Identifying and Managing Soil Salinity at Multiple Spatial Scales on King Island, Tasmania

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Declaration

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Abstract

Soil salinity is a major determinant of agricultural productivity in many regions of Australia. Soil salinity is also spatially variable. This thesis examines the application of electromagnetic induction geophysical techniques and coincident soil sampling to (1) represent the areal extent and magnitude of soil salinity on the agricultural areas of King Island, Tasmania, (2) constitute its major causes; and (3) address mitigation strategies.

An automated electromagnetic induction meter used in the vertical dipolar mode (EM31v) was used to capture apparent total soil conductivity data over 15,420 Ha of the island. A total of 447 soil samples were obtained from sixty-one soil sample holes typically to 350 cm below surface. Ordinary least squares-based regression methods were used to predict average EC_e at the soil sample sites using the conductivity data (EC_a) assessed by the EM31v ($R^2 = 0.76$, p-value = 0.0001). A local, exponential semi-variogram kriging model was developed to interpolate average EC_e to 350 cm depth across the surveyed area. An analysis of geographic information layers, further terrain modelling, and climatic estimates of salt accessions were used to isolate the geological, geomorphological and climatic determinants of soil EC_e on the island.

Across the island the major source of salt is from west coast generated sea spray. Down to 350 cm, the highest average soil conductivity (EC_e of 8 dS/m and above) were found to occur in soils formed on Proterozoic granite, Proterozoic shale and undifferentiated Quaternary sediments. A long-term climate prediction, compelled by climate change forecasts of less rainfall to flush salt from these lithologies by 2030, is that the risk of salinisation in these areas will increase (by 10 %). Terrain morphology was found to be a good predictor of high EC_e on Proterozoic shale, but was found to be unrelated to EC_e on other lithologies. More generally, high EC_e in soils formed on granite were observed to occur at the valley floors and toward the crests of hills. Elevation and geological data were used to estimate the spatial location of high EC_e to 350 cm depth across the entire island (103,000 hectares).

At the landscape scale, hydrogeology was considered to be a potential determinant of elevated soil EC_e. Soil EC_e at valley floors and drained wetlands is associated with salt deposition by capillary action from shallow, highly saline water tables. On sloping land, the lateral flow of groundwater is expressed as saline seepage at break-of-slope areas.

At a finer scale, areas of low permeability subsoil restrict water percolation in several of the island's soil types, causing the development of perched water tables and localised near surface salinity. High surface salinity levels, compared to levels at 50 cm depth, occur without attendant high groundwater levels in some soil types. In these instances, it is suggested that topsoil compaction by livestock has reduced topsoil hydraulic conductivity, reducing the flushing of salt from the topsoil. Under these conditions increased surface and topsoil salinisation is exacerbated by evaporation, however, more research would be required to confirm this theory. If proven, the predicted drop in flushing rains due to climate change is likely to exacerbate this style of salinisation in the future.

Previous soil salinity mapping programs on King Island have been undertaken at the land system scale, thus assuming that characteristics within land system units are homogeneous. Assessed against the results shown in this thesis, the assumption of land system uniformity is shown to be incorrect. Salinity management decisions based on prior land system salinity maps may also have been incorrect.

The soil EC_e maps produced in this thesis may be used to improve sustainable farm management on the island. The maps are currently being used in the development of an Environmental Management System for landholders on the island.

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