

Assessing salinity risk: a new approach implemented in Queensland, Australia

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Introduction

A number of broadscale studies assessing secondary salinity in Queensland have been released since 1999. These studies primarily focused on estimating salinity hazard i.e. the parts of the landscape which, due to the underlying soils, geology and groundwater, have stores of salt which have the potential to become mobilised. Even though these studies improved our knowledge of these systems and helped raise awareness of salinity in Queensland, they did not actively consider the implications of past and present land management practices and land use on salinity processes.

In late 2005 a methodology for assessing salinity risk was proposed (Grundy et al. 2007). This methodology consisted of a four component framework based on biophysical hazard (similar to the earlier salinity hazard assessments), current management influence, salinity stage and value of assets. The addition of salinity stage was an important step in assessing salinity risk because it allowed time lags between changes in land use and mobilisation of salt stores to be considered in predicting future salinity impacts.

Since 2006, this new risk assessment framework was implemented successfully in two catchments—the Fitzroy Basin catchment located in central Queensland (Chamberlain et al. 2007), and the Condamine catchment (Searle et al. 2007) located in southern Queensland (Figure 1). Both are subtropical areas, with a range of geologies. The methodology was modified in each catchment, depending on scale and quantity of available data. Predicting areas at risk from salinity was achieved by collecting and analysing data (e.g. geology, soil type, landform, slope, land use, tree cover, deep drainage, groundwater depth, quality and trends, salt sites) and relating it to the components outlined in the framework.

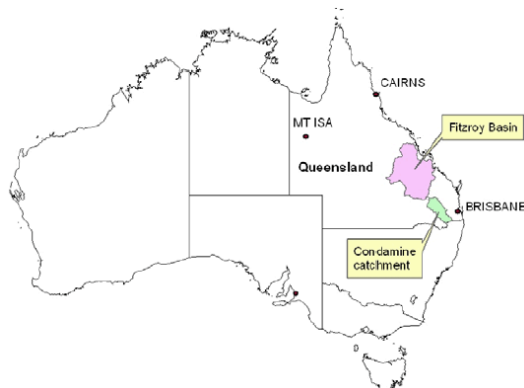


Figure 1 Location of Fitzroy Basin and Condamine catchment

The risk framework

The framework as originally stated by Grundy et al. (2007) consisted of four components, but only the first three of these were utilised, as data concerning the nature, vulnerability and value of assets was difficult to find. Furthermore, the absence of such data does not prevent the risk assessment occurring, rather it only limits the quantification of impacts.

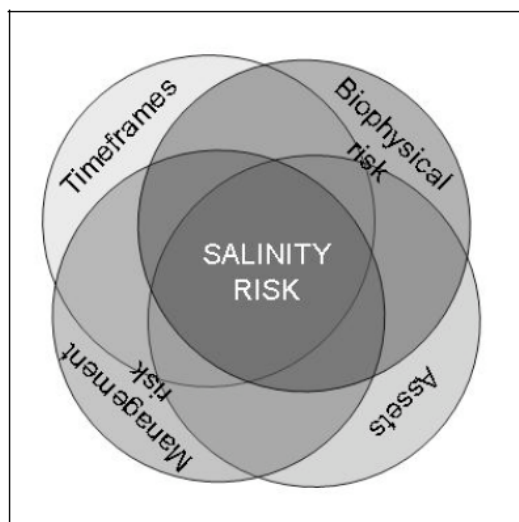


Figure 2 Components of the salinity risk framework (from Grundy et al. 2007)

Subcatchment units

The number of sub-catchment units differed substantially between the two studies, but derivation was similar – iterative classification of the DEM, in consultation with the client, aiming to produce units large enough to have measurable NRM outcomes but at the same time remain small enough to be of relevance to landholders. There were 43 sub-catchments in the Condamine and 178 in the Fitzroy. An issue identified in both cases is that of sub-catchments spanning dramatically different landscapes e.g forested hillslopes and irrigated alluvia. In these instances, the final sub-catchment risk rating is not truly reflective of the risk of the individual landscapes. For instance, the forested hillslopes may have a very low risk, while the irrigated alluvia may have a high risk. This may average across the sub-catchment as a moderate risk. An advantage of the approach used is that catchments may be redefined, and the risk processes re-run.

Biophysical hazard

The biophysical hazard component is similar to earlier salinity hazard assessments such as DNR (2000). The specific attributes used varied with data availability. Some layers, such as derivatives of digital elevation models (DEM), geology and land resource data were common to both studies. In the Condamine study, derivatives of the DEM were integrated with land resource mapping to identify specific landscape components that correspond to dryland salinity conceptual models described by Salcon (1997). This is the first time this approach has been taken in Queensland.

Stage

Both studies used layers such as catchment salt export/import ratio (E/I), presence of secondary salinity sites and groundwater levels and trends in the identification of salinity stage. The concept of stage when described by Grundy et al. (2007) included timelines for a threat to assets, resulting in 7 classes. When applied however, it became obvious that knowledge of timelines was often absent, and thus the stage component could be reduced to only a few classes. In simplest terms, catchments fall into either “expressing change” or “not expressing change”. The determination of time to change or threat to asset often requires detailed knowledge of the unsaturated zone and groundwater trends – data which is not always available.

The use of salinity sites includes some bias, as investigations into salt expressions have never been uniform across the study areas, thus a sub-catchment may contain no recorded salt expressions simply because no one has ever looked. Backwards/current stage indicators such as catchment salt export/import ratio are very useful, but often spatially limited. The necessary stream flow and EC data is generally only available on trunk streams.

Management influence

The concept of management influence is reasonably well understood due to significant amounts of agricultural production research and modelling in the two study areas. Factors used included land use, wooded cover and modelled deep drainage as a result of land use change. While land use mapping is available for the last decade or so, a critical need was identified for land use mapping from 50 or more years ago. Fortunately this was available in the Condamine catchment.

The database structure

Given the vast amount of information used in the assessment and the complexity of the decision rules used in the risk framework, all the spatial data and associated documents were packaged in an ArcGIS personal geodatabase (an Access database). The database also contains all the underlying data layers and decision rules so that rather than being a black box, the salinity risk assessment process is transparent. Spatial data was presented in an ArcGIS project, enabling users to query individual layers and understand why one area has a higher salinity risk than another, allowing the assessment tool to be used as an interactive management decision tool.

Discussion

Grundy et al. (2007) listed the four components in order of stage, management, assets and biophysical hazard. They do not state a specific order in which to assess the components (as each is independent), but use of the framework led to the development of a logical order. Biophysical hazard should be assessed first, and in Queensland, it often already exists from previous works. Stage is assessed second, as this encompasses historic interactions within the landscape. Management influence then captures current/future management practices. Assets are not necessary to a generic salinity risk assessment process. All parts of the landscape (natural, man-made, cultural etc) are assets, with varying values (depending on who is allocating the value). It is logical to assume that if salinity expression occurs, one or more assets will be affected. Whether or not the affect is significant is a matter to be determined in separate processes to the risk assessment.

The delineation of sub-catchments remains as an issue warranting further examination. Averaging of disparate landscapes across sub-catchments does not produce an optimum result. It is suggested that future analyses undertake a primary split on landscape/geology, and then a topographic split to produce sub-catchments. The framework does however provide the option to present results in a textual manner, thus avoiding the sub-catchment/landscape problem.

While the risk framework was applied in a quantitative sense (with explicit rule layers), in both studies, the value of local knowledge and “grey matter” was apparent. As is often the case with modelling natural resource systems, expert knowledge was required in aspects of the analysis, and the testing of the results. Care was taken though to run the spatial analysis blind, in order to avoid bias. The relevance of expert knowledge was particularly evident in the Condamine catchment, where the end result was not much different from the expert knowledge available prior to the study. Thus the risk framework did not necessarily increase knowledge, but it did substantially improve the manner in which it was available and understood by clients.

Assessment of threat to assets, while a stated aim of both studies, was impractical to implement. The primary constraint was data concerning the spatial extent of assets, and their vulnerability e.g where is a pipeline, and what is it made of? The absence of this data has been flagged as an issue for regional bodies and local governments to follow up, as it will always be a limitation to full salinity risk assessment.

Conclusions

The framework provided by Grundy et al. (2007) provides a robust basis for the further development of salinity risk assessment in Queensland. It encompasses the necessary aspects of risk, while providing the flexibility to incorporate various data as available. The local

natural resource management bodies (Condamine Alliance and Fitzroy Basin Association), local Landcare groups, local government and individual land managers are now using these products to prioritise on-ground investment and implement management options to reduce salinity risk in their catchments. Since the completion of the first two studies, the approach is now being applied across the remaining major regional body areas in Queensland.

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