Theme: Food and agriculture

ABSTRACT

Managing Salinity Risks Associated with Importing Irrigation Water into Clare, South Australia #292

Subtitle
This completely new approach to water management is based on the tonnage of salt imported rather than on the Mega Litres of water.

Description

Completed in 2005, the Clare Water Supply Scheme in South Australia was built to distribute additional water from the Murray River through the Clare River and beyond. So that the imported water can be used for irrigation without increasing the salinity of the soils or groundwater in the Clare district, a framework has been developed to enable irrigators to identify and to manage the environmental risks associated with the use of River Murray water for irrigation. The adopted framework has five innovative components. First, to limit and control salt accumulation over decades, irrigation water is allocated on the basis of its salt load rather than by volume. Second, the irrigation water can be applied only in a sub-catchment where the groundwater salinity trend is decreasing; it cannot be applied where the groundwater salinity trend is stable or increasing. Third, irrigators use district-scale Risk Maps and they undertake property-scale soil surveys to avoid applying irrigation water (and salt) onto areas where salt will accumulate. Soils data and the Risk Maps have been provided to irrigators as geographic information system map layers on an interactive computer compact disc. Fourth, equivalent salt loads are calculated to enable the exchange of a licence to access existing water resources (i.e. groundwater and / or surface water) for a licence to access a larger volume of lower salinity, River Murray (pipeline) water. Finally, monitoring and Irrigation Annual Reporting have been added to the conditions on water licences.

Lessons learned

- The water licensing policies determine the locations at which salt will accumulate and the number of years that will pass before salt becomes the major issue.
- A single source of regular, clear, consistent communication is essential to avoid confusion and to win support for any innovative strategy
- History shows that salt accumulation has caused the eventual failure of most irrigation schemes
- Wherever there is irrigation, salt management will eventually become the key issue
- a salt management strategy is highly relevant wherever there are plans to irrigate land that has not previously been irrigated
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Importance of the case for IWRM

- Irrigation Annual Reporting is an essential self-education tool for every irrigator
    - Simplicity: At the scale of each property, Irrigation Annual Reporting is a simple, inexpensive process where each irrigator measures and records information that is useful for them, on a locally-developed Irrigation Annual Report form.
    - Timely feedback: Feedback is an essential part of the Irrigation Annual Reporting framework. Feedback is achieved by providing a copy of the District Summary Irrigation Annual Report document to every contributor and then discussing the content of this Report at community meetings held within 2 months of collecting the data.
    - Benchmarking: This feedback provides data for benchmarking. Benchmarking enables each irrigator to compare their own irrigation management with the irrigation management of every other irrigator and with their own irrigation management in previous years. The feedback also enables industries to compare their irrigation performance with the performance of other industries. As additional districts adopt Irrigation Annual Reporting, these districts will be able to compare themselves with other districts. Eventually states will be able to compare themselves with other states.
    - Confidentiality: Only when the confidentiality of information provided by individual irrigators is guaranteed and delivered, will irrigators accurately report the sensitive data useful for them to see how their irrigation practices are changing from one year to the next and how their irrigation practices compare with other irrigators. For example the fraction of water that was wasted to drainage can be compared with how much was wasted in previous years and with the fraction wasted by other irrigators.
    - An irrigator will not provide accurate data if they suspect that their data may in future be used to their disadvantage. Irrigators know that independent checking of the accuracy of the data that they report is not affordable.
    - Legislated requirement: In South Australia a legislated requirement that licensees participate in Irrigation Annual Reporting is included in the current Water Allocation Plans for the Prescribed Areas of Northern Adelaide Plains, Barossa, River Murray, Angas Bremer, Mallee, Padthaway, Tatiara, Naracoorte Ranges, Comaum-Caroline, Lacepede Kongorong.
    - Community support: If Irrigation Annual Reporting is imposed without the support of the Irrigators, the information supplied by Irrigators is almost certain to be incomplete and inaccurate. If Irrigators feel no ownership of the data or of interpretations drawn from the data, the data has no value for improving their management of the water resource. Before a successful introduction of Irrigation Annual Reporting a

commitment is needed to selecting the right people and then to providing the resources to support them to do the hard work of clearly explaining the process and the benefits. Before legislating that licensees must participate in Irrigation Annual Reporting, the proponents of Irrigation Annual Reporting must build relationships, earn trust and respect and win the support of the majority in the community.

- Pride and profit: When Irrigation Annual Reporting is embraced by Irrigators, their interpretation of their own data and their comparison of their own data with data provided by other Irrigators can provide Irrigators with powerful incentives to improve irrigation efficiency. The incentives include pride and profit.

Importance of case for IWRM

This case illustrates the importance of

- Assessing the capability of land to be irrigated without being damaged
- Applying irrigation only onto appropriate land.
- Monitoring and reporting on the how the land and the height of the watertable are affected after irrigation water is applied

Tools used

A2.2 Legislation for water quality
B1.11 Building partnerships
C1.2 Water resources assessment
C1.4 Developing water management indicators
C4.2 Communication with stakeholders

Keywords

Irrigation, salt, salinity, risk, monitoring, agriculture

MAIN TEXT

Problems

The shortage of water for irrigation in the Clare district in South Australia (annex 1) had restricted expansion of the 4,000 hectare winegrape industry, which is known internationally for its premium wines. To further exacerbate this shortage are challenges relating to salt and water salination. Rainfall and wind carry about 8,000 t/year of salt into the district. In addition, work undertaken by Love (2004) and Love et al (2001) has shown that the fractured rock matrix of the district holds millions of tonnes of salt, which is probably a remnant of long-term (geological time) climatic factors. Also the clearance of native vegetation in the district, which commenced in the 1800s when the area was first settled by Europeans, has lead to increased volumes of recharge to the groundwater system resulting in the flushing of salts from the landscape.

In the year 2002-3 the volume of water that was used for irrigation in the Clare district was 2,800ML, with 2,000 ML sourced from groundwater and the remainder from surface water. Completed in 2005, the Clare Water Supply Scheme was built to transport up to 6 G/L of additional water across the 100km between the Murray and Clare rivers, and to distribute the water through the Clare district and beyond. Of the substantial amount of water used for irrigation, more than 90% is devoted to winegrapes. This is despite the fact that the water is used sparingly in order to maintain grape quality. In most irrigation districts in South Australia the main cause of environmental problems is the drainage water that leaks below the roots and causes the watertable to rise. At Clare, drainage is most unlikely to cause problems because the annual irrigation applications are extremely low and because the water is expensive. Consequently, the environmental challenge for Clare, however, is to avoid or to manage, local accumulations of the salt which over decades will be imported into the district with the irrigation water. Assuming that Murray River water has a salinity of 400 mg/L, the Clare Water Supply Scheme has the potential to import a further 2,400 t/year of salt along into the district. If this water was left to flow out of the district, it would remove salt from the landscape. However, its use for irrigation means that salt is retained within the catchment area.

2 Decisions and Actions Taken

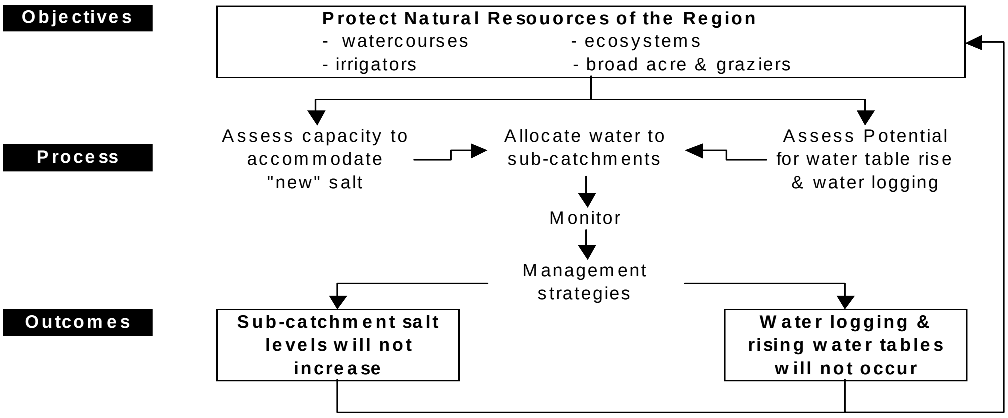
Salt Management at the District Level

In order to minimise the environmental problems that might be caused by any irrigation drainage water, and to protect the Clare reputation for growing winegrapes, the locally-developed Water Action Plan (WAP) for the Clare Valley Prescribed Water Resources Area was devised. The WAP sets out the regulatory framework for the use of water resources in the Clare district. The key objective is that the use of imported water will not contribute to adverse environmental effects and that beneficial uses of existing water resources within the district (e.g. irrigation, stock and domestic) are maintained into the future. The WAP involves a completely new management approach to water management that focuses on salt importation rather than on water volume, and on equipping irrigators with knowledge that will enable them to manage what happens to the salt that will be imported with the irrigation water.

This approach has been designed to maximise the information available to irrigators, to minimise the cost to irrigators and to minimise the administration costs of the water licensing agency.

Sub-catchments (see annex 2) form the regions for managing the use of imported water in the district. There is a general export of salt from the district but there are some sub-catchments where salinity trends are increasing.

The following flow-chart gives an overview of the process for allocating new (imported) water resources for irrigation purposes.



As shown in the flow chart, the key focus of management is upon maintaining the integrity of the natural water resources of the district for all users, including irrigators and the environment. Where the salinity of the groundwater in a sub-catchment is stable or increasing, it can be concluded that salt is accumulating within the sub-catchment rather than leaving the sub-catchment. A sub-catchment is considered closed to receiving imported water (and salt) if stable or increasing salinity trends are evident (see annex 2).

The management guidelines for the use of imported water are:

1. The capacity of down-stream receiving (eco)systems to accommodate an additional salt load without adverse effect provides the overall constraint in determining “new” water allocations.

2. Protecting the groundwater resources provides the basis for protecting other environmental assets, eg. phreatophytes rely on groundwater of a certain quality range (and depth), and baseflow contributes to stream and permanent pool water quality at times of low (or no) flow.

3. Where it has been assessed that groundwater salinity in any sub-catchment is increasing, no matter what the reason, access to “new” water (and salt load) is discouraged within that sub-catchment, and in any other sub-catchment located upstream of it, until such time that it is shown that adverse environmental effects will not eventuate from the use of imported water for irrigation.

4. Where it has been assessed that groundwater salinity in any sub-catchment is declining, access to “new” water is only allowed to occur to a level that offsets the calculated rate of decline.

The WAP includes legislation to restrict irrigation to an annual maximum of 1 ML/Ha of land owned. High water-use crops (e.g. vegetables) can be grown if they are surrounded by non-irrigated land. For example, a crop could be irrigated with 10ML/Ha if 10Ha were owned but only one hectare was irrigated. In addition to rainfall, grapes in the Clare district could use 5ML/Ha of irrigation water per year without any waste to drainage. The limit to a maximum of 1ML/Ha will ensure that the amount of irrigation water draining below the roots will be close to zero which reduces the risk of rising water tables or water logging.

In developing the water licensing policies and the conditions on the licences and on the permits, the goal has been to achieve a sensible balance between avoiding environmental problems and allowing development to proceed. One outcome has been a set of clear, sensible rules for development. The rules are designed to avoid

- Rising water tables
- Increases in soil salinity
- Soil water-logging
- Adverse impact to other water resources
- Adverse impact to ecosystems.

Salt Management at the Farm Level

- Irrigation Salinity Management Plans

For areas at higher risk of developing environmental problems, each irrigator needs to develop a plan for managing the salt that is always present in irrigation water. A copy of this plan is required by the Department of Water, Land and Biodiversity Conservation (DWLBC) before a permit or licence to irrigate will be issued. This plan is called an Irrigation Salinity Management Plan (ISMP). The ISMP is used to locate and to map those areas where salt will accumulate, and is used to help determine whether irrigation water (and its accompanying salt) may or may not be applied to certain areas.

- Risk Maps

The outline for an ISMP is designed to encourage irrigators to start asking questions about possible limitations to the use of their land and to find the answers to overcoming those limitations. For a small investment of time and money, the ISMP will help the irrigator to site new plantings on productive land and to avoid planting, or to apply special management, on land where future production is likely to decline due to salt build up or waterlogging. The content outline of an ISMP provides a guide for irrigators about which limitations to look for and a guide about where on the property to look for the limitations. An ISMP will not provide complete insurance against problems, but it will ensure that a minimum amount of investigation work is completed to provide irrigators with early warning of possible future problems. The ISMP collates and records information about the on-site investigations that have been undertaken to assess whether any of the problems suggested by the Risk Maps are present. If problems are present (e.g. a shallow water-table, saline soil or restricted deep drainage), the ISMP records the management strategy that will be used to avoid the development of additional environmental problems and the operational costs associated with managing those problems.

DWLBC has developed five Risk Maps to assist irrigators with their site investigation work. The maps suggest the problems to look for, and where to look for them. The Risk Maps present the available district-scale data. However, these maps are intended only as a guide because, at farm-scale, they do not define all possible risks and they do not show all risk locations. The Risk Maps show the general locations at which soil problems are more likely to be found and they show which problems are likely. In the risk-affected areas, on-site investigations (including an electro-magnetic soil-survey and the digging and inspection of soil-pits) are required in order to measure whether or not each potential problem is present at that site, and to what degree. The Risk Maps are provided on the Clare computer Compact Disc.

- The Clare Compact Disc (CD)

The Clare CD provides local irrigators with information that enables them to avoid applying water at locations where irrigation is likely to cause short or long-term environmental problems. The CD is used to help develop the ISMP by providing inexpensive, easy access to data previously available only to government specialists. The data includes Geographic Information System (GIS) software that enables the design, inspection and printing of maps made by selecting any combination of map layers. These layers include aerial photographs, topography details, natural and administrative water boundaries, as well as the location of soil pits and types. The software manufacturer, ESRI, provides this GIS software at no charge. Irrigators can view and print maps at any scale, ranging from the complete district to a single paddock. In the future, when rural access to the internet has been improved, this data could be made available from a web-site that could be regularly updated.

- Electro-magnetic Soil Suvey

For those areas of an "open" sub-catchment where the district-scale Risk Maps indicate that irrigation is more likely to cause environmental problems, the irrigator must develop an ISMP that is based on a property-scale electromagnetic (EM) survey together with a property-scale soil survey. To carry out the EM survey, the irrigator employs a consultant who collects data using a vehicle (e.g. a four-wheeled motorcycle) equipped with an EM38 device and with a Geographic Positioning System. The three maps that are produced from the EM survey include a contour map of the soil surface (1 metre height intervals), a map showing the electrical conductivity of the rootzone-depth of soil and a map showing the electrical conductivity of the soil below the rootzone (annex 3). The location at which to dig each soil pit is chosen by the irrigator after combining the property knowledge of the irrigator with the experience of the EM surveyor and the information on the three maps. Soil pit locations are chosen to obtain the maximum information from a minimum number of soil pits. The EM survey is also used to map a boundary for which the data collected from each soil pit can be applied.

- Soil Pits

Detailed farm-scale soil information is essential to identify locations where special management strategies are needed in order to avoid environmental problems being caused by the potential annual accumulation of salt. The Risk Maps and the EM survey are used to site some of the soil pits where soil problems are expected. A backhoe is used to dig each soil pit to a depth of 2 metres. When the soil pits are located based on an EM survey the minimum number of pits is one pit for each 2 hectares. If an EM survey is not used, more pits are needed (1.8 pits per hectare) and they are located on a 75m x 75m grid.

- The Clare Soils Book

The Clare Soils book is provided so that irrigators can themselves assess the capability of the soil that is exposed in each soil pit. The book displays a colour photo of each of the 20 soil profiles that are most likely to be found in the Clare district. The two-page data sheet for each soil includes a table that displays the laboratory results from the chemical analyses for each soil layer in that pit and an interpretation highlighting any potential soil problems and of how best to avoid or to manage them. Practical recommendations are given for pre-planting preparation and for post-planting management of each soil.

- Soil chemical analyses

Soil chemical analyses are required from some of the soil pits in order to decide whether an area should not be irrigated due to salinity or due to too much sodium. The Clare Soils book and the EM surveyor, or a soils specialist, can help the irrigator to decide which chemical analyses are useful for each pit. At each soil pit that is located where "salinity" is highlighted on a Risk Map, the soil salinity (ECe) is measured for each soil layer. At each pit located where "poor deep drainage" is highlighted on a Risk Map the exchangeable sodium percentage (ESP) is measured for each soil layer. Farm-scale problems will exist even in areas that are not highlighted on the district scale Risk Maps. Results from the full set of chemical analyses are obtained from a selection of at least 20% of the pits (one pit for each 10 hectares) because this sample will explore whether unexpected problems are present.

- The FullStop and Irrigation Annual Reporting

Irrigation Annual Reporting is a framework that supports self-education by irrigators. Where Irrigation Annual Reporting is used (misused) as a tool for extracting information from irrigators, the irrigators will not support it and the collected data becomes incomplete, inaccurate and of dubious value. With ownership and willing, active participation in Irrigation Annual Reporting irrigators assemble the information that helps them to manage and to improve their irrigation practices because it makes good economic sense. The District Summary Irrigation Annual Report is collated locally from the confidential, individual-property Irrigation Annual Reports. The district Summary provides the accurate district data that is needed to support good decisions about local resource management.

The CSIRO FullStop device is a monitoring tool that enables each irrigator to detect whether the target depth of soil has been wetted at each irrigation and to measure the salinity of the soil (annex 4). Each irrigator who uses water from the Clare Water Supply Scheme must install and use at least two FullStop devices. Requirements for monitoring and for Irrigation Annual Reporting have been added to the conditions on all water licences that will be activated as a result of gaining access to River Murray water.

3 Outcomes

The Risk Maps and the Clare CD have been developed and provided by the Government licensing agency to ensure that irrigators have access to the best information. In addition to these tools, significant resources are still being invested to involve the Clare community and to keep people informed. Interactions to date have included:

- Community consultation days where individuals met locally with agency staff to ask questions and to provide suggestions
- Meetings with individual environmental groups
- Presentation to Clare and Gilbert Valleys District Council
- Weekly meetings and other interactions between the water provider (SA Water) and the regulator (DWLBC)
- Press releases
- Newsletters
- A workshop with irrigators about how to develop an ISMP
- A Field day providing hands-on experience for irrigators in using the Clare Soils book to interpret what is visible in soil pits

The Eyre Creek sub-catchment (annex 2) was initially a “closed” sub-catchment because the salinity in the groundwater had been increasing gradually over time. It was the opinion of hydro-geologists and hydrologists that the increasing salinity trends were largely caused by intense groundwater development and large stream diversions, which cause salt to be retained in the sub-catchment and reduce environmental flows in downstream water-courses. Working with SA Water, DWLBC, Rural Solutions and Resource & Environmental Management Pty Ltd, the Eyre Creek irrigators successfully implemented a water management framework that reduced the volume of stream diversions and reduced groundwater pumping in exchange for imported water. Reduced the use of existing (catchment) water resources has resulted in them being returned as environmental flows to Eyre Creek, to the Wakefield River and to the groundwater system.

The adopted approach means that irrigators now have secure access to good quality irrigation water, and the environment now receives more water in the form of stream flows and base-flows, an outcome that has been achieved in a socially responsible and equitable manner (REM, 2004b).

The Eyre Creek approach has now been adopted for other sub-catchments in the district that were initially considered “closed”. These include Skillogalee Creek and Polish Hill River sub-catchments. The outcome is secure access to good quality irrigation water and improved environmental water provisions.

4 Lessons learned and replicability

- Scale: At the scale of each property, Irrigation Annual Reporting is a simple, inexpensive process where each irrigator measures and records information that is useful for them, on a locally-developed Irrigation Annual Report form.

- Timely feedback: Feedback is an essential part of the Irrigation Annual Reporting framework. Feedback is achieved by providing a copy of the District Summary Irrigation Annual Report document to every contributor and then discussing the content of this Report at community meetings held within 2 months of collecting the data.

- Benchmarking: This feedback provides data for benchmarking. Benchmarking enables each irrigator to compare their own irrigation management with the irrigation management of every other irrigator and with their own irrigation management in previous years. The feedback also enables industries to compare their irrigation performance with the performance of other industries. As additional districts adopt Irrigation Annual Reporting, these districts will be able to compare themselves with other districts. Eventually states will be able to compare themselves with other states.

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5 Contacts, references, organisations and people

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REM 2004b. *A Study to Assist in Allocating Imported Water for Irrigation Use in the Clare Region – Eyre Creek Sub-catchment.* Prepared for: Rural Solutions SA Pty Ltd. Resource & Environmental Management Pty Ltd. Ref. CY01-R001.

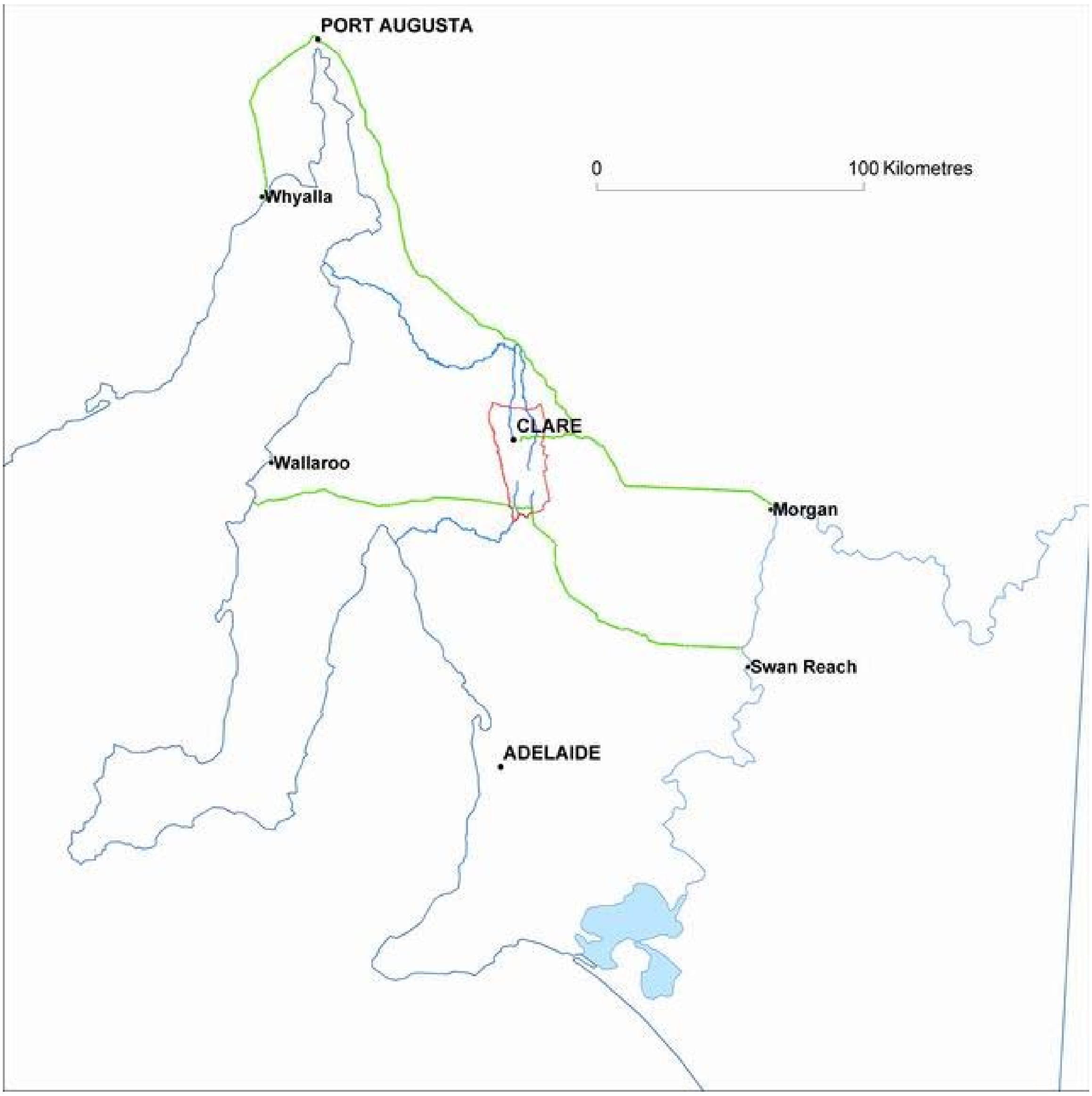
Websites

FullStop Weeting Front Detector: http://www.fullstop.com.au/

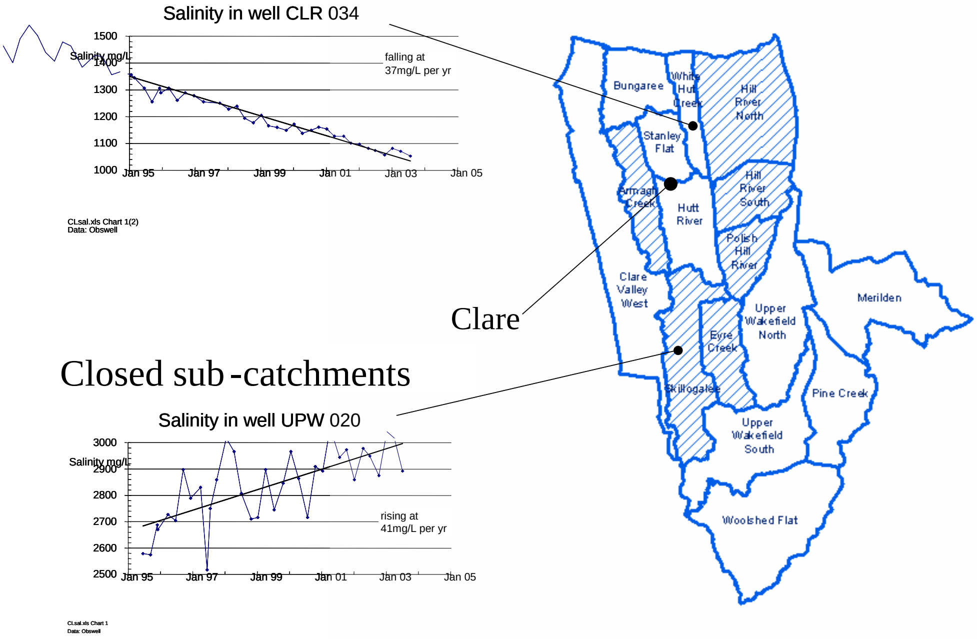
Angas Bremer Water Management Committee: www.angasbremerwater.org.au

Resource & Environmental Management Ltd: www.rem.net.au

Annex 1: The Clare district, the Broughton and Wakefield Rivers and the pipelines from the Murray River

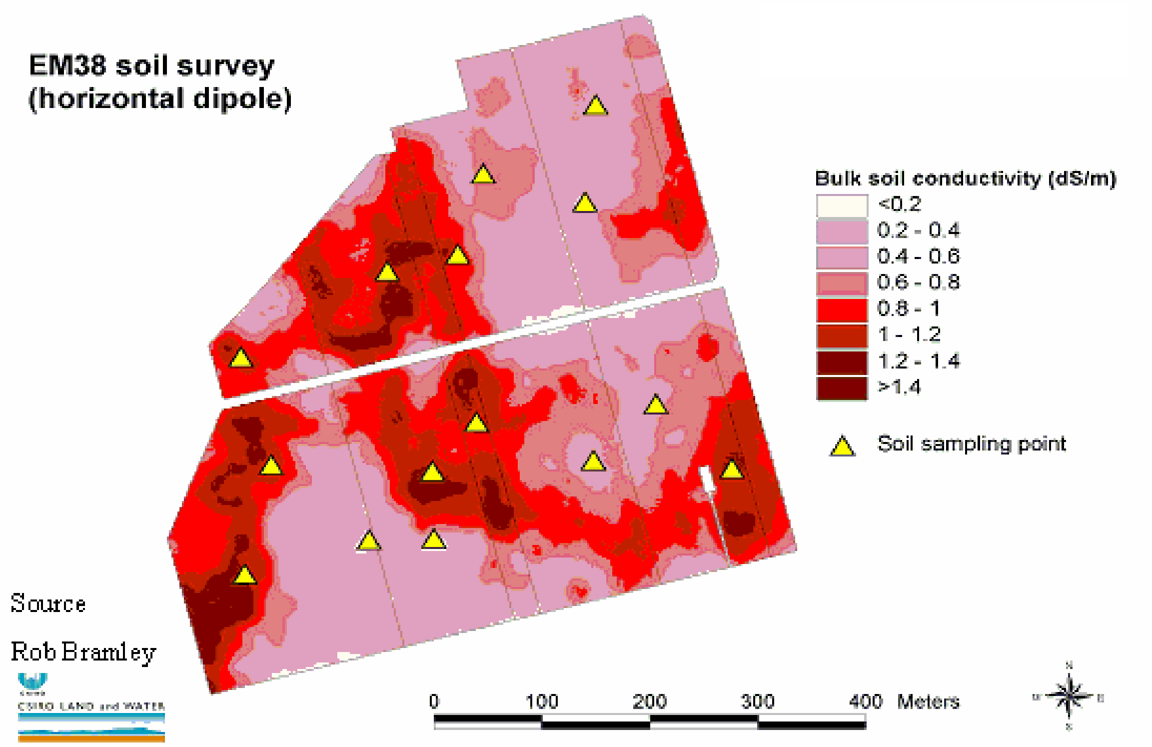


Open & closed sub-catchments



Annex 2:
Sub-catchments are closed to imported water if the groundwater salinity trend is increasing

Paddock Electrical Conductivity map



Annex 3

Paddock Electrical Conductivity maps are used to indicate possible soil boundaries and to choose the location for each soil sam pling pit

Annex 4: The FullStop wetting front detector

www.clw.csiro.au/products/fullstop/index.html

The new CSIRO FullStop device does two things:

1. A FullStop detects whether the soil is wetted down to the depth at which the FullStop is installed

The FullStop Wetting Front Detector is a specially shaped funnel, a filter, a float and a flag. The funnel is buried in the soil, at a depth in or below the active root zone of the plants. When rain falls or the soil is irrigated, water moves downwards through the soil. A wetting front is the boundary between the wet and the dry soil. The water moves as thin films around the soil particles. As the wetting front moves down into the buried funnel, the cross sectional area of the funnel narrows and the water in the films is contained in a shrinking volume of soil. This causes the soil at the bottom of the funnel to get wetter and wetter. The soil becomes so wet that water seeps out of it and passes through the filter to be collected in the reservoir. This water floats a light-weight rod which in turn operates a flag above the soil surface that indicates that the soil is “full” so irrigation should “stop”, hence the name “FullStop”.

The FullStop has no wires, no electronics and no batteries. Water from a wetting front converges in the funnel to fill the reservoir and this raises the float. If the soil is dry before irrigation, the dry soil absorbs more water and the wetting front penetrates the soil only to a shallow depth. However if the soil is wet before an irrigation, it cannot store much more water, so the wetting front penetrates the soil to a deeper level.

2. A FullStop collects a water sample that can be used to measure the amount of salt in the rootzone

A syringe is used to extract the water-sample from the FullStop, via the 6mm tube. The salinity of the water sample can be measured using an electrical conductivity meter.