Productive Saltland Pastures

Salinity Manual

Module 10

Interpretation of Salinity Data

Gillamii Centre

Government of Western Australia
Department of Primary Industries and Regional Development

natural resource management program

All photos from SGSL DAFWA team

SALINITY DATA

INTRODUCTION

This module provides standardised information on interpreting water and soil related salinity data so that it can be used to decide on appropriate management and use. Included in this module are the upper limit salinity tolerance levels for livestock, crops and pastures. In addition, due to the interest in groundwater disposal in the WA wheatbelt we have included an introductory section on acid groundwaters and interpreting samples.

CHANGES IN WATER QUALITY DUE TO SALINITY

In the agricultural areas of the state about three-quarters of the total soluble salt is common salt (sodium chloride). It is usually measure by electrical conductivity and quoted as millisiemens per metre (mS/m). It is sometimes expressed as milligrams of salt per litre (mg/l) for water or parts per million (ppm) which for most practical purposes are the same.

All farm-water sources e.g. dams, soaks and bores, should be regularly tested as salinity levels can change over a short period of time. This means the results are only accurate at the time of testing, for instance the salinity generally increases during summer because of evaporation. Monitoring farm water is an important factor in maintaining long-term production.

Many other factors influence the quality of water include:

- pH
- hardness
- nutrients
- Iron
- odour
- turbidit

SAFETY OF WATER FOR STOCK

The quality of water which stock drink varies greatly with circumstances and conditions. Usually stock become accustomed to the variations over the year and suffer no ill effects. However, stock suddenly introduced to salty water may either refuse to drink it or suffer ill-effects. Limits of soluble salts in water are listed in the table below. These figures are a guide to maximum levels but should not be rigidly followed. At these maximum levels there should be no harmful effect on health, although production may fall, and the animals should be watched carefully.

Where green feed is available, animals can tolerate more saline water than when dry feed, ‘bush’ or scrub; is the only feed.

SAFE UPPER LIMITS OF TOTAL SALTS IN WATER FOR LIVESTOCK

LIVESTOCK	MG/L	MS/M
Poultry	3,000	550
Dairy Cattle (Milk producing)	3,50	650
Pigs	4,500	800
Horses	6,500	1,200
Dairy Cattle (Dry)	7,000	1,300
Sheep (lambs, weaners, lactating ewes)	7,000	1,300
Beef Cattle	10,000	1,800
Sheep (adult,dry)	10,500 to 14,000	1,900 to 2,550

Stock can tolerate acid water values of a pH 3 however palatability is affected, and stock may not do well because of limited uptake due to taste.

See DPIRD webpages water quality for livestock and farm use

https://www.agric.wa.gov.au/livestock-biosecurity/water-quality-livestock

SALINITY TOLERANCE FOR CROPS AND PASTURES

A number of factors combine to influence the salinity tolerance of crops and pastures. These include climate, soil type (texture/structure) and internal soil drainage, plant species and varieties, stage of growth, the presence of a water table and its salinity concentration within the root zone.

As farmers in the WA wheatbelt and elsewhere in Australia increasingly incorporate saltland pastures and salt-tolerant crops into their farming systems a standardized terminology to describe the level of salinity in soils has been adopted (Barrett-Lennard et al. 2008). Salinity in the soil is determined as the electrical conductivity (EC) using the saturation extract (ECe) or the 1:5 extract (EC1:5). The EC1:5 are easy to measure in the field and are widely used and approximate conversion is made to relate to the more accurate ECe, however the EC1:5 must be regarded as an approximation due to a large number of variable factors including the level of saturation of the soil sample and the soil texture.

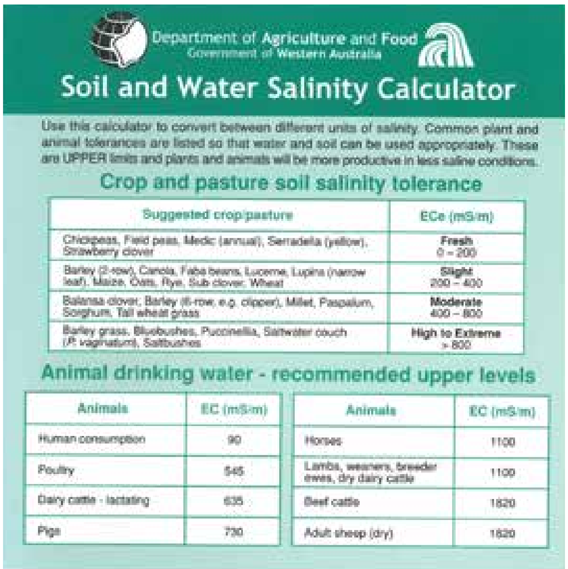
The table below is the adopted Australian classification system for categorization of soil salinity (Barrett-Lennard et al. 2008). The important factors to consider are the categories and the units (dS/m).

Suggested term	EC_e range (dS/m)	$EC_{1:5}$ range (based on conversions of George and Wren 1985)			Typical plants affected
		For Sands	For Loams	For Clays	
Non-Saline	0-2	0-0.14	0-0.18	0-0.25	-
Low Salinity	2-4	0.15-0.28	0.19-0.36	0.26-0.50	Beans[1]
Moderate Salinity	4-8	0.29-0.57	0.37-0.72	0.51-1.00	Barley[2]
High Salinity	8-16	0.58-1.14	0.73-1.45	1.01-2.00	River saltbush[3]; saltwater couch[4]
Severe Salinity	16-32	1.15-2.28	1.46-2.90	2.01-4.00	Puccinellia[5]
Extreme Salinity	> 32	> 2.29	> 2.91	> 4.01	Samphire[6]

References for effects on plants:

[1]Beans *(Phaseolus vulgaris)* - 50% decrease in grain yield at EC_e 4 dS/m (Steppuhn *et al.* 2005)
[2]Dryland barley *(Hordeum vulgare)* - 50% decrease in grain yield decreased at EC_e 8 dS/m (Steppuhn *et al.* 2005)
[3]River saltbush *(Atriplex amnicola)* - good survival at average EC_e values up to 12 dS/m (Barret-Lennard *et al.* 2008)
[4]Saltwater couch (Paspalum vaginatum) - good survival at average EC_e values up to 12 dS/m (Barret-Lennard *et al.* 2008)
[5]Puccinellia (*Puccinellia ciliata*) - can occur at EC_e values around 33 dS/m (Barret-Lennard *et al.* 2008)
[6]Samphire (*Halosarcia* spp.) - good survival at average EC_e values of 40 dS/m (Barret-Lennard *et al.* 2008); can survive at EC_e up to 105 dS/m (English 2004)

'Soil & Water Salinity Calculator' available at your local Department of Agriculture and Food office (pictured below).



Department of Agriculture and Food
Government of Western Australia

Soil and Water Salinity Calculator

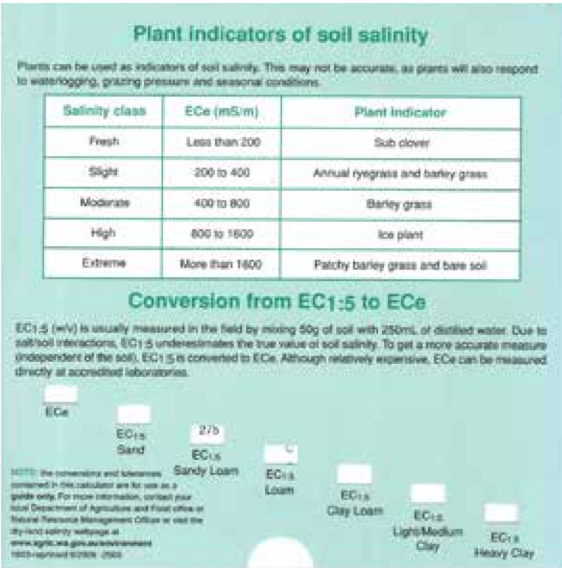
Use this calculator to convert between different units of salinity. Common plant and animal tolerances are listed so that water and soil can be used appropriately. These are UPPER limits and plants and animals will be more productive in less saline conditions.

Crop and pasture soil salinity tolerance

Suggested crop/pasture	ECe (mS/m)
Chickpeas, Field peas, Medic (annual), Serradella (yellow), Strawberry clover	Fresh 0 – 200
Barley (2-row), Canola, Faba beans, Lucerne, Lupins (narrow leaf), Maize, Oats, Rye, Sub clover, Wheat	Slight 200 – 400
Balansa clover, Barley (6-row, e.g. clipper), Millet, Paspalum, Sorghum, Tall wheat grass	Moderate 400 – 800
Barley grass, Bluebushes, Puccinellia, Saltwater couch (P. vaginatum), Saltbushes	High to Extreme > 800

Animal drinking water - recommended upper levels

Animals	EC (mS/m)	Animals	EC (mS/m)
Human consumption	90	Horses	1100
Poultry	545	Lambs, weaners, breeder ewes, dry dairy cattle	1100
Dairy cattle - lactating	635	Beef cattle	1820
Pigs	730	Adult sheep (dry)	1820



Plant indicators of soil salinity

Plants can be used as indicators of soil salinity. This may not be accurate, as plants will also respond to waterlogging, grazing pressure and seasonal conditions.

Salinity class	ECe (mS/m)	Plant indicator
Fresh	Less than 200	Sub clover
Slight	200 to 400	Annual ryegrass and barley grass
Moderate	400 to 800	Barley grass
High	800 to 1600	Ice plant
Extreme	More than 1600	Patchy barley grass and bare soil

Conversion from EC1:5 to ECe

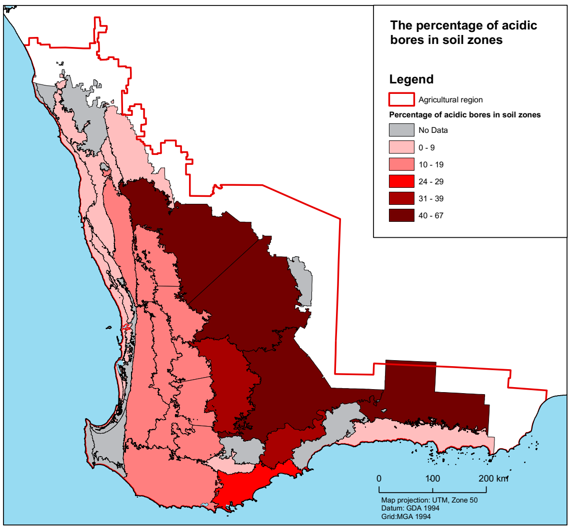
EC1:5 (w/v) is usually measured in the field by mixing 50g of soil with 250mL of distilled water. Due to salt/soil interactions, EC1:5 underestimates the true value of soil salinity. To get a more accurate measure (independent of the soil), EC1:5 is converted to ECe. Although relatively expensive, ECe can be measured directly at accredited laboratories.

ECe
EC1:5 Sand
EC1:5 Sandy Loam
EC1:5 Loam
EC1:5 Clay Loam
EC1:5 Light/Medium Clay
EC1:5 Heavy Clay

Use this calculator to convert between different units of salinity. Common plant and animal tolerances are listed so that water and soil can be used appropriately.

GROUND WATER ACIDITY SUMMARY AND INTERPRETATION OF DATA

Acid saline groundwaters are naturally occurring in the south west of Western Australia. Acidic groundwaters become more frequent as you move from higher rainfall areas to the drier flatter eastern wheatbelt and Esperance mallee (Lillicrap and George, 2008).



The 2007 Western Australian State of the Environment Report has identified acidification of inland waters as an important issue because in agricultural areas with clearing and drainage for salinity management there has been increased discharge of acid saline groundwaters into the environment.

Acidification impacts on agriculture, infrastructure and the environment. Agricultural impacts include decline in stock health where stock drink acidic water. Acid corrodes iron and concrete resulting in damage to infrastructure such as pipes and fencing. Environmental impacts include decline and loss of species such as: water birds, amphibians, aquatic plants and invertebrates (Jones et al 2009).

Key indicators are bare ground, iron stains on the ground and slimes in water (see photos).

Iron coloured slime in the water is a good indicator of acidic conditions

Acid groundwater with salinity preverents natural saltland regeneration processes

Groundwater can contain substances such as ferrous iron which when exposed to air can lead to further acidification of water. These stores of potential acid can not be detected with a pH meter therefore a separate test for acidy is required.

Field test kits for alkalinity (left) and acidity (right).

Acid groundwater effects on road culvert

Acid groundwater effects on amphibians

These tests measure acidity levels using a simple field titration technique. Groundwater can also contain substances that can buffer or prevent the groundwater from going acidic. The buffering capacity of the groundwater is determined by measuring the alkalinity of the groundwater. Alkalinity is also measured by a simple field titration technique. These field tests will usually quote acidity and alkalinity as milligrams per litre calcium carbonate (mg/L $CaCO3$). These field tests provide a quick and simple method to determine if the groundwater will become acidic if it has not already done so. If you subtract the acidity value from the alkalinity value and it gives a positive figure, it indicates that the buffering capacity is greater than the acidity store and the groundwater will not become acidic. However, if subtracting acidity value from the alkalinity value results in a negative value then the groundwater will likely become acidic. Please note to ensure that the acidity and alkalinity tests have the same units before trying to compare or subtracting results.

The field test kits are available from scientific or environmental suppliers.

REFERENCES

Barrett-Lennard EG, Bennett SJ, Colmer TD (2008) Standardising terminology for describing the level of salinity in soils in Australia. In 2nd International Salinity Forum: Salinity, Water and Society – Global Issues, Local Action'. Adelaide, South Australia.

Jones, S.M., Francis, C.J., Halliday, D.L. and Leung, A.E. (2009). The potential effects of groundwater disposal on the biota of wetlands in the Wheatbelt, Western Australia. Prepared for the Avon Catchment Council by the Department of Environment and Conservation, Perth

Lillicrap, A and George, R. (2008) Acidic groundwater in the south west of Western Australia: distribution and geospatial relationships in Shand, P., Degans, B., (eds) Avon catchment acidic groundwater- geochemical risk assessment. CRC-LEME Open File Report 191

http://crcleme.org.au/Pubs/OPEN FILE REPORTS/OFR 191/OFR 191.pdf

QUESTIONS

1. Salinity is one factor that affects water quality, what are some of the others?
   - ❑ pH
   - ❑ nutrients
   - ❑ odour
   - ❑ turbidity
   - ❑ all of the above

2. What is the maximum safe water salinity quality for sheep?
   - ❑ 1200mS/m
   - ❑ 2000mS/m
   - ❑ 1800mS/m

3. Units for measuring soil salinity are to be standardised throughout Australia and WA to dS/m?
   - ❑ True
   - ❑ False
   - ❑ Maybe

4. What are some of the impacts on agriculture of acidification?
   - ❑ decline in stock health
   - ❑ corrosion of concrete and iron in infrastructure
   - ❑ loss of species such as birds, fish and aquatic plants
   - ❑ all of the above

5. What are some of the key indicators for acid groundwater?
   - ❑ Iron stain on the ground and slime in the water
   - ❑ Water looks milky
   - ❑ Water looks clear

NOTES

PRODUCTIVE SALTLAND PASTURES

www.gillamii.org.au

Design by: Synergy Graphics 0439 936 514