Technical note 1

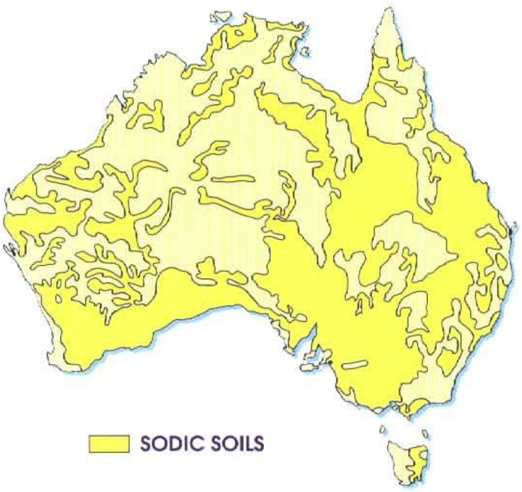
Introduction to soil sodicity

June 1994

Land managers with paddocks that are prone to waterlogging, poor crop or pasture emergence, gully erosion or tunnel erosion may be experiencing the effects of sodicity. Sodicity becomes a problem when there is sufficient sodium attached to the clay in the soil to affect soil structure. These soils are referred to as sodic and are often regarded as poorly structured and difficult to manage, and are susceptible to soil degradation such as erosion.

In Australia about 30% of the agricultural land is sodic. That is about five times the area of land that is estimated to be saline.

Not all poorly structured soils are sodic. Land managers need to distinguish between poorly structured non-sodic soils and sodic soils as management differs for each situation.



Distribution of sodic soils in Australia

Sodicity and salinity

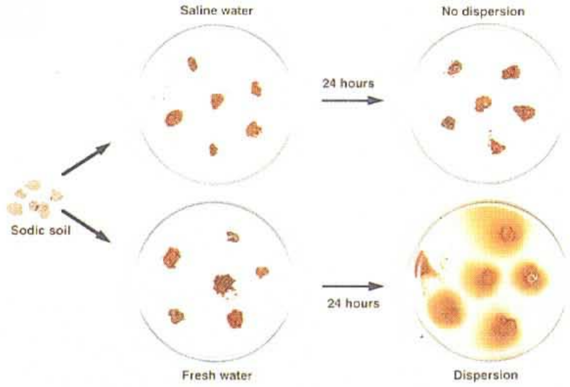
Both sodicity and salinity are caused by too much salt (usually sodium chloride) in the soil but sodic and saline soils have quite different problems and require different management techniques to maintain productivity.

Sodicity is caused by the presence of sodium attached to clay in soil. A soil is considered sodic when the sodium reaches a concentration where it starts to affect soil structure. The sodium weakens the bonds between soil particles when wetted resulting in the clay swelling and often becoming detached. When this happens the clay particles spread out or disperse making the soil water cloudy. This process is called **dispersion** and occurs in sodic soils without any disturbance of the soil. The dispersed clay particles can then move through the soil clogging pores. Both swelling and dispersion reduce infiltration and drainage. Once the sodic soil is broken down into very fine particles it can easily be moved by water or wind.

Most of the sodium in **saline soils** is in the form of soluble salts (mainly sodium chloride or common table salt) which can be easily dissolved and moved in soil water. Soluble salts reduce the availability of water to plants. The symptoms of salinity are commonly known and the severity can be easily measured. Sodicity is more common in Australian soils but its symptoms are not as well known and it is more difficult to recognise.

Salt, sodium and soil structure

A saline or salty soil will often not show the symptoms of sodicity even when sodium is present on the clay. The salt prevents the clay particles from dispersing.



Salt prevents clay dispersion but is detrimental to plant growth

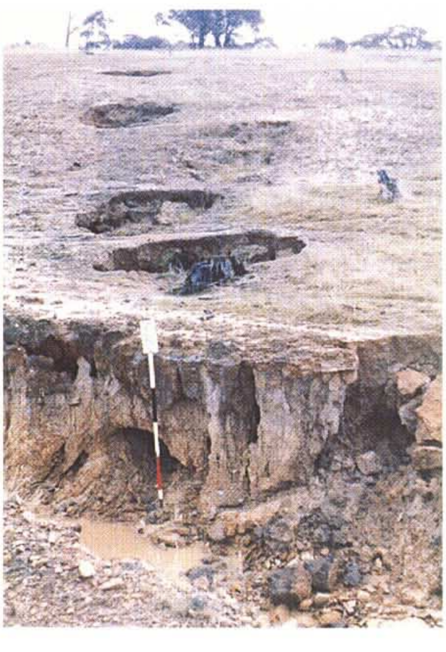
Sodium weakens the bonds between soil particles on wetting resulting in swelling and dispersion

Effects of saline and fresh water on swelling and dispersion

> Exchangeable sodium
>
> The sodium attached to soil particles is referred to as exchangeable sodium whereas the free sodium found in salt (eg. sodium chloride) remains unattached. The exchangeable sodium is moved out of the root zone by displacing it with calcium or subsequent leaching. The salt is moved by leaching alone.

Waterlogged sodic soil

Gully erosion of a sodic soil



Tunnel erosion of a sodic soil

If the soil is reclaimed by leaching the salt out of the affected soil layer, then symptoms of sodicity will start to appear. Temporary leaching of salts from surface soils, such as occurs after a rain storm, can also result in sodicity symptoms being observed.

Symptoms of sodicity

Sodicity can occur at any depth in the soil. A sodicity problem within a metre of the surface is more easily recognised than a problem deeper in the soil. In many soils that are agriculturally very productive, a sodic layer commonly exists below the rooting zone of the plants. This may have impact on crops or pastures if it is on flat land and could result in tunnel erosion if it is on a slope in a high rainfall climate. Symptoms are therefore a reflection of where the sodicity is a problem in the soil (topsoil, subsoil or both), climate (particularly rainfall) and slope (hilly country more susceptible to tunnel erosion).

Symptoms that are typical of a sodicity problem in the rooting zone of plants (ie. down to 60 - 100cm) include poor infiltration and drainage resulting in waterlogging, increased runoff and poor water storage, surface crusting, poor emergence of crops and pastures, problems with cultivation and erosion. The soils are often regarded as difficult to manage and have low productivity.

In irrigation areas the sodicity problem may occur in the topsoil as a result of sodic subsoil clay being brought to the surface or exposed by land forming.

Soils that are sodic below the rooting zone of plants often go unnoticed by land managers because there is frequently no obvious impact on farm management, especially in low rainfall regions. In some high rainfall areas, irrigation regions and where there have been high rainfall events, drainage can be reduced by sodicity resulting in waterlogging. This may not always be obvious by looking at the surface soil.

Visual symptoms of sodicity may occur in hilly country and where mole drains, interceptor drains and dams have been installed. Mole drains installed in sodic soil are susceptible to collapse. Interceptor drains and channels into and out of dams are susceptible to being eroded.

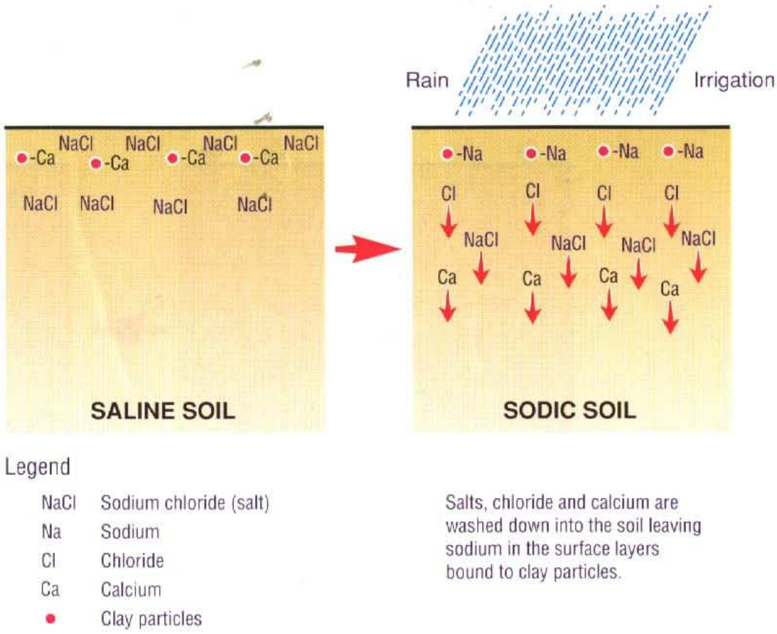
The effects of sodicity may also be seen in hilly country. Tunnel erosion can be a problem where the force of water moving down the hill can wash out soil, leaving cavities which eventually collapse to form gullies.

How do soils become sodic

A saline soil becomes sodic through the leaching of salt (eg. sodium chloride). This process may have occurred in the last 20 years or 10,000 years ago. As salt is washed down through the soil it leaves some sodium behind bound to clay particles displacing more useful substances such as calcium. This sodium builds up in the soil and interferes with soil structure.

The adjacent diagram highlights the steps in the formation of a sodic soil.

The amount of sodium and salt left determines whether the soil is non-sodic (very little sodium), sodic (a lot of sodium) or saline and sodic (a lot of salt and sodium).



Saline soil being leached with fresh water from rain or irrigation to form a sodic topsoil

Sources of salt and sodium

Soils can become saline due to rising watertables that bring the salt closer to the surface, through the use of saline irrigation water (eg. bore water, effluent), weathering of rocks containing salt or rainfall, and when paddocks are close to the sea or exposed to sea winds. In some regions, salt blown in from the sea has caused salinity several hundred kilometres from the ocean.

The additions of salt from rainfall and weathering rocks are very slow processes that take thousands of years before the concentration of salt in the soil becomes a problem.

Some soils are naturally saline due to trapped marine salts from land being inundated by the sea many thousands of years ago.

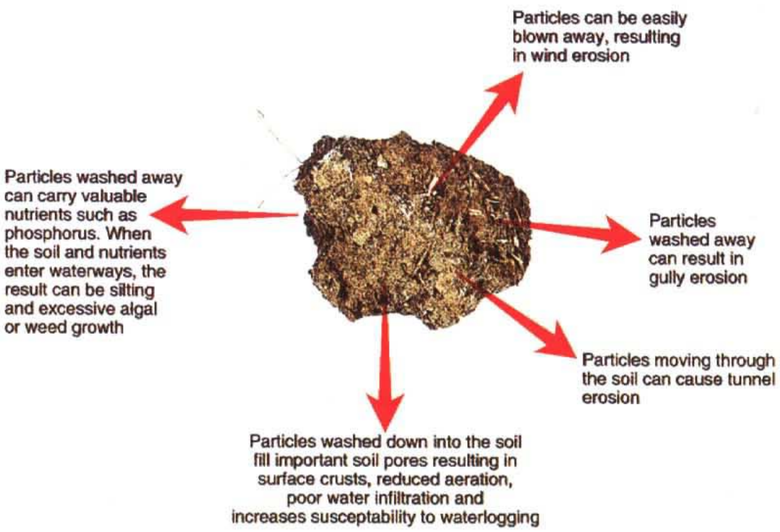
Not all dispersion is caused by sodicity

Erosion, waterlogging, poor emergence and a range of other symptoms can also be observed without sodicity being a problem.

Tillage and the impact of rainfall can cause sodic and non-sodic soils to disperse whereas in sodic soils dispersion occurs spontaneously. This means that when a lump of soil is put into water, it will disperse without any disturbance of the soil. Many soils will not disperse until disturbed by tillage or other mechanical operations. The presence of large amounts of sodium in the soil aggravate these problems and in many instances exert a considerable impact on plant productivity.

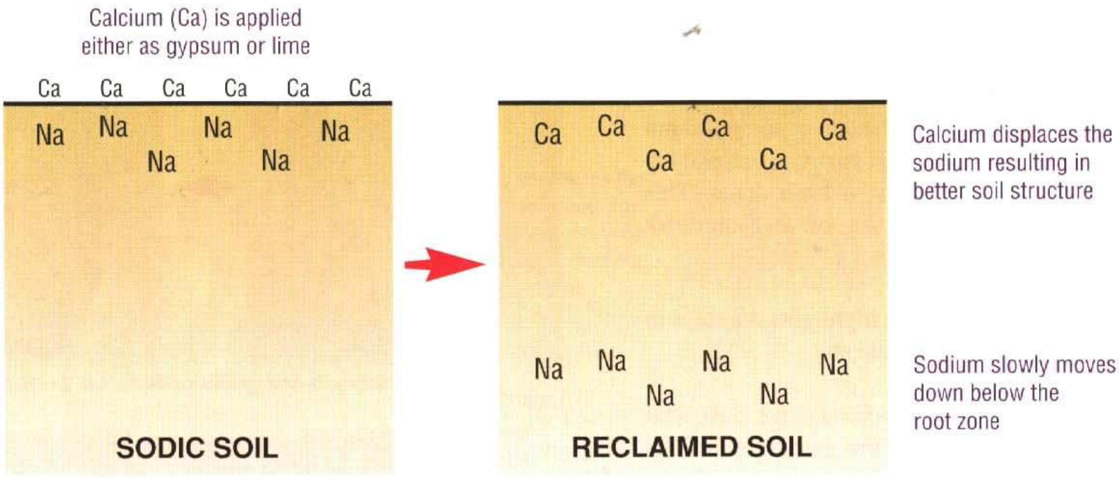
Soil testing for sodicity

Land managers can determine whether sodicity is a problem by sending soil samples to a reputable laboratory for analysis.



Movement of fine soil particles

Managing sodic soils



Reclaiming a sodic soil

To increase productivity of sodic soils, land managers need to apply gypsum or, in the case of acidic sodic soils, lime or a combination of both. The gypsum and lime have three important effects that contribute to better soil structure and increased plant productivity.

Firstly, the calcium in the gypsum and lime displaces the sodium which can then be leached deeper into the soil. This is a very slow process with the low rates that land managers can usually afford to apply.

Secondly, gypsum and lime act like common salt in that they help prevent the clay from swelling and dispersing. Unlike common salt , they are not detrimental to plant growth.

The land manager can therefore gain the benefits of better soil structure even though the sodium attached to clay is only partially displaced by the use of small amounts of gypsum or lime.

Thirdly, the higher plant production from the use of gypsum or lime will also result in more plant residues. If these are not removed or burnt they will aid in building up organic matter. The additional organic matter improves soil structure adding to benefits of using gypsum or lime.

Where sodicity is not a problem, but soils exhibit the symptoms mentioned above, organic matter alone will improve soil structure

For further assistance contact your local adviser

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