Identification of Potential Land for Long-term Sustainable Food Production

Stage 1: Identification of Soil and Water Resources

September 2011

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This report is to be cited as:


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1. INTRODUCTION

This report was compiled in response to the Territory 2030 Strategy, specifically the target identify suitable land and water for further long-term and sustainable food production (Economic Sustainability - Objective 3: Growing local industry). The information integrates soil and water resources with commodity requirements to identify areas with potential for development.

While many similar studies have been conducted, none have integrated existing data on soil and water resources with climate conditions such as rainfall and agronomic information such as growing period. Similar studies, such as that undertaken by the Northern Australia Land and Water Taskforce, investigated the potential for agriculture but did not consider multiple parameters.

This report integrates soil and land resource information together with rainfall, groundwater availability and climatic and agronomic conditions. It was a desktop GIS analysis of existing land, water and climate data with expert input from local agronomists, soil landscape scientists and hydro geologists. It does not consider other additional limiting factors such as land tenure, Native Title, accessibility by road or rail, skilled workers/employment, travel time from centres such as the 20 Territory Growth Towns and other anthropological factors. These factors would need to be examined at a later stage, once areas with potential have been identified.

The study used a combination of different methodologies to determine areas suitable for different types of food production. While some of these data, such as rainfall averages, has appeared to fit well with the knowledge of local agronomists and past trials, some have not. In such cases both methodologies have been presented in the Discussion.

The land system information used is broad scale and intended for Northern Territory wide and regional assessments and is not appropriate for detailed planning. These broad land system datasets essentially highlights those areas where more detailed information is required. In some instances, more detailed information is available but in other areas, broad scale information is all that is currently available.

The land assessment is based on two different spatial datasets. In the northern part of the Northern Territory, the assessment is based on 1:250,000 land system information. In the central and southern areas, the assessment is based on 1:1,000,000 information. The extent of these datasets is presented on Figure 1.

Groundwater assessment is based on 1:2,000,000 water resource information across the entire NT.

Figure 1. The extent of the two land system spatial datasets across the Northern Territory.
2. DATA REQUIREMENTS

2.1 Crop Types and Resource Requirements

Consideration of crop types and their resource requirements were discussed at a workshop held between officers of the Department of Resources (DoR) and Department of Natural Resources, Environment, The Arts and Sports (DNRETAS). Discussions focused on the climatic, water and soil requirements for a number of crop types. These requirements formed the basis for the analysis of soil and water resource data held by DNRETAS, as well as Climate Average data obtained from the Bureau of Meteorology (BoM).

The methodology can be described as determining the spatial extents of water, soils and landform suitability for each crop type independently and then intersecting them, to highlight where climatic, water and soil-landscape characteristics match crop requirements. Agreed classes of crop type requirements are presented in Table 1.

Some aspects of crop requirements were difficult to assess due to the lack of available data. In these instances a surrogate was utilised. These instances included ground water salinity, aquifer sustainability and aspects of land system information in the southern region. An example of this is the absence of detailed soil information in the land systems of the southern region. Landform information was used as a surrogate to inform the suitability of land for improved pasture.

The red text in Table 1 indicates where a surrogate has been used in the absence of detailed information.
<table>
<thead>
<tr>
<th>Resource Criteria:</th>
<th>Irrigated (ML/ha/yr)</th>
<th>Rainfall (mm per month) for dry land Ag</th>
<th>Growing period in months</th>
<th>WATER</th>
<th>SOIL</th>
<th>LANDFORM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Depth</td>
<td>pH</td>
<td>Rock Outcrop</td>
</tr>
<tr>
<td>Dataset Source:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BoM - Average Monthly Rainfall</td>
<td>DNRETAS - Land Systems of the Northern Part of the NT (1:250,000)</td>
<td>DNRETAS - Land Systems of the Southern Part of the NT (1:1,000,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table:</td>
<td>NT North Idealised Soils</td>
<td>Descriptors NAAg</td>
<td>Dataset Source:</td>
<td>Water</td>
<td>Soil</td>
<td>Landform</td>
</tr>
<tr>
<td>Attribute Field:</td>
<td>Depth ACP Impede</td>
<td>pH and depth</td>
<td>Rock Outcrop</td>
<td>Slope Class</td>
<td>Site Drainage</td>
<td>Horticulture Rating</td>
</tr>
<tr>
<td>Classes:</td>
<td>data m</td>
<td>data %</td>
<td>data %</td>
<td>&gt;= 5</td>
<td>1-10</td>
<td></td>
</tr>
<tr>
<td>Crop Type:</td>
<td>120mm+ (total over 4 months)</td>
<td>1 thru 5</td>
<td>4</td>
<td>Exclude Unsuitable Landforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Native pastures</td>
<td>4</td>
<td>40cm+</td>
<td>4.5 - 7.5</td>
<td>&lt; 2%</td>
<td>2</td>
<td>6+</td>
</tr>
<tr>
<td>2. Improved pastures</td>
<td>85+ (each month)</td>
<td>4</td>
<td>90cm+</td>
<td>4.5 - 8.0</td>
<td>&lt;=10%</td>
<td>&lt;= 2%</td>
</tr>
<tr>
<td>3. Field Crops (rain fed)</td>
<td>Dec 130-210 mm, Jan 165 - 292mm, Feb 177 - 305mm, Mar 125 - 235mm</td>
<td>4</td>
<td>90cm+</td>
<td>4.5 - 8.0</td>
<td>&lt;=10%</td>
<td>&lt;= 2%</td>
</tr>
<tr>
<td>4. Field Crops (Irrigated)</td>
<td>8+</td>
<td>6</td>
<td>90cm+</td>
<td>4.5 - 8.0</td>
<td>&lt;=10%</td>
<td>&lt;= 2%</td>
</tr>
<tr>
<td>5. Forage crops</td>
<td>Dec 130-210 mm, Jan 165 - 292mm, Feb 177 - 305mm, Mar 125 - 235mm</td>
<td>4</td>
<td>90cm+</td>
<td>4.5 - 8.0</td>
<td>&lt;=10%</td>
<td>&lt;= 2%</td>
</tr>
<tr>
<td>6. Hort annual crop</td>
<td>3 - 5+</td>
<td>1.5 - 7</td>
<td>40cm+</td>
<td>4.5 - 8.0</td>
<td>&lt;=10%</td>
<td>&lt;= 2%</td>
</tr>
<tr>
<td>7. Hort perennial crops</td>
<td>3 - 20+</td>
<td>12</td>
<td>90cm+</td>
<td>4.5 - 8.0</td>
<td>&lt;=10%</td>
<td>&lt;= 2%</td>
</tr>
</tbody>
</table>

Table 1 - Crop requirements and sources of data following consultation with agronomists and soil landscape scientists
3. METHODOLOGY

3.1 Rainfall

Bureau of Meteorology (BoM) Gridded Mean Monthly Rainfall, based on a 30 year period from 1961 to 1990, was used to determine areas in the NT where rainfall characteristics over the prescribed growing period met the crop requirements. The preliminary products generated are illustrated in Maps 1-3. These maps show major regional centres and the 20 Territory Growth Towns.

Map 1

Native pasture requires a total rainfall of 120mm or more over a 4 month period. GIS analysis was used to determine these areas by summing the average monthly rainfall from December to March. The results were reviewed by DoR pastoral agronomists familiar with the various pastoral regions.

Map 2

Improved pasture requires in excess of 85mm rainfall in each month for the growing period, December to March. This is a different approach to native pastures where total rainfall over the growing period was used.

Map 3

Field Crops (rain fed) and Forage Crops used a different method to establish the areas where rainfall would be suitable. There are lower as well as upper limits to the amount of rainfall required. The reason for the upper limit is, it is known that these crops will grow in conditions with much higher rainfall however, it is not normally viable to harvest them due to issues such as mould affecting grain quality and yield. In addition, it was determined that during the four month growing period the crop had different requirements for crop preparation, establishment (tilling, sowing etc), growing and harvesting.
Map 1  Rainfall Requirements for Native Pasture

Areas in the NT where rainfall in Dec, Jan, Feb and Mar totals 120mm or more.

Data Source: Mean monthly and mean annual rainfall data (c) Bureau of Meteorology Roads, Rail, Parcels, Towns: Dept Lands and Planning (c) Northern Territory of Australia

Major Towns
Territory 20 Growth Towns
Rainfall Dec to Mar exceeds 120mm
Rainfall Dec to Mar 79mm - <120mm
Map 2  Rainfall Requirements for Improved Pasture

Areas in the NT where rainfall in Dec, Jan, Feb and Mar exceeds 85mm in each month.

Map showing rainfall requirements for improved pasture areas in the Northern Territory, with data from the Bureau of Meteorology and the Northern Territory Department of Lands and Planning.
Map 3  Rainfall Requirements for Field Crops (Rain Fed) and Forage Crops

Areas in the NT where monthly rainfall averages are: Dec 130-210mm, Jan 165-292mm, Feb 177-305mm, Mar 125-235mm.

Data Source: Mean monthly and mean annual rainfall data (c) Bureau of Meteorology
Roads, Rail, Parcels, Towns: Dept Lands and Planning (c) Northern Territory of Australia

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production, Stage 1: Identification of Soil and Water Resources

Identification of Potential Land for Long-term Sustainable Food Production
Stage 1: Identification of Soil and Water Resources
3.2 Groundwater

Crop irrigation requirements posed a more complex issue. Table 1 states the irrigation requirements in terms of mega litres per hectare per year, however DNRETAS does not have such a dataset. Data used specifically for the purpose of this study was derived from Northern Territory Aquifers, a 1:2,000,000 dataset (Tickell, 2009). Specifically, the attribute Actual Yield Category was reclassified into four classes; shown in Table 2. A map showing the preliminary product generated is presented in Map 4.

<table>
<thead>
<tr>
<th>Actual Yield Category</th>
<th>Irrigation Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05-0.5 L/s</td>
<td>Nil Possibility of Irrigation</td>
</tr>
<tr>
<td>0.5-2.5 L/s and 0.5-5.0 L/s</td>
<td>Limited or Localised Irrigation</td>
</tr>
<tr>
<td>5.0-10.0 L/s</td>
<td>Small Scale Irrigation</td>
</tr>
<tr>
<td>5.0-50.0 L/s</td>
<td>Broad Scale Irrigation</td>
</tr>
</tbody>
</table>

**Table 2:** Reclassification of NT Aquifers dataset into Irrigation Potential

Map 4

Irrigation Potential was used as a substitute for ML/ha/yr to indicate only where there may be potential for irrigation. Growing period was not used in conjunction with Irrigation Potential as irrigation could occur at any time of the year, unlike rainfall which had to be reliable for a continuous growing period.
Map 4  Irrigation Potential – Groundwater resources not including soil

(C) Northern Territory of Australia
This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source: NT Aquifers 1:2,000,000
DNRETAS (c) Northern Territory of Australia
Roads, Rail, Parcels, Towns: Dept Lands and Planning (c) Northern Territory of Australia

Identification of Potential Land for Long-term Sustainable Food Production
Stage 1: Identification of Soil and Water Resources
3.3 Soil

Crop requirements, with regard to soil-landscape conditions, were the basis for interrogation of the spatial dataset *Land Systems of the Northern Part of the NT* for field crops, improved pasture and annual horticulture. For analysis purposes these were termed Soils Case 1, 2 and 3.

Table 3 below is a subset of the information presented in Table 1, summarising crop requirements for soil cases 1-3.

<table>
<thead>
<tr>
<th>Soil Case</th>
<th>Land Use</th>
<th>Soil Depth (cm)</th>
<th>Soil pH</th>
<th>Rock (%)</th>
<th>Slope (%)</th>
<th>Drainage (NCST, 2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Case 1</td>
<td>Field Crops</td>
<td>&gt;90</td>
<td>4.5-8.0</td>
<td>&lt;=10</td>
<td>&lt;=2</td>
<td>Well</td>
</tr>
<tr>
<td>Soil Case 2</td>
<td>Improved Pastures</td>
<td>&gt;40</td>
<td>4.5-7.5</td>
<td>-</td>
<td>&lt;2</td>
<td>-</td>
</tr>
<tr>
<td>Soil Case 3</td>
<td>Annual Horticulture</td>
<td>&gt;40</td>
<td>4.5-8.0</td>
<td>&lt;=10</td>
<td>&lt;=2</td>
<td>Well</td>
</tr>
</tbody>
</table>

*Table 3: Soil-landscape requirements for Field Crops, Improved Pasture and Annual Horticulture.*

The *Land Systems of the Northern Part of the Northern Territory* is a complex dataset consisting of a spatial layer with two related tables. One of the related tables formed the basis of the Northern Territory’s contribution to Land and Soil Resources in Northern Australia, CSIRO 2009, which is known within DNRETAS as Descriptors NAAg (Northern Australia Agriculture). The relationship between the tables and the spatial data is shown in Diagram 1.

![Diagram 1: Entity Relationship Diagram - Land Systems of the Northern Part of the NT](image)

The Idealised Soils Table contained several soil property fields, some of which were used for the analysis, however for soil pH, the available pre-classified field did not contain the pH range required (4.5 to 8), and so idealised soils were classified from Layer pH (or Horizon pH) and thickness. This process was significant in that appropriate soil pH was deemed to be 4.5 to 8 for every horizon present within the first 40cm of soil depth. The horizon thickness for each Idealised Soil vary greatly and so the method for classifying which Idealised Soils were suitable was scrutinised in a spreadsheet, and then taken back into GIS to match with the remaining soil characteristic, Depth to Impedance.

The selection of suitable Idealised Soils was then used to select corresponding records from the Descriptors NAAg table. Descriptors NAAg also contains data on Rock Outcrop, Slope, Drainage and the proportion of each Idealised Soil found within each Land System. The original selection from Idealised soils was then narrowed down to match the criteria required from Descriptors NAAg for each of the three Soils Cases described above. A summary table of the total proportion of the Land System suitable for Agriculture was calculated, so that the Land Systems could be mapped thematically by the amount of suitable soils likely to be available.
Map 5

Soils Case 1 was used for Field crops (both irrigated and rain fed), Forage Crops and Horticultural Perennials.

Whilst Soils Case 2 was intended for use in Improved Pastures, it was removed from analysis in favour of the use of Landform classes (see 3.4 Landform) which was also used for Native Pastures. Landform classes were not intersected with soils, as soils are essentially a subset of landform class.

Map 6

Soils Case 3 was used for Horticultural Annuals.

The use of these Soils Cases was only appropriate in the northern part of the NT where DNRETAS has readily available data and proportions of soils within Land Systems.

Map 7

Unlike the northern land system spatial dataset, the southern land systems currently does not contain detailed soil information as an attribute. A Horticultural Rating was allocated to each land system based on soil and landform descriptions in the original land system descriptions. Horticultural Ratings from Land Systems of the Southern Part of the NT were used for Irrigated Field Crops, and Horticultural Annuals and Perennials.

Criteria used to define Horticulture Rating 8+ is described in Table 1.
Map 5  Soils Case 1 – Northern Region: Soils suitable for Field Crops (rain fed and irrigated), Forage Crops and Perennial Horticulture

Major Towns

Territory 20 Growth Towns

Boundary extent of Northern Land System mapping (scale 1:250,000)

Suitable Soils
Proportion of Land System

- 1-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Suitable soils criteria (Case 1):
- Rock outcrop <=10%
- Depth >=90cm
- pH 4.5 - 8.0
- Slope <=2%
- Well Drained

Data Source: Land Systems of the Northern Part of the NT (Scale 1:250,000) DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

This map must be read in conjunction with the report: Identification of Potential Land for long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Northern Territory Government
(C) Northern Territory of Australia
Map 6  Soils Case 3 – Northern Region: Soils suitable for Annual Horticulture

Map showing suitable soils in the Northern Region. The map includes major towns such as Darwin, Katherine, and Umbakumba, and highlights suitable soils with proportions of land system:

- 1-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Suitable soils criteria (Case 3):
- Rock outcrop <=10%
- Depth >=90cm
- pH 4.5 - 8.0
- Slope <=2%

Data Source: Land Systems of the Northern Part of the NT (Scale 1:250,000) DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources
Map 7  Southern Region: Soils suitable for Horticulture

Data Source:
Land Systems Southern Part NT 1:1,000,000
DNRETAS (c) Northern Territory of Australia
Roads, Rail, Parcels, Towns: Dept Lands and Planning (c) Northern Territory of Australia

This map must be read in conjunction with the report:
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources
3.4 Landform

Map 8

Both Native and Improved Pasture suitability was determined using Landform information. Landform classes were available in both the Land Systems of the Northern Part of the NT and Land Systems of the Southern Part of the NT. These were used for consistency in analysis. Landform classes were reclassified into two values; Suitable and Unsuitable.

<table>
<thead>
<tr>
<th>Suitable Landform Classes</th>
<th>Unsuitable Landform Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial floodplains</td>
<td>Basalt hills</td>
</tr>
<tr>
<td>Basalt plains and rises</td>
<td>Coastal dunes</td>
</tr>
<tr>
<td>Clay plains</td>
<td>Desert dunefields</td>
</tr>
<tr>
<td>Coastal floodplains</td>
<td>Granite hills</td>
</tr>
<tr>
<td>Desert sandplains</td>
<td>Granite ranges</td>
</tr>
<tr>
<td>Elevated plateaux surfaces</td>
<td>Lateritic plateaux</td>
</tr>
<tr>
<td>Granite plains and rises</td>
<td>Limestone hills</td>
</tr>
<tr>
<td>Lateritic plains</td>
<td>Rugged quartz sandstone plateaux and hills</td>
</tr>
<tr>
<td>Limestone plains and rises</td>
<td>Salt pans</td>
</tr>
<tr>
<td>Sandstone plains and rises</td>
<td>Sandstone hills</td>
</tr>
<tr>
<td></td>
<td>Sandstone ranges</td>
</tr>
<tr>
<td></td>
<td>Tidal flats</td>
</tr>
</tbody>
</table>

Table 4 – Suitable and Unsuitable Landform Classes for Native and Improved Pasture
Identification of Potential Land for Long-term Sustainable Food Production
Stage 1: Identification of Soil and Water Resources

Map 8  Suitable Landform for Native and Improved Pasture

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources.
3.5 Intersection of Rainfall, Soil and Groundwater Information

Map 9

Areas suitable for Rain Fed Field and Forage crops were determined by intersecting the corresponding rainfall suitability and also Soils Case 1. Southern region data was not used as the footprint of suitable rainfall for Rain Fed Field and Forage crops excluded all areas in the southern region. Maps are coloured thematically depicting the proportion of the Land System with suitable soils and rainfall suitability.

Similarly, the method of intersecting rainfall and suitable landform, soils (both Northern and Southern) and irrigation potential were intersected to produce maps for Irrigated Field Crops, Perennial Horticulture and Annual Horticultural.
Map 9  Northern Region: Rainfall and Soil Suitability Overlay

Suitable rainfall criteria:
Monthly rainfall averages
Dec: 130 - 210mm
Jan: 165 - 292mm
Feb: 177 - 305mm
Mar: 125 - 235mm

Suitable Soils
Proportion of Land System
1-20% 20-40% 40-60% 60-80% 80-100%

Suitable Soils Criteria (Case 1):
Rock outcrop <=10%
Depth >=90cm
pH 4.5 - 8.0
Slope <=2%
Well Drained

Data Source:
Land Systems Northern Part NT (Scale 1:250,000) DNRETAS
Roads, Rail, Parcels, Towns: Dept Lands Planning
(c) Northern Territory of Australia
Mean monthly and mean annual rainfall data
(c) Bureau of Meteorology

Northern Territory Government

This map must be read in conjunction with the report:
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources
3.6 Transeau Ratio

The use of Monthly and Cumulative Transeau Ratios based on Williams et al. (1985) was trialled as a potential index for the classification of climate. The Transeau was defined as \( r/e^{0.75} \) in which \( r \) and \( e \) are mean monthly rainfall and evaporation respectively. Preliminary analysis of BoM average climate data produced some interesting maps, however the results were unexpected and did not fit well with documented ratios expected for Darwin, Katherine and Daly Waters, which were also documented in the same publication by Munchow et al.

Subsequent investigation into the Transeau Ratio revealed there were two slightly different methods for calculating Transeau ratios, the other being \( r/e \). Calculations were run again using the alternate method, however results were deemed to be too distant from expected values again and this method was abandoned.

Maps produced using the second Prescott Transeau method are in Appendix A.

3.7 Aquifer Salinity

The original methodology intended to utilise Aquifer Salinity to exclude areas unsuitable for agricultural production. DNRETAS has quite an extensive dataset of bore Total Dissolved Solids (TDS) values within its Hydstra database; however bores have not been attributed to aquifers. This is not a significant issue in areas where only a single water yielding aquifer is likely to occur, but it is a significant problem where aquifers overlap. Nonetheless, an attempt was made to interpolate TDS values of bores using the known location of aquifers as break lines. Inverse Distance Weighting was used with a power of 4, search radius 0.5 degrees and output cell size of 0.02 degrees.

These maps are presented in Appendix B.
4. RESULTS

Suitable land for a number of food producing land uses are displayed in a series of maps and are presented under two general headings: (i) Pasture Suitability and (ii) Field Crops and Irrigated Horticulture.

4.1 Pasture Suitability

Suitable Landform was intersected with the rainfall requirements for Native Pasture and Improved Pasture to produce two suitability maps.

Map 10 Native Pasture Suitability
Map 11 Improved Pasture Suitability
Identification of Potential Land for Long-term Sustainable Food Production
Stage 1: Identification of Soil and Water Resources
Map 11  Northern Region: Improved Pasture Suitability

Data Source: DNRETAS
Land Systems Northern Part 1:250,000
Land Systems Southern Part 1:1,000,000
Roads, Rail, Parcels, Towns: Dept Lands and Planning (c) Northern Territory of Australia
Mean monthly and mean annual rainfall data (c) Bureau of Meteorology
4.2 **Field Crops and Irrigated Agriculture**

Suitability maps for Field Crops (Irrigated), Annual and Perennial Horticulture have been split into the northern and southern regions, and also by irrigation potential.

**Northern Region**
- Map 12: Rainfall and Suitable Soils for Field Crops (rain fed and irrigated) and Perennial Horticulture
- Map 13: Field Crops (Irrigated) and Perennial Horticulture - Broad Scale Irrigation Suitability
- Map 14: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability
- Map 15: Field Crops (Irrigated) and Perennial Horticulture - Limited or Localised Irrigation Suitability
- Map 16: Annual Horticulture - Broad Scale Irrigation Suitability
- Map 17: Annual Horticulture - Small Scale Irrigation Suitability
- Map 18: Annual Horticulture - Limited or Localised Irrigation Suitability

**Southern Region**
- Map 19: Field Crops (Irrigated) and Annual and Perennial Horticulture
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Map 13  Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Broad Scale Irrigation Suitability

Proportion of suitable soils within areas of BROAD SCALE irrigation potential

- 1-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

NT Water Management Areas
- Water Allocation Plan Area
- Draft Plan
- Water Control District

Data Source:
- Land Systems Northern Part NT (Scale 1:250,000)
- NT Aquifers (1:2,000,000)
- NT Water Management Areas: DNRETAS
- Roads, Rail, Towns: Dept Lands Planning
(c) Northern Territory of Australia

This map must be read in conjunction with the report:
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources
Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Major Towns
Territory 20 Growth Towns
Boundary extent of Northern Land System mapping (scale 1:250,000)

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%

Map 14 Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Small Scale Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Parcels, Towns: Dept Lands Planning (c) Northern Territory of Australia

Proportion of suitable soils within areas of SMALL SCALE irrigation potential

1-20%
20-40%
40-60%
60-80%
80-100%
Map 15  Northern Region: Field Crops (Irrigated) and Perennial Horticulture - Limited or Localised Irrigation Suitability

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Towns: Dept Lands Planning
(c) Northern Territory of Australia

Proportion of suitable soils within areas of LIMITED OR LOCALISED irrigation potential

- 1-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS Roads, Rail, Towns: Dept Lands Planning
(c) Northern Territory of Australia
Map 16  Northern Region: Annual Horticulture - Broad Scale Irrigation Suitability

Proportion of suitable soils within areas of BROAD SCALE irrigation potential

- 1-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Data Source:
Land Systems Northern Part NT (Scale 1:250,000)
NT Aquifers (1:2,000,000)
NT Water Management Areas: DNRETAS
Roads, Rail, Towns: Dept Lands Planning
(c) Northern Territory of Australia

This map must be read in conjunction with the report:
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources  Page 33
Map 17  Northern Region: Annual Horticulture - Small Scale Irrigation Suitability

Proportion of suitable soils within areas of SMALL SCALE irrigation potential:
- 1-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Data Source:
- Land Systems Northern Part NT (Scale 1:250,000)
- NT Aquifers (1:2,000,000)
- NT Water Management Areas: DNRETAS
- Roads, Rail, Towns: Dept Lands Planning
(c) Northern Territory of Australia

This map must be read in conjunction with the report:
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Map 18  Northern Region: Annual Horticulture - Limited or Localised Irrigation Suitability

Proportion of suitable soils within areas of LIMITED OR LOCALISED irrigation potential

- 1-20%
- 20-40%
- 40-60%
- 60-80%
- 80-100%

Data Source:
- Land Systems: Northern Part NT (Scale 1:250,000)
- NT Aquifers (1:2,000,000)
- NT Water Management Areas: DNRETAS
- Roads, Rail, Towns: Dept Lands Planning
(c) Northern Territory of Australia

This map must be read in conjunction with the report:
Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Northern Territory Government
Map 19  Southern Region: Field Crops (Irrigated) and Annual and Perennial Horticulture

This map must be read in conjunction with the report: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Data Source:
- Land Systems Southern Part NT (Scale 1:1,000,000)
- NT Aquifers (1:2,000,000)
- NT Water Management Areas: DNRETAS
- Roads, Rail, Towns: Dept Lands Planning
(c) Northern Territory of Australia

Suitable soils within areas of Horticulture
Rating 8+ and also irrigation potential for

- Small Scale irrigation
- Limited or Localised Irrigation

NT Water Management Areas
- Water Allocation Plan Area
- Draft Plan
- Water Control District

Major Towns
Territory 20 Growth Towns
Boundary extent of Southern Land System mapping (scale 1:1,000,000)

Map of the Southern Region showing field crops (irrigated) and annual and perennial horticulture. Key towns and water management areas marked.
5. DISCUSSION

5.1 Limitations of the Study

5.1.1 Soil Landscape Data Limitations

The spatial data used in this analysis is broad scale. This enabled a precursory assessment into suitability for agricultural and horticultural development. The maps produced must therefore be used strictly according to scale.

Any plans to pursue agricultural or horticultural development should involve further detailed investigations using local scale datasets. When identifying suitable areas on a localised scale, mapping and data of a more detailed scale is required. However, this level of detail is not available consistently across the entire Northern Territory.

In some areas, such as the greater Darwin area and the Katherine Daly region more detailed land resource information, predominantly 1:25,000 and 1:50,000 respectively is available; however, in most regions this level of information does not currently exist. It is important to note that the scale of soil information required for an intensive agricultural development is generally at least 1:10,000.

5.1.2 Ground Water Resources and Irrigation Potential

Reclassified Actual Yield from the Northern Territory Aquifers (1:2,000,000) dataset was used as a substitute for the availability of ground water resources across the Northern Territory. This data is only indicative of the availability of water and does not include an analysis of other issues such as the sustainability of the water supply or salinity. Water Allocation Plans under the Water Act should be considered prior to any large scale development occurring to ensure water supplies are sustainable into the future.

5.1.3 Rainfall

The rainfall information used was Gridded Mean Monthly Rainfall from the Bureau of Meteorology. It is possibly not the best indicator of reliability as it is a 30-year average and not percentiles; however DoR Agronomists determined that for pastures a single good season is all that is required to establish the pasture. Forage and field crops however could be susceptible to poor rainfall years and the analysis could be recalculated using Rainfall Percentiles to indicate reliability of rainfall or perhaps reliability over a 10 year period.

5.2 Land Suitability

5.2.1 Forage and Rain Fed Field Crops Suitability

Suitability for forage and rain fed field crops is generally restricted to the Daly Region and some areas in the vicinity of Borroloola. It would appear that the limiting factors are rainfall as in both cases soil suitability extends to the north and south of the suitable areas. To the south, rainfall is too low to establish and grow the crops and to the north rainfall is too high and extends beyond the growing season making harvesting difficult.

5.2.2 Native Pasture Suitability

Rainfall suitability covered the majority of the Northern Territory. Native pastures were determined to be limited by Landform.
5.2.3 Improved Pasture Suitability

Improved pasture is limited by both rainfall and landform. The rainfall suitability extends south as far as Kalkarindji, Top Springs, Dunmarra and Benmara with Landform limiting suitability north of these locations.

5.2.4 Field Crops (Irrigated) and Horticulture (Perennial) Suitability - Northern Region

Three maps have been produced for Field Crops (irrigated) and Perennial Horticulture showing areas of suitable soils for (i) broad scale, (ii) small scale and (iii) limited/localised irrigation potential. Again the Katherine Daly Region stands out as having potential for broad scale irrigation potential. This is supported by existing published information.

Northern Territory Water Management Areas have also been displayed on these maps as an indicator of the knowledge and effort already in place to map and manage this resource. Areas with broad scale irrigation potential and suitable soils would be the most favourable areas for large scale commercial development.

Areas of small scale irrigation potential have been identified on the Tiwi Islands, Wadeye and the region between Dry River and Daly Waters. These areas stand out as having both suitable soils and the potential for small scale irrigation. They are potentially suitable for smaller commercial horticultural operations.

Limited/localised Irrigation Potential can be found throughout the remainder of the Top End. Although most of these areas have low percentages of suitable soils within Land Systems there are some areas that could potentially support local production around Borroloola, Benmara Station and the outer areas of the Katherine Daly Region. Broad and small scale commercial production is unlikely to be sustainable however there would likely be sufficient resources to supply local communities.

5.2.5 Horticulture (Annual) Suitability - Northern Region

As with Field Crops (irrigated) and Horticulture Perennial, three maps have been produced for Annual Horticulture in the Top End: broad scale, small scale and limited/localised irrigation potential. As with the horticulture perennials, annuals are suited to the Katherine Daly Region with the potential for broad scale irrigation. In addition, areas to the east of Darwin are also suitable for Pernnial Horticulture most likely as a direct result of Annual Horticulture being suited to shallower soils; as little as 40 cm compared to perennials which require a minimum of 90 cm.

Areas suitable for Annual Horticulture with small scale irrigation have been identified on the Tiwi Islands, Wadeye, south between Gapuwiyak and Yirrkala, Bulman and Dry River, and areas south east of Daly Waters.

The localised/limited irrigation potential shows a much greater extent of suitability, particularly east of Mataranka; however, given the irrigation potential is limited/localised, investigation for the sustainability of the water resources would be required to determine how feasible such a venture would be. It is unlikely that broad scale commercial production would be feasible in these areas but there may be some opportunity for small or local scale development around Borroloola, Ngukurr, Numbulwar and Ramingining.
5.2.6 Field Crops (Irrigated) and Horticulture (Annual and Perennial) Suitability - Southern Region.

Detailed spatial data with appropriate attribution in the southern region is limited. Horticulture Ratings were derived by experts in DNRETAS and DoR with local knowledge in soil-landscapes, crop requirements and ground water. There is little information on soil depth, pH or other factors which were used in the northern region assessment. The southern map therefore only shows these areas with the derived irrigation potential and some form of potential horticulture capability.

Based on the existing information, the southern region has no broad scale irrigation potential, only small scale and limited/localised potential. Areas of irrigated field crops and small scale irrigation potential occur in the vicinity of Three Ways, Ali Curung and Ti Tree. Limited irrigation potential is scattered across the rest of the southern region. Yuendemu has a large area of suitable land that could be further explored.

Aquifer salinity was not used in the analysis. As can be seen from the map in Appendix B, salinity varies greatly in the Northern Territory. Any proposals to utilise ground water resources should be assessed for salinity.
6. **THE 20 TERRITORY GROWTH TOWNS**

Table 5 provides a summary of the types of agricultural and horticultural development potential across the Northern Territory’s major centres and Territory 20 Growth Towns.

<table>
<thead>
<tr>
<th>Location</th>
<th>Native Pasture</th>
<th>Improved Pasture</th>
<th>Forage and rain fed field crops</th>
<th>Irrigated Field Crops and Hort Perennial</th>
<th>Hort Annual</th>
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<tbody>
<tr>
<td><strong>Existing Centres</strong></td>
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<td>-</td>
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<td>L</td>
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<td>Tennant Creek</td>
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<td>-</td>
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<td><strong>20 Territory Growth Towns</strong></td>
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<td>Numbulwar</td>
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<td>Yuendemu</td>
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</tbody>
</table>

*Table 5 – Summary of agriculture and horticulture suitability around existing centres and Growth Towns*

Pastoralism is currently the dominant land use for the Northern Territory landscape. However, there are opportunities for horticultural development around some of the 20 Territory Growth Towns and other centres.

Ali Curung, Borroloola, Nguju and Wadeye all have significant areas worthy of further investigation towards small scale commercial operations while the remaining centres have potential but the suitable land and water resources appear to be limited.
7. REFERENCES

Lynch, B. (2010) *Land Systems of the Northern Part of the Northern Territory, 1:250,000*. Natural Resources Division, Department of Natural Resources, Environment the Arts and Sport, Northern Territory.

Lynch, B. (2010) *Land Systems of the Southern Part of the Northern Territory, 1:1,000,000*. Natural Resources Division, Department of Natural Resources, Environment the Arts and Sport, Northern Territory.


8. APPENDICES
Identification of Potential Land for Long-term Sustainable Food Production

Stage 1: Identification of Soil and Water Resources

Appendix A - Monthly and Cumulative Transeau Ratios

Data:
- Calculated from BoM Climate averages; Rainfall 1961 - 1990 and Evaporation, based on all available stations with minimum of 10 years, 1975 - 2005.
- Transeau Ratio (Prescott) formula: rainfall/evaporation ^ 0.75

Data Sources:
- Towns, NT boundary - Dept Lands Planning (C) Northern Territory Government
- Rainfall, Evaporation - Bureau of Meteorology (C) Comm Australia

Monthly Transeau Ratio

<table>
<thead>
<tr>
<th>Monthly Transeau Ratio</th>
<th>Cumulative Transeau Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.5</td>
<td>&lt; 3</td>
</tr>
<tr>
<td>0.5 - 1</td>
<td>3 - 6 (Grassland /Dry Woodland)</td>
</tr>
<tr>
<td>0.5 - 1</td>
<td>6 - 12 (Woodland /Tree Savannas)</td>
</tr>
<tr>
<td></td>
<td>&gt; 24 (Forests)</td>
</tr>
</tbody>
</table>

Darwin
Katherine
Tennant Creek
Alice Springs

AUG
JUL
JUN
MAY
APR
MAR
SEPT
OCT
NOV
DEC
FEB
CUMULATIVE
Appendix B - Aquifer Salinity

Interpolation of TDS values from Bore samples.
Interpolation Method: IDW
Output cell size: 0.02 deg
Power: 4
Search Radius: 0.5 deg
Breaklines: NT Aquifers
No attempt has been made to assign bores to an aquifer in regions where there are multiple aquifers.

Interpolated TDS values
- < 500 mg/L
- 500 - 1,000 mg/L
- 1,000 - 3,000 mg/L
- 3,000 - 7,000 mg/L
- 7,000 - 14,000 mg/L
- > 14,000 mg/L
- Insufficient Data

Data Source: HYDSTRA database, DNRETAS Roads, Rail, Towns: Dept Lands Planning
(C) Northern Territory of Australia

Identification of Potential Land for Long-term Sustainable Food Production
Stage 1: Identification of Soil and Water Resources