Department of Environment
and Resource Management

Guide for use of environmental characteristic data sets

Wet Tropics priority catchment

August 2011

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1 Introduction

In 2010, the Queensland Government introduced the Reef Protection Package to assist in reducing the level of sediment, nutrients and herbicides (contaminants) reaching the Great Barrier Reef (GBR). The primary aim of this package is to encourage cane growers and graziers across the Wet Tropics, Burdekin Dry Tropics and Mackay Whitsunday catchments (priority catchments) to manage their farms in a way that reduces the risk of contaminant loss (sediment, nutrients and herbicides).

To support implementation of the package, DERM is coordinating science projects focused on answering the following questions:

1. What and where are the natural features that predispose landscapes to contribute above natural levels of sediment and deliver nutrients and herbicides offsite through water movement?
2. What systems/practices are being used on cane and grazing properties to take account of the landscape features (environmental characteristics)?
3. Within the priority catchments, what and where are the main risks associated with cane and grazing activities?
4. What are the management systems that should be adopted to minimise risk?
5. What information on environmental characteristics could be provided to assist landholders in determining appropriate practices to minimise movement of contaminants off-site?

DERM is coordinating a project to identify landscape features (‘environmental characteristics’) that influence soil and water movement in cane growing areas. This has identified and mapped four environmental characteristics in the Wet Tropics catchment, as the first step towards answering questions 1 and 5 above. Other landscape features also influence contaminant transport, but are not able to be mapped at this time.

In May 2011, a technical workshop reviewed the conceptual model and natural resource data used to assess the four environmental characteristics. Workshop attendees, including representatives from industry and NRM groups, accepted the information and concepts as technically sound and agreed the data sets are generally suitable for use at the strategic, regional and property level. However, attendees recommended that other property information should be brought in to support property planning at a finer scale, e.g. within individual blocks. The workshop supported DERM’s proposal to continue this assessment in the Burdekin and Mackay Whitsunday catchments, and incorporate over time information on other environmental characteristics and land management.

To date, the outputs of this project include a technical report, four environmental characteristic data sets (each consisting of a map) and this user guide. This user guide provides advice on how to use the currently available environmental characteristic maps to ensure this information is not used out of context. For example, the maps indicate the variability and general features of soils found across Wet Tropics cane farms, but they do not precisely identify the location of environmental characteristics at the farm level and cannot support detailed property planning (e.g. precision agriculture). If users require further information about the process used to map environmental characteristics, they should refer to the technical report available from DERM (DERM 2011a).

2 The aim of this user guide

The aim of this guide is to assist users to understand and interpret environmental characteristic data sets (maps) currently available across cane growing areas of the Wet Tropics priority catchment. This catchment is defined in Chapter 4A of the *Environmental Protection Act 1994* and is referred to hereafter as the 'Wet Tropics'.

This guide focuses on four environmental characteristics that influence the way soil and water moves across the landscape, including:

- Erosion potential
- Flooding frequency
- Dominant water pathway
- Soil transport potential.

The above characteristics were assessed because they could be mapped using existing natural resource data. Recognising that other landscape features also influence soil and water movement, DERM will investigate options to assess other environmental characteristics across the priority catchments.

Intended audience

Environmental characteristics maps are intended to assist DERM Reef Protection Officers, extension officers and other organisations to:

- Understand the occurrence and implications of natural features that can influence soil and water movement across cane growing areas
- Support landholders to adopt management practices appropriate to their local conditions
- Prioritise education, extension and awareness activities across the Wet Tropics catchment.

While these maps were primarily developed to support property planning for cane growing, a similar approach could be adopted for other cropping systems.

Environmental characteristics and their impact on water quality

The environmental characteristic maps that accompany this guide describe and map a range of inherent landscape features that remain relatively unchanged over time. These maps can help users gain an initial understanding of landscape features that could be managed to reduce the water-borne loss of soil, herbicides and nutrients. However, to fully understand the likelihood that these contaminants will be transported off farm, the interaction between environmental characteristics and human activities (management factors) needs to be considered.

Environmental characteristics and management factors interact in complex ways to produce an effect ('drive a response') in the landscape. The management factors used on farms can have a neutral, positive or negative effect on the quality of water leaving the farm. For example, implementing green cane trash blanketing—instead of burning the cane trash—on a farm with erodible soils could result in a rapid improvement to the quality of water leaving the farm. Some management practice changes may take longer to show an effect, i.e. there may be a lag period following the change. The interaction between environmental characteristics and management factors is illustrated in Figure 1.

To understand the risk that contaminants will be transported off-site, you need to consider the interaction between *management factors* and a range of *environmental characteristics*.

The four environmental characteristics in this guide are not the only landscape features that influence soil and water movement. Environmental characteristics such as rainfall, vegetation cover, proximity to watercourses and groundwater can also affect the quality of water leaving cane farms. Although these characteristics are not able to be mapped at this time, the influence of these characteristics should be considered as part of property planning.

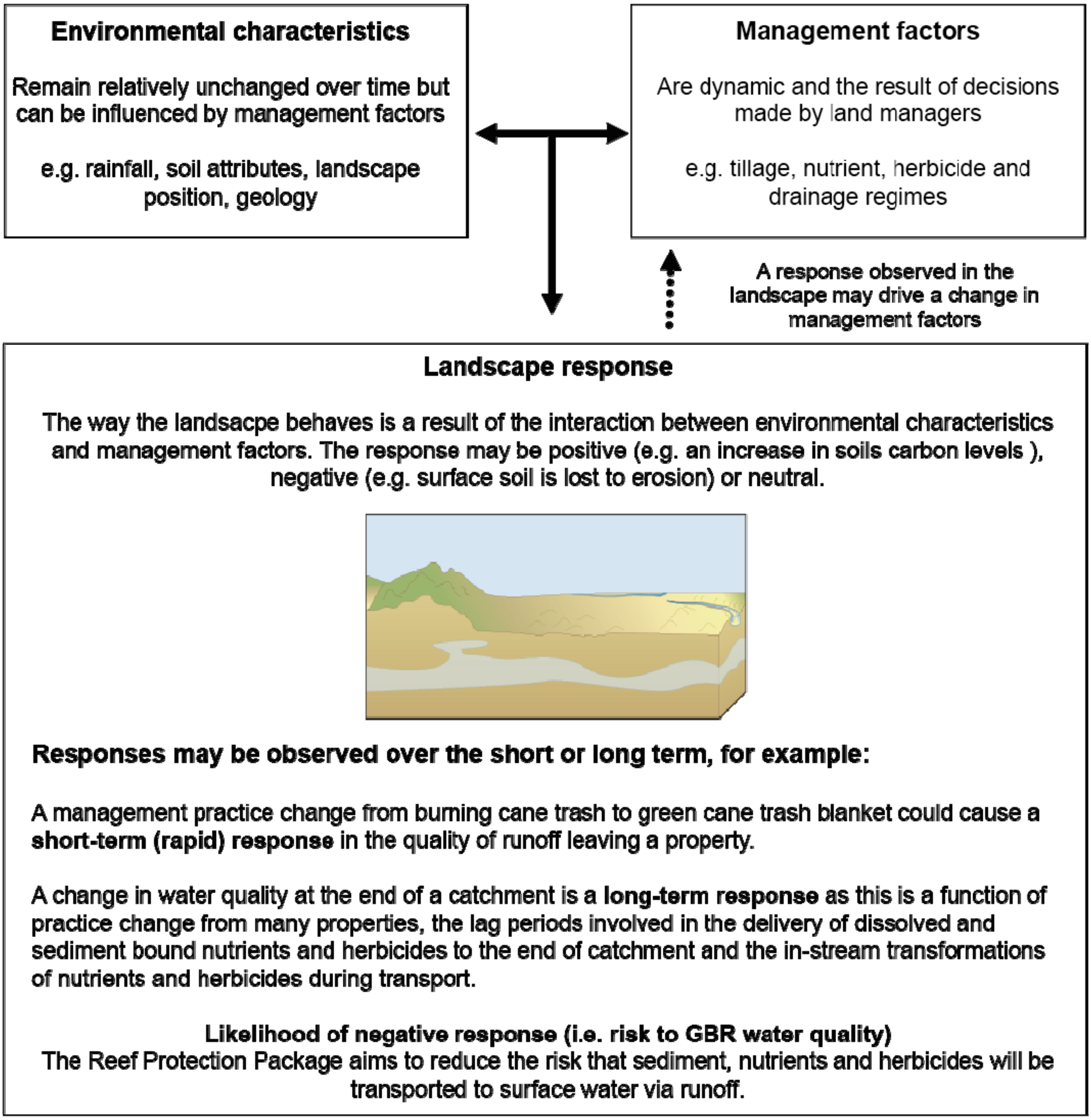

Figure 1. Overview of the interaction between environmental characteristics, management factors and landscape response.

How to use this guide

This guide explains how to use the four available environmental characteristic maps, which include:

Erosion potential – indicates the susceptibility of landscapes to erode, which can contribute sediment and associated nutrients and herbicides to waterways.

Flooding frequency – describes the potential of landscapes to experience flood events, and the frequency of these events. Areas under cane that flood more frequently represent greater potential sources of contaminants.

Dominant water pathway – indicates the potential of landscapes to generate runoff, as inferred by the drainage and permeability characteristics of soils.

Soil transport potential – indicates the potential for soil to be transported long distances, as inferred by the relative proportion of sand, silt and clay soil particles in the surface soil. Clay particles (<0.002 mm) are more easily transported over longer distances than larger silt and sand particles.

Sections 3 to 6 of this guide describe the above characteristics and provide information on:

- How the characteristic may affect water quality (background)
- A description of the data sets used and information products
- Information to support on-property interpretation of the characteristic (additional considerations)
- General implications for management (management)
- Other sources of information.

Section 7 gives an overview of the soils orders found across cane growing areas of the Wet Tropics, as defined by the Australian Soil Classification.

Data used to assess environmental characteristics

Environmental characteristic maps are based on soils information collected during natural resource surveys (refer to Appendix 1 for a list of surveys). Table 1 indicates the soil attributes used to assess environmental characteristics. For further information about the process used to assess the four characteristics, refer to the technical report (DERM 2011a).

Table 1. Summary of soil attributes used to assess environmental characteristics.

Environmental characteristic	Soil attributes assessed	Description of environmental characteristic
Erosion potential	Soil erodibility Slope	These data describe erosion potential based on soil type and slope, as assessed during land resource surveys. It refers to hillslope (rill, sheet and scald) erosion processes; it does not describe streambank or gully erosion potential. These land resource surveys were focused on areas suitable for intensive agricultural production, therefore erosion potential data is limited to these areas.
Flooding frequency	Flood frequency	These data describe the extent and frequency of flooding events, as collected during land resource surveys. These land resource surveys were focused on areas suitable for intensive agricultural production, therefore flooding data is limited to these areas.
Water pathway	Drainage class Permeability class	Water pathway is derived by combining drainage and permeability attributes of soil, as collected during land resource surveys. The decision matrix used to identify runoff and drainage landscapes is described in the technical report.
Soil transport potential	Surface soil texture	These data describe the generalised soil texture for the surface horizon in terms of sand, loam or clays. The classification of soil texture codes into four categories (sand, loam, clay and other) is provided in the technical report.

Rules for using maps and supporting information

Environmental characteristics maps form part of a suite of spatial information that can assist RPOs, extension officers and other organisations to understand the natural features of farms across the Wet Tropics. Through the use of spatial information, users can start to identify features that could be managed to improve water quality. This can support in a number of tasks, e.g. preparing for field assessments or having effective conversations with landholders. It is important that users are aware of the following conditions when using maps and supporting information:

1. Each map should be considered separately. Combining data sets obscures the importance of each characteristic and does not adequately represent the natural features of farms.
2. Information about the four environmental characteristics should be considered in conjunction with other property features that influence soil and water movement, for example:
    a. Users may access other information sources to gain an understanding of characteristics such as rainfall, vegetation cover, location of watercourses and stream bank stability. Satellite or aerial imagery can be useful to identify some of these features. This guide provides contextual information about the influence of rainfall and vegetation cover.
    b. If users are aware of the management system used on farm, e.g. through an environmental risk management plan, they can check how well landholders understand and manage the water quality implications of natural features on the farm. Where it is clear that landholders are using reasonable and practical measures to manage risk associated with environmental characteristics, it is not necessary to investigate farm management further. However, where a management system does not seem appropriate, the maps can support a conversation with the landholder about their farm.
3. Environmental characteristic maps are a guide to the types of features present on farm and may not always reflect the on-ground environment for a range of reasons, such as scale limitations or influence of human activities. These maps were developed using natural resource data at 1:50,000 scale (except for the Ingham area, which is at 1:100,000 scale[1]). This scale of mapping can assist users to understand the variability and general features of soils across, or between cane farms, e.g. farms of 50 hectares or greater. However, this scale does not precisely identify location of soil boundaries and should not be used to support detailed property planning, such as nutrient/herbicide use within block. Therefore, users should check with growers if the maps represent the level of variation found on farm and if management has influenced the inherent environmental characteristics. For example, an area described as ‘poorly drained’ on the water pathway map could become well drained following the construction of farm drains. At times, growers will have access to more detailed soil information, which can better inform landscape assessment.

In light of the conditions described above, the environmental characteristic maps are not intended to support ranking of properties for any purpose.

[1] Ingham soil mapping is considered suitable for use because it was completed after significant knowledge of the area had been attained through previous surveys. The mapping is therefore considered to be a similar quality as the finer scale (1:50 000) studies.

Scale of land resource surveys

The scale at which land resource data is collected (cartographic scale) is a reflection of the sampling density or number of observations taken throughout the survey. Therefore, data collected at a fine scale, e.g. 1:10 000 provides a higher level of detail about soils on a farm than data collected at a broader scale, e.g. 1:100 000.

The number of sites required to accurately map an area is prescribed in the standard *Guidelines for Surveying Soil and Land Resources* (McKenzie *et al* 2008). Figure 2 shows the number of observations required for different map scales and Figure 3 demonstrates the appropriate use of different map scales.

Attendees at the technical review workshop, held in May 2011 to review the environmental characteristics maps, agreed that land resource surveys at 1:50 000 scale are generally appropriate for use at the farm level, e.g. farms of 50 hectares or greater. This scale indicates the variability of soils found on farms, which can then be fine-tuned through onsite observations and conversations with growers. However, workshop attendees agreed that the maps are not suitable for use at the individual block scale. Table 2 describes how maps at different scales support different purposes.

Table 2. Map scale and purpose

Type of map:	Environmental characteristics maps e.g.**1:50 000 or 1:100 000 scale**	EM map, yield map, NDVI map, e.g. **1:5 000 scale**
For use at:	Catchment/property scale	Individual block scale
Purpose:	Identify the possible landscape features present on a property as a guide only for property planning/ERMPs.	Inform site specific management of drainage, fertiliser inputs at the block/ property scale.

When using environmental characteristics maps, it is also important to be aware of the scale at which the map is displayed, whether this is on a paper map or via a GIS application such as ArcMap. For example, when viewing environmental characteristics at a scale of 1:50 000, a 1 mm line on the map represents 50 metres on the ground. This means that while variations in soil type may appear linear on the map, in reality soils change gradually across the landscape.

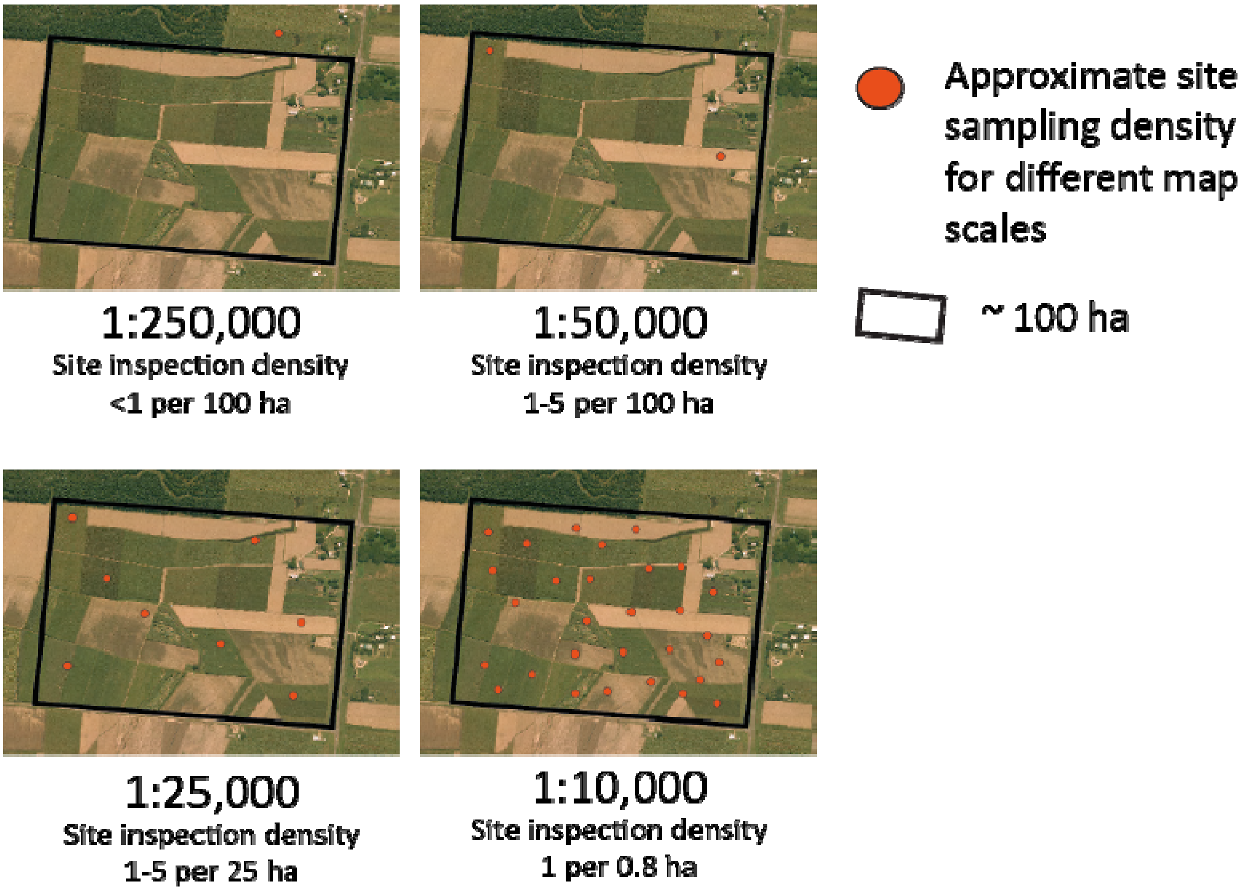

Figure 2. Site sampling density required for different mapping scales (Source: McKenzie *et al* 2008).

Figure 3. Appropriate use of mapping at different scales (Source: Gallant et al 2008).

(Note: Figures 2 and 3 show the relative influences of scale, but are printed smaller than the scales indicated.)

Access to information

Spatial information (DERM officers)

DERM officers can access the spatial layers for the four environmental characteristics through SIRQRY. The options for viewing spatial information are:

ArcMap/ArcView

The spatial layers are best accessed using ArcGIS (e.g. ArcMap or ArcView), therefore a basic knowledge and understanding of ArcGIS is required. If RPOs need assistance to obtain ArcGIS software or learn how to use it, advice can be sought from a Principal RPO or a regional GIS officer.

ArcReader

RPOs can view and query spatial layers using ArcReader. This is a desktop mapping application that allows you to view, query, and print spatial information, and is free to download. However the data cannot be manipulated using ArcReader (as for ArcMap or ArcView).

A few points about ArcReader:

- It is easy to search and zoom via a lot and plan or coordinate search.
- A standard layout (including date stamping and adding disclaimers) can be applied when printing maps.

PET Tool

The PET tool can produce maps for a farm or at sub catchment / catchment scale if information is required at a broader scale.

Spatial information (external parties)

External parties can obtain spatial layers for the four environmental characteristics as ArcGIS compliant files, e.g. shape-files. The data is anticipated to be available in late 2011 and can be requested by emailing: <ProductDelivery@derm.qld.gov.au>.

Technical report

The supporting technical report – Mapping environmental characteristics important for GBR water quality: Wet Tropics assessment methodology (DERM 2011a) – explains how the four environmental characteristic maps were developed. It is anticipated the report will be available in late 2011 and can be obtained by

- emailing: <ProductDelivery@derm.qld.gov.au>
- searching the DERM library catalogue <http://www.derm.qld.gov.au/library/index.html>

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3 Glossary

Alluvial

Alluvial refers to soils formed by the deposition of sediment in riverine landscapes.

Australian Soil Classification (ASC)

Australia's official system for classifying and identifying Australian soils. The system is based around 14 soil orders: Anthroposols, Organosols, Podosols, Vertosols, Hydrosols, Kurosols, Sodosols, Chromosols, Calcarosols, Ferrosols, Dermosols, Kandosols, Rudosols, Tenosols. Information regarding the ASC is available at: http://www.clw.csiro.au/aclep/asc_re_on_line/soilhome.htm

Drainage

Refers to the rate of removal of water from the soil profile. It describes the 'local soils wetness conditions' and is determined by soil properties, and the position of the soil within the landscape (e.g. topography, slope etc).

The following terms are a description of drainage attributes:

- **Very poorly drained** – water is removed from the soil so slowly that the water remains at or near the surface for most of the year.
- **Poorly drained** – water is removed very slowly from the soil in relation to supply which may result in seasonal ponding. A perched water table may also be present.
- **Imperfectly drained** – water is removed slowly from the soil. Intermittent waterlogging throughout the soil results in many profiles having a gleyed, mottled colour or rusty root channel linings.
- **Moderately well drained** – water is removed relatively slowly after supply. Some horizons may remain wet for as long as one week after water addition.
- **Well drained** – water is removed readily but not rapidly from the soil. Some horizons may remain wet for several days after water addition.
- **Rapidly drained** – water is removed from the soil rapidly. The soil is not normally wet for more than several hours after water addition.

Electromagentic induction (EM) map

EM maps measure the ability of soils to conduct electricity (conductivity). If combined with soil sampling, EM maps can be used to indicate soil properties such as texture, moisture and salinity.

Environmental characteristics

Characteristics of the landscape which remain relatively unchanged but can be influenced by management factors (e.g. rainfall, soil properties, landscape position, geology and geomorphology).

ERMP

Environmental Risk Management Plan. Landholders who grow cane on more than 70 hectares in the Wet Tropics catchment are required to have an ERMP.

Groundwater

Water beneath the surface contained in saturated soil or porous rock. Groundwater systems are connected to surface water and the marine environment, but further research is required to quantify this connectivity. Groundwater is not considered in this assessment, but may be incorporated in future work.

Landscape response

The combination of environmental characteristics and management factors will drive a response in the landscape. For example, burning trash (management factor) on an erodible soil (environmental characteristic) can lead to erosion and sediment movement (landscape response).

Management factors

Land management practices which are dynamic, require input, and are influenced by decision making (e.g. green trash blanket, controlled traffic farming, timing and rate of fertiliser or herbicide application).

Mottles

Mottles are spots, blotches or streaks of subdominant colours which are different to the matrix colour. Mottles are an indication of water fluctuation throughout a soil profile.

Normalised Difference Vegetation Index (NDVI) map

NDVI maps are derived from satellite imagery and measure vegetation density and condition.

PAWC (Plant Available Water Capacity)

The amount of water stored within the soil that can be extracted by plants, expressed as millimetres of water within the root zone. A soil with a high water-holding capacity may store water in the profile for periods of time and not require additional inputs of water for plant growth. Soils with a low water-holding capacity may require frequent irrigation to support plant growth. DERM's land resource data provides an indication of the PAWC of Wet Tropics soils. Information on PAWC is also provided in the ERMP map package supplied to landholders.

Permeability

Refers to the potential of a soil to transmit water internally. Permeability is related to the saturated hydraulic conductivity of the soil profile and is independent of the soils' position in the landscape. The following terms are a description of permeability attributes:

- **Very slowly permeable** – transmission through the soil profile is very slow. It would take at least a month for the profile to reach field capacity after wetting.
- **Slowly permeable** – transmission through the soil is slow. It would take at least a week or more after wetting for the soil to reach field capacity.
- **Moderately permeable** – transmission through the soil profile is relatively fast, field capacity is reached between 1–5 days after wetting.
- **Highly permeable** – transmission through the soil profile is very fast, field capacity is reached within 1–12 hours after wetting.

Rainfall erosivity

Measured by the individual storm erosion index (EI30), where E is the total storm kinetic energy and I30 is the maximum 30-minute rainfall intensity. Rainfall intensity is extremely variable over very small areas and is not regularly measured.

Regolith

Regolith is the term used to describe all the components that exist between fresh air and fresh rock (bedrock). It includes weathered rock, volcanic materials, gases, sediment, water and biota (e.g. plant roots, worms, bacteria and other organisms that live in the soil).

Sodic soil

Soil with a high percentage of sodium ions (in exchangeable form), which may exhibit degraded soil behaviour such as dispersion when wet and crusting when dry. Sodicity can occur at any depth in the soils. The effects are more pronounced if the sodicity is exposed to the surface.

Soil erodibility

Susceptibility of soil particles to detach and be transported by rainfall, runoff and flooding.

Soil structure

Refers to the way soil particles group together to form aggregates (or peds). These aggregates vary in size and shape from small crumbs through to large blocks. Where there are no peds present, the soil is described as 'structureless' and may be either loose (single grain) or hard (massive).

Soil texture

Refers to the proportion of sand, silt and clay sized particles that make up the mineral fraction of a soil. For example, a light soil refers to a soil high in sand relative to clay, whereas heavy soils have a higher proportion of smaller clay particles.

Water pathway

Describes the dominant pathway or movement of water, when it comes into contact with the soil surface. This is inferred from the drainage and permeability characteristics of soils

4 Erosion potential

Background: Types of erosion

Queensland's high-intensity summer rainfall means there is a significant risk of erosion by water, which may take any of the following forms:

Rill erosion (a form of hillslope erosion)
Small channels are eroded in soil as runoff water concentrates down a slope.

Sheet erosion (a form of hillslope erosion)
A sheet of water running over the landscape carrying eroded sediments. This form of erosion may be less visible as it happens uniformly across a slope.

Streambank erosion
The direct removal of soil from banks by flowing water, exacerbated during periods of high streamflow or lack of vegetation cover.

Tunnel erosion
Dispersible subsoils with naturally high levels of sodium are removed through subsurface water movement. Surface soil initially remains intact, but may collapse and form gullies.

Gully erosion
Caused by the concentration of runoff water until flow velocity is sufficient to detatch soil particles along a drainage line. A waterfall may form over the gully head, and splashback causes the gully to migrate its way up the slope.

In the Wet Tropics, hillslope (i.e. sheet and rill) and streambank erosion are the dominant processes that contribute sediment to watercourses. As there is no available data to map streambank erosion, the erosion potential map focuses only on **hillslope erosion processes**.

The important factors to consider when managing land to minimise hillslope erosion are:

- **Soil** – some soil types are inherently more erodible than others.
- **Slope** – steeper slopes increase the velocity of runoff water, which can increase erosion. Longer slope lengths also increase the likelihood that soil particles will travel further from the point of origin.
- **Rainfall** – high intensity rainfall events can facilitate large erosion events on susceptible soils.
- **Cover** – vegetation cover protects the soil surface from raindrop impact and slows runoff water.

Other environmental characteristics: streambank erosion

Streambank erosion can contribute a significant amount of sediment to watercourses. While streambank erosion potential is not mapped, users can access other information sources, such as aerial imagery to identify the watercourses and extent of riparian vegetation across a farm. Information provided in an Environmental Risk Management Plan (e.g. farm maps and Part G) can also help to understand the likelihood that streambank erosion will occur on-farm.

Description of erosion potential mapping

The erosion potential map indicates the natural susceptibility of landscapes to erode. However, the likelihood that soil will erode is largely dependant on land use and management practices. Hence soils that are naturally prone to erosion may not erode under good land management practices and conversely soils with low erosion potential may erode under poor management practice.

Hillslope erosion potential is assessed during land resource surveys by considering slope (which can increase the velocity of runoff) and the natural erodibility of soils. The erosion potential map has been developed using this land resource data. The erosion potential categories are described in Table 3 and the erosion potential map for the Wet Tropics is shown in Figure 4. The highest erosion potential exists where natural erodible soils occur on steep slopes.

There are a few distinct features of the Wet Tropics landscape that have been taken into consideration when assessing erosion potential. Certain areas, which would normally be considered too steep for agriculture (i.e. slopes > 15%), have been included as cane growing can occur on steep slopes in the Wet Tropics catchment. Where steep slopes are cultivated for cane, this is predominantly on red basaltic soils (Ferrosols). Ferrosols are associated with volcanic landscapes located along the Great Dividing Range. Ferrosols have a high agricultural potential because of their good structure and moderate to high fertility and water-holding capacity. As a result of this good structure, these soils are less erodible compared to other soils on similar slopes. This has been taken into account in assessing the erosion potential of Wet Tropics soils.

The effects of rainfall and vegetation cover are not represented in the erosion potential map. However, these characteristics also influence the potential of landscapes to erode and it is important to consider these as part of property planning. Some contextual information about the effect of rainfall and vegetation cover is provided in the ‘Additional considerations’ section below.

Table 3. Categories for erosion potential

Category	Description of soil and slope attribute
Lower potential	< 2% slope for granitic soils or < 3% slope for basaltic and metamorphic soils 3–8% slope, basaltic or metamorphic soils < 1.5% slope, cracking clays and imperfectly to poorly drained non-cracking clay soils, podzolics, earths and soils with sodic B horizons at >40 cm 1.5–4% slope, cracking clays and imperfectly to poorly drained non-cracking clay soils, podzolics, earths and soils with sodic B horizons at >40 cm < 2% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) 2–5% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) < 2% slope, other soils (texture contrast/soils with sodic B horizons at < 40 cm) < 5% slope, shallow/skeletal soils/imperfectly to poorly drained soils Miscellaneous water map units Miscellaneous Urban Unclassified land other
Moderate potential	8–15% slope , basaltic or metamorphic soils 15–20% slope, basaltic or metamorphic soils 20--30% slope, basaltic or metamorphic soils 4–6% slope, cracking clays and imperfectly to poorly drained non-cracking clay soils, podzolics, earths and soils with sodic B horizons at >40 cm > 6% slope cracking clays and imperfectly to poorly drained non-cracking clay soils, podzolics, earths and soils with sodic B horizons at >40 cm 2–4% slope, other soils (texture contrast/soils with sodic B horizons at < 40 cm) 4–6% slope, other soils (texture contrast/soils with sodic B horizons at < 40 cm) 6–8% slope, other soils (texture contrast/soils with sodic B horizons at < 40 cm) 5–8% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) 8–12% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) 12–20% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) 5–8% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) in the MDIA area 8–15% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) in the MDIA area 5–10% slope, shallow/skeletal soils/imperfectly to poorly drained soils 10–15% slope, shallow/skeletal soils/imperfectly to poorly drained soils > 15% slope, shallow/skeletal soils/imperfectly to poorly drained soils MDIA* steep dissected gullies Miscellaneous mining quarry units
Higher potential	> 30% slope, basaltic or metamorphic soils > 8% slope, other soils (texture contrast/soils with sodic B horizons at < 40 cm) > 20% slope, granitic soils/well to moderately drained alluvial soils/red-brown clays (excludes texture contrast soils) 10–14% slope, granitic soils (excludes texture contrast soils) WTC only > 14% slope, granitic soils (excludes texture contrast soils) WTC only
Not assessed	Miscellaneous mountains MDIA* steep dissected hills Stream channel

^ Wet Tropical Coast – North Queensland – Ingham and Herbert River Section

*Mareeba Dimbulah Irrigation Area

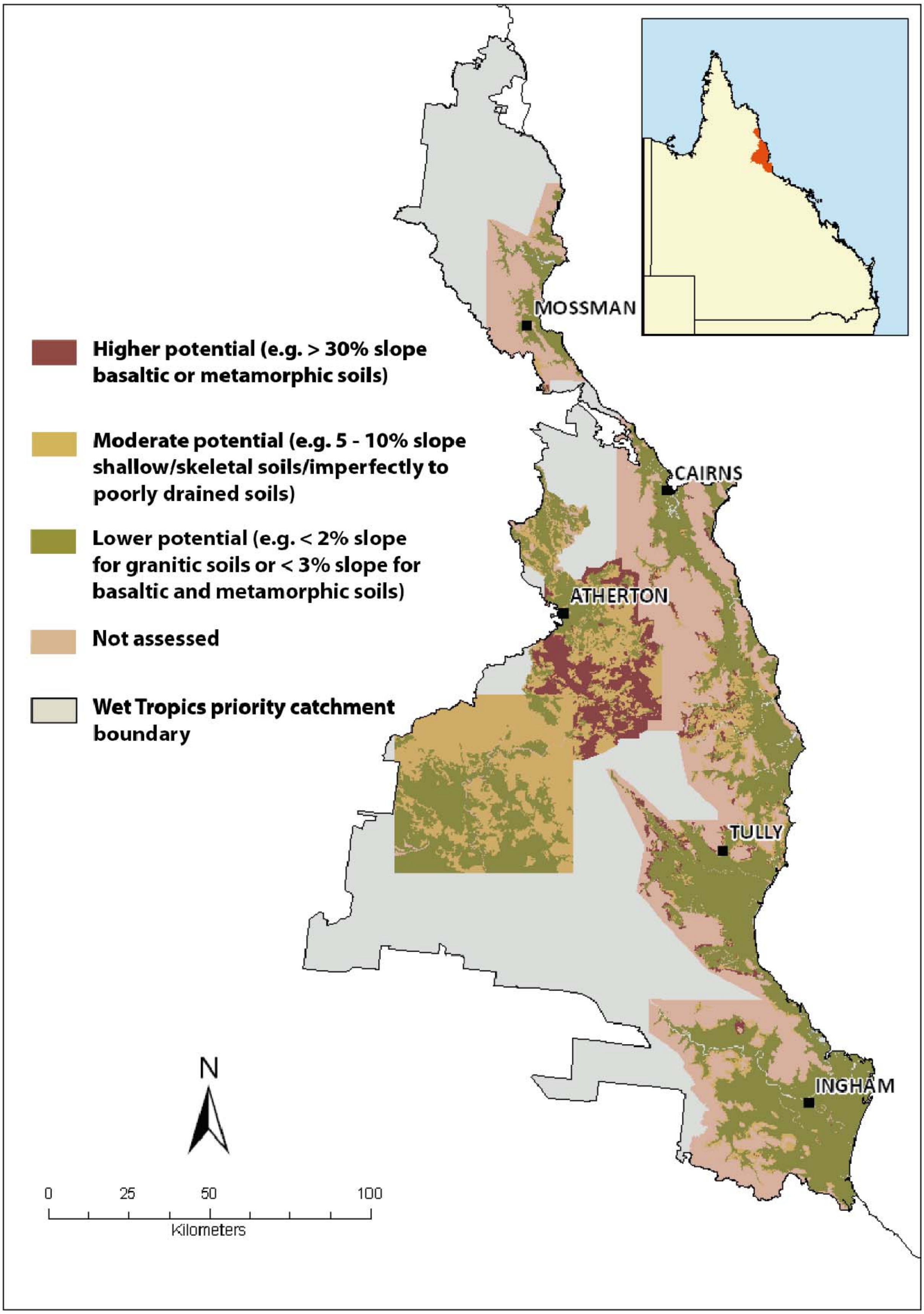

Figure 4. Erosion potential – Wet Tropics priority catchment

Additional considerations

Rainfall

Patterns and intensity of rainfall events can have a strong influence on erosion rates:

- Rainfall varies considerably within the Wet Tropics (Figure 5), therefore landscapes in different rainfall zones may experience different rates of erosion despite similar management practices (Figure 6). The average rainfall for key areas (Ingham, Tully and Mareeba) is outlined in Table 4. Information on daily, monthly and annual rainfall is also available from the Bureau of Meteorology website.

  For example, the high rainfall of Tully (~4000mm/yr) is likely to result in very different erosion rates compared to the drier climate of Mareeba (~800mm/yr).

- Rainfall intensity, in addition to amount of rainfall, influences erosion. High intensity rainfall events increase the potential for erosion to occur.

  For example, 100mm of rain delivered in one hour is likely to cause greater erosion than the same amount delivered over one day.

- Rainfall intensity is variable across small areas, and is best discussed with property owners. When considering intensity, it may be sufficient to acknowledge that rainfall events are likely to be more intense during the wet season and in high rainfall areas, and ensure management practices are seasonally appropriate.

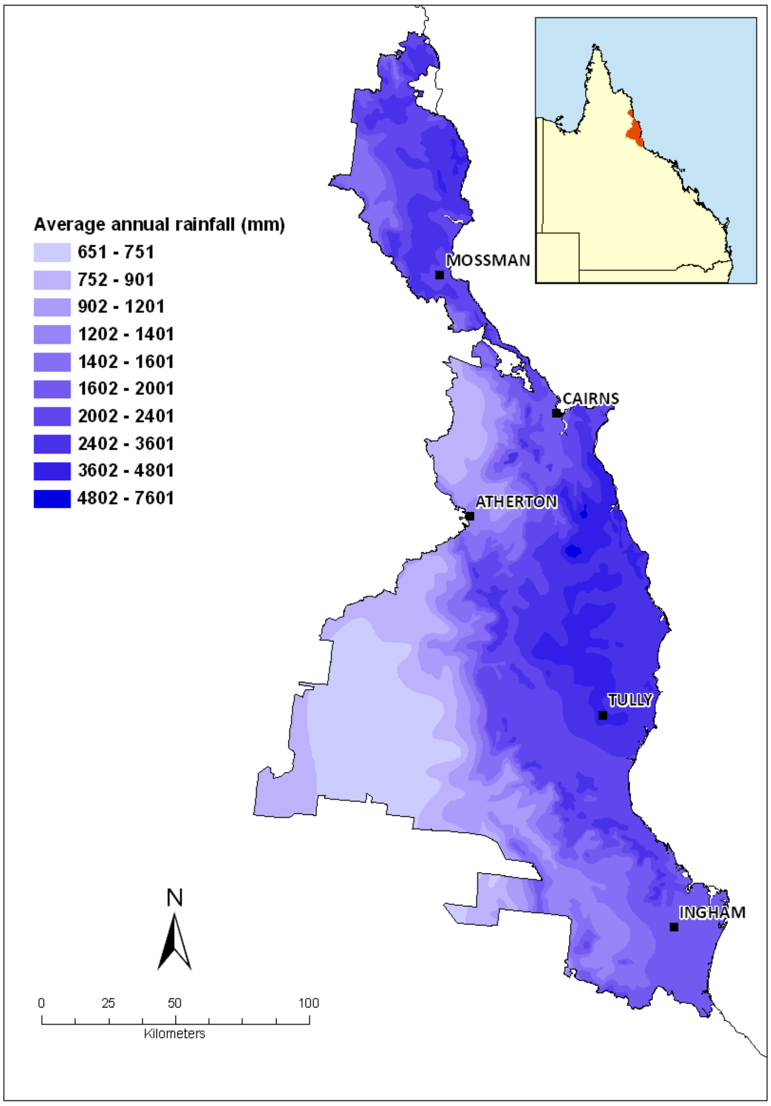

Figure 5. Average annual rainfall in the Wet Tropics priority catchment between 1920 and 1969 (DERM 2011b).

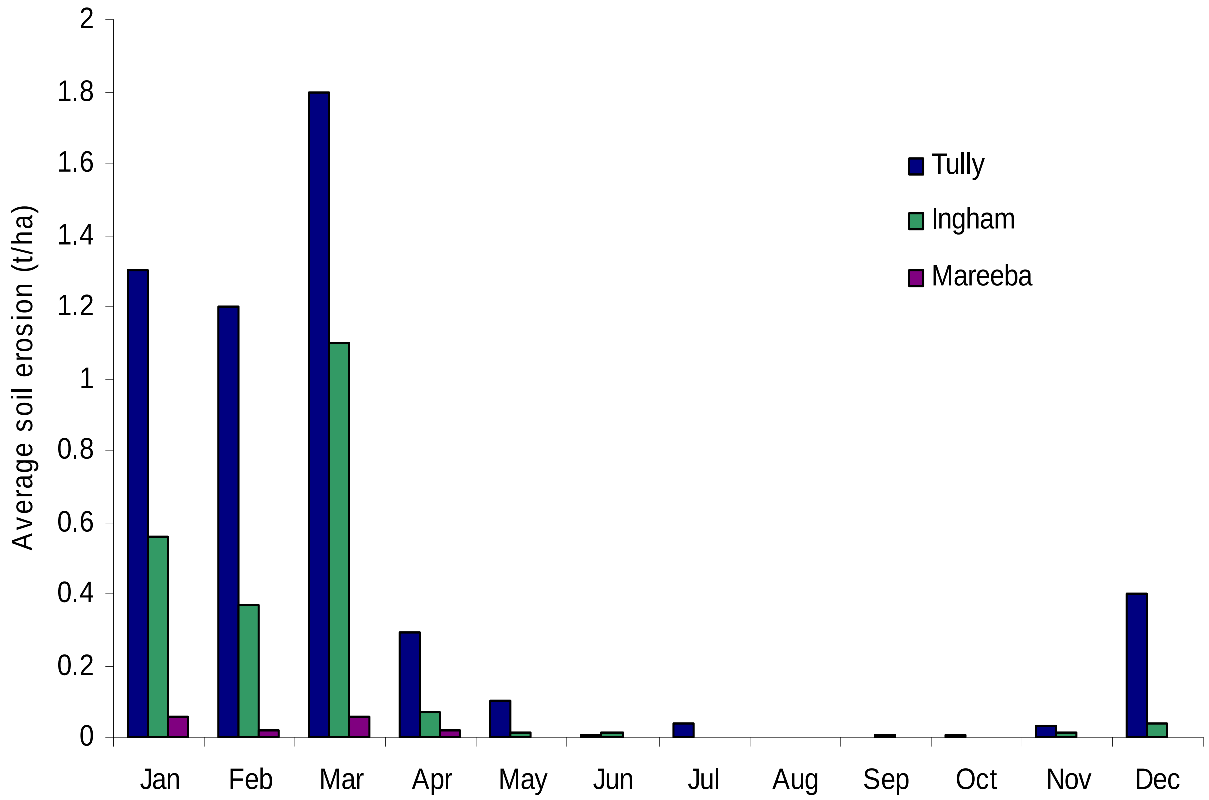

Figure 6. The effect of high (Tully), medium (Ingham) and low (Mareeba) rainfall on soil erosion rates in the Wet Tropics, comparing average monthly soil erosion for a Dermosol under cane (graph produced using outputs from HowLeaky, a daily simulation model based on a crop cycle of: plant cane, ratoon cane, soybean fallow crop).

Table 4. Average rainfall at Ingham, Tully and Mareeba.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ingham	398	410	438	212	126	43	35	37	33	47	112	217	**2167**
Tully	532	678	745	568	371	176	123	110	104	97	170	297	**3971**
Mareeba	204	222	215	55	26	17	7	6	5	17	63	117	**957**

Long-term average monthly rainfall statistics for the period 1961–90 (BOM 2011)

Vegetation cover

Erosion is influenced by the level of vegetation cover present i.e. full crop, ratoon, break crop, fallow etc. Greater levels of cover reduce the chance of erosion exponentially, meaning less than 100% cover can still significantly reduce erosion (Figure 7).

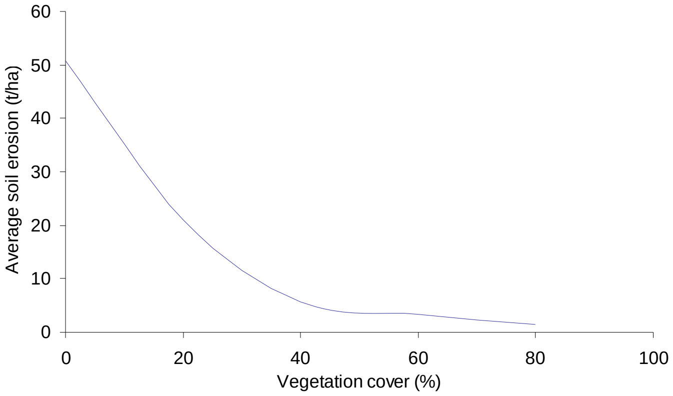

Figure 7. The influence of vegetation cover on soil erosion for a Dermosol in Tully. This relationship is similar for other soil types (graph produced using outputs from How-Leaky).

At any point in time, approximately 15% of cane paddocks may be in fallow (Figure 8). Paddocks without appropriate cover have greater potential to erode, which increases if the soils are also prone to erosion.

Figure 8. Paddock in fallow near Cairns.

Trash blanketing has had a major impact on reducing erosion across cane farms (Figure 9), as it:

- reduces the effect of raindrop impact, which can dislodge soil particles
- slows the velocity of runoff, which reduces the likelihood of sediment being dislodged and also allows suspended sediment to settle out.

Figure 9. Trash blanket on a cane paddock in Ingham.

Soil type

The greatest potential for erosion occurs during the wet season (approximately December – April); however soil type also influences the degree to which soils will erode (Figure 10).

For example:

- sodic soils (e.g. Sodososls) can erode rapidly, if exposed, because of their highly dispersive nature when wet
- highly permeable basaltic soils (e.g. Ferrosols) are less susceptible to erosion because they are well structured
- sandy soils (e.g. Podosols) tend to erode less as they are very permeable and have large soil particles which are less susceptible to movement by water.

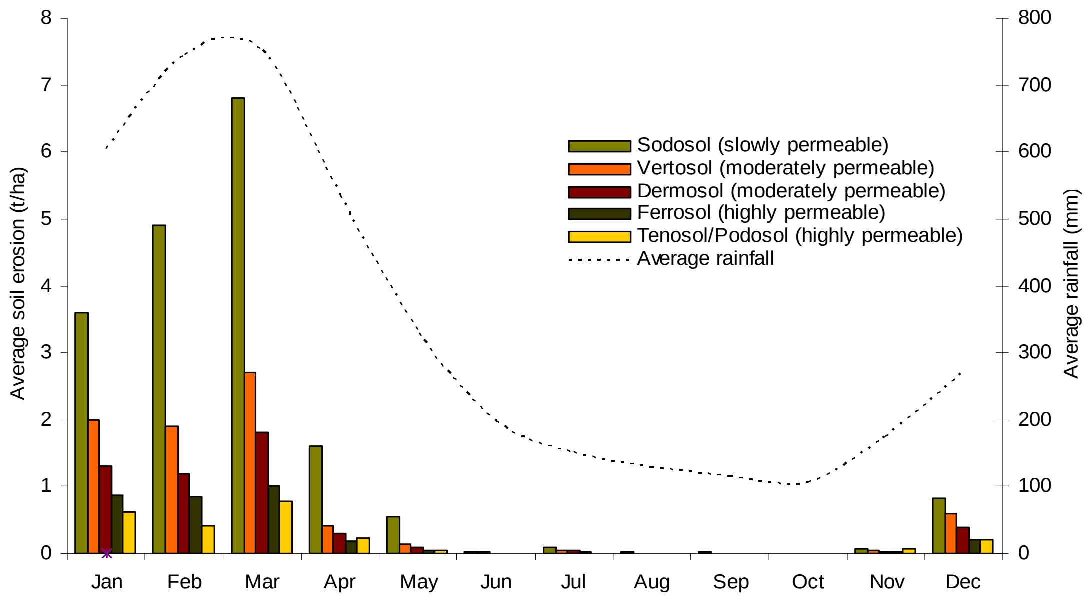

Figure 10. The variability in erosion rates according to soil type, comparing average monthly soil erosion for five different soil types at Tully (graph produced using outputs from HowLeaky).

The picture below (Figure 11) shows a cutting in a cane paddock located on a red basaltic soil near Babinda (Ferrosol, local soil name Pin Gin). This area is subject to approximately 4000 mm of rainfall each year. Despite the high rainfall, the attributes of the soil (good structure, well drained etc) make it relatively stable to erosion. This large cutting is stable enough to support the growth of moss on the exposed soil face.

Figure 11. Moss growing on an exposed soil face of a Pin Gin soil (Ferrosol) near Babinda.

Constructed farm drains as a source of sediment

Many cane farms in the priority catchments are located in flat floodplain environments and improved drainage can be required to minimise water-logging of cane crops. In the high rainfall environment of the Wet Tropics, even sloping country may require drains to facilitate water transport off farm in the wet season.

Constructed farm drains, such as deep square drains, spoon drains and sub-surface mole drains are designed to collect and divert surface runoff and groundwater from cane crops. In the Wet Tropics, drains generally connect to natural watercourses, which can result in efficient delivery of water and mobilised contaminants. Drains may also be a source of sediment where the banks have slumped.

Management

The likelihood that soils will erode is largely dependant on management practices. Soils that are naturally prone to erosion may not erode under certain land management practices and conversely, soils which are naturally quite stable may erode under poor land management practices. For example, Ferrosols are fairly stable soils in terms of erosion due to their structure and drainage characteristics (Figure 12), hence in the Wet Tropics these soils are able to support cane production on slopes considered quite steep for agriculture. They may still erode however if there is no cover to protect these soils on sloping land.

To reduce erosion potential, management practices must consider the implications of slope, soil type, rainfall, and cover. Table 5 outlines example management principles that could be employed to address these factors and minimise the risk of erosion.

Figure 12. Cane grown on a stable Ferrosol with steep slopes in the Wet Tropics.

Table 5. Management options for mitigating impacts of erosion

Erosion factor	Erosion principle	Examples of management principles to minimise erosion
Slope	Steeper slopes = increased chance of erosion	Cultivation on steep slopes is conducted with consideration of soil type Cultivated slopes are not exposed at the onset of the wet season Contour planting to reduce the velocity of water runoff
Soil type	Erodible soils = increased chance of erosion	Minimum or zero till adopted The timing of cultivation on erodible soils is specifically managed for high rainfall periods Drains are well vegetated with soils not exposed
Rainfall	Higher rainfall intensity = increased chance of erosion	Soil is not exposed at the onset of wet season when rainfall intensity is considered to be greater
Cover	Less cover = increased chance of erosion	Appropriate cover is maintained for the climate Riparian vegetation is maintained

Further information

Erosion fact sheets – DERM website <www.derm.qld.gov.au>

- Soil conservation planning in cropping lands
- Runoff control measures for erosion control in cropping land
- Controlled traffic farming – soil conservation considerations
- Maintaining contour banks
- Contour bank specifications
- Erosion control on property roads and tracks – cross sections and locations
- Erosion control on property roads and tracks – managing runoff
- Erosion control on fences and firebreaks
- Soil conservation waterways – planning and design
- Soil conservation waterways – Construction and management
- Soil conservation waterways – Plants for stabilisation
- Erosion control in cropping lands
- How healthy is your watercourse?
- Stream bank planting guidelines and hints
- Stream bank vegetation is valuable
- What causes bank erosion
- What causes stream bed erosion
- Catchments and water quality.

Soil conservation measures—Design manual for Queensland

DERM is producing a web based publication – ‘*Soil conservation measures—Design manual for Queensland*’. It provides current information on: planning, runoff estimation, channel design and special application. Refer to the DERM website: <www.derm.qld.gov.au/land/management/erosion/index.html#design_manual>

Land resource reports for the Wet Tropics

Land resource reports provide information on the soils of the Wet Tropics (see Appendix 1 for a list of Wet Tropics soil surveys used to assess environmental characteristics).

Land resource reports can be viewed and downloaded through

- the DERM library catalogue at: <www.derm.qld.gov.au/library/index.html>
- the Queensland Digital Exploration Reports system (QDEX) at: <www.dme.qld.gov.au/mines/company_exploration_reports.cfm>

Alternatively, reports can be requested by emailing: <productdelivery@derm.qld.gov.au>.

5 Flooding frequency

Background

Flooding occurs when a river can no longer be contained within its banks and spreads over adjacent land as floodwater. Wet season floods have a high capacity to transport contaminants, particularly those in dissolved forms, and are the major delivery mechanism of land-derived contaminants to the GBR (Brodie *et al* 2008). Where cane farms are located in areas that flood relatively frequently, e.g. annually, there may be a higher potential for contaminants to be mobilised and delivered off-farm in floodwaters, compared to cane farms located in areas that do not flood frequently (Figure 13). Floods can also facilitate transport and spread of weeds, which may mean more herbicides are used.

Figure 13. Ingham floodplain showing cane growing in areas that may flood relatively frequently.

Description of flooding potential mapping

The flooding potential map identifies landscapes that are more likely to experience flood events and describes how often flooding usually occurs. Where cane farms are located in frequently flooded environments, there may be a higher potential for contaminants to be mobilised and transported off-farm in floodwaters. The flooding categories used are outlined in Table 6 and the flooding frequency map for the Wet Tropics is shown in Figure 14.

Table 6. Description of flooding potential attributes.

Flooding category	Landscape example
Flooding frequency approaches annual occurrence (Higher frequency)	Lower channel benches
Flooding frequency of approximately 1 in 2 to 1 in 10 years (Moderate frequency)	Levees, back swamps and some higher channel benches

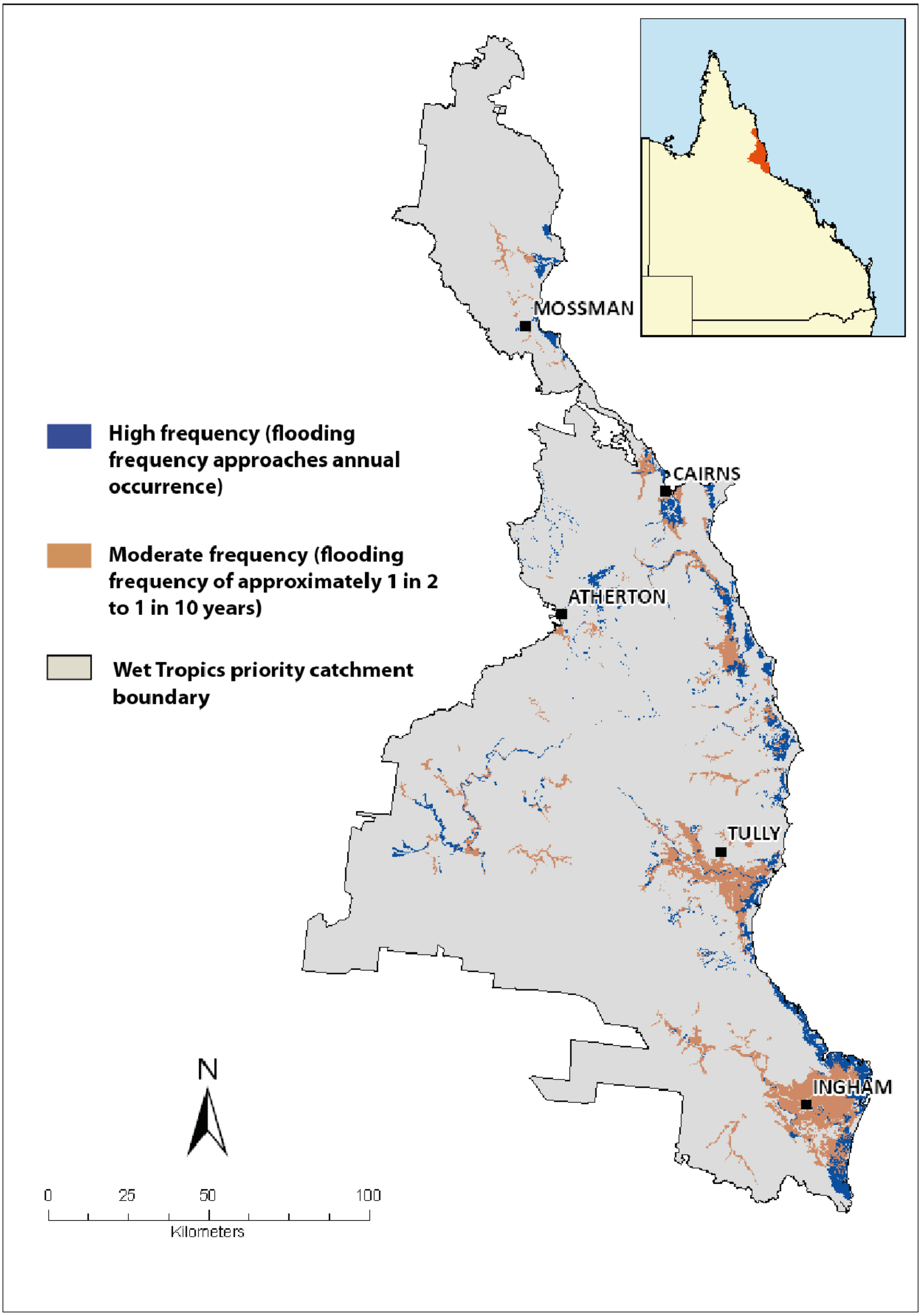

Figure 14. Flooding frequency – Wet Tropics priority catchment.

Management

Nutrients and herbicides applied on the floodplain can be mobilised in their dissolved forms and transported by floodwaters. Dissolved contaminants are the most likely to reach the GBR because there is no potential for them to settle out of suspension. Sediment and associated nutrients and herbicides may also be mobilised and transported shorter distances. It is therefore critical to consider timing of land management practices to reduce the movement of contaminants in floodwaters, either via sediment or in dissolved forms. Table 7 outlines example management principles that can assist to minimise the movement of sediment, nutrients and herbicides in floodwaters.

Table 7. Management options for mitigating impacts of flooding.

Transport process	Principle to reduce movement in floodwaters	Example of management principles to mitigate impacts of flooding
Nutrients and herbicides transported attached to sediment	Reduce offsite movement of sediment	Soil is not exposed during the wet season when flooding potential is greatest Grass headlands maintained Use of water treatment infrastructure to collect first flush and prevent discharge of contaminated runoff
Nutrients and herbicides transported in dissolved form	Minimise soil concentrations during times of likely flooding	Consider timing and method of nutrient and herbicide application. Where possible, use direct application method and avoid applying during high risk periods (wet season) Use of water treatment infrastructure to collect first flush and prevent discharge of contaminated runoff

6 Dominant water pathway

Background

Water pathway indicates whether soils are more likely to drain or generate runoff, based on the drainage and permeability characteristics of the soil. Impermeable or poorly drained soils are more likely to generate runoff, which can transport sediment, nutrients and herbicides to nearby watercourses. Figure 15 displays the difference in appearance between a well drained soil and a poorly drained soil. The bright red colours of the basaltic soils (Ferrosol) on the left are an indicator of good drainage. The pale colours and mottling (see glossary) in the soil on the right (Hydrosol) indicates that this soil is poorly drained.

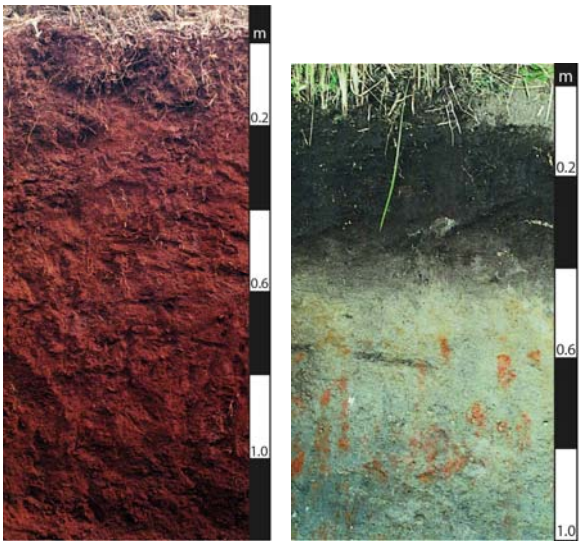

Figure 15. Example of a well drained soil (left) and a poorly drained soil (right).

Description of water pathway mapping

To generate water pathway data, soil permeability and drainage classes (see glossary) were combined to identify the dominant pathway of water when it contacts the soil surface (Moody and Cong 2009). The classification of water pathway categories and description of potential implications are outlined in Table 8 and the water pathway map for the Wet Tropics is shown in Figure 16.

Table 8. Description of water pathway categories.

Dominant water pathway	Description	Implications*
Drainage	Highly permeable and well or rapidly drained soils	Nutrients such as nitrate may leach - resulting in accelerated soil acidification and groundwater (see glossary) contamination
Drainage/runoff	Permeable and imperfectly drained soils	
Runoff/ponding	Poorly drained and slowly permeable soils	Runoff can lead to accelerated soil erosion, which can impact on surface water quality

* Source: Moody and Cong 2009

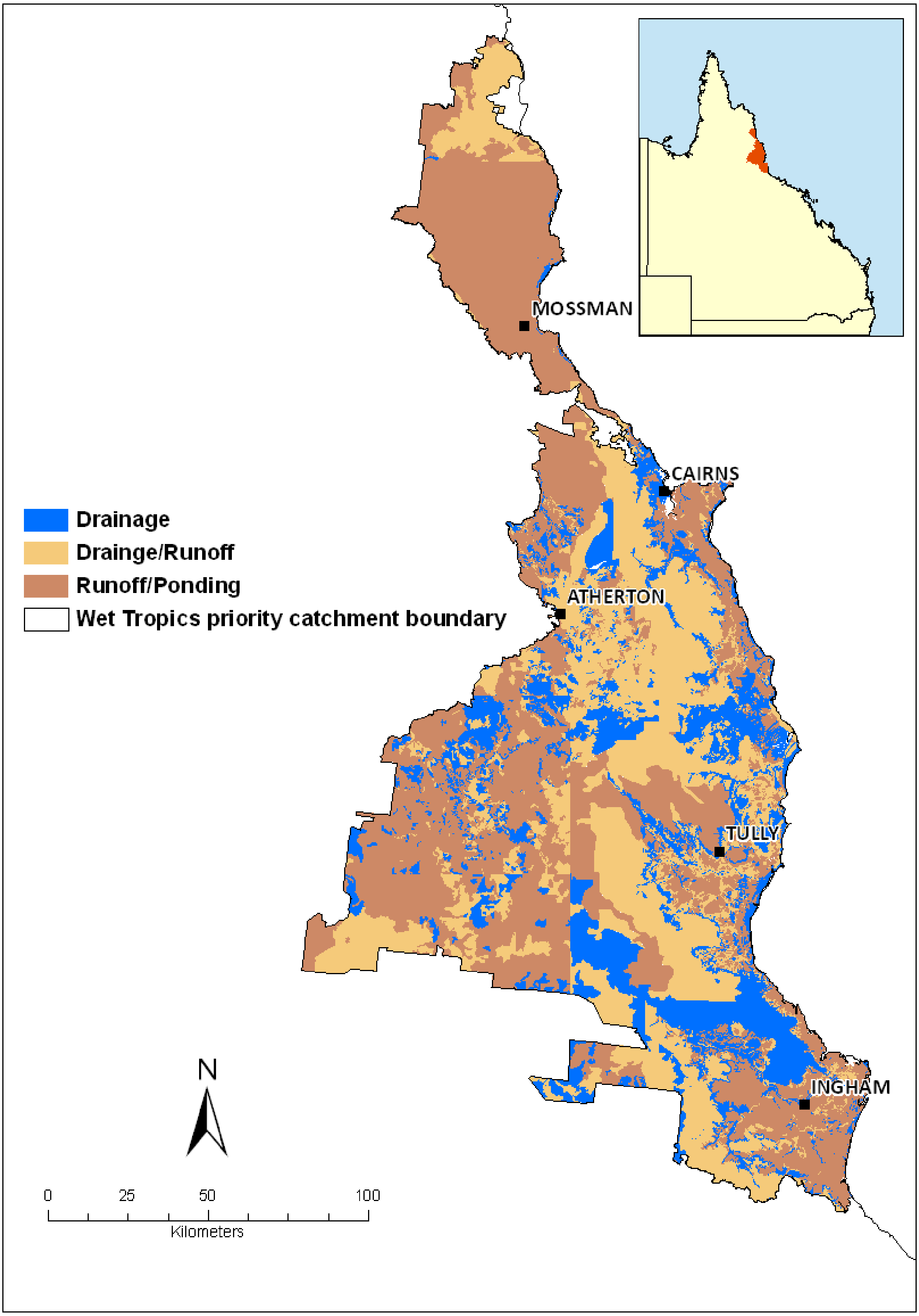

Figure 16. Water pathway – Wet Tropics priority catchment.

Additional considerations

Rainfall

Wet season rainfall typically saturates the soils of the Wet Tropics. Anecdotal evidence suggests that two months into the wet season, soils will become saturated and be more likely to generate runoff, regardless of whether they are naturally well drained or not. The quantity of rainfall during the wet season, and therefore the time taken for soils to reach saturation, varies significantly across the Wet Tropics. If farms are irrigated, this will also influence the time taken to reach saturation. Figure 17 shows the variation in monthly rainfall across five locations.

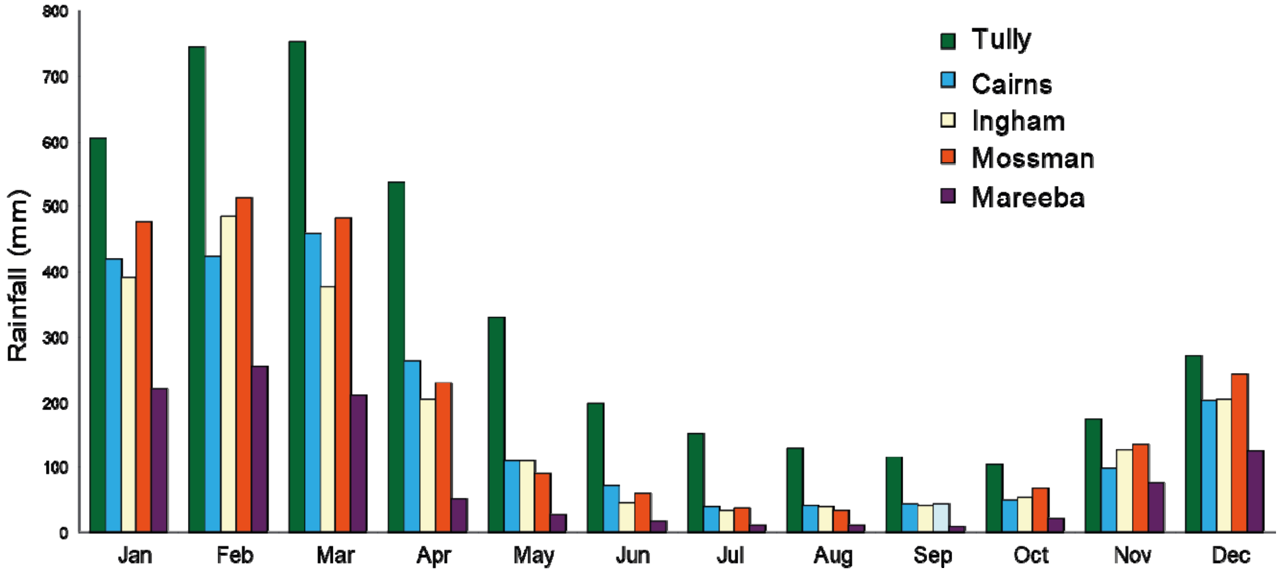

Figure 17. Monthly average rainfall at five locations throughout the Wet Tropics (BOM 2011).

Farm drains

During land resource surveys, soil drainage and permeability characteristics are described in their natural state. However, the majority of cane farms in the Wet Tropics have farm drains, which can alter the drainage characteristics of soils, i.e. poorly drained soils can become well drained following the construction of drains.

Management

Management principles should be adapted depending on whether landscapes are likely to drain (e.g. sandy soils) or generate runoff (e.g. heavy clays). In all instances, it is important to optimise inputs (nutrients and herbicides) to reduce the volume of contaminants available for transport – whether via surface water run-off or leaching past the root zone. Table 9 outlines example management principles for mitigating impacts of water pathway.

Other environmental characteristics: groundwater contamination

Environmental characteristic maps focus on the potential for contaminants to be transported off farm via surface water. However, nutrients and herbicides can also be transported to the GBR via groundwater pathways.

Users can start to identify areas vulnerable to groundwater contamination by considering parts of the landscape that facilitate drainage (as shown on the water pathway map). The focus in these areas should be to minimise leaching of nutrients and herbicides past the root zone.

The likelihood that contaminants will actually be transported to groundwater is influenced by a range of features, e.g. rainfall, soil and regolith properties, and proximity to aquifers. Some of these features are not well understood at this time, however work is ongoing to improve understanding of groundwater transport processes across the GBR catchments.

Table 9. Management principles for mitigating impacts of water pathway.

Dominant water pathway	Principle to minimise runoff and leaching	Examples of management principles that mitigate the impact of water pathway
Drainage	Minimise leaching of excess water and nutrients /herbicides	Optimise timing and rates of nutrient/herbicide application, e.g. split fertiliser and variable rate applications Timing of application to avoid periods of profile saturation where the conductivity of water through the soil is increased
Drainage/runoff	Maintain water balance	
Runoff/ponding	Minimise erosion and contaminant transport associated with runoff	Soil is not exposed during the wet season when flooding potential is greatest Grass headlands maintained Use of water treatment infrastructure to collect first flush and prevent discharge of contaminated runoff Optimise timing and rates of nutrient/herbicide application to reduce the volume of contaminants available for transport

Further information

SCAMP: A decision support system for the sustainable management of sugarcane soils.

The 'SIX EASY STEPS' program (Schroeder et al. 2005) forms the basis of best practice nutrient management in the Australian sugar industry. Use of the SIX EASY STEPS package enables the determination of appropriate nutrient inputs for individual soils based on soil chemical analyses and cropping history. The first principle of the 'SIX EASY STEPS' is 'know your soil'. The Soil Constraints and Management Package (SCAMP) complements the SIX EASY STEPS by identifying the intrinsic soil constraints to long-term sugarcane productivity, and then by indicating management practices that will minimise the impacts of these constraints on productivity and the environment.

It is anticipated the report will be available in late 2011 and can be obtained by

- emailing: <ProductDelivery@derm.qld.gov.au>
- searching the DERM library catalogue <http://www.derm.qld.gov.au/library/index.html>

Fact sheet – DERM website <www.derm.qld.gov.au>

- Soil limitations to water entry

7 Soil transport potential

Background

Soils vary in their potential to be eroded (erosion potential – see chapter 2) and their potential to be transported over long distances (soil transport potential). Smaller soil particles such as clays are transported more easily and over longer distances than larger silt and sand sized particles, which are more likely to fall out of suspension (Figure 18). Soils with high clay content therefore have a greater potential to reach the GBR (Figures 19 and 20). Due to the negative charge of clays, these soils are more likely to bind to nutrients and herbicides, which can also be delivered to the GBR.

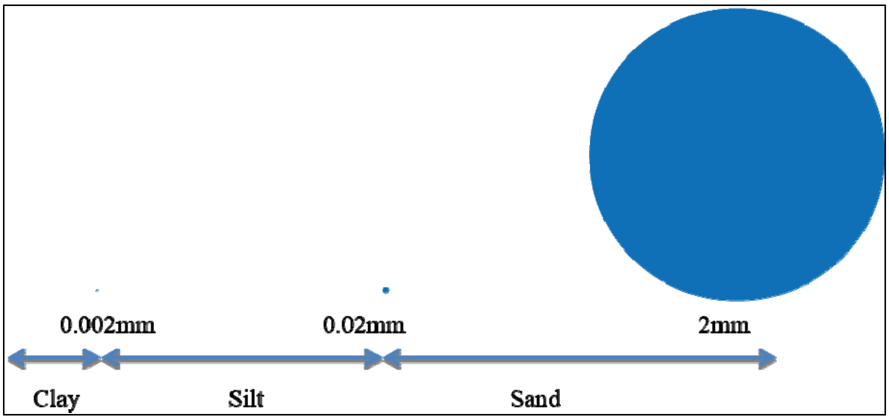

Figure 18. Relative difference in particle sizes for clays, silts and sands.

Figure 19. Sediment plume in the Burdekin catchment. Smaller soil particles will be transported further and are more likely to reach the GBR.

Figure 20. Clays particles may remain suspended in rivers giving them a turbid appearance. These soil particles can be transported long distances in suspension.

Description of soil transport potential mapping

The amount of sand, silt and clay particles in the surface soil is determined by soil texture tests in the field (see further information section). Table 10 divides surface soil texture into sand, loam and clay classes. The soil transport potential map for the Wet Tropics is shown in Figure 20, recognising that soils over 35% clay have a higher potential to be transported over long distances.

Table 10. Description of surface soil texture classification.

Surface soil texture	Field texture
Sands (lower transport potential)	Sands, loamy sands, clayey sands
Loams (moderate transport potential)	Sandy loams, loams, clay loams, silty loams
Clays (higher transport potential)	Light clays, medium clays, heavy clays

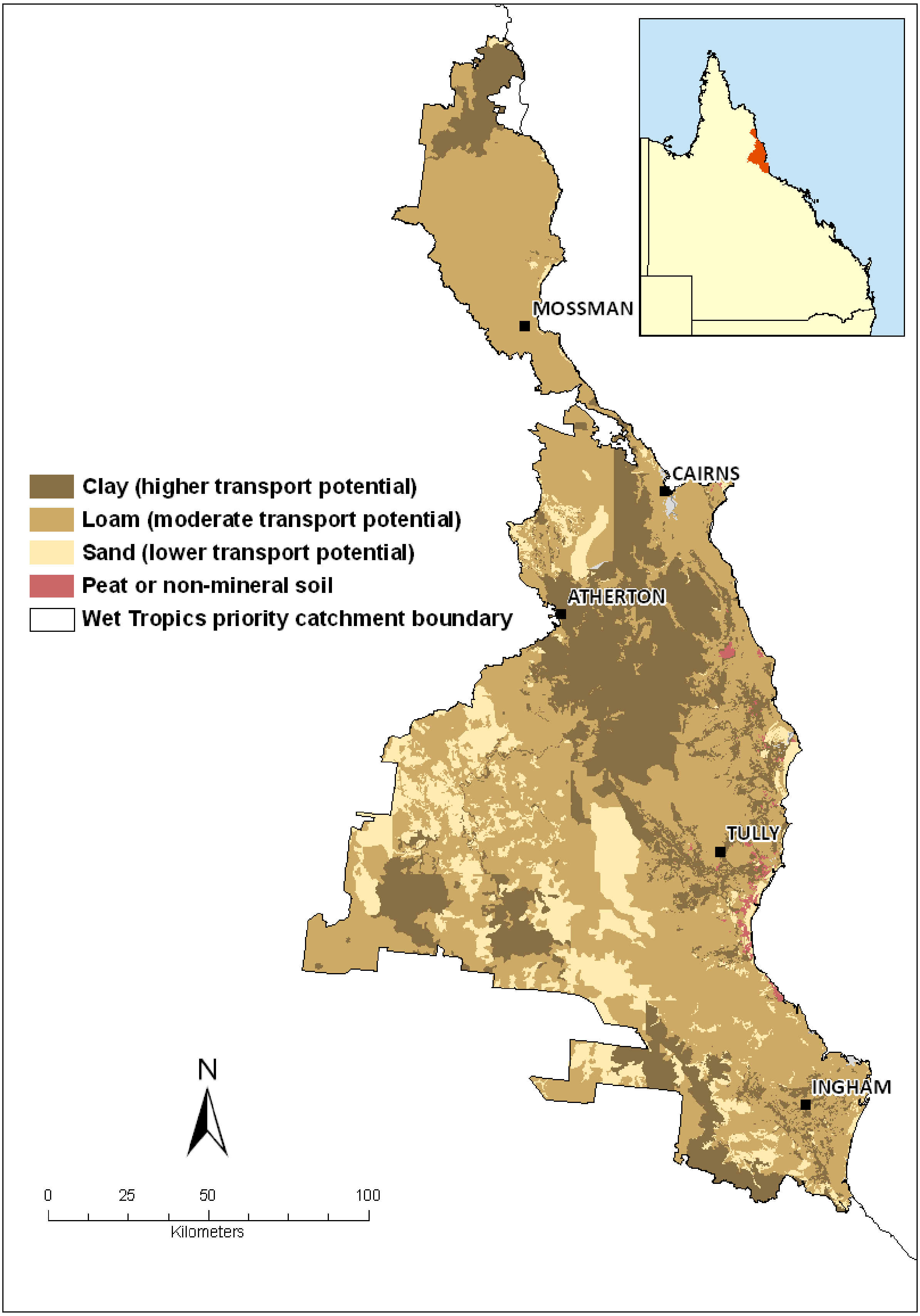

Figure 21. Soil transport potential – Wet Tropics priority catchment.

Additional considerations

Soil structure

Soil structure influences the stability of soils and their behaviour while in suspension. For example, a well structured soil allows water to infiltrate and excess water to drain. This reduces the likelihood that water will runoff and transport mobilised contaminants off-farm. Environmental characteristic maps do not currently consider soil structure as this characteristic is not accurately mapped for cane growing areas. Although soil structure is described during land resource surveys, it is easily influenced by land management practices and therefore the soil structure present in cultivated situations is likely to be different to that described by surveys.

The publication *SCAMP: A decision support system for the sustainable management of sugarcane soils* (see further information) describes a range of simple field tests that can assist landholders and field officers to gain an understanding of the soil structure of a farm.

Clay types

The mineral composition (or mineralogy) of clays influences their ability to attach to contaminants. Clays can be divided into two broad groups based on their mineral composition – 1:1 clays (e.g. kaolinite and serpentine) and 2:1 clays (e.g. illite and smectite). Mineralogy affects the capacity of clays to draw water and positively charged ions (e.g. Na^+) between layers and therefore the capacity to absorb water and bind to nutrients. Generally, 2:1 clays have a higher capacity to bind to nutrients and herbicides; however this process is highly complex and influenced by other features such as organic matter content and chemical characteristics of nutrients and herbicides.

Clay mineralogy can be broadly correlated to soil orders of the Australian Soil Classification (ASC), as outlined in Table 11.

Table 11. Approximate clay mineralogy according to soil orders of the ASC (Blosch et al. 2005, unpublished).

Soil Order	Approximate mineralogy
Anthroposol	Mixture
Calcarosol	Illite and kaolinite
Chromosol	Illite and kaolinite
Dermosol	Mixture
Ferrosol	Mixture
Hydrosol	Illite and kaolinite
Kandosol	Illite and kaolinite
Kurosol	Illite and kaolinite
Organosol	Mixture
Podosol	Illite and kaolinite
Rudosol	Mixture
Sodosol	Mixture
Tenosol	Mixture
Vertosol	Smectite

Management

To minimise soil transport potential it is important to ensure that soils with high clay content are not exposed to erosive processes. Options for managing different soil textures are broadly outlined in table 12.

Table 12. Management options for mitigating impacts of soil transport potential.

Surface soil texture	Principle to minimise erosion and leaching	Examples of management principles to mitigate impact of surface soil texture
Sands	Minimise leaching of excess water and nutrients /herbicides	Considers timing of nutrient and herbicide application at all times of the year, and split application where appropriate
Loams	Maintain water balance	
Clays	Minimise erosion	Soil is not exposed during the wet season when flooding potential is greatest Grass headlands maintained Use of water treatment infrastructure to collect first flush and prevent discharge of contaminated runoff

Further information

SCAMP: A decision support system for the sustainable management of sugarcane soils.

The 'SIX EASY STEPS' program (Schroeder et al. 2005) forms the basis of best practice nutrient management in the Australian sugar industry. Use of the SIX EASY STEPS package enables the determination of appropriate nutrient inputs for individual soils based on soil chemical analyses and cropping history. The first principle of the 'SIX EASY STEPS' is 'know your soil'. The Soil Constraints and Management Package (SCAMP) complements the SIX EASY STEPS by identifying the intrinsic soil constraints to long-term sugarcane productivity, and then by indicating management practices that will minimise the impacts of these constraints on productivity and the environment.

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Fact sheet – DERM website <www.derm.qld.gov.au>

- Paddock guide to determining soil texture

8 Additional information

Common soils of Wet Topics cane growing areas (as described by the Australian Soil Classification – soil order)

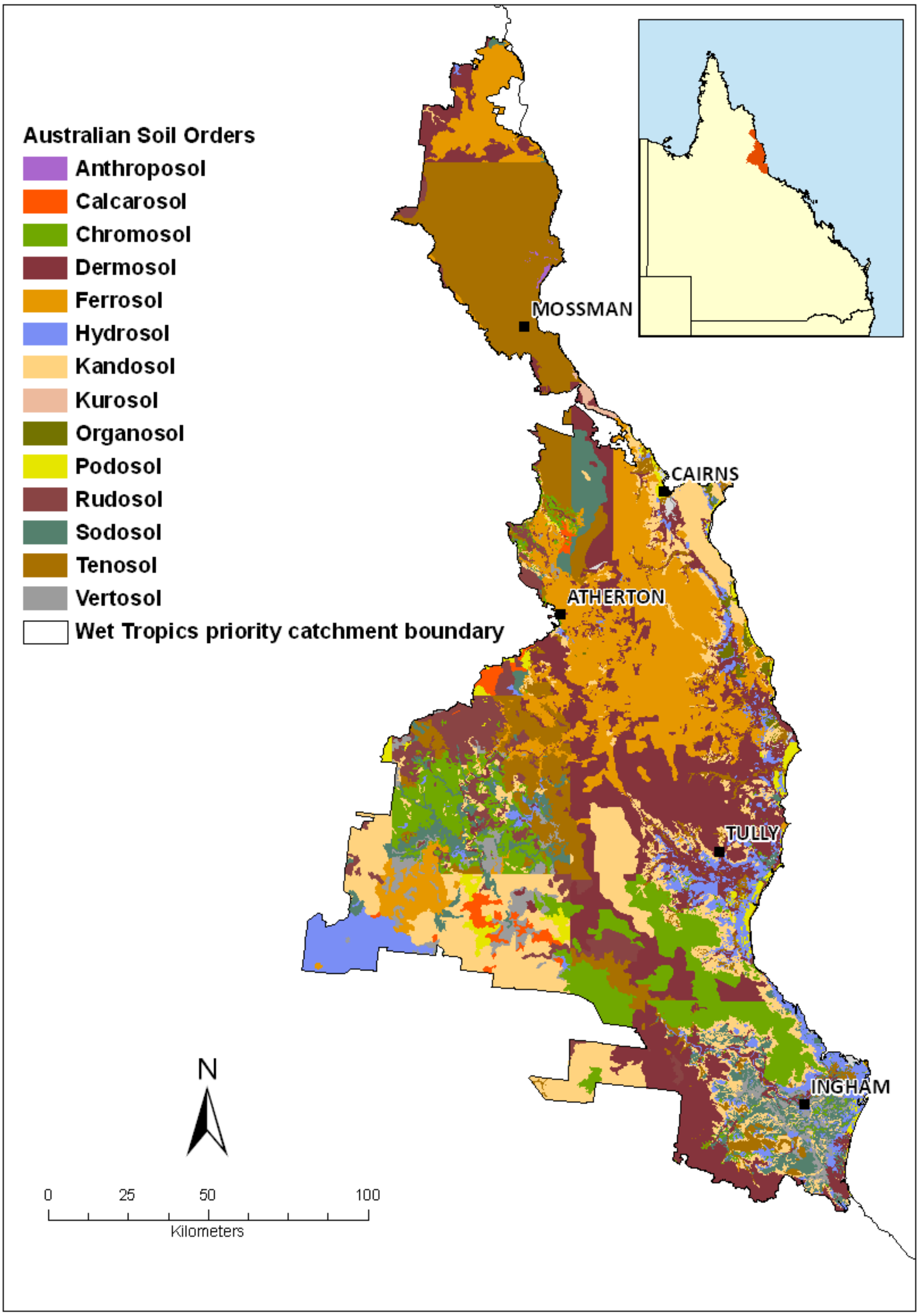


Figure 22. Soil orders across the Wet Tropics priority catchment.

Table 13. Local soil types and corresponding ASC soil orders and Great Soil Groups for cane soils in Wet Tropics.

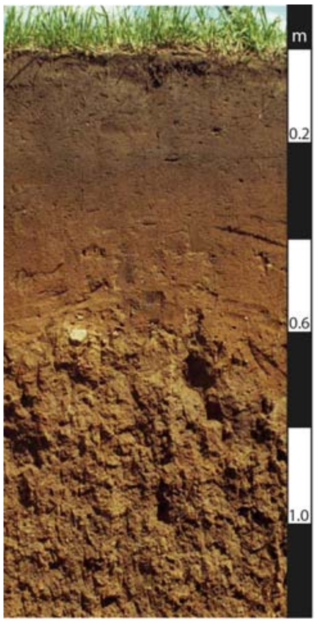
Local soil types	Soil Order (ASC)	Great Soil Group (Stace *et al.* 1968)
Abergowrie (Ag)	Kandosol	Red earth/Red podzolic soil
Alma (Am)	Kandosol	Red earth
Althaus (Al)	Sodosol	Soloth
Arnot (An)	Tenosol	Silaceous sand
Arriga (Ar)	Vertosol	Solonized solonetz/Solodic soil
Arriga Sandy (ArSy)	Dermosol	Solodic soil/Solonized solonetz
Ashton (As)	Kandosol	Yellow earth/Grey earth/Earthy sand
Aunt (At)	Tenosol	Silaceous sand/Earthy sand/Solodic soil
Babinda (Bd)	Organosol	Acid peat
Banyan (Ba)	Hydrosol	Humic gley
Bicton (Bt)	Dermosol	Xanthozem
Bingil (Bl)	Ferrosol	Krasnozem
Bluewater (Bw)	Kandosol	Red earth
Brae (Br)	Hydrosol	Humic gley
Brosnan (Br)	Kandosol	Red earth
Buchan (Bc)	Kandosol	Yellow earth
Bulgun (Bg)	Dermosol	Affinity with Gleyed podzolic soil
Bulguru (Bu)	Hydrosol	Not recorded
Byabra (Bb)	Sodosol	Solodic soil/Solonized solonetz
Cadillah (Cd)	Dermosol	Red podzolic soil
Canoe (Cn)	Kandosol	Yelow earth
Carrington (Cn)	Hydrosol	Humic gley
Cassidy (Cs)	Podosol	Podzol
Catherina (Ch)	Dermosol	Affinity with Grey clay
Clifton (Ct)	Kandosol	Yellow podzolic soil
Cobra (Cb)	Kandosol	Red earth/Red podzolic soil
Coom (Co)	Hydrosol	No suitable group
Cudmore (Cm)	Kandosol	Soloth
Dagmar (Dg)	Dermosol	Yellow podzolic soil
Daintree (Dt)	Podosol	Podzol
Daradgee (Dd)	Hydrosol	No suitable group
Dayman (Dm)	Dermosol	No suitable group
Derra - Nq (Dr)	Dermosol	No suitable group
Dingo (Do)	Ferrosol	Krasnozem
Donlen shallow phase (DlS)	Sodosol	Solodic soil
Edmonton (Et)	Dermosol	Yellow podzolic soil
Elliot (Eo)	Tenosol	Earthy sand
Emerald (Ee)	Kandosol	Red earth
Eubenangee (Eu)	Ferrosol	Krasnozem
Feluga (Fe)	Chromosol	Lateritic podzolic soil
Galmara (Ga)	Dermosol	Red podzolic soil

Garradunga (Gu)	Ferrosol	Krasnozem
Googarra (Gg)	Podosol	Silaceous sand
Goolboo (Go)	Tenosol	Silaceous sand
Gwynne (Gn)	Dermosol	Affinitiy with Xanthozem
Hamleigh (Hl)	Vertosol	Grey clay
Hawkins (Hk)	Rudosol	Alluvial soil
Herbert (Hb)	Dermosol	Brown earth
Hewitt (He)	Hydrosol	Humic gley
Hillview (Hv)	Kandosol	Red earth
Holloway (Ho)	Hydrosol	Soloth
Hull (Hu)	Podosol	Rudimentary Podzol
Ingham (Ih)	Sodosol	Affinity with Soloth/Solodic soil/Grey-Brown podzolic soil
Inlet (Il)	Hydrosol	No suitable group
Innisfail (In)	Dermosol	No suitable group
Jaffa (Jf)	Not recorded	Yellow podzolic soil
Japoon (Jp)	Rudosol	Alluvial soil
Jarra (Jr)	Dermosol	Affinity with Yellow podzolic soil
Kaygaroo (Ka)	Podosol	Podzol
Kimberley (Ki)	Ferrosol	Krasnozem
Kirrama (Km)	Kandosol	Yellow earth
Kirrima (Km)	Kandosol	Yellow earth
Kurrimine (Ku)	Podosol	Humus Podzol
Lannercost (Ln)	Sodosol	Soloth
Leach (Lh)	Hydrosol	Affinity with Grey clay
Leadingham (Ld)	Sodosol	Solodic soil/soloth
Lee (Le)	Kandosol	Grey earth
Liverpool (Li)	Tenosol	No suitable group
Lucy (Lc)	Kandosol	Red earth/Yellow earth
Lugger (Lu)	Hydrosol	Grey earth
Macknade (Mk)	Tenosol	Alluvial soil
Malbon (Mb)	Kandosol	Affinity with Yellow earth
Mandam (Md)	Hydrosol	Humic gley
Manor (Mn)	Sodosol	Affinity with Soloth
Maria (Ma)	Kandosol	No suitable group/Yellow earth
Masterton (Mt)	Tenosol	Lithosol
Midgenoo (Mi)	Dermosol	No suitable group
Midway (Mw)	Dermosol	Yellow podzolic soil
Mirriwinni (Mr)	Not recorded	Not recorded
Mission (Ms)	Kandosol	Red earth
Molonga (Ml)	Vertosol	Grey clay
Morgan (Mg)	Vertosol	Black earth/Grey clay/Brown clay
Morganbury (Mb)	Kandosol	Red earth/Red podzolic soil
Mossman (Mm)	Dermosol	No suitable group
Mulligan (Ml)	Chromosol	Yellow podzolic soil
Mundoo (Mu)	Ferrosol	Krasnozem

Murphy (Mp)	Chromosol	Gleyed podzolic soil
Narcotic (Nc)	Chromosol	Gleyed podzolic soil
Needep (Ne)	Hydrosol	Peaty podzol
Newell (Nl)	Not recorded	Humic gley
Nicotine (No)	Tenosol	Silaceous sand/Earthy sand
Nind (Nd)	Organosol	Not recorded
Nullinga (Nl)	Chromosol	Yellow podzolic soil/Yellow earth
Orient (Or)	Sodosol	Soloth
Palm (Pl)	Chromosol	Non calcic brown soil/Red podzolic soil
Pawngilly (Py)	Not recorded	Not recorded
Penman (Pm)	Dermosol	Soloth/Solodic soil
Pin Gin (Pg)	Ferrosol	Krasnozem
Ponzo (Po)	Not recorded	Soloth
Poplar (Pl)	Dermosol	Grey clay
Porter (Pt)	Sodosol	Soloth
Price (Pi)	Rudosol	Alluvial soil
Prior (Pr)	Kandosol	Gleyed podzolic soil
Ramleh (Ra)	Dermosol	Affinity with Yellow podzolic soil
Ray (Ry)	Dermosol	Grey clay
Ripple (Rp)	Hydrosol	Soloth
Rumula (Ru)	Dermosol	Soloth
Rungoo (Rg)	Chromosol	Soloth
Silkwood (Si)	Kandosol	Red earth
Spanos (Sp)	Tenosol	Earthy sand
Stone (Sn)	Vertosol	Black earth
Sumalee (Sl)	Organosol	Acid peat
Sylvia (Sy)	Chromosol	Soloth
Tawalla (Ta)	Rudosol	Silaceous sand
Thorpe (Th)	Kandosol	Yellow earth
Timara (Ti)	Hydrosol	Affinity with Gleyed podzolic soil
Tinkle (Tk)	Tenosol	Earthy sand
Tolga (To)	Ferrosol	Euchrozem
Toobanna (Tb)	Sodosol	Soloth/Solodic soil/Solodized solonetz
Trebonne (Tr)	Kandosol	Grey earth/Yellow earth
Tully (Tu)	Dermosol	No suitable group
Tyson (Ty)	Kandosol	Red earth
Uncle Shallow Phase (UcS)	Not recorded	Not recorded
Utchee (Ut)	Kandosol	No suitable group
Virgil (Vi)	Kandosol	Red earth
Walkamin (Wk)	Ferrosol	Xanthozem
Walsh (Ws)	Kandosol	Red earth/Brown earth/Red podzolic soil
Warrami (Wm)	Dermosol	No suitable group
Weatherby (We)	Kurosol	Soloth
Whelan (Wh)	Tenosol	Lithosol
Whitfield (Wf)	Tenosol	No suitable group

Wongabel (Wg)	Kandosol	Affinity with Yellow earth
Yuruga (Yr)	Sodosol	Solodic soil

Chromosol

Brief description	Chromosols have a distinct texture-contrast between the surface and subsoil. Chromosols have sandy or loamy surface soils overlying a yellow, brown, red-brown or sometimes black clay subsoil, which is generally neutral to alkaline. In contrast to Sodosols, the subsoil is not sodic (see glossary), at least in the upper section.	
Agricultural implications	Where there is adequate rainfall these soils constitute important grain producing areas, particularly on lower slopes. They are generally used for sown pastures on moderate slopes and native pastures on drier or steeper slopes. Chromosols have a reasonable agricultural potential with moderate fertility and water-holding capacity. They can be susceptible to soil acidification and soil structure decline and may experience poor local drainage.	
Percentage of cane soils in Wet Tropics ~ 4%		

Local soil types:

Feluga (Fe), Mulligan (Ml), Murphy Mp), Narcotic (Nc), Nulliga (Nl), Palm (Pl), Rungoo (Rg), Sylvia (Sy)

Dermosol

Brief description	Dermosols are a diverse group of soils with loam to clay textures that may be of varied red, brown, yellow, grey or black coloured. They have structured subsoils. This soil order mainly occurs throughout the higher rainfall coastal and sub-coastal regions of Queensland.	
Agricultural implications	Dermosols are commonly quite fertile and, in the drier sub-coastal areas, used for intensive horticulture. Dermosols generally have high agricultural potential with good structure and moderate to high fertility and water-holding capacity, and are generally well drained.	
Percentage of cane soils in Wet Tropics ~36%		

Local soil types:

Arringa Sandy (ArSy), Bicton (Bt), Bulgun (Bg), Cadillah (Cd), Catherina (Ch), Dayman (Dm), Dagmar (Dg), Derra – NQ (Dr), Edmonton (Et), Galmara (Ga), Gwynne (Gn), Herbert (Hb), Innisfail (In), Jarra (Jr) , Midgernoo (Mi), Midway (Mw), Mossman (Mm), Penman (Pm), Poplar (Pl), Ramleh (Ra), Ray (Ry), Tully (Tu), Warrami (Wm)

Ferrosol

Brief description	Ferrosols do not have a strong texture-contrast between the surface and subsoil. They are well drained soils with clay-loam to clay textures throughout the surface and subsoil. They are high in iron and can be red or yellow coloured and are generally well structured.
Agricultural implications	Good structure with moderate to high fertility and water-holding capacity. Prone to compaction and nutrient leaching and in high rainfall areas they may suffer from acidification. Ferrosols also have a high phosphorus fixing capacity which affects the application of fertilisers.

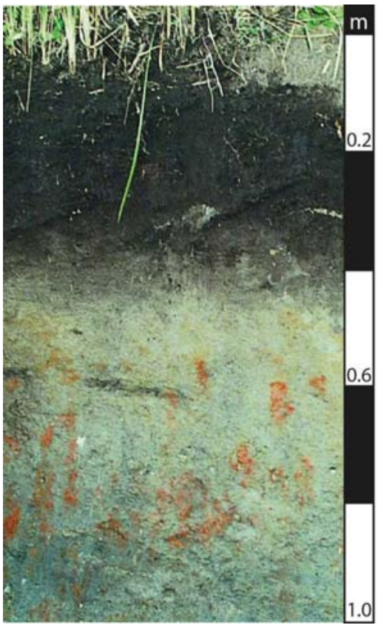
Percentage of cane soils in Wet Tropics ~ 6%

Local soil types:

Bingil (Bl), Dingo (Do), Eubeneangee (Eu), Garradunga (Gu), Kimberly (Ki), Mundoo (Mu), Pin Gin (Pg), Tolga (To), Walkamin (Wk),

Hydrosol

Brief description	Hydrosols are soils that are saturated with water for long periods of time (for at least 2-3 months). They are typically grey (or greenish-grey) in colour with strong yellow, brown, orange or red mottling. Hydrosols can vary in texture.
Agricultural implications	This soil type is mainly found in coastal areas however, many inland wetlands are dominated by Hydrosols even though these areas may only be intermittently inundated. Saturation by a water table may not necessarily be caused by low soil permeability. Often site drainage will be the most important factor, while in other cases tidal influence is dominant.

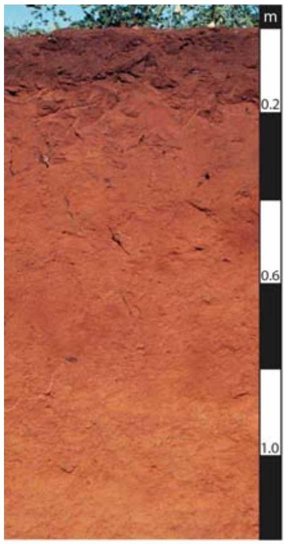


Percentage of cane soils in Wet Tropics ~ 25%

Local soil types:

Banyan (Ba), Brae(Br), Bulguru (Bu), Carrington (Cn), Coom (Co), Daradgee (Dd), Hewitt (He), Holloway (Ho), Inlet (Il), Leach (Lh), Lugger (Lu), Mandam (Md), Needep (Ne), Ripple (Rp), Timara (Ti)

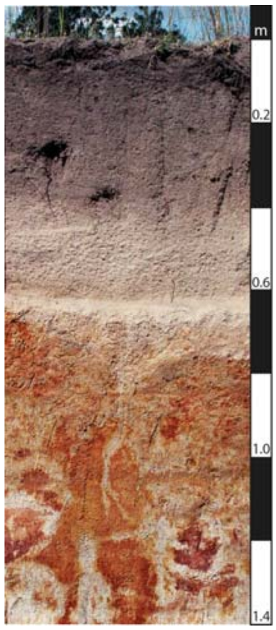
Kandosol

Brief description	Kandosols are porous sand to loamy soils that may be red, yellow or grey. They have unstructured subsoils, (and are also known as massive earths) and usually have a gradational increase in clay content with depth.	
Agricultural implications	They generally have low fertility and low water-holding capacity, however physical properties are favourable for plant growth. A wide range of crops can be grown on these soils where rainfall is higher or where irrigation is available. Generally, Kandosols have a low to moderate agricultural potential and land use is more suited to the grazing of native pastures.	
Percentage of cane soils in Wet Tropics ~12%		

Local soil types:

Abergowrie (Ag), Alma (Am), Ashton (As), Bluewater (Bw), Brosnan(Br), Buchan (Bc), Canoe (Cn), Clifton (Ct), Cobra (Cb), Cudmore (Cm) Ererald (Ee), Hill view (Hv), Kirrama (Km), Lee (Le), Lucy (Lc), Malbon (Mb), Maria (Ma), Mission (Ms), Morganbury (Mb), Prior (Pr), Silkwood (Si), Thorpe (Th), Tirrabella (Tb), Trebonne (Tr), Tyson (Ty), Utchee (Ut), Virgil (Vi), Walsh (Ws), Wongabel (Wg)

Kurosol

Brief description	Kurosols are texture-contrast soils with a strongly acidic subsoil. The sub-soil is generally moderately permeable and may vary in colour from red, in well-drained situations, to yellow and mottled-grey in poorly drained areas.	
Agricultural implications	They generally have lower agricultural potential because of their acidic sub-soil (pH < 5.5) and lower fertility and reduced water-holding capacity. However the physical characteristics of a Kurosol are often satisfactory for plant growth. Primary uses are grazing, in steeper drier areas, and cane, horticulture and softwood forests elsewhere.	
Percentage of cane soils in Wet Tropics ~ less than 1%		

Local soil types:

Weatherby (We)

Organosol

Brief description	Organosols occur in wetland areas along the coast in high-rainfall zones. Organosols are rich in peat and other humus rich layers. Areas of these soils are quite small.	NO PHOTO AVAILABLE
Agricultural implications	Often site drainage will be the most important factor.	

Percentage of cane soil in Wet Tropics ~ less than 1%

Local soil types:

Babinda (Ba), Nind (Nd), Sumalee(Sl)

Podosol

Brief description	Podosols occur in the more humid coastal regions where annual rainfall is greater than about 700 mm. The subsoil of a Podosol is dominated by compounds of organic materials, aluminium and/or iron and may contain an irregular dark pan called 'coffee rock'. Podosols are uniform textured soils of loamy sand to sand, which are usually very permeable unless continuous hard setting pans are present in the subsoil.
Agricultural implications	Generally, Podosols have little agricultural potential with very low fertility and water-holding capacity. They are also susceptible to wind erosion if vegetation is removed. Groundwater contamination may be a problem due to the high permeability of these soils.

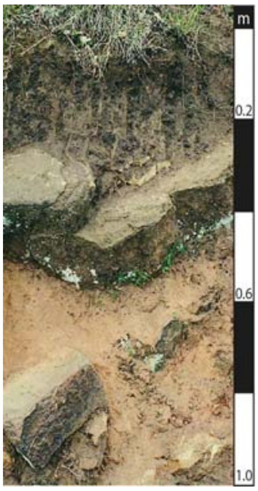
Percentage of cane soils in Wet Tropics ~ less than 1%

Local soil types:

Cassidy (Cs), Daintree (Dt), Googarra (Gg), Hull (Hu), Kaygaroo (Ka), Kurrimine (Ku)

Rudosol

Brief description	Rudosols have virtually no soil profile development apart from the slight accumulation of organic matter at the surface. They are usually young soils in the sense that soil forming factors have had very little time to modify the parent materials. They are commonly found adjacent to watercourses where flooding is frequent.
Agricultural implications	Rudosols are usually sandy and may also be shallow and stony.



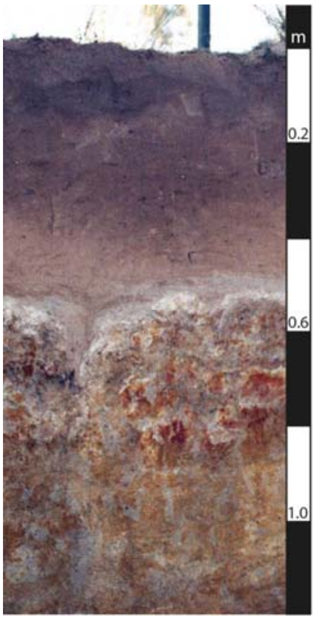
Percentage of cane soils in the Wet Tropics ~ less than 1%

Local soil types:

Hawkins (Hk), Japoon (Jp), Price (Pi), Tawalla (Ta)

Sodosol

Brief description	Sodosols are texture-contrast soils (also known as duplex soils) with sodic (see glossary), low permeability subsoils. The sodic subsoil is dispersible and prone to gully erosion if exposed to the surface or tunnel erosion if drainage conditions are altered. Most Sodosols have hardsetting surfaces that reduce infiltration. Seasonal perched water tables are common.
Agricultural implications	Sodosols generally have low fertility and are susceptible to erosion and dryland salinity if vegetation is removed. The key to managing these soils is reducing disturbance and being aware of how thick the protective surface soil is. These soils are more suited to grazing of native or improved pastures but are used for both dryland and irrigated agriculture, though they commonly experience poor drainage.



Percentage of cane soils in Wet Tropics ~ 2%

Local soil types:

Althaus (Al), Byabra (Bb), Donlen (Dl), Ingham (Ih), Lannercost (Ln), Leadingham (Ld), Manor (Mn), Orient (Or), Porter (Pt), Toobanna (Tb), Yuruga (Yr)

Tenosol

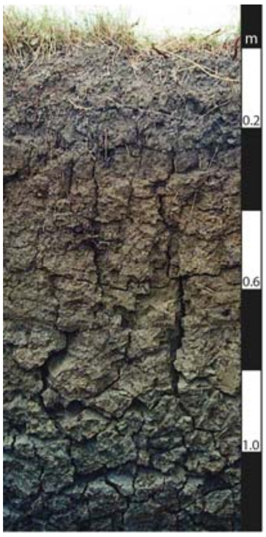
Brief description	Tenosols have weakly developed soil profiles (that show very little change with depth). The group includes deep sands and shallow stony soils.
Agricultural implications	Tenosols generally have lower agricultural potential due to very low fertility, poor structure and low water-holding capacity. Hence these soils are more suited to grazing of native pastures. Ground-water contamination can be a potential problem due to the high permeability of these soils. Some of the deep sands have agricultural potential if groundwater is at a depth that crop roots can access without being waterlogged.

Percentage of cane soils in Wet Tropics ~ 9%

Local soil types:

Arnot (An), Aunt (At), Elliot (Eo), Goolboo (Go), Liverpool (Li), Macknade (Mk), Masterton (Mt), Nicotine (No), Spanos (Sp), Tinkle (Tk), Whelan (Wh), Whitfield (Wh)

Vertosol



Brief description	Vertosols are cracking clay soils. By definition they must have a clay content of at least 35% throughout the whole profile. Vertosols are divided into subgroups based on colour (e.g. black, grey, brown) and/or wetness. They sometimes have a hummocky microrelief called gilgai, and many have a loose crumb like surface (known as a 'self-mulch'). They are the most common soil type in Queensland.
Agricultural implications	A moderate to high fertility and high water-holding capacity. Heavy clays can be difficult to cultivate especially when they are wet. Vertosols are extensively used for dryland agriculture but are also irrigated for a variety of crops such as cane and cotton. Vertosols feature significantly in the grazing areas of Queensland

Percentage of cane soils in Wet Tropics ~ 6%

Local soil types:

Arriga (Ar), Hamleigh (Hl), Molonga (Ml), Morgan (Mg), Stone (Sn)

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Appendix 1 – Land resource surveys in the Wet Tropics

The land resources surveys used to assess environmental characteristics in the Wet Tropics are listed below.

Land resource reports can be viewed and downloaded through:

- the DERM library catalogue at: <www.derm.qld.gov.au/library/index.html>
- the Queensland Digital Exploration Reports system (QDEX) at: <www.dme.qld.gov.au/mines/company_exploration_reports.cfm>

or be requested through <productdelivery@derm.qld.gov.au>

- Soils of the Babinda Cairns Area
- Cardwell Innisfail Land Suitability study
- Soils of the Cape York Peninsula
- An assessment of the agricultural potential of soils in the Gulf region
- Soils of the Mareeba – Dimbulah Irrigation Area
- Agricultural Land Suitability of the Wet Tropical coast, Mossman – Julatten area
- Land resources of the Ravenshoe-Mt Garnet area
- Land resources of the Einasleigh – Atherton dry tropics
- Soils and Agricultural Land Suitability of the Atherton Tablelands, North Queensland
- Soils and Agricultural Land Suitability of the Wet Tropical coast of North Queensland – Ingham Area
- CSIRO Burdekin Townsville region – soils
- CSIRO General report on lands of the Leichhardt- Gilbert Area
- CSIRO Lands of the Mitchell Normanby Area
- CSIRO ATLAS of Australian Soils