

Reef Rescue Research & Development

Technical Report

Capturing paddock scale hydrology
and water quality experiences relevant
to the Great Barrier Reef
RRRD011



David M Freebairn and Justin L Cutajar



Capturing paddock scale hydrology and water quality experiences relevant to the Great Barrier Reef (Project RRRD011)

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RPS Australia East Pty Ltd



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April 2013

Executive Summary

This project captured and synthesised over 100 studies dealing with hydrology-water quality related to land use and management, predominately at the paddock scale. These studies are all relevant to estimating changes in hydrology and water quality associated with various management practices in the Great Barrier Reef catchments.

A hierarchical data structure was used to summarise experimental sites with sufficient detail that audiences such as the Great Barrier Reef catchment modellers can pursue and add value to current and future modelling exercises.

Time-series of hydrology and water quality data are used to produce 'best bet' vegetation and soil parameters across a variety of land uses and regions. A protocol for pragmatic water quality modelling is established that estimates hydrology and water quality for a range of environments with reasonable accuracy.

Synthesised studies, datasets and best bet vegetation and soil parameter files are published on a publicly available database, <http://www.Howleaky.net/index.php/library>. These data summaries will be updated periodically.

This study has demonstrated that a range of data or reporting detail can be applied to inform hydrology and water quality simulation. While daily time series of hydrology, sediment and water quality are ideal, annual summaries are valuable.

We have successfully captured several datasets that would have almost inevitably have been lost. Yet such studies represent significant past effort and can provide useful physical evidence to support future management and modelling activities.

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Acronyms Used In This Report

DERM	Queensland Department of Environment and Resource Management
DNRM	Queensland Department of Natural Resources and Mines
CSIRO	Commonwealth Scientific and Industrial Organisation
GRDC	Grain Research and Development Corporation
ACIAR	Australian Centre of International Agricultural Research
Hydstra	Corporate hydrologic time series database used by DERM and DNRM
DARTS	Data Recording Tool for Science

Acknowledgements

The success of this project has been dependent on the openness and generosity of spirit from the scientists whose data and insights we have brought together.

Dr David McClymont of DHM Environmental Software Pty Ltd provided the map interface and web design for the website

Introduction

Field studies of management impacts on erosion and water quality are crucial for informing science, policy and land-management practices, particularly for farmers, yet there is a paucity of data from paddock scale studies. This project synthesises data from historic experiments to produce tables and relationships to complement water quality modelling in the Reef Rescue Research and Development portfolio.

There has been significant research over the last 5 decades describing impacts of management on erosion and water quality, with historic studies identified that can support the quantification of water quality leaving farms. Poor publication output, data management and lack of synthesis have led to results from these studies largely being ignored. Recent experience has shown that these data can provide valuable points of truth and build credibility in model estimates of water quality signatures.

Soil and management parameters for use in models such as Howleaky were created as baseline descriptions for modelling activities required in generalising field experiments.

The objectives of this project were:

- To capture key descriptions, datasets and insights from previous land management-water quality studies that are currently unavailable, lost, misplaced or inaccessible;
- Synthesise data from previous studies to complement current field research and quantify linkages between land use, management and water quality;
- Provide water quality modellers with a synthesis of past research and provide best bet model parameters for these conditions; and
- “Publish” all findings on a Reef Water Quality exchange portal being developed by the Queensland Department of Natural Resources and Mines (DNRM).

Capturing Key Descriptions, Datasets and Insights from Previous Water Quality Studies

A pragmatic approach was utilised to collate the abundance of paddock and catchment scale water quality studies that were either, published or not publicly accessible. The approach included:

- Searches through the web of science database using key word identifications such as, land use (cropping, horticulture, sugarcane, grazing, pastures), management practices (tillage, vegetation buffers, controlled trafficking, irrigation method), water quality (nutrients, pesticides, herbicides, sediment) and hydrology (runoff, deep drainage);
- Manual searches through research and society organisation websites for related conference papers, bulletins, presentations and featured articles;
- Searches through reference lists of published studies; and
- Contact with key stakeholders from government and research departments (DEHP, DNRM, CSIRO, GRDC and ACIAR).

The number of experimental sites far surpassed original expectations, with initial estimates of approximately 50 sites. This approach identified 119 sites concerning paddock and catchment scale hydrology and water quality investigations in Queensland (**Figure 1**). Cropping (both dryland and irrigated crops) recorded the greatest number of investigations (35), followed by sugarcane (30), grazing (26), horticulture (14), natural vegetation (7) and other (7). Cropping refers mostly to dryland grain cropping or irrigated cotton while sugarcane production is practiced along the coastal regions. Horticulture includes tress crops such as bananas and row crops such as pineapple production. Other land uses consisted of mining and industrial activities.

Land use investigations were generally limited spatially, for instance sugarcane investigations clustered in the Wet Tropics and Burdekin catchments, while cropping and grazing experiments generally occurred in the South-East Queensland and Fitzroy catchments, respectively.

A Google Earth file is available on request detailing site locations used in this report.

A bibliography is provided in **Appendix 1**. This identifies the referenced material and any additional documents relevant to this project.

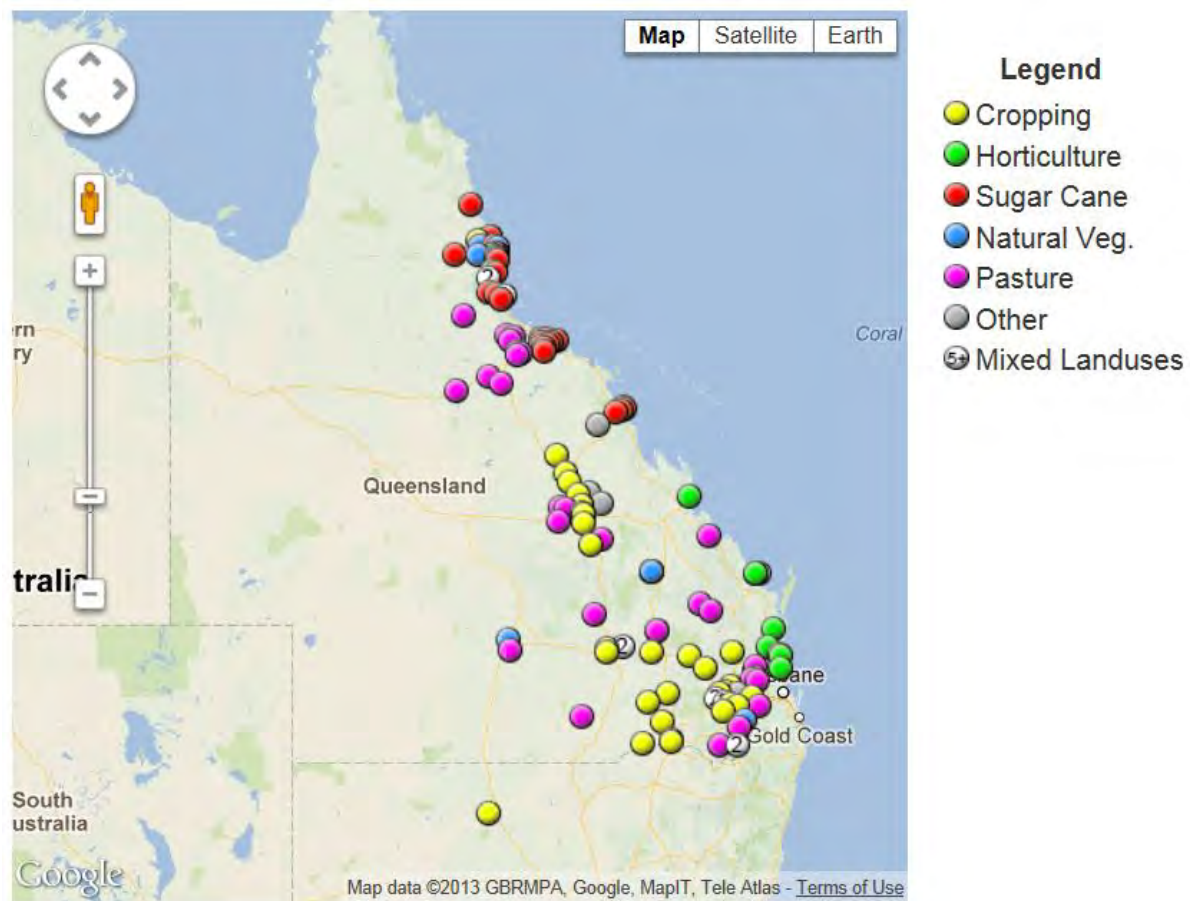


Figure 1: Location of experimental sites

Synthesise data from previous studies to complement current field research and quantify linkages between land use, management and water quality

Hierarchical Data Structure

Experimental sites were comprehensively reviewed using a hierarchical data structure where applicable:

- Level 1 - general description of experiment / monitoring activities - created before data collection, deals with high level description of the study, intended to provide a first view of what is being done, where and by whom. Key results are also provided at this level;
- Level 2 - detail of experimental conditions and methods - created during project development, deals with more detail on static site descriptions;
- Level 3 - dynamic site descriptions and observations - data in a range of detail from raw to processed (seven sites have been described at this level);
- Level 4 - data summaries, reports, tables, figures, images providing an overview of major hydrologic and water quality events to report summary outcomes. Commonly used by modellers for reality checking and “big picture” summaries; and
- Level 5 - model parameters and parameter sets, derived from experimental data to represent a “best current description” of field data in model terms.

As the level of detail available for each experimental site varied, components of the above hierarchical data structure was not applicable to every sites. Those sites which contained time series data were generally modelled; therefore levels 3 and 5 were only applicable to sites with experimental data. Sites that were published in journals or at conference proceedings were generally synthesised using level 1, 2 and 4, while sites containing basic information with little to no detail on results were synthesised using level 1 only.

Quality, Access and Level of Detail of the Data

In terms of water quality, the quality and level of information varied (**Figure 2**). For instance, many published studies did not give annual average loads for many parameters such as runoff, sediment loss, nutrients etc. This made it difficult to validate best bet model parameters; however we adapted to the level of data available (e.g. interpreting summary graphs and tables), which gave confidence in parameter files created.

Cropping

Cropping was the best documented land use in terms of available detailed data (time-series data). Access to time-series data generally occurred via Hydstra or contact with the principle investigator of the project. We obtained a total of 6 sites that included time-series data. Published reports, journal articles, conference papers and presentation (summaries) may not have contained times-series data, though were well documented in terms of providing

annual loads for runoff and other water quality parameters. Approximately 20 experimental sites are documented in this way. Some studies are related to rainfall simulation extension activities with a 1-2 page summary document.

Several studies with excellent time series data were available in a number of Excel files but yet not archived in a database with assured tenure. This is a common feature of many hard won datasets that require further effort to be secured for longer term and broader access.

Sugarcane

Sugarcane related experiments were well published. Publication was predominantly in peer-reviewed journals and generally lacked detail in terms of annual water quality loads. Water quality discussions mostly related to summarised event mean concentrations over a number of years (2 to 3). Access to time series data was not achieved, though with the inception of DARTS, time-series data related to sugarcane land use should now be available.

Grazing

Grazing studies are not particularly well published, while time-series datasets were obtained directly from the data custodian or principle investigators. For instance, the data for Mt Mort (Silburn 1994) and Keilambete grazing trials (Waters 2004) were not archived in the Hydstra database, but was well organised and readily available from the principle investigators.

Horticulture

Similar to grazing studies, experimental sites relating to horticultural land use were not well published. Excluding the pineapple site near Imbil (Cyril et al. 1995), access to these studies was via reports submitted to horticultural industries or internal documents passed on from key project investigators. None of the studies contained time-series data.

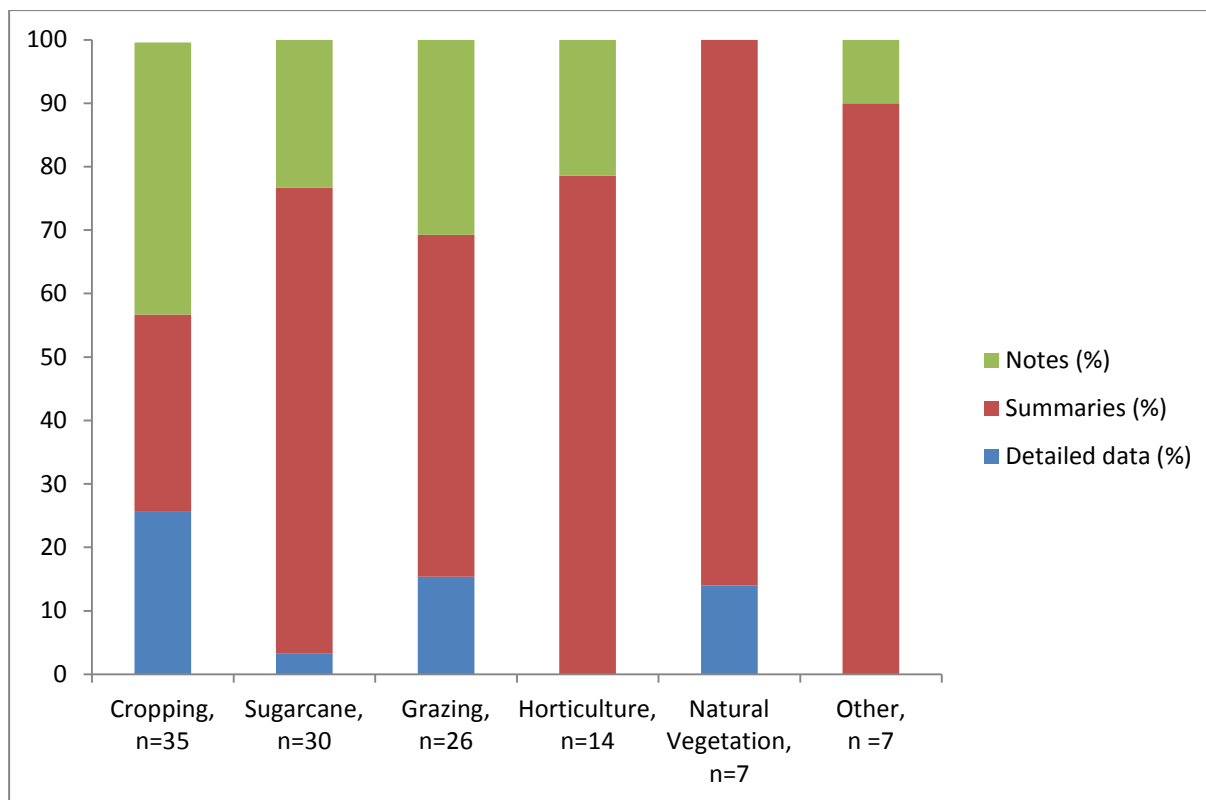


Figure 2: The level of detail provided in experimental studies for six land use categories. “n” refers to the number of studies in each land use class.

Provide a synthesis of past research and best bet model parameters for water quality models

Water balance models are a standard tool for describing and summarising hydrology and water quality attributes of land use systems, often relying on limited data to “calibrate” models. A key step in calibrating a model is determining how best to describe system conditions encountered in the real world.

In order to streamline water-balance model-assessment of water and sediment flows off farms, we explored model sensitivity to simplified soil and crop inputs. Where sensitivity is low, analysis can be more efficient with simpler inputs. The appropriateness of simplified models was recently tested for the Mt Mort grazing trial and the Wallumbilla cropping study. Two key inputs were explored; the level of detail in soil water description and vegetation description, such as those tuned to actual data (optimised models) or those described by general variations occurring both seasonally and annually (generalised models).

We found little difference between optimised models utilising measured vegetation covers and specific soil descriptions and generalised models utilising generic vegetation covers and soil descriptions. Therefore, generalised models are capable of quantifying runoff and soil loss for a variety of land uses and management. It is unlikely that simplified model inputs will result in serious errors in estimates of hydrology, soil loss or water quality (Freebairn et al. 2012).

A generic set of model parameters is likely to be more useful and transferable than a parameter set that describes an experiment explicitly, especially since vegetation patterns from an experiment are unlikely to be repeated and soil types are spatially variable.

We do not propose that model inputs should be simplified *per se* but it does suggest that modellers can be more pragmatic in describing systems at least in terms of vegetation and soil water holding properties. Vegetation can be described by a generic green and residue cover pattern (as mean monthly values) while soil water description requires a reasonable estimate of plant available water capacity (PAWC) with less detail on the number of layers described. An advantage of using water balance as a foundation for estimating water quality is that these models provide realistic estimates of water excess (runoff and deep drainage) and timing of excesses using qualitative assessments of soil properties, vegetation patterns and weather data.

We have found that if soil PAWC can be estimated from texture and rooting depth, and combined with descriptions of vegetation and of the soil’s propensity to crust at the surface, then estimates of hydrology and water quality responses to management is achieved for a wide range of environments with reasonable confidence and efficiency.

Comparison of Vegetation Descriptions for Grazing Study

Calibration

To explore the impact of the level of vegetation description required for model estimates of runoff and soil loss for grazing systems, the Howleaky model (V5.37.06, McClymont et al. 2011) was applied to data from the Mt Mort pasture study conducted by the Queensland Department of Natural Resources and Mines (1991–2000) (DM Silburn pers. Comm., Rattray et al. 2006). Runoff and soil loss were measured on three land management practices (grazed, exclosed and bare soil treatments) at “Old Hidden Vale”, Mt Mort, 27 km SSE of Gatton in southern Queensland.

Three levels of vegetation and soil description were applied to simulate runoff and soil loss at Mt Mort (**Figure 3**):

- A time series of measured green and residue covers and optimised soil descriptions for each treatment (a literal re-enactment of the experiment);
- The above vegetation description and a site average soil description; and
- A generic mean monthly green and residue cover distribution reflecting pasture growth and residue for each treatment and a single soil description as above.

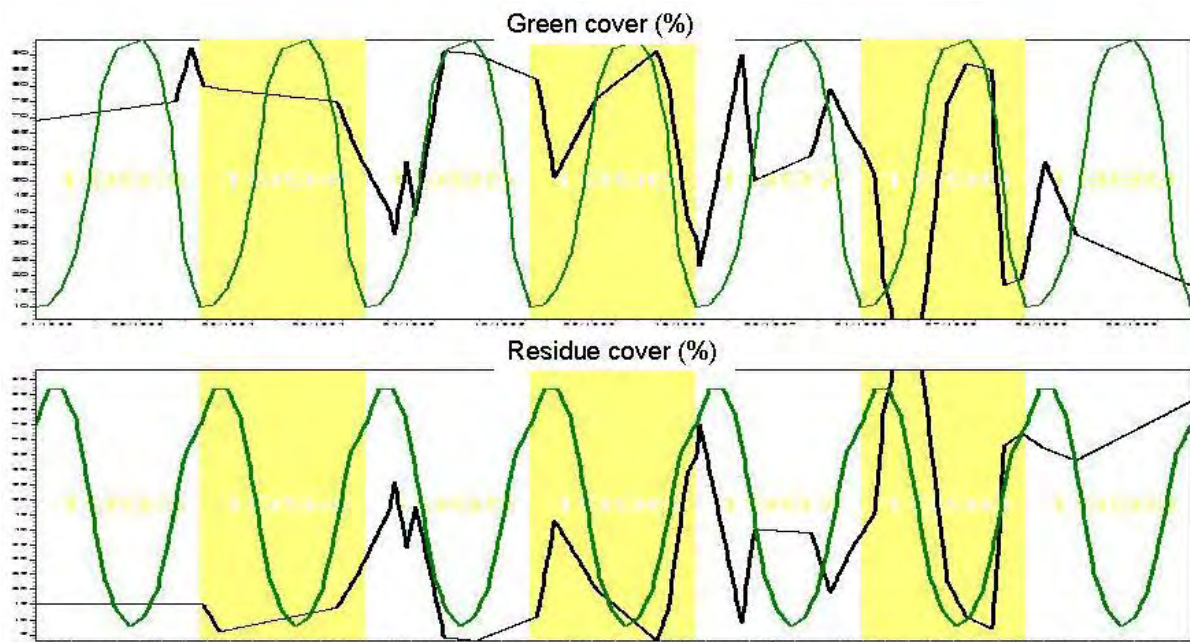


Figure 3: Two levels of cover descriptions for the exclosed treatment used in testing Howleaky: measured time series of observed cover (black line); and a generic seasonal distribution which captures typical seasonal variation (green line). Green and residue are both described in the model.

Results

Table 1 presents observed and predicted runoff and soil loss for three grazing treatments, each with three levels of detail in system description. The model was able to predict the impact of management on hydrology and erosion with reasonable reliability and estimates for the three levels of description. **Figure 4** presents a cumulative time series of runoff for the data summarised in **Table 1**.

Table 1: Summary of observed and predicted average annual runoff and soil loss for the Mt Mort grazing trial (1993-1999) with three levels of system descriptions.

Description of Management system	Observed (1993-1999)		Predicted (1993-1999)	
	Runoff (mm)	Soil Loss (t/ha)	Runoff (mm)	Soil loss (t/ha)
Level 1 model description (time series of measured green and residue cover and individual soil type)				
Measured Bare	136	46	159	50.3
Measured Grazed	22	0.5	18.4	0.67
Measured Exclosed	3	0.06	3.7	0.12
Level 2 model description (generic time series of green and residue cover and site soil type)				
Measured Bare	136	46	147	65.4
Measured Grazed	22	0.5	14.9	0.39
Measured Exclosed	3	0.06	11.7	0.18
Level 3 model description (generic time series of green cover, residue cover and soil type)				
Generalised Bare	136	46	142	53.8
Generalised Grazed	22	0.5	20.4	0.7
Generalised Exclosed	3	0.06	16.8	0.23

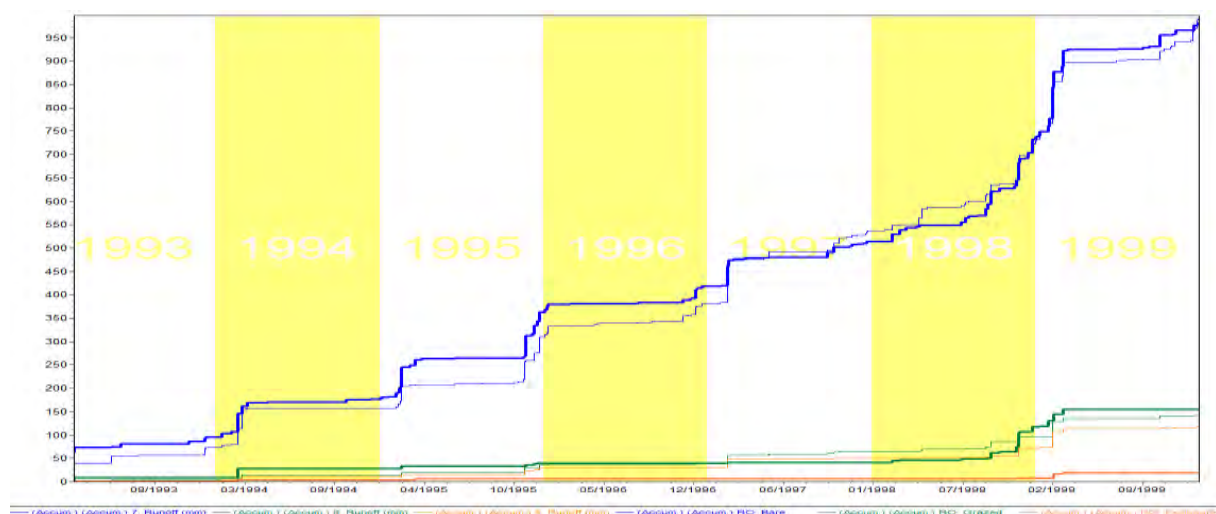


Figure 4: Simulated (bold lines) and measured cumulative runoff (mm) for three grazing treatments: bare (blue); green (grazed) and excluded (orange) at Mt Mort, QLD (1993-1999).

Comparison of Soil Description for Cropping Study

Calibration

To explore the impact of the level of soil description required for model estimates of runoff and soil loss in cropping systems, three varying levels of soil water description were used to simulate a winter cropping regime near Wallumbilla in south western Queensland (Freebairn *et al.* 2009). Two contrasting tillage - fallow stubble cover regimes were used to demonstrate hydrology and water quality responses to fallow management conditions.

PAWC and internal drainage were derived from wilting point, drained upper limit and total porosity of soil layers. Air dry and saturated content were used to describe evaporation store and deep drainage respectively.

Soil is described using three levels of detail shown in **Figure 5**:

- Six layered soil with all four parameters for each layer, (n=24 where n=number of parameters);
- Four soil layers,(n=12); and
- A pseudo three layer soil specified by: available soil water range of the surface layer; “evaporation depth”; and rooting depth (n=3).

The third soil description method ignores soil water below wilting point and represents a very simplistic view of soil water stores.

Approximately 5-12 other variables were required to describe evaporation, runoff and drainage processes. The three soil descriptions used here were constructed to have similar PAWC values. Hydrology, erosion and water quality estimates were used to compare the results for the various levels of input.

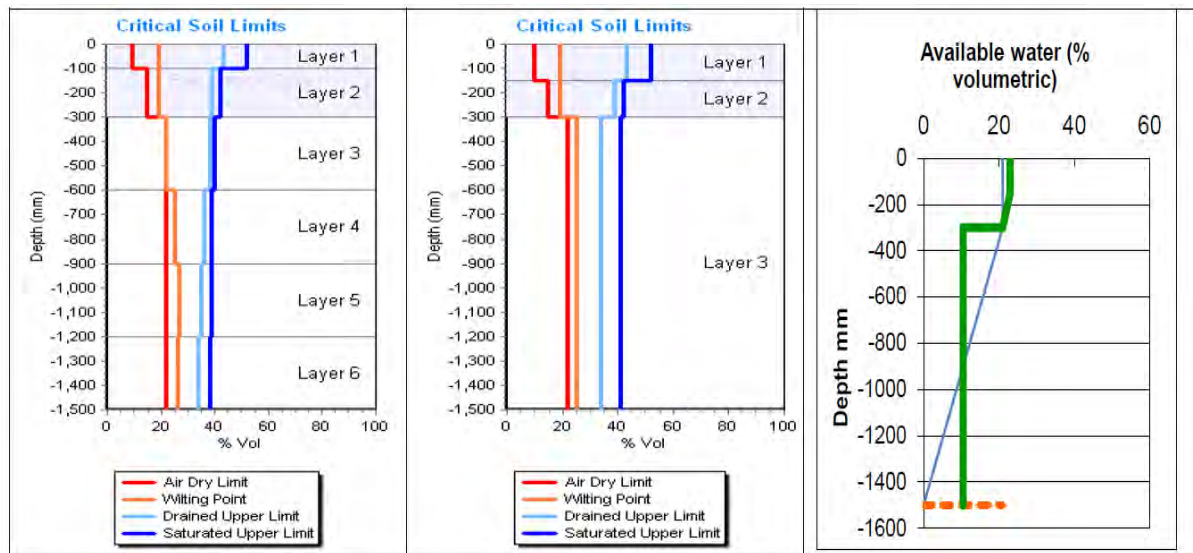


Figure 5: Three levels of soil water description for a brown sodosol near Wallumbilla: a full description with six layers (ApSoil profile No. 064); the same soil with 3 layers; and the much simplified soil water description based on three input values.

Results

The impact of soil description on runoff, soil loss and sediment concentration estimates for cropping under two levels of soil management is presented in **Table 2**. Soil with six or three layers resulted in similar hydrology, erosion and sediment estimates while the simplified soil water description estimated higher runoff. In terms of estimating differences between management practices, all three soil descriptions provide similar estimates in terms of absolute values and relative rankings. It is clear that the intermediate soil description (3 layer) is adequate, and errors associated with a very simple soil description capture gross differences between management practices.

Table 2: Summary of runoff, erosion and event mean sediment concentration for two cropping systems with three levels of soil description. “n” refers to the number of soil parameters in each soil parameter file.

Soil description 'n' refers to the number of parameters values in each description	Runoff (mm)	Hill slope soil loss (t/ha)	Sediment Event Mean Concentration (g/L)
High tillage, low residue retention			
Full soil description, 6 layers n = 32	48	5.2	1.5
Partial soil description 3 layers n = 19	47	5.4	1.1
Simple soil description n = 10	69	8.2	1.2
Low tillage, high residue retention			
Full soil description, 6 layers n = 32	65	0.27	0.06
Partial soil description 3 layers n = 19	64	0.34	0.05
Simple soil description n = 10	85	0.64	0.08

Modelled Experimental Sites and Generated Parameters Sets

Detailed (time series) and summary (e.g. annual or mean annual values) data from experimental studies have been applied to water balance models in order to capture and summarise field behaviour. These sites include a variety of land uses (cropping, pasture, horticulture) and management practices (tillage type, grazing intensity). Case studies generally contain a set of files that describe time series of observed climate, runoff, soil erosion, sediment concentration and in some cases, nutrient concentration values. The modelling process has resulted in the development of best bet Howleaky parameter files (soil and vegetation parameter files). These resultant parameter files can be used with reasonable confidence to explore the effect of varying management practices on water quality. With minimal adjustment, these derived files can be restructured to suit a range of models or at least provide an informed starting point for similar modelling exercises.

Howleaky parameter files have been developed for the following land use studies/sites:

Cropping;

1. Wallumbila (Freebairn et al 2009). Impacts of soil conditions on hydrology and water quality from a brown clay in the north-eastern cereal zone of Australia. *Australian Journal of Soil Research*. 47: 389-402.
2. Capella (Carroll et al 1997). The effect of crop type, crop rotation, and tillage practice on runoff and soil loss on a Vertosol in central Queensland. *Australian Journal of Soil Research* 35: 925-39.
3. Kairi (Cogle et al 2011). The effect of crop type, crop rotation, and tillage practice on runoff and soil loss on a Vertosol in central Queensland. *Australian Journal of Soil Research* 35: 925-39.
4. Brigalow Research Station (Thornton et al 2007) The Brigalow Catchment Study. II. Clearing brigalow (*Acacia harpophylla*) for cropping or pasture increases runoff. *Australian Journal of Soil Research* 45: 496–511.
5. Greenmount (Freebairn DM and Wockner GH. 1986). A study of soil erosion on Vertosols of the Eastern Darling Downs, Queensland. I Effects of surface conditions on soil movement within contour bay catchments. *Australian Journal of Soil Research* 24:135-58.
6. Greenwood (Freebairn DM and Wockner GH. 1986). A study of soil erosion on Vertosols of the Eastern Darling Downs, Queensland. I Effects of surface conditions on soil movement within contour bay catchments. *Australian Journal of Soil Research* 24:135-58.

Horticulture;

7. Goomboorian (Coughlan KJ, Rose CW. 1997). Field experimental results - runoff, soil loss and crop yield in Tropical Steeplands (Chapter 3) in *A New Soil Conservation Methodology and Application to Cropping Systems*. A comparative synthesis of results obtained in ACIAR Project PN 9201 ACIAR Technical Reports No 40. 147 pp. ISBN 1 86320 211 0

Pasture.

8. Kielambete (Waters et al. 2004) Grazing management implications and runoff and erosion processes in semi-arid Central Queensland. ISCO 2004 – 13th International Soil Conservation Organisation Conference),
9. Mt Mort (Silburn, 1994 Mt Mort field visit notes) Management practices for productivity and sustainability of duplex soils under grazing.
10. Brigalow Research Station (Thornton et al 2007) The Brigalow Catchment Study. II. Clearing brigalow (*Acacia harpophylla*) for cropping or pasture increases runoff. Australian Journal of Soil Research 45: 496–511.
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12. Wallumbila (Freebairn DM, Wockner GH, Hamilton NA, Rowland P 2009). Impacts of soil conditions on hydrology and water quality from a brown clay in the north-eastern cereal zone of Australia. Australian Journal of Soil Research. 47: 389-402.

Natural vegetation.

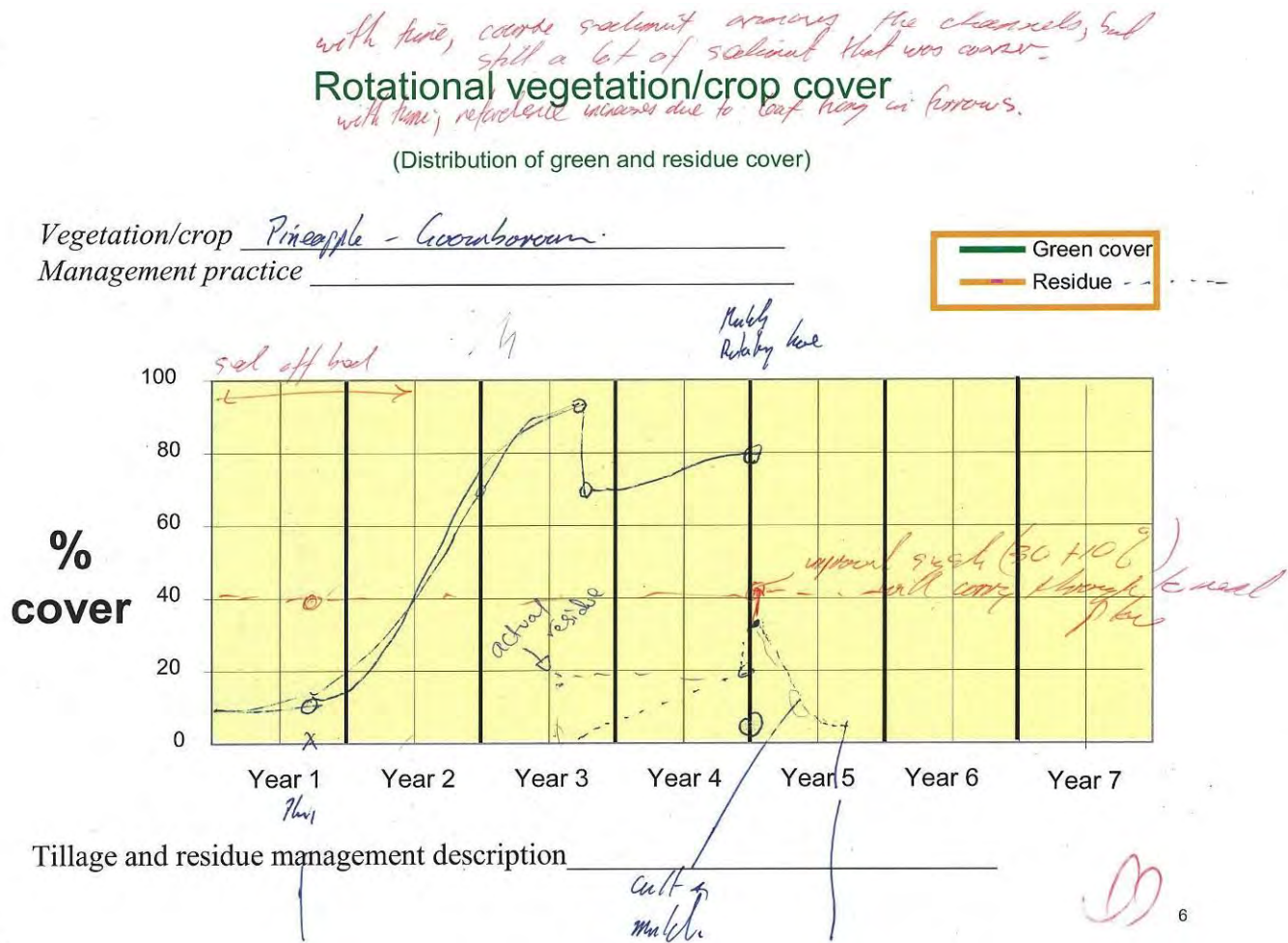
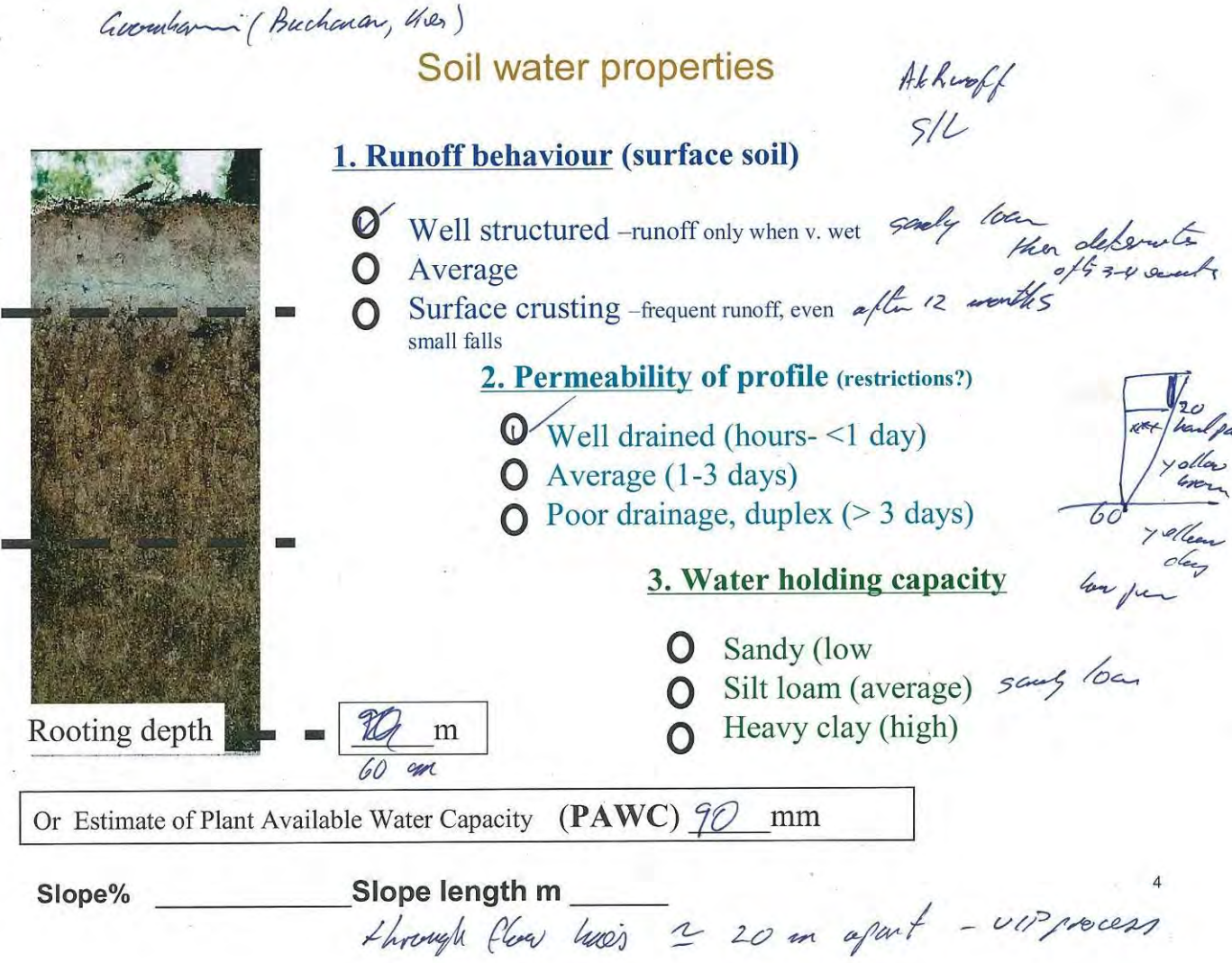
13. Brigalow Research Station (Thornton et al 2007) The Brigalow Catchment Study. II. Clearing brigalow (*Acacia harpophylla*) for cropping or pasture increases runoff. Australian Journal of Soil Research 45: 496–511.

Excluding the Goomboorian pineapple study, all parameter files were calibrated with time-series hydrology and water quality data. Interestingly, we were able to simulate runoff and soil loss at Goomboorian with relative ease and accuracy (**Table 3**) using average annual load values. Further, calibration of Goomboorian parameter files typically took 15 minutes with minimal effort to tune each parameter set to the model. **Figure 6** presents a protocol for pragmatic water quality modelling, which was used in the Goomboorian modelling exercise. A report was completed for each modelled experimental site, explaining the rationale and success of generated parameters. The collection of experimental sites presents a sound basis for generalised water quality modelling, while providing a pragmatic protocol for such modelling. **Appendix 2** contains an example of a modelled experimental site report and generated parameter files.

Table 3: Summary of average annual runoff and soil erosion for Goomboorian pineapple study (1992-1995).

Description of Management system	Observed (1991-1995)		Predicted (1991-1995)	
	Runoff (mm)	Soil Loss (t/ha)	Runoff (mm)	Soil Loss (t/ha)
Calibrated soil descriptions for each management practice				
Bare (D)	286	216	287	204
Conventional (C)	213	51	214	59
Furrow Mulching (B)	150	3	148	4
Single soil description for all three management practices				
Simple Soil Bare (D)	286	216	288	205
Simple Soil Conventional (C)	213	51	217	59
Simple Soil Furrow Mulching (B)	150	3	149	4

Figure 6: Soil water properties and rotational vegetation / crop cover for the Goomboorian pineapples study identified by C. Ciesolka and D. Freebairn (2012).



Publish all Findings on a Reef Water Quality Exchange Portal

DARTS

As part of the Reef Rescue Program, Department of Environment and Resource Management (DERM) established a publicly accessible database, Data Recording Tool for Science (DARTS). DARTS is a scientific data and information management system that facilitates the need to support land use and management recommendations with defensible science. Users are able to manage their experimental site details and time-series data with the longer term view of publishing this data. DARTS functionality at the time of this project's completion was unable to attach site photos, key / summary tables and graphs or any other documents relevant to their site. This is particularly important for historical experimental sites, as this project has found that time-series data is often not available and analysis is based on interpretation of summary tables, graphs and text. In due time data in DARTS will be published and discoverable.

e-Atlas

The use of E-ATLAS as a repository for synthesised experiments, time-series data and best bet parameter files was also considered. Contact with government agencies associated with e-Atlas was not successful. After several attempts, the use of e-Atlas to publish hierarchical data was disregarded.

Howleaky Web Portal

To meet the needs of the types of summarised works, a paddock scale water quality website has been developed <<http://www.Howleaky.net/index.php/library>>. This site has become the portal where synthesised studies, best bet model parameters and key data sets are published and publicly accessible.

The site provides summaries of ~130 historic water quality studies which complement current research and quantify linkages between land use, management and water quality. Time-series data and Howleaky parameter files have been attached at levels 3 and 5, respectively. Data sets and parameter files are downloadable as text files which are suited to direct input into any modelling program. These data sets are valuable in testing models, providing "points of truth". Observed data and parameter files are provided for approximately 9 studies representing 12 landuse sites (as of 7/11/2012).

This web portal is distinguished from DARTS in that data is: easily discoverable (open web access); searchable by key word, map location or industry focused data hierarchy; and has an open architecture that can accommodate two non-proprietary file types (text and PDF).

Screen shots of the website are shown in **Appendix 3**.

Recommendations

The following recommendations arose from the project and interaction with “Reef” personnel:

1. While this project has been able to access ~130 studies relating to water quality, more studies exist. *The search, collation and value adding for other studies should be further progressed* using existing “reef” networks, with the current WWW database being a reference point. Our estimate is that there are at least another 20 sites yet to be included.
2. *Synthesise and summarise paddock scale studies to provide a consolidated view of what the range of management practices mean in terms of managing water quality.* The studies should be used to confirm or change the current conceptual models of water quality response to management.
3. There is considerable scope to *extract new time series data and add-value to these studies* (so called “supersites” in this study). This study has shown that bringing old data to light is an efficient means of adding to the data base and our knowledge bank. There are at least 10 sites listed below whose data could be further extracted and be used as a sound basis for water quality model development and testing.
 - a. Horticulture:
 - i. Macadamia: Stork PR, Lyons DJ, Bell MJ. 2009. Losses of nitrogen in surface runoff from a plantation horticulture farm in coastal Queensland, Australia. *Australian Journal of Soil Research* 47: 565-573.
 - ii. Pineapples: Ciesiolka CAA, Coughlan KJ, Rose CW, Smith GD. 1995. Erosion and hydrology of steep lands under commercial pineapple production *Soil Technology* 8:243-258.
 - iii. Johnstone River: Nutrient balances and transport from agricultural rainforest lands: a case study in the Johnstone River Catchment.
 - b. Cropping:
 - i. Emerald: Management practices for control of runoff losses from cotton furrows under storm rainfall. I. Runoff and sediment on a black Vertisol. *Australian Journal of Soil Research* 40:1-20.
Silburn DM, Simpson BW, Hargreaves PA. (2002). Management practices for control of runoff losses from cotton furrows under storm rainfall. II. Transport of pesticides in runoff. *Australian Journal of Soil Research* 40:21-44.
Silburn DM, Hunter HM. (2009). Management practices for control of runoff losses from cotton furrows under storm rainfall. III. Cover and wheel traffic effects on nutrients (N and P) in runoff from a black Vertisol. *Australian Journal of Soil Research* 47:221-233
 - ii. Gatton: Tullberg JN, Ziebarth PJ, Li Y. 2001. Tillage and traffic effects on runoff. *Australian Journal of Soil Research* 39: 249-257.
 - c. Grazing:
 - i. Glentulloch: Grazing management implications and runoff and erosion processes in semi-arid Central Queensland. ISCO 2004 – 13th International Soil Conservation Organisation Conference

- ii. Springvale: Silburn DM, Carroll C, Ciesiolka CAA, deVoil RC, Burger P. (2011). Hillslope runoff and erosion on duplex soils in grazing lands in semi-arid central Queensland. I. Influences of cover, slope, and soil. *Soil Research* 49:105-117.
 - iii. Wambiana: O'Reagain P.J, Brodie J, Fraser G, Bushell J.J, Holloway C.H, Faithful JW, Haynes D (2005). Nutrient loss and water quality under extensive grazing in the upper Burdekin river catchment, North Queensland. *Marine Pollution Bulletin* 51: 37-50.
 - d. Sugarcane
 - i. Range of sites: Prove BG, Doogan VJ, Truong PNV (1995). 'Nature and magnitude of soil erosion in sugarcane land on the wet tropical coast of north-eastern Queensland', vol. 35, pp. 641-649.
 - ii. Victoria Plains: Ken Rhode (currently undertaking approximately 2 years of data). Nutrient and pesticide runoff from sugarcane farms.
- 4. While a large number of data sets have been re-discovered, these data has not been entered into a corporate database such as DARTS. *Resources should be allocated to facilitate entry of existing data into DARTS.*
- 5. Databases need to be flexible to accommodate a wide range of document formats. It should be recognised that resources will not always be available to enter data into a structured system. A data storage system needs sensible minimum data fields or metadata standards and the ability to attach any file format. *These minimum standards should be documented and published.*
- 6. As a relatively modest effort in data management, this project has relied on our networks and the goodwill of scientists from many organisations. It was always unclear what other data management or modelling activities were occurring in other groups. It seems quite a piecemeal activity within the major research provider originations. *Communication and coordination of data management across institutions would be useful in prioritising activities.*
- 7. This project has focused on studies that were generally > 10 years old. There is a body of work that sits between studies documented here and current work. In addition, some studies were uncovered but not available due to institutional issues. *These studies should be included in existing databases.*
- 8. The DARTS interface is functional but has room for development. We believe it should be enhanced to have similar functionality to the database developed < <http://www.howleaky.net/index.php/library> > in that the database should be: discoverable; keyword searchable, structured to allow simple navigation; and have a map interface to find sites geographically. At the time of publication, DARTS had none of the mentioned capability. Additionally, given data management protocols embraced in DARTS are seen as an encumbrance to many scientists. DARTS needs to have functions that add value or save time for scientists as an incentive to use it. *Significant on-going policy and financial commitment is needed to embed professional data management practice into natural resource science in Queensland.*

Conclusions

This project has been a focused effort to “discover” historic studies, demonstrate the value of these studies and ‘publish’ summaries of all studies and detailed data and interpretation of selected studies.

This project has collated data from > 130 studies dealing with hydrology, water quality, landuse and land management at the paddock scale. All these studies have some degree of relevance to understanding the interactions between environment, management and water quality.

It is very likely there are other studies with useful data sets and findings but remain in the grey literature or in filing cabinets. This is a reflection on past management of research where it was often the case that new studies were established before current and recent studies were analysed and published.

Available datasets were in many instances not well documented or summarised. Nevertheless, these datasets have added value to the Paddock to Reef (P2R) water quality assessment process through increased breadth of data sources from a range of soil types, environments, landuse and management options.

Where sufficient data and site descriptions were available, preliminary model calibration resulted in an efficient addition to knowledge with best-bet parameter sets produced. The datasets created in this activity are well suited to further exploration, model development and testing.

There is considerable scope to add value to the currently available experiments through further analysis as this project was only able to analyse twelve sites in detail (so called supersites).

We found that to generate model parameters with confidence, that calibration against time series data was preferred. However, as a minimum, annual or annual average loads or summary graphs can provide sufficient evidence to parameterise a model and create confidence in simulated estimates of hydrology, sediment and erosion losses for the study. This “calibration” is a good starting point for exploration of management impacts, especially when accompanied by similar datasets and analyses.

A web portal constructed as part of the project was an efficient means of “publishing” project summaries and data from paddock scale water quality studies < <http://www.howleaky.net/index.php/library> >. The time series data and parameter files are a resource for Great Barrier Reef catchment modellers to further pursue and add value to future paddock and catchment scale modelling activities. Early feedback has been very positive, with many Reef personnel learning about studies that they were not previously aware of. A Google search would not have discovered these valuable studies.

While the DARTS tool is now available, it was not available to accept data from this project during our associated deadlines.

The most gratifying component of the project was to bring datasets to light that would most likely have been lost. In several cases, published studies had excellent data records which were previously not available (on a hard drive overseas). For several studies, the project has added value to existing data and made datasets available in an easy to use and accessible format. Most data are still not in a formal database.

Given the effort in retrieving historic datasets relative to the cost of data collection, this project represented a good investment in providing baseline datasets for model development and testing.

The web portal represents a significant step forward in making relevant studies available to a wide audience. The ability to search by keyword, industry or map location makes for efficient discovery of historic studies.

This project arose from a previous study which discovered that awareness of historic studies relevant to water quality and management was poor, and access to summaries and data was difficult. The project has gone some way to alleviating this situation.

Publications

Freebairn DM, Cutajar J, Silburn DM. 2012. Assessing water quality from farms – how much detail is required for a model to be useful? Joint SSA and NZSSS Soil Science Conference 2-7 December 2012 Wrest Point, Hobart

Robinson JB, Melanie Shaw M, Chamberlain T, Searle R, David Freebairn DM. 2012. A quantitative and functional soil classification for modelling the terrestrial water balance of north-eastern Australia. Joint SSA and NZSSS Soil Science Conference. 2-7 December 2012 Wrest Point, Hobart

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< <http://www.howleaky.net/index.php/library> >

Appendix 1

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Appendix 2

Modelled Experimental Site Report – Greenmount

Howleaky assessment – Greenmount runoff and soil erosion catchment study

PROJECT TITLE: Capturing historic small catchment study (paddock scale) data to support quantification of management impacts on water quality on the Great Barrier Reef (RRRD011).

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
Draft A	Howleaky Assessment - Greenmount catchment Study	DF	JC	23/1/2012

1.0 Summary

The Howleaky model (V5.37.06, McClymont et al. 2011) was applied to data from the Greenmount catchment study (Freebairn and Wockner 1986) where up to 17 years of soil water, runoff and crop data have been collected for four tillage treatments (stubble burnt, stubble incorporated, stubble mulched and zero tillage after winter cropping), a summer crop and pasture land uses. The model was not tuned to specific crop management practices such as specific planting and tillage dates or site and management descriptions. A set of generalised soil, crop and tillage regimes were applied.

Overall, the model describes field observations of hydrology such that the resultant parameter sets can be used with confidence to explore a range of management options. Plant available soil water was described inaccurately. Runoff is well described and differentiated between treatments. Hillslope erosion and suspended sediment loss were well described by the model although suspended sediment loss was the least accurate. The model is sensitive to soil type and vegetation management.

A summary of hydrology and water quality predictions and measurements are shown in Table 1.

Summary of measured and predicted Average Annual Runoff, Hillslope Erosion and Suspended Sediment Loss for the Greenmount catchment study (1978-1990).

Management system	Measured			Predicted		
	Runoff (mm)	Hillslope erosion (t/ha)	Suspended Sediment loss ¹ (t/ha)	Runoff (mm)	Hillslope erosion (t/ha)	Suspended Sediment loss ² (t/ha)
Stubble burnt (1978-89)	68	45	4.6	66	42	9
Stubble incorporated (1976-89)	47	13	1.4	46	14	4.3
Stubble mulch (1978 -89)	47	9	0.8	47	10	2.9
Minimum tillage (1979-89)	35	1	0.3	33	1.5	0.6
Perennial pasture (1987-90)	32	1	0.2	35	1.1	0.4

1 - Based on available data, some smaller events not sampled

2 - No tuning, assumed delivery ratio of 0.14, K=0.35 metric units

A set of files has been compiled that present time series of climate, soil cover, soil water, plant and harvest dates, runoff, erosion and sediment. These files are documented and are well suited to further exploration using a range of models and statistical approaches.

Also a set of soil and vegetation parameter files have been constructed for use in the Howleaky model and may provide a starting point for further analysis and refinement.

2.0 Methodology

Howleaky has approximately 40 variables which can be manipulated to varying degrees: 12-40 values to describe soil water holding capacity; two for evaporation, four for infiltration; two for sediment delivery; a set of curves to describe vegetation (green and dead cover and root depth); and several tillage parameters.

Rather than apply exhaustive model fitting, a pragmatic process was followed to ensure the model reproduced field observations. Once data was assembled, model tuning took ~4 hours to complete. Little attempt was made to improve model performance if model estimates were in the ballpark of observed values. The Pareto principle¹ was applied ruthlessly. If model outputs describing the main hydrologic processes survived a quick visual inspection for sensibility (absolute values and trends), parameter sets were accepted. More iterations of parameter values would likely improve the coincidence of modeled and measured values, but the aim was to generate a set of useful parameter values that can be applied with fair confidence in other studies.

2.1 Tuning strategy

1. Build soil file based on observed soil water values, generating best bet lower limit (LL), and field capacity or Drained Upper Limit (DUL) values as Plant Available Water capacity (PAWC) is one of the more important soil descriptors.
2. Plant and harvest dates and crop yields used to tune an LAI model for winter cropping. A fixed plant date of 1st June was used to avoid uncertainties of variable plant rules. A set of more generic "cover" models may also be constructed.
3. Tillage rules and parameters sets were constructed to reproduce soil cover measurements.
4. Optimise the infiltration parameter (CN) and CN-Cover response to describe runoff, then tune either or both drainable porosity and maximum drainage rate for the lower soil layers to estimates of deep drainage if available. In this case, no attempt was made to tune drainage rates as values appeared sensible using a generic drainage rate of 12 mm/day.
5. Erosion was tuned using K - ensure slope and slope length are correct and re check cover if there are serious mismatches between observed and predicted
6. Observed soil water was used to check the model was using water sensibly.
7. Soil erosion from the model was compared to measured data.
8. Delivery Ratio will be used to tune for suspended sediment loads.

¹ The **Pareto principle** (also known as the **80–20 rule**, the **law of the vital few**, and the **principle of factor scarcity**) states that, for many events, roughly 80% of the effects come from 20% of the causes (Wikipedia)

2.2 Howleaky parameter reports

2.2.1 Soil

Soil files were based on available soil descriptions and plant available water data. These descriptions represent an informed opinion rather than a definitive description –which would be naive given site variability.

2.2.1.1 Building soil profile files

Plant available water (PAW) was derived from gravimetric sampling over 14 years. Based on this data PAW was 290 mm.

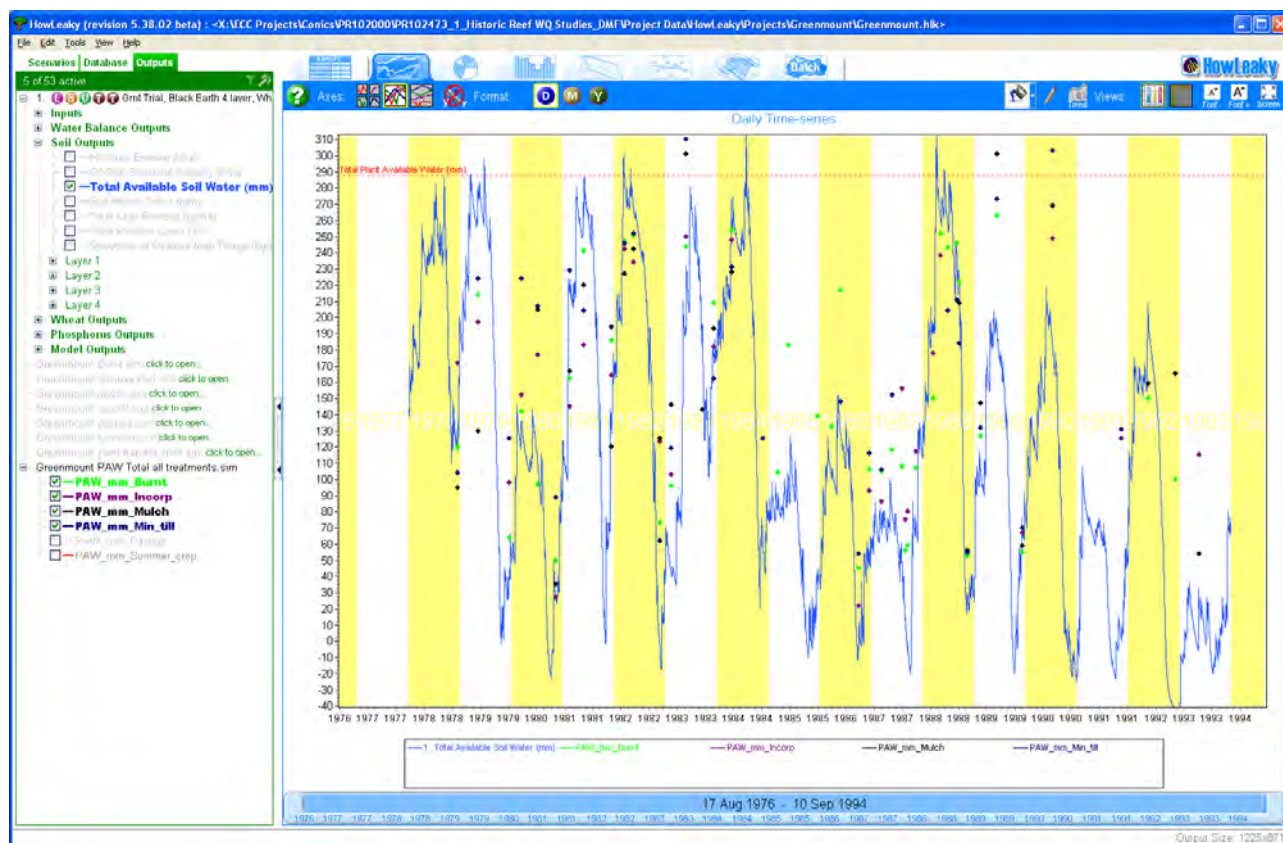


Figure 1: Observed plant available soil water on the Greenmount catchment study catchments. (1978-93).

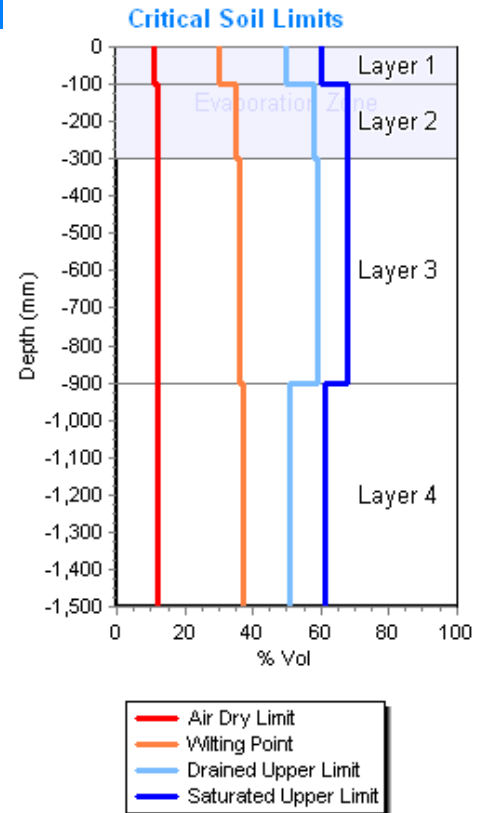
2.2.1.2 Soil Data: Black Earth 4 layer

Greenmount black earth 4 layer soil water description

Based on reworked PAW using mean LL and DUL

Main soil description used in model testing, to be consistent with most soil description being 4 layer
DMF 17/1/2012

Name	CurrentValue
Number of Horizons	4
Layer Depth (Cumulative)	100,300,900,1500 mm
Air dry moisture	11,12,12,12 %Vol
Wilting point	30,35,36,37 %Vol
Field capacity	50,58,59,51 %Vol
Sat. water content	60,68,68,61 %Vol
Maximum drainage from layer	100,50,50,12 mm/day
Bulk density	1,1.2,1.4,1.4 g/cm ³
Plant-available water	20,46,138,84 mm (Total = 288mm)
Maximum drainable water	10,20,54,60 mm
Stage 2 evap., Cona	6 mm/day ^{0.5}
Stage 1 evap. limit, U	0 mm
Runoff curve no.(bare soil)	82
CN Reduction 100% cover	15
CN Reduction - Tillage	0
Rainfall to 0 roughness	0 mm
USLE K factor	0.35 metric
USLE P factor	1
Field slope	7 %
Slope length	60 m
Rill/interrill ratio	1 (0-1)
Soil cracking	No
Sediment Delivery Ratio	0.14 (0-1)



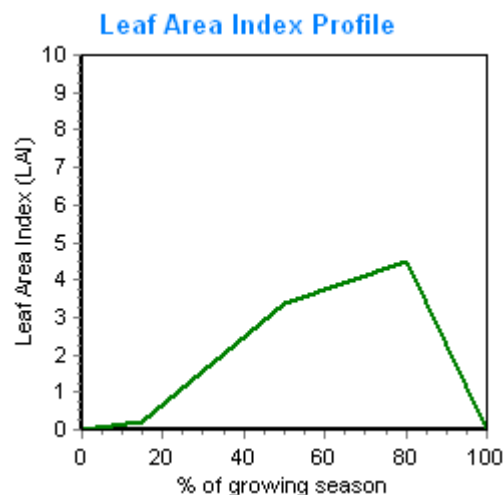
2.2.2 Vegetation

2.2.2.1 Vegetation Data: [Wheat June 1](#)

Wheat fixed plant date June 1

LAI set to match Woodruff wheat model and plant and harvest dates observed at Greenmount
DMF 17/1/2012

Name	CurrentValue
Potential max LAI	4.5 cm ² /cm ²
Prop. season for max LAI	0.8 fraction
Prop. max LAI (1st)	5 %
Prop. grow-season (1st)	15 %
Prop. max LAI (2nd)	75 %
Prop. grow-season (2nd)	50 %
Degree days plant-harvest	2200 oC
	Doyle and Fischer AJAR 1979 quote 1650 for Tamworth for sowing to 4t/ha DM. Assuming 4t/ha is 0.75 of harvest GDD, GDD = 2000 for Timgalen. JBR
Senescence coefficient	1
	Moderate senescence post anthesis. Approx 4 -5 weeks (as per Doyle and Fischer AJAR 1979) JBR
Radiation use efficiency	1.5 g/m ² /MJ
	Values in Purcell et al Crop Science 2002 range mostly from 1.3 to 1.6 g/MJ PAR JBR
Harvest index	0.33
	Modern semi-dwarfs range from 0.38 to 0.45 JBR Used value of 0.33 to match observed yields DMF
Base temperature	0 oC
Optimal temperature	15 oC
Maximum root depth	1800 mm
Daily root growth	15 mm
Water stress threshold	0.2 (0-1)
Stress days to death	21 days
Residue decomposition rate	2 %/day
	Set at 3 %/day to mimic fallow cover for zero till and allowed a rapid breakdown at planting using a tillage DMF
Residue at full cover	6000 kg/ha
Prop. GGD to end irrigation	80 %
Planting scheduling	Fixed Date (annual)
Planting date	1 Jun
Rotation options	Uncontrolled
Ratoon crop	No



2.2.3 Tillage scenarios

Four tillage scenarios were used to describe the range of tillage and cover conditions created on the trial. These are summarised below and detail of each tillage regime is listed

1. **L S U T T** Gmt Trial, Black Earth 4 layer, Wheat, Burn Dec1, Scarify [Jan 1978 to Dec 1993]
2. **L S U T T** Gmt Trial, Black Earth 4 layer, Wheat, Disc, Scarify [Jan 1976 to Dec 1993]
3. **L S U T T** Gmt Trial, Black Earth 4 layer, Wheat, Blade, Plant [Jan 1978 to Dec 1993]
4. **L S U T** Gmt Trial, Black Earth 4 layer, Wheat, Plant [Jan 1978 to Dec 1993]
5. **L S U** Gmt Trial, Black Earth pasture, Summer active pasture [Jan 1987 to Dec 1993]

2.2.3.1 **Tillage Data: Burn Dec1**

Name	CurrentValue
Tillage format	Fixed Dates (annual)
Tillage type	Burn
Crop-residue multiplier	0.1 ratio
Roughness ratio	1 ratio
Tillage date 1	1 Dec

2.2.3.2 **Tillage Data: Scarify**

Name	CurrentValue
Tillage format	Automatic
Tillage type	Scarify
Crop-residue multiplier	0.7 ratio
Roughness ratio	1 ratio
Start tillage window	1 Jan
End tillage window	1 Jun
Accumulated rainfall for tillage	100 mm
Number of days to total rain	30
Minimum days between tillage	45

2.2.3.3 **Tillage Data: Disc**

Name	CurrentValue
Tillage format	Fixed Dates (annual)
Tillage type	Disc
Crop-residue multiplier	0.6 ratio
Roughness ratio	1 ratio
Tillage date 1	1 Dec

2.2.3.4 **Tillage Data: Scarify**

Name	CurrentValue
------	--------------

Tillage format Automatic
 Tillage type Scarify
 Crop-residue multiplier 0.7 ratio
 Roughness ratio 1 ratio
 Start tillage window 1 Jan
 End tillage window 1 Jun
 Accumulated rainfall for tillage 100 mm
 Number of days to total rain 30
 Minimum number of days between tillage 45

2.2.3.5 Tillage Data: Blade

Name	CurrentValue
Tillage format	Fixed Dates (annual)
Tillage type	Blade
Crop-residue multiplier	0.8 ratio
Roughness ratio	1 ratio
Tillage date 1	1 Dec
Tillage date 2	15 Jan
Tillage date 3	1 Mar
Tillage date 4	-

2.2.3.6 Tillage Data: Plant

Name	CurrentValue
Tillage format	At Planting (All Crops)
Tillage type	none- ZeroTill
Crop-residue multiplier	0.6 ratio
Roughness ratio	1 ratio

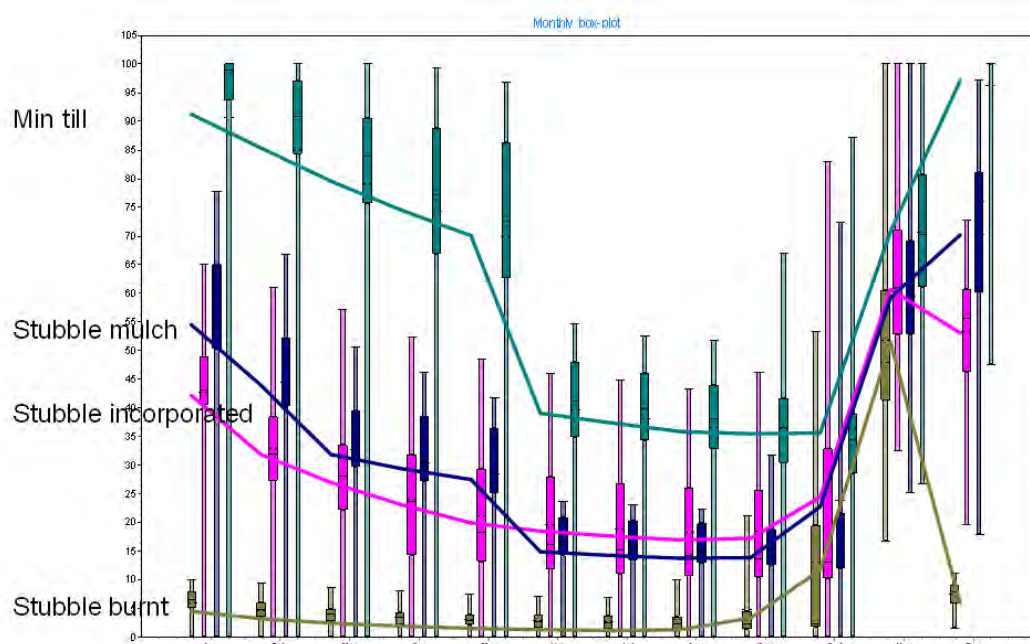


Figure 2: Distribution of monthly cover for the four main tillage treatments. Box plots represent in declining order –maximum, 75%ile, median, mean[dotted], 25%ile and minimum

2.3 Plant and harvest date, soil cover and crop yield

Planting and harvest dates (dots at 10 and 90 respectively) and crop cover (%) showing a fixed plant date of 15th May results in good reproduction of on farm actions but ignores summer crops.

Nevertheless, a cover model was used to represent the cropping catchment as it is stable and simpler to generalise.

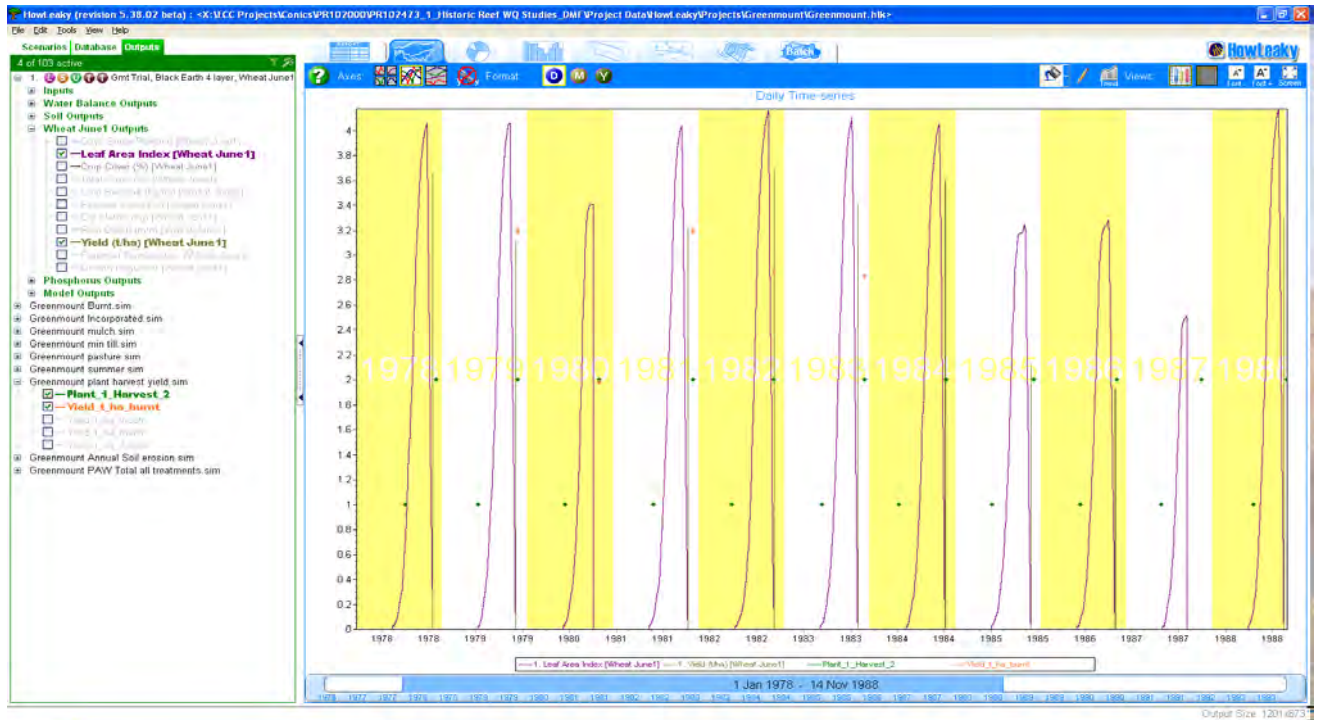


Figure 3: Simulated and observed plant and harvest dates and wheat yield

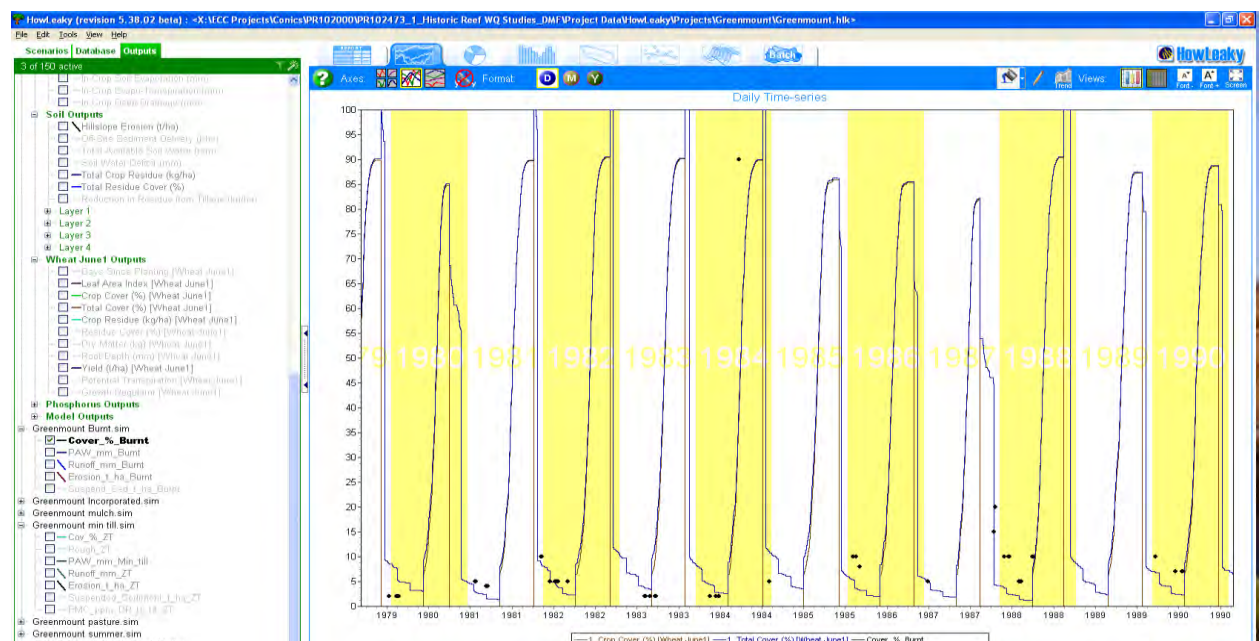


Figure 4: Simulated and observed total cover -stubble burnt

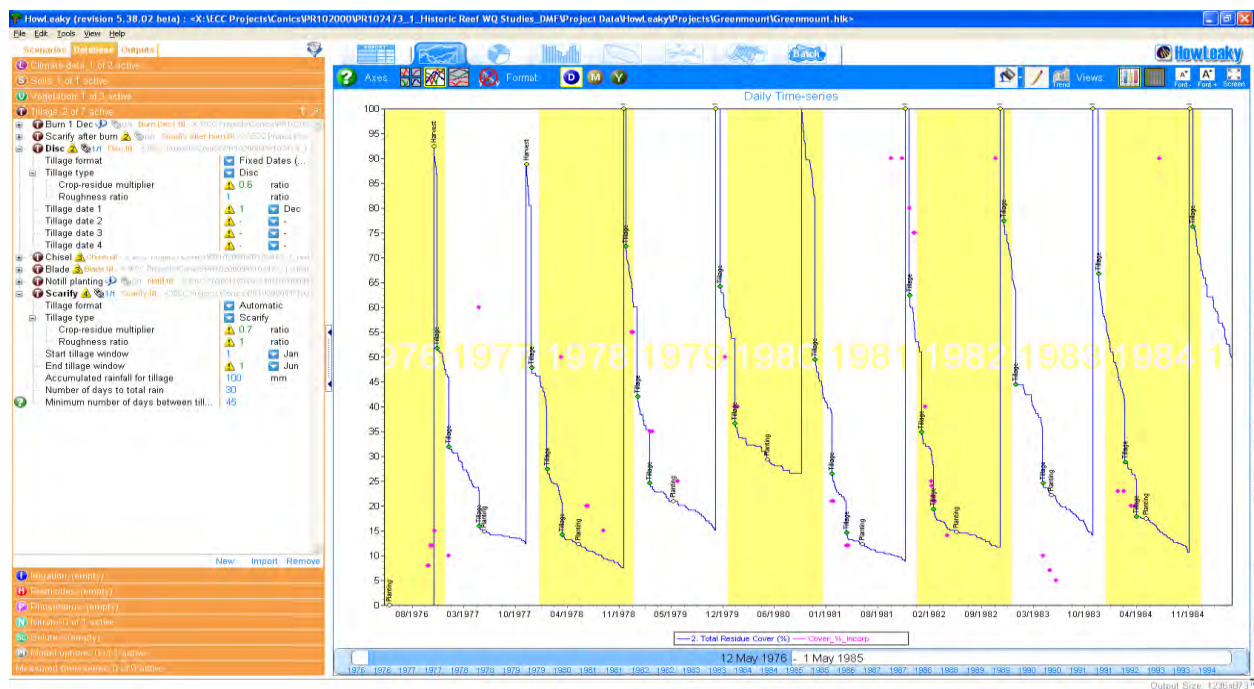


Figure 5: Simulated and observed total cover -stubble incorporated

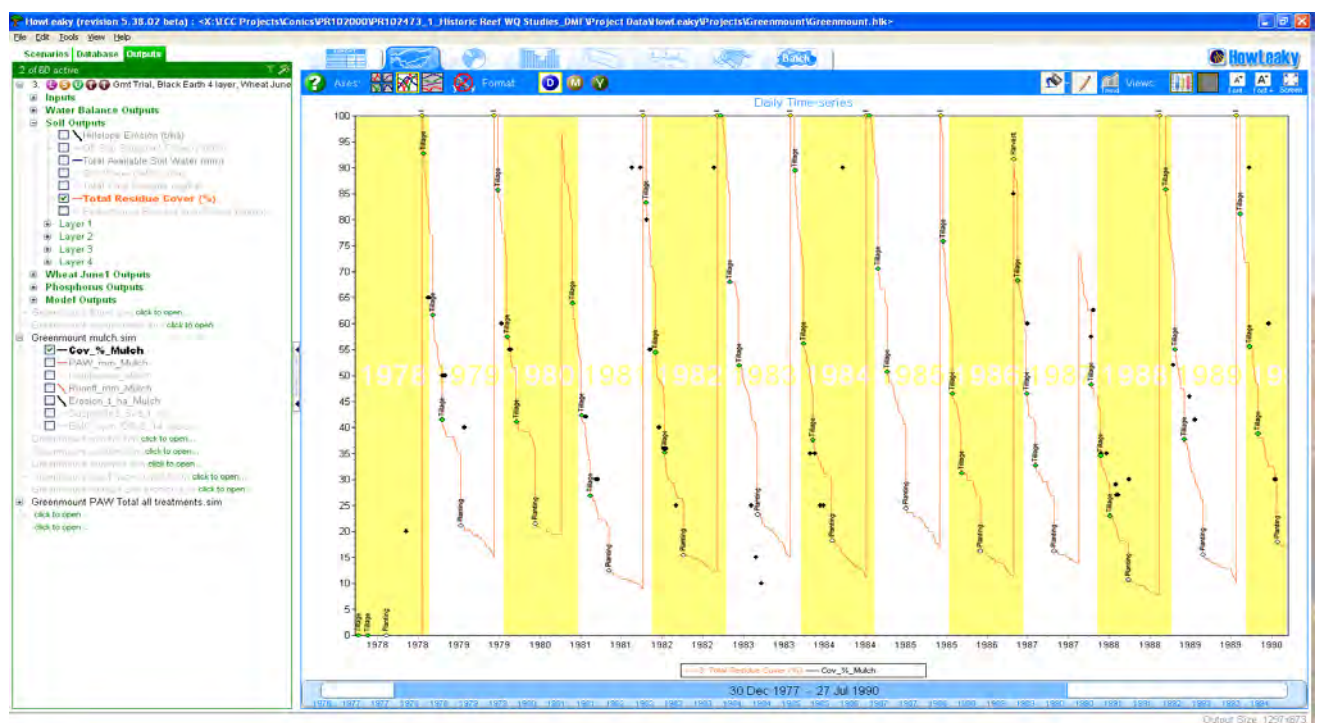


Figure 6: Simulated and observed total cover -stubble mulch

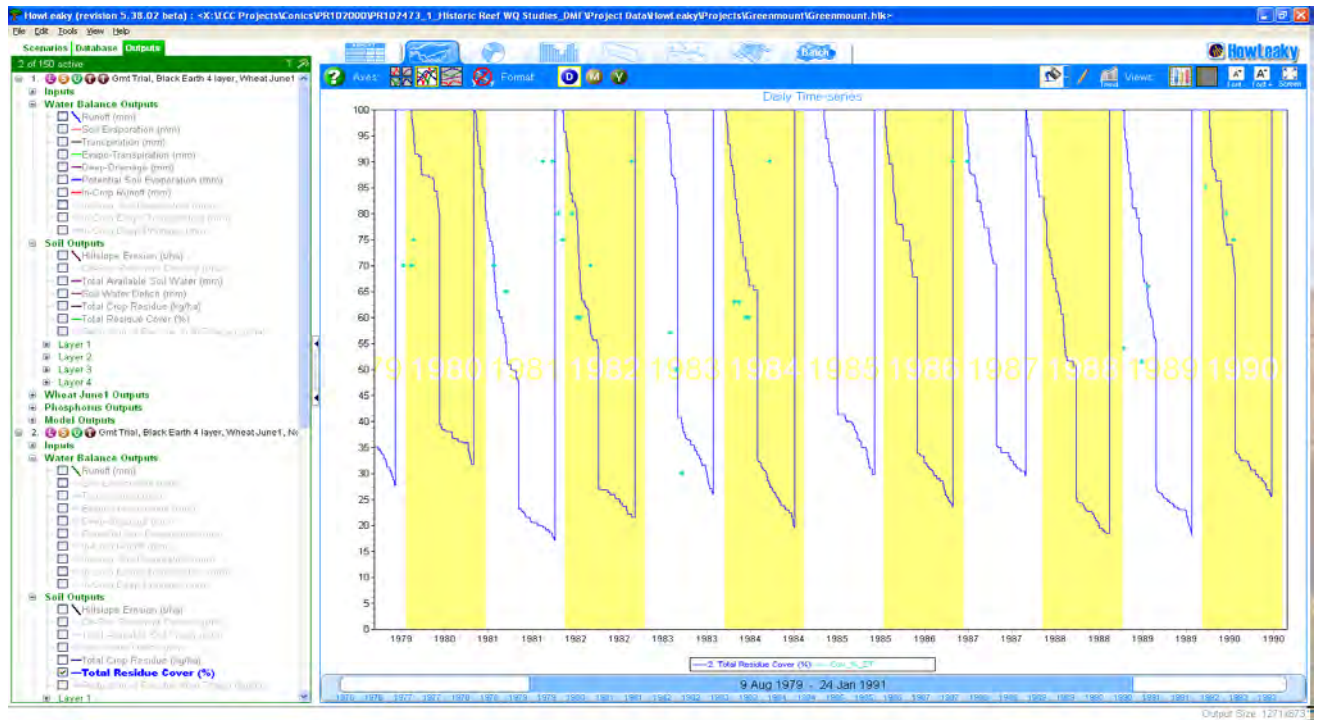


Figure 7: Simulated and observed total cover -zero tillage

3.0 Results

3.1 Soil water

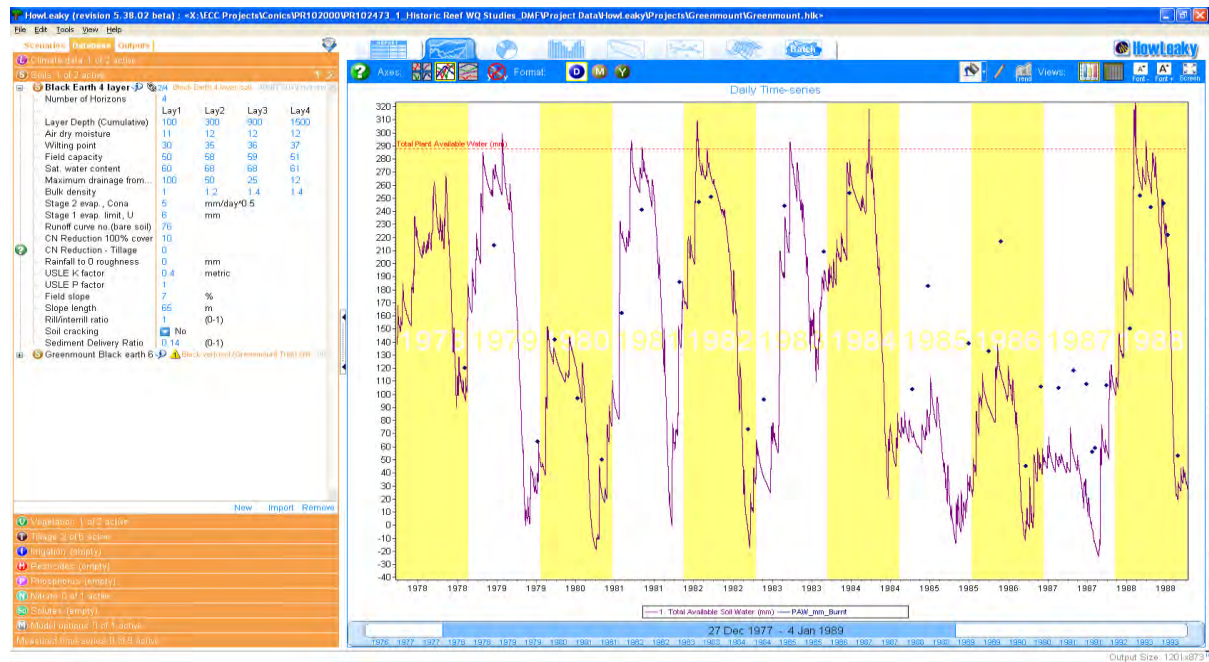


Figure 8: Simulated and measured plant available soil water (mm) for the stubble burnt treatment

3.2 Runoff and soil erosion



Figure 9: Simulated and measured cumulative runoff and soil erosion from the stubble burnt –winter crop catchments at Greenmount (1976-1990)

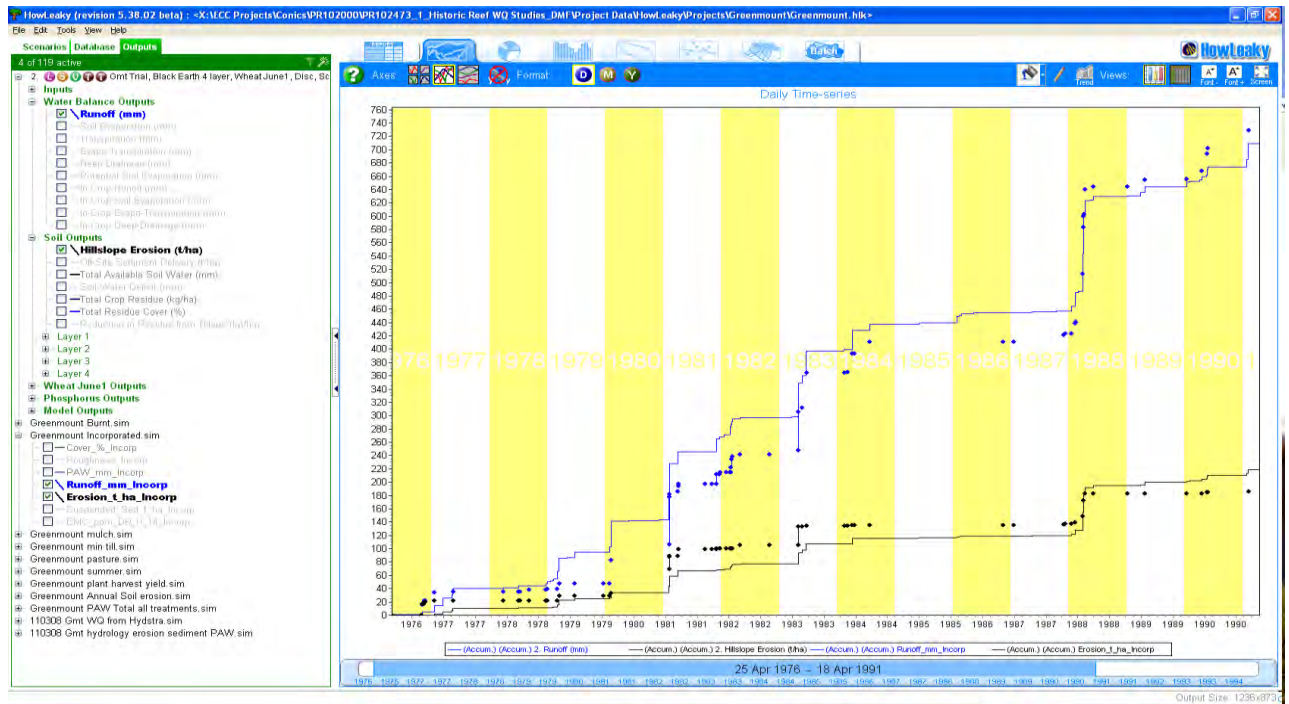


Figure 10: Simulated and measured cumulative runoff and soil erosion from the stubble incorporated – winter crop catchments at Greenmount (1976-1990)

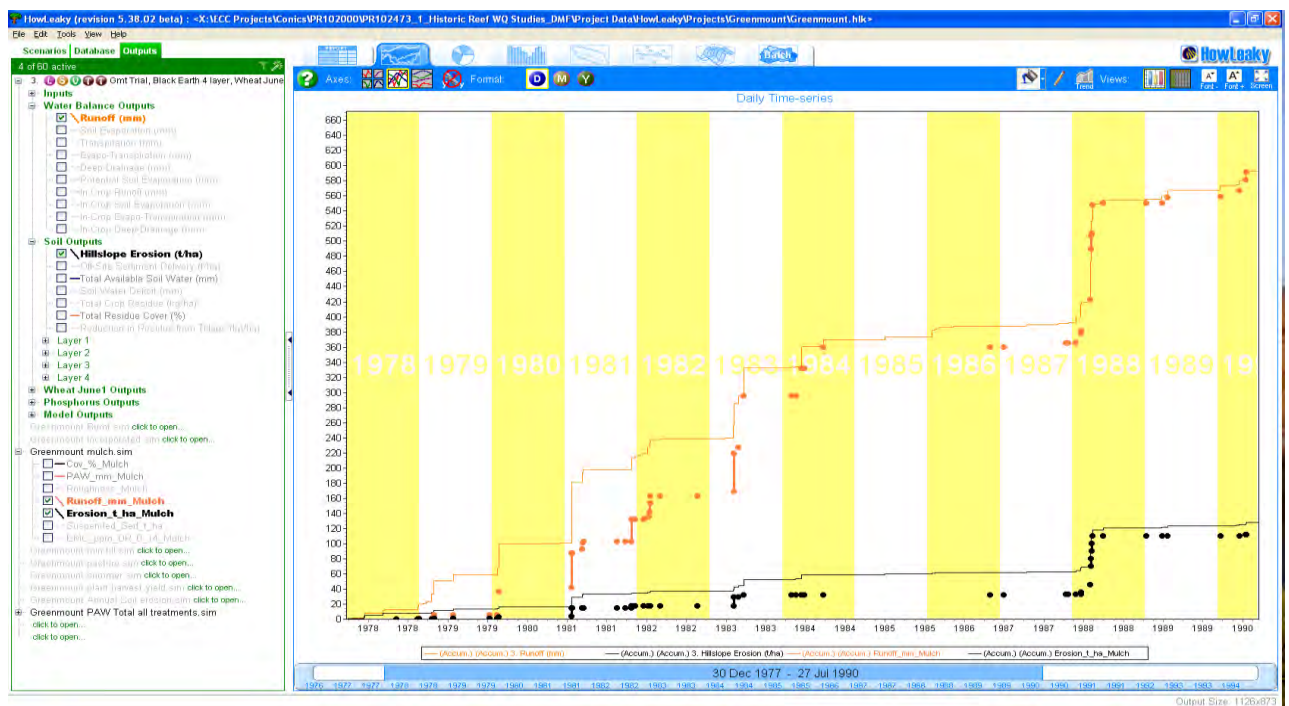


Figure 11: Simulated and measured cumulative runoff and soil erosion from the stubble mulch – winter crop catchments at Greenmount (1976-1990)



Figure 12: Simulated and measured cumulative runoff and soil erosion from the minimum tillage–winter crop catchments at Greenmount (1976-1990)

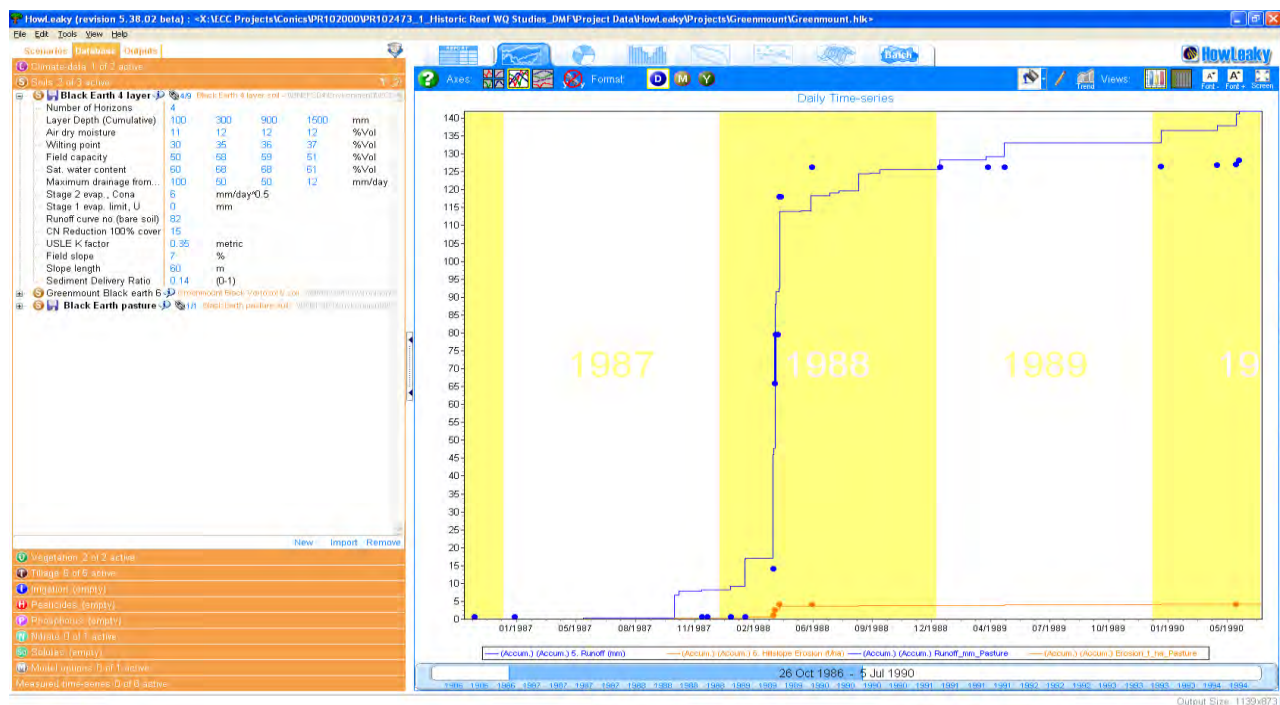


Figure 13: Simulated and measured cumulative runoff and soil erosion from the pasture catchments at Greenmount (1987-1990)

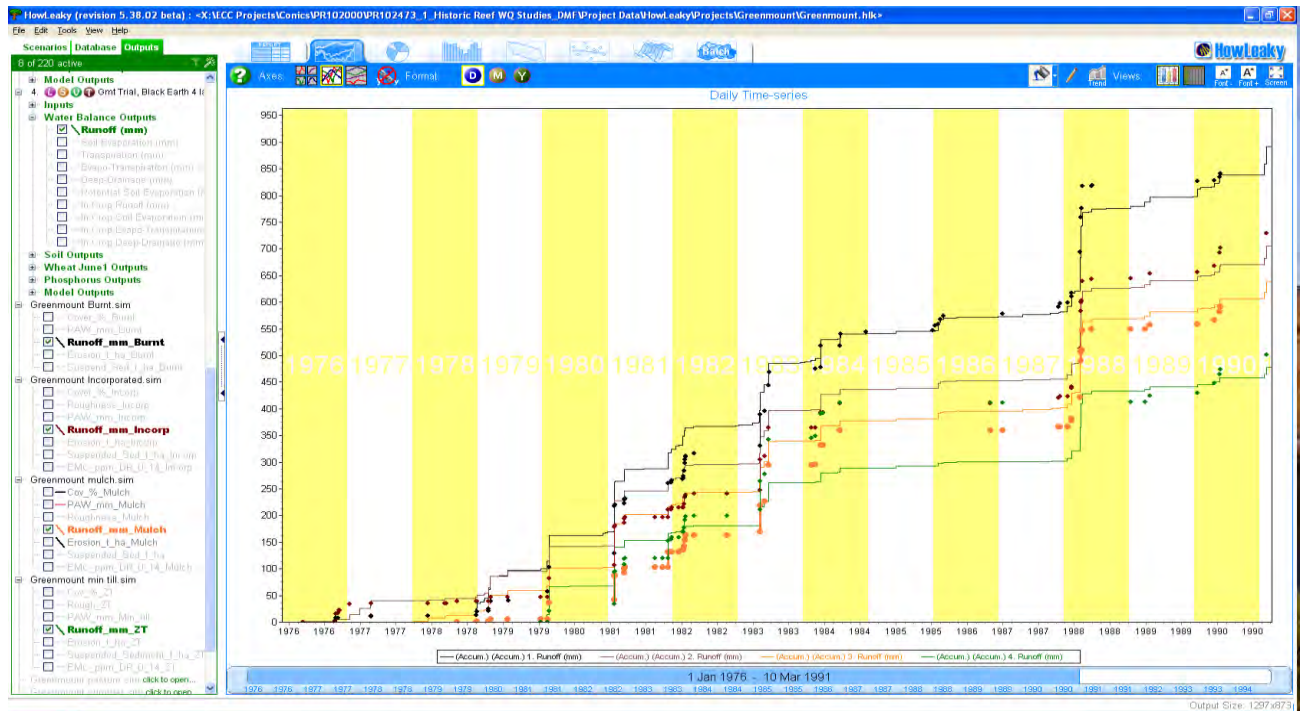


Figure 14: Simulated and measured cumulative runoff from all catchments at Greenmount (1976-1990)



Figure 15: Simulated and measured cumulative soil erosion from all catchments at Greenmount (1987-1990)Water balance

Table 2: Summary of Annual Simulated Water Balance for Greenmount (1978-1993). Annual average rainfall 700 mm.

Simulation Name	Runoff (mm/yr)	Soil Evaporation (mm/yr)	Transpiration (mm/yr)	Drainage (mm/yr)
Stubble burnt	66.5	428	259	15.4
Stubble incorporated	45.7	387	272	28.5
Stubble mulch	47.3	398	275	46.4
Minimum tillage	33.3	340	310	80.8
Perennial pasture	35.5	391	333	0

3.3 Soil erosion

Table 3: Summary of Annual Simulated Soil erosion and event mean concentration of sediment for Greenmount (1978-1993). Annual average rainfall 700 mm.

Simulation Name	Hillslope erosion (t/ha)	Event mean sediment concentration (g/L)
Stubble burnt (1978-89)	42.2	8.9
Stubble incorporated (1976 -89)	14.1	4.3
Stubble mulch (1978-89)	10.3	3
Minimum tillage (1979-89)	1.5	0.64
Perennial pasture (1987-90)	1.1	0.42

3.4 Long term runoff and erosion

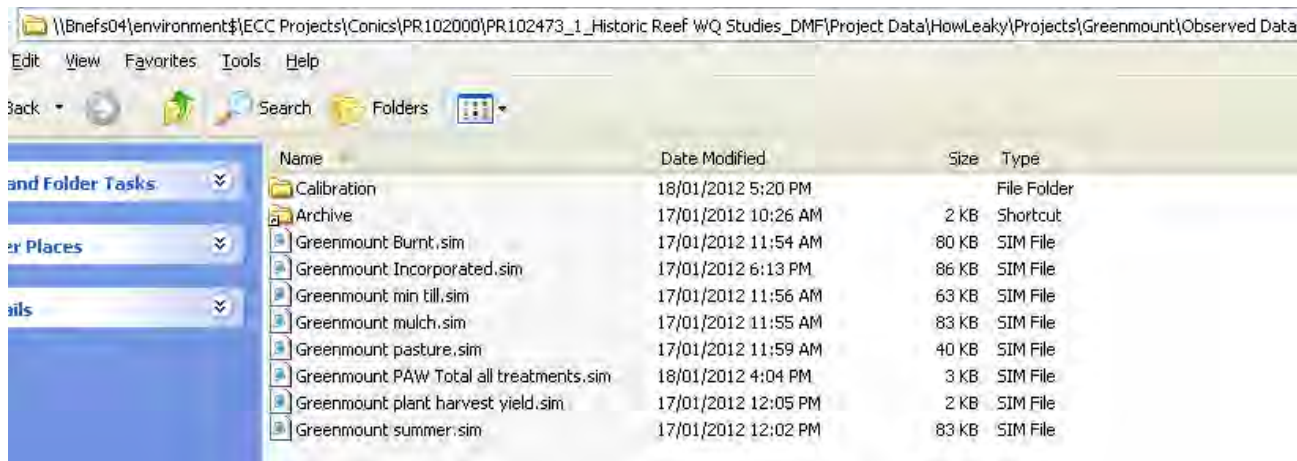
Table 4: Annual runoff and erosion for Greenmount (1900-2005). Annual average rainfall 724 mm.

Simulation Name	Runoff (mm/yr)	Drainage (mm/yr)	Soil erosion (t/ha)	EMC (g/L)
Stubble burnt	47.8	7	29.3	8.6
Stubble incorporated	34.1	17.5	9.2	3.8
Stubble mulch	30.8	21.7	5.7	2.6
Minimum tillage	22.3	53.9	0.78	0.49
Perennial pasture	7.9	0.81	0.22	0.38

4.0 Observed data files

Considerable effort was put into double checking the observed data files that were extracted from Hydstra and event summary sheets. During model testing, further data omissions and errors were found. Ideally, the data files created here should be re-entered into Hydstra and any new data management system.

A snapshot of relevant data files follows with a description of each files content.



Name	Date Modified	Size	Type
Calibration	18/01/2012 5:20 PM		File Folder
Archive	17/01/2012 10:26 AM	2 KB	Shortcut
Greenmount Burnt.sim	17/01/2012 11:54 AM	80 KB	SIM File
Greenmount Incorporated.sim	17/01/2012 6:13 PM	86 KB	SIM File
Greenmount min till.sim	17/01/2012 11:56 AM	63 KB	SIM File
Greenmount mulch.sim	17/01/2012 11:55 AM	83 KB	SIM File
Greenmount pasture.sim	17/01/2012 11:59 AM	40 KB	SIM File
Greenmount PAW Total all treatments.sim	18/01/2012 4:04 PM	3 KB	SIM File
Greenmount plant harvest yield.sim	17/01/2012 12:05 PM	2 KB	SIM File
Greenmount summer.sim	17/01/2012 12:02 PM	83 KB	SIM File

4.1 Greenmount burnt.sim

- // Data type: Comprehensive data for winter crop -stubble burnt. A cleansed and a reliable data set for modelling
- // Cover_%, direct from summary sheets
- // PAW based on GHW sheets, recalculated by DMF 6/1/2012 using LL for each bay see ""120106 Greenmount Soil water summary.xls"" for base data and calculations
- // Runoff from event summary sheets and GHW input sheets for Hydstra - maybe some variances in allocation of runoff between days
- // Erosion based on event summary sheets
- // Sediment loss through flume based on summary sheets
- // EMC_ppm_DR_0.14 based on 14% of total soil movement - used to compare with modelled EMC

4.2 Greenmount Incorporated.sim

- // Data type: Comprehensive data for winter crop -stubble incorporated. A cleansed and a reliable data set for modelling
- // Cover_%, direct from summary sheets
- // PAW based on GHW sheets, recalculated by DMF 6/1/2012 using LL for each bay see ""120106 Greenmount Soil water summary.xls"" for base data and calculations
- // Runoff from event summary sheets and GHW input sheets for Hydstra - maybe some variances in allocation of runoff between days
- // Erosion based on event summary sheets
- // Sediment loss through flume based on summary sheets

// EMC_ppm_DR_0.14 based on 14% of total soil movement - used to compare with modelled EMC

4.3 Greenmount mulch.sim

// Data type: Comprehensive data for winter crop –stubble mulchA cleansed and a reliable data set for modelling

// Cover_%, direct from summary sheets

// PAW based on GHW sheets, recalculated by DMF 6/1/2012 using LL for each bay see ""120106 Greenmount Soil water summary.xls"" for base data and calculations

// Runoff from event summary sheets and GHW input sheets for Hydstra - maybe some variances in allocation of runoff between days

// Erosion based on event summary sheets

// Sediment loss through flume based on summary sheets

// EMC_ppm_DR_0.14 based on 14% of total soil movement - used to compare with modelled EMC.

4.4 Greenmount min till.sim

// Data type: Comprehensive data for winter crop –minimum tillage. A cleansed and a reliable data set for modelling

// Cover_%, direct from summary sheets

// PAW based on GHW sheets, recalculated by DMF 6/1/2012 using LL for each bay see ""120106 Greenmount Soil water summary.xls"" for base data and calculations

// Runoff from event summary sheets and GHW input sheets for Hydstra - maybe some variances in allocation of runoff between days

// Erosion based on event summary sheets

// Sediment loss through flume based on summary sheets

// EMC_ppm_DR_0.14 based on 14% of total soil movement - used to compare with modelled EMC

4.5 Greenmount pasture.sim

// Data type: Comprehensive data for perennial pasture. A cleansed and a reliable data set for modelling

// Cover_%, direct from summary sheets

// PAW based on GHW sheets, recalculated by DMF 6/1/2012 using LL for each bay see ""120106 Greenmount Soil water summary.xls"" for base data and calculations

// Runoff from event summary sheets and GHW input sheets for Hydstra - maybe some variances in allocation of runoff between days

// Erosion based on event summary sheets

// Sediment loss through flume based on summary sheets.

4.6 Greenmount summer.sim

// Data type: Comprehensive data for summer crops.

// Cover_%, direct from summary sheets

// PAW based on GHW sheets, recalculated by DMF 6/1/2012 using LL for each bay see ""120106 Greenmount Soil water summary.xls"" for base data and calculations

// Runoff from event summary sheets and GHW input sheets for Hydstra - maybe some variances in allocation of runoff between days

// Erosion based on event summary sheets

// Sediment loss through flume based on summary sheets

4.7 Greenmount plant harvest yield.sim

// Data type: Plant harvest dates and wheat yield.

4.8 Greenmount PAW Total all treatments.sim

// Data type: Total Plant available water 0-150 cm depth

// PAW based on GHW sheets, recalculated by DMF 6/1/2012 using LL for each bay see ""120106 Greenmount Soil water summary.xls"" for base data and calculations

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Appendix 3

Howleaky Web Portal Screen Shots

Home Page

HOME ABOUT TUTORIALS **FIELD STUDIES DATABASE** DOWNLOADS CONTACT SEARCH LOGIN

HowLeaky

"Exploring water balance and water quality implications for different land-uses"

Latest news

Version 5.44.06 Released

This version sees new irrigation runoff options added and fixes a crash in the sensitivity analysis.

[Read more...](#)

Sites (132)

INFORMATION

HowLeaky is water balance and water quality simulation software incorporating the *PERFECT* (Littleboy *et al.* 1992) model. It has been developed to assess the impacts of different land uses, soil types, management practices and climates on water balance and water quality. **HowLeaky** is being continually supported by a range of Australian organisations, including Queensland and Victorian Governments, RPS, and DHM Environmental Software Engineering Pty Ltd.

This site provides:

- Information about the **HowLeaky** simulation environment;
- [A Downloadable version of HowLeaky](#) (provided without warranty or support); and
- Field Studies Database describing experimental studies dealing with the impact of management on water balance, hydrology and water quality mainly at the paddock or management unit scale. Most studies relate to the Great Barrier Reef catchments and grain growing areas across Australia. This database can be accessed via the Realated Studies tab.

[Download HowLeaky v5.44.07](#)

Field Studies Database

Paddock Scale Hydrology and Water Quality Studies



CARING
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Grains Research &
Development Corporation





» Site Summaries

» Supersites

» Site Locations

Sites (132)



INFORMATION

Page 1 of 3

Data sets dealing with the impact of management on water balance, hydrology and water quality at a range of scales have been collected in Queensland and across Australia. Many of these studies and their associated data were difficult to access yet represent an important asset in natural resource management.

This website synthesises over 100 historic water quality studies to complement current field research. The focus is on paddock or single management unit scale studies that aim to quantify links between land use, management and water quality.

Study sites have been reviewed using a hierarchical data structure (5 levels).

Prev [Next >>](#)

- [Field Studies Database](#)
- [Site Summaries and Supersites](#)
- [Funding and Supporting Organisations](#)
- [All Pages](#)

Site summaries - Horticulture

■ Site Summaries

Horticulture
Cropping
Pasture
Sugarcane
Natural Vegetation
Other

■ Supersites

Horticulture

Location and Study Name	What was measured?			
	Hydrology	Sediment Erosion	Nutrients	Herbicides/Pesticides
Beerwah - Is there a sustainable system for pineapple farming	y	y	y	n
Bundaberg - The use of sugarcane in rotation with horticulture crops for removal of residual nitrogen	n	n	y	n
Cairns - Tracing nitrogen through wet tropical aquifers	n	n	y	n
Goomboorian - Field experimental results: runoff, soil loss and crop yields	y	y	y	n
Imbil - Erosion and hydrology in steepplands under commercial pineapple production	y	y	n	n
Innisfail - Performance of grass and rainforest riparian buffers in the wet tropics, Far North Queensland.	y	y	y	n
North Queensland - Nutrient balances and transport from agricultural and rainforest lands	y	n	y	n
Philippines - Erosion and productivity of vegetable systems on sloping volcanic ash - derived Philippine soils	y	y	y	n
Nambour - Soil erosion in perspective	y	y	n	n
South Johnstone - Banana nutrition in NQ	n	n	y	n
South East Qld - Losses of nitrogen in surface runoff from a plantation horticulture farm in coastal QLD, Australia	y	n	y	n
Tully - Nitrogen loss in sub-surface drainage from bananas in tropical north QLD	n	n	y	n
Tully - Plot scale runoff of nutrients and sediments under varying management regimes on banana and cane farm in the wet tropics	y	y	y	n
Woombye - Erosion in Pineapples	n	y	n	n
Yeppoon - Is there a sustainable system for pineapple farming	y	y	y	n

Imbil Experimental Site – Level 1

Imbil Level 1



Hydrology, sediment and erosion in pineapples in steep areas of south-eastern Queensland (Imbil) (Ciesiolka et al. 1995)

Level 1 General description

Purpose

This study monitored hydrology and soil erosion over a range of slope lengths (rows) and slopes on a pineapple farm in order to identify parameters to design sustainable production systems in steep areas (33-38%).

Methods (brief)

The study was undertaken on a commercial farm 3 km from Imbil in the Gympie district. All plots were on a hillside of rectilinear slope approximately 30 m in length and 35-38% slope. Plot lengths studied were 7, 12, and 22 m. A number of larger catchments were also monitored to better understand hydrology and erosion at the paddock scale.

Key findings (brief)

For the period 1988 to 1991 (3 water years) annual average rainfall, runoff and soil erosion was 1232 mm, ~400 mm and 27-116 t/ha respectively for the site. Erosion and sediment concentrations from 7 and 12 m length rows were similar and nearly double for 22 m. Here rilling was evident. The USLE LS relationship appears to underestimate erosion at longer and steeper slopes in this study.

Table 1. Mean annual runoff, erosion and water quality exploring the impact of slope and slope length in steep-land pineapples - Imbil (Ciesiolka et al. 1985) Duration of study:1988-91 (3 Water Years), AAR 1232 mm.

Slope length (m)	Slope (%)	LS ¹	Runoff (mm)	Soil loss (t/ha)	EMC ¹ (gm/L)	Normalised ² Soil loss (t/ha)	Normalised ³ EMC (gm/L)
7	34	5.3	445	27	6.0	5.0	1.1
12	33	6.6	436	30	6.9	4.6	1.0
22	38	11.7	390	116	29.7	9.9	2.5

¹ Soil loss divided by runoff, primary sediment source, no allowance for deposition.

² USLE factor used to correct normalised data to an LS =1

³ EMC normalised to an LS =1

Location

Ray Walker's Imbil is Lat 26° 27' 42.59"S, Lon 152° 40' 42.45"E

Related studies

Buchanan's farm at Goomboorian is Lat 26° 3' 26.97"S, Long 152° 47' 39.71"E

Beerwah Pineapple Research Farm Lat 26° 56' 0.17"S, Long 152° 57' 18.97"E

Capelin MA, Truong PN 1985. Soil erosion within pineapple fields in south-east Queensland.

[Level 2](#), [level 3](#), [level 4](#) and [level 5](#)