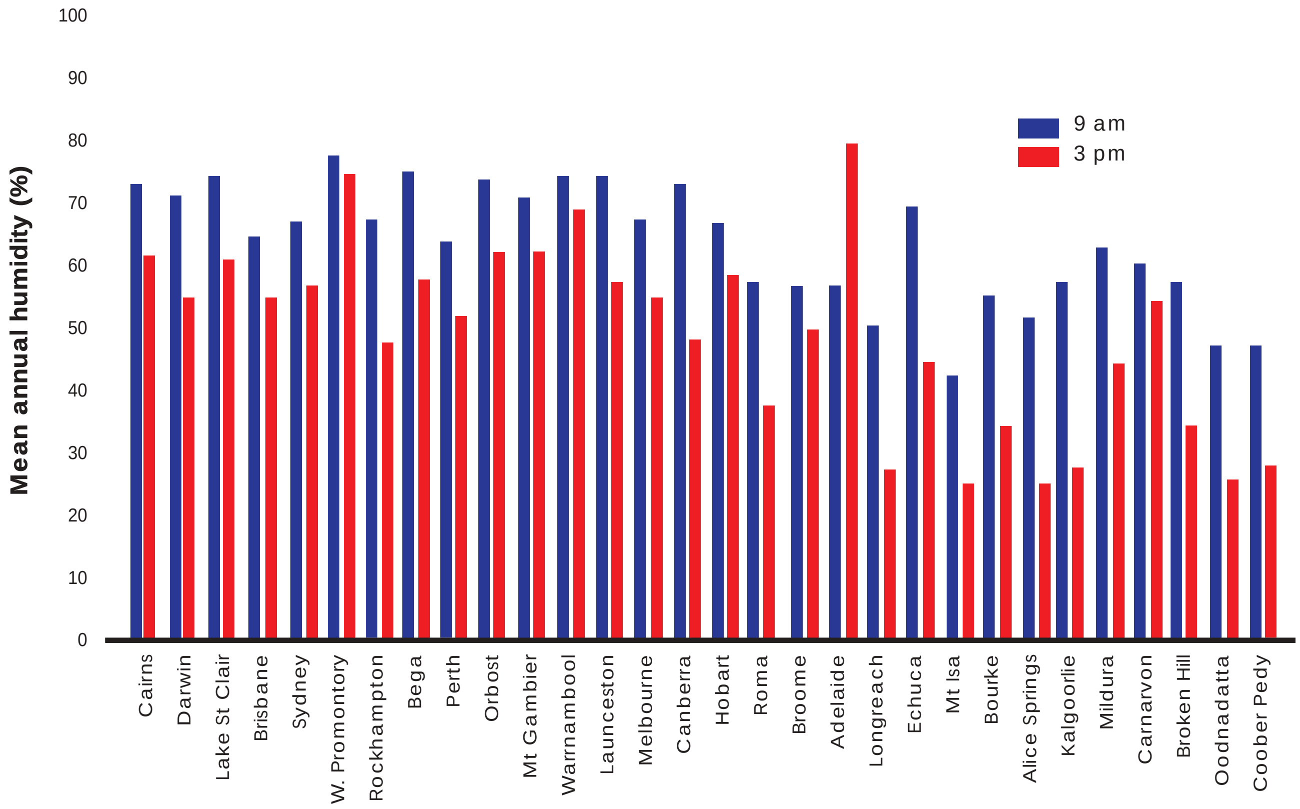


figure 59 - Annual humidity around Australia (Bureau of Meteorology, 2003)

The more humid the air the more efficient the process of extracting water from air becomes. Humidity can be variable throughout the year and during different times of the day, and is usually highest at night and early morning and lowest in the afternoon (LASD, 2003).

Generating water from air relies on high and stable humidity. Around Australia humidity rates vary considerably between location and time of day. In many dry inland areas such as Mt Isa, Bourke, Alice Springs and Kalgoorlie, humidity doesn't reach 60%, which is required for viable water generation.

The variability of humidity throughout the day and the year means that the amount of water produced from air would be highly variable and the energy costs associated with the process would also be variable. Dry parts of Australia would not be suitable for this process of water generation to be used.

No studies were found on the quality of drinking water produced from air from household or office environments. It would be prudent to do such studies before introducing these devices on a large scale, due to the possibility of airborne disease.

Collecting water from household air conditioning systems for use outside would be an efficient use of the by-product which otherwise is wasted. This is provided the air conditioners are being used as the normal cooling function for the house, and are not being used to generate water. Currently water is collected in buckets or large open containers located near the household air conditioner.

It has been estimated that a personal 'water from air' unit can produce 22 litres of drinking water a day at a temperature of 21.1°C and 60% relative humidity, with 7.6 litres produced if the humidity is 30%. An industrial unit has been touted as producing 45,000L of water a day. (Razali, 2003)

Based on calculations from Singapore for a single 'water from air' unit, the unit would cost about $1,200 to purchase and produce water for about 9.5 cents per litre, or $95 per kilolitre. The various filters for the unit would cost about $120 per year. (Teik, 2003)

Collecting water from already operating air-conditioning units would be between 1 litre an hour for a small system, and 6 litres an hour for a large system. (ACDA, 2002)

A final comment...

Generating water from air is extremely costly, though it may have isolated applications when no other choices are available.

Tow an iceberg

An iceberg is a floating mass of freshwater ice that has broken from the seaward end of a glacier or a polar ice sheet. One of the largest icebergs known was one that broke off from the Ross ice shelf in the Antarctic, with an area of 6350 square kms.
The iceberg that sunk the Titanic has been estimated at 15 to 30 metres high and 60 to 120 metres long.

Since two-thirds of the world's freshwater is found in icebergs and glaciers, it has long been suggested that Australia could meet its increasing demand for water by towing icebergs from Antarctica to the mainland for input into urban supplies.

Ken Truswell from Picton on the NSW south coast wrote to Alan Jones suggesting a unique way of harnessing water from icebergs. According to Mr Truswell, the icebergs could be anchored to the seabed once captured, then covered with a curtain-like material. As it melts, the freshwater will rise and fill the material, forming an 'inflatable harbour' which can then be towed to its destination and pumped to shore.

The size of the global iceberg resource is estimated to be sufficient to supply the whole of the world's water needs for urban and industrial use. More than 90% of the world's mass of icebergs (including most of the large icebergs) is found in Antarctic waters. As yet, no country has attempted to capture water from icebergs at either poles for urban water use.

One scenario for such an operation has been suggested by Professor Quilty, chief scientist with the Antarctic Division of the Department of the Environment, Sport and the Territories. He has nominated an example of a suitable iceberg of about 32 million tonnes, approximately 400 metres by 600 metres, with a depth under water of 150 metres. (Quilty, 2001)

As icebergs are introduced to warmer waters they will begin melting and most of the water (50% to 80%) will be lost (Sobinger, 1985 cited in Quilty, 2001). Professor Quilty, suggests a concept of wrapping the iceberg in plastic until it reaches its destination (Quilty, 2001). Of the plastic wrapping process, Quilty explains, "With all that surface area, it was only about 40 times the area of the MCG (Melbourne Cricket Ground), and so if they can cover the MCG fairly quickly in case of rain, I suspect a couple of decent trawler operators could lead this lot under an iceberg and start the wrapping process fairly readily." (ABC, 1997)

The icebergs would drift somewhat on currents and be pulled by large vessels towards their destination

where they would then need offshore melting, treatment and piping infrastructure to feed into the urban water supply.

According to Quilty, before Australia uses Antarctic icebergs as a water source, there needs to be much rationalisation of our own water usage and distribution (Quilty, 2001).

Peter Schwerdtfeger, a scientist who completed a report on the possibility of icebergs as sources of water concluded that "the possibility of utilising icebergs in regions outside of their natural range of occurrence generates an abundance of physical, environmental, technological, economic, sociological, legal and political questions" (Schwerdtfeger, 1985).

Issues

The Antarctic is the last great wilderness or frontier, largely unexplored by humans. The utilisation of icebergs raises a number of environmental and feasibility issues.

Wildlife is abundant and reactive to disturbance in the Antarctic region. Artificial movement of icebergs has been known to seriously interrupt breeding colonies of species such as penguins. Increased shipping movements in the area bring with them an increased chance of oil spills.

Based on the predicted losses due to melting as the icebergs reach warmer water (50% to 80%), only icebergs in the 300 million to 350 million tonne range could be considered to be economically viable. Such weights would require tugs with a towing capacity well beyond that of any existing vessel (Hanley, 2002). Any towing scheme would utilise significant amounts of energy.

A report from the 1970s noted that it would take 128 days to tow an iceberg from Antarctica to the Middle East - 24 days longer than it would take for the iceberg to melt (Curtis 2002).

In 1978 Dick Smith played an April Fools Day joke on Sydney by towing a fake iceberg made out of white plastic and shaving cream into Sydney Harbour. Smith, founder of Dick Smith Electronics, used it primarily as a publicity stunt. The stunt made headlines world-wide. Dick Smith has said that the idea started off as a genuine idea when a newspaper reported that an overseas company was seriously considering a feasibility study into towing an iceberg from Antarctica to Saudi Arabia. (Huxley, 2003 and Bain, 2002)

If the icebergs were to be wrapped in plastic, this would constitute major production of specialised plastic from petroleum. The wear and tear of such a covering on the long journey to the mainland, or during the covering process would make it likely that some plastic would break away into the ocean. Many animals such as whales and fish mistake plastic for floating jellyfish, eat them and perish. Plastic that sinks to the sea floor is known to suffocate and kill sea grasses.

An iceberg often has up to 90% of its mass underwater at great depth. The environmental effects of icebergs running aground are well documented. Scientists from the British Antarctic Survey have discovered that over 99.5% of all visible sea-bed dwellers are massacred when the icebergs collide with the ocean bottom. (BBC, 1999)

The depth of the iceberg would also prevent it from being towed close to land. The closest an iceberg could come would be the continental shelf, 50 km off shore (Schonfeldt, 1999). Large infrastructure would therefore be required out at sea to provide piping, treatment and storage space at great expense and energy. If the iceberg were to be brought close to land, dredging of coastal waters would be required to increase the depth which has associated effects of loss of habitat for wildlife and interruption of coastal ecosystems such as estuaries and seagrass beds, of contaminants, release of nutrients, increased toxicants, noise and air emission and visual impact.

The amount of water generated would depend on the size of the operation and the degree of melting. If the iceberg of study was delivered to the urban supply without any melting, it would provide 32 GL, or 10% of Perth's annual water usage. Antarctica yields about 1,250km^3 in the form of icebergs each year, about three to four times Australia's annual renewable water supply. (Quilty, 2001)

A study by the South Australian Government in 1989 estimated that an operational scheme would cost about $1.8 billion (SA Govt, 1989). Allowing for inflation since then, the cost of water from icebergs would be about $3.20 per kilolitre or $3,200 per megalitre.

A final comment...

The fallback of being able to tow icebergs to Australia for urban water use will be the subject of further investigation in times of extreme drought, but the high costs and environmental problems do not make it likely in the future.

Carpark the catchment

"They paved paradise
And put up a parking lot"
Joni Mitchell, (1970), Big Yellow Taxi
from Ladies of the Canyon.

The quantity and quality of water produced by a catchment is dependant on the physical characteristics of the catchment. It has been suggested that our water catchments could be sealed, like a carpark, to capture more water.

In a natural catchment, rainfall either becomes surface water runoff to replenish streams and rivers, soaks into the ground, or is returned to the atmosphere through evapotranspiration. Water stored in the soil will either recharge into the groundwater and may eventually enter streams and rivers or be available after the rain for uptake by plants.

In a natural catchment, the roots of plants and trees, the borings of worms and other animals and other natural cracks and cavities helps the water to soak into the soil. On the ground, a layer of leaves and twigs breaks the fall of the rain and keeps the soil openings clear.

A catchment covered solely by bitumen could potentially provide additional water by eliminating that portion of rainfall that is taken up by plants and trees or is released back to the atmosphere through transpiration. It could be argued though that there would be additional evaporation as there would be much less shading than in a forested catchment.

Issues

As much of Australia's lower catchments are flatter landscapes, most of these areas have been turned into farming, grazing or residential areas, with little remnant native vegetation remaining.

Sealing catchments with bitumen would only be able to occur in the upper areas of the catchment ('the headwaters'). These are mostly mountainous, forested areas, often National Parks or nature reserves. Environmental, social and energy issues are enormous when considering this option.

Creating more surface water comes at the expense of groundwater. This water emerges from the ground at springs to form creeks, enabling the watercourse to keep running even in dry weather. (Museum of Victoria, 2002)

Reducing the amount of rain that soaks into the ground would reduce the flow in our rivers and streams after the rainfall has ceased. Often this is when we need it most.

Sealing catchments with bitumen would eliminate these areas as habitat for flora and fauna and be a permanent scar on the landscape.

figure 60 - A typical suburban carpark (News Ltd)

figure 61 - A forested catchment, flowing into Maroondah Dam which provides water to Melbourne (News Ltd)

It has been suggested that the value of buying major catchments and operating them solely as water supply catchments would far outweigh the value of other activities in the catchment. Natural catchments supply clean water, which does not require treatment. Activities such as farming in water catchments means water needs to be extensively treated to remove sediment and pollutants. Worldwide, cities such as New York are buying out their catchments from other activities to operate them solely for water generation. The protected forested catchments of the Brindabella Ranges in the ACT were excised from NSW in 1909 for the principal purpose of a reliable water supply for Canberra (Weirick, 2003).

In 1994, a study of the Thomson catchment, the largest source of Melbourne's water, showed that the value of clean water outweighs the current timber in the forest. Logging rotations of 20 years would decrease the value of the catchment by $525 million and require building a $250 million water treatment works (PMSEIC, 2002).

Flash floods would become more common in a bitumen-sealed catchment.

Protecting our catchments for water quality also has the effect of protecting environmental values of catchments, such as stream environments and forest biodiversity. Socially, recreation and nature-based tourism are highly valued. The carbon dioxide emitted for clearing native vegetation for bitumen sealing or grassing of catchments would be a significant contributor to climate change.

The amount of water that bitumen-sealing a catchment could produce depends on the amount of rain, the size of the catchment and characteristics such as slope. However given Australia's highly variable rainfall patterns, the times we need a steady source of water is in dry spells, which is reliant on a good amount of water stored in the soil and recharging our groundwater and river systems.

Bitumen sealing catchments would require considerable upfront costs plus ongoing maintenance. Retaining the catchment in its natural state is inexpensive. Any economic benefit would be more than offset by the additional costs needed to treat the water for consumers, and the loss of income from the nature-based tourism industry.

The Maroondah water supply catchment, 60 kilometres north-east from Melbourne, has an area of 163km^2. This catchment is currently forested and managed for its water quantity and quality. (Vertessy et al, 1998)

It has been estimated that the cost to carpark the Maroondah catchment would be just over $19 billion and would yield addition water at a cost of $16,700 per megalitre (HWA, 2003).

A final comment...

Turning forested catchments into carparks is very costly, eliminates the natural environment and would create major scars on our mountainous regions.