



The Benefits of Soil Conservation Works in the Moonie (Back Ck) and Upper Boogera Clusters of the Talwood Planning Group

Final Report

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Note: This report was originally prepared by Natural Solutions in March 2009 for the Queensland Murray Darling Committee. In March 2009 Natural Solutions joined with Conics then in July 2009 Conics joined with the international consultancy, RPS. Reflecting this change, Natural Solutions and Conics became known as RPS on 1 March 2010 and this document has been reformatted accordingly.

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1.0 BACKGROUND

After considerable investment in Natural Resource Management (NRM), some observers suggest that there is little to show in terms of improved natural resource condition. In the language of NAPSWQ and NHT, the link between management action and resource condition has apparently not been made with sufficient rigour to convince all stakeholders of the value of public investment in NRM. It seems a reasonable expectation that significant public investment should be able to demonstrate positive changes.

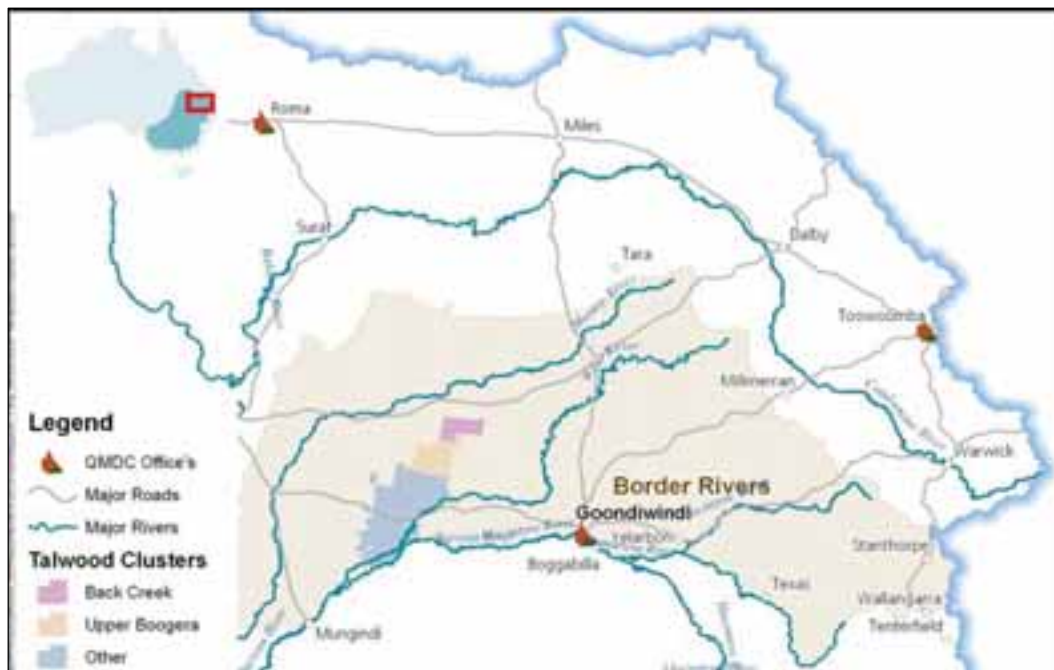
This project aimed to use a modelling approach to assist the Queensland Murray Darling Committee Inc (QMDC) make an estimate of benefits of soil conservation structures in the Moonie (Back Ck) and Upper Boogera clusters of the Talwood Planning Group. It should be noted that while QMDC has not done all of the soil conservation work that exists in the area, its input has enabled the completion of catchment scale plans, ensuring new work combine with historic work to allow the full benefits to be realised.

An estimate of the benefit of these structures has been made that includes both the local benefit (i.e. sediment trapped in contours banks) and also of an anticipated reduction in sediment loads in the Weir River (Talwood Gauging Station (G.S.) and the Moonie River (new Flinton G.S.).

1.1 Locality

The area of interest is the Moonie (Back Creek) and Upper Boogera clusters of the Talwood Planning Group. This group is located about 80km North West of Goondiwindi. The group is predominantly located in the Weir River catchment, however the Northern area of the group are in the Moonie River catchment. A general locality map is shown in **Figure 1.1**. A more detailed map of Back Creek and Upper Boogera clusters is included as Appendix 1.

FIGURE 1.1 GENERAL LOCALITY MAP OF THE CLUSTERS OF THE TALWOOD SUB-CATCHMENT PLANNING GROUP.



The Moonie (Back Ck) group covers 20,074 hectares which is almost entirely in the Upper Moonie catchment. The Upper Boogera group covers 31,381 hectares with most properties in the Lower Weir catchment except for two properties in the Upper Moonie and parts of several other properties in the Upper and Lower Moonie catchments (approx 6,000 ha or 20%).

The area ranges in elevation from 210 to 270m with mostly less than 1% slopes except near ridges and creek lines.

1.2 The Advantage of Models to Predict NRM Benefits

Models are regularly used in NRM research and development, yet there are conflicting views about their validity as tools to support planning and evaluation. Much of this mistrust comes from their lack of transparency and the fact that models are used by a small group of specialists. What you don't understand you don't trust. So why use models to predict NRM benefits of management action on Resource Condition as compared to using monitoring.

If we monitor resource condition what are we seeing?

It helps to be clear about what to expect if we monitor. In this discussion, hydrology and water quality data from catchment studies in southern Queensland are used to demonstrate possible outcomes from a monitoring program. This data was collected as part of a research program over 20 years; a situation of relative luxury in terms of data richness and completeness.

Assuming that measurements are accurate, an observation or measurement will produce variable results due to:

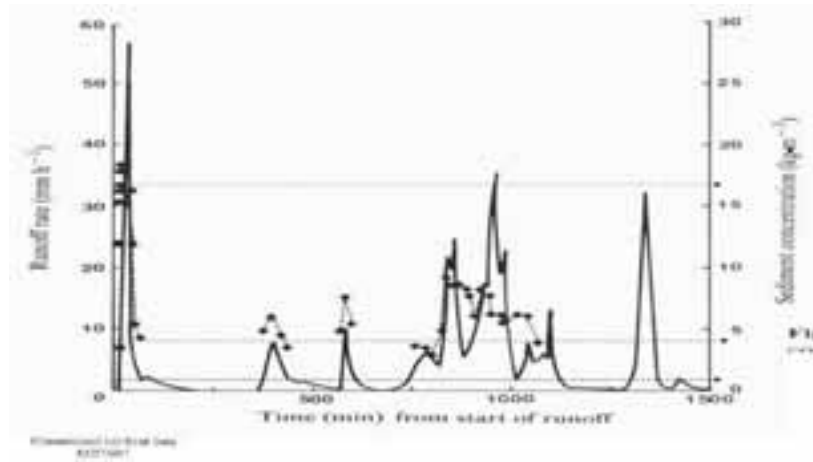
- Sampling error within an event or area;
- Natural variation associated with weather;
- Scale or location in the catchment;
- Change associated with land use and management (the purpose main of monitoring in this papers context).

Further discussion of these errors and impacts follows:

1. Sampling error – the sample collected is often too small to be representative of the larger unit of interest, especially if spatial or temporal variation is naturally high.

Most physical variables used to describe the environment exhibit high spatially or temporally variability. For example, a soil sample of 0.1kg, even if replicated several times may not represent even one hectare. **Figure 1.1** shows the variation in sediment concentration within a runoff event over 25 hours. A sample collected randomly during this event could provide a sediment concentration value of between 4 and 17kgm⁻³. Samples collected at the beginning of the event would grossly overestimate total sediment load while samples taken later in the event would underestimate loads. In this case, differences due to management need to be much greater than these differences to demonstrate changes associated with changed management.

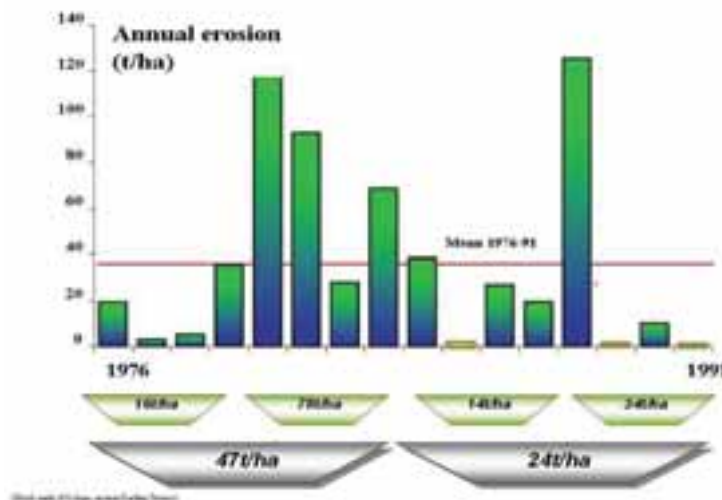
FIGURE 1.2 HYDROGRAPH AND SEDIMENT CONCENTRATION DURING A 25 HOUR RUNOFF EVENT FROM A 1 HA CONTOUR BAY CATCHMENT. NOTE VARIATION IN SEDIMENT CONCENTRATION OVER TIME. (FREEBAIRN AND WOCKNER, 1986)



- Natural variation associated with weather – a climate which has large variations in rainfall patterns and intensity results in equally variable and unpredictable runoff, erosion and water quality.

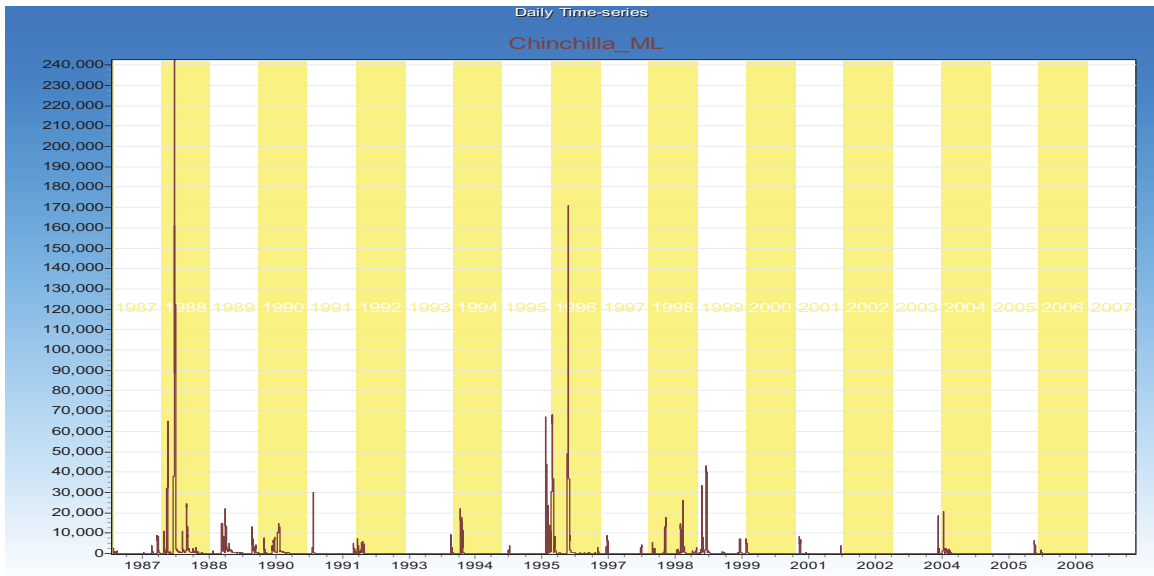
Some degrading processes are highly episodic, being driven by extremes in weather (wet, dry, hot, cold). To demonstrate this variability, average erosion rates measured for consecutive 3 year periods varied from 14-78 t/ha/year for a small catchment study on the Darling Downs (**Figure 1.2**). Over a 14 year period 81 rainfall events resulted in runoff with 556 t ha⁻¹ of soil movement. More than 70% of this erosion resulted from just six rainfall events (Wockner and Freebairn, 1990). Even when management impacts are large, it is difficult to detect whether a change in erosion was due to management or chance unless a side by side comparison can be arranged, similar to research studies.

FIGURE 1.3 ANNUAL EROSION FROM A CONTOUR BAY WITH WINTER CROP, BARE SUMMER FALLOW, SHOWING EXTREME VARIABILITY IN EROSION RATES EVEN THOUGH MANAGEMENT WAS CONSTANT (WOCKNER AND FREEBAIRN, 1990).



At the larger catchment scale, stream flows are equally variable (**Figure 1.3**). Many streams in northern Australia have very low flows for greater than 70% of the time! This in itself makes sampling difficult, and interpretation of collected samples challenging. It is easy to imagine why a sampling regime based on fixed dates might miss the main hydrologic events, sampling a series of low flows for years or decades (**Figure 1.3**).

FIGURE 1.4 DAILY STREAMFLOW FOR THE CONDAMINE RIVER AT CHINCHILLA WEIR (1987-2006).



3. Scale and location – hydrology, erosion and sediment transport are strongly influenced by scale or catchment size.

As catchment area increases, the impact of management declines. Storage in the system, time lags and dilution result in attenuation of management impacts. Dilution refers to the managed area being a small proportion of the catchment. For example, changing 2% of a catchment to a new practice that reduces erosion by 50%, in an environment with a natural coefficient of variation in runoff and erosion of >70% means that any changes in water quality due to investment are unlikely to be seen at the catchment scale where this change might be in the order of 1% ($0.5 * 0.02 = 0.01$).

Figure 1.4 shows a photo mosaic of catchments from 1 ha to 1 million ha. Small catchments (< 50 ha) responds to rainfall in < 1 hour, while large catchments take weeks to months for a flow event to pass. This variation in catchment response time make sampling difficult, either being too fast to capture samples or too prolonged to collect representative samples. In either case, samples need to be taken throughout an event to provide a reliable estimate of total load.

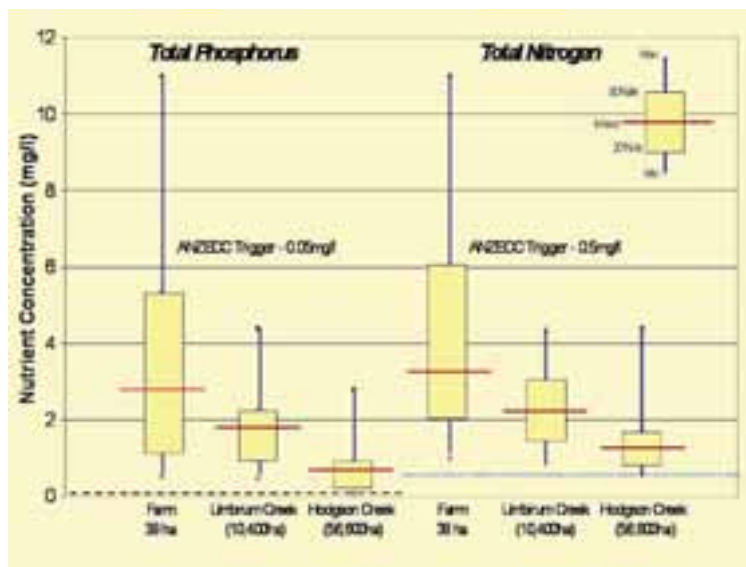
At the paddock scale, management impacts are generally clear while the sub catchment or catchment has a range of land uses, management practices, soil types, topography and even climates. **Figure 1.5** shows the changes in observed phosphorus and nitrogen in runoff water for three sizes of catchment on the eastern Darling Downs. As expected, changes in scale through several orders of magnitude (factors of 10) result in

changes dissolved nutrients of at least two orders of magnitude. Therefore any sampling regime needs to be designed to minimise impacts of scale unless this is the question being explored.

FIGURE 1.5 FROM 1HA TO 1 MILLION HA CATCHMENTS. THIS RANGE OF SCALES POSES CHALLENGES FOR MONITORING AND INTERPRETATION



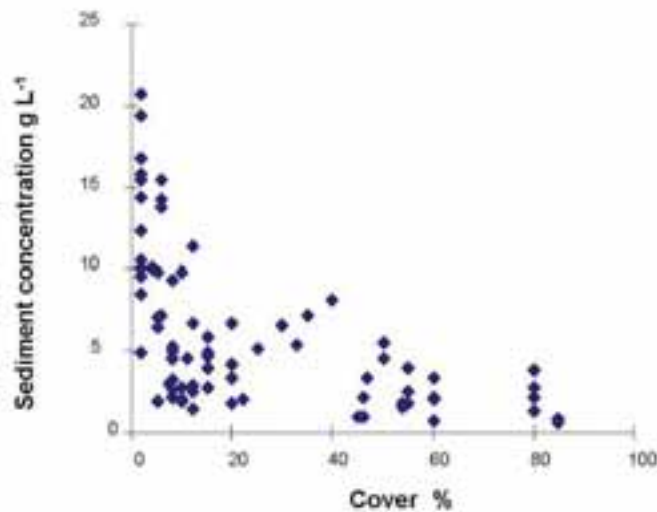
FIGURE 1.6 BOX WHISKER PLOTS OF TOTAL PHOSPHORUS AND NITROGEN IN RUNOFF FROM A SET OF NESTED CATCHMENTS ON THE EASTERN DARLING DOWNS (SILBURN ET AL., 2007). CONCENTRATION OF NUTRIENTS IN RUNOFF VARIES BY AN ORDER OF MAGNITUDE ACROSS 38-56,000 HA, REFLECTING DEPOSITION AND DILUTION AS AREA INCREASES



4. Change in land use and management – responses to management is the crux of what monitoring and evaluation is about.

Figure 1.6 shows a relationship between soil cover and sediment concentration derived from a set of 4ha catchments which were monitored intensively for >10 years. Even though there is a clear relationship between cover and sediment concentration, there is still significant variation attributed to different hydrologic conditions, and other physical factors such as roughness, storage and soil moisture. Similar relationships have been found for many other catchment and rainfall simulator studies, and this relationship is similar to that used in the Universal Soil Loss Equation (Wischmeier and Smith, 1978), a model used extensively in the USA for allocation of NRM resources.

FIGURE 1.7 RELATIONSHIP BETWEEN SOIL COVER AND SEDIMENT CONCENTRATION LEAVING CONTOUR BAY CATCHMENTS NEAR WALLUMBILLA (1983 -2000) (FREEBAIRN ET AL., 2009).



The case for using models to estimate benefits to resource condition due to management actions.

Models can be simple or complex, but the simpler the better. Models help structure data and extrapolate our understanding beyond limited conditions we have measured. **Figure 1.6** is an example of data showing the relationship between soil cover and erosion, and such data (collected under experimental conditions) allows us to develop models. In this case the raw data has been regressed against runoff, soil moisture and other factors and has been used to build the erosion model in PERFECT and Howleaky? allowing us to estimate changes in erosion due to soil cover conditions.

Models allow us to analyse some aspects of production and natural resource management that cannot be done efficiently with traditional experiments. Models rely on sound experimentation to provide a basic understanding of processes. By combining knowledge gained from many experiments and using long term weather records, estimates can be made of what is likely to happen in other environments, soil types and inputs. Models help us think through what are the most important processes in a system but they will always be incomplete because we don't know everything even from detailed experiments. Models do not invent knowledge; they are good integrators and data stretchers.

2.0 EROSION AND SEDIMENT DELIVERY ESTIMATES

An estimate of annual average hillslope erosion was made for the Moonie (Back Ck) and Upper Boogera clusters of the Talwood Planning Group using the Howleaky? model (a description of the model is included as Appendix 2). Howleaky? is a paddock scale water balance model that estimates soil hydrology and erosion uses a combination of soil, land use, land management and climatic information to estimate the dynamics of water balance (including soil water, runoff and drainage), and be used to make estimates of hillslope erosion. An understanding of soil properties (sediment size distribution) also allows for estimates of sediment losses further through the catchment

Spatial data of the soils, land use and topography were combined with local knowledge of land management to develop a model of farming systems for the group. Climate data for the area was sourced from the Bureau of Meteorology. The methods used to combine and utilise the available data were:

1. Data layers of soil, land use and slope were overlaid to develop a map of unique combinations or Hydrologic Response Units (HRU). The area (in hectares) was calculated for each HRU represented;
2. Howleaky was used to estimate average annual erosion for each HRU combination using a climate period 1901-2008; and
3. The erosion rates were averaged to calculate an average erosion rate for the sub-catchment area.

2.1 Paddock Scale Erosion: Input Data and Assumptions

The assumptions in making erosion estimate were:

- Crop rotations were not considered explicitly but was dealt with by averaging predictions from long term mono-culture scenarios; and
- Gullies were not considered in the erosion estimate

Soils and Farming System

Soils in the Moonie group are mostly Grey Vertosols but also include some Red Kandosols and Red Sodosols. Soils in the Upper Boogera group area are dominated by Brown Vertosols but also include Red Kandosols and Red Sodosols. One property in the Upper Boogera Group is located in the Moonie catchment and soils are predominantly Grey Vertosols.

Land uses in both group areas are predominantly cropping or grazing (unimproved pastures). Cropping is mostly confined to lower areas on Vertosols, whilst grazing dominates the ridges on predominantly Kandosols and Sodosols.

Cropping is largely opportunistic with some adoption of conservation tillage and crop/grazing rotations. A nominal breakup of cropping in an “average year” (McDonald pers. comm. 2007) is:

- 20% sorghum;
- 40% wheat;
- 15% legume crop;

15% legume/improved pasture (being grazed); and
10% bare fallow as part of a rotation or pending pasture establishment.

2.2 Result of Paddock Scale Erosion Estimate

The average annual erosion estimates presented below include an erosion estimate for three main land use types, cropping, grazing and native vegetation and represent the whole catchment. The analysis is not spatially explicit and has not differentiated between the land area in the two catchment (Upper Moonie and Weir) but has rather applied the average annual rate of 4.3 t/ha to these areas (**Table 2.1**).

TABLE 2.1 AVERAGE EROSION RATE FOR MAJOR LAND USES

LANDUSE	AREA (HA)	EROSION (T/HA/ANNUM)	EROSION (T/ANNUM)
Cropping	20,600	8.4	173,000
Grazing	30,150	1.6	48,240
Native vegetation	700	0.2	140
Catchment average	51,450	4.3	221,240

2.3 Sediment delivery estimates: Method and Assumptions

Outputs of the paddock erosion modelling were used to infer the amount of sediment trapped by contour banks and waterways in the sub-catchment areas and delivered downstream past the Moonie and Weir gauging stations. It should be noted that the conceptual model used to make these estimates makes no consideration of other sources of sediment in the catchment, such as gullies or streambank erosion.

Two scenarios were considered for comparison, without and with contour banks. The following estimates are based on 3 key pieces of information.

1. Manning equation has been used to make estimates of flow velocities from hillslopes (with and without contours) and in-stream;
2. The Hjulstrom curve has been used to estimate the particle sizes that would fall out of suspension (using the velocities calculated in 1) (See **Figure 1.7**); and
3. The percentage of eroded material in the various particle sizes (Rattray unpublished data) (See **Figure 2.1**).

In this way, the impact that contour banks have on flow velocities has been used to infer their trapping efficiency and the benefits.

FIGURE 2.1 HJULSTROM CURVE (SOURCE WWW.GEOGRAPHYALLTHEWAY.COM)

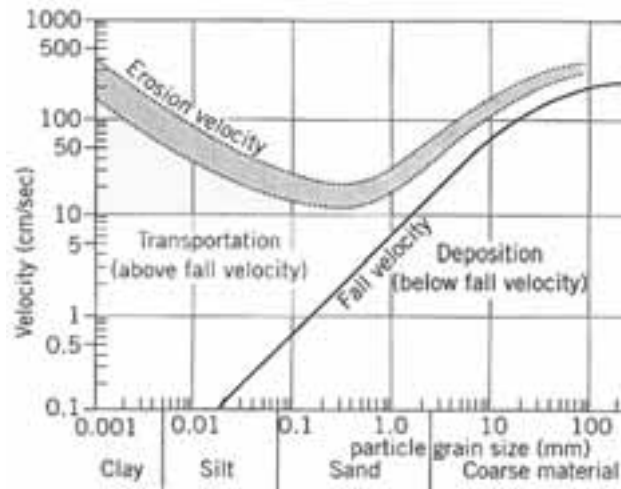
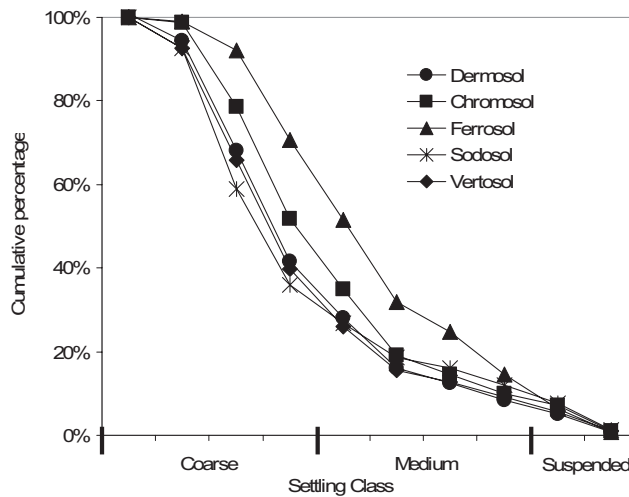


FIGURE 2.2 THE PERCENTAGE OF MATERIAL IN VARIOUS SETTLING VELOCITY CLASSES. SETTLING VELOCITY CLASSES RELATE TO PARTICLE SIZES AS "SUSPENDED" IS FINE SILT AND CLAY, "MEDIUM" IS COARSE SILT TO FINE SAND, "COARSE" IS >FINE SAND. (RATTRAY UNPUBLISHED DATA)



The use of a trapping efficiency assumes no major failures in contour system due to extreme events causing blowouts or due to blowouts from other events when contours and waterways are poorly maintained. This report only provides an erosion estimate for hillslope processes and takes no account of any other sources of sediment in the area, such as gullies.

The estimates for the two receiving catchments are based on the area from the sub-catchment draining into them. The Moonie (Back Ck) group covers 20,070 hectares which is almost entirely in the Upper Moonie catchment. The Upper Boogera group covers 31,380 hectares with most properties in the Lower Weir catchment except for two properties in the Upper Moonie and parts of several other properties in the Upper and Lower Moonie catchments (approx 6,000 ha).

2.4 Result of Sediment Delivery Estimate

Runoff and stream velocities were calculated using Mannings equation and were estimated as:

- Hillslope with no contours 1-2 m/s;
- Contours <0.5 m/s; and
- Stream and River 0.5 - 1 m/s.

The analysis, based on the assumptions above and considering fall velocities from the Hjulstrom curve (**Figure 1.7**) and eroded material particle size distribution (**Figure 2.1**) result in the following:

Without contour banks

1. 10-40% of eroded material drops out on the hillslope.
2. The remaining 60-90% of eroded material reaches the stream network (or a major drainage line).
3. Of this material about 11% can be transported downstream to the gauging stations.

With contour banks

1. 10-40% of eroded material drops out on the hillslope before reaching the contour bank.
2. About 6% of the eroded material can be transported out of the contour banks.
3. All of the material delivered to the stream network is able to be transported downstream to the gauging stations.

In summary this represents the following benefits:

- Contour banks are estimated to have a trapping efficiency of 54-84%; and
- Sediment delivery to gauging stations is estimated to be reduced by 5% with the inclusion of contour banks.

Benefits to be estimated in terms of sediment retained in each sub-catchment (**Table 2.2**) and reduction in sediment loads in the Weir River (Talwood GS) and the Moonie River (new Flinton GS) are presented in **Table 2.3**.

TABLE 2.2 ESTIMATED SEDIMENT TRAPPED BY CONTOUR BANKS

SUB-CATCHMENT PLANNING GROUP	AREA (HA)	TOTAL EROSION (T/ANNUM)	SEDITMENT TRAPPED (T/ANNUM)
Moonie River (Back Ck)	20,070	86,300	46,600 - 72,500
Upper Boogera	31,380	134,940	72,900 - 113,400
Total	51,450	221,240	119,500 - 185,900

TABLE 2.3 ESTIMATED IMPROVEMENT IN SEDIMENT DELIVERED TO GAUGING STATIONS

CATCHMENT	AREA (HA)	TOTAL EROSION (T/ANNUM)	11% SEDIMENT DELIVERY (T/ANNUM)	6% SEDIMENT DELIVERY (T/ANNUM)	REDUCTION IN SEDIMENT DELIVERED TO DOWNSTREAM GAUGING STATIONS (T/ANNUM)
Moonie River	26,070	86,300	9,500	5,200	4,300
Weir River	25,380	134,940	14,800	8,100	6,700
Total	51,450	221,240	24,300	13,300	11,000

FIGURE 2.3 NO CONTOURS: SEDIMENT BUDGET FOR THE HILLSLOPE EROSION SOURCES AND SINKS IN THE MOONIE AND WEIR RIVERS SYSTEMS WITHOUT CONTOURS. (NOTE THAT OTHER SOURCES OF SEDIMENT SUCH AS GULLIES AND STREAMBANK EROSION ARE NOT CONSIDERED IN THIS CONCEPTUAL MODEL).

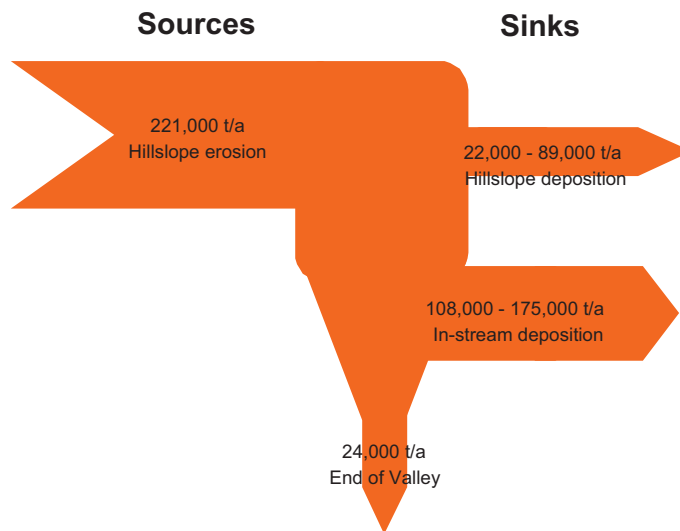
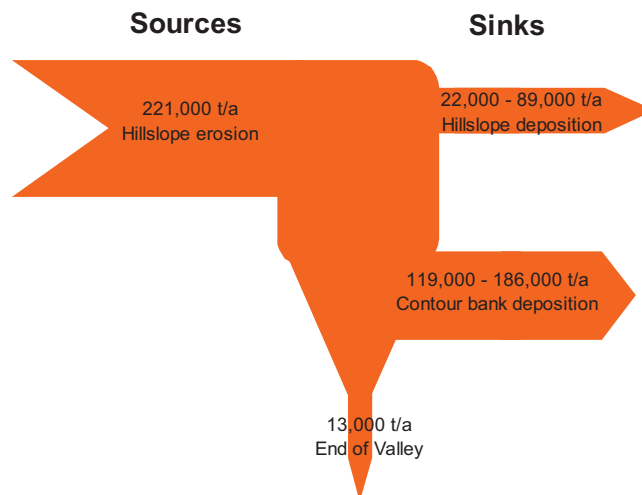


FIGURE 2.4 CONTOURS: SEDIMENT BUDGET FOR THE HILLSLOPE EROSION SOURCES AND SINKS IN THE MOONIE AND WEIR RIVERS SYSTEMS WITH CONTOURS. (NOTE THAT OTHER SOURCES OF SEDIMENT SUCH AS GULLIES AND STREAMBANK EROSION ARE NOT CONSIDERED IN THIS CONCEPTUAL MODEL).



3.0 SUMMARY

While there are conflicting views about the validity of models as tools to support planning and evaluation, models should be seen as valuable tools to predict NRM benefits of management action on Resource Condition. While on ground monitoring may appear to provide direct evidence it should be borne in mind that an observation or measurement will produce variable results due to:

- Sampling error within an event or area;
- Natural variation associated with weather;
- Scale or location in the catchment;
- Change associated with land use and management (the purpose main of monitoring in this papers context).

This project aimed to use a modelling approach to assist the QMDC make an estimate of benefits of soil conservation structures in the Moonie (Back Ck) and Upper Boogera clusters of the Talwood Planning Group. An estimate of the benefit of these structures has been made that includes both the local benefit (i.e. sediment trapped in contours banks) and also of an anticipated reduction in sediment loads in the Weir River (Talwood Gauging Station (G.S.) and the Moonie River (new Flinton G.S.).

In summary modelling has been used to show the advantages of these structures are three-fold:

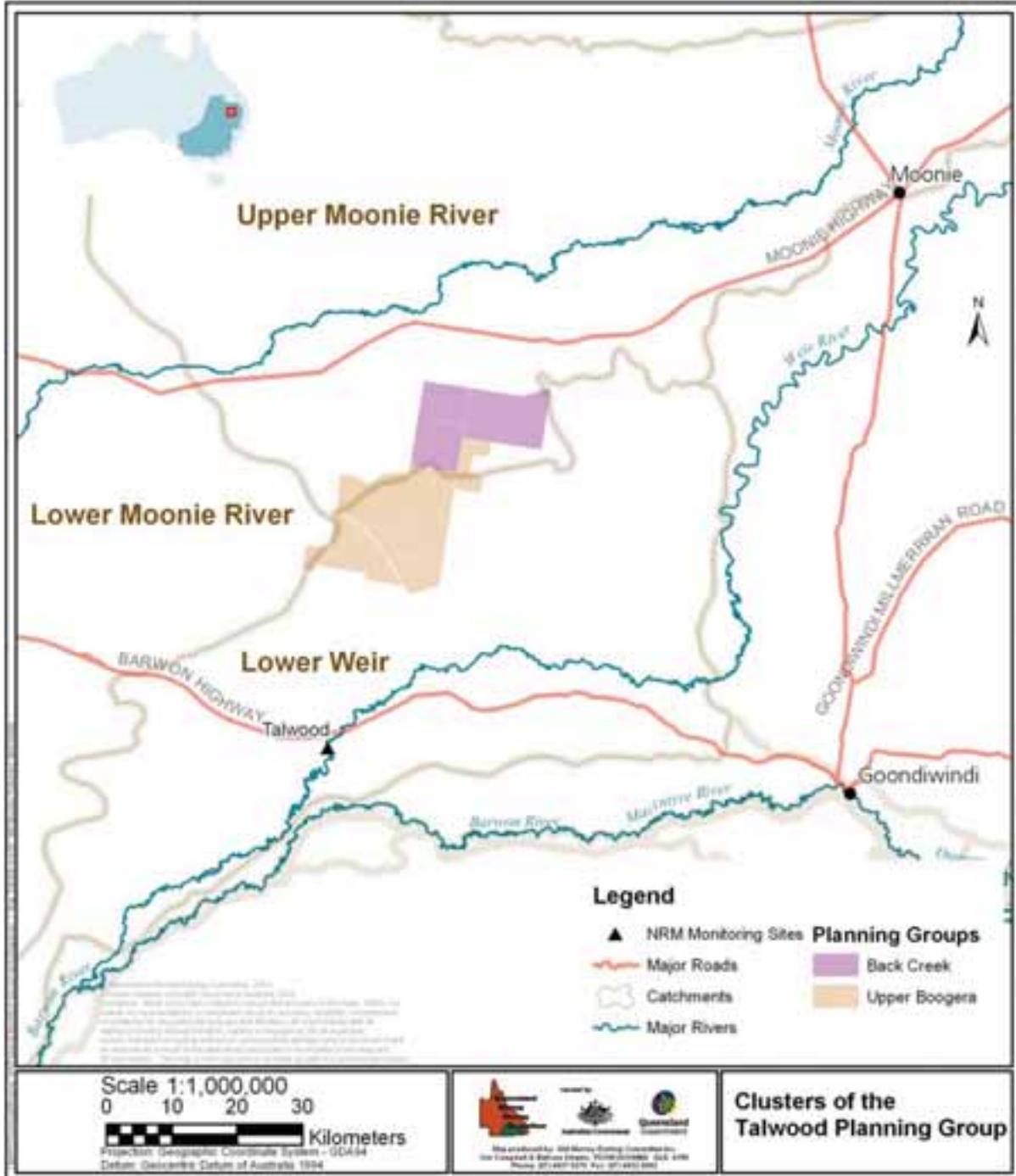
- Benefits to the landholder, It is estimated that the soil conservation works assessed have the potential to capture between 119,500 - 185,900 t/annum of topsoil that would otherwise be lost from the paddock. This topsoil represents the material with the greatest fertility potential and its loss will be reflected in lower productivity;
- Benefits to the local stream system due to reduced sedimentation. The capturing of sediment on farm reduces its threat to the stream and the risk of sedimentation of waterholes. The soil conservation works assessed therefore reduce sediment reaching the stream and drainage network by between 119,500 - 185,900 t/annum; and
- Benefits to downstream water users and the wider environment. By capturing sediments on farm the threat of this material being transported through the river network, decreasing downstream suspended sediment loads and turbidity are reduced. It has been estimated that the soil conservation works assessed have the potential to reduce suspended sediment loads by 11,000 t/annum.

Looking ahead, while this analysis has not considered the benefits of conservation farming practices (tillage and grazing practices that maintain higher groundcover) it would be possible to quantify these benefits using similar techniques as presented in this report. If we consider the implications of reduced hillslope erosion using the conceptual model given in **Figure 2.3** (and logic presented in section 2.4), a reduction in hillslope erosion will flow on to result in both lower rates of sedimentation in contour banks and a reduction in sediment being delivered to the downstream gauging stations. An increase in the rate of adoption of conservation farming practices will therefore offer both private benefits (reduced maintenance costs for contour bank as they will need to be de-silted less frequently) and public benefits (improved water quality in-stream). Using an approach similar to that presented in this report, modelling offers an opportunity to quantify the public and private benefits of investment in both conservation farming and soil conversation structures.

4.0 REFERENCES

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APPENDIX A MAP SHOWING BACK CREEK AND UPPER BOOGERA CLUSTERS OF THE TALWOOD SUB-CATCHMENT PLANNING GROUP



APPENDIX B BRIEF DESCRIPTION OF HOWLEAKY?—A TOOL FOR EXPLORING THE IMPACT OF LAND USE AND MANAGEMENT ON WATER BALANCE AND WATER QUALITY.

HowLeaky? is a water balance simulation model for exploring the impact of land use on water quality and water balance. A daily water balance model accounts for water flows – rainfall, evaporation, runoff, transpiration and deep drainage on a daily basis using simple mathematical relationships.

Its primary purpose is to explore implications of:

- Different land uses (including crops, pasture and trees);
- Climates;
- Soil types;
- Management of water balance (evapotranspiration, run-off, deep drainage);
- Erosion;
- Sediment; and
- Pesticide movement.

This leads to better understanding of landscape water dynamics and implications of management, and better connection between science and community.

Where does it fit in?

Simulation methodologies have much to offer in the debate on impacts of land use changes. Land managers can explore the implications of alternative land uses for a range of locations and soil types.

Currently, access to easy-to-use simulation models is poor. However, HowLeaky? is a new interface that will allow more people to explore the power of computer simulation.

HowLeaky? provides a pathway to better understanding and use of more complex models such as APSIM, GRASP and PERFECT. It can also be used as a training aid and tool for land use system analysis.

HowLeaky? capability to simulate degradation of agrichemicals in the soil, and their transport in runoff and sediment make it the best tool for exploration of chemical transport. AS with all models, the data behind the model sets the standard for its reliability and robustness.

Typical applications

Key questions that can be asked of HowLeaky? include:

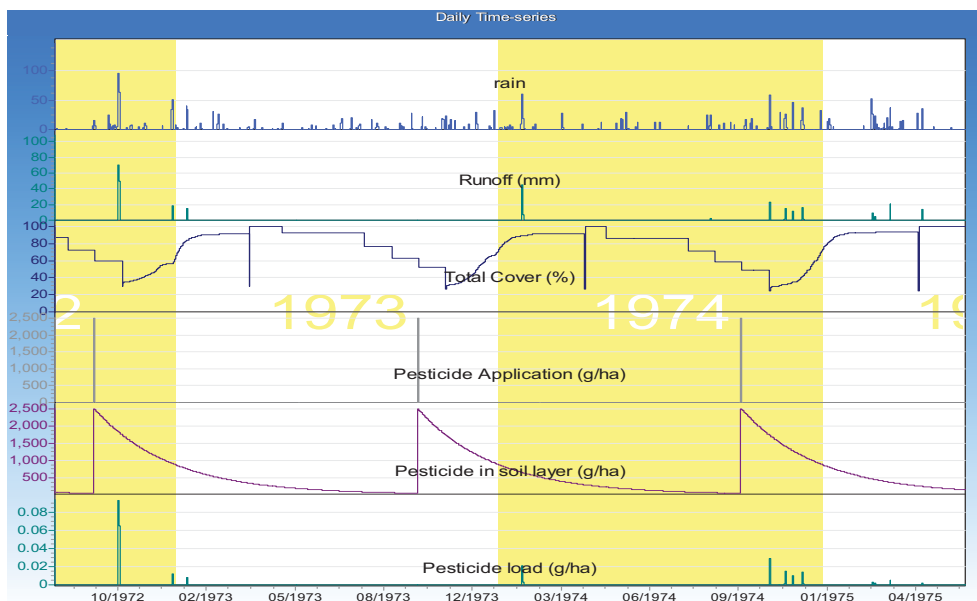
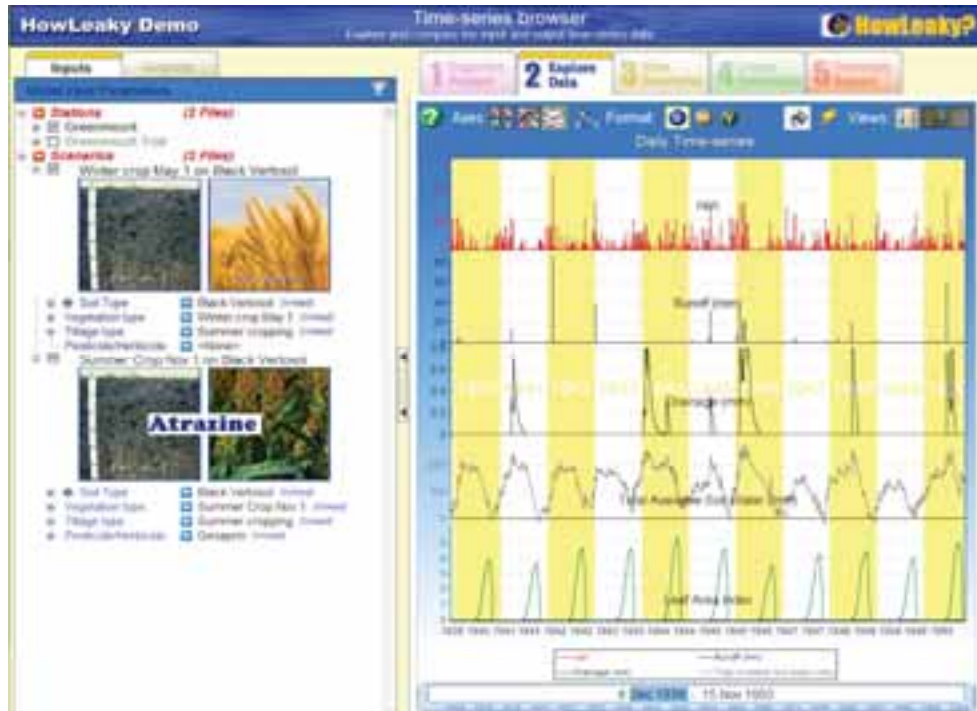
- How much water is lost as run-off and what is the subsequent erosion?
- How much water leaks below the root zone are creating potential salinity risks under different lands uses?
- What is the risk of pesticide loss off farm?

Outputs

A range of views of data can be attained with one to two clicks, and responses to changed conditions can be viewed instantly.

Tables, graphs and customised reports provide insight into how systems perform, allowing users to explore interactions between climate, vegetation water use and management. A pseudo animation allows the user to visualise system dynamics.

Screenshots showing visual cues for input condition and time series of outputs (rainfall, runoff, deep drainage, soil water and leaf area index).



Water Quality Report

Sorghum-V1 on Average Black earth	
Runoff (mm)	73.9
<i>Annual Loads</i>	
Erosion (t/ha)	8.3
Pesticide (g/ha)	2.4
Phosphorus (kg/ha)	0.76
<i>Event Mean Conc. (EMC)</i>	
Sediment (mg/L)	1.8
Pesticide (ug/L)	0.0017
Phosphorus (mg/L)	1

Pesticide Summary

Sorghum-V1 on Average Black earth	
Applications	105
Application rate(g/ha/yr)	2500
Load (water) (g/ha/yr)	0.036
Load (Sed) (g/ha/yr)	2.4
Load (Total) (g/ha/yr)	2.4
Loss/Applic Ratio (%)	0.096
Conc > 1 Crit (days/yr)	0.028
Conc > 0.5 Crit (days/yr)	0.28
Conc > 2 Crit (days/yr)	0
Conc > 10 Crit (days/yr)	0

Phosphorus Summary

Sorghum-V1 on Average Black earth	
<i>Event Mean Concentration (EMC)</i>	
Particulate P Conc. (mg/L)	0.18
Dissolved P Conc. (mg/L)	0.85
Bioavailable Particulate P Conc. (mg/L)	0.086
Bioavailable P Conc. (mg/L)	0.76
Total P Conc. (mg/L)	1
<i>Annual Loads</i>	
Particulate P Export (kg/ha)	0.13
Dissolved P Export (kg/ha)	0.63
Bioavailable Particulate P Export(kg/ha)	0.064
Bioavailable P Export (kg/ha)	0.57
Total P Export (kg/ha)	0.76

Further information

HowLeaky? can be downloaded from www.apsru.gov.au (products).

The software has an extensive set of Help files within the program, and as with any complex simulation tool, requires significant training and understanding of the system being simulated before any confidence can be placed in model estimates.