The causes and risk of dryland salinity

information step **A1**

Dryland salinity (sometimes referred to as secondary salinity) throughout the Murray-Darling Basin results from changes in the water balance of landscapes following the removal of native vegetation and the introduction of European agricultural practices, most significantly the adoption of shallow rooted annual crops and pastures.

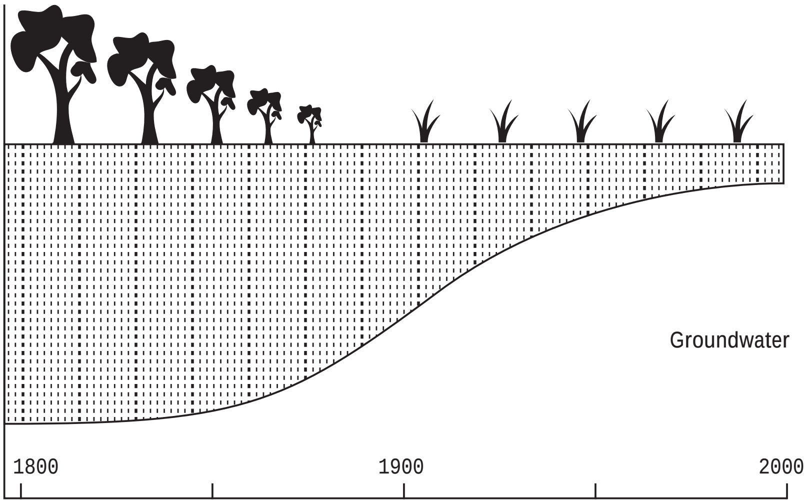
Native vegetation, adapted to the environs of the dryland Basin, through evolution over millennia, has a great capacity to optimise water use. The extensive root systems of native plants draw water from deep within soils during dry times, which serves to increase the soil water deficit and provide ‘room’ for the next season’s rainfall. This avoids the tendency for water to drain beyond the root zone as soils approach saturation.

Increased groundwater recharge

Under native vegetation, the supply of rainfall to groundwater is limited by interactions between vegetation and soils, involving soil water. Under the most common European agricultural crops, less of the rainfall is transpired and more moves past the root zone, increasing groundwater recharge. With this increase in recharge adding to the volume of groundwater systems, the result is a general increase in the elevation of watertables. Most often this increase in groundwater pressure leads to increased groundwater flow at some point lower in the catchment. Ultimately, groundwater systems fill in response to these processes, and more groundwater discharges to streams and soils alike. Where saline groundwater is discharging — or where it is concentrated through evaporation — dryland salinity develops.

Soil type and climate modulate these processes. Where the soils are shallow they are less capable of storing seasonal rainfall. Therefore, the incidence of deep percolation and potential for increased groundwater recharge is greater. Where the active growing season is out of phase with the dominant rainfall season, there is a greater tendency for recharge to occur in most years. The southern regions of the Basin, which experience cold wet winters and hot, dry summers, are particularly susceptible to increases in annual recharge.

Changes in land management leading to salinity are not exclusive to the southern climes of the Basin. High annual rainfall in the temperate regions of central west New South Wales and even the subtropics of southern Queensland, is likely to drive these salinity processes.



Groundwaters rise as the landscape is cleared of native vegetation for agriculture or urban development. Dryland salinity develops as a consequence of the hydrology of the landscape shifting towards a new equilibrium based on increased groundwater recharge and increased groundwater discharge.

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Other contributors to groundwater recharge include leakage from rivers after the riverbed has been disturbed. Again, this 'disturbance' is most often a consequence of increased runoff following agricultural development. There is evidence of this phenomenon within the Campaspe River basin in the southern Riverine Plains of central Victoria. Groundwater recharge may also increase as a consequence of a greater incidence of flooding following agricultural development. The impact of this process is particularly well documented in the Loddon River catchment on the southern Riverine Plains.

Appreciating the fundamental causes of dryland salinity is the first step towards understanding how the problem is managed, but other landscape processes can strongly dictate the feasibility and efficacy of management options (See Information Step E).

Dryland salinity risk

Key factors determining dryland salinity risk include climate, vegetative cover, salt stores, and geological and geomorphic characteristics of the landscape. The roles of these attributes in contributing to dryland salinity are interrelated. However, climate and vegetative cover will determine whether dryland salinity will occur, given a pre-existing salt store and requisite hydrogeological characteristics.

In Mediterranean climates cold wet winters together with hot dry summers provide a relatively short growing season that is out of phase with seasonal rainfall. This in conjunction with land use change in turn promotes an increase in groundwater flow, resulting in elevated down-basin groundwater presures, rising watertables, and ultimately an increase in the incidence and volume of groundwater discharge.

This general model of dryland salinity explains most of the current incidence of dryland salinity in Australia. Since evaporation is low, and common agricultural plants have very shallow root systems, the soil water under most farming enterprises is not fully exploited in the growing season. In consequence, the soil more readily saturates under winter rainfall, increasing the incidence and volume of annual recharge.

There is a remarkable coincidence between the national distribution of Mediterranean climates and land currently affected by dryland salinity. This correlation lends strong support to the winter dominance model.

However, a great deal of dryland salinity also occurs outside these regions. The incidence of regional groundwater discharge and dryland salinity in the semi-arid Mallee lands of north-western Victoria or the Liverpool Plains of New South Wales, for example, demonstrates that other processes must also be acting. The answer lies in the fact that in some years rainfall far exceeds that experienced under normal seasonal conditions. The recharge occurring during these periodic events is responsible for rising water tables and consequent salinity in both the more arid and temperate regions.

Event-based recharge associated with periods of extraordinarily high seasonal rainfall appears to be responsible for the more recent increases in the incidence of dryland salinity, such as in the temperate climates of the central west of New South Wales. The risk of dryland salinity is therefore not confined to only the more southern, temperate areas of the Basin.

At this point it should be noted that increasing groundwater recharge is the causal factor behind the increase in dryland salinity. However, the nature of the aquifers strongly influences the processes and the delay in problems occurring following agricultural development, whilst the salt store of the landscape determines the salinity of the discharging groundwater.

A contemporary view of dryland salinity risk in the Basin cannot escape the dominance of these climatic zones. In the Mediterranean climates of the Basin's southern sectors and in the more humid climates of the temperate zones in the eastern Basin normal seasonal conditions have caused dramatic increases in annual recharge following agricultural development — the aquifers are filling rapidly. Where these regions have accumulated high salt stores over millennia, the risk of dryland salinity is progressively realised as groundwaters laden with salts discharge to the land surface.

In the more arid zones of the interior of the Basin, generally where annual rainfall is greater than 300mm, and in the more temperate lands of NSW, groundwaters rise in response to episodic rainfall. Salinity might take longer to occur, but the end result, in terms of the appearance of dryland salinity, is the same.

In the subtropics of Queensland, although dryland salinity is known to occur, the risks are known with much less certainty. Logic suggests that dryland salinity in these regions must also occur after episodic events where rainfall dramatically exceeds evaporation. Much less is known, however, of the processes in this region and few long-term groundwater records are available to aid understanding of the future threat of dryland salinity.

The risk of dryland salinity is present throughout much of the Basin, although the situation is less clear in southern Queensland where groundwater data is lacking. The 'boundaries' for areas at risk are broadly set by the 300mm annual rainfall isohyet, below which recharge is minimal, and 800mm above which much of the salt has been flushed from the system. Within these limits it is not so much a question of where salinity will ultimately occur, but when. The immediate risk is highest in those landscapes with local aquifers that have the least capacity to store groundwater and contain the highest mass of salt. Conversely, in areas where regional groundwater systems are fresh and there is higher storage capacity, it may take much longer for salinity impacts to develop.

Key References:

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