Water Quality, Productivity and Salinity - Action learning tools to help people of all ages and backgrounds to understand the benefits of best practice in agriculture for production and for the environment

Paul Webb and Kate Reilly
Queensland Murray Darling Committee
Contact: paulw@qmdc.org.au

ABSTRACT: The Queensland Murray Darling Committee (QMDC) is working with the community in the Maranoa Balonne and Border Rivers catchments to encourage and support sustainable use of natural resources. A number of initiatives have given QMDC direct contact with landholders managing over 30% of the catchment. Sharing a vision for healthy landscapes and viable communities, it is important that stakeholders gain insights into the links between production systems and the condition of our natural resources.

Some simple action learning activities have been used to assist with information exchange. Cover, erosion, water quality, infiltration and salinity are discussed during these activities with equipment including lunch boxes and paint trays. Drink bottles and table salt are also used to demystify landscape salinity. Activities link productivity and natural resource management issues in simple terms. They are in no way comprehensive but they have helped to build a common understanding of landscape processes providing a platform for planning to address specific issues.

These simple activities, or tools, can be adapted onsite to suit specific interests or time constraints. They have been delivered with moderate success on kitchen tables, town halls and in the paddock. Beneficiaries have included the young and the not so young, school of hard knocks and PhD graduates, and various NRM agencies' staff. Even those who "knew that" have commented that the perspectives and productivity links are enlightening and beneficial.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the work of Landholders in the Queensland Murray Darling Basin, staff of Western Farming Systems and Queensland Department of Natural Resources and Water, Landcare Co-ordinators and other QMDC staff members who have provided ideas, materials and feedback to allow the development of meaningful action learning activities.

Gratitude is also extended to funding bodies which include:

- National Heritage Trust
- Queensland Murray Darling Committee, and,
- Bureau of Rural Sciences

INTRODUCTION

The Queensland Murray Darling Committee (QMDC) is working with the community in the Maranoa Balonne and Border Rivers catchments to encourage and support sustainable use of natural resources. Extensive community consultation resulted in a regional Natural Resource Management Plan (NRM Plan) which was produced in 2004. The vision presented in this plan is:

"The community working together to build healthy, sustainable, attractive and profitable regions, through the effective management of our natural resources." [1]

To realise this vision, and guided by the NRM Plan, QMDC is working with many stakeholders covering a broad area. Targets in the plan cover themes of revegetation and biodiversity, riverine, floodplain and wetland, energy and waste, community capital, institutional assets, weeds and pests, land and soils, water, and, Aboriginal interests and cultural assets.

The region is dominated by agriculture with many holdings over a vast region. To effectively engage landholders in sustainable management QMDC has used a number of initiatives including Sub Catchment Planning, soil and vegetation tenders, Landcare Discovery Conferences and Indigenous consultations. With these initiatives, QMDC has direct contact with landholders managing approximately on third of the region's land area. QMDC is also supporting community monitoring of soil and water resources which incorporates land and vegetation monitoring and a coordinated expansion of WaterWatch activities. QMDC technical staff working in the water and rivers themes have had the challenge of making river health and stream monitoring tangible concepts in an agricultural production environment.

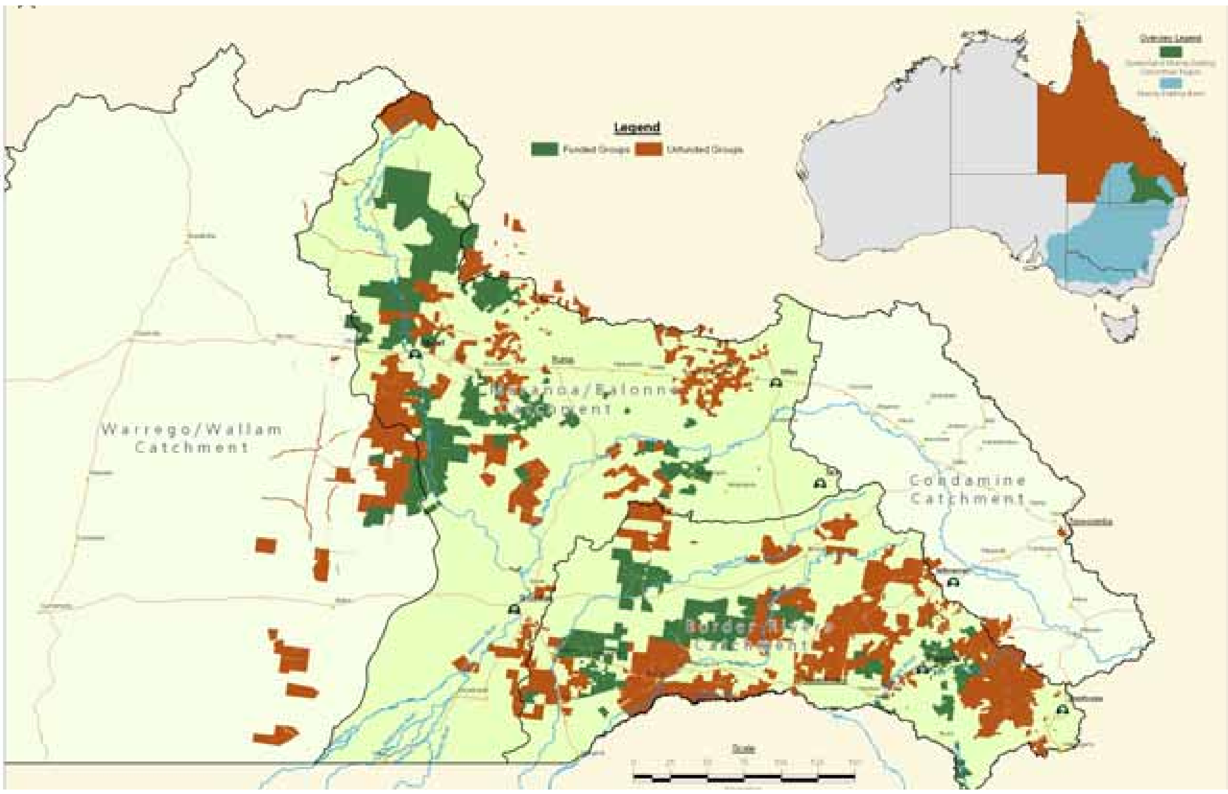


Figure 1 Landholders engaged by QMDC in Natural Resource Management in the Border Rivers and Maranoa-Balonne region.

Independent of QMDC activities Queensland Government staff working with Eastern Farming Systems have developed a training program in Soil Water. This program is aimed to help farmers and graziers to understand soil and water interactions in a productive landscape. The training program includes a number of action learning activities specifically aimed at helping landholders understand soil and water processes.

QMDC staff recognised the value of soil water action learning activities/tools for engaging landholders and, with some adaptations, to demonstrate the links between land management and river health. Following is an explanation of basic soil water principles and some action learning activities that have been used to explain these to landholders whilst introducing links to water quality and stream monitoring.

SOIL AND WATER IN A PRODUCTION LANDSCAPE

Following are extracts from available information arranged to demonstrate the links between productivity, water quality and salinity risk using soil water research findings. These are adapted from the QMDC factsheet on this topic. [2]

Stream Water Quality

The water quality in our rivers and creeks tells a story about how well we are managing our land. In the Queensland Murray Darling Basin stream sediment load has been identified by community, industry and environmental groups as a major concern. Land management practices that increase sediment load also generally increase the export rates of other contaminants from paddocks into streams. Thus, stream sediment loads also represent soil loss, nutrient loss and possibly wasted pesticides which all threaten the profitability and sustainability of agricultural enterprises. Another concern with stream water quality is increasing baseflow salinity. This may indicate rising groundwater tables and associated risk of landscape salinity.

Ground Cover

Soil loss can be minimised if vegetation cover is increased in grazing or cropping lands. Increasing the amount of vegetation cover on the ground not only decreases the loss of soil and other contaminants, but also results in better infiltration and increased soil water storage. Note the graphs below showing research findings that demonstrate that with increased ground cover there is both a decrease in soil loss and a decrease in runoff (increase in infiltration). Ground cover refers to plant material and debris on or near the soil surface which has the capacity to protect the soil from the splash impact of rain drops

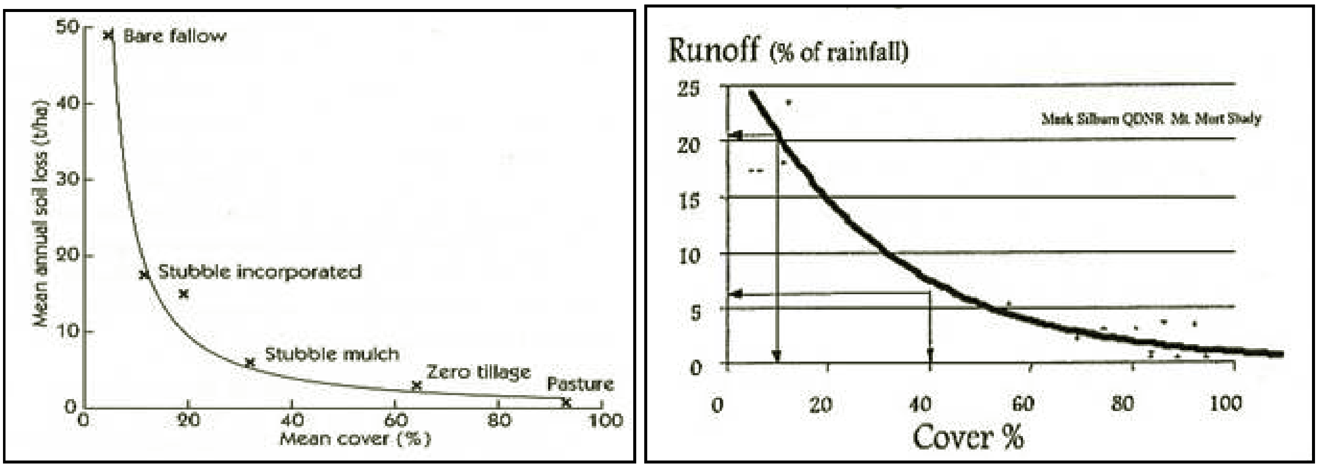


Figure 2 Research findings from Freebairn and Silburn demonstrating increased cover reduces erosion and increases infiltration (decrease in runoff equates to increase in infiltration)

Soil Water

(This section is adapted from Wockner et al, 2004) [3]
The retention of soil, and the increased infiltration achieved by maximising cover, represents increased production potential. To realise this potential it is useful to understand and measure soil water with a view to using what is available for plant growth. The maximum water available for plant growth is known as the Plant Available Water Capacity (PAWC); it varies with soil type and crop. PAWC is the difference between the upper water storage limit of the soil (DUL) and the lower extraction limit of a crop (CLL) over the depth of rooting. In many seasons, the maximum water storage capacity is not reached due to insufficient rainfall, fallow weeds, run-off and evaporation.

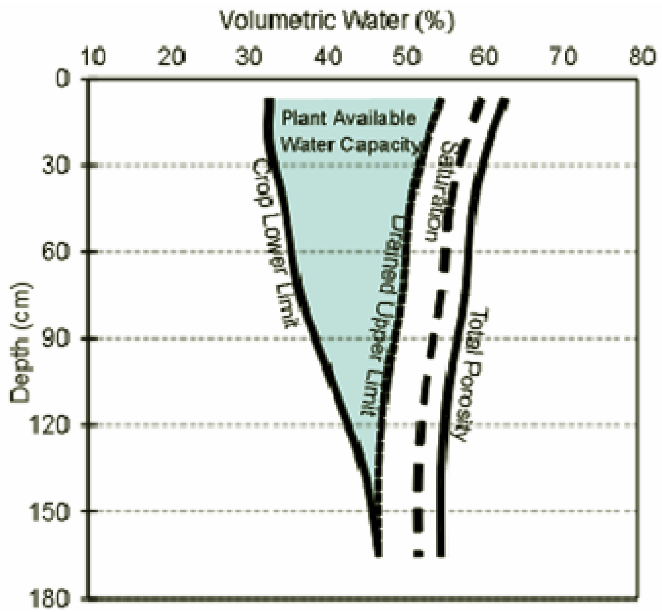


Figure 3: PAWC and Water distribution in soil profile

In these cases, the actual water present is described in terms of the PAWC, that is, how full is the bucket. However, in other cases it is possible that even after the bucket is full, more rain falls which infiltrates but is not used by crops or pastures. This is likely to result in deep drainage, being drainage below the crop or pasture root zone. In native vegetation areas most of this deep drainage was used by deeper rooted trees.

Salinity Risk

In agricultural areas where broad scale clearing has occurred, deep drainage is likely to result in recharge of shallow groundwater aquifers. This in turn represents a risk to production as the resulting rising groundwater is likely to contain salt concentrations above crop or pasture tolerance levels. Deep drainage varies in different landscapes but is likely to approximate:

- 1mm under native vegetation
- 10mm under dryland cropping
- 100mm or more under irrigation

The deep drainage risk is greatest when irrigation water is applied inefficiently and, or, when winter crop rotations result in fallow paddocks during maximum recharge periods. Risk can be minimised by ensuring all or most of the water stored in the soil is used by plants. This can be achieved through initiatives such as: increased water use efficiency, opportunity cropping, and native vegetation management.

ACTION LEARNING TOOLS

Ground Cover and Stream Water Quality Activities

These activities demonstrate how soil cover protects soil from splash erosion and results in better soil retention, more plant available water and improved water quality. Activities have been adapted from Eastern Farming System action learning activities. [

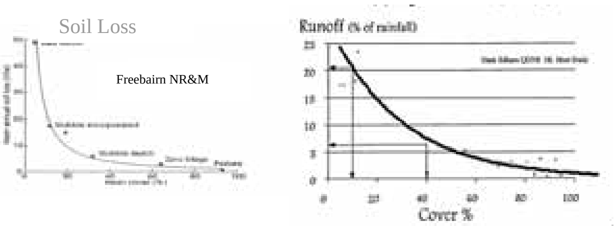
Delivery steps:

1. Fill 3 lunch boxes with soil and level off flat on top in line with the top of the lip.
2. Cover one lunch box completely with shade cloth and clip to edges
3. Cover one lunch box with shade cloth with approximately 50% of the area of the shade cloth cut out as a series of small holes.
4. Place a lunch box in the shallow slope part of each of 3 paint trays to represent paddocks in a catchment.
5. Have two vials or dishes near each paint tray.
6. Fill the “cloud” (garden watering can) with the equivalent of approximately 1” of rain.
7. Rain on each paddock making sure all rain falls on the paddock area.
8. Get a participant to use a pipette to collect a water sample from each tray catch (stream) during the runoff event and again a few minutes after the event.

Observations:

1. Bare paddock should show more soil loss as paddock erosion, catchment deposition, and stream sediment
2. Covered paddock should show the least soil movement and partly covered paddock Should show a mid range of soil movement.
3. Water samples during the “runoff event” should reflect cover levels as per points 1 and 2 above.

4. Water samples after the event should be fairly similar for all catchments as most of the suspended soil drops out of solution when the water is still. This highlights the importance of event sampling for estimating soil loss and stream sediment loads.



A watering can and lunchboxes can show how cover reduces soil loss and runoff. This means cover retains soil and water for

Figure 3. Cover, erosion and water quality linked with action learning

Lessons:
1. Soil cover minimises erosion.
2. Partial cover protects stream but still results in mobilisation of soil within the paddock – possible cost to relocate soil from bottom of paddock and/or loss of soil structure.
3. Water sampling to determine soil loss needs to be during events and even then misses some of the soil loss.

Optional Riparian Management Extension Activities

An optional extension of this activity, for extended workshops, demonstrates the effects of slope and riparian buffer strips on erosion and soil loss. Put a simulated riparian vegetation strip under the bare paddock extending to the edge of the stream. A combination of shade and cotton cloth packed to 0.5-1cm thickness should work. Prop the other two catchment lunchboxes up at an angle. Rerun the rainfall event:

- Less sediment should reach the stream from the bare paddock than in the previous activity. This highlights the value of riparian vegetation as a sediment and pollutant filter.
- The partly covered paddock should have significantly more sediment runoff than the covered paddock in this run – highlighting the need for better cover on riparian areas (and slopes).

Soil Water Activities

Follow-on activitiesfrom the ground cover, erosion and riparian management can include:

- Splash impact activity. On a bare smoothed soil paddock drop single drops of water from 1m above using a pipette and observe the splash effect on the paddock. Get someone to hold a piece of shadecloth just above the soil on another bare smoothed patch and drop single drops from 1m. Comparing the soil disturbance with the single drop shows the value of cover in minimising splash erosion. Refer to Western Farming Systems for a more graphic splash impact activity using flour.
- Infiltration effects of dirty water. Cut the tops off two transparent plastic water bottles. Block the openings with pieces of sponge and insert tops upside down into the bottoms of the bottles. Place 2-3cm of soil into the inverted tops ensuring there are no large air gaps. Pour well shaken dirty water into one inverted top and clean water into the other. The clean water should

infiltrate more quickly down through the soil demonstrating why dirty runoff water from soil with poor cover blocks soil surface pores resulting in increased runoff and poor infiltration.

- From infiltration to soil water. Set up a water bottle as per the previous infiltration demonstration without putting soil into the inverted top. Poke a straw up through a fitted hole in the bottom of the bottle so that water will leak out through the straw when the water level in the bottle is nearly up to the inverted top. Pour different amounts of water into the bottle explaining the bottle neck/foam is the infiltration limitation. Water left in the bottle neck after rain can be tipped out explaining that water near the soil surface is lost to evaporation. Water poured in at sustained fast rates will overflow the inverted top simulating runoff. After a series of events the bottle will fill enough to leak out the straw introducing the concept of deep drainage. The water left in the bottle after the deep drainage has finished is the soil water store or drained upper limit. Refer to Western Farming Systems for a more extensive soil water bottle activity with one month simulated rainfall.
- From soil water to Plant Available Water Content (PAWC). Using two different sponges the variation between PAWC for different soils can be introduced. Use a standard piece of foam for one sponge and a car wash sponge which holds water better, for the other. Ensuring each sponge is dry at the start, put a litre of water in each of two containers then place a sponge in each container. Get participants to squeeze and release the sponges in the water to absorb as much water as possible. Sponges are now at saturation point. Each sponge should be lifted up over the container allowing water to drain freely back into the container. The standard foam sponge will lose more water simulating a sandy soil. The car wash sponge can be aligned with clay or clay-loam soil. After the sponges stop leaking, squeeze each one into a separate measuring container. The amount squeezed out represents PAWC. The brawniest person in the room could be asked to give one of the sponges another squeeze to get a bit more out. This introduces the variation between different plants in their capacity to take up water from the soil. Even after the last squeeze the sponge is still cool to touch showing some water is retained in the soil even with aggressive root systems.

Salinity Risk Activities

To demystify salinity and to introduce landscape salinity issues, a number of quick attention grabbers have been successfully used. These activities can stand alone but linked with cover, erosion and water quality activities they enable the integration of themes at an introductory level.

- Introduction to salinity and Electrical Conductivity (EC). Salinity jargon can be explained with a basic EC meter, some metal, salt, soil and cups. Explaining that Electrical Conductivity or EC is an indirect measure of salinity is a good first step. Watch the EC meter readings max out with metal across the electrodes. Then watch the EC reading jump when a pinch of salt is placed in a cup of rain water. For eager recipients you can even do the maths to predict the EC based on the amount of salt and the volume of water. Milligrams of salt per litre by 1.5 will give a rough estimate of EC in microseimens/cm.
- Effect of evaporation. Evaporation affects the salt store in wet patches of the landscape. To demonstrate this, measure the EC of some tap water. Pour (say) four cups into a kettle and boil half of this away by holding the button down on the kettle. After the water has cooled enough to touch, measure the EC again. It should be approximately twice that of the source water. In the kettle, as with a landscape, very little salt is taken up with evaporation. With each wetting up from seepage, or rising groundwater and drying from evaporation, there is the potential for salt to accumulate in the vicinity.

- Water accepts soil salts into solution as it infiltrates. Measure water EC before and after it is "infiltrated" through 10cm of soil (as per the clean water from previous section on infiltration effects of dirty water). For eager recipients calculate the amount of salt that moves below the root zone for one hectare of land with native vegetation, dryland cropping and irrigated cropping. Use the infiltrated water EC times 0.64 for mg/l salt. Assume deep drainage of 1mm for native vegetation, 10mm for dryland cropping and 100mm for irrigated cropping (rounded from NR&M factsheet L109)

Questions from these salinity activities especially have indicated a lot of thought has been prompted by the activities. In many cases this has indicated a raised awareness of this NRM issues and links between water quality and to productivity.

CONCLUSION AND DISCUSSION

These action learning activities have been delivered in a wide range of settings. Working with landholders, they have been delivered in sheds, on riverbanks and on kitchen tables. The same activities have been well accepted in high school and primary school settings. In many cases stream water quality and macroinvertebrate monitoring concepts are explained as a follow on from these soil water activities.

Brainstorming is currently underway for ways to introduce other concepts using these and similar activities. It would be good to explain the links between water quality and stock live weight gain with a tangible activity. Also, the role of native vegetation in managing landscape salinity risk is a concept that has, to date, been difficult to get across using literature or powerpoint type presentations.

The action learning activities have provided a common understanding and language for subsequent discussions between landholders and other natural resource management advocates. They can also be used to break up more academic presentations to people who find these difficult or tedious.

Action learning activities are seen as a useful addition to the tools available for promoting and supporting sustainable land management in the Queensland Murray Darling Basin and beyond.

REFERENCES

1. Queensland Murray Darling Committee, Regional Natural Resource Management, QMDC, Toowoomba, Queensland, p9 (2004).
2. QMDC Factsheets, Productively managing water quality, accessed online 26th October, 2007 at http://www.qmdc.org.au/publications/fact-sheets-and-case-studies/water-use-and-management/productively-managing-water-quality.pdf
3. Wockner G, Dalgliesh NP, Dang Y, Price L and Voller J, Measuring and Managing Soil Water – Training Manual, Queensland Department of Natural Resources, and Mines, Toowoomba (2004).
4. NR&M Factsheets, Qld Dept of Natural Resources and Mines factsheets accessed February 2006 at http://www.nrm.qld.gov.au/factsheets/index.php
5. Western Farming Systems 2005, Action learning Tools accessed online February 2005, http://www.apsru.gov.au/apsru/Projects/WFS/ActionLearning/ActLearnToolIndex.htm