

## VARIATIONS IN GROUNDWATER SALINITY

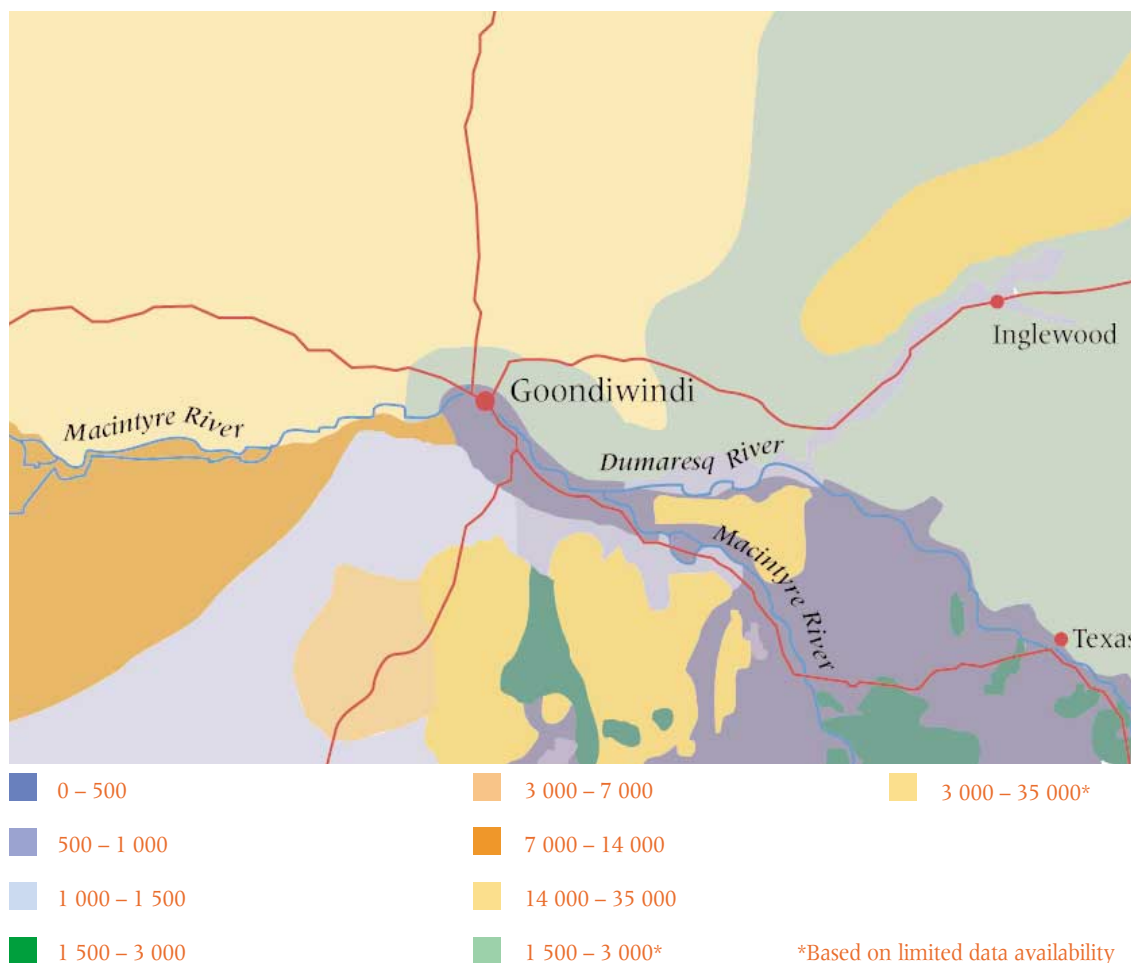


Figure 13: Variations in groundwater salinity levels. As this illustration from the Border Rivers area of Queensland and New South Wales shows, the problem of variations in groundwater salinity levels over short distances is not confined to the Murray Basin. Source: Evans et al. 1994.

### iv. Groundwater the under-utilised resource

Given the nature of the issues outlined in the above sections, it is hardly surprising that much of the research on the MDB's groundwater has focussed on the problems and their potential solutions. But the research is also having other outcomes; this includes providing much more information about the availability of groundwater. It is increasingly clear that the groundwater potential of many parts of the MDB is considerable and groundwater is an under-utilised resource. In the Murray Basin aquifers, the recoverable reserves of groundwater are now known to be much greater than was earlier believed, with current use in most areas only a very small percentage of the sustainable yield (Table 2). There are a number of reasons for this, including a lack of incentive for the development of existing allocations, the availability of surface water, high start-up capital costs for the use of groundwater, and the highly variable water quality, often over short distances (quite apart from the sodicity problems

indicated earlier) (Figure 13). Of the shallow groundwaters, the best quality water is found around the Basin's margins, especially in the east and south-east and the south-west, in the South Australian Mallee. In other areas, especially adjacent to the course of the River Murray downstream of its confluence with the Murrumbidgee, the groundwaters are highly saline. Where the quality is good, the potential for conjunctive use of groundwater and surface water is high in parts of the Murray Basin, as in the Darling River Basin.

Good quality groundwater represents a major economic resource, for use on its own and conjunctively with surface water, as was illustrated earlier. It can also be argued that the existence of a number of subsidies lowering the cost of surface water in many areas has resulted in under-utilisation of groundwater as a water supply. In many cases, if the full cost of surface water was charged, groundwater would be a more attractive alternative to surface water. This resource will still need to be managed wisely to ensure that over extraction and pollution do not compromise it in the longer term.

# The changing picture

The changes that have been made to the land use of the Murray-Darling Basin over the past 150 years have caused massive disruption of the region's groundwater systems and contributed to major land and water degradation problems.

If the major problems are to be tackled and if the groundwaters are to provide a sustainable source of water for the long-term, then much more needs to be known about them, in terms of the qualities and quantities of water stored in the aquifers, the ways in which water moves through the aquifers, and the rates at which they are recharged (Table 3). Only when such information is known can sustainable yields and extraction intensity limits be determined for each system, to ensure that extraction does not exceed recharge. It is only by understanding the groundwater processes, both local and regional, that effective management plans can be formulated to ensure the sustainability of the resources and to combat the spread of salinity and other related resource degradation problems in the MDB. To protect the continuing quality of groundwater systems, effective land use zoning and bore management will need to be implemented. At the same time, it has to be recognised that salinity is essentially a groundwater problem.

A further point has been highlighted by recent research.

There is now much greater awareness of the links between groundwater, surface water and other natural resources that make up the MDB's many catchment ecosystems, both terrestrial and aquatic. Land and water management practice needs to ensure that there is no loss of biodiversity. One part should not, and cannot, be considered to the exclusion of others. For example, it has already been pointed out that an increasing proportion of the flow in many of the MDB's rivers is base flow. Thus, for management purposes, surface and groundwater must be regarded as one, as an inter-related whole. As indicated earlier, this should be the objective of conjunctive use and management. A good example is the approach being developed in the Condamine Valley.

Gradually, increased attention is being given to groundwater resources, in both qualitative and quantitative terms. Quality issues are being examined in a number of projects being undertaken by the Australian Geological Survey Organisation, the Bureau of Rural Sciences, the CSIRO, and State government and other agencies. Among the pollutants being studied are pesticides, herbicides, nitrates, and faecal indicator bacteria. These are particular problems in areas of more intensive farming with the greater use of agricultural chemicals. Quite apart from the impact on the quantities of groundwater available, overuse can also contribute to quality problems. In some locations, excessive long-term lowering of water levels can cause contamination of productive aquifers with saline groundwater.

In many parts of the MDB, groundwater management plans are being developed to address the many issues that have been identified at the regional level. This is a recognition of the fact that the management issues are different in different parts of the MDB and that there are often significant differences over short distances.

*Table 3: Importance of Management Issues for Groundwater in Different Regions of the Murray-Darling Basin*

Issues	Uplands	Murray Riverine Plain	Murray Mallee	Northern Riverine Plain	Coastal Plain	Semi-arid Rangelands
Minimise saline groundwater flow to rivers	N	H-M	H	L	N	L
Sustainable groundwater irrigation development	L	H	H	H	M	L
Management of existing groundwater irrigation areas	N	H	H	L	H	N
Minimise the impact of dryland salinity	H	M	M-L	M	H	L
Conjunctive use	N	H	N	H	N	L
Groundwater quality protection	M	H	M	H	M	L
Irrigation land salinisation	N	H	M	L	L	N

H: high importance; M: medium importance; L: low importance; N: nil importance. Source GWG 1996b, 8.

# A national resource for the future

It is clear that groundwater is of fundamental importance in Australia, yet it still does not have the place that it should in the management of Australia's natural resources.

**G**roundwater resources are being utilised in many areas. However, only 15 per cent of the estimated total sustainable yield of some 26 million ML a year is being used. It is estimated that groundwater accounts for some 18 to 20 per cent of all water used in Australia and approximately 12 per cent of irrigation water. In the inland arid and semi-arid regions, the figure rises to 50 to 100 per cent. Approximately 700,000 people are fully dependent on groundwater for their water supplies and a further 2 million are partially dependent. With limited surface water resources, Australia will become increasingly dependent on groundwater. Restrictions on the use of surface water and increases in its cost will, other things being equal, make groundwater much more attractive to many users. There can be no doubt that groundwater is a major resource.

The challenges for groundwater management are many, not least the inter-relationships between groundwater and surface water. There are clearly long term effects of groundwater usage on surface water availability (and vice versa), on natural ecosystems, and on the availability of water resources for future generations.

In the northern parts of the Murray-Darling Basin, much work is needed to understand and quantify the relationship between recharge from the surface water systems to the alluvial fan aquifers, and leakage from these into the GAB aquifers immediately below. If, as appears to be the case, the groundwater resources of many of these areas have been fully allocated, careful management is needed. This is especially so now when increasing restrictions have been placed on the use of surface water thereby causing increased attention to be given to groundwater alternatives. In the southern parts of the Basin, groundwater usage can also play a positive role by reducing rising groundwater levels, but this has to be carefully managed.

In keeping with the COAG water reform agenda, the achievement of efficient sustainable yields for aquifers, with allocations limited to the sustainable yield where appropriate, has been identified as a key policy objective by the Agriculture and Resource Management Council of Australia and New Zealand. Another objective is the improved integration of surface water and groundwater management. There must also be a clear focus on minimising salinity problems.

A study is being undertaken of the status of groundwater throughout the Murray-Darling Basin. Consistent and regular monitoring of groundwater levels and quality will not only provide information on the availability of groundwater as a resource, but also indicate the success of the MDB Initiative's policies aimed at limiting environmental damage within the Basin.

The groundwater systems respond very slowly to the massive disturbances that have been outlined in this booklet. That is why the full consequences of the human impacts have begun to be felt only after decades, or even a century after the actions which have caused the changes. As has been observed, "we now know that the incipient degradation processes will often continue for centuries to come. We have released a timebomb with a slow fuse... Things will get worse before they get better". Decisions made today regarding land and groundwater management will have implications for many generations. 'Doing-nothing' is not a viable option as the degradation processes will continue and accelerate. There must be change in the way land and water are currently managed. This change will involve accepting the presence of salt and learning to live within a saline environment. It will involve the management of groundwater as part of the total hydrological system with a focus on achieving long-term sustainable use and the minimisation of salinity problems. It is imperative that the remaining groundwater resources are properly managed in the future to ensure that we do not continue to repeat mistakes of the past. Remediation of problems associated with groundwater is expensive and in some cases impossible.



*Drilling for groundwater.*

# Glossary

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<b>Alluvium:</b>	days, sands, gravels and other materials that are transported and deposited by running water and which typically form a floodplain.
<b>Aquifer:</b>	materials below the surface of the ground which can store and transmit groundwater. Aquifers generally occur in sands, gravels, limestone, sandstone, or highly fractured rocks.
<b>Aquitard:</b>	a layer that retards but does not prevent the movement of water to or from an adjacent aquifer. Aquitards usually comprise materials such as siltstone, mudstone, marl, or clay.
<b>Artesian:</b>	groundwater which rises above the surface of the ground under its own pressure by way of a spring or when accessed by a bore.
<b>Artesian bores:</b>	those having a static water level (head) above the top of the aquifer being tapped. If the head is above ground level, the bore is free-flowing unless capped.
<b>Australian Height Datum (AHD):</b>	the reference point (very close to mean sea level) for all elevation measurements, used for depths of aquifers and water levels in bores.
<b>Baseflow:</b>	the component of flow in a river which has come from groundwater discharge.
<b>Bore/well:</b>	a structure drilled or dug below the surface to obtain water from an aquifer system.
<b>Confined aquifer:</b>	a term used by the gold miners of Victoria to describe an aquifer which is bounded above and below by aquitards which inhibit groundwater recharging or discharging from the aquifer. Confined aquifers are normally unconfined at their recharge sites. Groundwater stored in such aquifers is under pressure which may become artesian if the pressure is great enough.
<b>Conjunctive use:</b>	the combined use of surface water and groundwater storage to optimise total available water resources.
<b>Deep lead:</b>	an aquifer at great depth formed in the sand and gravel that has filled an ancient river valley and been covered by more recent deposits. It may lie at depths of up to sixty metres or more and be several kilometres wide. Deep leads are the major regional aquifers under the Loddon, Campaspe and Goulburn Plains in northern Victoria.
<b>EC:</b>	an acronym for Electrical Conductivity unit. 1 EC = 1 micro-Siemens per centimetre, measured at 25°C. It is used as a measure of water salinity (see salinity below).
<b>Fractured rock aquifers:</b>	these occur in igneous and metamorphosed hard rocks which have been subjected to disturbance, deformation, or weathering, and which allow water to move through joints, bedding planes and faults. Although fractured rock aquifers are found over a wide area, they contain much less available groundwater than surficial and sedimentary aquifers and, due to the difficulty of obtaining high yields, the quantities of water taken from them are relatively low.
<b>Groundwater:</b>	water which occurs beneath the ground surface and which is stored in an aquifer.
<b>Impermeable layers:</b>	layers of rock which do not allow water to pass through them.
<b>Infiltration:</b>	the movement of water from the land surface into the ground.
<b>Local groundwater systems:</b>	aquifers which respond rapidly to recharge due to a shallow watertable and/or close proximity of the recharge and discharge sites. These types of flow systems occur almost exclusively in unconfined aquifers.
<b>Megalitre (ML):</b>	one million litres.
<b>Metamorphic rock:</b>	rock that has been altered through heat, pressure, stress or chemical action.

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<b>Mound springs:</b>	these occur in the south-western and western margins of the Great Artesian Basin. When the water comes to the surface in the arid environments, minerals are precipitated around the spring by evaporative concentration and cooling. The springs are sites of rich endemic flora and fauna. They have long been important to the Aboriginal people and to the pastoral industry.
<b>Permeable strata:</b>	layers of rock through which water can pass.
<b>Recharge:</b>	the process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the watertable and by river water entering the watertable or exposed aquifers; the addition of water to an aquifer.
<b>Regional groundwater systems:</b>	extensive aquifers which take longer than local systems to respond to increased groundwater recharge because their recharge and discharge sites are separated by large distances (>10 km), and/or they have a deep watertable. Unconfined aquifers with deep watertables that are part of regional flow systems may become, in effect, local flow systems if there is sufficient recharge to cause the watertable to rise close to the surface (< 5m).
<b>Salinity:</b>	the concentration of sodium chloride or dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/l TDS). The conversion factor is 0.6 mg/l TDS = 1 EC unit is used as an approximation.
<b>Salinisation:</b>	the accumulation of salts via the actions of water in the soil to a level that causes degradation of the soil.
<b>Sedimentary aquifers:</b>	these occur in consolidated sediments such as porous sandstones and conglomerates, in which water is stored in the intergranular pores, and limestone, in which water is stored in solution cavities and joints. These aquifers are generally located in sedimentary basins that are continuous over large areas and may be tens or hundreds of metres thick. In terms of quantity, they contain the largest groundwater resources.
<b>Sub-artesian:</b>	water which does not rise above the surface of the ground when accessed by a bore and must be pumped to the surface,
<b>Surficial aquifers:</b>	these occur in alluvial sediments in river valleys, deltas, and basins, in lake or lacustrine sediments, and in aeolian or wind-formed deposits. They are essentially unconsolidated clay, silt, sand, gravel, and limestone formations, mainly of Quaternary age (under 1.8 million years). These deposits are easily exploited and are the major sources of freshwater groundwater when associated with larger river systems.
<b>Sustainable yield:</b>	for a groundwater system, the quantity of water that can be used without permanent depletion of the resource; it is generally considered to be equivalent to the rate of recharge, minus the volumes required to maintain ecosystems.
<b>Total dissolved solids (TDS):</b>	a measure of the salinity of water, usually expressed in milligrams per litre (mg/l). Sometimes TDS is referred to as total dissolved salts, or as TSS, total soluble salts. See also EC.
<b>Transpiration:</b>	the loss of water vapour from plants.
<b>Unconfined Aquifer:</b>	an aquifer that contains the watertable and is normally exposed to the surface. Occasionally there may be a layer overlying this type of aquifer protecting it from the surface.
<b>Watertable:</b>	the upper level of the unconfined groundwater, where the water pressure is equal to that of the atmosphere and below which the soils or rocks are saturated. It is the location where the sub-surface becomes fully saturated with groundwater; the level at which water stands in wells that penetrate the water body. Above the watertable, the sub-surface is only partially saturated (often called the unsaturated zone).

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# References & additional reading

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## FURTHER INFORMATION

Further information on groundwater and related topics in the Murray-Darling Basin may be obtained from the following websites.

Murray-Darling Basin Commission: [www.mdbc.gov.au](http://www.mdbc.gov.au)

Australian Geological Survey Organisation: [www.agso.gov.au](http://www.agso.gov.au)

Bureau of Rural Sciences: [www.brs.gov.au](http://www.brs.gov.au)

CSIRO Land and Water: [www.clw.csiro.au](http://www.clw.csiro.au)

Land & Water Resources Research and Development Corporation:

[www.lwrrdc.gov.au](http://www.lwrrdc.gov.au)

Queensland Department of Primary Industries: [www.dpi.qld.gov.au](http://www.dpi.qld.gov.au)

Queensland Department of Natural Resources: [www.dnr.qld.gov.au](http://www.dnr.qld.gov.au)

NSW Department of Land and Water Conservation: [www.dlwc.nsw.gov.au](http://www.dlwc.nsw.gov.au)

NSW Agriculture: [www.agric.nsw.gov.au](http://www.agric.nsw.gov.au)

Natural Resources and Environment Victoria: [www.nre.vic.gov.au](http://www.nre.vic.gov.au)

Primary Industries and Resources South Australia: [www.pir.sa.gov.au](http://www.pir.sa.gov.au)

Environment ACT: [www.act.gov.au/environ](http://www.act.gov.au/environ)

