Indian Ocean Climate Initiative

Informed Adaptation

Government of Western Australia

How salinity has changed

Compiled by Don McFarlane (CSIRO); John Ruprecht (DoE)

Climate Note 11/05 (August) in a series outlining observed climate changes or variations over recent decades in south-west Western Australia.

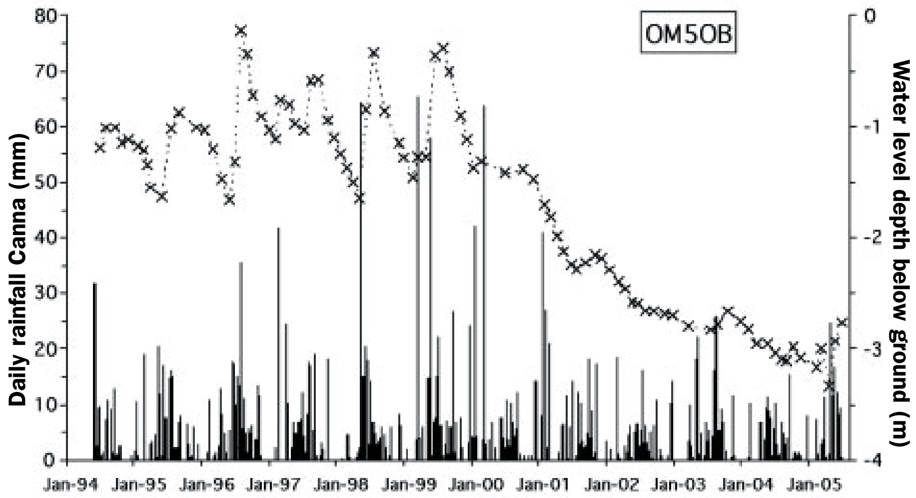

Figure 1: Groundwater trend in a north-east Wheatbelt valley (Russell Speed).

Summary

Dryland salinity is driven by excess water in the landscape resulting from clearing of perennial vegetation. The decrease in winter rainfall and virtual absence of 'wet winters' has caused a slowing in the process of salinisation, and in some cases groundwater levels have fallen. Deeper bores are continuing to rise while shallow (< 8m) groundwaters have flattened. In the north-eastern Wheatbelt, the occurrence of summer storms has created an erratic response.

Stream salinities in many streams have continued to increase because of reduced fresh runoff which, in wet years, dilutes the saline groundwater discharge. However, in catchments where groundwater levels no longer intersect the valleys because of falling levels, runoff has freshened.

Salinisation processes prior to 1975

Dryland salinity has been ranked as the State's number one environmental problem, with over 6,000,000 ha (30% of cleared land) considered at risk of being affected to some degree.

While salinisation is a progressive, chronic process on cleared agricultural catchments, its rate of spread is most rapid after wet winters and after heavy summer and autumn rainfall.

Annual crops and pastures don't have the ability to use this excess water, and the amount of recharge to saline aquifers increases sharply with increasing rainfall.

In wet winters, plant roots are shallow because of waterlogging and water ponds for long periods, providing downward leakage and increased recharge, even in clayey soils.

In high intensity summer storms, runoff into Wheatbelt valleys has been shown to result in groundwater levels rising in the valleys, even in the absence of significant recharge on the valley flanks.

Salinisation processes since 1975

In the past 30 years there have been almost no very wet winters in Wheatbelt areas and this mechanism for the rapid expansion of saline areas has been absent. In higher rainfall areas in the Great Southern and South Coast, groundwater levels still rise in most winters and saline areas are expanding. However, there have been few instances of rapid growth in affected areas as a result of wet winters.

Some areas in the north-eastern Wheatbelt especially have received summer and autumn rain as a result of the tail end of cyclonic depressions and north-west cloud bands. These areas have reported the rapid expansion of salinity in the following year, but the distribution of the rainfall is erratic and subsequent year's rains may not coincide and continue the salinisation process. Some runoff events may be so rapid that the water has insufficient time to infiltrate and raise groundwater levels in the upper parts of catchments.

It is possible that the relative importance of wet winters to summer/autumn storms in causing salinity has changed, with the more of the latter in recent decades (IOCI Climate Note 6/05).

What do groundwater hydrographs show?

In the drier parts of the north-eastern Wheatbelt, groundwater levels have declined in the upper to mid-slope areas as a result of the lack of wet winters. However, the valley floors have shown a range of response, ranging from falls to little or no reduction in groundwater table levels.

Groundwater levels on the sandy northern Perth Basin have continued to rise under cleared land. Fortunately the groundwater in these areas is usually fresh to brackish and they constitute a resource rather than a threat.

The groundwater levels in the central and eastern parts of the Wheatbelt are also not rising as quickly as they previously were, and in some cases, where the watertables are shallow (<8 m) they are also stable or declining. Long-cleared areas (>75 years) appear to be reaching equilibrium while relatively recently cleared areas continue to show rising trends.

On the South Coast and wetter parts of the Wheatbelt and Great Southern, groundwater levels are continuing to rise if the landscape is poorly drained (e.g. low slopes, few drainage lines). The rises are particularly noticeable in areas where land was cleared within the past 20-30 years, which is relatively common on the South Coast.

What do the groundwater hydrographs mean for salinity?

Even when groundwater levels have fallen, soils may continue to appear salt affected. Salts accumulate at the soil surface over many years of evaporation and soil structures are lost, making it difficult for the salts to be leached lower in the profile.

Often the topsoil has been eroded from saline areas and it is difficult for plants to re-establish in the less fertile sub-soil. Therefore once salinised, many areas are permanently degraded.

How quickly is salinity spreading under a drier climate?

Measurements of salt-affected land using the Land Monitor method over a seven-year period 1989-1996 indicated that salinity was still affecting an additional 14,000 ha each year. By 1996, almost 1,000,000 ha had been affected.

What is happening to stream salinities?

More than half of the rivers in the south-west are now marginal in quality, brackish or saline. Stream salinity is still rising at many of the rivers across the south-west. Sixty-six per cent of the rivers analysed in a recent report had higher salinities in the past 10 years (1993–2002) than in the previous 10 (1983–1992). Part of the reason for the higher salinity was lower rainfall over the past 10 years.

Streamflow is more saline in dry years as shown in Figure 1. However, the wet years lead to greater recharge to the groundwater leading to more saline groundwater discharge and increasing stream salinities in later years.

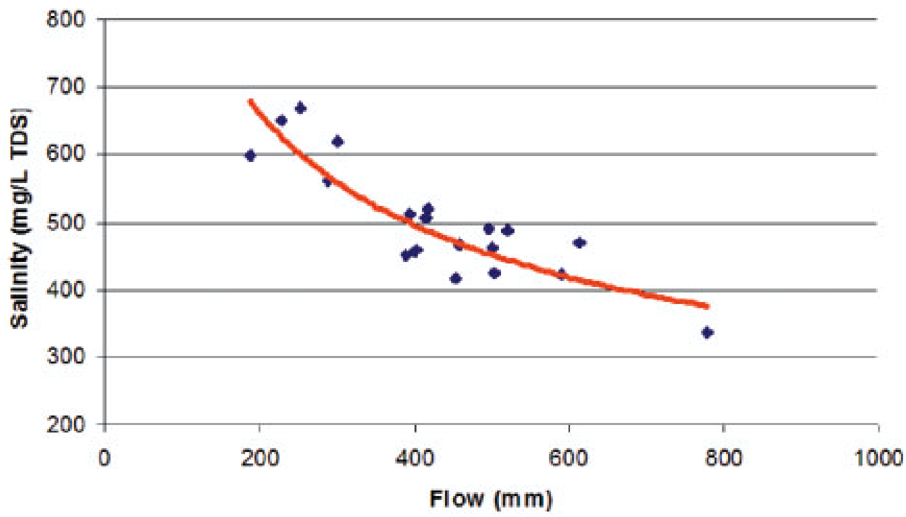

Figure 2: Stream salinity trend with flow showing that higher salinities are observed with lower streamflow.

What can we conclude?

The reduced incidence of wet winters since the mid-1970s has almost certainly resulted in a slowing in the rate of salinisation in many parts of the agricultural area.

In selected areas, especially the northern Wheatbelt, groundwater levels have declined in many bores. This trend may be partly due to the region's relative dryness and high evaporative demand. In other areas the trend is less clear. Reduced water tables are not necessarily associated with a complete recovery of fertility. Salt accumulation in soils requires time to leach.

Salinity remains a very serious degradation process for the State but we may now have more time to develop solutions than we previously thought. If dry conditions persist it may be possible to consider reclamation of previously affected areas.

Further work is needed to understand the interactions between decadal climate variability, climate change, and land use change and assess their relative impacts on land and stream salinity.

2005255(11)-08-2000