Natural resource information for policy development: A national salinity map

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Context

Australia is a huge tract of land divided between several States that maintain independent attitudes and autonomy in managing their land and other resources, and individual landholders who enjoy similar freedom of action. At the Commonwealth level, there remains a need for overviews of the condition and trends of natural resources, for policy development and as a basis for interventions to address problems that transcend or ignore administrative and ownership boundaries.

Salinity respects none of these boundaries and demands responses at local, regional and even continental scales. A recent request for a national map of salinity risk from Agriculture, Fisheries and Forestry – Australia's Natural Resources Policy Division exposed the fragmented nature of the information that is available. This paper outlines the rationale behind the map we produced, which is provisional pending better baseline data from the forthcoming National Land and Water Resources Audit, and which complements the projections of river water quality provided to the Murray Darling Basin Commission's salinity audit (MDBC 1999).

Risk and hazard

The policy issue is not the distribution of saline soil and saline groundwater. In a dry continent, these are facts with which we have to live. The issue is the perception that:

- Good land and water is at risk from the spread of salinity;
- The problem is induced by past and present policies and management practices;
- The situation will get worse unless these policies and management practices are changed.

Policymakers are not natural resources specialists. They need the big picture presented in such a way that it can be grasped quickly, so the map should not be too complex. Knowledge of the land and water already affected by salinity is the starting point. Beyond this, policy makers want to know:

- What further land and water is at risk from salinity if present land use trends continue;
- A similar analysis for other future scenarios, for instance a cutback of 20 per cent in grain production in favour of tree planting.

Salinity risk is the magnitude of future salinity multiplied by the likelihood of its occurrence. Information on a national basis is not yet available on either count. We can, however, identify the extent of the hazard using information already to hand.

Principles

Salt stores

Land use-induced salinity depends, in the first place, on the existence of mobilisable salt in the landscape. For this information, we have drawn upon the digital soils atlas (NRIC/CSIRO 1991) to reinterpret the 1:5 million scale map of soil management properties in the Atlas of Australian Resources (NATMAP 1980). Figure 1 shows saline soils (category Bd, soils with > 1% sodium chloride in the subsoil) and soils with deep salt stores. For the latter, we have assumed that all thick clay soils, and probably the underlying regolith, retain salt against moderate leaching and have included duplex soils (categories A2, Cc, and Cd) which are in many cases sodic, probably the imprint of salinity; massive earths (Bb4); and calcareous earths (Bc2) which overly marine alluvium in the Murray Basin. In the first version of our maps, we excluded the cracking clays (Cb) which certainly accumulate salt but which we judged to be watertight in

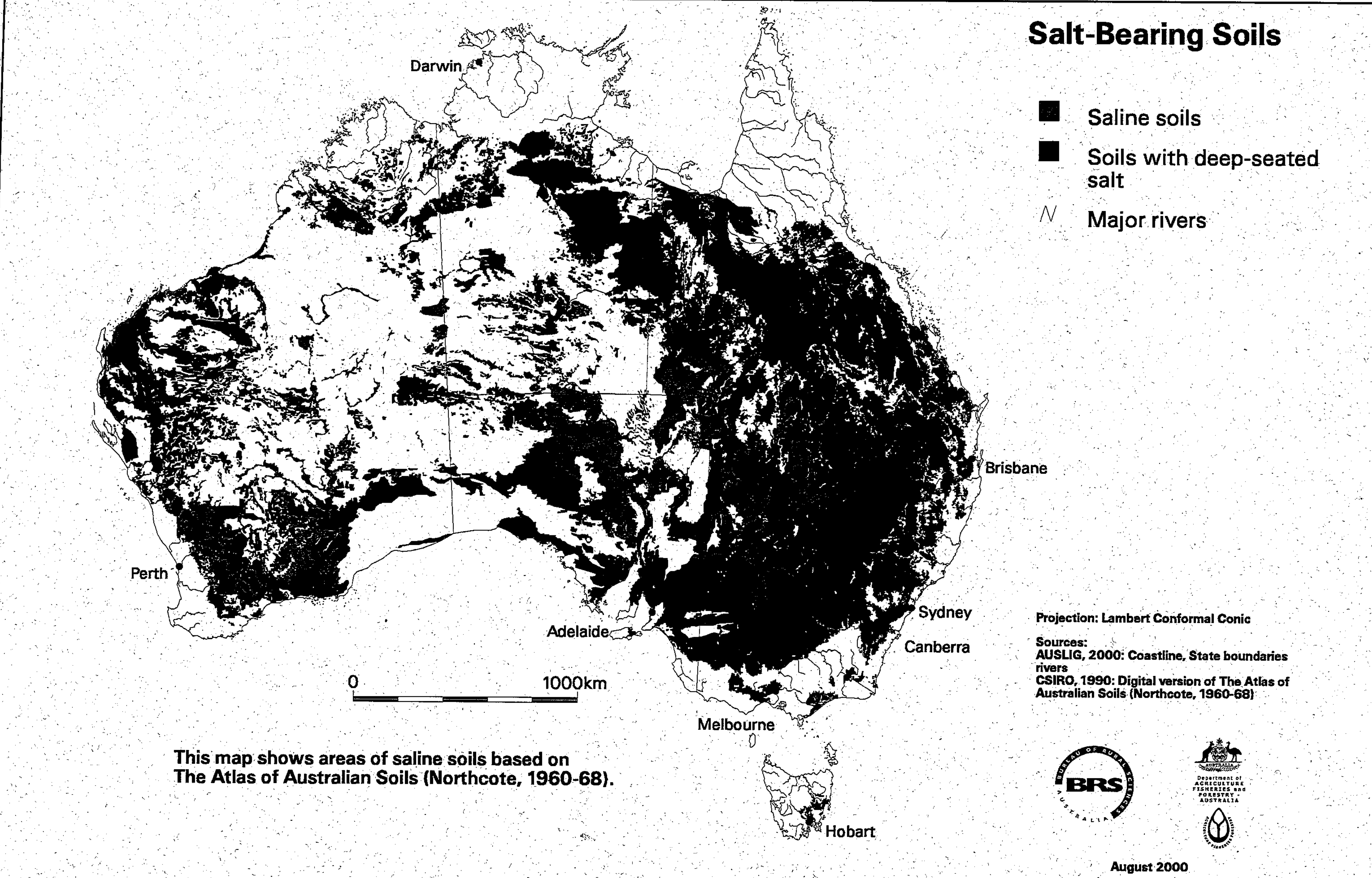

Figure 1. Saline soils and soils with deep salt stores.

which case the salt would stay entrapped. On the advice of Dr John Williams (pers. comm.), these soils are now included. Field experimental measurements indicate that although the drainage through cracking clays is slow, it is enough to leach a significant amount of salt over the time scale we are considering (over several decades) for development of dryland salinity. The soil/regolith thickness criterion was implemented by excluding slopes > 12 % using the national $^1/_4$° digital elevation model (AUSLIG 1998).

In the humid areas, even clays are leached of soluble salt. The discontinuous humid rim of Australia was defined as the area with a seasonal rainfall surplus ($R > 0.75\ E_{pan}$) greater than 125 mm. These data were taken from national climatic surfaces (Centre for Resource and Environmental Studies, Australian National University 1999) using monthly normals of rainfall and evaporation. The value of 125 mm was arrived at by local calibration against areas known to be close to the humid margin of salinity.

Land Use Induced Salinity

Salt mobilisation is attributed to changes of land use and management that have increased deep percolation through the subsoil, mobilising salt and carrying it to slicks (sumps in the lower part of the landscape), and through buried plumbing systems in the upland basins and terraces to the major streams. The land use changes include clearance of woodland, and more recently, clearance of trees in lightly wooded pastures and the replacement of grassland by arable crops that leave the land bare during much of the cool season when much of the rain falls in southern Australia. We have adopted a range of regional coefficients to convert evaporation pan values to estimates for consumptive use by pastures ($E_0 = E_{pan} * 0.4 - 0.85$) following FAO (1986); and have multiplied this regional value by a crop coefficient of 0.5 for cool season crops in winter rainfall areas and 0.75 for crops in summer rainfall areas.

We assume that where there is no seasonal rainfall surplus, there will be no deep percolation so salts will not be mobilised. Therefore, the areas of land use-induced salinity hazard are those with a rainfall surplus of 0-125 mm.

By overlaying the areas of 0-125 mm rainfall surplus and areas with mobilisable salts, we arrived at two concentric zones subject to land use-induced salinity, under rainfed crops and pastures, and under rainfed arable soils respectively (Figure 2).

Salt transport

Some of the mobilised salt moves directly to the rivers which, therefore, carry increased salt loads away from the salt-source areas. Some moves indirectly to the rivers by local and intermediate groundwater flows (Coram *et al.* 1999) which supply the base flow of rivers, in some cases well beyond the salt-source areas. For these reasons, stream and groundwater salinity are problems in areas downstream of the source areas.

Irrigation adds substantial additional volumes of water, all containing salt. Much of the water is lost by deep percolation so that a combination of rising groundwater and salinity is familiar in most irrigation schemes. This is indicated in Figure 3 by the addition of proportional circles to represent the areas under irrigation in each shire (ABS, 1997).

Calculation and iteration

Calculations of data for $^1/_4$° pixels, overlays and subtractions of the various layers of data, and successive iterations to produce the present map were accomplished using ASSESS decision-support software that enables interactive interrogation of a digital data base (Veitch and Bowyer 1996).

Limitations

We have used readily available national scale datasets as surrogates for maps of salt stores, hydrological surpluses, and groundwater transport mechanisms. It needs to be emphasised that these are complex issues that involve many other factors than those used here. For this reason, the derived map is no more than a first approximation of salinity hazard.

References

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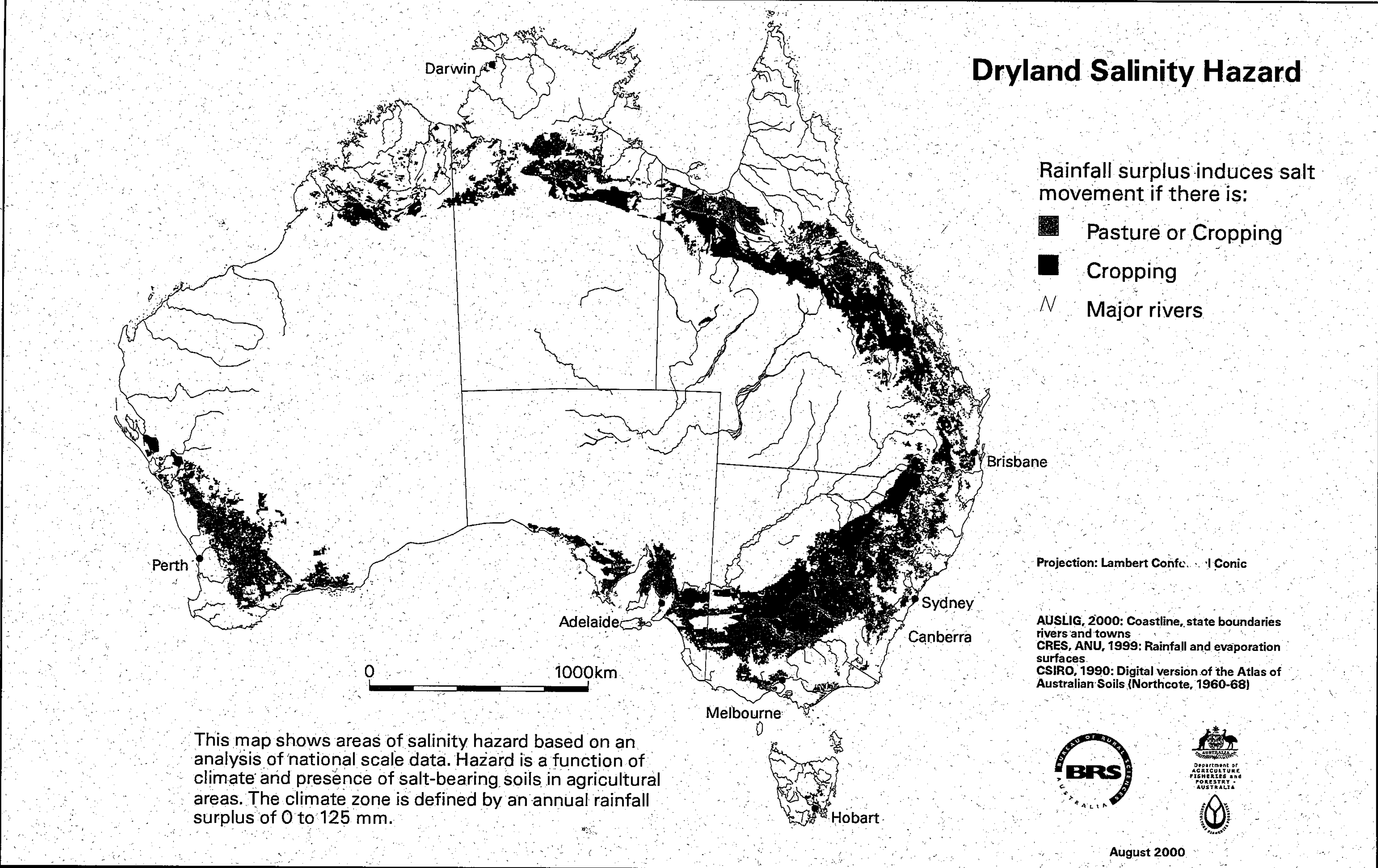

Figure 2. Zones subject to land use-induced salinity under rainfed crops and pastures and rainfed arable soils.

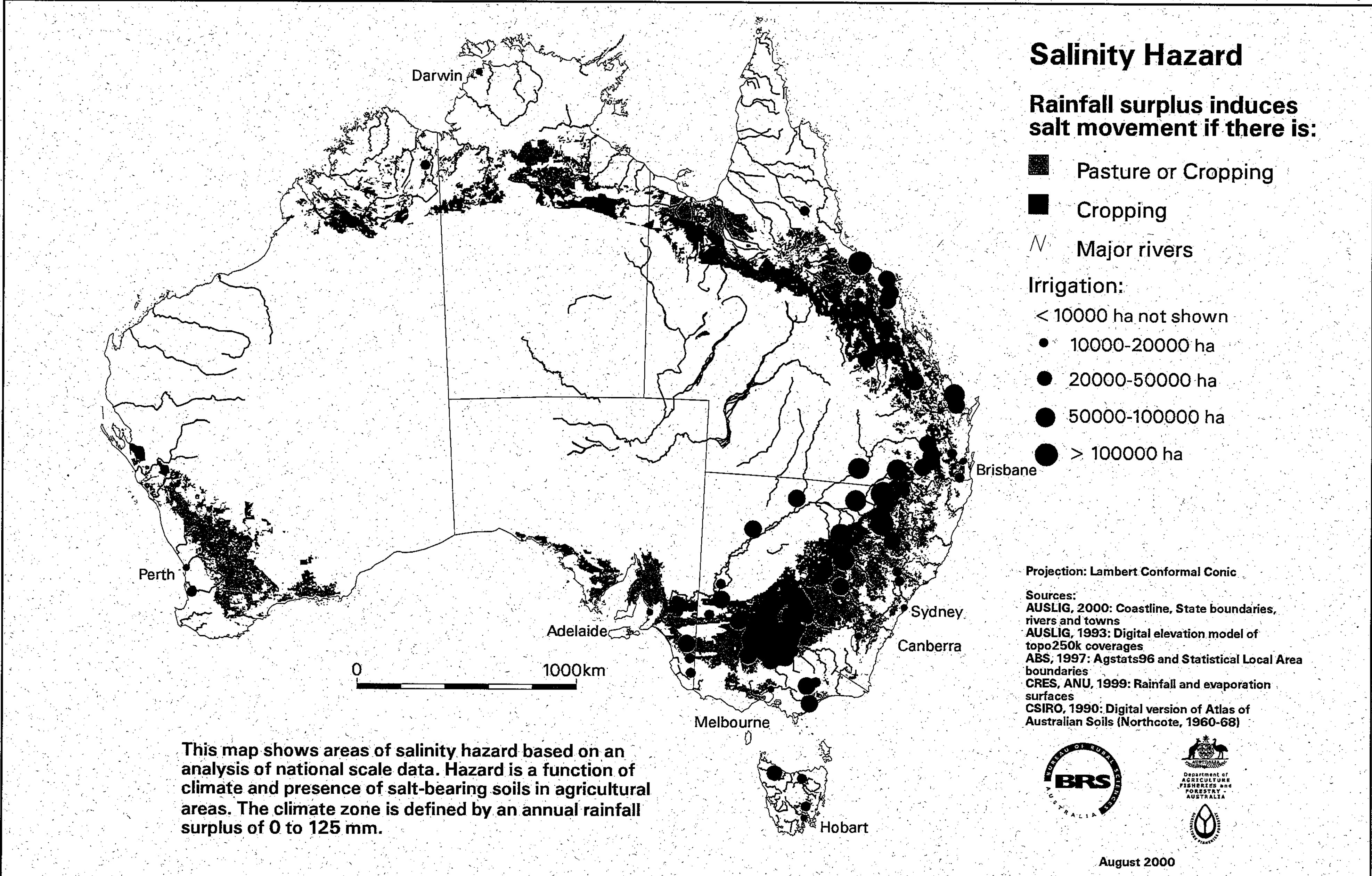

Figure 3. Irrigation adds volumes of water containing salt.

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Resource information revival - the foundation for rural Australia's sustainable future

Richard Tucker

Documenting and understanding natural resources remain essential tasks; and knowing the distribution of natural resources contributes to the understanding of the resources themselves as well as facilitating and relating management considerations, and other findings and interpretations, to an objective spatial view of the continent and its regions.

The assessment of the distribution of natural resources is critical for all levels of land use planning and environmental assessment, and it needs to be revived at a national level.

At the moment there is an impression that useful work is being done. However much is simply re-massaging old data, particularly that from the Atlas mapping, published in 1968. A lot of emphasis is being placed on remote-sensing, however much of its proofing is most likely based on the limited data already in existence. Ready access to GIS and its application can convey false impressions of the substance behind slick presentations - rubbish in, rubbish out, and users none the wiser.

Commonwealth, State and Territory agencies are forced to address important resource-based projects through piecemeal approaches. This is often done by reassigning staff from other areas, and then on completion of projects, reassigning them away from that area of work. This, or the ad-hoc staffing via funding from NHT etc., is not a good foundation for a national approach to establish and maintain a national resource inventory and associated task force to address the complex recording and management issues involved.