National standards and methods for the measurement of land salinity

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Introduction

As part of the National Action Plan for Salinity and Water Quality (NAP), Australian, state and territory governments have committed $1.4 billion over seven years to 2008 to tackle two major natural resource management issues facing Australia's rural industries, regional communities and our environment (Australian government – NAP 2007). Significant investment in salinity has also been made through the National Dryland Salinity Program (the precursor to the NAP) and the Natural Heritage Trust (NHT). These initiatives, together with other funding have led to significant gains in on-ground action as well as improved knowledge from research and development.

Salinity is one of Australia's major natural resource management issues. The Australian Dryland Salinity Assessment (NLWRA 2001) estimated that there was approximately 5.7 million hectares at risk or affected by dryland salinity. The assessment also estimated this number to grow to 17 million hectares by 2050. While we now know that these figures may have been over-estimated, there is little doubt that the area of land (and other assets) at risk or affected by salinity will continue to grow (Pannell 2001).

Importantly, the 2001 assessment looked at how salinity was affecting different assets, be they agriculture, biodiversity, water or infrastructure-related. Thus, while salinity has traditionally been perceived as a problem for land managers, it is becoming increasingly important in the public agenda in urban environments (Christiansen 1995).

With much of Australia in drought, recharge to groundwater has been significantly reduced and salinity is currently presenting fewer problems to land and natural resource managers. Some have argued that investment in salinity could be reduced, at least for the present. The framework and the suite of products described in this paper will inform future investment in salinity.

In 2001, the National Farmers Federation and the Australian Conservation Foundation estimated that it would cost $65 billion over 10 years to fully prevent and repair land degradation in Australia, with the majority of these funds required for salinity (Madden *et al.* 2000, in Pannell 2001*)*. The land salinity indicators described in this paper and the associated protocols will assist in making better decisions on how to use available funds, and manage our land and water to avoid unnecessary impacts.

Salinity in Australia

The increase of surface soil salinity from non-saline to saline levels results largely from changes in vegetation or land use practices (Peck and Hatton, 2003). In particular, changes in water balance due to irrigation or the clearing of native vegetation can promote salinisation through impacts of watertable heights (Amezketa, 2006). Research over the past decade has revealed, however, that while rising groundwater is a major cause of salinsation, the mechanisms of salinisation along the east coast of Australia also incorporate lateral groundwater flow (i.e., discharge). In these cases, altered groundwater flow paths allow the transport and mobilisation of salt, with significant consequences for land managers.

The indicators described herein cover this range of conditions and provide land managers with a useful measure of both the current salinity status of land, and the likelihood of salinity developing in the future. Targeting often limited resources to get the most value for money in addressing salinity issues requires the best possible knowledge - not just of current salinity problems, but also the magnitude and timeframes of potential salinity problems that may develop in the future.

The suite of indicators described below, and the data that is derived from their application, can tell us where and when to act to mitigate both existing and potential salinity, and how management may need to be improved.

Framework

The National Natural Resource Management Monitoring and Evaluation Framework (NM&EF) was established by Australian, state and territory governments to assess the health of Australia's land and water resources. It also aims to assess the performance of major government policies and programmes such as the NAP and NHT.

Land salinity is one of twelve major natural resource themes under the NM&EF. In order to reach national agreement on standards to measure salinity - through the development of the indicators and associated protocols - the National Coordination Committee for Salinity Information (NCCSI) was established. The NCCSI comprises representatives from the Australian government department of Agriculture, Fisheries & Forestry (Bureau of Rural Sciences and Natural Resource Management Division), all state governments, the Murray Darling Basin Commission, Geoscience Australia, the Commonwealth Science and Industrial Research Organisation (CSIRO) and the National Land & Water Resources Audit (NLWRA).

Over a number of years, the NCCSI has worked on developing the standards for a set of salinity indicators that fall under the heading "areas of land threatened by shallow or rising water tables". The indicators have been developed by all of the aforementioned organisations and development has included input from hydrologists and hydrogeologists, natural resource managers, policy makers and salinity experts.

The four indicators under the land salinity theme are:

- Depth to groundwater;
- Groundwater salinity;
- Baseflow salinity; and
- Location, size and intensity of salt affected areas.

These indicators were endorsed by the NCCSI and subsequently by the NLWRA Advisory Council in March 2007.

Developing the indicators

Indicators are a vital part of investment in natural resource management, as they allow natural resource managers to measure and monitor changes in the condition and extent of resources and threats, and assist in understanding if these changes have occurred as a result of intervention. It is therefore important that the indicators are applicable in a range of situations (e.g. rural and urban) and over a range of scales, as they will be used to assess where investment in salinity mediation has been effective and for the efficient allocation of resources available for salinity.

The four salinity indicators are:

- Depth to groundwater

  Rising trends in the average level of watertables may provide an early indication of an increased land salinity risk in a catchment. Similarly, falling watertable levels may be an indicator of the effectiveness of mitigation strategies (Coram, Dyson & Evans 2001). However rising and falling groundwater levels may also be a consequence of reduced recharge due to climatic factors or increased groundwater extraction from bores.

  It is therefore important when looking at salinity indicators to look not just at the salinity indicator, but relevant contextual information such as short- and long-term climatic variations, groundwater extraction patterns and changes in relevant catchments. This is discussed further in a later section of the paper.

- Groundwater salinity

  Groundwater salinity can be a useful indicator for potential severity of land salinisation; groundwater salinity becomes important once the watertable nears or breaches two metres below ground surface because of the salinisation of the root zone and the exacerbation of damage to infrastructure.

However, groundwater salinity by itself is a weak indicator of salinity risk, because salt scalding on the surface is often produced by the evaporative concentration of very dilute groundwaters in many local flow systems in south-eastern Australia.

- Baseflow salinity

  Stream salinity is often a very useful indicator of catchment salinity. It may be comprised of baseflow (groundwater) and surface water components. Baseflow salinity is important because it indicates the relative contribution of groundwater salinity to total stream salinity.

  Baseflow salinity can be a useful means for identifying sub-catchments where further salinity investigations may be warranted, however it can be a difficult indicator to interpret correctly. In more rapidly-responding local groundwater flow systems, rising baseflow salinities over time generally indicate an increasing groundwater contribution to the stream flow and, therefore rising watertables. However baseflow salinity levels can vary quite erratically, and to use baseflow salinity as an indicator for the potential development of salinity problems it needs to be interpreted in conjunction with other contextual information such as climate and land-use.

  A major positive of the baseflow salinity indicator is its value as an educational and community involvement tool, as much as a salinity indicator. It can be readily measured by community based initiatives such as Waterwatch or Saltwatch, and unlike monitoring groundwater salinity, it does not require expensive infrastructure such as monitoring piezometers.

- Location, size and intensity of salt affected areas

  This is the traditional 'salt-scald' expression of salinity. It occurs where soils and vegetation are degraded by the discharge and evaporative concentration of saline groundwater. This commences when the watertable either reaches the root zone or where it can be evaporatively concentrated (commonly within two metres of the ground surface). Monitoring the expansion or contraction and intensity of salt-affected areas provides an effective tool for assessing changes in salinity status over time. It can also aid in determining risk and hazard assessment.

Importance of "context"

It is important to understand that the salinity indicators can be influenced by a variety of factors – not just developing salinity, and that these factors need to be considered when evaluating the effectiveness of remediation and management efforts. Relevant contextual information must therefore be considered when interpreting the salinity indicators. For example a rising watertable may be an indicator of the potential for a salinity problem to develop – or it may also be the result of high rainfall (climate) or a change in land use (anthropogenic factors) or a variety of other factors. Taken in context, the salinity indicator may actually be registering these other processes, rather than an increased risk of a salinity problem developing. Therefore in order to understand why and how salinity processes are occurring, the use of contextual information is critical.

Understanding the hydrologic impacts of climate, coupled with the way in which the land is managed and the land-use history (e.g. time since clearing) and other contextual information are critical in interpreting information derived from the application of the indicators.

Indicator trials

In order to test the effectiveness of the salinity indicators, trials were undertaken in each Australian state. These were done in a variety of different environments, and in areas with variable data availability. To this point, development of the salinity indicators had been largely a theoretical exercise. The purpose of the trials was to test how effectively these theoretical frameworks could operate in the real world.

The trials showed that the indicators were effective over a variety of scales and in different environments, although they highlighted that in some areas that the necessary data pertaining to one or more of the indicators was lacking. For example while changing depth to groundwater over time was determined to be a good indicator of developing salinity problems, its usefulness was often limited by the limited availability of relevant groundwater monitoring data.

The trials showed that the current capacity – and in some instances lack of capacity - to report against the salinity indicators due to a lack of relevant data in some areas, meant that the indicators were currently more useful over local scales. However the trials also indicated that if more data was available, and monitoring and interpretation capacity was improved, that the indicators could be effective over local, regional and national scales.

Next steps

In order to move forward, the use of the salinity indicator protocols needs to be ensured in the various natural resource management organisations. In order to build a national picture of the true state of salinity in Australia – and the effectiveness of programs designed to remediate it – the relevant salinity indicator data needs to be collected consistently throughout Australia. Only then will it be able to be compared and aggregated to form a national picture of salinity.

Concluding comment

Pannell (2001:542) states that 'past experience with salinity highlights the critical importance of high quality scientific information to guide policy design'. It has been shown that with the consistent framework described (including through data derived from the indicators) and through ongoing collaboration and cooperation from the organisations involved, salinity information will be improved in the future.

Salt is part of the Australian landscape, and the indicators described above help us to understand and live with salinity. It will be true that in many areas the problems cannot be fixed, but in many areas can be prevented with carefully targeted intervention. The indicators will help us monitor changes in these areas, and inform whether these changes have occurred as a result of natural processes or anthropogenic processes

These indicators have been developed to assist in anticipating where salinity is likely to emerge as a land management issue and, where salt is currently an issue, where investment in remediation ormanagement is likely to be most effective, and to help natural resource managers in determining themost appropriate policy response.

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