Water resource assessment for the Roper catchment

A report from the CSIRO Roper River Water Resource Assessment for the National Water Grid

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Important disclaimer

CSIRO Roper River Water Resource Assessment acknowledgements

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Aspects of the Assessment have been undertaken in conjunction with the Northern Territory Government.

The Assessment was guided by two committees:

i. The Assessment's Governance Committee: CRC for Northern Australia/James Cook University; CSIRO; National Water Grid (Department of Climate Change, Energy, the Environment and Water); NT Department of Environment, Parks and Water Security; NT Department of Industry, Tourism and Trade; Office of Northern Australia; Qld Department of Agriculture and Fisheries; Qld Department of Regional Development, Manufacturing and Water

ii. The Assessment's joint Roper and Victoria River catchments Steering Committee: Amateur Fishermen's Association of the NT; Austrade; Centrefarm; CSIRO, National Water Grid (Department of Climate Change, Energy, the Environment and Water); Northern Land Council; NT Cattlemen's Association; NT Department of Environment, Parks Australia; Parks and Water Security; NT Department of Industry, Tourism and Trade; Regional Development Australia; NT Farmers; NT Seafood Council; Office of Northern Australia; Roper Gulf Regional Council Shire

Responsibility for the Assessment's content lies with CSIRO. The Assessment's committees did not have an opportunity to review the Assessment results or outputs prior to its release.

This report was reviewed by Kevin Devlin (Independent consultant).

For further acknowledgements, see page xxii.

Acknowledgement of Country

CSIRO acknowledges the Traditional Owners of the lands, seas and waters of the area that we live and work on across Australia. We acknowledge their continuing connection to their culture and pay our respects to their Elders past and present.

Photo

Looking along the Roper River at Red Rock, Northern Territory. Source: CSIRO – Nathan Dyer

Part I Introduction and overview

Chapter 1 provides background and context for the Roper River Water Resource Assessment (referred to as the Assessment).

This chapter provides the context for and critical foundational information about the Assessment with key concepts introduced and explained.

Looking across the middle-section of the Roper River plain

Photo: CSIRO – Nathan Dyer

1 Preamble

Authors: Cuan Petheram, Caroline Bruce and Ian Watson

1.1 Context

Sustainable regional development is a priority for the Australian and Northern Territory governments. For example, in 2023 the Northern Territory Government committed to the implementation of a new Territory Water Plan. One of the priority actions announced by the government was the acceleration of the existing water science program 'to support best practice water resource management and sustainable development'.

Many rural communities in northern Australia see irrigated agriculture as a means of reversing the long-term human population declines in their areas and as a critical element of broader regional development. This belief is supported by commentators overseas who have observed that no country or region in a tropical or subtropical climate has experienced significant economic development without developing their water resources (Biswas, 2012). Furthermore, studies in Australia have shown that irrigation production in the southern Murray–Darling Basin generates a level of economic and community activity that is three to five times higher than would be generated by rainfed (dryland) production (Meyer, 2005). Domestic investors in irrigation in southern Australia are also increasingly looking north for agricultural opportunities due to recent experience of drought, overallocation of water resources, future projections of reduced rainfall in southern Australia and perceptions of an abundance of water in northern Australia. Some foreign companies have already invested heavily in irrigation in northern Australia and this trend is likely to continue.

Development of northern Australia is not a new idea; there is a long history of initiatives to develop cultivated agriculture in the tropical north of Australia. Many of these attempts have not fully realised their goals, for a range of reasons. It has recently been highlighted that although northern Australia's environment poses challenges for irrigated agriculture, the primary reason that many of the schemes did not fully realise their goals is that they did not have sufficient or patient capital to overcome the failed years that inevitably accompany every new irrigation scheme (Ash et al., 2014). The only large schemes still in operation in northern Australia had substantial government financial support during the construction phase, as well as ongoing support during the establishment and learning phases.

The efficient use of Australia's natural resources by food producers and processors requires a good understanding of soil, water and energy resources so they can be managed sustainably. Finely tuned strategic planning will be required to ensure that investment and government expenditure on development are soundly targeted and designed. Northern Australia presents a globally unique opportunity (a greenfield development opportunity in a first-world country) to strategically consider and plan development. Northern Australia also contains ecological and cultural assets of high value and decisions about development will need to be made within that context. Good information is critical to these decisions.

Most of northern Australia's land and water resources have not been mapped in sufficient detail to provide for reliable resource allocation, mitigate investment or environmental risks, or build policy settings that can support decisions. Better data are required to inform decisions on private investment and government expenditure, to account for intersections between existing and potential resource users, and to ensure that net development benefits are maximised.

In 2012, the Australian Government commissioned CSIRO to undertake the Flinders and Gilbert Agricultural Resource Assessment in north Queensland. This assessment developed fundamental soil and water datasets and provided a comprehensive and integrated evaluation of the feasibility, economic viability and sustainability of agricultural development in two catchments in north Queensland (Petheram et al., 2013a, 2013b). Following the success of the Flinders and Gilbert Agricultural Resource Assessment, between 2016 and 2018 the Australian Government commissioned CSIRO to undertake further assessments in the Fitzroy catchment (Western Australia) (Petheram et al., 2018a), four catchments between Darwin and Kakadu (Northern Territory) (Petheram et al., 2018b) and the Mitchell catchment (Queensland) (Petheram et al., 2018d).

These assessments provided baseline information on soil, water and other environmental assets of these five study areas to help enable more informed decisions relating to resource management and sustainable regional development. The outcome of the assessments was to inform planning decisions by Traditional Owners, citizens, landholders, investors, local government, state Northern Territory and federal governments, reduce the uncertainty for investors and regulators and provide numbers the general public could trust to facilitate open and transparent debates. However, these previous studies covered only about 350,000 km^2 (approximately 11%) of northern Australia and acquiring a similar level of data and insight across northern Australia's more than 3 million km^2 would require more time and resources than were available at the time.

Consequently, in consultation with the Northern Territory Government, the Australian Government prioritised the catchment of the Roper River for investigation (Figure 1-1) and establishment of baseline information on soil, water and the environment.

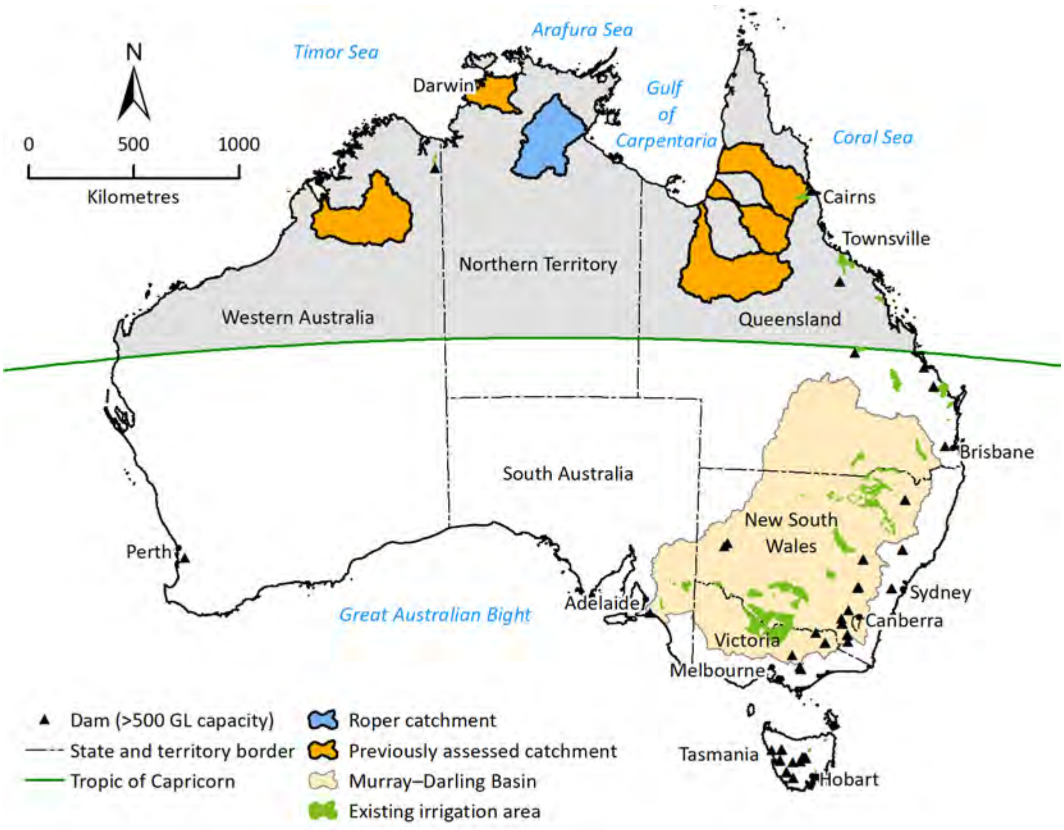

Figure 1-1 Map of Australia showing Assessment area

Northern Australia is defined as the part of Australia north of the Tropic of Capricorn. The Murray–Darling Basin and major irrigation areas and major dams (greater than 500 GL capacity) in Australia are shown for context.

1.2 The Roper River Water Resource Assessment

The Roper River Water Resource Assessment has undertaken fundamental baseline data collection on water, soil and other environmental assets in order to support regional and country planning, resource management and sustainable regional development.

In 2019 the Roper catchment was identified by the Australian and Northern Territory governments as being a suitable candidate for a large-scale assessment of the water and soil resources because there was both interest in, and concerns about, the development of irrigated agriculture in the catchment. With the proximity of the headwaters of the Roper River to Katherine, one of the major agriculture centres in the NT, the area is seen as having the potential to overcome some of the challenges that typify agriculture in northern Australia.

The Assessment aimed to:

- improve baseline datasets of water, soil and other environmental assets
- understand the nature and scale of potential water resource development options
- understand the development interests and aspirations of Indigenous communities
- assess potential environmental, social and economic impacts and risks of water resource and irrigation development.

The techniques and approaches used in the Assessment were specifically tailored to the study area.

It is important to note that although these four key research areas are listed sequentially here, activities in one part of the Assessment often informed (and hence influenced) activities in an earlier part. For example, understanding ecosystem water requirements (the third part of the Assessment, described in Part IV of this report) was particularly important in establishing rules around water extraction and diversion (i.e. how much water can be taken and when it should be taken – the second part of the Assessment, described in Part III of this report). Thus, the procedure of assessing a study area inevitably included iterative steps, rather than a simple linear process.

In covering the key research areas above, the Assessment was designed to:

- explicitly address the needs of and aspirations for local development by providing objective assessment of resource availability, with consideration of environmental and cultural issues
- meet the information needs of governments as they assess sustainable and equitable management of public resources, with due consideration of environmental and cultural issues
- address the due diligence requirements of private investors, by exploring questions of profitability and income reliability of agricultural and other developments.

Drawing on the resources of all three tiers of government, the Assessment built on previous studies, drew on existing stores of local knowledge, and employed a broad range of scientific expertise, with the quality assured through peer-review processes.

The Roper River Water Resource Assessment, which incurred delays due to the COVID-19 pandemic in 2020 and 2021, took 4 years between 1 July 2019 and 30 June 2023.

1.2.1 Scope of work

The Assessment comprised several activities that together were designed to explore the scale of the opportunity for irrigated agricultural development in the Roper catchment. The full suite of activities is outlined below (1.3), and a series of technical reports was produced as part of the Assessment (listed in Appendix A).

In stating what the Assessment did, it is equally instructive to state what it did not do.

The Assessment did not seek to advocate irrigation development or assess or enable any particular development; rather, it identified the resources that could be deployed in support of potential irrigation enterprises, evaluated the feasibility of development (at a catchment scale) and considered the scale of the opportunities that might exist.

In doing so, the Assessment examined the monetary and non-monetary values associated with existing use of those resources, to enable a wide range of stakeholders to assess for themselves the costs and benefits of given courses of action. The Assessment is fundamentally a resource evaluation, the results of which can be used to inform planning decisions by citizens, investors, and the different tiers of government – local council, Northern Territory, and Australian governments. The Assessment does not replace any planning processes, nor does it seek to; it does not recommend changes to existing plans or planning processes.

The Assessment sought to lower barriers to investment in the Assessment area by addressing many of the questions that potential investors would have about production systems and methods, crop yield expectations and benchmarks, and potential profitability and reliability. This information base was established for the Assessment area as a whole, not for individual paddocks or businesses.

The Assessment identified those areas that are most suited for new agricultural or aquaculture developments and industries, and, by inference, those that are not well suited. It did not assume that particular sections of the study area were in or out of scope. For example, the Assessment was ‘blind’ to issues such as land-clearing regulations that may exclude land from development now, but might be possible in the future.

The Assessment identified the types and scales of water storage and access arrangements that might be possible, and the likely consequences (both costs and benefits) of pursuing these possibilities. It did not assume particular types or scales of water storage or water access were more preferable than others, nor does it recommend preferred development possibilities.

The Assessment examined resource use unconstrained by legislation or regulations, to allow the results to be applied to the widest range of uses, for the longest time frame possible. In doing so, it did not assume a particular future regulatory environment but did consider a range of existing legislation, regulation and policy and the impact of these on development.

It was not the intention – and nor was it possible – for the Assessment to address all topics related to water, irrigation and aquaculture development in northern Australia. Important topics that were not addressed by the Assessment (e.g. impacts of irrigation development on terrestrial ecology) are discussed with reference to, and in the context of, the existing literature.

Functionally, the Assessment adopted an activities-based approach to the work (which is reflected in the content and structure of the outputs and products, as per Section 1.2.3) with the following activity groups: land suitability; surface water hydrology and climate; groundwater hydrology; agriculture and socio-economics; surface water storage; Indigenous water values, rights, interests and development goals; and ecology.

1.2.2 Plausibility of development pathways

To understand how hydrology, ecology and economic factors in the Roper catchment interact and respond to various types and scales of development, a wide range of potential development scenarios were examined. These ranged from small incremental increases in surface and ground water extraction, to water volumes defined only by the physical limits of the catchment. However, these scenarios deliberately excluded regulatory considerations, such as land tenure or land-clearing regulations that may prevent land from development now but might change over time to permit new prospects in the future. The likelihood of different scenarios eventuating will be strongly influenced by the regulatory framework at any point in time and by community acceptance of irrigated agriculture and its benefits and risks. However, one way of understanding the nature and likely scale and rate of change in irrigated agricultural development and to have meaningful discussions about future prospects in the Roper catchment, is to examine the scale and recent historical rate of change of irrigated agriculture across northern Australia.

The following section broadly compares historical irrigation development in that part of northern Australia west of the Great Dividing Range and on Cape York from the Normanby River and Endeavour rivers north (which encompasses the Roper catchment) with that part east of the Great

Dividing Range where the biophysical and socio-economic setting is very different (Petheram and Bristow, 2008) and settlements are much closer. For example, the eastern part contains Cairns and Townsville and large irrigation areas such as the Burdekin Delta and Burdekin Haughton Water Supply Scheme which total about 80,000 ha. Whereas 'west of the Great Divide', the area of about 300 million ha (3 million km^2) remains relatively undeveloped, except in some specific aggregations such as the Ord River Irrigation Area.

The definition of northern Australia is that used by the Office of Northern Australia which includes all of the Northern Territory and catchments such as the Gascoyne River catchment in Western Australia. The areas of irrigation were calculated from a combination of sources including the Australian Collaborative Land Use and Management Program (ACLUMP; ABARES, 2022), the latest available state or Northern Territory land use mapping (e.g. https://data.nt.gov.au/dataset/land-use-mapping-project-of-the-northern-territory-2016-current-lump) with some revisions produced by this Assessment using satellite imagery and other sources in 2023. The revised data show areas being used for irrigation, rather than areas developed for irrigation, but not being used for that purpose. Not included in this analysis is the Mareeba-Dimbulah Water Supply Scheme, which was developed in the 1960s and 1970s with substantial government financial support during the construction phase, and during the establishment and learning phases in the 1970s and 1980s. The reason for this is that while the scheme spans the headwaters of the east draining Barron catchment and the west draining Mitchell catchment the majority of water used for irrigation is sourced from the Barron catchment. Islands were not included in the analysis.

There are about 81,000 ha of irrigated agriculture in northern Australia 'west of the Great Divide', which is about 0.03% of the land area. By comparison, nine of the top ten catchments in northern Australia by irrigated area drain east of the Great Divide and total about 351,700 ha of irrigated land. For comparison, there is about 2,400,000 ha of land developed for irrigated agriculture in the Murray–Darling Basin.

Of the 81,200 ha of land developed for irrigation in northern Australia 'west of the Great Divide', broadacre cropping (e.g. forage sorghum, cotton, chia) contributes about 38,100 ha, perennial horticulture crops such as mango contribute about 12,700 ha, perennial plantations (such as sandalwood and African mahogany) about 14,000 ha and seasonal horticulture (such as melons) about 11,000 ha.

Approximately 28% of the 81,200 ha, is located in three government subsidised schemes: the surface water Ord River Irrigation Area (19,200ha) and surface and groundwater based Lakeland Irrigation Scheme (2700 ha) and the groundwater based Carnarvon Irrigation Scheme (1400 ha). The remaining 72% of irrigated land (58,260 ha) some of which was developed over 40 years ago, is scattered across the north and is a mixture of groundwater and small-scale surface water developments sourcing water from gully dams or harvesting river water and storing it in ringtanks.

Thirty percent of the 81,200 ha sources water for irrigation from groundwater, with the main areas being near to Darwin (5620 ha), in the Daly catchment (9140 ha), in the Flinders catchment (4800 ha) and in the Sandy Desert basin (2320 ha) near 80 Mile Beach in north-west Western Australia. These all take the form of mosaics of irrigation and have been developed incrementally by private enterprise over the last 30 to 40 years.

Accurately determining change in irrigated area over time is difficult for a number of reasons. However, preliminary analysis suggests that the average net increase in irrigated area in the NT has been in the order of less than 50 ha per year over the last 20 years. In Queensland, west of the Great Divide, north of the Tropic of Capricorn and on Cape York from the Normanby and Endeavour rivers north, the area under irrigation increased by a mean of about 1100 ha per year over the last 24 years. This highlights that changes in irrigation across northern Australia have been modest over the last couple of decades (equivalent figures for Western Australia are not readily available at the time of writing).

Figure 1-2 shows the number of large dams (defined here as listed in the Australian National Committee on Large Dams (ANCOLD) database with a storage capacity of 10 GL or greater) constructed across Australia and northern Australia (west and east of the Great Divide) over time. Over the last 40 years there have been only nine large dams constructed across all of northern Australia (including the east coast) and only three of these nine dams were constructed for the supply of water for irrigation, rather than suppling water for mining or urban use, and one of the three dams was also listed as having a purpose of flood mitigation, recreation and water supply for urban use. All three of the dams constructed to supply water for irrigation are east of the Great Divide. No large dam has been constructed anywhere in northern Australia for the supply of water for irrigation for more than 25 years.

Irrespective of the physical resources that may support water and irrigated agricultural development in the Roper catchment, if the future trajectory of irrigation development is similar to historical trends the scale of future irrigation development in the Roper catchment is likely to be modest and unlikely to encompass large dam development.

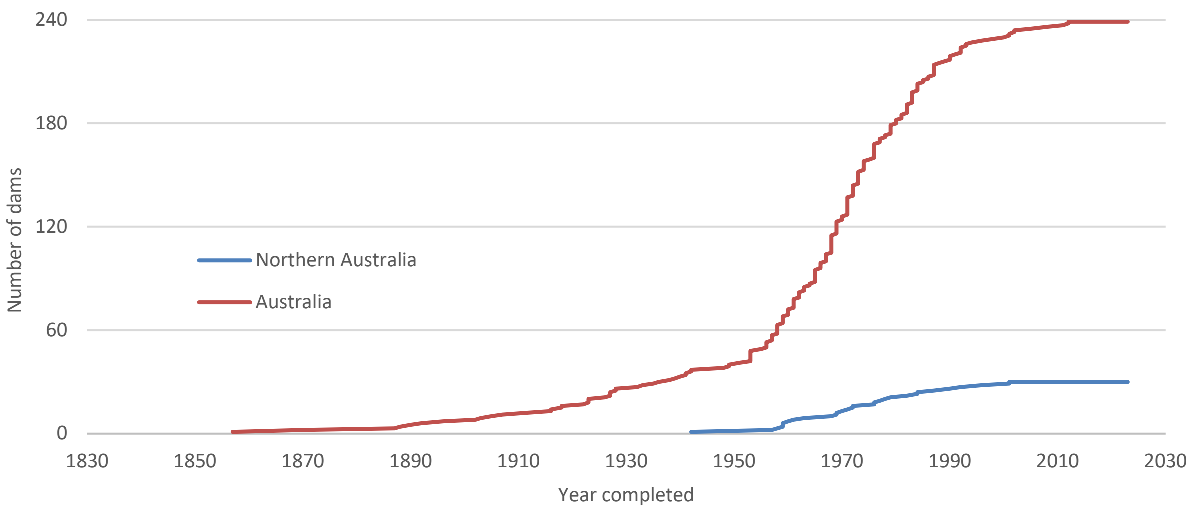

Figure 1-2 Number of dams constructed in Australia and northern Australia over time

Large dams are defined as dams listed in the ANCOLD database and with a storage capacity of 10 GL or greater.

1.2.3 Assessment products

The Assessment produced written and internet-based products. These are summarised below, and written products are listed in full in Appendix A. Downloadable reports and other outputs can be found at:

https://www.csiro.au/roperriver

Written products

The Assessment produced the following documents:

- Technical reports, which present scientific work in sufficient detail for technical and scientific experts to independently verify the work. There is at least one technical report for each of the activities of the Assessment.
- A catchment report, which combines key material from the technical reports, providing well-informed but non-scientific readers with the information required to inform judgments about the general opportunities, costs and benefits associated with water and irrigated agricultural or aquaculture development.
- A summary report, which is provided for a general public audience.
- A factsheet, which provides a summary of key findings for the Roper catchment for a general public audience.

Audio-visual products

The following audio-visual products were produced by the Assessment:

- a video, providing an overview of the work.

Internet-based platforms

The following internet-based platforms were used to deliver information generated by the Assessment:

- CSIRO Data Access Portal (DAP) – enables the user to download key research datasets generated by the Assessment
- NAWRA Explorer – a web-based tool that enables the user to visualise and interrogate key spatial datasets generated by the Assessment
- internet-based applications that enable the user to run selected models generated by the Assessment.

1.3 Report objectives and structure

This is the catchment report for the Roper catchment. It summarises information from the technical reports for each activity and provides tools and information to enable stakeholders to see the opportunities for development and the risks associated with them. Using the establishment of a 'greenfield' (not having had any previous development for irrigation) irrigation development as an example, Figure 1-2 illustrates many of the complex considerations required for such development – key report sections that inform these considerations are also indicated.

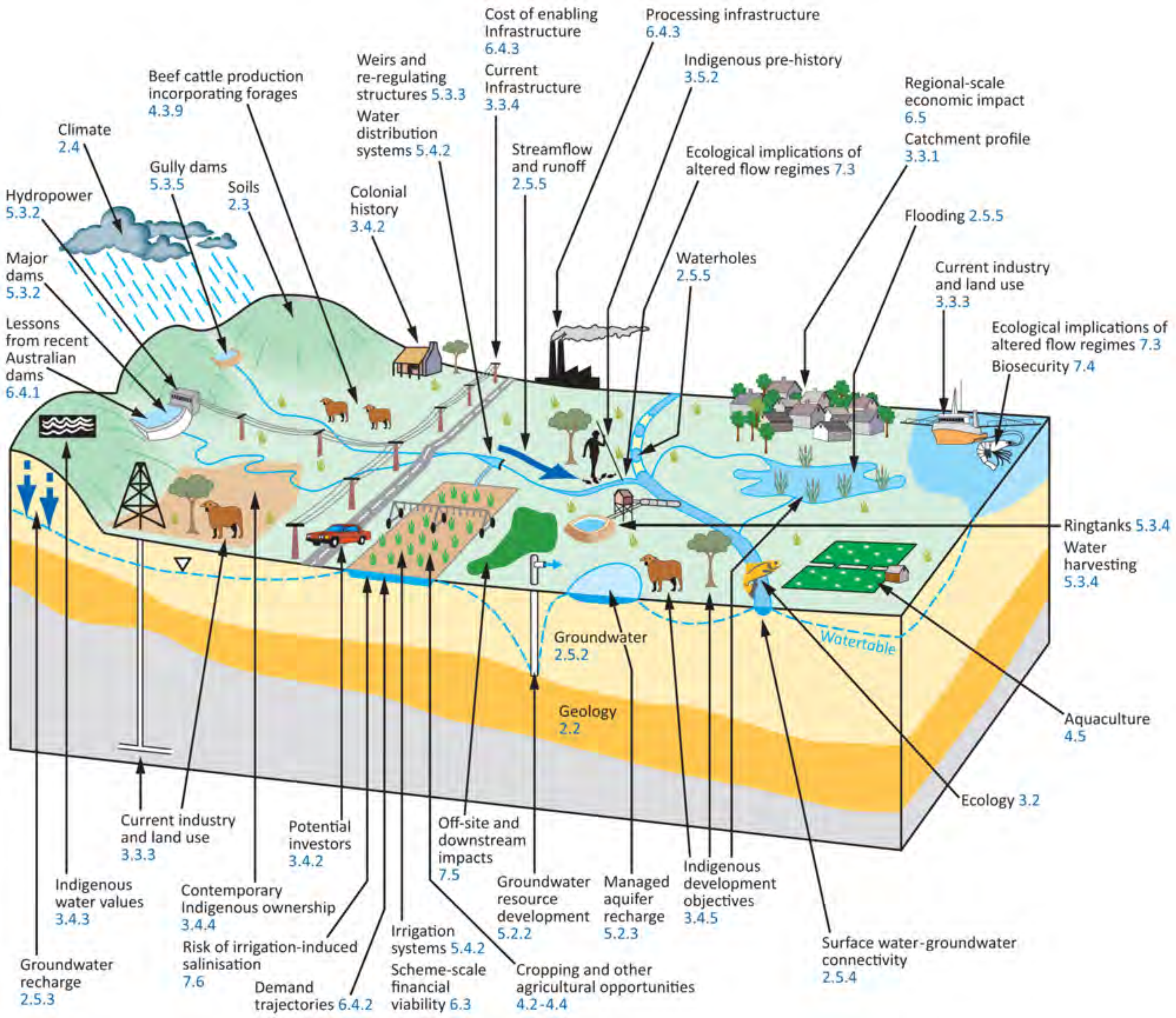

Figure 1-3 Schematic diagram of key components and concepts in the establishment of a greenfield irrigation development

Numbers shown in blue refer to sections of this report.

The structure of the Roper catchment report is as follows:

- Part I (Chapter 1) provides background, context and a general overview of the Assessment.
- Part II (Chapter 2 and Chapter 3) looks at current resources and conditions within the catchment.
- Part III (Chapter 4 and Chapter 5) considers the opportunities for water and agricultural and aquaculture development based on available resources.
- Part IV (Chapter 6 and Chapter 7) provides information on the economics of development and a range of risks to development, as well as those that might accompany development.

1.3.1 Part I – Introduction

This provides a general overview of the Assessment. Chapter 1 (this chapter) covers the background and context of the Assessment. Key findings can be found in the front materials of this report.

1.3.2 Part II – Resource information for assessing potential development opportunities

Chapter 2 is concerned with the physical environment and seeks to address the question of what soil and water resources are present in the Roper catchment, describing:

- geology and physical geography: focusing on those aspects that are important for understanding the distribution of soils, groundwater flow systems, suitable water storage locations and geology of economic significance
- soils: covering the soil types within the catchment, the distribution of key soil attributes and their general suitability for irrigated agriculture
- climate: outlining the general circulatory systems affecting the catchment and providing information on key climate parameters of relevance to irrigation under current and future climates
- hydrology: describing and quantifying the surface water and groundwater hydrology of the catchment.

Chapter 3 is concerned with the living and built environment and provides information about the people, the ecology of the catchment and the institutional context of the Roper catchment, describing:

- ecology: ecological systems and assets of the Roper catchment including the key habitats, key biota and their important interactions and connections
- socio-economic profile: current demographics and existing industries and infrastructure of relevance to water resource development in the Roper catchment
- Indigenous values, rights, interests and development goals: generated through direct participation by Roper catchment Traditional Owners.

1.3.3 Part III – Opportunities for water resource development

Chapter 4 presents information about the opportunities for irrigated agriculture and aquaculture in the Roper catchment, describing:

- land suitability for a range of crop × season × irrigation type combinations and for aquaculture, including key soil-related management considerations
- cropping and other agricultural opportunities, including crop yields and water use
- gross margins at the farm scale
- prospects for integration of forages and crops into existing beef enterprises
- aquaculture opportunities.

Chapter 5 presents information about the opportunities to extract and/or store water for use in the Roper catchment, describing:

- groundwater and subsurface storage opportunities
- surface water storage opportunities in the Roper catchment including major dams, large farm-scale dams and natural water bodies

- estimates of the quantity of water that could be pumped or diverted from the Roper River and its major tributaries
- water distribution systems (i.e. conveyance of water from a dam and application to the crop)
- costs of potential broad-scale irrigation development.

1.3.4 Part IV – Economics of development and accompanying risks

Chapter 6 covers economic opportunities and constraints for water resource development, describing:

- balance of scheme-scale costs and benefits
- cost–benefit considerations for water infrastructure viability
- regional-scale economic impacts of irrigated development.

Chapter 7 discusses a range of risks to development, as well as those that might accompany development, describing:

- ecological impacts of altered flow regimes on aquatic, riparian and near-shore marine ecology
- biosecurity risks to agricultural or aquaculture enterprises
- potential off-site impacts due to sediment, nutrients and agro-pollutants to receiving waters in the catchment
- irrigation-induced salinity due to rising watertable.

1.3.5 Appendices

This report contains four appendices:

Appendix A – list of information products.

Appendix B – shortened forms, units, data sources, glossary and terms.

Appendix C – list of figures and list of tables.

Appendix D – detailed map of Roper catchment and surrounds.

1.4 Key background

1.4.1 The Roper catchment

The Roper catchment covers an area of 77,400 km^2 and extends from just east of Katherine and south of Daly Waters to the Gulf of Carpentaria. Much of the catchment is low relief, consisting of open woodlands with escarpments, grassy alluvial plains, gorges and plateaux. The catchment is sparsely populated with a population at the 2016 Census of 2512 people. This includes the regional centre of Mataranka (350 people), towns of Larrimah (47 people) and Daly Waters (55 people), as well as the Indigenous communities of Ngukurr (largest population centre in the catchment with 1149 people), Beswick, Barunga and Bamyili. There are also some smaller Indigenous communities, outstations and roadhouses. Katherine (population 6303 in 2016) is the closest urban service centre and is located about 100 km north-west of Mataranka, just outside the catchment. The nearest major city and population centre is the NT capital of Darwin (population of Greater Darwin area was 136,828 in 2016), approximately 420 km from Mataranka.

The Roper River is a large, perennial flowing river with headwaters in the Mataranka Springs Complex and draining one of the largest catchment areas flowing into the western Gulf of Carpentaria. The main land uses are extensive grazing of beef cattle on native rangelands (46%), other protected areas including Indigenous freehold tenure (45%), and nature conservation (6%). Protected areas in the catchment include two national parks (Elsey National Park (140 km^2) and Limmen National Park (9300 km^2, much of this extending beyond the Roper catchment)) and the South East Arnhem Land Indigenous Protected Area. About 2040 ha of irrigated agriculture exists in the Roper catchment including 850 ha of sandalwood (some of which was cleared of sandalwood in 2023), 803 ha of melons, 320 ha of mangoes and 64 ha of sorghum forage. Adjacent to the Roper catchment are two contiguous marine parks, Limmen Bight (870 km^2) in Territory waters and the Limmen Marine Park (1400 km^2) in Commonwealth waters.

Figure 1-4 Roper Bar on the Roper River

Photo: CSIRO - Nathan Dyer

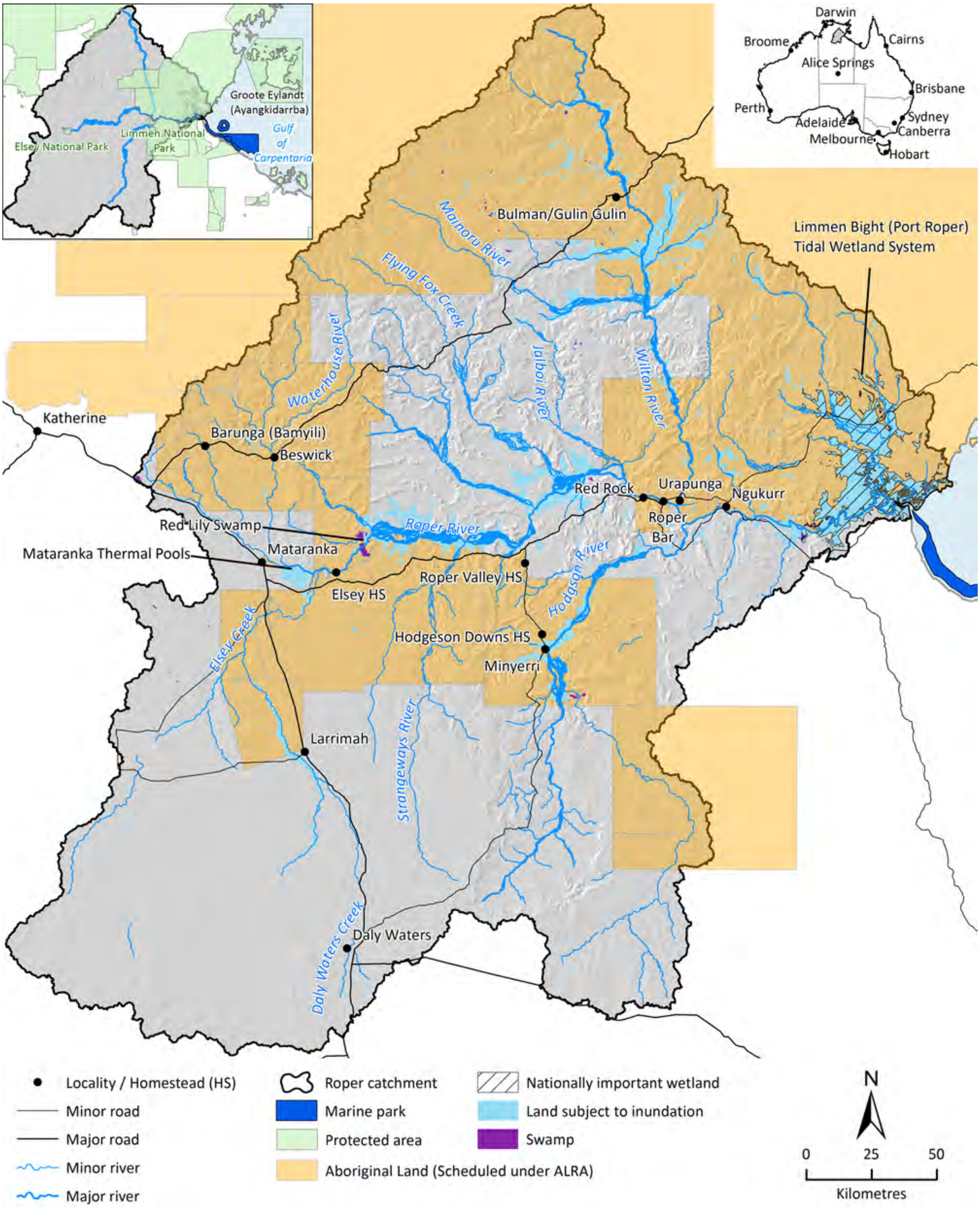

Figure 1-5 The Roper catchment

Land without colour overlay in main map is pastoral leasehold land. ALRA = *Aboriginal Land Rights (Northern Territory) Act 1976*

1.4.2 Wet-dry seasonal cycle: the water year

Northern Australia experiences a highly seasonal climate, with most rain falling during the 4-month period from December to March. Unless specified otherwise, this Assessment defines the wet season as being the 6-month period from 1 November to 30 April, and the dry season as the 6-month period from 1 May to 31 October. However, it should be noted that the transition from the dry to the wet season typically occurs in October or November and the definition of the northern wet season commonly used by meteorologists is 1 October to 30 April.

All results in the Assessment are reported over the water year, defined as the period 1 September to 31 August, unless specified otherwise. This allows each individual wet season to be counted in a single 12-month period, rather than being split over two calendar years (i.e. counted as two separate seasons). This is more realistic for reporting climate statistics from a hydrological and agricultural assessment viewpoint.

1.4.3 Scenario definitions

The Assessment considered four scenarios, reflecting combinations of different levels of development and historical and future climates, much like those used in the Northern Australia Sustainable Yields projects (NASY) (CSIRO, 2009a, 2009b, 2009c), the Flinders and Gilbert Agricultural Resource Assessment (Petheram et al., 2013a, 2013b) and the Northern Australia Water Resource Assessments (Petheram et al., 2018a, 2018b, 2018d):

- Scenario A – historical climate and current development
- Scenario B – historical climate and future development
- Scenario C – future climate and current development
- Scenario D – future climate and future development.

Scenario A

Scenario A and its subset, Scenario AN, both assume a historical climate. The historical climate series is defined as the observed climate (rainfall, temperature and potential evaporation for water years from 1 September 1910 to 31 August 2019). All results presented in this report are calculated over this period unless specified otherwise.

Scenario AN assumes no surface water or groundwater development. Because the impacts of licenced groundwater extraction near Mataranka (~24 GL) on baseflow in the Roper River are yet to be fully realised, Scenario AN is considered most representative of the hydrological regime in the Roper catchment at 31 August 2019. Scenario AN was used as the baseline against which assessments of relative change were made. This will give the most conservative results.

Scenario A assumes historical climate and current levels of surface water (~0.1 GL) and groundwater development (~24 GL near Mataranka and ~8 GL near Larrimah) assessed ~2070. The difference between Scenario A and Scenario AN is that the potential impacts of current groundwater extraction on baseflow in the Roper River are calculated over ~50 years from 31 August 2019. This corresponds to a period about twice as long as a typical agricultural investment timeframe (~20-30 years). The year 2070 also roughly corresponds to the time slice over which the future impacts of climate on water resources were explored.

Scenario B

Scenario B is historical climate and future hypothetical development assessed at ~2060. Scenario B used the same historical climate series as Scenario A. River inflow, groundwater recharge and flow, and agricultural productivity were modified to reflect potential future development. Hypothetical development options were devised to assess response of hydrological, ecological and economic systems ranging from small incremental increases in surface water and groundwater extraction through to extraction volumes representative of the likely physical limits of the Roper catchment (i.e. considering the colocation of suitable soil and water). All price and cost information was indexed to 2021 (i.e. reflective of pre-COVID-19 prices). All water harvesting and dam based hypothetical development scenarios assume 35 GL of groundwater extraction south of Larrimah in addition to current licenced extractions. It should be noted that the difference in baseflow at 2070 under the three groundwater development scenarios examined in the Assessment, 35, 70 and 105 GL, are negligible (~1%), and the majority of modelled impacts to baseflow at 2070 are due to current licenced extractions near Mataranka. However, groundwater drawdown assuming a hypothetical development of 105 GL/year was considerably larger than the 70 GL/year hypothetical development, which in turn was considerably larger than 35 GL/year hypothetical development (see Chapter 5).

The impacts of changes in flow due to these future hypothetical development scenarios were assessed, including impacts on:

- instream, riparian and near-shore ecosystems
- economic costs and benefits
- opportunity costs of expanding irrigation
- institutional, economic and social considerations that may impede or enable adoption of irrigated agriculture.

Scenario C

Scenario C is future climate and current levels of surface water and ground development assessed at ~2060. It will be based on the 109-year climate series (as in Scenario A) derived from Global Climate Model (GCM) projections for an approximate 1.6°C global temperature rise (~2060) relative to the 1990 scenario, representing Shared Socioeconomic Pathway, SSP2-4.5. The GCM projections will be used to modify the observed historical daily climate sequences.

Scenario D

Scenario D is future climate and future development. It used the same future climate series as Scenario C. River inflow, groundwater recharge and flow, and agricultural productivity were modified to reflect potential future development, as in Scenario B. Therefore, in this report, the climate data for scenarios A and B are the same (historical observations from 1 September 1910 to 31 August 2019) and the climate data for scenarios C and D are the same (the above historical data scaled to reflect a plausible range of future climates).

1.4.4 Case study

The Assessment produced a case study to complement case study material presented in the Flinders and Gilbert Agriculture Resource Assessment (Petheram 2013a,b) and the Northern Australia Water Resource Assessment (Petheram et al., 2018c). This case study considers the regulatory processes and approval steps required for land and water development in the Roper catchment. The case study brings information about NT's current land and water regulatory and approvals landscape together and structures it in an orderly way. It is intended to provide a useful introduction to the topic for proponents and others with an interest in advancing new developments in the NT (and the Roper catchment in particular). The case study is described in full in the companion technical report on regulatory considerations for land and water development in the Roper catchment (Vanderbyl T., 2023).

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