The Murray — more salt coming?

Mallee vegetation adjacent to land cleared for crops.

Each time they turned on a tap during the 1978–79 South Australian drought, the residents of Adelaide were reminded of what the Murray River carries to the sea — not fresh, but salty water.

The Murray River and its tributaries — the largest river system in Australia — drain more than a million sq. km of land, or about one-seventh of the total area of the continent. Although its salinity has always been a problem, the river is becoming even more salty, a cause for concern among the people of South Australia. In years of moderate rainfall, it provides up to 30% of Adelaide's water supply. In dry years, the figure can climb to 80%.

Where does the salt come from? Much comes in groundwater flowing into the river from the surrounding country. The level of the water table in the lower Murray has always been higher than river level, so the aquifers have slowly spilt their salty load into the river.

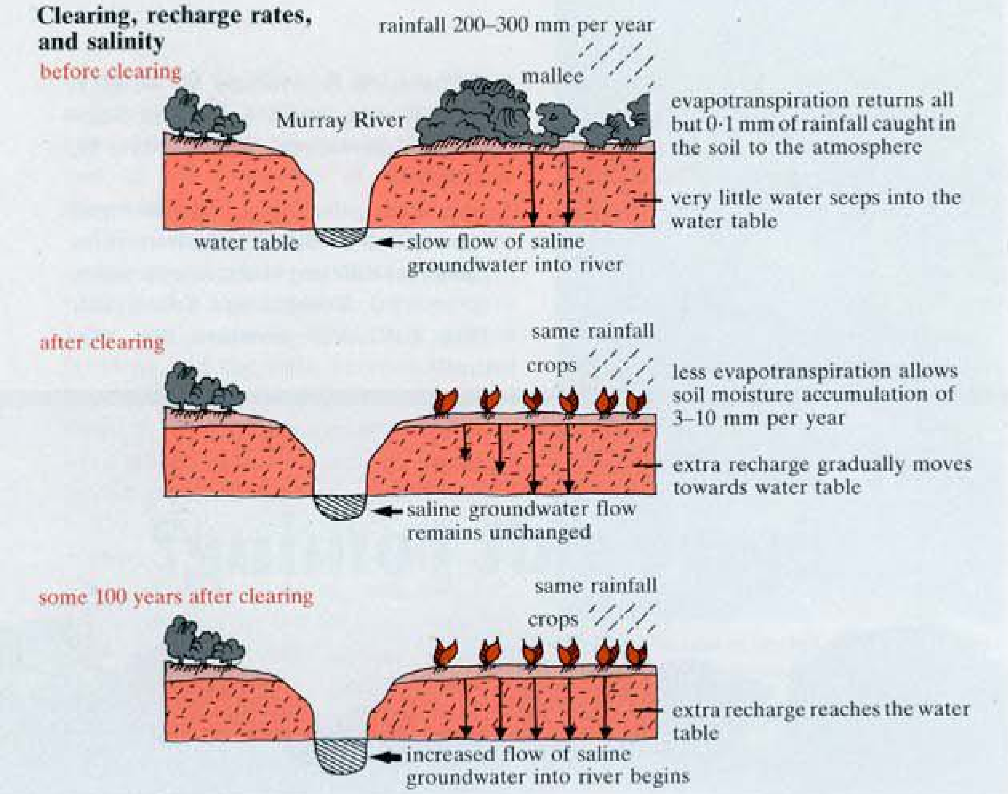
However, scientists are uncertain about the source of salt in Murray Basin aquifers. Some think it comes from salt left behind in marine limestones when these emerged from the ocean. Much of the Murray valley was once submerged below sea water forming an arm of an ancient ocean that reached as far upstream as Swan Hill in Victoria.

Dr Graham Allison of the CSIRO Division of Soils in Adelaide argues, instead, that much of the salt is derived from rainfall. He has calculated that enough time has elapsed since the seas withdrew from the region for the trapped salt to have been flushed away.

Whatever the origin, Dr Allison is more concerned with the immediate problem of how land-clearing has changed the rate of movement of the salty water through the soil and consequently into the river.

Roots and recharge

Most studies of salinity in the Murray have focused on the effect of irrigation on salt inflow. But clearing of the native vegetation can also contribute to the problem. A great deal of clearing has occurred; for example, during the past 50 to 80 years, land-owners in the counties of Albert and Alfred, which



The increased recharge of groundwater after clearing will force more saline water to flow to the Murray River.

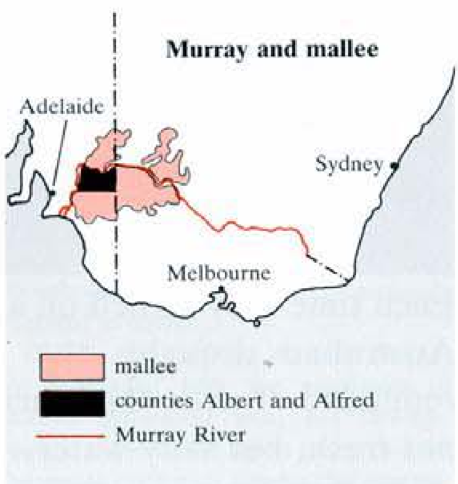
have a combined area of about 9000 sq. km (see the map), have cleared up to 90% of the region's characteristic mallee scrub.

Mallee trees have very deep root systems, which can sometimes penetrate to a depth of 18 m. This enables them to reach water in soil far below the surface. The trees 'suck up' this water when they transpire, losing water to the atmosphere. Water that remains in the soil after the plants' demands have been satisfied, or that has bypassed roots, becomes deep drainage (local recharge) and eventually moves down to the water table.

Farmers have replaced mallee trees with crops such as wheat, which have shallow roots. The result has been a drop in the transpiration rates of the region; so plant roots now bring up less water from deep in the soil to be released from the leaves.

In other areas a change in the water balance like this eventually causes the water table to rise. In low-lying areas, it may cause groundwater to rise to the surface, killing crops and pastures. This is already a serious problem in northern Victoria and Western Australia.

In the Murray region, though, the main problem is that the increase in the amount of recharge will force more saline water into the river. Dr Allison and Mr Murray Hughes, also of the Division, have measured the chloride concentrations of soil water at various depths and made some rough calculations of recharge rate. Their work has thrown light on the likely impact of clearing on the Murray's salt load.



Clearing of regions such as the counties of Albert and Alfred is adding to the Murray's salt problem.

The scientists carried out their studies in the western part of the Murray Basin in north-western Victoria and in South Australia. They found that, at the surface of the soils there, water brought by rain contains only about 4 parts of chloride per million. With depth, however, salinity increases until chloride levels reach 12–15 000 p.p.m. — close to the amount of chloride in sea water — at a depth of about 5 m, the depth beneath which only a few mallee roots occur. This salt has been concentrated in the soil by transpiration, which takes water into the plant and back to the atmosphere, but leaves ions, such as chloride, in the soil.

The scientists estimated that the recharge rate of groundwater to aquifers under uncleared mallee was less than 0·1 mm per year. The bulk of the area's annual average rainfall — 250 mm per year — is recycled through plant transpiration, evaporation, and run-off and only 0·1 mm per year manages to escape through the root zone to the water table beneath.

But cleared areas produced different figures. While average rainfall was the same, the recharge rate increased to between 3 and 10 mm per year. Because of the great depth of the water table beneath the soil surface the effect of this extra water will take some time to be felt there. A long-term wetting process has to take place in the 30 to 40 metres of unsaturated soil above the water table before the increased recharge is transmitted to it.

Dr Allison has made a rough estimate of how long this wetting process will take to bring about a rise in the water table. Drawing on the results of earlier studies in Holland, he calculated that the impact of clearing will be seen in an increased flow of saline groundwater into the river about 100 years after clearing began. The salt input may be double the present load or even worse.

The problem begins to look urgent. Clearing in the Murray mallee area began 50 to 80 years ago, so going on Dr Allison's estimates the region may be facing an even more serious salinity problem than the present one in as little as 30 years' time. As well as this, increased irrigation will also add to the amount of salt flowing to the river. Work by the Engineering and Water Supply Department in South Australia and by the Australian National University has shown that the salinity of the river is already increasing each year.

Dr Allison, with Mr Fred Leaney of the Division, has refined his techniques for measuring recharge rates. By measuring the concentration of the naturally occurring radioactive isotope of carbon, C-14, they were able to develop a model that provides information about the ratio of recharge water to the amount of groundwater. The results — giving a figure of 0·2 mm per year for recharge — confirmed the low recharge rates that he found in vegetated parts of the Mallee using other methods.

Mary Lou Considine

More about the topic

Recharge in karst and dune elements of a semi-arid landscape as indicated by natural isotopes and chloride. G.B. Allison, W.J. Stone, and M.W. Hughes. *Journal of Hydrology*, 1985, **76**, 1–25.

The use of natural tracers as indicators of soil-water movement in a temperate semi-arid region. G.B. Allison and M.W. Hughes. *Journal of Hydrology*, 1983, **60**, 157–73.