

Citation

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Part I Introduction

Chapter 1 provides background and context for the Assessment.

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

1 Preamble

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1.1 Context

Sustainable regional development is a priority for the Australian, Western Australian, Northern Territory and Queensland governments. In 2015, the Australian Government released the ‘Our North, Our Future: White Paper on Developing Northern Australia’ (PMC, 2015), which highlighted the opportunities for regional development based on northern Australia’s water resources. In particular, many rural communities in northern Australia see irrigated agriculture as a means of reversing the long-term human population declines in these 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 sub-tropical 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 establishment and learning phases.

Although 95% of Australia’s irrigated land lies south of the Tropic of Capricorn, and 65% of this is located in the Murray–Darling Basin (MDB), northern Australia is now seen as an opportunity to implement ‘the right policies, at the right time’ (PMC, 2015).

Between 2000 and 2050, the world’s population is projected to grow from 6 to 9 billion people (UNESCO, 2009), and increased food and fibre production is needed to meet anticipated increased demand. Most of this growth is projected to occur in the tropics, particularly sub-Saharan Africa and South-East Asia. Two-thirds of the world’s food insecurity is in Asia, and sharp upward price movements in food have the potential to result in political and social unrest in this region. At the same time, it is projected that Asia will become home to the majority of the world’s middle class,

which will result in an increasing demand for high-quality food produce. Irrigated agriculture in northern Australia has the potential to meet some of that demand as well as the increasing demand for beef.

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 2013, 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). It identified several opportunities for large-scale (greater than 10,000 ha) irrigation development, based on the coincidence of suitable soils and new water storage capacity. The Flinders and Gilbert Agricultural Resource Assessment described the data and analysis required to identify and support development opportunities in north Queensland. The outcome of the assessment was to reduce the uncertainty for investors and regulators, and to give the base information to allow development to occur in a sustainable manner. However, this previous study covered only 155,000 km² (approximately 5%) of northern Australia, and acquiring a similar level of data and insight across northern Australia's more than 3 million km² would require more time and resources than were available at the time.

Consequently, the 2015 Northern Australia White Paper prioritised about a dozen regions in northern Australia where more detailed water and agriculture resource assessments should be undertaken. It also provided \$15 million to initiate the Northern Australia Water Resource Assessment in the Fitzroy catchment (Western Australia), Darwin catchments (Northern Territory) and Mitchell catchment (Queensland) (Figure 1-1).

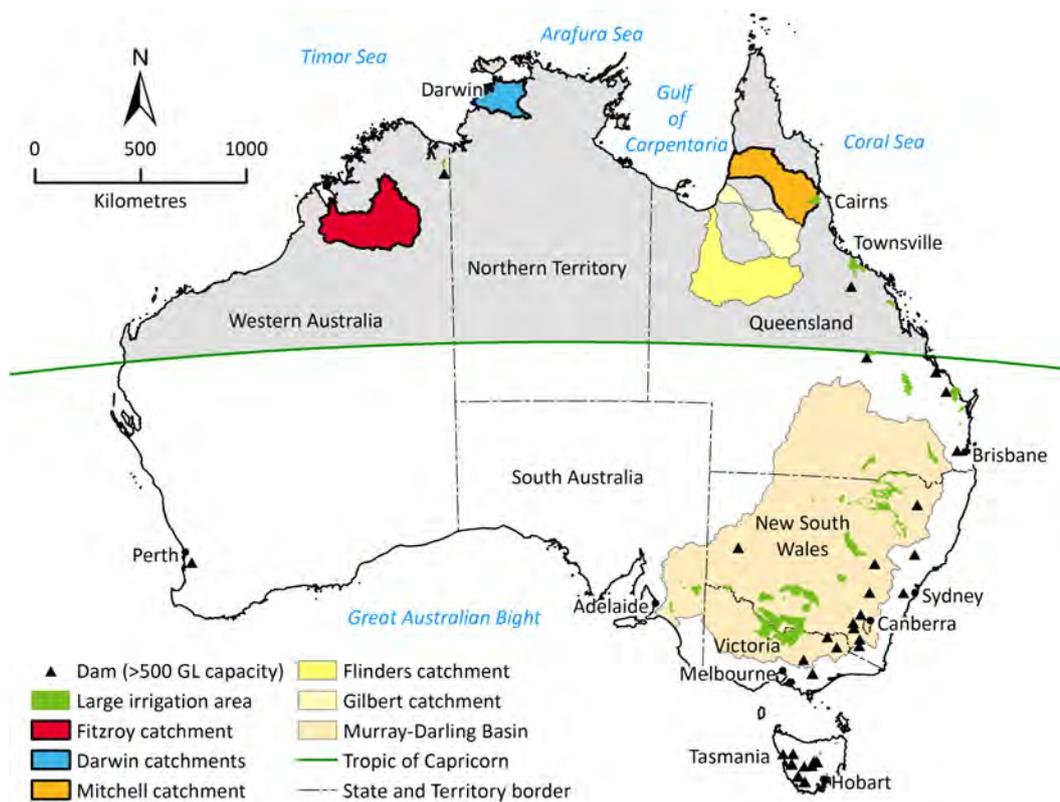


Figure 1-1 Map of Australia showing Assessment area

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 Northern Australia Water Resource Assessment

The Northern Australia Water Resource Assessment has undertaken a comprehensive and integrated evaluation of the feasibility, economic viability and sustainability of water resource development in three priority areas in northern Australia: the Fitzroy catchment, the Darwin catchments and the Mitchell catchment.

The Fitzroy and Mitchell catchments were identified by the Northern Australia White Paper as being suitable candidates for a large-scale assessment of the economics and sustainability of irrigated agriculture because they appear to have large areas of soil suitable for irrigated agriculture and adequate water. The four catchments adjacent to Darwin were chosen because they are relatively close (about one to four hours’ drive) to the third largest population centre in northern Australia, Darwin, the capital of the Northern Territory.

The assessment of each of the three study areas aimed to:

- evaluate the climate, soil and water resources
- identify and evaluate water capture and storage options
- identify and test the commercial viability of irrigated agricultural, forestry and aquaculture opportunities
- assess potential environmental, social and economic impacts and risks of water resource, aquaculture and irrigation development.

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

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 world-class scientific expertise, with the quality assured through peer-review processes.

The Northern Australia Water Resource Assessment took two and a half years between 16 December 2015 and 30 June 2018.

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 Fitzroy, Darwin and Mitchell catchments. The full suite of activities is outlined below (Section 1.2.2), 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, state and territory, and Australian Government. 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 three study areas were in or out of scope. For example, the Assessment was 'blind' to issues such as land clearing 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 possible, 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 1.2.2) with the following activity groups: climate, land suitability, surface water hydrology, groundwater hydrology, agriculture and aquaculture viability, water storage, socio-economics, Indigenous water values, rights and development aspirations, and aquatic and marine ecology.

1.2.2 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/en/Research/Major-initiatives/Northern-Australia/Current-work/NAWRA>

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.
- Catchment reports, one for each of the three study areas, which combine key material from the technical reports, providing well-informed but non-scientific readers with the information

required to make decisions about the general opportunities, costs and benefits associated with water and irrigated agricultural or aquaculture development.

- A development example report, which through case studies in each study area, provides examples of how information produced by the Assessment can be assembled to help readers ‘answer their own questions’. They are illustrative only, designed to help readers understand the type and scale of opportunity in the catchment.
- Summary reports, one for each of the study areas, are provided for a general public audience.
- Three factsheets providing a summary of key findings for the Fitzroy, Darwin and Mitchell catchments for a general public audience.

Audio-visual products

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

- video vignettes summarising key results
- video vignettes demonstrating how to use the Assessment’s internet-based products.

Internet-based products

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.
- The 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 Darwin catchments. 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) 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.

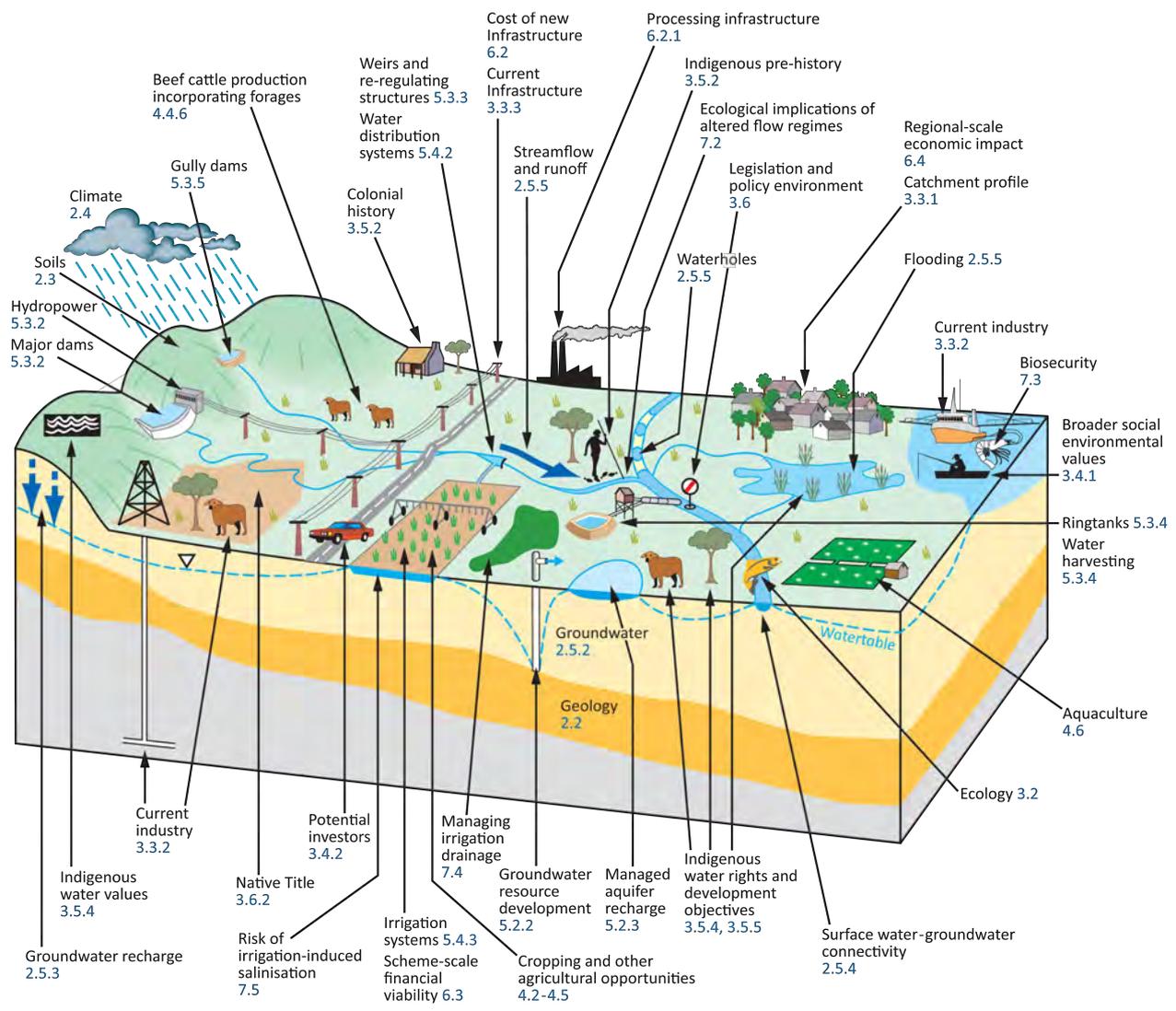


Figure 1-2 Schematic diagram of key components and concepts in the establishment of a greenfield irrigation development

The catchment report addresses questions such as the following:

- What soil and water resources are available for irrigated agriculture?
- What are the existing ecological systems, industries, infrastructure, people and values?
- What are the opportunities for water and irrigation development?
- Is irrigated agriculture economically viable?
- How can water resources be developed and agriculture undertaken sustainably?

Separate catchment reports are provided for the Fitzroy catchment (Petheram et al., 2018a) and the Mitchell catchment (Petheram et al., 2018b). The structure of each 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/s.
- 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 Darwin catchments, describing:

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

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 Darwin catchments, describing:

- ecology: ecological systems and assets of the Darwin catchments 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 Darwin catchments
- stakeholders: their values and potential engagement strategies and the perspectives of potential investors in the Darwin catchments
- Indigenous values, rights, interests, and development objectives: generated through direct participation by Darwin catchments Traditional Owners in the Assessment
- the legal, regulatory and policy environment relevant to water-related development.

1.3.3 PART III – OPPORTUNITIES FOR WATER RESOURCE DEVELOPMENT

Chapter 4 presents information about the opportunities for irrigated agriculture and aquaculture in the Darwin catchments, 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
- the 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 Darwin catchments, describing:

- water storage opportunities including major dams, large farm-scale dams, natural water bodies and subsurface water storage opportunities in the Darwin catchments
- estimates of the quantity of water that could be regulated (i.e. made available for irrigation)
- water distribution systems (i.e. conveyance of water from a dam and application to the crop).

1.3.4 PART IV – ECONOMICS OF DEVELOPMENT AND ACCOMPANYING RISKS

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

- regional-scale economic impacts and the costs of infrastructure
- scheme-scale financial viability, including capital costs, farm performance and value adding
- risks due to variability in farm performance, especially during the early years
- learning and staged development as a means of managing risk.

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 catchments
- 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 location map of the Darwin catchments and surrounds.

1.4 Key background

1.4.1 THE DARWIN CATCHMENTS

The Darwin catchments spans an area of approximately 30,000 km² and is comprised of four predominantly north-south draining catchments: the Finniss (9490 km²), Adelaide (7460 km²), Mary (8075 km²) and Wildman (4820 km²) catchments, as defined by the Australian Water Resources Council (AWRC) river basin boundaries (Figure 1-3). These rivers originate as incised channels in the southern uplands before broadening into alluvial plains and then extensive coastal and marine floodplains eventually flowing into the Arafura Sea. They lie in a broader area known locally as the 'Top End'. Elevation ranges from sea level to the highest point of 385 mAHD on the plateau at the south-eastern boundary. Typically, the catchments are below 100 mAHD elevation with the higher areas along the southern boundary.

The Darwin catchments are characterised by a distinctive wet and dry season due to their location in the Australian summer monsoon. Mean annual rainfall over the 125-year historical period (1890 to 2015) over the Darwin catchments was 1423 mm and decreases from northeast to southwest.

The population of the Darwin catchments is about 140,000, of whom 98% live within the Greater Darwin area. The study area contains two very different settings: the 'urban areas' including Darwin and the surrounding suburbs (Greater Darwin area population was 136,828 as at the 2016 census), and the remaining 'rural areas'. Outside the Darwin urban footprint, the Darwin catchments are characterised by a sparse road network of major roads (Figure 3-18) with the Stuart Highway being the main access to Darwin from the south. Distances across the study area are not great; Darwin to Pine Creek (just outside the southern catchment boundary) is 225 km.

The Darwin catchments fit mostly within the Darwin Coastal and Pine Creek bioregions but contain parts of the Daly Basin and Arnhem Plateau bioregions on the southern and eastern flanks respectively. Land use in the study area is dominated by conservation and natural environments (38%), and production from relatively natural environments (32%). Small areas of dryland agriculture, irrigated agriculture and plantations exist. A significant area is set aside for military training.

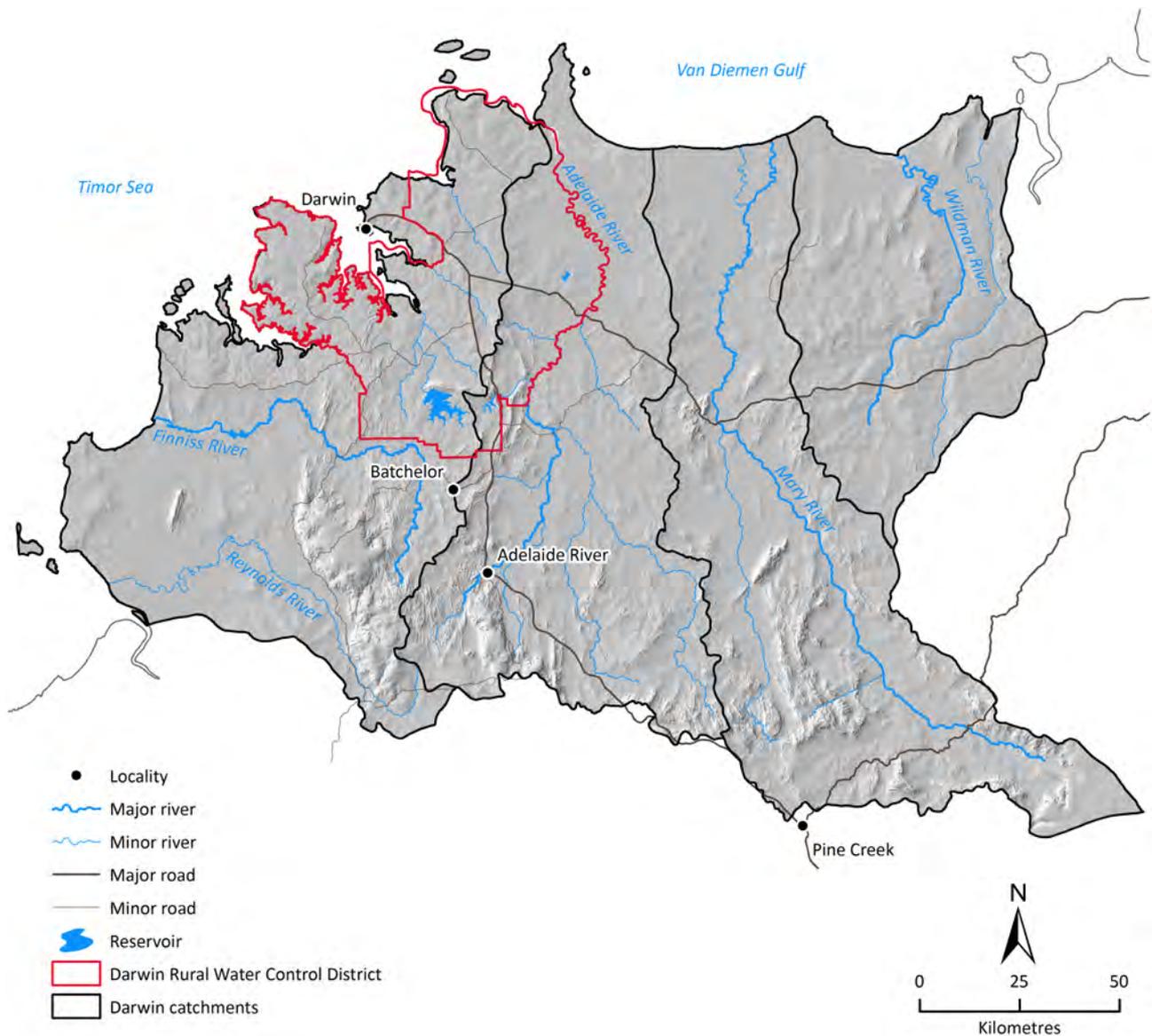


Figure 1-3 The Darwin catchments

A more detailed map of the Darwin catchments can be found on the inside back page of this report.

1.4.2 WET-DRY SEASONAL CYCLE: THE WATER YEAR

Northern Australia experiences a highly seasonal climate, with most rain falling during 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. These definitions were chosen because they are the wettest and driest 6-month periods respectively for all three study areas. 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 project (NASY) (CSIRO, 2009a, 2009b, 2009c) and the Flinders and Gilbert Agricultural Resource Assessment (Petheram et al., 2013a, 2013b):

- 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 is historical climate and current development. The historical climate series is defined as the observed climate (rainfall, temperature and potential evaporation for water years from 1 September 1890 to 31 August 2015). All results presented in this report are calculated over this period unless specified otherwise. The current level of surface water, groundwater and economic development was assumed (as of 31 August 2015). Scenario A was used as the baseline against which assessments of relative change were made. Historical tidal data were used to specify downstream boundary conditions for the flood modelling.

Scenario B

Scenario B is historical climate and future development, as generated in the Assessment. 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. All price and cost information was indexed to mid-2017. The impacts of changes in flow due to this future development were assessed, including impacts on:

- instream, riparian and near-shore ecosystems
- Indigenous water values
- 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 development. It was based on a 125-year climate series (as in Scenario A) derived from global climate model (GCM) projections for an approximate 2.2 °C global temperature rise relative to the ~1990 climate statistics, which under the Representative Concentration Pathway (RCP) 8.5 socio-economic narrative (i.e. high emissions scenario) was projected to occur in about 2060. The GCM projections were used to modify the observed

historical daily climate sequences. The current level of surface water, groundwater and economic development were assumed. Carbon dioxide concentrations were perturbed to reflect projected 2060 carbon dioxide concentrations under RCP 8.5.

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 1890 to 31 August 2015) 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 STUDIES

The case studies in the Assessment are used to show how information produced by the Assessment can be assembled to help readers ‘answer their own questions’. They are also used to help readers understand the type and scale of opportunity for irrigated agriculture or aquaculture in selected parts of the Assessment area, and explore some of the nuances associated with greenfield developments in the study area. Case studies are provided for each study area.

The case studies are illustrative only. They are not designed to demonstrate, recommend or promote particular development opportunities that may be being currently proposed, nor are they CSIRO’s recommendations on how development in the Darwin catchments should unfold. However, they are designed to be realistic representations. That is, the case studies will be ‘located’ in specific parts of the Assessment area, and use specific water and land resources, and realistic intensification options.

The case studies are described in full in the companion technical report on case studies (Petheram et al., 2018c).

1.5 References

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