Salinity Education Booklet for Community Monitors

In North Central Victoria

action Salinity & Water AUSTRALIA

Australian Government
Department of Agriculture, Fisheries and Forestry
Bureau of Rural Sciences
Department of the Environment and Heritage

WATERWATCH North Central
Communities Caring for Catchments

North Central Waterwatch-
Community Stream Sampling Program

COMMUNITY STREAM SAMPLING and SALINITY MAPPING in the Murray Darling Basin

North Central Waterwatch has received funding through the Australian Government's "Community Stream Sampling and Salinity Mapping Project—in the Murray Darling Basin" to implement a regional community based salinity monitoring and mapping project. The project will run over the next two years and is funded by the Australian Government through the National Action Plan for Salinity and Water Quality (NAP). The overall project is being managed by the Department of Agriculture, Fisheries and Forestry's Bureau of Rural Sciences (BRS) and delivers on the 2004 election commitment of the Australian Government to commit $20 million to identify and manage underground salt deposits in the Murray Darling Basin.

The main objectives of this program are to:

- build on existing salinity data with the acquisition of new stream sampling and salinity mapping data;
- provide communities within the Murray Darling Basin with the means to identify areas of high salinity risk; and
- prioritise investments for future salinity management by providing comprehensive, comparable data.

COMMUNITY STREAM SAMPLING

The community based stream sampling aspect of this project is designed to strategically monitor salinity, stream flow and temperature within the Murray Darling Basin over a two year period. This project relies on the efforts of the community to undertake surface and shallow water monitoring to provide information which will be used by catchment management authorities and community groups to plan and target salinity and water management programs. The project will also provide a consistent database on salinity levels across the Murray Darling Basin to assist with setting priorities for future salinity investment.

A web-based database and mapping tool will be developed by the Bureau of Rural Sciences, which will allow community groups to: enter, access and analyse data online. The data will also be collated at the catchment and basin level to provide maps identifying sub-catchment trends.

COMMUNITY STREAM SAMPLING IN NORTH CENTRAL VICTORIA

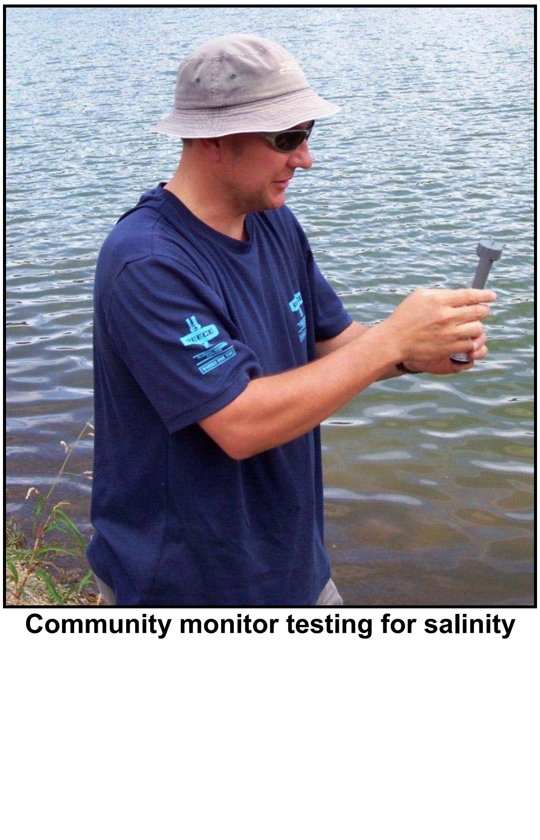
In June 2006 North Central Waterwatch obtained funding through the Community Stream Sampling and Salinity Mapping project to undertake targeted salinity monitoring which will build on its existing community monitoring program.

Efforts will be focussed on recruiting and training new and current community monitors to collect salinity data at strategic locations along waterways and other surface waterbodies. North Central Waterwatch have developed a range of supporting documents, including: a data confidence plan, interpretation and methods manual and regional monitoring plan to assist community monitors in gathering high quality water quality data.

The North Central Community Stream Sampling project only requires monitors to test for electrical conductivity (salinity), temperature and stream flow. However, there are a range of other parameters community monitors can monitor by participating in the existing North Central Waterwatch program in conjunction with this new program.

Water quality monitoring is performed on a monthly basis to ensure that a comprehensive dataset is created, from which reliable trends can be extrapolated. Strategic monitoring sites, chosen by Waterwatch staff, are allocated to community monitors depending on the individual's/group's interest and location.

Salinity information gathered through this program will be of great use to the community, government agencies and other land managers within the North Central region, as well as contributing to the overall dataset collected across all regions within the Murray Darling Basin.



Community monitor testing for salinity

Salinity Explained

The term ***SALINITY*** refers to the movement and concentration of salt - dissolved in water - though the landscape. Soils and natural water can both become saline, therefore salinity can be described as either soil or water salinity. Salts include sodium chloride (common table salts), calcium carbonate (limestone) and many others. These salts are dissolved by water as it runs over and through rocks and soils.

All natural waters contain some dissolved salts, which are vital for aquatic plant and animal growth. However, high levels of salt can make water unsuitable for uses such as drinking and irrigation, and may harm plants and animals. High salt concentrations make it hard for many types of plants and animals to absorb water, leading to dehydration, upsetting natural electrolyte (salt) levels within tissues and in severe cases, leading to death.

Where does the salt come from?

There are three major sources of salt in Australia. Retreating seas, rain and rocks have contributed to the amount of salt in our soils and natural waters.

Rain

Salts can be carried from the sea by strong winds and fall as rain across inland areas. Salt concentration in rainfall is obviously higher nearer to the coast, but still contributes a substantial amount of salt to inland environments. Between 20 and 200 kg/ha of salt can be deposited during a year of average rainfall.

Retreating Seas

Many areas across Australia were once covered by an inland sea. When the sea retreated about 10 million years ago, the sediments that were left behind contained large amounts of salt.

Rocks

Salts are contained within rocks and are released during the weathering process. Many types of rocks including marine sediments, granites and rhyolites contain high levels of sodium and potassium (salts) which may be mobilised after weathering.

Salinity in Australia

Throughout the Australian landscape, there are large amounts of naturally occurring salt. Many Australian rivers drain to internal lakes where they have, over time, been concentrating salts. Naturally occurring salt affected areas such as these are referred to as ***PRIMARY SALINITY***.

Increasing salinity is one of the most significant environmental problems facing Australia. Salinity problems in Victoria have resulted largely from human activities which have modified the natural distribution of salt in the landscape.

Naturally, water moves into the soil during and after rainfall and is stored in the soil profile. Much of this water is used by plants; however, the remainder finds its way past the root zone and into the groundwater system, dissolving salts as it percolates through the soil. This leads to a natural concentration of salts it groundwater. The upper surface of the groundwater is known as the watertable.

Many of the salinity affected areas in Victoria were previously covered by deep rooted, native vegetation, which kept the watertable well away from the soil surface. The discovery of gold in Victoria during the 1850's and 1860's had a major impact on the natural landscape. Miners stripped the vegetation from mining areas and cleared nearby forests for timber and fuel. This coincided with the opening up of Crown Land for selection which required them to clear and fence their land in order to maintain their tenure. Large areas of Stringybark and Box-ironbark forests disappeared while Red Gum forests were reduced to small pockets along roadsides and creeks. These vast areas of native vegetation were, in many cases, replaced with shallow rooted crop plants and pasture grasses. This led to an increase in the rate of groundwater recharge, leading to a rise in watertable level.

When the watertable reaches a level of 1-2 meters from the ground's surface the water moves by capillary action and brings salt with it. Water evaporates and leaves the salt within the surface layers of the soil. Over time this causes the soil to become saline and limits the growth of vegetation. At increased salinity levels salt sensitive plants begin to die and leave the soil prone to erosion. High salt content also causes the decline of soil structure which further exacerbates soil erosion. This accumulation of salt in the soil is referred to as **SOIL SALINITY.**

Salt brought to the surface is washed into streams when it rains. This is often referred to as "**WASHOFF**" and can be the major contributing factor to stream salinity in many areas.

As watertables rise, they may reach a point where they reach the surface. This will generally occur in the lower parts of the landscape such as streams and other surface water accumulation points. Stream incision caused by increased stream power due to the removal of catchment vegetation is very common in Victoria and increases the likelihood that raised groundwater will discharge into stream channels. This groundwater intrusion is referred to as "**BASEFLOW**". In areas with highly saline groundwater, baseflow can contribute high amounts of salt to surface waters.

Soil and water (groundwater and surface water) salinity caused by the removal of vegetation and the resulting elevation of groundwater table is referred to as **DRYLAND SALINITY**.

Water balance before clearing **Water balance after clearing**

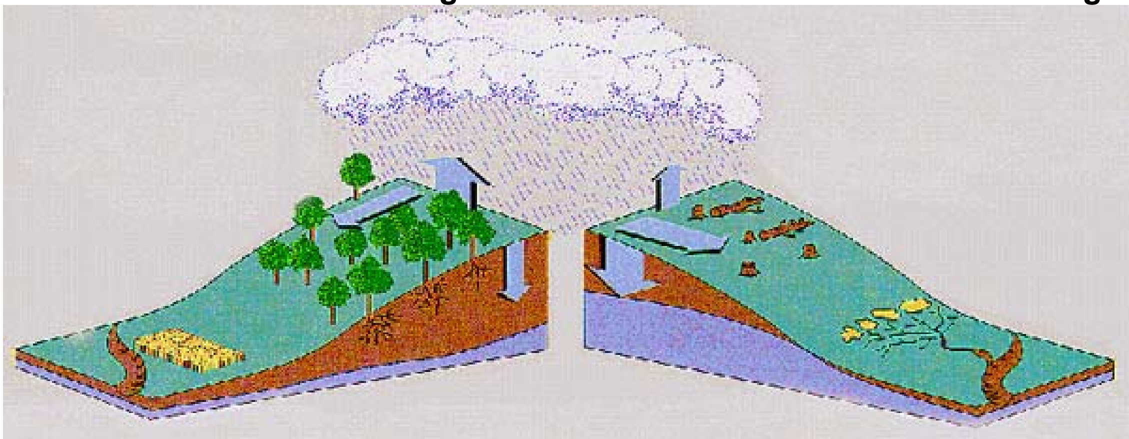


Figure1. Dryland salinity (Taken from Landcare Notes 1999).

Irrigation has the same affect as an increase in rainfall. Sub-surface drainage and salt disposal are required in irrigation areas that are impacted by saline groundwater. This will prevent a rise in the saline watertable and accumulation of surface salt which result in productivity loss and infrastructure damage through waterlogging and salinisation.

Saline areas that have resulted due to human intervention in the landscape are referred to as ***SECONDARY SALINITY***.

The Impacts of Salinity

The National Land a Water Resources Audit (2001) estimated the area of land in Australia that has a high potential to develop dryland salinity at 5.7 million ha, which may rise to 17 million ha by 2050. The proportion of agricultural land that is at risk of being affected exceeds 15 percent nationally.

The effects of salinity are broad and include:

- reduced productivity capacity of affected land,
- degradation of the environment and wildlife habitats,
- reduction in plant and animal diversity due to saline soils and water,
- deterioration of water quality which limits the use of water for stock and domestic water supplies and increases the cost of water treatment,
- loss of production causing social, psychological and economic hardship,
- damage to roads,
- damage to other infrastructure such as channels,
- damage to water using equipment/machinery.

It has been estimated that salinity costs $304 million per year in the Murray Darling basin. This figure includes: loss of agricultural production, damage to infrastructure and water quality associated costs (treatment etc).

Impacts on productivity and biodiversity

Some types of vegetation are tolerant of very saline soils and water, while others are extremely sensitive to even the slightest increase in salinity levels. Many annual crop species will suffer productivity losses as soil and water salinity increases and may become economically unviable in many salt affected areas.

Animals such as cattle and sheep have varying degrees of sensitivity to water salinity, which may be exacerbated with young or lactating individuals. As a guide, *maximum* desirable levels (measured in Electrical Conductivity (EC) of salt for stock water are as follows:

Effects of saline drinking water for different livestock types

Livestock	**No adverse effects** on animals expected.	Animals may have initial reluctance to drink or there may be some diarrhoea, but **stock should adapt** without loss of production.	Loss of production and a **decline in animal condition and health** would be expected. Stock may tolerate these levels for short periods if introduced gradually.
	EC in µS/cm	**EC in µS/cm**	**EC in µS/cm**
Poultry	0 to 3100	3100 to 4700	4700 to 6300
Beef cattle	0 to 6300	6300 to 7800	7800 to 15,600
Dairy cattle	0 to 3900	3900 to 6300	6300 to 10,900
Sheep	0 to 7800	7800 to 15,600	15,600 to 20,300*
Horses	0 to 6300	6300 to 9400	9400 to 10,900
Pigs	0 to 6300	6300 to 9400	9400 to 12,500

* Sheep on lush green feed may tolerate salinity up to an EC value of 20,300 µS/cm without loss of condition or production.

(Source: http://www.agric.nsw.gov.au/reader/wm-animals-waterquality/water-tests-livestock-4270.htm#symptoms)

Stock may also be affected by reduction in the availability of fodder due to salinity increases.

Natural biodiversity is also affected. Native plants may be affected in the same manner as crops, aquatic animals and plants may be affected due to increases in stream salinities, just as animals dependent on streams as a drinking water supply may be adversely affected. In Western Australia there are 450 plant species and an unknown number of invertebrate species at risk of extinction due to increasing salinities in lower catchment wetlands.

Deterioration of water quality

Salinisation of ground and surface waters can render them unusable for many applications. As water quality deteriorates, so does the cost of water treatment and repair of infrastructure. It has been estimated that a 5% increase in salinity, turbidity and sedimentation throughout Australia would cost $1433 million over the next 20 years.

Damage to infrastructure, equipment and machinery

Salt causes damage to infrastructure in various ways:

- Encroaching saline watertables cause damage to brickwork and foundations as salt is drawn up into the mortar or concrete. The resulting chemical and physical processes then weaken mortar/concrete, compromising the stability of the structures they comprise.
- Saline water causes bitumen to break up, causing very costly damages to roads.
- Lawns and trees in public or private gardens can be destroyed by rising salt.
- Stability of earthen channels (irrigation channels) can be compromised by rising saline water tables.
- Salt present in reticulated water supplies can cause damage to pipes and hot water systems through increased corrosion rates.
- Concrete sewers and potable water pipes can be weakened by rising saline water tables resulting in breakages and costly repairs.

Damage to infrastructure caused by salinity is a very expensive problem. Saline water causes millions of dollars damage each year and will continue to do so into the future. The National Land and Water Resources Audit (2001) identified that 67,000km of road, 5,100 km of rail and 220 towns will be at high risk of damage due to saline watertables by 2050.

The Extent of Salinity in the North Central Region

Prior to European settlement, hydrological and salt balances were maintained entirely by native vegetation. Loss of this native vegetation to agricultural pastures and crops and irrigation are largely responsible for salinity problems across the region. The North Central region has some of the most severely salt-affected areas in Victoria, which directly affect the Murray River. It also has some of the highest levels of mobilised salts loads in Victoria. Both dryland and irrigation salinity occur within the North Central region of Victoria. Almost 32,000 hectares of land have been mapped as being affected by dryland salinity, with around half of this located in the Avon-Richardson catchment. Only 1% of the North Central region is affected by dryland salinity, however 10% is considered to be at risk of developing shallow water tables and salinity. More than 50% of the land irrigated in the lower catchment area is estimated to be affected by salinity.

Shallow watertables and salinity pose a pervasive threat across dryland and irrigated areas of North Central Victoria. They already impact on the condition of many of the region's most significant natural assets and affect cultural heritage sites and infrastructure. The costs of salinity are substantial in economic, environmental and social terms. Dryland salinity threatens agricultural production across the region, as well as threatening native vegetation and fauna. Estimates suggest that 2,800km of the region's road network traverses land at risk from salinity and shallow watertables. Shallow groundwater and salinity discharge are major issues affecting the environmental values of many smaller blocks of public land and public land corridors, especially those located in floodplain and lower landscape positions. The most threatened ecosystems are those that are highly fragmented and located in lower landscape positions in mid and lower catchment areas. Wetlands, riparian zones, floodplains and aquatic communities are at highest risk.

A study conducted by the National Dryland Salinity Program, reports that dryland salinity costs Local Governments over $3 million annually, mostly due to damage to infrastructure; State Government and infrastructure based utilities incurred costs of over $6 million; households and businesses were set back almost $7 million; and agricultural producers were slogged with over $30 million in salinity based costs.

Avon-Richardson catchment

The lower Avon-Richardson catchment is one of the most severely salt-affected sections of the North Central region. Salinity in this area poses an immediate risk to the lower Richardson River, to the catchment's lakes and wetlands, and the flora and fauna that rely upon these systems. Concern was raised in the late 1960's by farmers who began noticing productivity losses in their crops, a problem that has been progressively worsening over the years. Salinity also threatens some of Donald's infrastructure as well as the amenity of residents and visitors. Processes that are believed to contribute to salinity across the Avon-Richardson catchment include: recharge associated with flooding; rainfall recharge, which is linked to agricultural or other land uses; leakage of water from surface water features; and interference with flood flows by infrastructure. Recharge associated with flooding appears to be the main driver of salinity on the Avon and Richardson River floodplains and around the catchment's lakes and wetlands. Irrigation farming practices are not employed within this catchment; hence it only suffers from dryland salinity.

Salinity in the Richardson River near Donald. This part of the river is highly saline; with a salinity four times that of seawater!

Avoca catchment

Salinity in this area is similar to that of other dryland areas of the North Central region. Some parts of the catchment have been cleared of deep-rooted, native vegetation which has caused watertable levels to rise resulting in increasingly saline soils and waterways. Salinity levels of water in the Avoca River basin are relatively high making it unsuitable for irrigation or domestic use and only moderately suitable for stock for most of the year.

Loddon and Campaspe Catchments

The geology of the Campaspe catchment makes it prone to salinity. Salinity in the dryland areas of the Loddon and Campaspe catchments is predominately due to the clearing of land and replacement of deep-rooted native trees with shallow-rooted annual pastures and crops; urbanisation also contributes to the salinity issue in these areas. The northern sections of the Loddon and Campaspe catchments also suffer from irrigation salinity due to poor irrigation practices such as over watering and inadequate drainage which have caused saline groundwater to be transported up to the surface. Approximately 55,000 tonnes of salt each year enters the Murray River from the Campaspe River.

How can we Manage this Problem

A whole catchment approach is required to manage such a widespread salinity problem. While sometimes causes and effects of salinity can be seen within a single farm, in the majority of cases the cause and effects cross property boundaries. The long-term solution to salinity is obviously to restore the balance of inputs and outputs of the soil-water system. This involves controlling the process of groundwater recharge. The treatment of salt affected land is a vital component of salinity management.

Large scale establishment of deep-rooted plants such as native trees and lucerne is required in dryland areas to restore the water balance. Strategic tree planting as part of a whole farm plan or catchment plan will also provide benefits. However, care must be taken when planning large scale, catchment wide revegetation, due to the impact it may have on stream flow. Increasing tree cover will reduce groundwater recharge, but in some areas, it may also decrease stream flow, decreasing dilution and leading to an increase in surface water salt concentration. This stresses the importance of careful planning at the catchment scale and the value of monitoring and evaluation strategies for salinity control works.

In irrigation areas, control techniques may include more efficient irrigation methods, drainage and reuse systems, groundwater pumping and re-layout of land to facilitate surface drainage and water application.

Appropriate management in salt affected areas can reduce further degradation of land and actually enhance productivity. The use of salt tolerant pasture species and grazing management may also increase productivity. There are multiple other options for utilising salt affected land and water with varying levels of applicability depending on the site characteristics. Saline aquaculture is one such option, with stock such as snapper, oysters, prawns and barramundi proposed. Seaweed and other salt tolerant algae species may also be grown in salinity affected waters. Saline waters can also be used to produce energy or to harvest valuable salts and minerals. Of these many options, only a few are viable at a scale that would make a real impact on the overall salinity issue. Further research into feasible and profitable options for managing salinity must be developed so farmers can adopt these practices.

Salinity management in the Murray-Darling Basin relies on joint action from all states within the Basin. Victoria is already committed to salinity control programs which coordinate the efforts of landholders and community groups with salinity control activities across catchments. The success of such programs relies on both community support and government resources.

The North Central region has strong and well established dryland and irrigation salinity programs in place. These programs address a wide range of natural resource issues linked to salinity, including: community engagement and capacity building; improving land management practices; protecting and restoring terrestrial, riparian and aquatic biodiversity; and improving river health and water quality.

As mentioned earlier, through the Community Stream Sampling Project and the North Central Waterwatch program vital salinity information is being collected and collated across the North Central region of Victoria, and more widely across the Murray-Darling Basin. Salinity information gathered by monitoring waterways for electrical conductivity (EC) across the region is a simple way to work out where salt is moving. This salinity information will be utilised to guide government agencies in the strategic management and targeting of priority salinity areas.

Salt affected farm land around Marnoo area.

GLOSSARY of terms

Catchment- The entire area from which a stream or river receives its water, from both surface and sub-surface or groundwater run-off.

Dryland salinity- the accumulation of salts in soils, water and groundwater often as a result of clearing native vegetation.

Groundwater- water beneath the surface held in or moving through saturated layers of soil, sediment or rock.

Irrigation salinity- accumulation of salt in soil, water and groundwater due to irrigation practices.

Primary salinity- salinity that is caused by an arid climate and internal drainage systems. This form of salinity is caused by natural processes.

Salinisation- the process that increases the concentration of dissolves salts.

Salinity- the process where a rise in underground watertables brings naturally occurring salt to the surface in a concentrated form.

Secondary salinity- salinity that results from human intervention of the landscape.

Water quality- a general term that describes the suitability of water for a given use (E.g. human drinking water, stock water, irrigation, etc).

Watertable- the upper surface of the groundwater.

Weathering- The disintegration and decomposition of rocks and other earth materials through exposure to the atmosphere (E.g. exposure to wind, water and ice).