Northern Australia Environmental Resources Hub

National Environmental Science Programme

# Multi-objective planning in northern Australia: co-benefits and trade-offs between environmental, economic, and cultural outcomes

Final report

Jorge G. Álvarez-Romero, Milena Kiatkoski Kim, David Pannell, Michael Douglas, Ken Wallace, Rosemary Hill, Vanessa Adams, Alaya Spencer-Cotton, Mark Kennard, Bob Pressey

James Cook University Australia
The University of Western Australia
CSIRO
Griffith University Queensland, Australia
University of Tasmania

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[1] Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, QLD 4810, Australia
[2] Centre for Environmental Economics and Policy, School of Agriculture and Environment, The University of Western Australia, Crawley, WA 6009, Australia
[3] School of Biological Sciences, The University of Western Australia, Perth, WA 6009, Australia
[4] CSIRO and James Cook University Division of Tropical Environments and Societies, Cairns, QLD 4878, Australia
[5] School of Technology, Environments & Design, University of Tasmania, Hobart, TAS 7001, Australia
[6] Australian Rivers Institute, Griffith University, Nathan, QLD 4111, Australia

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Back cover: Satellite image of the lower Fitzroy River catchment and King Sound. © ESRI

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# Contents

# List of figures

# List of tables



# List of boxes

# Abbreviations and acronyms

ABS.....Australian Bureau of Statistics
CC.....Carrying capacity
CVS.....Conservation Value Summary (NatureServe Vista)
EPBCA.....Environmental Protection and Biodiversity Conservation Act
FTE .....Full-time equivalent
FX .....Fitzroy Crossing, Western Australia
GA.....Geoscience Australia
GIS.....Geographic Information System
ILSM.....Indigenous Land and Sea Management
ILUA .....Indigenous Land Use Agreement
IPA .....Indigenous Protected Area
IUCN .....International Union for Conservation of Nature
JCU .....James Cook University
KAP.....Knowledge adoption plan
KDC .....Kimberley Development Commission
KLC .....Kimberley Land Council
NAERH .....Northern Australia Environmental Resources Hub
NAWFA .....Northern Australia Water Futures Assessment
NAWRA.....Northern Australia Water Resource Assessment
NERP .....National Environmental Research Program
NESP .....National Environmental Science Program
NGO.....Non-government organisation
NRM.....Natural resource management
NTD.....Native Title Determination
PBC.....Prescribed Body Corporate
PSP.....Participatory scenario planning
SDWK .....Shire of Derby-West Kimberley
SOHC.....Shire of Halls Creek
SNA.....Social network analysis
ST .....Scenarios team
TO .....Traditional Owner (Aboriginal Australian)
ToC .....Theory of change
TRA.....Tourism Research Australia
TRaCK .....Tropical Rivers and Coastal Knowledge
UWA.....University of Western Australia
WoC .....Working on Country program

# Acknowledgements

The authors of this report would like to acknowledge the Traditional Owners and Custodians of Country throughout Australia and their connections to land, water, and community. We pay our respect to their Elders past and present, and extend that respect to all Aboriginal and Torres Strait Islander peoples today.

In particular, we wish to acknowledge the Traditional Owners of the Martuwarra (Fitzroy River) catchment, the Bunuba, Giniyjawarrni Yoowaniya Riwi, Gooniyandi, Jaru, Kurungal, Mangala, Ngarrawanji, Nyikina, Warrwa, Wilinggin, Yi-Martuwarra Ngurrara, Yungngora, and Yurriyangem Taam peoples. We recognise their continuing culture and contributions to the Kimberley region and Australia.

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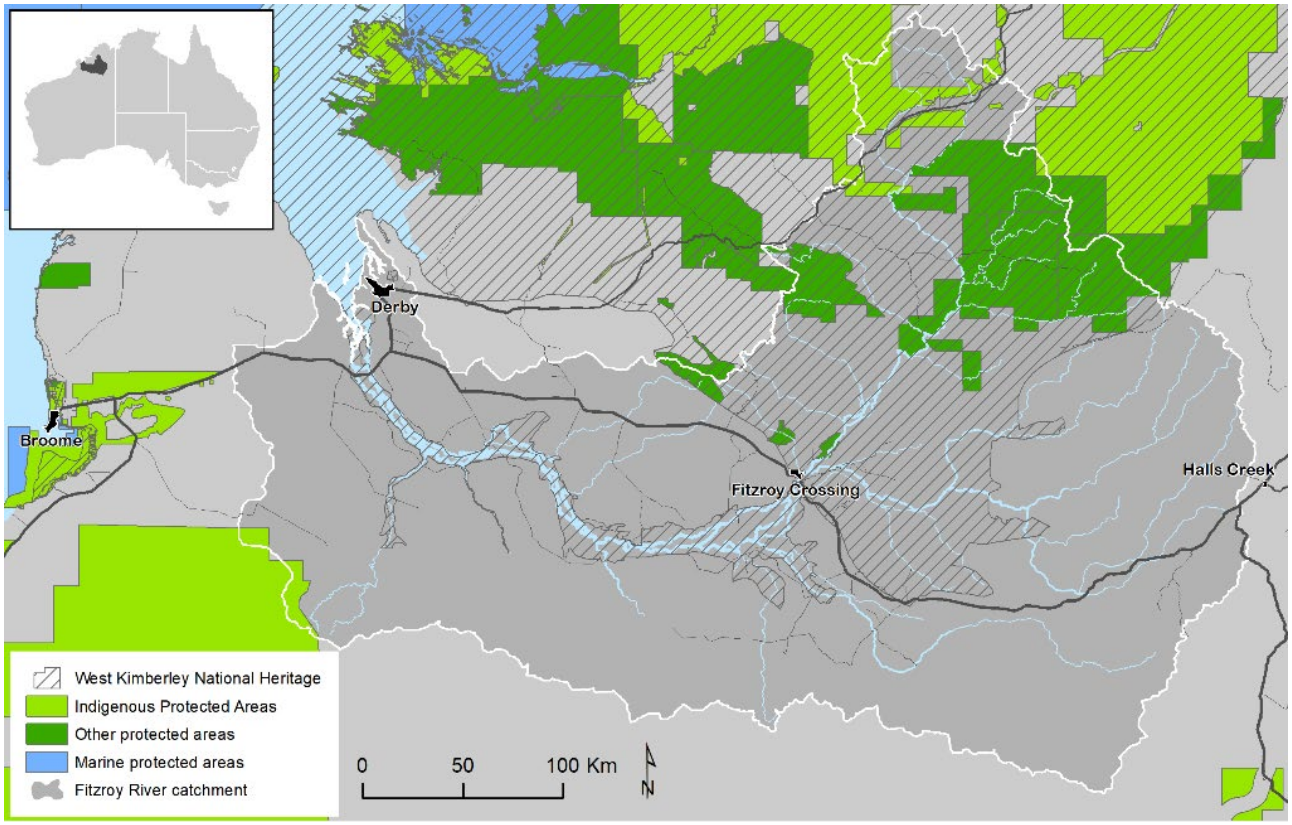
# 1. Executive summary

Given ongoing plans to develop northern Australia and resulting tensions among diverse interest groups, there is a need to develop new planning approaches that support multiple uses of land and water, while maintaining environmental and cultural values. This project aimed to demonstrate one way to operationalise multi-objective catchment planning through the creation and exploration of scenarios. The project used the Fitzroy River catchment in the Kimberley region of Western Australia as case study, hereafter 'Fitzroy catchment' (**Figure 1.1**).

*Figure 1.1. Fitzroy catchment used as case study area of the project.*




We used participatory scenario planning (PSP) to undertake a systematic and critical examination of possible development trajectories and their environmental and socioeconomic outcomes. Scenarios are stories that consider how alternative futures may unfold and allow people to consider and discuss their perceptions and visions of the future. Scenarios are useful to identify opportunities and risks associated with decisions – for example, environmental and socioeconomic changes associated with alternative development options. Through this multi-stakeholder PSP process, Traditional Owners and stakeholders (hereafter 'scenarios team') collaboratively built and assessed the outcomes of four alternative futures for the catchment in 2050.

This technical report describes the process and outputs of this project, which can be used in similar projects aiming to inform future land and water use decisions. The project was developed in five stages, hereafter 'modules', which describe the methodologies, tools, inputs, and outputs used along the project.

The five modules, summarised below, are:

1. Scoping: identify stakeholders, assemble the scenarios team, and understand the planning context.

2. Mapping values: identify and model landscape features of potential conservation and socioeconomic value.

3. Creating scenarios: share views about development, explore driving forces of land use change, and develop a set of four plausible alternative development scenarios.

4. Mapping scenarios: produce spatial configurations of future land uses under each scenario.

5. Assess scenarios: explore, discuss and assess potential changes in wellbeing associated with each scenario.

This project generated methods, information, tools and spatial outputs that can support spatial planning in the study area but are adaptable to use elsewhere. In particular, the project aimed to support the planning and decisions of multiple groups with significant and diverse interests in the Fitzroy catchment. These groups were represented in the PSP process by diverse organisations, including government agencies (federal, state, local), Aboriginal corporations representing the interests of Traditional Owners, industry (agriculture, mining, and tourism), environmental groups, and natural resource management (NRM) organisations.

## 1.1. Module 1: Scoping

### *1.1.1. Aim*

Activities in this stage aimed to:

- Ensure early and effective involvement of Traditional Owners and stakeholders (hereafter ‘participants’) in order to promote the ownership and use of outputs by participants.

- Identify current and future land and water use issues and identify the people that would become part of the team participating in the scenario development and assessment workshops.

- Understand the preferences of different interest groups regarding opportunities and constraints around different land uses associated with ongoing and future developments.

### *1.1.2. Activities*

We started by presenting, discussing, and refining the research approach with key research users.

This stage involved three main activities:

a) Undertaking a comprehensive literature review of planning in the region: we compiled and summarised about 30 planning exercises, including ongoing, proposed, and completed, all relevant to inform different aspects of multi-objective planning.

b) Assembling the scenarios team: the process of selecting candidates for the team followed two steps. First, we did a quantitative analysis of collaboration networks using social network analysis, which identified the top 30 organisations playing important roles in NRM in the region. Candidates included people from these organisations, in addition to 15 others identified through interviews (described below). Participants were selected from a list of candidates using the following guiding criteria: knowing about development in northern Australia; being insightful,

curious and systemic thinkers; being influential; having experience in planning or on-ground land management; and being action-oriented.

c) Interviewing the members of the scenarios team to gather information about the diversity in understandings, concerns, and aspirations around development in the region, as well as to discuss expectations, perceptions and suggestions regarding the research process.

### *1.1.3. Results*

Our early engagement with stakeholders resulted in a project that could respond to important information needs of research users and reflected their views in the approach to the scenario planning process. The main results of this stage are the following:

a) The literature review identified key elements of planning exercises relevant to the Fitzroy catchment and sources of information for the project. Through the review, we also identified and refined our list of organisations to involve in the project activities. It improved our understanding of development and conservation goals of different stakeholder groups and sectors.

b) Assembling the team involved inviting all main actors with a stake in the future of the region, including people from organisations making and/or influencing decisions about land/water use and management to participate in the development and assessment of scenarios. The group benefitted from including people in positions (e.g. within government, business, civil society) that can influence or enable changes in the region.

   Overall, the project included 58 participants from 30 different organisations representing interests and perspectives of Traditional Owners, federal, state and local government (including agencies from the agriculture, conservation, environment, lands, mining, planning, and water sectors), natural resource management, industry (agriculture, pastoral, tourism, mining), and environmental organisations.

c) We interviewed 26 members of the scenarios team between 14 March and 28 May 2018. Interviewees worked for: Aboriginal corporations (six organisations, all self-identified as Aboriginal people); federal (two), state (nine) and local governments (one); non-government organisations (NGOs; two); and the mining (three), pastoral (two) and tourism (one) industries.

   We identified two general contrasting views on development from the interviews:

   - Almost a quarter of interviewees (23%) emphasised the need for economic growth in the Fitzroy catchment. Some of those considered that agriculture would be an appropriate base for development, while others suggested a more varied production base could be more beneficial. The, sometimes implicit, premise in such statements was that economic growth would create jobs and the associated income would improve the access to services, thereby addressing social problems in the region and potentially improve wellbeing.

   - In contrast, 19% were critical of a development model focused on financial gains. They suggested that a largely economic focus could affect people's wellbeing adversely, resulting in risks to human health and the environment. Some of these interviewees questioned whether the benefits of economic growth would 'trickle down' to residents, based previous experiences in the region. About 42% considered that the historical model of development has resulted in an unequal or unfair distribution of benefits. Among these, 31% stated that external investors had benefited most, to the detriment of local (and especially Traditional Owner) groups, who had contributed significantly to the economic growth in the region.

   Despite noted differences, most interviewees (62%) considered that planning for future development should balance financial and social outcomes, focusing explicitly on benefits to residents, especially Traditional Owners.

## 1.2. Module 2: Mapping values

### *1.2.1. Aim*

The aim of this module was to identify and map landscape features associated with social, economic, and cultural values across the Fitzroy catchment. Values refer to the potential benefits associated with natural assets and the capacity of the landscape to support different economic activities. The information generated in this stage aimed to guide the mapping of future land use maps and support the assessment of changes in the landscape associated with alternative development scenarios.

### *1.2.2. Activities*

Through a review of the scientific literature and spatial data repositories (e.g. NRM plans, scientific studies, government reports, public databases), we identified diverse landscape features of potential value for the project. These included species of conservation and cultural importance, terrestrial and aquatic ecosystem types, and land potential for different industries (e.g. agriculture, carbon farming, mining). We also identified and collated information about landscape processes threatening these values, such as altered fires regimes and invasive species.

We collated publicly available spatial data related to Aboriginal cultural heritage, but we did not to use or share this information based on discussions and advice about the limited time and resources that would be required to follow an appropriate process to obtain prior informed consent from the corresponding Aboriginal organisations. This was beyond the scope of the project.

All the information was documented, prepared and processed using Geographic Information System (GIS) tools, including extracting or sub-setting data to areas and components relevant to our study area, correcting spatial inaccuracies (e.g. topological errors, incomplete and outdated data), supplementing spatial data with new features or attributes, integrating multiple datasets, and other spatial processing steps to ensure quality and usability for further analysis in subsequent stages of the project. We also used spatial modelling, optimisation, and conservation planning tools (e.g. MaxEnt, Marxan, Nature Serve's Vista) to identify areas of socioeconomic and conservation interest across the region.

### *1.2.3. Results*

The result of this stage resulted in hundreds of spatial layers (maps) representing individual features (e.g. species distributions, habitats), composite maps (e.g. species richness), and prioritised areas (e.g. conservation areas), including the following broad types:

- Areas with value for biodiversity conservation, based on current distribution of features of conservation interest, habitat types, and predicted distribution of aquatic and terrestrial species, including species important for subsistence and of conservation concern in northern Australia.

- Areas of potential importance for carbon farming via savanna burning, based on fire history, vegetation types, potential carbon abatement, management costs, profitability, carbon price, and management efficiency.

- Areas of potential importance for agriculture, based on land suitability for different dry- and wet-season crops and aquaculture, as well as other spatial constraints to agriculture developments, such as access to water, flood risk, and accessibility to areas with potential for agriculture.

- Areas of potential importance for grazing, based on long-term average carrying capacity (CC) of land systems based on accessibility and utilisation of pasture, median pasture growth (kg/ha), reduction in grasses/CC due to fires, and accessibility to grazing areas.

- Areas of potential importance for resource extraction, based on available data on current and proposed mining leases and exploration permits (e.g. petroleum, minerals, coal, infrastructure, known mineral occurrences).

- Areas of potential importance for subsistence and recreational use of terrestrial and aquatic plants and animals, based on information about the presence of species of recreational and subsistence importance, access to areas (influenced by distance to populated areas, existing roads, terrain, and type of vegetation), and the availability and quality of habitat.

As noted above, mapping 'cultural values' was outside the scope of this project because it requires a dedicated and extensive process co-designed and implemented with Traditional Owners. Other considerations included known issues and challenges regarding mapping of these values, participation fatigue, and disclosure/sharing of culturally sensitive information.

## 1.3. Module 3: Creating scenarios

### *1.3.1. Aim*

The aim of this stage was to design and implement a participatory scenario planning process to create logical, possible, and distinguishable scenarios of development trajectories for the Fitzroy catchment in 2050. This included creating a space for constructive conversations about the future development of the region. Activities and outputs aimed to create shared understandings about development, explore drivers of land use change, identify development initiatives, building the structure the scenarios, and fleshing out scenarios.

### *1.3.2. Activities*

Researchers worked with the scenarios team through two facilitated multi-stakeholder workshops to develop shared understandings about development options for the region and systematically explore possible development trajectories. The workshop activities were supplemented with conversations and one-on-one meetings with participants and desktop analyses to refine and flesh out the scenarios.

During *workshop 1* the scenarios team worked together and in groups to:

a) Build a shared understanding of what is happening in the system of which team members are part of and which they want to influence. This was achieved through a group discussion on the meaning of 'development' and an exercise to mapping out key events that changed the region over the past 60 years.

b) Identify the driving forces shaping development in the region and that could influence land use change in the catchment. This was achieved through subgroup discussions to identify and describe the drivers, and plenary discussions to identify those that were missing or common across subgroups.

c) Identify development initiatives that have been proposed or that could be implemented in the catchment. This was achieved through subgroup discussions in facilitated tables, including the identification of people and sources of information to document and explore these initiatives further.

During *workshop 2* the scenarios team worked together and in groups to:

d) Identify the most influential drivers for the region (those with the potential to cause major shifts in terms of the extent of land use change in the next 30 years). Participants identified and ranked the top-5 drivers based on their perceived influence on land use change using an online survey completed with help of table facilitators.

e) Identify the drivers that participants are most uncertain in terms of how they will play out in the future and thus could shift development in very different directions. Participants identified and ranked the top-5 drivers based on the perceived uncertainty about the direction the drivers could take using an online survey.

f) Select a subset of drivers based on the results of both rankings to identify drivers that are both highly influential and uncertain, including identifying the top-two drivers that would be used to describe the main differences between scenarios and other key drivers that could shape development in the region further.

g) Describe the possible variations of the selected drivers. In small groups, participants defined at least the two end states (opposite poles, e.g. low and high) and, if needed, intermediate states (e.g. low, moderate, high) for each driver, and wrote brief texts describing how these alternative states might look like.

h) Combine the top-two most influential and uncertain drivers to create the logic or structure that would define the four scenarios. This required additional discussions during the workshop and electronically to refine the meaning of drivers and to define the final structure of the four scenarios.

Following the two workshops and one-on-one discussions with members of the scenarios team, researchers refined the structure and narratives of the four scenarios before fleshing out the four scenarios. This involved desktop work informed by previous research, expert advice, and feedback from participants, to describe the key features of scenarios, including the landscape and socioeconomic changes associated with each scenario.

### *1.3.3. Results*

*Workshop 1*

- Description of key historical events and periods of time where change has been most evident, notably shaping the region. Using this information, researchers created an online map-based Story Map (storymaps.arcgis.com) of the timeline, which can be viewed online. Researchers are exploring the option to share, update, and include new events into the timeline.

- Full list of driving forces that could shape the future of the catchment in the next 30 years and detailed description of the 14 drivers identified by the scenarios team as the most relevant in terms of their influence of land use change in the Fitzroy catchment.

- List of development initiatives proposed for the region, which supplements the draft list derived from the interviews. Based on this list, researchers compiled available studies and spatial information relevant to inform planning. Developing the scenarios included a detailed exploration and mapping of development initiatives with sufficient information (e.g. spatial data, land/water requirements) required for the land use mapping and socioeconomic analyses.

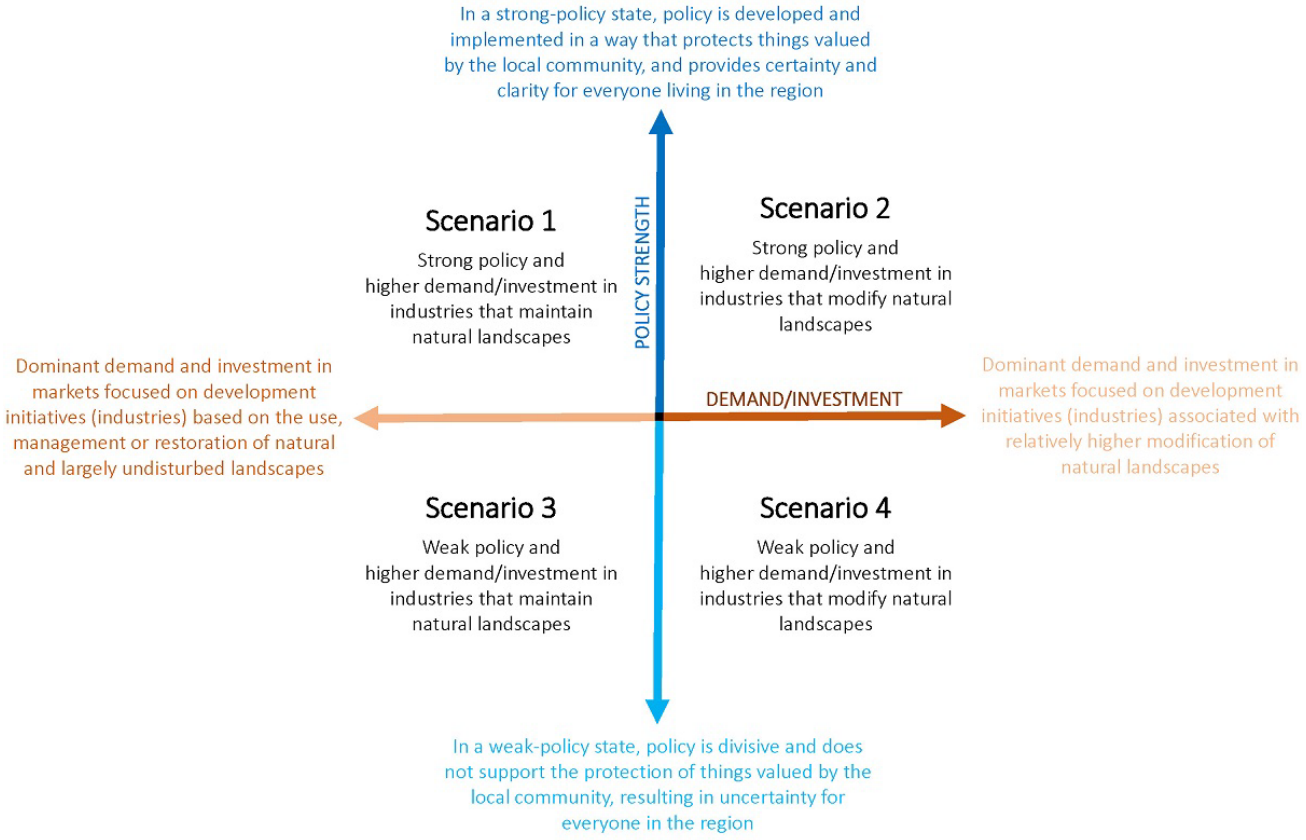
*Workshop 2*

- A graphical analysis of drivers based on the ranking of drivers based on their potential influence and uncertainty. This graph was used to identify the six most important drivers. Policies and markets were ranked as highly influential and uncertain, but the results were used to identify another four drivers (leadership, Indigenous governance, technology, and tenure reform) used while fleshing out the four scenarios.

- The structure of the four scenarios based on the combination of the two most influential and uncertain. The resulting scenarios (**Figure 1.2**) were built based on steps (a) to (g). Social and environmental impacts are not implicit in the definition of the drivers, and end state do not represent ‘good’ or ‘bad’ states or paths to development, simply different possibilities.

Development initiatives in either side of the spectrum could have small or large and positive or negative environmental and/or socioeconomic impacts, which will depend on a combination of location, footprint, risks, and approach of the development initiatives. The potential impacts were explored by the scenarios team during the assessment stage of the project.

*Figure 1.2. Four scenarios for the Fitzroy catchment in 2050.*




## 1.4. Module 4: Mapping scenarios

### *1.4.1. Aim*

The aim of this module was to use the outputs of module 3, including tables and narratives created by the scenarios team, to created possible spatial representation of the scenarios.

### *1.4.2. Activities*

Researchers used available information, including maps and computer modelling tools, to create maps representing each scenario. These maps are not predictions of the future, rather possible spatial representation of scenarios. Whilst this was a desktop exercise, researchers drew on the knowledge of the scenarios team to inform the construction of alternative configurations of land and water uses (including proposed developments, e.g. agricultural precincts).

Building future land use maps was guided by spatial analyses using GIS and Marxan (conservation areas), a readily available and widely used spatial optimisation software. Individual land use allocation analyses were undertaken in GIS using standard modelling suitability analyses based on available spatial data about land use/management constraints (e.g. tenure, Native Title, protected areas, land use agreements) and landscape suitability (e.g. agriculture suitability, conservation value, carbon abatement potential, flooding risk). Future land use configurations were guided and constrained by defined scenarios and available spatial data.

Based on the scenario features, the maps were constructed sequentially by preferentially allocating each new land use associated with the type of development initiatives expected to be more prominent in the corresponding scenario. We used ArcGIS weighted overlay tool, a method commonly used to inform suitability modelling and multicriteria analyses. The amount of land under new land uses was guided by the scenario narratives and constraints determined based on literature and expert advice.

### *1.4.3. Results*

The result of the module was the creation of five different land use maps representing the distribution of the new land uses that we were able to model using available information. These included aquaculture (barramundi), irrigated agriculture (supplied by both off-stream and groundwater), carbon farming via savanna burning, environmental management, and resource extraction. The representation of resource extraction and potential areas with potential for cultural and nature tourism were not linked to specific land use changes but described in terms of their extent and maps representing their potential distribution were presented to support the scenario assessment in the next stage. Following is a brief summary of the main inputs and features of the modelled land uses used to build the scenarios:

*Aquaculture*: scenarios were constructed based on barramundi aquaculture farms (earthen lined ponds, using local water supply) located near Derby. The spatial distribution was based on land suitability, development costs (infrastructure, access), available water options, risk (flooding), and avoidance of areas of high conservation value. Scenarios including aquaculture assume these enterprises could generate an internal rate of return >7% despite remoteness of the catchment, assuming efficient operations, infrastructure and investment.

*Irrigated agriculture*: scenarios were constructed based on variations of two options under consideration: a mosaic of irrigated cotton–mungbean–forage sorghum rotation (groundwater) and irrigated forage Rhodes grass, both integrated into existing beef enterprises. The scale of developments was based on best estimates of potential water availability and use for relevant crops. The spatial distribution was based on land suitability, development costs (infrastructure, access), available water options, risk (flooding), and avoidance of areas of high conservation value.

*Carbon farming*: scenarios were constructed based on savanna burning, which involves management regimes that makes extensive use of strategic early dry season burning, with fires deliberately lit at times of mild fire weather, and in parts of the landscape where burnt areas will be most effective as firebreaks. Such burning is likely to reduce the occurrence of large/severe late dry season fires. Scenarios with more extensive savanna burning will likely have additional benefits for pastoral industry by reducing loss of grass and infrastructure to wildfires. Well-established practices and growing market, particularly for northern Australia indicated this was a viable industry in the catchment. Revenue estimates are conservative and only based on abatement, but new carbon abatement and sequestration methods could mean higher revenue.

*Environmental management*: scenarios were constructed assuming a combination of national and state conservation parks, IPAs, private reserves (which may involve active management and total or partial exclusion and management of livestock to minimise grazing impact and restore critical habitats), and other stewardship programs (e.g. ILSM, conservation covenants) funded by government and private funding sources. The location determined using spatial optimisation tools (Marxan) based on representation of features of conservation interest based on their rarity and vulnerability (varying across scenarios): bioregions; species (plants, fish, amphibians, reptiles, birds, mammals, invertebrates); ecosystems (vegetation types, land systems, aquatic systems); water bodies (dry season pools, billabongs, wetlands, etc.); vegetation cover and structure.

*Resource extraction*: to estimate the likelihood of resource extraction taking place within the catchment, we collated all available data on current and proposed mining leases and exploration permits (petroleum, minerals, coal, infrastructure and known mineral occurrences). The data from

each source was split into five categories in order of likelihood: currently active mine sites; proposed mines and applications for mining leases; current exploration permits; known resource presences; and applications for exploration permits and areas advertised for exploration. In scenarios of strong governance, risk for resource extraction was considered low within the boundaries of the West Kimberley National Heritage site and the boundaries of the conservation areas were used to exclude these areas from the corresponding scenarios. The impact of resource extraction on the environment depends on projects following policy, best practice, and environmental impact guidelines and cannot be estimated without dedicated studies.

*Cultural and nature tourism*: scenarios did not include spatially explicit areas for new tourism enterprises but assumed that the existing and new conservation areas (mainly conservation parks, IPAs and private wildlife reserves) will be the focus of these activities. Enterprises may vary in their scope, but we assumed most would incorporate a combination of cultural- and nature-based tourism aspects and, due to its nature, new enterprises would be predominantly lead and managed by Indigenous organisations.

## 1.5. Module 5: Assessing scenarios

### *1.5.1. Aim*

The aim of this module was to develop and test a method to identify and assess the potential effects of alternative development pathways on the wellbeing of different social groups. The question guiding the assessment of scenarios was: How could changes associated with future scenarios affect (positively or negatively) the wellbeing of people who live in or have significant interests in the Fitzroy catchment?

### *1.5.2. Activities*

The assessment described in this section systematically explored possible changes in people's wellbeing under each scenario. We held two scenario assessment workshops: a multi-stakeholder workshop with the scenarios team and a workshop with Traditional Owners only. We asked participants how people currently satisfy nine wellbeing categories in the catchment (**Table 1.1**). Participants then used a scale to rate the level of worsening or improvement of each wellbeing category in each scenario against the current situation. Participants discussed the rationale behind their scores throughout the process.

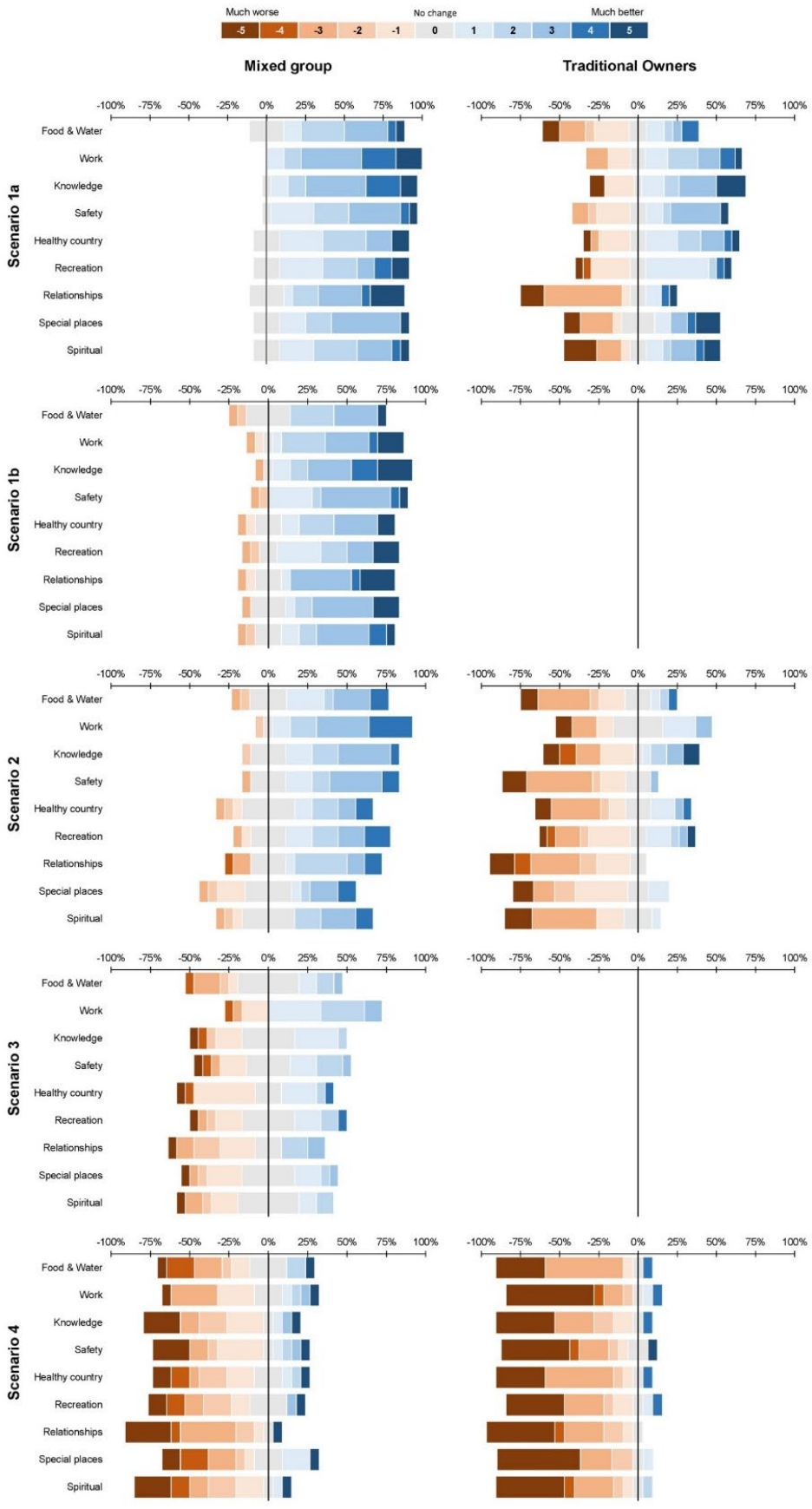
*Table 1.1. Definitions of the wellbeing categories for the scenario assessment*

| Categories include having… | Description and example |
|---|---|
| *Enough food and water to drink* | Having enough food and drinking water. Having wood or power to cook food. Includes beef, fish, bushfood, and food from the supermarket. |
| *Satisfying work* | Work that makes you feel good. Includes paid, unpaid, full time, part time, and casual work. |
| *Knowledge of country and culture* | Knowledge that comes from country/nature and knowledge that comes from special places, such as dreamtime places, water places and historic sites such as station homesteads, cattle yards, and rock art. |
| *Safety/security* | Living in country where you are safe from:<br>• Disease and injury<br>• Feral animals, mosquitoes and their diseases<br>• Poisonous and other dangerous plants and animals<br>Living in country where you are safe from people with altered behaviour (e.g. people affected by drugs and alcohol). |
| *Healthy country and river* | Having a good, comfortable environment where you are not too hot, not too cold. An environment where you are not affected by heavy dust, fire/smoke, or poisons like pesticides. Includes wood for warmth, clothes to wear, good houses and air conditioning, and shade from trees. |
| *Fun – recreation, leisure* | The happiness you get from having a good time. Includes recreation such as camping, fishing, boating, having a picnic. |
| *Strong family and community relationships* | Family fulfilment (contentment): includes belonging to a family (e.g. a kinship or skin group) that provides:<br>• Harmonious and supportive relationships<br>• Sense of family belonging<br>• Some close friendships, not necessarily within the immediate kinship group.<br><br>Community fulfilment (contentment): includes belonging to a group, or groups, that provide harmonious and supportive relationships at a group level. Leads to a sense of social belonging and influences self-respect and dignity. |
| *Places and things that make you feel good* | Having places or things that are beautiful; that you will never get sick of looking at; that you can look at day in and day out and you still like it. Affects all the senses – touch, taste, smell, hearing, seeing. Examples include a beautiful landscape, boomerang, painting; or the smell of plants and the ground after rain. |
| *Inner peace, spiritual fulfilment* | The peace you get from living a life that is in harmony with your beliefs and having a strong spiritual connection with your environment. |

### *1.5.3. Results*

Despite the notable variation in responses (**Figure 1.3**), participants' ratings followed a similar pattern in both workshops, with scenarios 1, $1_b$ and 2 (strong policies) being rated positively by the majority of participants across most categories, and scenarios 3 and 4 (weak policies) being rated mostly negatively. Scenario 2, with increased large-scale irrigation, was scored mostly positively by the multi-stakeholder group, and mostly negatively by Traditional Owners. Graph adapted from Kiatkoski Kim et al. (Kiatkoski Kim et al., 2021a; Kiatkoski Kim et al., 2021b); Scenarios $1_b$ and 3 were not assessed during the workshop with Traditional Owners.

*Figure 1.3. Participant ratings of scenarios per workshop.* The diverging bars show the percentage of participants that rated positively (blue tones, right), negatively (orange tones, left), or neutrally (grey, centre) the changes in each wellbeing category for each scenario. Different tones of orange or blue correspond to the level of decline or improvement, respectively. The width of each segment corresponds with the percentage of participants that rated the change



In the TOs' workshop, the negative ratings seem to be linked with an aversion to large-scale irrigated agriculture and its perceived potential impacts, especially the withdrawal of water from the river (but also groundwater) and pollution. Another important potential impact of large-scale agriculture noted by participants was the potential loss of access to country, which could decrease 'inner peace and spiritual fulfilment', as well as other aspects of wellbeing.

'Knowledge of country and culture' seemed to improve in scenarios 1 and 2 (and 3, but it was rated positively by only one participant), being mostly related to an increase in ranger jobs, and to better access to country in scenario 1. 'Satisfying work' was also positively assessed in scenarios 1 and 2, mainly due to the increase in ranger jobs and the potential for Aboriginal-owned enterprises. However, participants emphasised that these jobs and enterprises could only be fulfilled by TOs, and thus be considered as satisfactory, if there were training initiatives in place to build TO's capacity. Likewise, 'satisfying work' was the most negatively affected category in scenario 4 due to limited ranger jobs and uncertainty regarding who would be able to fulfil those vacancies.

In the scenarios team workshop, participants emphasised the importance of good governance, strong policies, and regulation of economic activities so that residents can benefit from such activities. Conversely, in weak-policy scenarios there could be negative social and environmental impacts that would affect residents and communities; and the eventual economic benefits could be reaped by a few locals, or by non-residents (e.g. temporary workers and corporations). 'Satisfying work' improved in all scenarios, but especially in scenarios 1, $1_b$ and 2; and 'knowledge of country and culture' improved in scenarios 1 and $1_b$, possibly linked to improved access to country and employment that could allow people to spend time on country. Conversely, 'healthy river country' worsened in scenarios 2, 3 and 4, possibly linked to the larger potential expansion of irrigated agriculture and associated potential impacts from, for example, the extraction of water and use of pesticides.

Our approach to assess the potential effects of alternative scenarios on wellbeing, focusing on stakeholders' perceptions of changes in wellbeing, can complement and improve the current use of objective wellbeing indicators in scenario planning. The methodology produced rich and nuanced results that can support ongoing planning initiatives. Moreover, its application in a cross-cultural and contested landscape reinforces its usefulness in a range of contexts.

# 2. Introduction

There are varied development plans for northern Australia, including irrigated agriculture, nature and cultural tourism, extraction of mineral resources, payment for ecosystem services (e.g. carbon farming), and others (Hill et al., 2006; Australia 2015; Gerritsen et al., 2019). New developments can alter terrestrial and aquatic ecosystems and compromise some of the services they provide (e.g. carbon sequestration, water supply, traditional uses), as well as modify the access to land and water resources by different groups (Stoeckl et al., 2015; Bryan et al., 2016; Connor et al., 2019). Yet, the views about the costs and benefits of development options vary (Chambers et al., 2018; Chambers et al., 2019; Gerritsen et al., 2019), and knowledge about their effects on people and biodiversity is limited (Stoeckl et al., 2015; Adams et al., 2016a; Whitehead et al., 2016; Connor et al., 2019; Boschetti et al., 2020).

Exploring possible development options and having a better understanding of their socioeconomic and environmental outcomes can improve management decisions (Adams et al., 2016a; Bryan et al., 2016; Grundy et al., 2016). This requires identifying the broader social, economic, and political environment that could lead to different development projects (KDC 2015; Adams et al., 2016a; Bryan et al., 2016; ACF 2017). A critical examination of the possible futures of the region can support effective planning for development and conservation of northern Australia's nationally and globally significant cultural and natural values (Álvarez-Romero et al., 2015a; Pintor et al., 2019).

Scenario planning can be useful to deal with high uncertainty and low controllability of management decisions (Peterson et al., 2003; Oteros-Rozas et al., 2015; Cork 2016), thus it can help inform discussion around development, particularly given the diverse socioeconomic and political factors shaping development in northern Australia (Dale et al., 2014; Adams et al., 2016a; Adams et al., 2017). In particular, participatory scenario planning (PSP) exercises can promote ownership by stakeholders, allow collaborative and innovative development of solutions (Beery et al., 1997; Cork 2016; Allan et al., 2018), and provide opportunities for useful conversations about alternative development futures for the region (Bohnet and Smith 2007; Butler et al., 2012; Auge et al., 2017).

The National Environmental Science Programme (NESP) Northern Australia Environmental Resources Hub's project on multiple objective planning in northern Australia used PSP to construct and assess the outcomes of alternative development scenarios in the Fitzroy catchment, Western Australia. The scenarios team worked through a series of workshops to explore possible development pathways for the catchment and their outcomes.

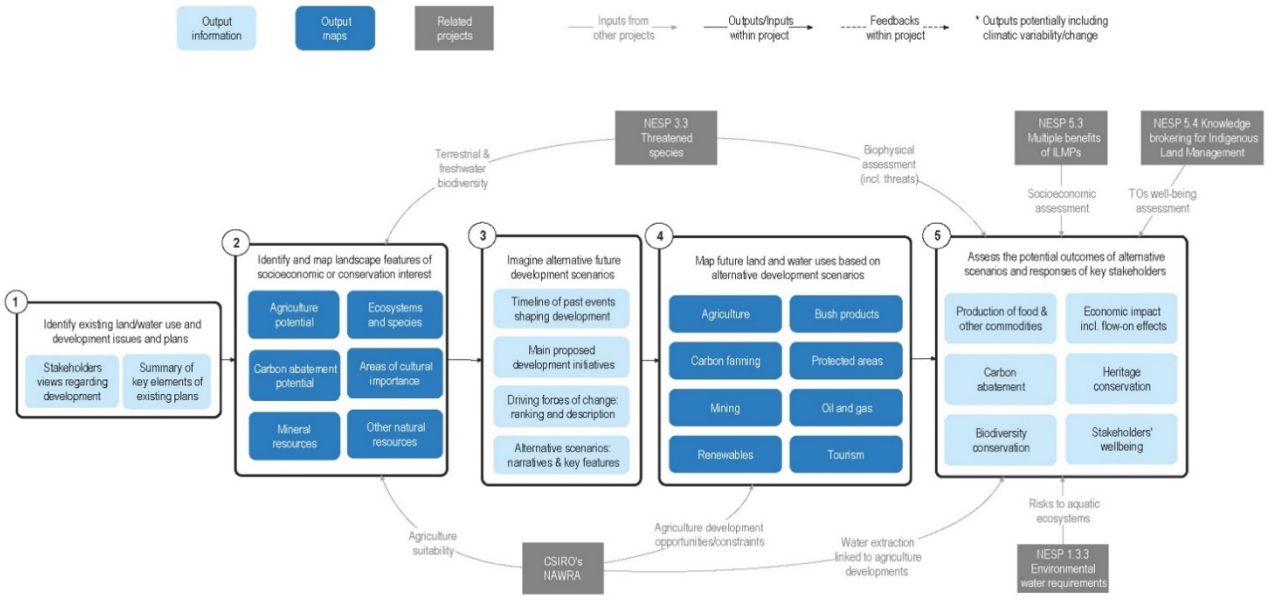
Through a series of meetings and workshops researchers and stakeholders worked together to: exchange views and concerns about development options; collaboratively imagine possible development futures and build spatially explicit maps of alternative future land/water use scenarios; and assess the potential outcomes of these scenarios. This included identifying and assessing the positive and negative impacts of different future scenarios on environmental, socioeconomic, and cultural values associated with different areas of the water/landscape, including those associated with specific assets of interest found in the study area.

The project included five main stages or modules (**Figure 2.1**): (1) identify current and future land/water use and management issues as a basis for understanding stakeholder preferences for and constraints on land and water uses associated with ongoing and future developments; (2) identify and map land and water values/benefits associated with natural assets and ecosystem services for different stakeholder groups; (3) explore development options and drivers of change to create narratives of possible futures; (4) build spatially explicit maps of future land/water use scenarios based on narratives; and (5) evaluate and discuss the potential outcomes, including potential co-benefits and trade-offs, of alternative land/water use scenarios.

In particular, we were interested in understanding how changes in the landscape associated with different development trajectories can affect people who live in the region. The five modules are closely linked and roughly follow a sequential approach, but several outputs can be developed in

parallel and require revisiting and updating along the planning process. Details for each of the modules are provided in individual chapters below.

*Figure 2.1. Stages of the multi-objective planning project, key inputs and outputs.*




The process followed in this project can be adapted to different planning contexts, including agriculture development and diversification, environmental impact assessment, carbon abatement projects, protected area planning, and integrated catchment management. Potential research users include Aboriginal organisations, federal and state agencies, NRM groups, industry organisations, and local government planners. Further, it has the potential to directly inform and support land/water use and management decisions, from local (e.g. inform decisions by pastoralists and PBCs) to national scales, although it is more suited to regional and catchment-scale planning.

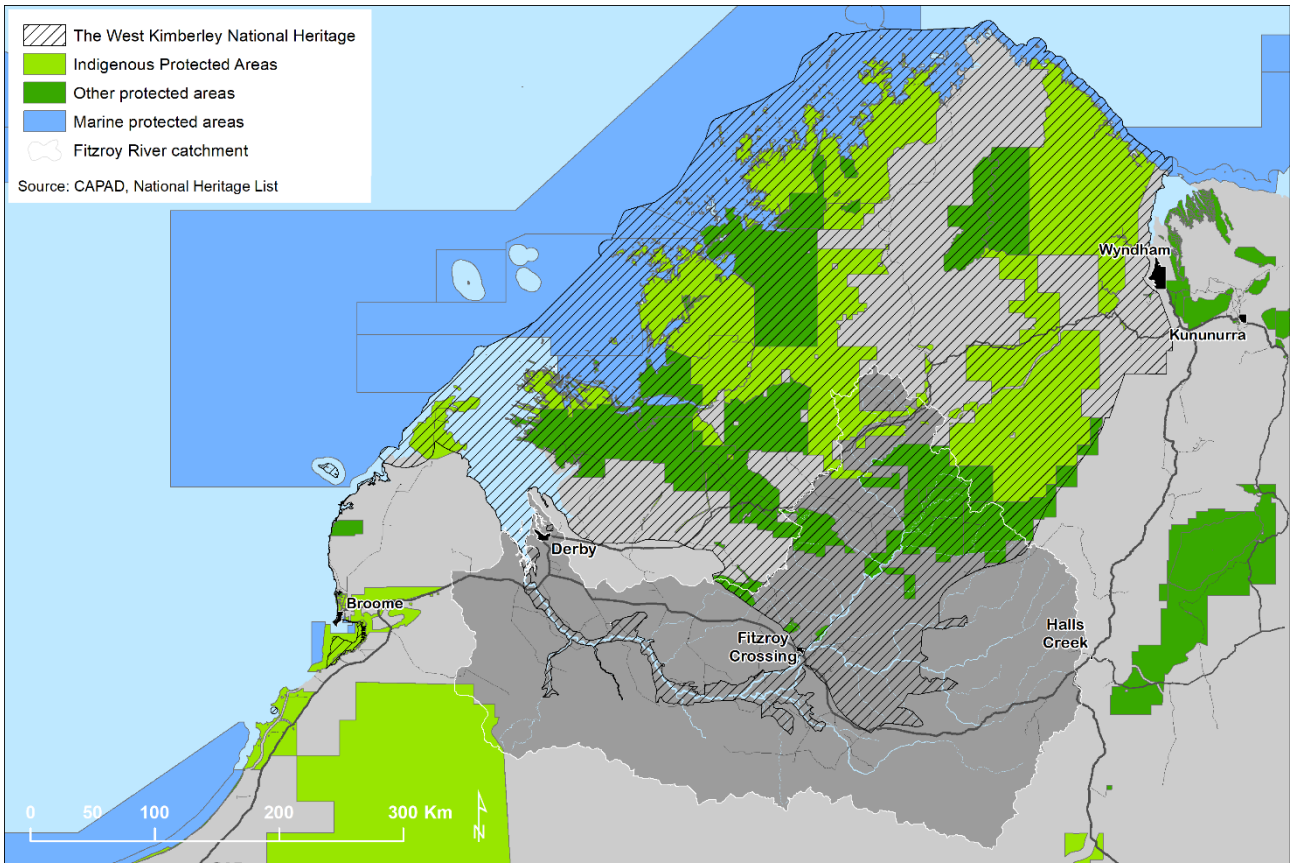
The overall process and demonstration of how different outputs can be integrated to support decision-making can be useful to the above-mentioned planning processes. However, different outputs from individual modules (e.g. mapped values of land and water) can be useful inputs into different processes, such as Environmental Impact Assessments (e.g. related to mining and agriculture developments) and Indigenous-driven planning activities (e.g. Indigenous Protected Areas [IPAs], Healthy Country Planning). Land use scenarios can be particularly useful to inform discussions regarding future investments in agriculture developments.

Following discussions with research users about tensions and diverging views about the plans to develop and protect the catchment, the project was adjusted to develop and assess alternative development scenarios. Consequently, the modules of the project were adjusted to follow a PSP approach. Associated with these changes are new outputs related to the scenario planning process (e.g. analysis of land use change drivers, narratives describing scenarios). Tensions among stakeholders around ongoing and proposed development and conservation projects requires careful planning and execution of engagement activities. To address this concern, the project also decided to use professional facilitation to ensure the successful development of the PSP workshops.

## 2.1. Study area

The project uses the Martuwarra (Fitzroy River) catchment as a case study and aims to provide outputs that can guide ongoing and future planning in the catchment, but methods are transferable to other areas in northern Australia and beyond. The outputs of this planning process provide information regarding alternative land and water uses and how these can affect land and water values, thus explicitly aiming to inform decisions, inclusive of future developments in the region (Dale et al., 2014). In particular, there is potential to contribute with information that can inform a catchment land use/management plan proposed by the government of Western Australia. The globally significant cultural and natural values of the area are well recognised and protected under the West Kimberley National Heritage Place listing (CENRM 2010), which covers 34% of the catchment (**Figure 2.2**).

*Figure 2.2. Location of the Fitzroy catchment, Kimberley region, Western Australia.*

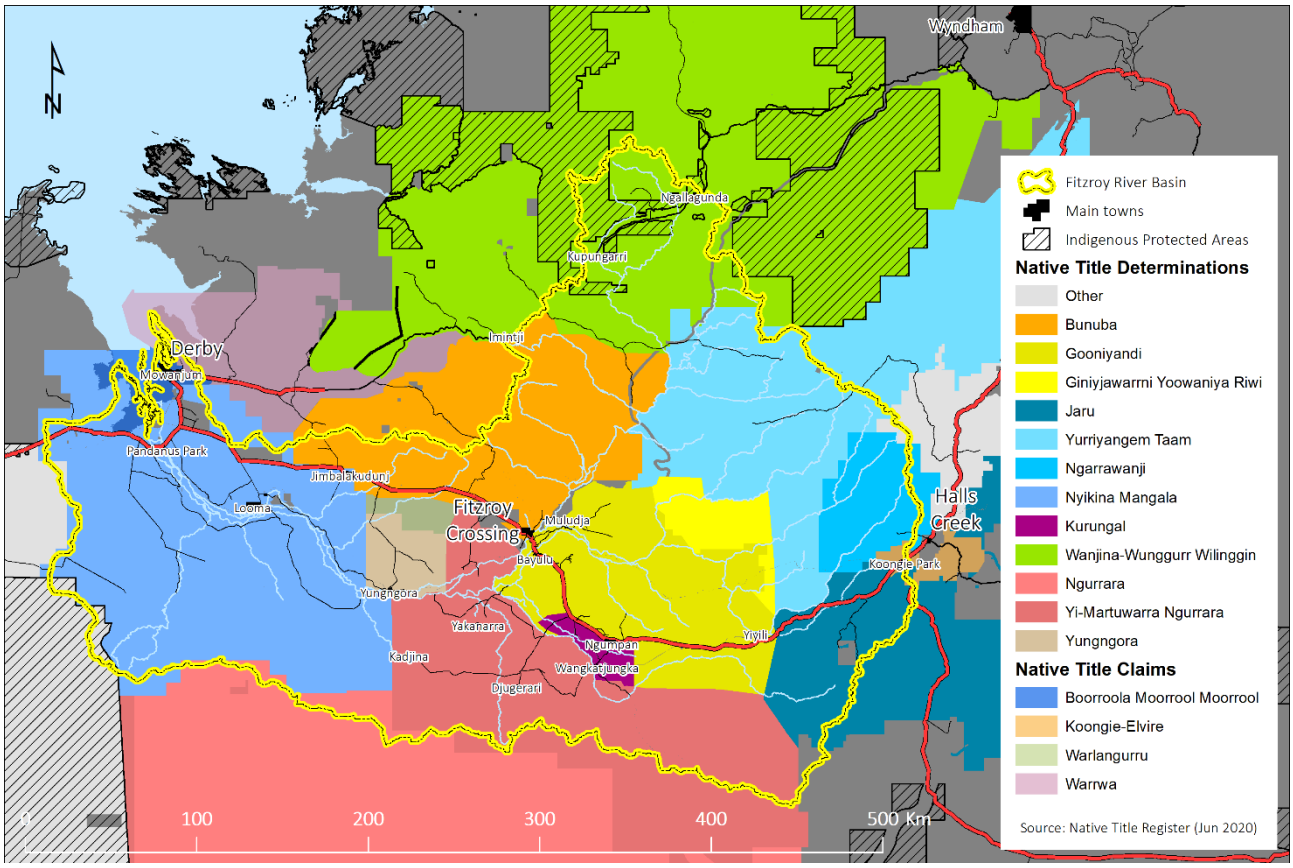



Organisations participating in NRM planning are commonly organised by catchments, so focusing on the catchment scale allowed us to developing and testing the approach under typical settings in which stakeholders (e.g. agencies, NRM organisations) are required to consider land/water use and management decisions. Likewise, a catchment approach is necessary to explore the potential conflict between local (e.g. terrestrial biodiversity conservation) and downstream (e.g. maintaining water quality and environmental flows) land/water values.

The Fitzroy River connects the lands of 10 Traditional Owner groups (**Figure 2.3**), where at least nine Aboriginal languages are widely spoken (McGregor 2002). The area has been inhabited and under the stewardship of Aboriginal Australians for more than 47,000 years (Vigilante 2001; Maloney et al., 2018). The social–cultural–ecological system is characterised by the strong interdependence between Country and the Aboriginal peoples living in the region (Toussaint et al., 2001; Griffiths and Kinnane 2011; Poelina et al., 2019). Over thousands of years, this unique system has been shaped and maintained by its Traditional Owners through active management (e.g. traditional burning), use (e.g. ceremony, medicinal, fishing), and protection of land and water

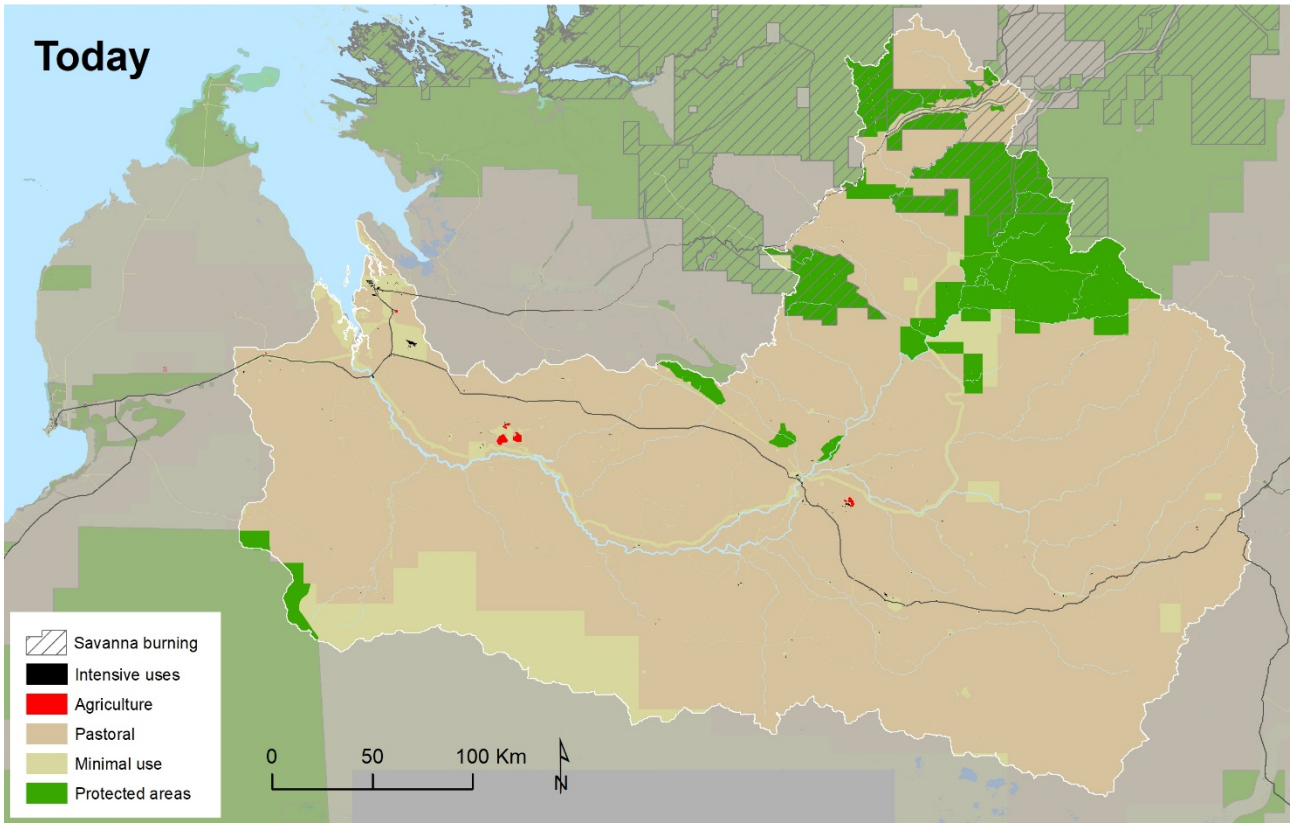
following customary law and practices (Vigilante 2001; Jackson 2015; Maloney et al., 2018; Poelina et al., 2019).

*Figure 2.3. Land boundaries of the Traditional Owners of the Martuwarra, based on Native Title determinations and claims.*




Following the arrival of the first European settlers, around 1880 (Vigilante 2001), the predominant use of the Fitzroy basin quickly shifted to livestock grazing (currently 81% of the basin), along with small areas of irrigated agriculture (0.05%) and other intensive uses (0.2%), such as roads, housing, and mining (**Figure 2.4**). Today, most of the basin retains its native vegetation (~99.7%), including almost 10% protected under diverse conservation schemes (1.4% State Parks, 2% Indigenous Protected Areas, 6.4% Private Nature Reserves). Beyond agricultural uses, extensive traditional and subsistence uses of land and water contribute significantly to the local Aboriginal customary economy across the region (Jackson et al., 2012; Jackson et al., 2014; Jackson 2015). These uses are very important because the basin is inhabited by almost 9,000 people, 65% of whom are Aboriginal Australians who live in two major towns (Derby and Fitzroy Crossing) and 48 remote Aboriginal communities across the basin (ABS 2016; DOP 2016; Petheram et al., 2018a; DPLH 2020).

*Figure 2.4. Current broad land uses in the Fitzroy catchment.*




The diversity of land uses overlay a complex land-tenure system that includes a majority of Crown leasehold land or reserves (**Figure 2.5**), and virtually the entire catchment (98%) is subject to Indigenous Native Title rights and interests under the federal Native Title Act 1993. Within this area, Traditional Owners hold exclusive and non-exclusive (e.g. access and use the land for fishing, ceremony or camping) rights over 32% and 63% of the catchment, respectively (**Figure 2.6**). Across the Indigenous estate, diverse Indigenous land use agreements (ILUAs) further define the use of lands and waters across 47% of the basin. These agreements include conditions regarding access (e.g. pastoral stations), co-management of conservation areas, and mining exploration and operation, which contribute to the complex environmental governance of the region.

*Figure 2.5. Fitzroy catchment boundaries and land tenure. The catchment dominant tenure is pastoral lease land and conservation (e.g. national and state parks), with significant areas of unallocated Crown land, and some minor freehold areas. The catchment boundary overlaps with 45 pastoral stations, including Aboriginal owned and managed stations (pink).*

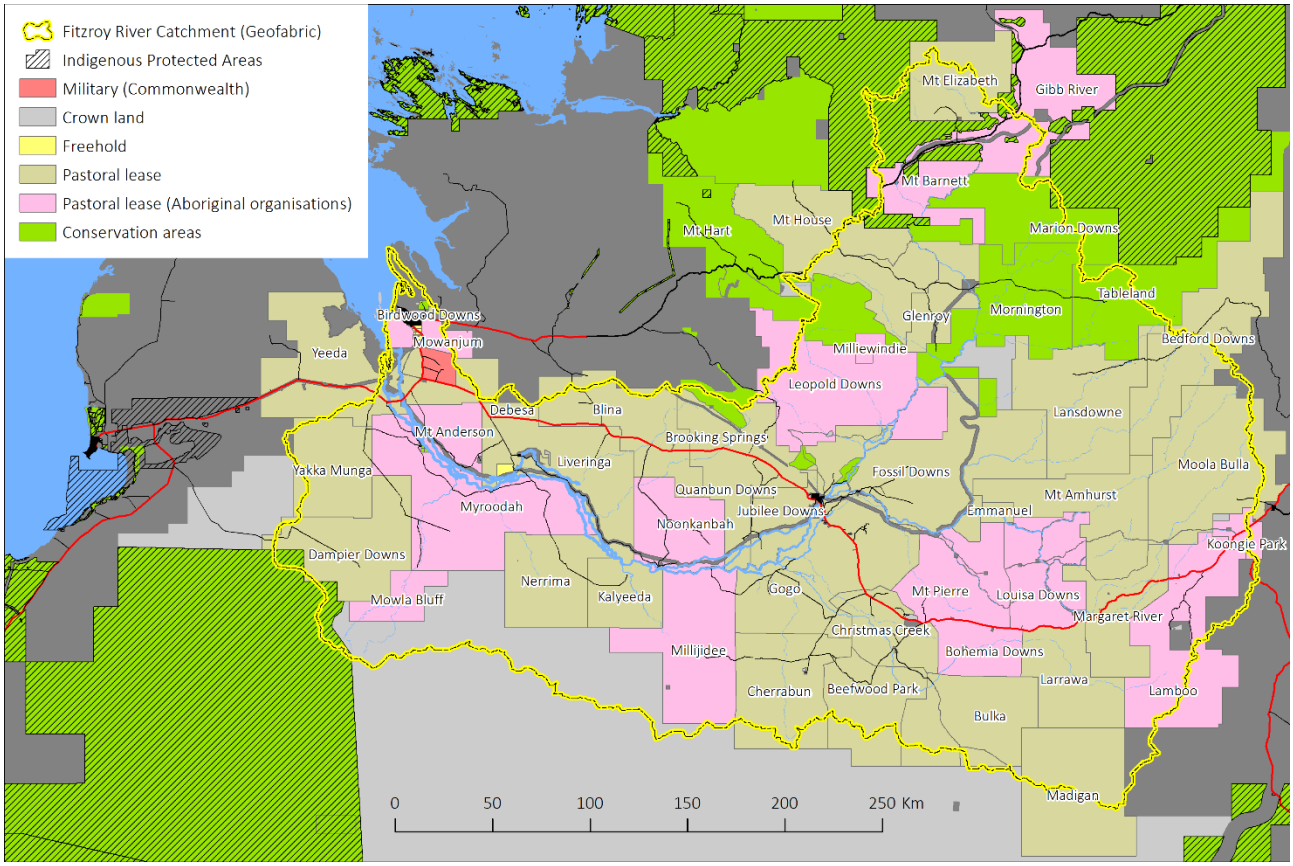
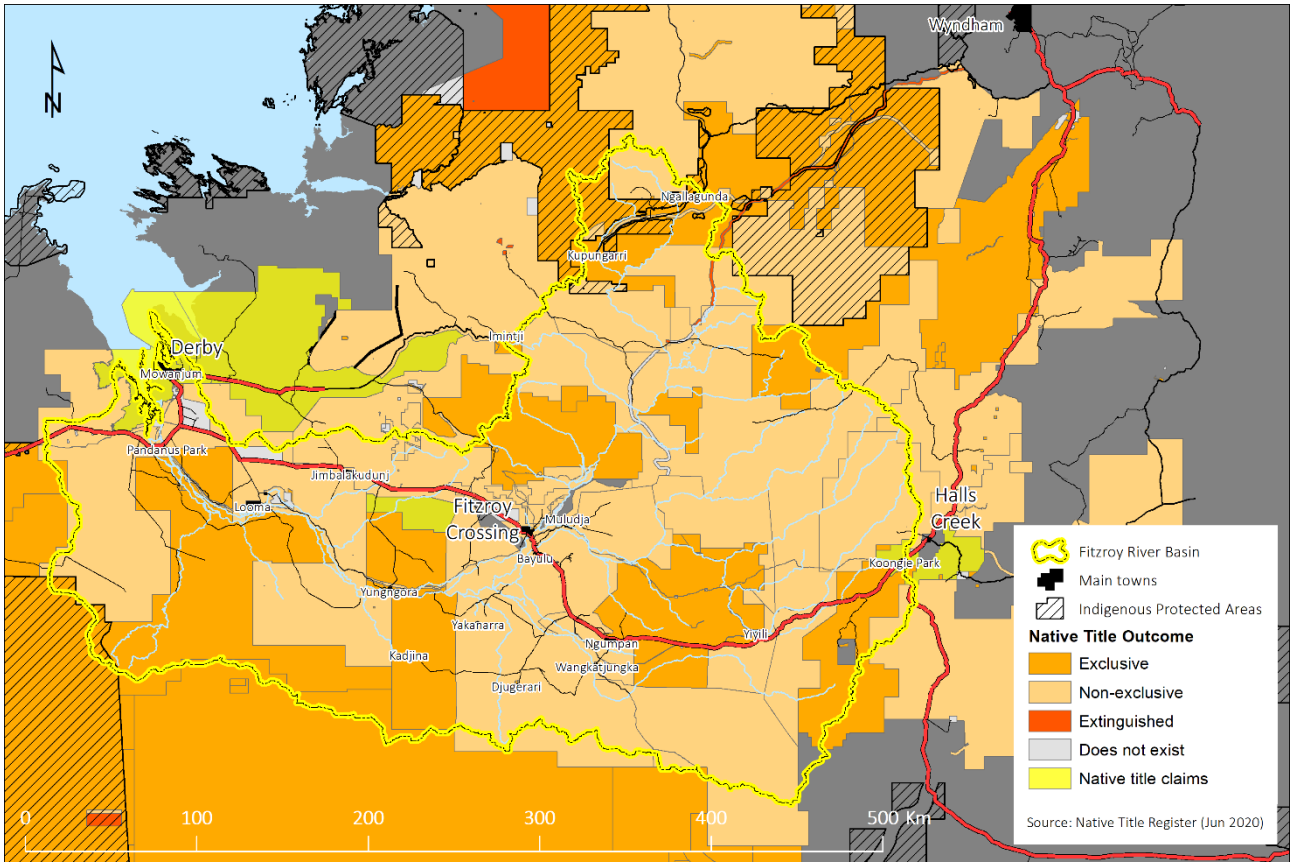



*Figure 2.6. Outcomes of the Native Title determinations, including exclusive and non-exclusive Native Title rights.*



Whilst most of the basin is in moderately healthy environmental condition (Pusey and Kath 2016), the introduction of domestic livestock, invasive species, altered fire regimes, and impacts of intensive uses, have led to notable changes to the social-cultural-ecological landscape, with significant impacts on the rich and unique biodiversity of the region (CENRM 2010; Carwardine et al., 2011; Carwardine et al., 2012). Local efforts have led to improved rangeland management (e.g. grazing practices, fire management), but further work is needed to maintain and restore the rich cultural and natural values of the area (Legge et al., 2011a; Legge et al., 2011b; Skroblin and Legge 2013; NRM 2017).

Whilst the Fitzroy River remains as one of the largest unregulated rivers in Australia, recurrent and recent calls to 'develop northern Australia' has flared interest in expanding irrigated agriculture and other intensive land- and water-use industries (Australia 2015; KDC 2015), with concerns being raised around the potential cumulative impacts on the landscape and people (Connor et al., 2019; Heiner et al., 2019; RiverofLife et al., 2020). In particular, there is interest in irrigated agricultural developments based on extraction of groundwater and in-stream water, which may include building off-stream reservoirs (Petheram et al., 2018a; WA-Government 2020). Mining is currently limited (e.g. mineral resources), but there is potential and interest in further developments (e.g. coal mining, oil and gas, unconventional gas), which have generated diverse concerns about their environmental and social impacts (Poelina et al., 2020). This has reopened debates on competing uses of land and water for non-extractive purposes that underpin traditional economies and the exploration of alternative development initiatives (e.g. culture- and nature-based tourism, bushfood production) with potential to promote the equitable participation of Indigenous peoples (Hill et al., 2006; Gerritsen et al., 2019; Woodward et al., 2019).

## 2.2. Pathway to impact

The project was designed to work closely with research users and stakeholders along the project to ensure the relevance, timely and adequate delivery of outputs, and improved uptake of research outputs. In line with these goals, the scenario planning process also aims to enhance participants' networks (e.g. meeting new people), increase their understanding about the views of others operating in the region, and build trust (e.g. willingness to work with others). These are all key elements that can contribute to positive impacts of the project. In addition to following a participatory approach, the project used four strategies to maximise research impact and uptake: follow a transdisciplinary approach, develop a theory of change, design a knowledge adoption plan, and systematically evaluate the research activities. Here we summarise these strategies, while the rationale and details of the scenario planning process.

### *2.2.1. A transdisciplinary approach*

Transdisciplinary research is solution-oriented, multidisciplinary and includes participants from outside academia with the aim of increasing the uptake of research results by users. This project has adopted a transdisciplinary approach, which includes a series of strategies.

First, the project used participatory research methods that incorporate research participants' feedback in project design (see the item 'evaluation' below) and involves them in the co-production of knowledge with researchers (Hill et al., 2021). The development of future scenarios used PSP methods, which broadly followed a transformative scenario planning approach (Kahane 2012b). During the PSP process, participants from various interest groups collaborated with researchers in (i) identifying drivers of future change in the catchment, (ii) developing contrasting scenarios based on the interaction of such drivers, and (iii) assessing the potential impacts of changes associated with scenarios in their wellbeing. Another reason to adopt this participatory approach to the development of scenarios was the complexity of the socio-political context in which the project is operating, where different stakeholder groups have divergent perspectives on future development. PSP has been adopted in other multi-stakeholder settings to successfully support meaningful dialogue regarding possible future pathways (Kahane 2012b; Oteros-Rozas et al., 2015; Freeth and Drimie 2016; Pearson et al., 2016).

Second, the use of both participatory research methods and the transformative PSP approach has been contributing to strengthening the potential social (applied) outcomes of research.

Third, the project team comprises researchers from multiple disciplines, including conservation planners, environmental social scientists and environmental economists and ecologists collaborating in a truly interdisciplinary approach. Such interdisciplinary and applied research characters are amplified by the collaboration with other projects of the Northern Australia Environmental Resources Hub (NAERH) of the Australian Government's National Environmental Science Program (NESP) with the aim to inform water management in the Fitzroy catchment (for more information, please refer to NESP-NAERH project 6.2). Such collaboration aims to improve the integration of knowledge across related projects and learn from the unique opportunity that NESP projects happening in the region provides. Such approach includes the collaboration between projects 1.6, 1.3.3, 1.5 and 5.4. This initiative contributed to the integration between the NAERH projects in the Fitzroy catchment, and strengthen the links between research providers, users and funders. This means better knowledge to address environmental matters (including the Fitzroy River's recognised matters of national environmental significance) and better channels for the application of such knowledge.

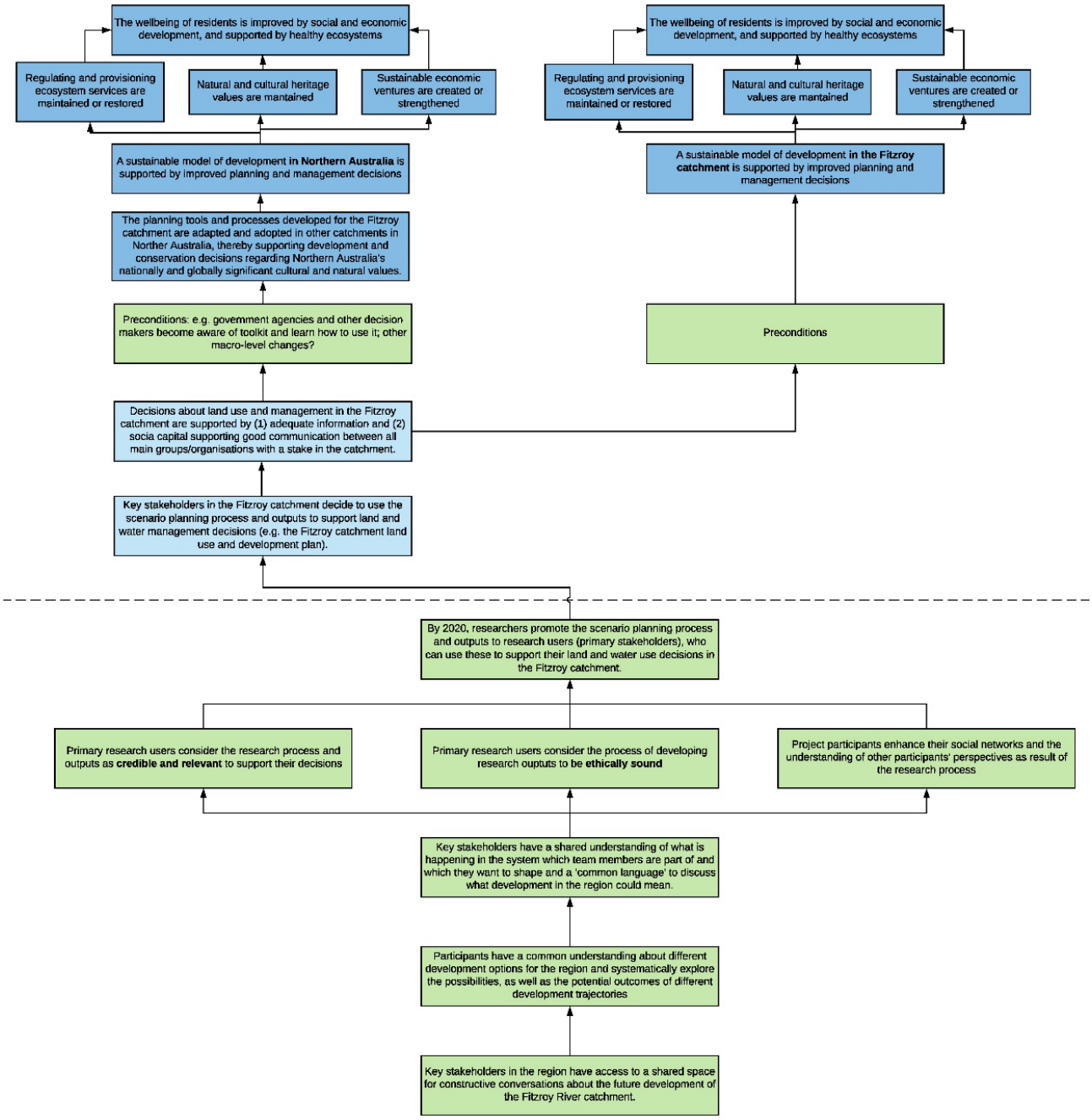
### *2.2.2. Theory of change*

The theory of change (ToC) describes how the project is seeking to influence the social, political and environmental conditions, and other actors able to influence change. This includes a baseline analysis of the problem (e.g. evidence on the drivers and factors of problems in the issue area or geographical context), identifying primary and secondary stakeholders and research users, refining the project's long-term change that we seek to support, and mapping the sequence of changes that lead to the desired long-term outcome (**Figure 2.7**).

### *2.2.3. Knowledge adoption plan*

This research aims to support sustainable development in northern Australia by enabling improved planning and management decisions through participatory multi-objective catchment planning. To achieve this goal the research team, in collaboration with the NESP-NAERH's Knowledge Brokering and Communications Team, created a Knowledge Adoption Plan (KAP) that describes the pathway, activities and outputs required to develop and deliver research outputs that facilitate uptake by key research users (**Supplementary Material**). The KAP and ToC are meant to operate in coordination and thus several components and outputs are related.

*Figure 2.7. Theory of change of the project.*




### *2.2.4. Systematic evaluation*

To achieve the benefits outlined in this section and the introduction, the project had to ensure that research participants provide feedback on project activities and outputs in a timely manner, contributing formatively to project design, rather than just at the end of the project. Therefore, the project is using post workshop surveys to elicit participants' perceptions of workshop organisation (food, venue, etc.) and goal achievement. These surveys also collect information on participants' perceptions of project performance in relation to its core governance principles (credibility, usefulness, accountability, transparency, inclusiveness and fairness), which can highlight project strengths as well as areas for improvement.

Further, our participatory approach aims to bring together stakeholders with divergent views and goals, thus creating opportunities to create shared understandings about development issues, build trust, and bridge otherwise disconnected actors in the region. Through this process the

project can thus facilitate discussions about and agreements on future proposed development initiatives in the catchment. Whilst some scenario planning projects have attempted to achieve this, few have actually undertaken a systematic approach to identify whether these goals were achieved. To address this gap, we are using a social network survey to better understand the links between project participants, shared understandings, and trust.

We used this information to investigate whether workshop participants (a) met, through the project, new people from organisations operating in the Fitzroy catchment (i.e. expanded their social networks), (b) improved their understandings of other participants who may have different views about development in the region, and (c) strengthened existing relationships, for example increasing their trust and willingness to collaborate in land-use and management related matters. Baseline data was collected using this survey before the start of the workshops, and the survey will be repeated at the end of the project to identify any changes.

## 2.3. Research ethics

The research presented in this report was carried out according to Human Research Ethics requirements from James Cook University (approval number H6773) and The University of Western Australia (approval number RA/4/1/9235), which ensured the appropriate protocols were in place for engaging with research participants. During workshops, participants were read a description of the research activities and gave signed consent to participate but were free to withdraw at any moment. The **Supplementary Material** includes examples of the information sheets and consent forms used in this project. The research was guided by a set of principles (below) and, after each workshop, participants evaluated the project based on such principles (see the previous section: Systematic evaluation).

### *2.3.1. Governance principles guiding research activities*

Credibility: A sound process using trustworthy information.

Relevance: The project is relevant or useful to participants' (and/or their organisations') knowledge needs for land and water planning and management decisions.

Accountability: The roles and responsibilities of project participants (scenarios team, facilitators, and researchers) are clear and reasonable; and participants are answerable, to their peers, for their responsibilities.

Transparency: Relevant information regarding the project process and outputs is made available within a reasonable timeframe, and open to scrutiny by participants; the reasoning behind processes and decisions is clear or readily clarified by the relevant project team members; and information is presented in forms appropriate to participants' needs.

Inclusiveness: All the relevant groups have appropriate opportunities to participate in the project (given time, resources and group size constraints).

Fairness: Participants are heard and treated with equity and respect; the project reasonably incorporates participants' suggestions and concerns; and the project team uses different engagement approaches, according to the perceived needs of each group.

*Adaptability: New knowledge and learning is incorporated into the project process and outputs; there is systematic reflection on project performance; and threats, opportunities and associated risks are anticipated and managed.

*Capability: There are enough resources, skills, leadership, knowledge and experiences to enable the project to deliver effectively on its objectives.

* These principles guided research activities but were not included in the systematic evaluation.

### 2.3.2. Participation of Aboriginal peoples

The activities and outputs described in this report involved collaboration with representatives from six PBCs representing the rights and interests of Aboriginal groups with determined Native Title areas in the catchment, including Bunuba, Gooniyandi, Nyikina Mangala, Wilinggin, Yi-Martuwarra Ngurrara, and Yungngora (**Figure 2.3**).

Research activities with Aboriginal peoples were designed in collaboration with NESP project 5.4; we provide details of this collaboration in Module 5 (scenario assessment). Research protocols aligned with the approaches for working with Traditional Owners outlined by the Kimberley Land Council (KLC). Informed consent for data collection approaches were developed through collaborative agreement making with the PBCs and place conditions on the release of collected data. General conditions regarding data management and intellectual property regarding Aboriginal knowledge are detailed in the Header Agreement common to all NESP Fitzroy projects. Specific considerations regarding this project are included in the research agreements with each PBC. The terms of the collaboration are presented in a sample agreement (**Supplementary Material**).

To facilitate working with Aboriginal participants, the NESP-NAERH funded a Regional (Fitzroy) Research Coordinator (hereafter 'Regional Coordinator'), who worked with researchers to prepare research agreements and liaise with the KLC, PBCs and Native Title claimant groups to help coordinate engaging for this and the other NESP projects with research activities in the study area. Key supporting activities included: (a) ensuring all relevant Aboriginal organisations were invited (and had opportunity) to participate in research activities (e.g. focus groups, workshops) in a timely manner and in line with agreed engagement protocols; (b) working with researchers to ensure that these activities are developed in a manner that is appropriate and culturally sensitive to Aboriginal peoples; and (c) helping coordinate the different research activities of relevant NESP projects, to ensure the best use of time, minimise overlap, and avoid consultation fatigue.

# 3. Assembling the scenarios team and understanding the planning context (Module 1)

## 3.1. Summary

The project was designed to ensure early and extensive involvement of Traditional Owners and stakeholders during the research project to promote the ownership and uptake of outputs by them and other research users. To achieve this, the research team presented, discussed, and refined the approach with key research users (e.g. Australian Department of Agriculture, Water and the Environment, WA Department of Biodiversity Conservation and Attractions, WA Department of Water and Environmental Regulation, WA Department of Planning, Lands and Heritage, WA Department of Primary Industries and Regional Development, Rangelands NRM, KLC) and adjusted the process accordingly. This module focused on undertaking a comprehensive literature review, meeting with key stakeholders, and assembling and interviewing members of the scenario team to gather information about stakeholders' understandings, concerns and aspirations around development in the region, as well as to discuss expectations, perceptions and suggestions regarding the research-planning process.

## 3.2. Assembling the scenarios team

The first step in the PSP process (Module 3) was to convene a team that included all main actors with a stake in the future of the region, including people from organisations making and/or influencing decisions about land use and management in the catchment. Team members should represent different parts of the system, thus researchers aimed to include people with a range of backgrounds and perspectives (i.e., sectoral, ideological, professional, geographical). In this case, it was critical to include people with diverse views about development in the region. The team as a whole had positions (e.g. within government, business, civil society) and connections that could influence or enable changes in the system.

**Team size**: previous PSP exercises suggest 25–35 members, including conveners; successful projects have included up to 40 team members.[1] The team must be large enough to ensure the diversity of the system for whole-system insight and influence is represented and small enough to allow developing intimacy and proper engagement/discussions, which is required by the structured scenario planning activities.

**Team composition**: members have the greatest influence on the content and outcome of the planning process, and most influenced by the process, so convening a good team was critical. The team should include individuals who can stimulate the team to look at 'the situation' from alternative and challenging perspectives (e.g. different political views and in our case different views of what is development or what type of development is 'good' for the region). Members should include insightful, influential, and dedicated people; thus, they may include strong-minded people and respected leaders within their sectors (not necessarily holding senior positions and also looking for age and gender balance). Given the likely heterogeneous nature of such team, members do not have to (initially) agree with or trust all other members.

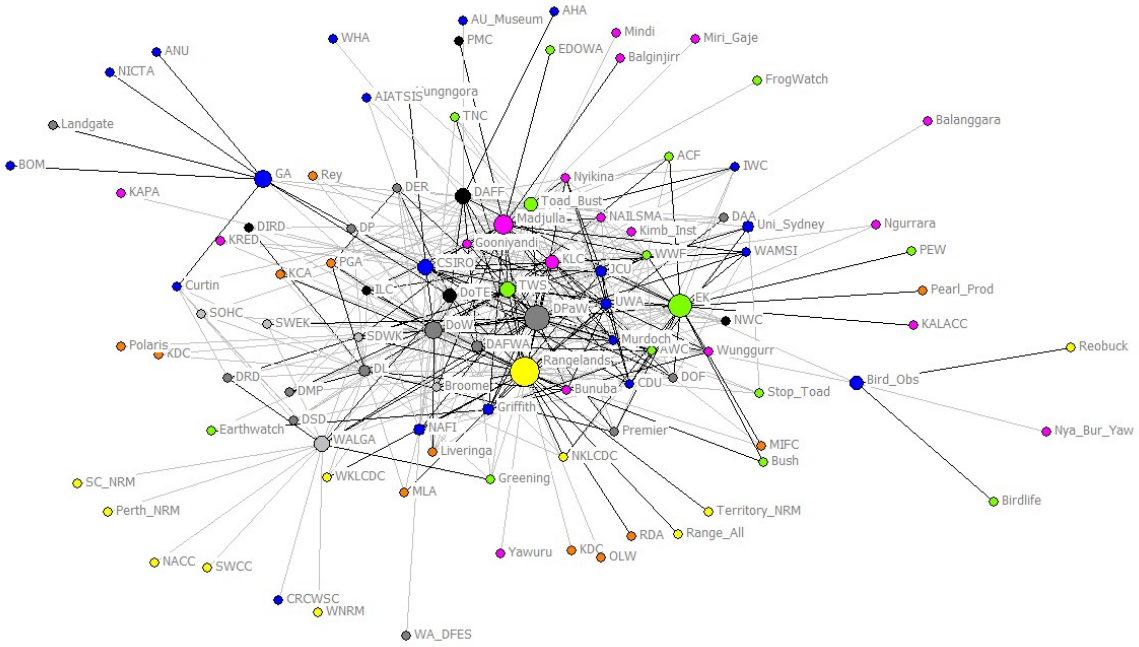
Following the identification of key interest groups and discussions with local organisations, researchers assembled a scenarios team. The team comprised all main groups and organisations with a stake in the region, including people from organisations making or influencing decisions about land use and management in the catchment. The team included people with varied backgrounds and perspectives, including sectoral, ideological, professional and geographical. The next sections describe the process followed to identify and assemble the team.

[1] Participatory scenario planning exercises vary widely, but a review by Oteros-Rozas et al. (2015) found that, on average, projects lasted 16 months, included five workshops, and were attended by 52 participants, who represented between one and seven stakeholder groups.

### *3.2.1. Pre-selection of team members*

The process of selecting candidates for the scenarios team followed two steps. First, we did a quantitative analysis of collaboration networks using social network analysis (SNA) methods (Bodin and Crona 2009; Adams et al., 2018). Our analysis focused on mapping the collaboration networks of organisations working in NRM matters in the Fitzroy catchment. Following mapping of networks, we calculated centrality metrics to identify those most central, and thus potentially playing important roles in NRM activities (including planning) in the region (**Figure 3.1**). From a network perspective, these organisations are in positions of 'power' within the network, for example acting as brokers (e.g. coordinators, gatekeepers, liaisons, representatives). This analysis was used to identify the top 30 central organisations. Candidates for team members included interviewees or people from these organisations identified through one-to-one discussions with interviewees. Further details on the methods and results of this analysis are given in **Supplementary Material**. The results from this analysis were used to create a directory, which was regularly updated.

*Figure 3.1. Example of mapped social network of the Fitzroy catchment depicting advice exchange and potential brokering role of organisations participating in natural resource management*




The second step was to make sure we were not missing key organisations/people and that all key sectors were represented. To achieve this, we had one-to-one talks with candidates to ask for feedback and advice on the initial list of members. Following these conversations, we identified another 15 key organisations previously not considered or identified as central through the SNA. Following the recommendations from previous scenario planning exercises, we used the following screening criteria to select people from the preliminary list of candidates:

- Knowledgeable: good knowledge about development issues in northern Australia, preferably about key topics for the Fitzroy catchment or the Kimberley region.

- Insightful, curious and systemic thinkers: members should be able to understand the complexities of the situation under examination, in our case the future development of the region.

- Influential:[2] people seen as current/potential leaders, people that potentially can drive and implement actions that will affect the system, and people that will be perceived as credible in presenting their conclusions from our work to their organisation, group or sector.

- Experienced: people with practical experience in planning and/or on-ground natural resource use or land management (e.g. Healthy Country plans, land use planning, conservation planning, NRM) and/or business planning and implementation (e.g. agriculture, carbon farming, pastoral, tourism).

- Action-oriented: people that are energetic, not just spectators or followers that can take insights from the process and act on them in their own sphere of influence, including their organisation, community and sector.

### *3.2.2. Final selection of candidates*

The next step was the selection of people that were invited to be part of the scenarios team. Given the nature of the activities and previous experience in planning exercises we suggest using the following *selection criteria* for the final selection of team members and as conditions for their participation:

- comfortable talking and listening in large groups (~30 people) during workshops

- willing to work with others and listen to different perspectives

- willing and able to reflect and speak freely and openly

- committed to participate in all four workshops (2-3 full days, plus travelling time)

- communicate regularly with researchers via email and/or phone; researchers sent selected information in preparation for workshops and ask for feedback when preparing reports and outputs.

### *3.2.3. Invitation and formally assembling the team*

Following identification and pre-selection of candidates, we formally invite them and confirm their participation and commitment to the process.[3] This required preparing a brief factsheet explaining the process, requirements (see selection criteria above) and key features of the process (see principles below). Simultaneously, researchers discussed potential options and arrangements for one-to-one meetings in preparation for the first workshop.

## 3.3. Review of previous planning initiatives in the region

The literature review aimed to summarise key elements of planning exercises that include the Fitzroy catchment, including ongoing, proposed and completed. We compiled plans developed at various spatial (from local to national) and temporal (up to the year 2050) scales, varying in terms of their central goals (from conservation- to development-oriented strategies), and following diverse approaches (from expert-based to highly participatory processes). These exercises were led by different organisations, thus mainly reflect the views of their corresponding sector or group. The review allowed us to identify and refine our list of organisations to involve in scenario planning

[2] Includes organisations or people with significant political and/or economic power that can hamper the process or team's results if they oppose it.

[3] People will join if they believe is worthwhile (i.e. the future of the region matters to them), so during our talks and invitation we discussed some of the benefits and how we have designed the process in ways that: (a) working with the team can enable participants to have a greater (wiser, larger, faster) influence on the system; (b) there is no hidden/biased agenda, and (c) joining will not compromise their own interests.

activities (including potential experts in different topics). This review improved our understanding of development and conservation goals and preferences of different stakeholder groups and sectors.

We summarised key information about ~30 planning exercises that included or focused on the Fitzroy catchment (including ongoing, proposed and completed) and that were considered relevant to multi-objective planning. Plans were summarised in a database (**Supplementary Material**) shared with the scenarios team. The database includes the following fields: status, geographic scope, description of planning area, leading and participating organisations, goals, approach (including brief description of methods and tools), assets and features of interest considered, environmental threats considered, Aboriginal groups involved, and engagement approach, among other information considered relevant. A summary of the results of the review, interviews, and focus group discussions were presented for discussion during the first PSP workshop and documented as the first output of the project.

# 4. Interviewing the scenarios team (Module 1)

## 4.1. Summary

In preparation for the second PSP workshop, we interviewed 26 members of the scenarios team between 14 March and 28 May 2018. Other scenarios team members were either not available to be interviewed or joined the process after the interviews had been concluded. Interviewees worked for: Aboriginal organisations (6, all self-identified as Aboriginal people); federal (2), state (9) and local governments (1); non-governmental organisations (2); and the mining (3), pastoral (2) and tourism (1) industries. The interviews included a discussion on how development should look like in the Fitzroy catchment and the current state of development in the region. These results were summarised and presented during the second workshop, which led to a discussion about the diverse views on development held by participants. The second half of the interviews focused on exploring the constraints, opportunities and knowledge gaps associated with several development options (e.g. irrigated agriculture, tourism, carbon farming, mining), focusing on the interviewee's expertise. The development initiatives suggested by interviewees were presented to workshop participants, who identified additional initiatives for further consideration.

## 4.2. Introduction

Following assembly of the team, the process required one or two of the conveners to conduct in-depth interviews (2–3 hours) with each team member and prepare a synthesis of these interviews.[4] The purpose of these interviews was to elicit the current thinking of team members about development in the region (focal issue of the scenario planning process) and the process, which was needed to prepare and adjust the process. During the interviews, researchers explained the process and responded to any misunderstandings about what team members may think the process aimed to achieve and responded to any concerns they might have about it.[5] These interviews were also important to build or strengthen relationships and trust. Key aspects explored during interviews were:

- What is important in what is happening or could happen in and around the system?
- What are their main concerns and aspirations around the topic (i.e. development in the region)?
- What are their expectations for this project?

## 4.3. Purpose of interviews

Participatory multi-objective planning for sustainable development aims to support diverse management objectives, including multiple uses of land and water, while maintaining diverse cultural and environmental values (Adams et al., 2016b). Participatory planning can be particularly helpful when stakes are high and interests diverge (Kahane 2012a; Freeth and Drimie 2016). In such cases, people's interpretations of key words like 'development' may vary, and be emotionally and politically charged. Discussions around development in the region are not new (Hill et al. 2006), but we wished to provide people with an opportunity to talk about what they would like to achieve via different development options or their concerns around changes associated with these.

[4] At the same time we organise one-to-one interviews the research team set up an online survey with potential dates (previously screened by research team) to agree dates for the workshop, preferable at least 1 month in advance. The method suggest 3-4 workshops (3-4 days each), with supporting work being done in between the workshops, spread over 4-8 months. This will ensure (a) enough time to go deep enough and transform their understandings and intentions and (b) maintain energy and momentum of the team.

[5] This process started informally during the initial engagement activities the shaped the project, but were not focused on the scenario planning activities. During these informal meetings, researchers received some initial feedback from candidates (to be formally invited to be part of the scenario planning team) and started collating information about their concerns around development and the project.

Researchers conducted a series of in-depth interviews with the scenarios team with the aim of better understanding their views on development in the Fitzroy catchment. Another aim was to raise awareness among participants of the diversity of meanings development had to other team members; and to provide a venue for project participants to discuss: (1) the current state of development in the catchment; (2) what they thought development should achieve (the purpose of development); and (3) what they care about within the catchment and believe should be maintained or improved.

## 4.4. Methodology of interviews

Twenty-six members of the scenarios team were interviewed between 14 March and 28 May 2018. The interviews were conducted in Derby, Broome, Fitzroy Crossing and Perth, in a place convenient to the interviewee, usually the interviewee's office. Interviews lasted between 35 minutes and 1.5 hours, were audio-recorded with the consent of the interviewee, and fully transcribed. One interviewee did not consent to be audio-recorded, thus only notes were taken. In two cases interviewees requested a group interview (two interviewees simultaneously) to allow joint contributions and/or to address time constraints.

Interviewees worked for various types of organisations, including: Aboriginal organisations (6, all self-identified as Aboriginal peoples); federal government (2); Western Australian government (9); local government (1); environmental organisations (2); and the mining (3), pastoral (2) and tourism (1) industries. Other scenarios team members were either not available to be interviewed or joined the process after the interviews had been concluded.

The interviews included a conversation around their views on development, how development should look like in the region, and the current state of development in the Fitzroy catchment. These results were summarised in a presentation presented during the workshop which led to a discussion about the diverse views on development held by participants. This first stage was followed by the identification of development initiatives proposed for the catchment (e.g. irrigated agriculture, tourism, carbon farming, mining) and an exploration of the constraints, opportunities and knowledge gaps associated with these initiatives focusing on the expertise of the interviewee. The development initiatives suggested by interviewees were presented to workshop participants, who identified additional initiatives for further consideration. Finally, researchers presented a list of the plans that researchers are considering to be most relevant to the process (e.g. development strategies, NRM plans, Healthy Country plans) to ensure all relevant plans were considered. The broad script followed by researchers when conducting the interviews is available on request.

Interview transcripts were organised using the software NVivo 11; the content was coded according to the structure of the interview. The interviews were thematically analysed (Thomas 2006), which involves carefully reading the transcripts and identifying the main themes discussed by interviewees. Such themes are summarised below.

## 4.5. Key findings from interviews

The term development was generally associated with change or impact. This agrees with the Cambridge dictionary's definition of development, as "*the process in which someone or something grows or changes and becomes more advanced*".[6] Some interviewees referred to changes in the landscape or intensification of land use, or a change in the mix of economic activities in a region.

"My view of development is anything that changes from what it is at the moment to something different. Whether it be damming, infrastructure, change in agriculture use, tourism, mining and extraction."

[6] https://dictionary.cambridge.org/dictionary/english/development

Other types of change included enhancing people's knowledge, or increasing the efficiency of current economic activities:

"(…) you don't need to just make things bigger to be development, development can be making something smaller and more efficient."

### *4.5.1. Change from what? Current state of the Fitzroy catchment*

Interviewees were asked 'what is the current state of the catchment?'. Their responses referred to several themes, including the: level of economic development or resource use; social issues; positive social and economic initiatives; environmental and cultural values in the region.

Nine respondents (31%, **Figure 4.1**) deemed the catchment as underdeveloped or in strong need for development. They referred mostly to social or economic development, or to perceptions that some natural (e.g. minerals) or social resources (e.g. local knowledge) were underutilised:

"The biggest issue is water. You see what happens in the wet season. Surely there's got to be ways we can actually manage the wet season runoff better just by slowing it down. (…) Surely there's areas where you can actually either have shallow sort of water catchment areas like we use, or just other methods of keeping water without creating a 30-metre-high dam wall and flooding a whole area of country. But when you see that water just disappearing into the ocean..."

Most interviewees (17 respondents, or 65%) referred to at least one social issue afflicting people living in the catchment (**Figure 4.2**).

Some of these issues were seen as inter-related:

"When you look at the population of Indigenous young people in that 15 to 25 [years old] they are self-destructing, because there's no investment in building their capacity to engage, to be trained, to be educated, to become the new workforce."

On the other hand, a third of the interviewees (35%) referred to positive economic (5 respondents) or social (3 respondents) initiatives current in the catchment, such as land management programs that provide cultural, social and economic benefits to local groups. Others emphasised the significant potential in terms of social capital or the knowledge of local people to address the issues above (3 respondents):

"I think one of the underutilised areas in that region is people, to be honest, and their knowledge."

*Figure 4.1. Number of interviewees that have referred to each theme related to the current state of development in the Fitzroy catchment. Each interviewee could have referred to more than one theme.*

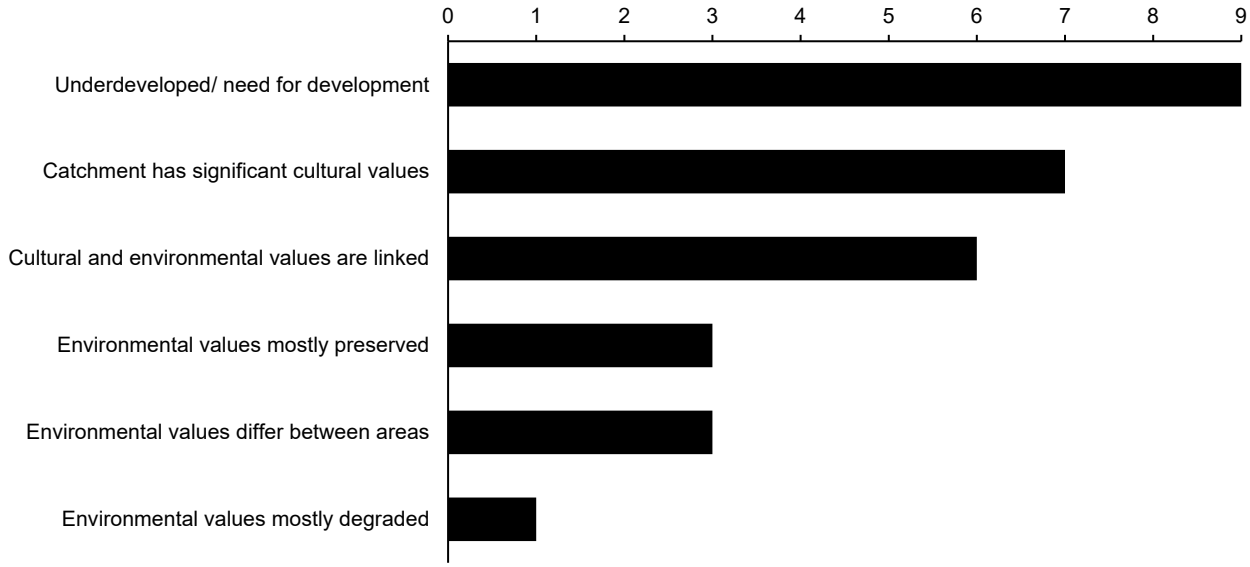
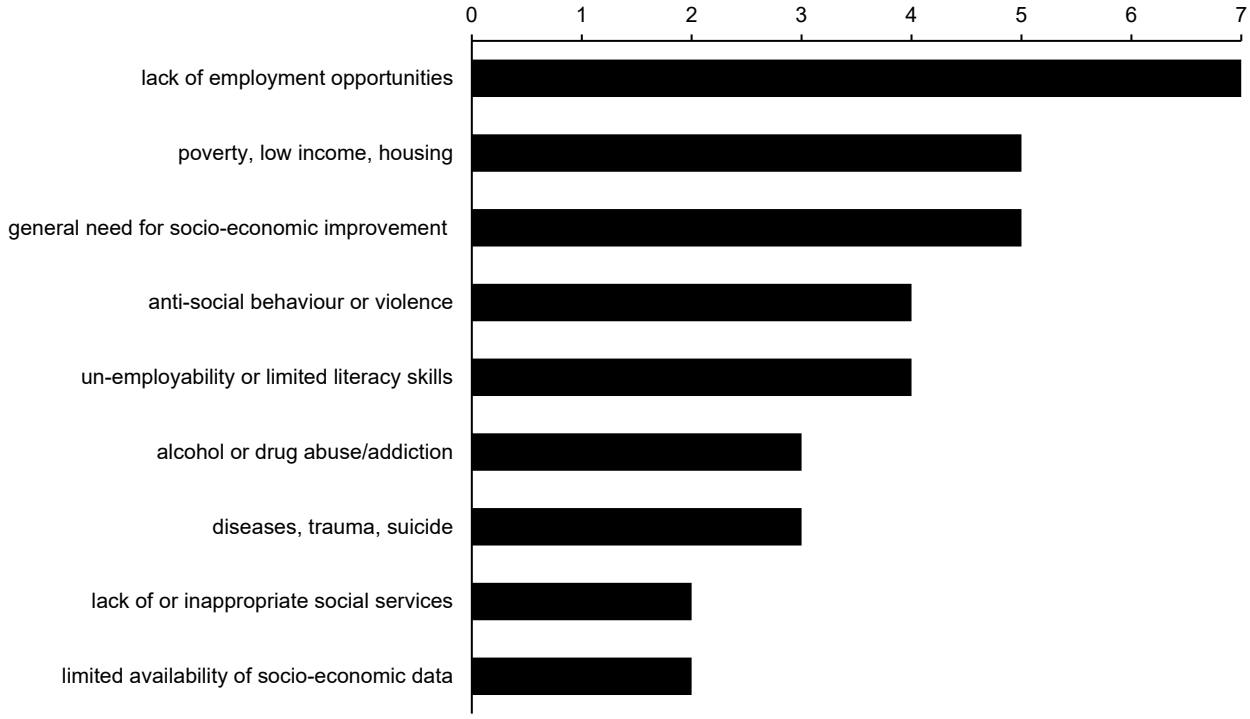



*Figure 4.2. Number of interviewees that have referred to each theme related to social issues in the Fitzroy catchment. Each interviewee could have referred to more than one theme.*




Despite the limited access to monetary income by some social groups, three interviewees considered that access to natural assets through hunting and gathering helped ameliorating the restricted ability of these groups to purchase food.

There was a diversity of views regarding the current state of environmental values in the area. Three interviewees (12%) emphasised the significance of the environmental values present in the area, while another three stated that those values varied between different areas in the catchment (e.g. higher values in specific parts of the catchment), or depended on the quality of land

management in pastoral stations. One interviewee considered that the environmental values of the area have been significantly impacted as compared to the rest of the Kimberley region:

"(…) in comparison to the Kimberley region [the Fitzroy area] is probably one of our more degraded areas."

Seven interviewees (27%) stressed the significance of the cultural values present in the catchment. While some respondents considered that there are currently good initiatives to maintain such values (for example, the maintenance of certain sites of cultural importance), others emphasised the need for further acknowledgement of the significance of those values and additional initiatives to ensure their maintenance.

Six interviewees (23%) identified links between environmental and cultural values. They emphasised the knowledge local people have of their environment, the contribution of those values to spiritual connection and identity, and their ultimate link with the wellbeing of Aboriginal peoples:

"The sustainability of people that live on that part of the country and the Indigenous stakeholdership [is understood] in terms of its connection to the land and the water and its spiritual umbilical connection. And all that comes from the ability to grow our children and allowing them to maintain that connection and identity and responsibility, to be able to manage our lands and its waters in a responsible way."

### *4.5.2. The purpose of change*

Development has diverse meanings and purposes. Some definitions emphasise the physical and economic progress of places and peoples, and the cumulative economic growth in production, income and consumption. Other interpretations may focus on wellbeing, the satisfaction of basic needs, self-reliance, and rights-based structural change, emphasising 'quality of life' rather than 'standard of living' (Kelly and Westoby 2018). This variety of perspectives was also reflected in the interviewees' views of development.

Six interviewees (23%) emphasised the importance of and need for economic growth in the catchment. Some of those considered that the economy in the region currently depended on government grants, and a more varied industrial base would be required, while others considered that primary industries should be the main type of industry supporting such development. The (sometimes implicit) premise in such statements was that economic growth will create jobs, and the associated income would improve the access to services, therefore addressing social issues in the catchment. On the other hand, five interviewees (19%) critiqued a development model focused mainly in financial gains. They suggested that such focus could result in human health and environmental risks. Some of these interviewees also questioned the actual potential of benefits 'trickling down' to residents under such model.

Eleven respondents (42%) considered that the model of development historically present in the catchment has resulted in an unequal or unfair distribution of benefits. Among these, most (8 respondents, or 31%) stated that external investors had mostly benefitted from it, to the detriment of local (and especially Aboriginal) groups, who have contributed significantly to the economic growth in the region. Two respondents considered that inequities internal to Aboriginal groups have also resulted in unequal distribution of benefits within such groups.

Despite noted differences, most interviewees (16 respondents, or 62%) considered that planning for future development should balance financial and social outcomes, or explicitly focus on benefits to residents, especially Aboriginal peoples. Of those respondents, five stressed the need for Aboriginal organisations to effectively participate in negotiations and decisions on development in the catchment. Another four interviewees emphasised the need for capacity building and education of residents to ensure their effective participation in decisions and access to benefits resulting from development.

Such ideas resonate with concepts focused on ‘people’s development’, or having social wellbeing as the main focus of development, which were expressed by nine interviewees. For example,

“I am actually interested in people development. That's really what I do. I think we can talk about diamonds and gold, but I think Kimberley people are amazing. So I am interested in investing (…) in people so that they have a better network or knowledge or information to get to make decisions for themselves and their families, and their clan group, their business and the community, etcetera. So I suppose for me, development means, making sure that we are investing in people and perhaps challenging our worldviews.”

Ten interviewees (38%) discussed the need for a balance between economic and environmental outcomes. Of those, seven emphasised the need to protect the environmental values in the region, or at last to constrain economic development to the local environmental capacity. Conversely, three interviewees considered that overly strict environmental protection and some activities of environmental groups could hinder economic prosperity in the region:

“But just to say we can't do anything. Well, that doesn't benefit anyone, and if at the end of the day if they just lock up parts of the Kimberley and say these areas are a national park, you must just fly or drive up through the Pilbara and go straight to the Northern Territory because government are going to say well we can't do this in the Kimberley, it's just a big National Park.”

Twelve interviewees (46%) stressed the need for future development to balance economic outcomes and the protection of culture and/or the cultural values associated with the environment in the region:

“As much as people want to participate in their economy and engage in meaningful employment they still like their country and the way that it is. There needs to be a balancing act [between] the impacts and the opportunities they bring.”

## 4.6. Conclusions

The results show a diversity of views on development through the past, present and future of the Fitzroy catchment. There was general agreement that the current model of development generated an unequal distribution of wealth, with Aboriginal residents being mostly disadvantaged. Most interviewees also acknowledged the existence of social issues in the catchment (e.g. limited employment opportunities, low income, housing shortage, social conflict, lack of skills to participate in economic opportunities). There was also general agreement on the need for systemic changes (including governance) that help address such issues.

Some interviewees generally focused on a development model that intensifies the use of natural resources to grow the economy, assuming that the wealth created would trickle down to residents through jobs and increased consumption. Conversely, other interviewees generally focused on the need for a new development model that maintains and emphasises the cultural and environmental values in the region, centred on the human resources available and focusing on the wellbeing of the local population. Most interviewees held a nuanced perspective, emphasising one of those models but acknowledging that the future ‘development’ of the Fitzroy catchment should involve a balance between social, cultural, economic and environmental outcomes.

# 5. Identifying and mapping values (Module 2)

## 5.1. Summary

The aim of this module was to identify and map landscape features associated with social, economic and cultural values across the Fitzroy catchment. Values refer to the potential benefits associated with natural assets and ecosystem services. Traditional Owners and pastoralists were identified as key groups because their interests will be most likely and directly affected by changes in the region. The expression of values relies strongly on the assessment of impacts of future development scenarios on the social and cultural values associated with key stakeholders (see Module 5). Therefore, this module provided information (including maps) to support the assessment of potential impacts of alternative development scenarios on land and water values. This module did not include 'cultural values' to minimise known issues regarding mapping of these values, such as participation fatigue and disclosure of culturally-sensitive information. This approach allows Aboriginal peoples to indicate their preferences for different scenarios without having to disclose sensitive information or delineate sites of cultural importance.

## 5.2. Features of conservation and socioeconomic interest

This module included the compilation and analysis of secondary data on the documented values associated with natural assets and ecosystem services for relevant stakeholder groups. We identified features of potential value from existing sources, including NRM plans, Healthy Country plans, previous research under TRaCK (Tropical Rivers and Coastal Knowledge), NERP (National Environmental Research Programme) and NESP, and Western Australia's Department of Planning, Lands and Heritage (formerly Department of Aboriginal Affairs – DAA) database of cultural heritage, among others. Publicly available spatial data related to Aboriginal cultural values was compiled, but researchers decided not to use it following discussions with the KLC and researchers from NESP projects working directly with Traditional Owners (see details below).

We used Geographic Information System (GIS) tools and conservation planning software (i.e. Marxan, Nature Serve's Vista) to process spatial data and create maps depicting the spatial distribution of areas of socioeconomic and/or conservation interest across the whole catchment. Nature Serve's Vista was also used in module 5 to generate indicators of potential environmental impact under alternative scenarios, thus outputs of these analyses are summarised in that section.

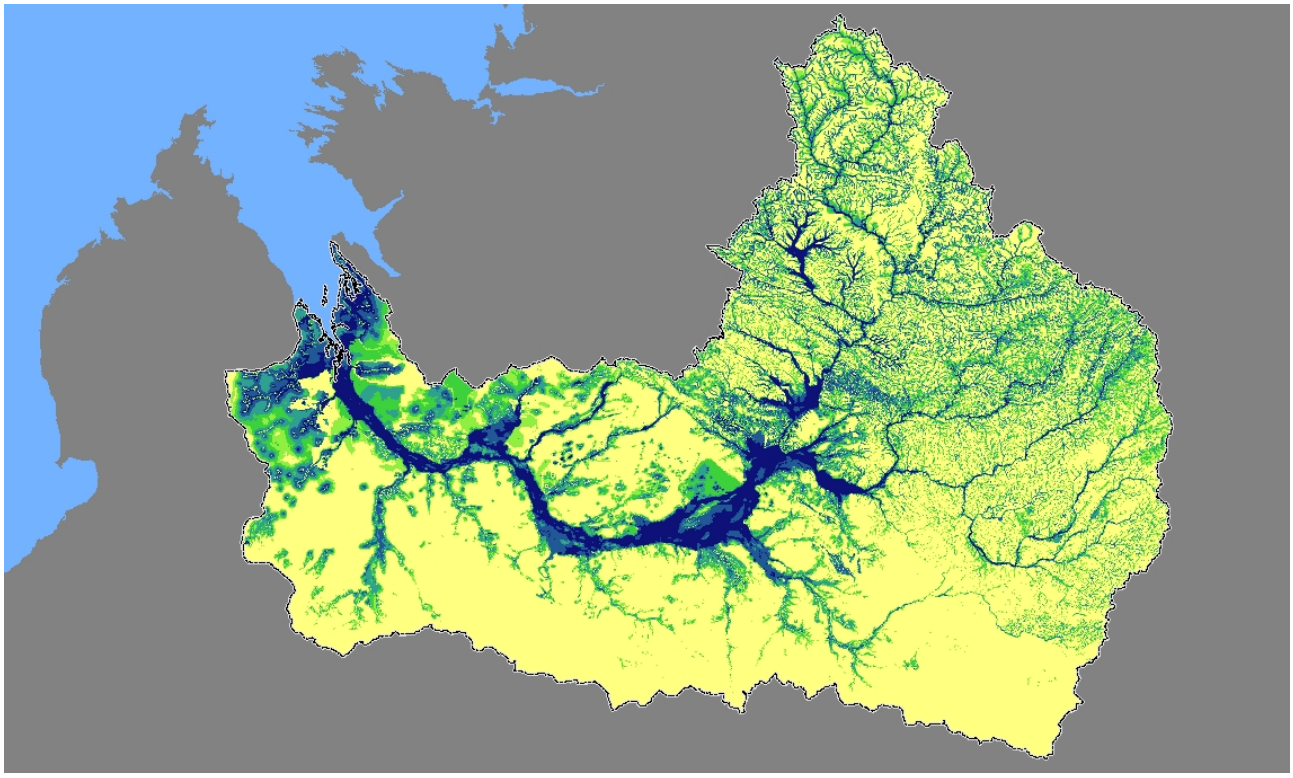
### *5.2.1. Biodiversity conservation*

Our maps of areas with value for biodiversity conservation are based on current distribution of features of conservation interest (e.g. dry season pools, wetlands), habitat types (e.g. bioregions, land systems, vegetation types, aquatic ecosystems) and predicted distribution of aquatic (fish, reptiles, invertebrates, waterbirds) and terrestrial species (plants, fish, invertebrates, amphibians, reptiles, birds and mammals) occurring in the catchment, including species important for subsistence and of conservation concern in Northern Australia (e.g. the Environmental Protection and Biodiversity Conservation Act [EPBCA], WA-listed, International Union for Conservation of Nature [IUCN] Red List); see details in **Supplementary Material**.

High-resolution potential distribution models of species were derived from expert-vetted species distribution models (i.e. habitat suitability) created using Maxent or buffered occurrence records when the information about their occurrence was very limited (Pintor et al., 2019). The original maps were derived from (and processed) using multiple sources, including the dataset created under NESP project Prioritising threatened species and threatening processes across northern Australia and previous mapping and modelling exercises, including CliMAS (Vanderwal et al., 2021), and Northern Australia Water Futures Assessment (NAWFA) (Kennard 2011; Reside et al., 2012; James et al., 2013).

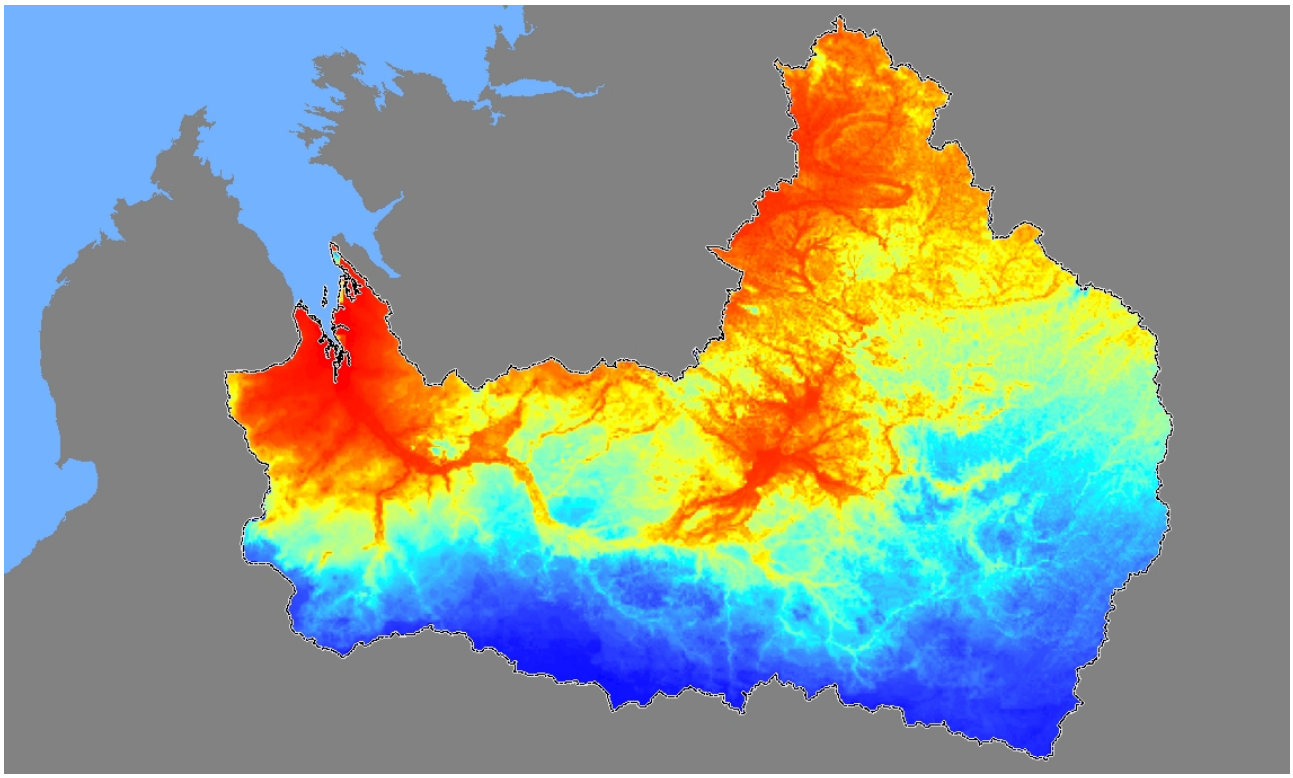
To gain a better understanding of the potential importance of different areas for biodiversity conservation we did a number of spatial analyses. First, we used ArcGIS to create maps representing conservation value for different groups of interest, such as aquatic species and plants and animal importance for subsistence. These maps were created using weighted sums based on their conservation requirements (e.g. species range, threatened status). For example, the map of aquatic species shows the relative value of areas for aquatic species (from 0 = low to 1 = high) based on the potential co-occurrence of aquatic species of 'significant' conservation concern in the Fitzroy catchment (**Figure 5.1**). These species were defined based on their past, current and/or potential commercial, cultural and/or other importance, as recorded in the literature. In particular, this model includes a subset of significant species recorded as being harvested or collected traditionally, commercially or for domestic/international trade. The model can be used to identify the potential importance of different areas for protection of these species or as input for risk assessments.

*Figure 5.1. Example map of relative conservation value for aquatic species. Areas in red orange-to-red indicate areas of higher potential conservation importance based on modelled species; yellow represents intermediates values; green-to-blue areas have relatively lower values.*



Following, we used NatureServe Vista conservation planning and assessing software (NatureServe 2018) to calculate different metrics of conservation value for groups of species based on different criteria. This required parameterising a Vista project built around a spatially explicit database (**Supplementary Material**). Key inputs of the database included information about species (e.g. range maps and probability of occurrence of species, information about their conservation status, compatibility with different land uses), land use maps, and spatial distribution of key threatening processes (e.g. grazing, fire history, invasive species) and the probability of persistence of each species under different threat levels (Álvarez-Romero et al., in prep). We created two types of maps: Element Conservation Value (ECVs) and Conservation Value Summaries (CVS), representing conservation value for individual and groups of elements, respectively. ECVs represent the relative value of areas for a single element (e.g. species, ecosystems, feature of social or economic importance). In contrast, CVS identify areas of high conservation value in the planning region based on combinations of elements and their attributes. In contrast, CVS represent an index of element conservation values derived for each grid cell, based on attributes of elements and/or their occurrences (**Figure 5.2**).

*Figure 5.2. Example of a Conservation Value Summary (CVS) map for terrestrial and aquatic species based on species richness weighted by conservation status.*



The CVS maps can help to visualise areas of relatively high/low conservation importance and can be used in conservation planning to identify areas where incompatible land uses could negatively impact important elements of biodiversity. Within Vista, CVS maps can be explored interactively to examine the details on the conservation value for user-defined areas, including information about the contributing biodiversity elements occurring in the selected area. The CVS maps can also be overlaid using any GIS software to undertake spatial assessments to inform conservation and development decisions. For example, overlaying CVS and maps of managed or protected areas can help to identify areas of high conservation value that need to be managed or protected. Also, combining CVS maps with information about tenure and ownership is useful to identify properties that are most important to manage to conserve high-value biodiversity areas. Combining CVS and proposed plans for zoning, infrastructure or developments are useful to identify likely conflicts.

Finally, we used conservation planning methods (Margules and Pressey 2000) to identify high-priority areas for biodiversity conservation based on their irreplaceability (Kukkala and Moilanen 2013). We used Marxan with Zonae Cogito (Ball et al., 2009), a widely used spatial optimisation tool to create maps indicative of the importance of any given area across the catchment to identify conservation area systems that achieve ecologically-relevant conservation outcomes efficiently. The prioritisation analyses were based on 1-km hexagonal planning units that cover terrestrial, freshwater and intertidal coastal environments and followed standard approaches combining information about the species conservation requirements (Ardron et al., 2008; Watts et al., 2017).

We set conservation objectives (a.k.a. targets) for terrestrial and freshwater conservation features (hereafter 'features'), including species, habitats and special elements (e.g. persistent waterholes) based on their rarity, heterogeneity and vulnerability to threats. Our approach aimed to represent features by protecting a percentage of their current distribution commensurate with their specific conservation requirements (Álvarez-Romero et al., 2015b). We set higher objectives for features that are relatively rare (i.e., occupy smaller areas within the planning region) and are subject to higher pressure from local stressors (e.g. grazing, altered fire regimes, invasive species), which we assessed based on models developed by Pintor et al. (Pintor et al., 2019). Our vulnerability assessment considered variable responses of species (based on functional groups of species) to individual threats (Álvarez-Romero et al., in prep). Representation objectives also integrated an

index for the heterogeneity of features distributions. Including rarity and heterogeneity indices allowed us to increase representation objectives for features with smaller and patchier spatial distributions, which we calculated using the following equations:

***Objective***

$$S_i = (0.3 \times w_i) + (0.1 \times h_i) + (0.1 \times v_i)$$

$S_i = \text{representation objective for feature } i \text{ (proportion)}$
$w_i = \log - \text{indexed rarity score for feature } i \text{ (rarity)}$
$h = \text{heterogeneity index for feature } i$
$h = \text{vulnerability index for feature } i$

***Rarity***

$$w_i = \frac{\max \Delta y - \Delta y_i}{\max \Delta y - \min \Delta y}$$

$w_i = \log - \text{indexed rarity score for feature } i$

$$\Delta y_i = \log_{10} y_i - \log_{10} \min(y)$$

$\Delta y = \text{diff. between } \log - \text{transformed area of feature } i \text{ and extent of smallest area } (\text{km}^2)$

$y_i = \text{total extent of distribution area of feature } i \ (k\text{m}^2)$

***Heterogeneity***

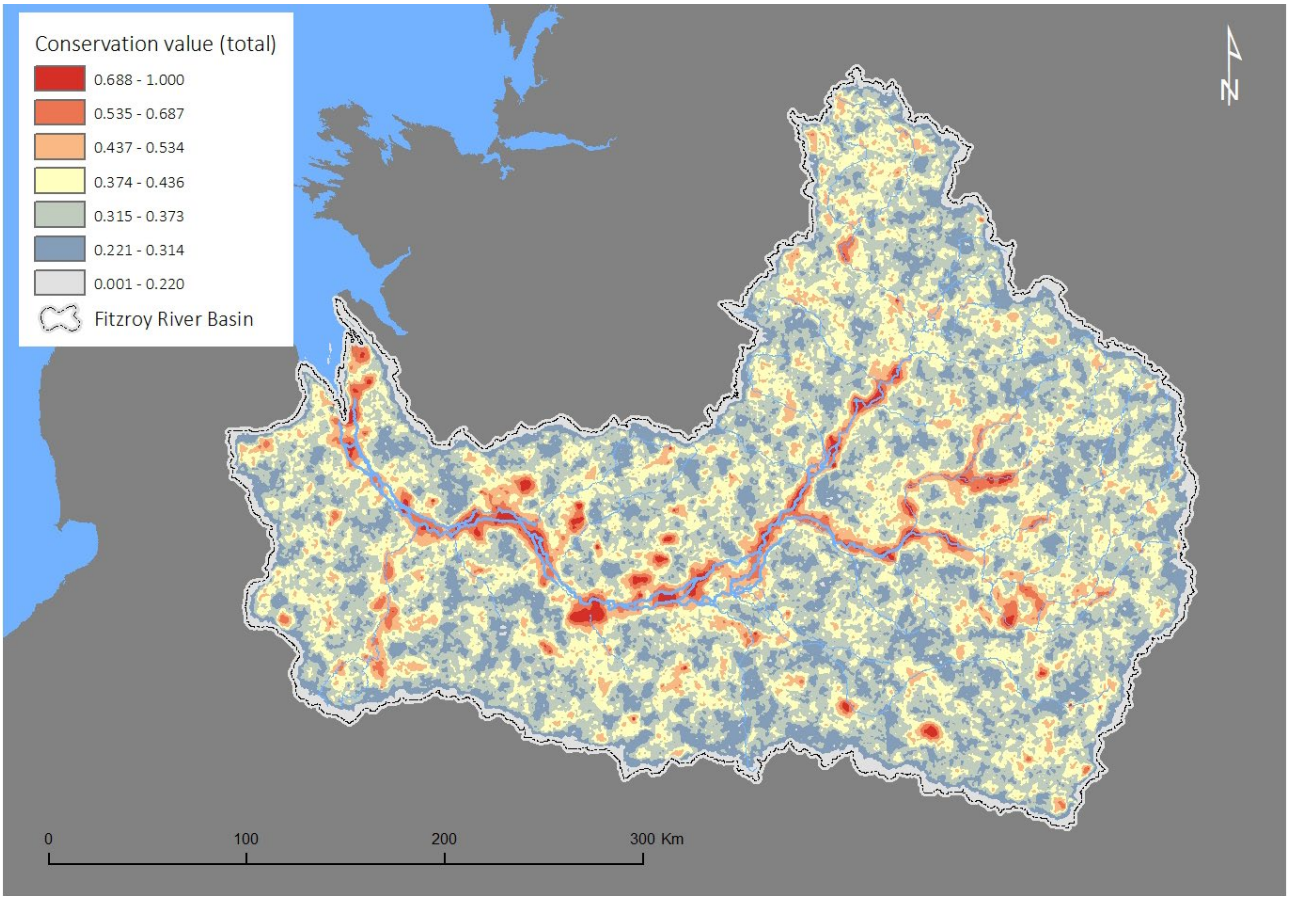
$$h_i = \frac{\left(1 - \left(\frac{a_i}{\max(a)}\right)\right) \times \left(\frac{p_i}{\max(p)}\right)}{\max(h)}$$

$h_i = \text{heterogeneity index for feature } i$
$a_i = \text{area occupied by feature } i \text{ across northern Australia } (\text{km}^2)$
$p_i = \text{num patches comprising distribution area of feature } i$

We used Marxan to create different solutions that achieved the set objectives, setting a uniform 'cost' to create maps of conservation value irrespective of the potential costs associated with the protection or management of land parcels. We used 1-km$^2$ hexagonal planning units (n = 99,569) covering terrestrial, freshwater and intertidal coastal areas. The size of the planning units matched the spatial resolution of key input datasets (e.g. ecosystem maps, species distribution models) and was the smallest possible given the size of planning area and targeted features (Cheok et al., 2016). We adjusted the Boundary Length Modifier to aggregate planning units to generate larger potential conservation areas that were adequate to encompass the home range of species. Clumping contributed to reduce the number of conservation areas, maximise their individual size and minimise the overall perimeter of the conservation area system, which can improve ecological adequacy and facilitate management (Fernandes et al., 2005; Arias et al., 2016).

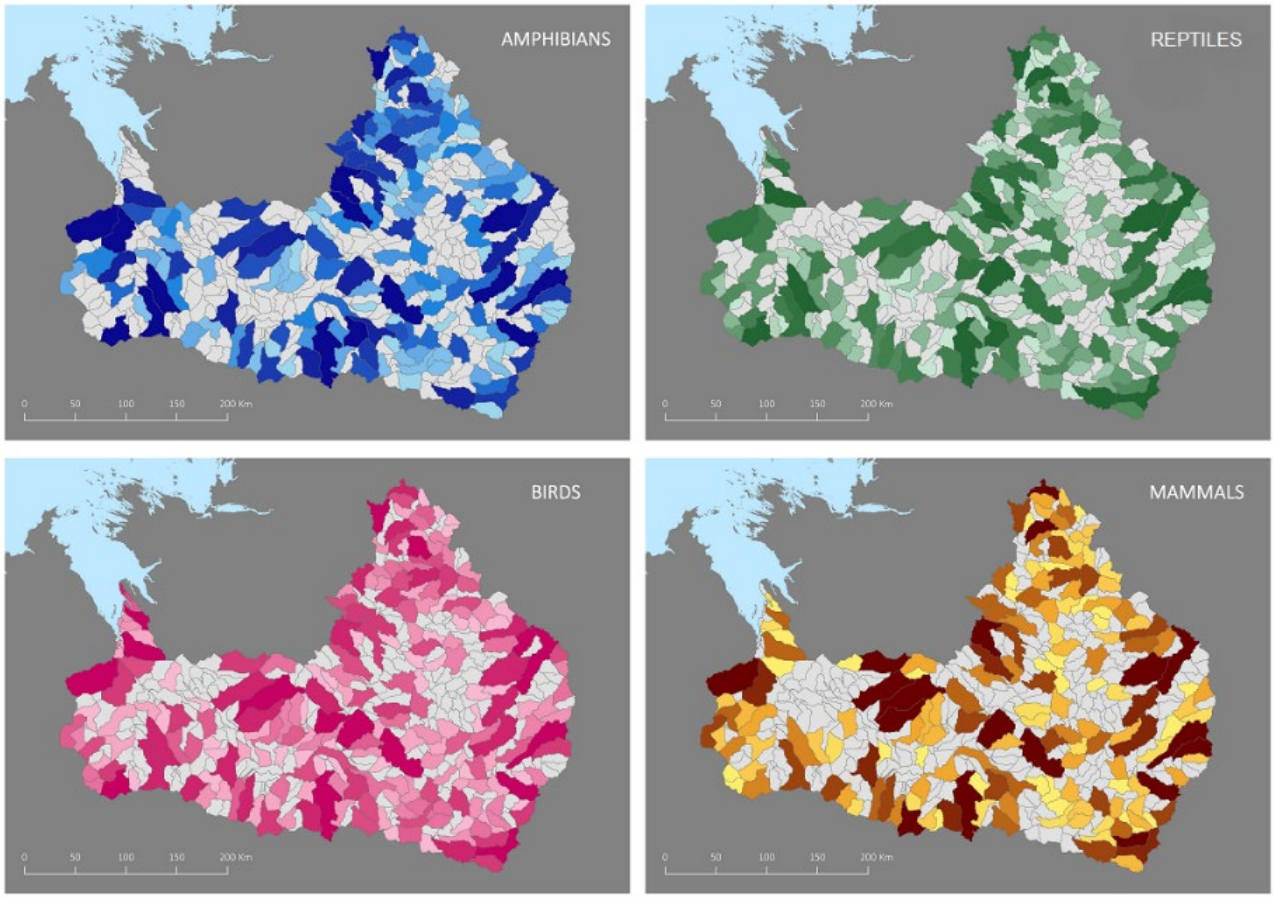
For this stage, we calculated selection frequency (summed solution), which indicates the number of times each planning unit was selected across all the individual solutions (**Figure 5.3**). This map gives an indication of the priority or relative importance of individual planning units to create an efficient conservation area system (Watts et al., 2017).

*Figure 5.3. Relative value for biodiversity conservation across the Fitzroy catchment. The map shows Marxan's summed solution output, displayed as the proportion of 100 runs. Planning units that were never selected in the optimisation analyses have a selection frequency of 0, while those units that were always selected have a selection frequency equal to 1.*




We also identified areas of conservation importance using subcatchment as planning units, which are useful to compare with existing maps of priority areas for conservation of aquatic biodiversity (NAWFA); see the examples below (**Figure 5.4**). Marxan analyses have been fully parameterised and can be easily replicated or updated using additional or updated spatial information about threats, species distribution models. Additional modifications may include adding or removing features or creating priority maps for subsets of features of interest, as well as adding constraints based on new land-use maps and costs (e.g. opportunity, management), currently set as uniform across the region.

*Figure 5.4. Examples of relative value of sub-catchments for biodiversity conservation of selected taxonomic groups of species based on set conservation objectives for the Fitzroy catchment.*




### 5.2.2. Carbon abatement potential

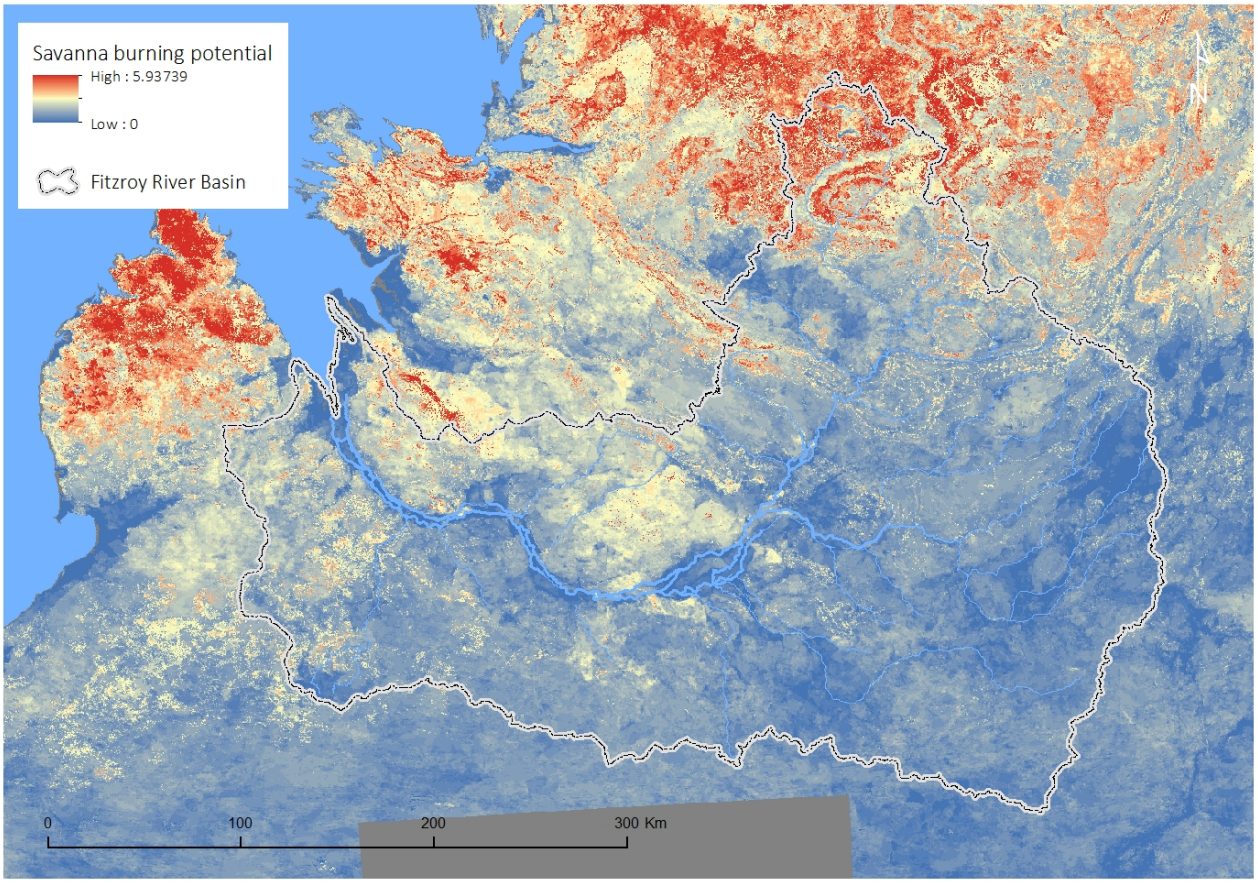
Northern Australia has a large proportion of savannah country prone to seasonal fires (Russell-Smith et al., 2007). Carbon farming in this context is thus focused on fire management (controlled burning) to reduce the extent of fires and adjust their timing by burning earlier in the dry season, thereby reducing occurrence and extent of late-season hot wildfires and the total emissions associated with fires (Whitehead et al., 2008; Adams and Setterfield 2013).

Savanna burning is an approved methodology for greenhouse-gas abatement under the Carbon Farming Initiative (CFI) in Australia. The benefit of these programs is a net reduction of carbon emissions because early season cold fires produce about half the carbon dioxide emissions of late season hot fires (Russell-Smith et al., 2009; Heckbert et al., 2012). These programs include several benefits, including: significant employment opportunities for Aboriginal people (e.g. 28,000 $km^2$ western Arnhem Land carbon farming project employed on an annual basis up to 400 people and resulted in >100,000 tonnes of abatement), potential reinvestment into other enterprises (e.g. tourism), and improvements in biodiversity through reducing risks associated with extensive hot wildfires (Adams and Setterfield 2013; Bradshaw et al., 2013; Australia 2014; Russell-Smith et al., 2015).

Mapping potential for carbon farming included spatial analyses to create maps depicting the maximum potential abatement and potential profitability based on savanna burning methodology (**Figure 5.5**). We generated alternative models of carbon farming based on alternative vegetation mapping, offset prices, and management efficiency (**Supplementary Material**). Savanna burning models were created using the most up to date fire history maps (www.firenorth.org.au), vegetation maps, and recent amendments to the savanna burning methodology. The methods to build these maps follow those described in Adams and Setterfield (2013) and Heckbert et al. (2012). The

models include the whole Kimberley region because fire management is likely to be implemented at large scales and involve multiple properties that transcend the boundaries of the Fitzroy catchment.

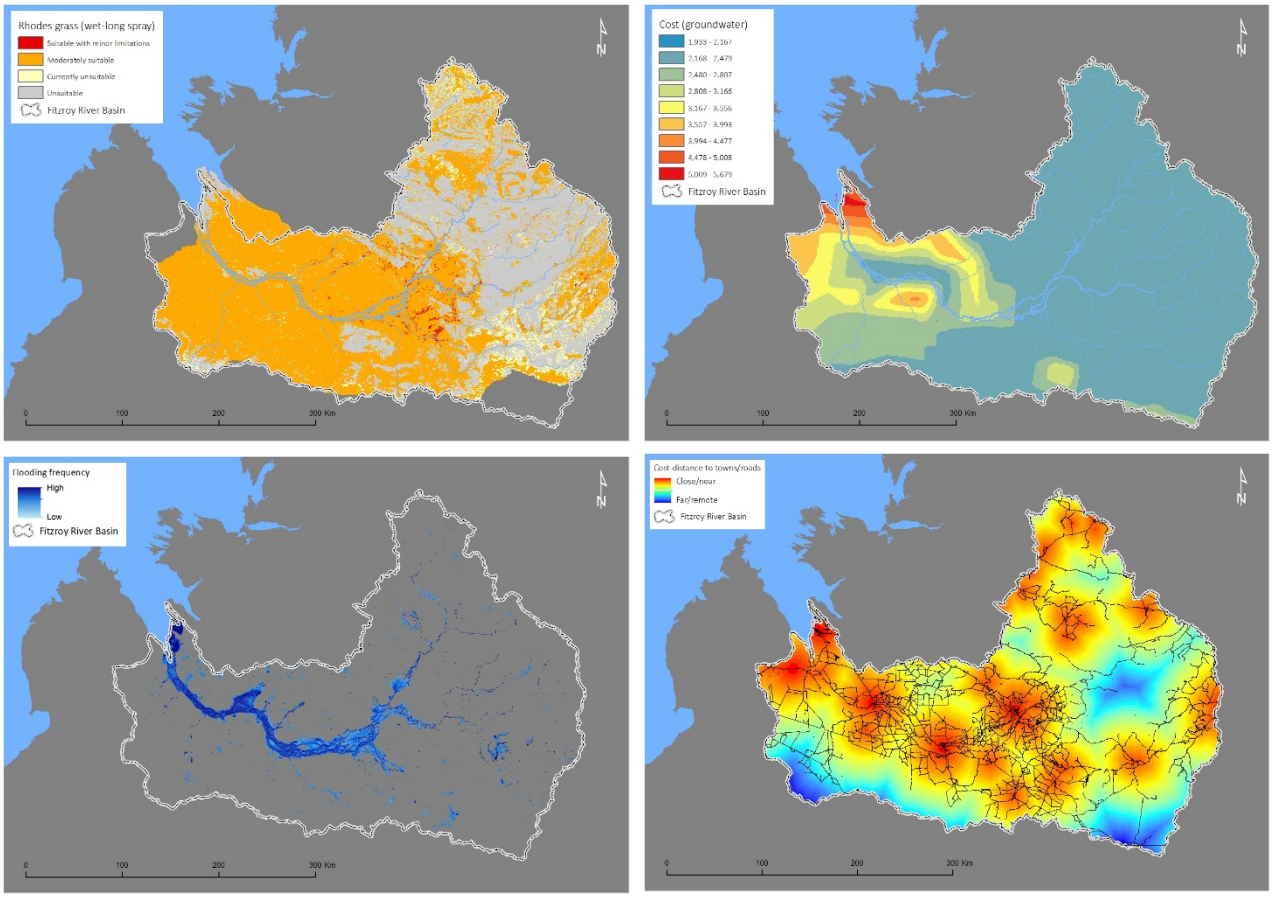
*Figure 5.5. Example model of potential value (profitability, in AUD/ha) for carbon farming across the Kimberley region based on savanna burning methodology.*




### *5.2.3. Agriculture and aquaculture potential*

The information for mapping agricultural and aquaculture potential was mostly derived from CSIRO's Northern Australia's Water Resource Assessment (Petheram et al., 2018a), which includes maps of agriculture suitability for different dry- and wet-season crops and aquaculture, as well as other data relevant to mapping the areas with potential for different types of agriculture development (e.g. flooding risk, development costs, water availability). The following map exemplifies modelled land suitability for Rhodes grass grown in the wet season using spray irrigation (**Figure 5.6**). Suitability maps do not take into consideration flooding, risk of secondary salinisation or availability of water, which among other constraints (e.g. tenure) were used to map the likelihood of areas to be developed for irrigated agriculture and aquaculture (Module 4). Our spatial analyses to generate possible future land use under alternative scenarios were based on best available spatial information about land suitability, groundwater (bore) development costs (mainly based on aquifer depth), likelihood of flooding (risk, high cost), and distance to towns and roads (access and cost).

*Figure 5.6. Examples of spatial information used to create maps depicting the potential for irrigated agriculture as basis to build land use configurations under alternative scenarios.*




### 5.2.4. Grazing potential

The Fitzroy catchment includes 50 stations with predominantly pastoral use, summing 116,795 km$^2$ and covering 83,107 km$^2$ (84%) of the catchment. Eighteen are owned/managed by Aboriginal organisations, covering 27,026 km$^2$ (27%) of the catchment. The catchment includes 79,726 km$^2$ of pastoral land (43% of Kimberley: ~185,860 km$^2$), thus – based on theoretical carrying capacity values – we estimate pastoral stations can hold ~208,572 head and sell ~39,883 head (28,317 to live market). We assume most of the current area under grazing of native vegetation will remain as such, but some scenarios include diversification (e.g. irrigated agriculture, carbon farming via savanna burning) and/or allocate portions to conservation.

Our maps of potential importance of areas for grazing builds on the methods regarding likelihood and potential intensity of grazing on northern Australia (Pintor et al., 2019). Value of grazing land was assessed based on key factors influencing grazing potential (**Figure 5.7**), including: long-term average carrying capacity (CC) of land systems[7] based on accessibility and utilisation of pasture (Payne and Schoknecht 2011); median pasture growth (kg/ha) for 2000-2018 based on Aussie GRASS data;[8] and eduction in grasses/CC due to fires.[9] Further constraints affecting the value of pastoral land relate to accessibility, which is largely determined by cost-distance to population

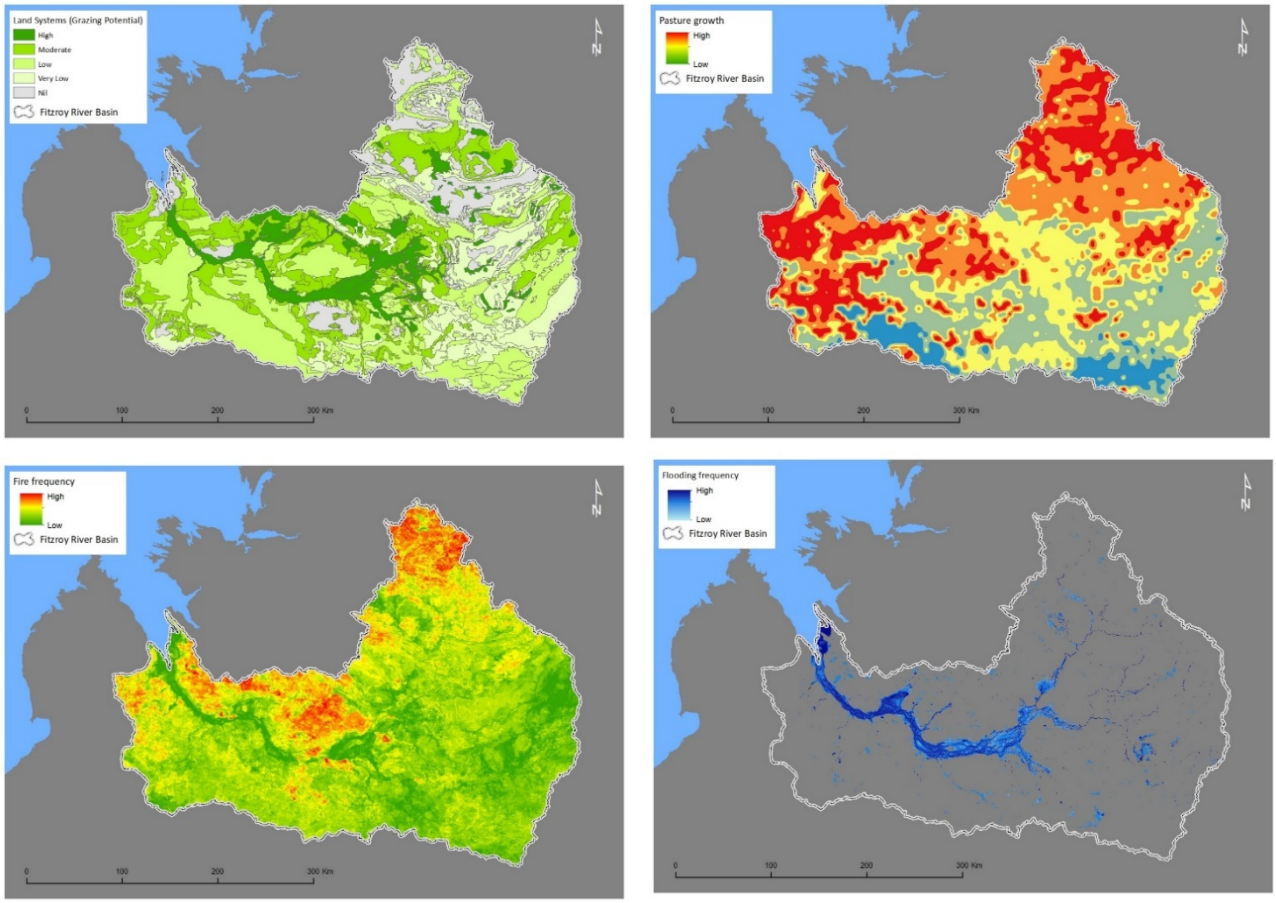
[7] Following Skroblin et al. (2014) we converted range of theoretical stocking rates (i.e. guide to livestock numbers that can be carried without degrading pasture or soils) into intermediate, single values of CC for each land system. One CU is defined as a dry cow or steer in excess of 2 years of age; a breeding cow is 1.4 CU and a bull is 1.5 CU.

[8] A spatial implementation of the GRASP daily time-step pasture production and water balance model based on daily climate data and calibrated using satellite data and pasture biomass observations.

[9] Early- and late dry-season fires can result in 63% and 95% loss in grass area, respectively.

centres, roads and tracks adjusted to landscape features;[10] and flood risk.[11] Erosion and patch grazing (linked to water points and fencing) influence value/use, but we lack spatially consistent of data.

*Figure 5.7. Spatial information used to create maps depicting the value and potential for pastoral activity, which were the basis to build land use configurations under alternative scenarios.*



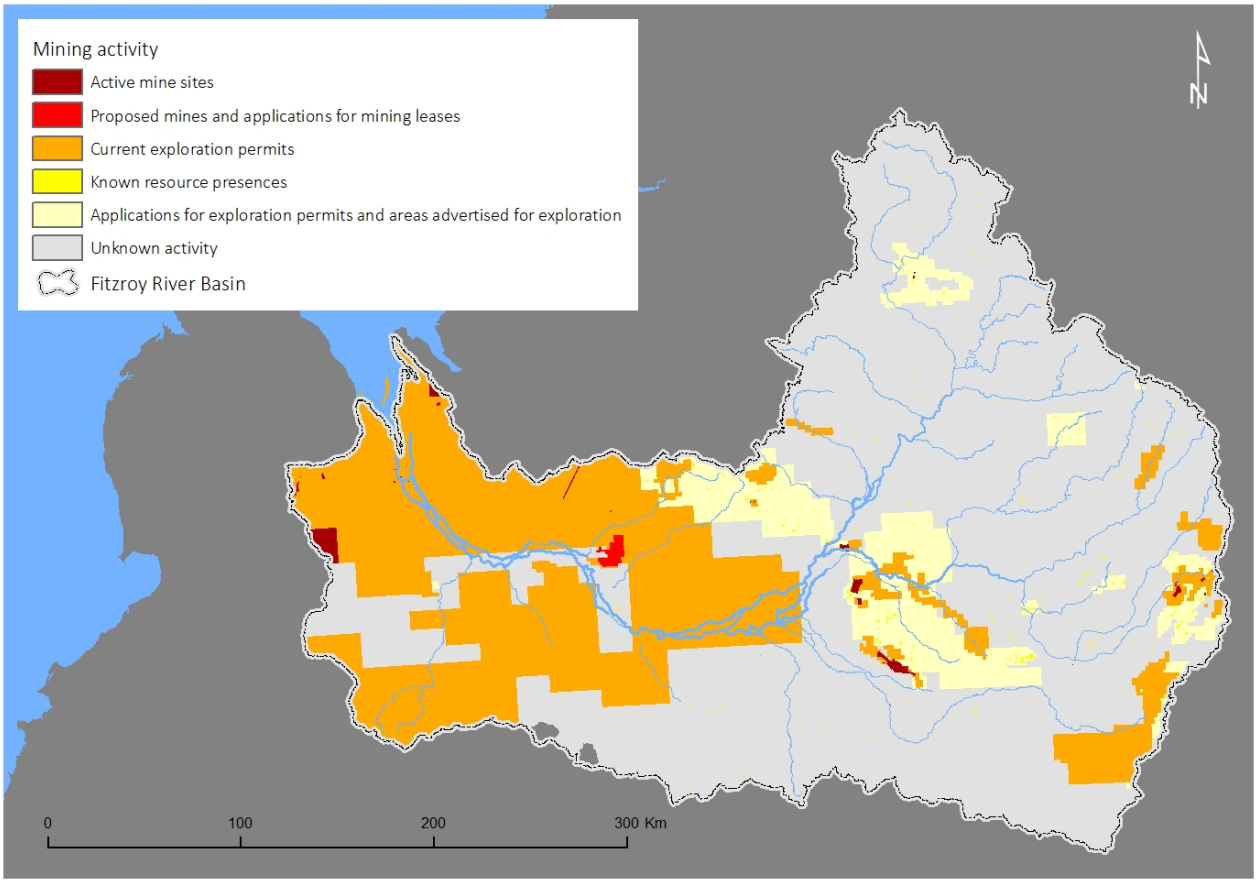

### 5.2.5. Resource extraction

Our maps of potential importance of areas for resource extraction builds on the maps and methods regarding likelihood of mining activities taking place across northern Australia (Pintor et al., 2019). The maps represent potential based on available data on current and proposed mining leases and exploration permits (petroleum, minerals, coal, infrastructure and known mineral occurrences) from Western Australia's and Geoscience Australia's spatial databases. The map depicts potential likelihood or uncertainty, from very likely/most certain (proposed mines and applications for mining leases) to less likely/most uncertain (applications for exploration permits and areas advertised for exploration) (**Figure 5.8**).

[10] Cost distance calculated using a combination of distance from population centres (modelled as Euclidean distance using exponential function), slope (modelled as an exponential function), vegetation cover, waterways (acting as barriers), and distance to roads.

[11] Estimated using flooding frequency from NAWRA's modelled flooding and satellite-derived observation over 10 years.

*Figure 5.8. Maps depicting current potential for resource extraction activity, which were the basis to build land use configurations under alternative scenarios.*




### 5.2.6. Other features

Researchers also explored options to build on the methods developed to map likelihood of over-exploitation of wildlife across northern Australia to create models of potential importance for recreational and subsistence harvesting, hunting and/or fishing of native wildlife. These maps incorporated information about the presence of species of recreational and subsistence importance (based on literature), access to areas (influenced by distance to populated areas, existing roads, terrain and type of vegetation), and the availability and quality of habitat. Further considerations relevant to the assessment of scenarios included tenure and agreements, also influencing current and future access. The preliminary models are available for use but are considered preliminary due to limited spatial data and opportunity to discuss further with experts and Traditional Owners to ensure they are adequate to represent areas of potential importance for these activities. For these reasons, these maps were not used to construct or assess future land-use scenarios and should be considered carefully for planning applications.

## 5.3. Cultural values

This module involved compiling existing publicly available spatial data on heritage and cultural values, directly (and only) using readily available mapped values (e.g. compiled National and Western Australia's heritage databases). However, the use of this data in further spatial analyses (e.g. generating or assessing alternative land use scenarios) was considered inadequate for a number of reasons, including the following:

First, using and interpreting such maps is a sensitive matter that required proper discussion with Traditional Owners, which was beyond the scope of the PSP process;

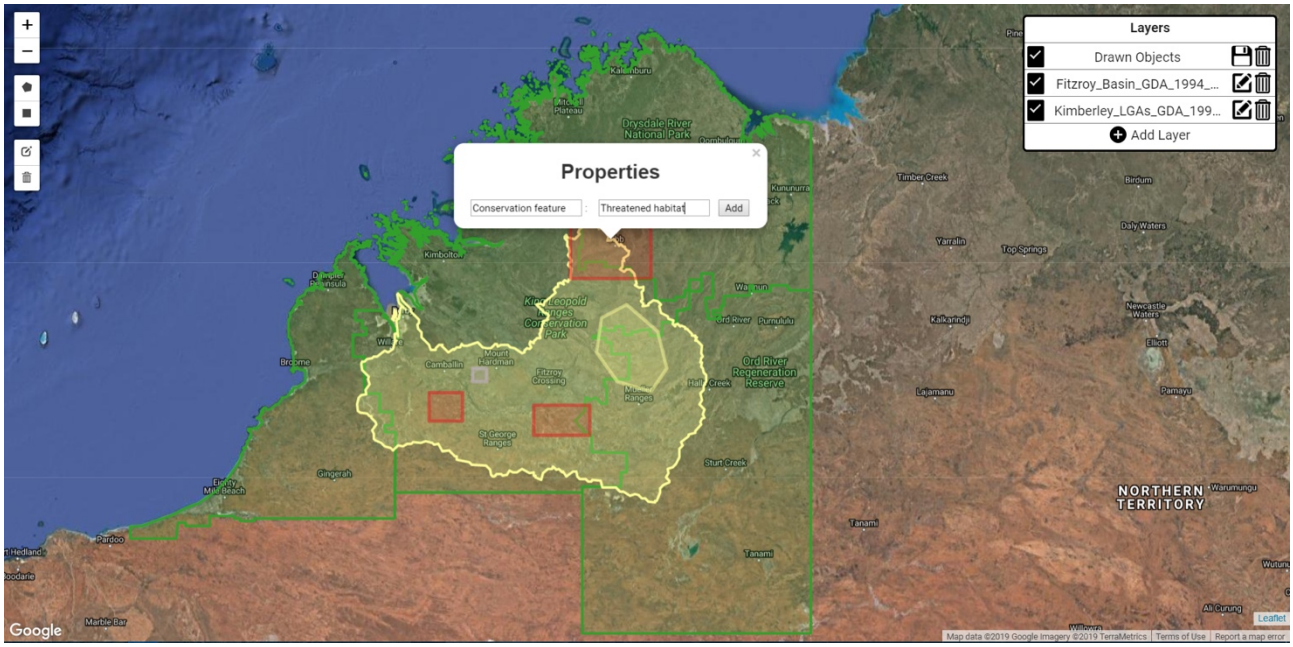
Second, several mapped values from past and ongoing local mapping efforts are not included in these databases because of confidentiality (thus, publicly available databases are incomplete); third, access to some datasets is restricted to specific PBCs (e.g. Walalakoo) or the KLC (acting as custodian of information for registered Native Title areas); and

Third, determining which values could be mapped and how these maps could be shared and stored (e.g. electronically), if at all, are ongoing areas of research under NESP projects 3.5 and 5.4.

Our decision to exclude this information from our analyses was discussed with other NESP researchers, the KLC and PBCs during our early engagement stage, which was received positively. However, during the assessment stage, participants had the opportunity to use and discuss this information and were able to point out to places that could be affected under possible future scenarios.

In addition to the compilation of existing public information, researchers developed a prototype spatial mapping tool that was presented to PBCs during a couple of workshops. The mapping web-based interface (**Figure 5.9**) allows to draw and save polygons with information about values or features of interest by users and is publicly available to support spatial planning in the region.

*Figure 5.9. Screen shot of the interface of ValueMapper, a flexible web-based spatial mapping tool developed by the project to support mapping features of interest and document their names, types and any other relevant characteristics. The tool allows mapping, modifying, and saving in ESRI Shapefile format, which can be used in any GIS software.*



# 6. Imagine alternative development scenarios (Module 3)

## 6.1. Summary

This module describes the core activities of the PSP process, which aimed to build possible development trajectories for the Fitzroy catchment. Scenarios are stories that consider how alternative futures may unfold and allow people to consider and discuss their perceptions and aspirations for the future. Scenarios are useful to identify opportunities and risks associated with decisions – for example, environmental and socioeconomic outcomes associated with alternative development pathways. Activities in this module allowed the scenarios team to share views on development, explore alternative development options, and collaboratively create narratives of possible futures. The PSP activities aimed to create a space for constructive conversations about the future development of the region. Researchers worked closely with the scenarios team through facilitated multi-stakeholder workshops to develop shared understandings about development options for the region and systematically explore the possibilities, as well as the potential outcomes of different development trajectories.

## 6.2. Participatory scenario planning

Scenarios provide alternative future visions that that allow collective consideration and articulation of perceptions and aspirations for the future (Kahane 2012b). They allow exploring opportunities and risks that may be associated with particular decisions (Cork 2016). A key goal of scenario planning is helping stakeholders to understand key uncertainties about the future (Cork et al., 2013). Scenario planning can also play an important role in opening up thinking to the need for change (Peterson et al., 2003). In the context of development, scenarios can help to identify decisions that stakeholders can make, together or individually, to improve land and water use (Cook et al., 2014).

Constructing scenarios allow people with diverging opinions to see the world from the point of view of those with different perspectives. They allow people to think not only about futures that they accept, but those that they reject. For the same reason, thinking about the future can take participants outside their comfort zone. The process has the potential to change understandings, create empathy, and build trust, which together can lead to changes in individual or collective action that, directly or indirectly, can shape the future (Kahane 2012b).

Scenario analysis is a structured process of generating imaginative future possibilities (Cook et al., 2014), such as exploring alternative development pathways and their effects on ecosystems and wellbeing. Scenarios consist of convincing stories that consider how alternative futures may unfold from combinations of influential and uncertain drivers (Oteros-Rozas et al., 2015; Cork 2016). Scenarios are best suited to explore situations with high uncertainty and low controllability (Peterson et al., 2003), such as the future development of the Fitzroy catchment.

Traditionally, scenario planning exercises have focused on the perspectives of a focal group, organisation or industry (Kahane 2012b; Oteros-Rozas et al., 2015; Cork 2016). This approach is inadequate when studying and adapting to possible futures is not enough (e.g. when stakeholders find the situation is unacceptable, unsustainable or unstable) and demand changes (i.e. when actors want to influence what could happen), thus requiring multi-stakeholder approaches (Kahane 2012b). Discussions about developing northern Australia share many of these features (Hill et al., 2006; Australia 2014, 2015; ACF 2017; Chambers et al., 2018; Jarvis et al., 2018; Heiner et al., 2019), where ongoing planning and development projects have resulted in tensions among stakeholders.

Transformative PSP aims to shape the future collaboratively (Kahane 2012a; Oteros-Rozas et al., 2015; Waylen et al., 2015). To achieve this, the method is designed to facilitate change in views, relationships, and actions (Kahane 2012a) . Through an intensive intellectual and social encounter of diverse people, the process has the potential to shift thinking about what is

necessary and possible, and can contribute to creating trust among stakeholders (Beery et al., 1997). The method postulates that, through the planning process, transformation can ripple out from individual members to the scenarios team, organisations and sectors, and eventually to the larger system they belong to and are trying to influence (Kahane 2012b).

Transformative scenario planning aims to improve:

1. Systemic understandings: articulate a collective synthesis of what is happening and could happen, and better understand their role in the situation.

2. Cross-system relationships: increase the empathy for and trust in other members of the scenarios team, and consequently their ability and willingness to collaborate (including through building alliances).

3. System-transforming intentions: through the process, people can shape their motivations, which can then lead to shaping their own actions.

### *6.2.1. Why participatory scenario planning?*

Participatory scenario planning (PSP) is suitable for cases where:

- People see the situation they are in as unacceptable, unstable, or unsustainable, but disagree over what the future should look like; the situation could have been problematic for some time, it could be becoming problematic, or may possibly become this way in the future.

- Individual actors (e.g. people, organisations, sectors) cannot transform their situation on their own (unilaterally) or by working only with friends, allies, like-minded people and/or colleagues.

- People cannot transform their situation directly because it is polarised and people do not necessarily trust one another; transformation can be approached indirectly, through first building shared understandings, relationships, and intentions.

- People do not necessarily understand or agree what the solution is (or even what the problem is) and at best they agree they face a situation they all find problematic, although in different respects and for different reasons.

- The larger socio-political-economic system is too complex, has too many actors, too many interdependencies and is highly unpredictable for a single actor to understand and shape (general condition conducive to scenario planning).

This project used PSP to enable and facilitate the participation of all relevant stakeholders and to ensure participants were aware that it followed a scientific process and was independent of the planning processes happening in parallel. A key aspect of the process was to allow members of the team to work together comfortably, think creatively and become aware and challenge (and have challenged) their own views.

The project was designed and managed in a rigorous manner to ensure the scenarios team can generate plausible, convincing, clear and challenging stories about what could happen in terms of development of the region. This included generating relevant qualitative information about changes in the configuration of land uses, information to guide the construction of maps depicting future land uses, and a method to assess the outcomes of these configurations (benefits and costs) for different stakeholders.

### 6.2.2. Boundaries of the scenario planning process

While the scenarios team had the liberty to shape and define the boundaries of the situation we aimed to explore, researchers provided a broad proposal defining the boundaries of the system. The team had opportunities to consider developments beyond these boundaries, but discussions were managed and facilitated to ensure they remain bounded by the situation under examination (Kahane 2012b). Defining a common goal was critical to increase ownership of the process and have clarity of what the team embarked on.

The project broad goal was to create a shared space for constructive conversations about the future development of the Fitzroy catchment. Through this process, the scenarios team aimed to develop common understandings about different development options for the region and systematically explore the potential benefits and trade-offs of different development trajectories. Participants had different views and preferences about development but shared the conviction that these conversations are necessary to ensure a sustainable development of the catchment.

## 6.3. Workshop 1: Views on development, drivers of change and development initiatives

On 10–11 July 2018, NESP researchers led the first project workshop, gathering 40 people from 26 organisations across all main interest groups, including the Australian Department of Agriculture, Water and the Environment, WA agencies, local governments, mining, agriculture and tourism organisations, environmental NGOs, Rangelands NRM, KLC, and PBCs representing the interests of Bunuba, Gooniyandi, Nyikina Mangala, Yi-Martuwarra, and Yungngora peoples.

The workshop involved a series of activities for team members to get to know each other, strengthen relationships, and build trust – all critical elements of the PSP approach. During the workshop, the team discussed the meaning of the term ‘development’, driving forces of land use change, and the diverse development initiatives proposed for the catchment. An important goal of this first workshop was to create shared understandings of what is happening in the region that could shape the future development of the catchment. This included a discussion about the diverse views on development.

Before exploring the future, the group looked back into the past. They created a timeline for the Fitzroy, identifying the events and forces that have shaped how the catchment looks today and could drive development in the future. Finally, the group started exploring development initiatives proposed for the catchment, such as irrigated agriculture, cultural and nature-based tourism, mining, and carbon farming.

### 6.3.1. Aim of the workshop

The goal of the first workshop was to build a shared understanding of what is happening in the system of which the scenarios team is part of and want to influence. It aimed to allow participants to expand their particular perspectives and see more of the whole system through the views of other participants and the information presented by the research team. Similar to other PSP exercises, the first workshop was important for participants to improve their understanding of each other and to create a ‘common language’ about the situation, in this case the development of the catchment. This was particularly important in the case of the Kimberley, where the perceptions and meanings of development are very different among the diverse groups that are part of the system. The workshop also aimed to identify the driving forces shaping development in the region and that could influence land use change in the catchment. Finally, the team identified various development initiatives that have been proposed or could be implemented in the catchment.

### 6.3.2. Introduction to the workshop

The first workshop included introductory activities, including an overview of the project (what has happened in the project so far, project stages, timeframes, activities), geographic area (including an explanation of the concept of a catchment), and an overview of development in northern Australia and how this triggered the project. It included an explanation of scenarios (including examples) and introducing the research team and facilitators, including a clear description of their roles[12]. The research team also introduced the information and consent forms (sent electronically before the workshop) and explained their need and emphasise confidentiality, access and sharing of outputs, photos, audio/video recording. Most introductory activities were included in all workshops, adjusted to the specific requirements of each meeting.

The introductory session included defining a mechanism to capture and address questions and concerns of workshop participants. To achieve this, the facilitators introduced the '**Need to know more**' sheet (placed on the wall), which was used throughout the workshop by participants to write questions, queries or concerns they want researchers (or facilitators) to answer, clarify or discuss during the workshop or throughout the project (**Figure 6.1**).

Researchers explained the overarching goal of the scenario planning process and outlined some of the benefits for participants involved in the project (**Figure 6.2**), including:

1. opportunities for group learning and networking

2. learning about strategic planning to support land and water use decisions

3. access to information, maps and tools

4. identify possible land use changes and their effects on people and their environment.

Researchers explained that the process also has the potential to shift thinking, create empathy, understanding, and trust, which together can then lead to changes in individual and collective actions that could shape the future of the region.

[12] Facilitators were in charge of running the process and their key role was managing discussions, helping to keep everyone on track, ensuring everyone gets to have a say, and creating a space and atmosphere that allow people to contribute equally and non-judgementally. In contrast with researchers, facilitators did not have an opinion on content and focus on the process.

*Figure 6.1. Example of questions and concerns raised by the scenarios team.*

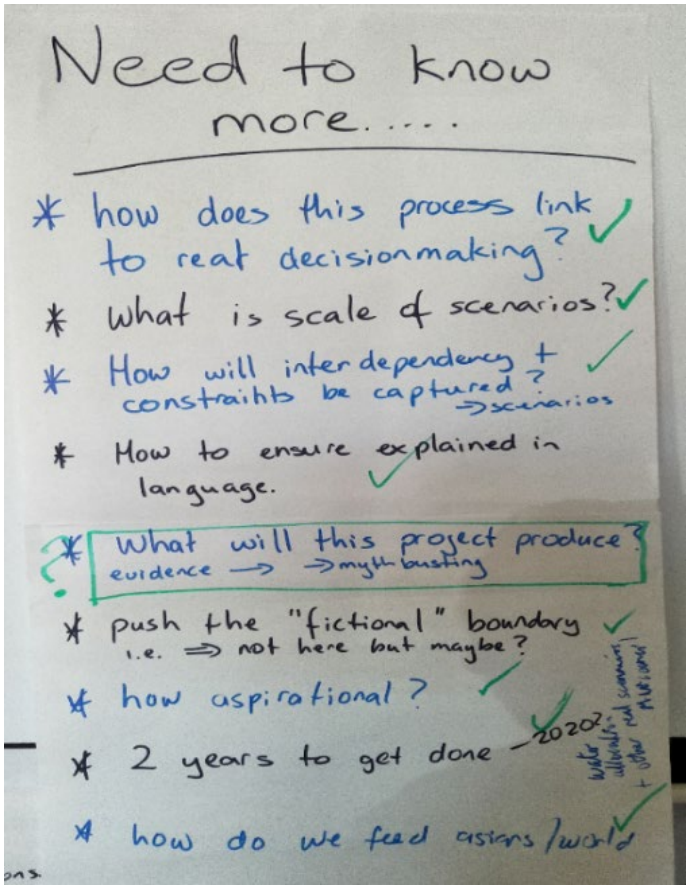



*Figure 6.2. Discussing and agreeing on the goals of the PSP exercise was critical.*

### *Define the approach, expectations, and principles of the planning process*

Early in the process, the group discussed and agreed on the approach and rules that shaped their work along the whole scenario planning process. Everyone had to be clear on what we were trying to achieve, what process would facilitate achieving that goal, and what things could pose difficulties. Likewise, it was essential to identify, discuss and manage any unrealistic expectations early in the process, and as they emerged. Facilitators ensured this was observed along the process.

Researchers emphasised that the project was carefully designed and managed to ensure that: scenario planning activities are as inclusive as possible; all views and actors in the region are included; and outputs are unbiased, thus the process was not driven by or for the benefits of any one organisation, party or sector. Researchers were explicit about this goal and the actions taken to ensure the inclusiveness of the process; any concerns regarding unbalance were clarified as they were raised.

During the first workshop, researchers introduced and explained the **project principles**, which refer to the general features or givens for how a PSP project operates (**Figure 6.3**); these were shared electronically and in hard copy during the workshop:

- First, and most important, we won't talk about what we predict will happen or what we believe should happen, only about what we think *could* happen (plausible and convincing stories).
- The process aims to facilitate seeing development from the point of view of people that may have opposite or diverging views to ours, thus allowing us to see not just their part of the system but more of the whole system and learn from others.
- Throughout the process each of us need to become aware of and critically review the way we think about the past, present and future of development in the region, thus we need to continuously recognise and even challenge our assumptions.
- We need to think not only about futures that we accept, but those that we reject, thus the process can take us outside of our comfort zone and may be confronting at times.
- We don't need to agree on creating a shared vision, but as a team may decide to do so.
- We won't have to negotiate or compromise the interests or goals of our community, organisation or sector.
- Participating doesn't preclude people from undertaking, supporting or opposing activities related to development projects, advocacy campaigns, etc., thus people shouldn't feel they will compromise their ongoing agendas and activities.

*Figure 6.3. General principles of the PSP process discussed with the scenarios team.*


In addition to the discussion on project principles, researchers also explained the project's **core governance principles**, this is how the research team committed to behave with the participants, which was checked along the process:

*Accountability*

- The roles and responsibilities of project participants are clear and reasonable.
- Participants are answerable for their responsibilities.

*Transparency*

- Information regarding the project is made available within a reasonable timeframe.
- The reasoning behind processes and decisions is clear.
- Information is appropriate to participants' needs.

*Inclusiveness*

- All the relevant groups have opportunities to participate in the project.

*Fairness and adaptability*

- Participants are heard and treated with equity and respect.
- The project reasonably incorporates participants' suggestions and concerns.
- The project team uses different engagement approaches, according to the perceived needs of each group.

### *Group charter*

In addition, facilitators introduced the **group charter**, which refers to a set of guidelines or ground rules of how all participants want to operate and communicate with each other during the

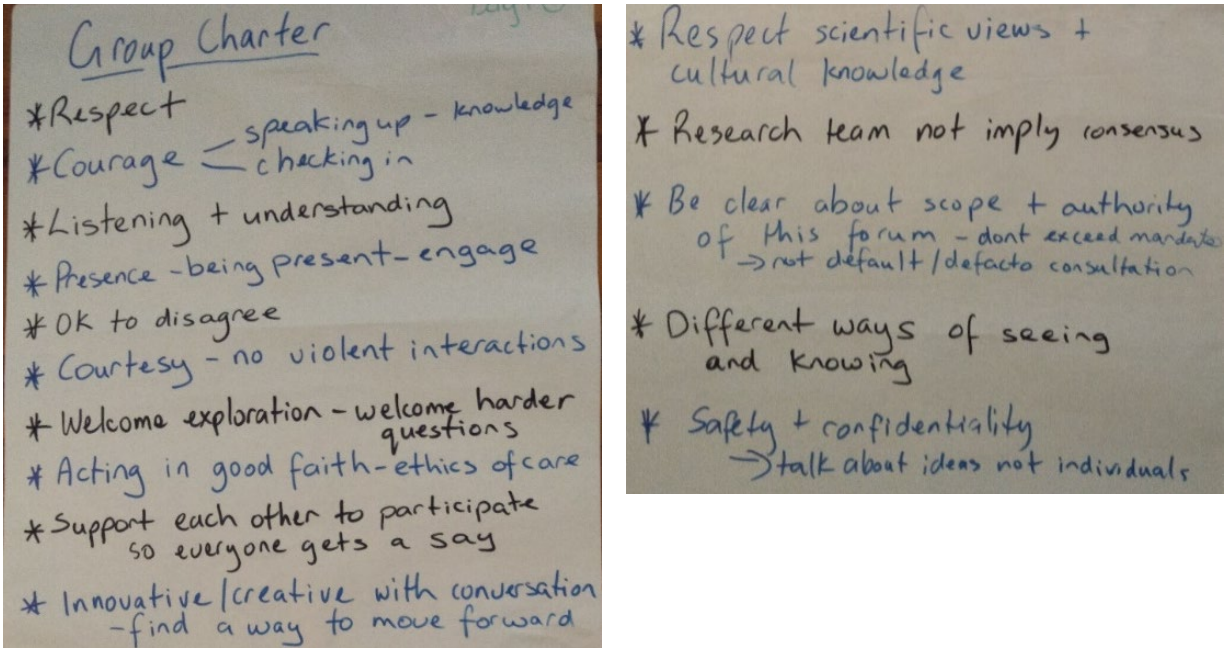
workshops. The group charter functioned along the whole process but was put forward to be revisited and updated for each workshop as required. The charter is very important because we were seeking to discuss a complex topic with many alternate points of view.

The facilitators introduced some examples based on what participants mentioned during meetings with researchers and during the interviews. Examples used to prompt the discussion included: people with different views are included in the scenarios team; everyone's opinion is important and should be respected by others, thus everyone will be given the opportunity to participate and share their ideas; participants should not push their own interests or those of their org, community or group; and the process and discussions should be transparent.

Facilitators asked participants to write two or three thoughts and share with the person next to them on tables. The list was presented on the screen and participants discuss the notes using the following question: *What does this look like or what behaviour does it imply?*

Once the group agreed on the content, the charter was transcribed into a sheet and placed in prominent position on wall (**Figure 6.4**), thus it could be referred to during workshop, as needed.

*Figure 6.4. Group charter developed by the scenarios team to guide participation.*




## *Group introductions*

This activity aimed to know about each other to help people have more open and honest conversations. During this activity, participants introduced themselves by telling their name, favourite foods and one word to describe how they were feeling at the moment. Participants then lined up in alphabetical order and briefly discussed with the person besides them the origin/meaning of their name. Following facilitators asked participants for any surprises or similarities.

## *Development in northern Australia and defining development in context of the project*

An important step involved contextualising and framing the discussions. To achieve this, researchers gave an overview of development in northern Australia and how certain policies and other development planning initiatives (e.g. RDA 2013; Australia 2015; KDC 2015) contributed to the development of the project (**Figure 6.5**) and gave a summary of key findings from the interviews to the scenarios team, focused on describing the diversity of views and meanings development (and perceptions about the state of development in the catchment).

*Figure 6.5. Examples of some of the background documents discussed during the workshop.*


The team identified key issues from ongoing discussions around developing northern Australia:

- early stage of development
- transformation, achieving its enormous potential
- unlocking opportunities and confronting challenges
- solutions to pressing social challenges
- economic and social advancement
- cultural and wilderness assets and unparalleled resources
- new economy led by agriculture, minerals and energy production, tourism, and other industries, new jobs
- improving land and water access, use and management
- engaged Aboriginal population, leadership, locally owned and managed.

To facilitate exchange of ideas the facilitators invited participants to discuss the term ‘development’, including examples of how the term is used in different countries and contexts (avoiding qualifying it as negative or positive). The question guiding this discussion was:

- What does development mean to you?

It was stressed that the goal of this discussion was to create shared understandings of the varied perceptions and views about development in the context of this project. In preparation for this discussion, facilitators guided an activity designed to help people listen to each other without having to provide a comment or rebuttal.

Facilitators presented colloquial discussion topics; in pairs, each person talked for three minutes about one of the topics of their choice with the other person listening carefully to what was said. At the end of the three minutes the listener had to summarise what their partner said without debating, agreeing or disagreeing; following, they switch roles and repeated the process.

Following, the group discussed the following questions:

- When you were speaking how did you feel about your partners' ability to listen with an open mind?

- Did your partners ‘body language’ communicate how they felt about what was being said?

- When you were listening how did you feel about not being able to speak your own views on the topic?
- How well were you able to keep an open mind?
- How well did you listen?
- How well did the listening partners summarise the speakers' opinions?
- Do you think you would get better if you repeated the exercise?
- How can we use the lessons from this exercise in this workshop (or anywhere else)?

Following, researchers presented a summary of the results from interviews, particularly regarding participants views on how development should look like in the Fitzroy catchment and the current state of development in the region. These results were summarised in a presentation to start the discussion about the commonalities and differences in views on development held by participants (**Figure 6.6**).

*Figure 6.6. Word cloud derived from interviews regarding the meaning of development.*


### *6.3.3. Putting change into perspective*

During this activity, the scenario team mapped out key changes over the past 50 years. Specifically, the group identified the events that have changed the region notably and shaped the way things are today. Identifying waves of change helped participants to understand and share ideas about forces in the region and opened up thinking on how local and external events and processes have created and could continue to generate change in the catchment. The activity also served to introduce the concept of 'driving forces of change' and to start thinking about how these drivers can create change in the future. Creating a timeline helped to reveal how change has been a constant, sometimes directed by people living in the region and other times originating from the outside. Previous scenario planning exercises have used similar approaches to understand and identify divers of change (Enfors et al., 2008; Oteros-Rozas et al., 2015; Mitchell et al., 2016a).

To achieve this goal, the group had table discussions to identify major events, happenings, changes, policy, organisations, etc. that have influenced the catchment. Participants worked in tables, wrote down events in as few words as possible (including date), and discussed with others on their table. Each table gave notes to facilitators as they emerged, who put them on the wall in chronological order. Participants then identified sections that stood out, by responding to the question 'Can we identify different eras or patterns?'.

The group then identified and named each section (era),and discussed key elements of each.

The group identified key historical events and periods of time when change had been most evident, notably shaping the region. Participants grouped events into the following eras or periods of change:

**1960s** – From a pastoral perspective, this period saw the largest move of Aboriginal peoples, who left pastoral stations.

**1970s** – An important event was the formation of the Kimberley Land Council (1978), which pushed forward all the Indigenous activities that happened afterwards regarding Indigenous self-determination.

**1980s** – A period characterised by more internal processes; the Western Australia Aboriginal Land Inquiry (1983–1984) which explored forms of land use and title over Aboriginal land, namely what kind of Aboriginal relationship to land should be protected and the ways in which to satisfy the reasonable aspiration of Aboriginal people to rights in relation to land; this was accompanied by significant cultural activism. From a pastoral perspective, this decade also saw the return of Aboriginal people to the stations, including the purchase of some stations.

**1990s** – Building on the events during the 1980s, this was a period with very active environmental activism, including several community activities and increase of general environmental awareness; the end of this decade marked the start of the post-determination pastoral era (after the Northern Territory).

**2000s** – Building on the changes in the 1990s, the early 2000s saw the culmination of the pastoral transition, which affected the way pastoral stations are managed today.

**2010s** – Period where there seems to be stronger presence of big corporations, perceived to be supported by some government policies; also a time with noticeable changes in allocation of research funding more directly to community.

The team also identified elements that, despite the significant and ongoing changes, appeared to be persistent in the region and, to some extent, the constants define aspects of the region and that will continue to affect its future (**Figure 6.7**). In some cases, the constants actually referred to continuous change, such as political policies and funding. The constants included aspects related to people, main land uses, and environment:

- Aboriginal people still live throughout the region and continue being born; based on the account of historical events, there was a recognition that Aboriginal peoples can stand up for their rights and they can continually engage with mainstream politics and media.

- Pastoralism, in some form, has been there for a long time, with Aboriginal people working on stations or with stations; observed changes in relations of Aboriginal peoples with stations across time exemplify the potential influence of forces originating outside the region, such as divisions between Indigenous and non-Indigenous Australians more broadly.

- Repeated attempts (or proposals) to establish some form of irrigated agriculture; in many instances, these have been driven by external forces and not by locals.

- Petroleum exploration drilling has been happening in the catchment since 1921 (Freeney No. 1 well, drilled near Christmas Creek), coexisting with pastoral uses. Since that time, there have been almost 300 wells drilled in the Canning Basin. Exploration has followed the price of oil with peaks of drilling most recently in the late 1970s to early 1980s, and more recently from 2008 until today.

- Marked seasons, with periodic significant floods.

- Continuous state and federal policy changes, perceived mainly as an external force in the shape of legislation constantly affecting the region and being a driver of change. Policies are associated with varied and episodic funding streams. Some noted that federal decisions do not always fit well into the regional Kimberley context.

- The Kimberley is highly susceptible to outside forces; this is reflected in how locals change in response to these forces, such as pastoral stations adjusting to external markets.

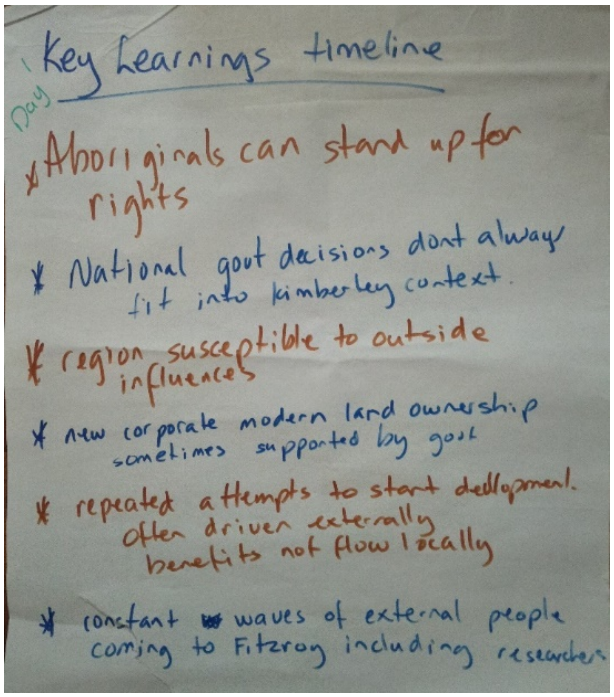
- People also observed the constant waves of external people coming to the catchment (including researchers) to understand the system and to explore development options.

The awareness (and concern) that external forces keep influencing the region was well articulated by one of the participants:

> *Kimberley people are always told what to do; now we can figure it out for ourselves, counter those market forces and decide what is next.*

Some noted the recurrent concerns about the flow of benefits from developments to local people, even in cases where these developments have proven to be profitable. Others expressed concerns regarding the relatively smaller role that other industries (e.g. mining) have had in the recent history of development of the catchment.

*Figure 6.7. Notes from group discussion regarding lessons from the exercise to develop a timeline of the Fitzroy catchment*




From this first discussion, the group shared ideas and developed a broader understanding about driving forces of development. The session finalised with the group identifying a first list of drivers that could be important in terms of influencing change now and in the future, including:

- government policy has driven every change we see today and will likely continue
- people and industry working together
- locally driven development agenda
- foreign investment could play a stronger role
- reliability of climate, particularly rainfall
- developing land infrastructure and resulting changes in proximity to markets

- changes in world markets
- environmental management of impacts and risk (e.g. biosecurity, biodiversity)
- Increase local governments' land use and management decision-making power (e.g. constitutional changes)
- changes in civic participation
- investment to assist transition to renewable energy
- reclaiming indigenous sovereignty to self-determination
- shift in relationship between government, communities, and Aboriginal peoples
- changes in (opening of new) markets
- vulnerable local meat market, easily affected by conditions at point and time of sale
- growing awareness and concern from other parts of Australia about the Kimberley
- new and upcoming Native Title determinations
- future markets, future opportunity, diversifying opportunity to markets.

Overall, participants thought the timeline was a useful exercise and draw some lessons about the influence of local and external forces that have shaped development of the region. Remarks made by participants about the timeline exercise during the workshop evaluation included comments

- about the exercise process, e.g.

  *The timeline was really good, not as boring as I thought; it would have been good to dig a little deeper and talk a bit about the things that failed so that we don't repeat them.*

- its meaning

  *The timeline allowed us to create a survey of historic impacts.*

- and things that the exercise allowed exploring, such as:

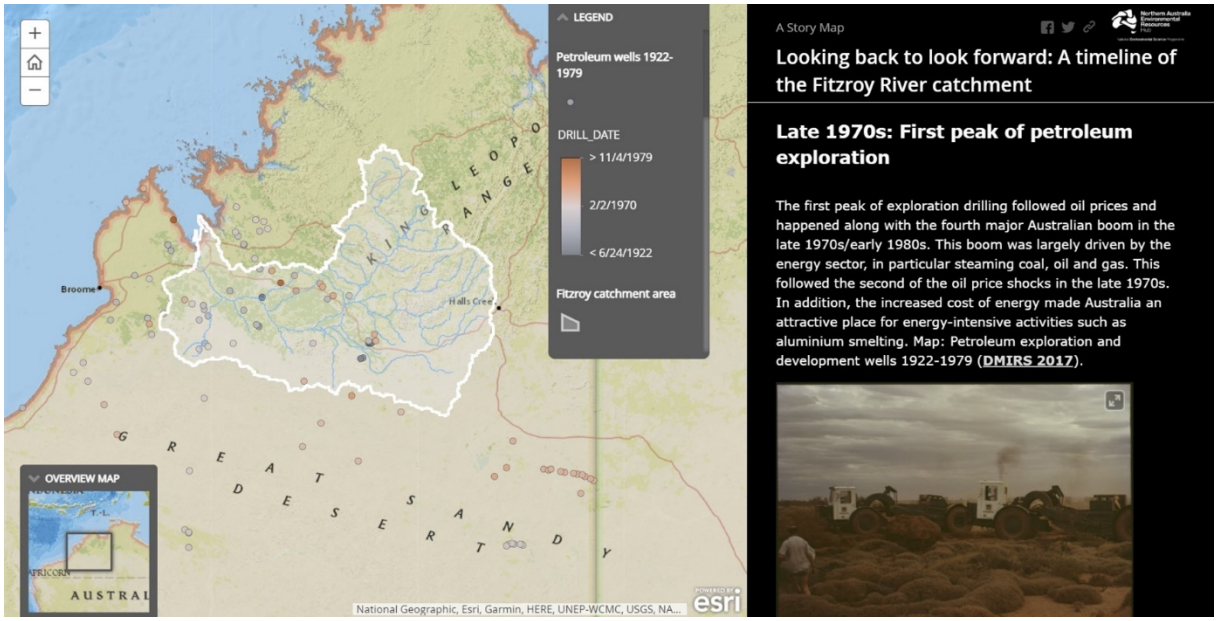
  *relationships that underpin the timeline*.

Using the information from this activity, researchers created a Story Map of the timeline, which participants can explore online (**Figure 6.8**). The story map describes a timeline of key events that have shaped the Fitzroy River catchment. It was created to help understand and explore the driving forces of development in the region.

*Figure 6.8. Opening page of the Story Map created to share the timeline of the Fitzroy catchment.*

This application allows results to be shared in a user-friendly format, to keep it updated (and live) after the process finishes, and to help to communicate the timeline with the wider community. Creating a story map allowed images and interactive maps relevant to events to be included and updated as needed (**Figure 6.9**). Researchers are discussing the process to update, incorporate feedback from participants, and add new events, including past, ongoing and future.

*Figure 6.9. Example of an event with photograph and spatial information relevant to the topic.*




The timeline is not comprehensive and cannot be generalised as representative of all interest groups or residents of the catchment. However, our participatory approach based on experts representing diverse views allowed us to identify significant events and driving forces shaping land use change in the region. The activities designed to get participants familiar with each other and to share views of development were critical to create shared understandings of the processes that can shape the future development in the catchment. Creating a timeline was an important step of the scenario planning exercise because it gave the group a better understanding of the concept of driving forces, which underpin the structure and process of building scenarios. Creating the timeline was also a good opportunity for participants to share their perspectives, which differed across different groups, about how different events were more or less relevant in shaping the ways things are today. The timeline also exposed sensitive discussions, such as the inequalities in access to opportunities provided by different development initiatives and policies. Overall, we suggest that creating a timeline of events can be an important early step when developing scenarios, particularly in multi-stakeholder PSP exercises in contested landscapes.

### *6.3.4. Driving forces of change*

Drivers are referred in several ways in the literature, including drivers of [ecosystem, environmental, land use] change, driving forces, and internal/external forces (Peterson et al., 2003). Generally, we can recognise five broad types of drivers: demographic, economic, socio-political, science and technology, cultural and religious, and biophysical (Nelson et al., 2006). The Millennium Ecosystem Assessment describes these five types and provides examples commonly referred to in the scenario planning literature (Nelson 2005; Nelson et al., 2006):

- *demographic*: changes in population numbers and distribution
- *economic*: introduction, expansion or contraction of different economic activities/sectors
- *socio-political*: changes in governance and policy structure; encompass the forces that influence decision making in the large conceptual space between economics and culture

- *science and technology*: introduction, substitution or transfer of technologies, including new to the region

- *cultural and religious*: changes in lifestyle, values, norms, knowledge and education; focus on values, beliefs, and norms that a group of people share and that have the most influence on decision making about the environment.

Most PSP exercises identify drivers of change through participatory methods, particularly through workshops, but also by way of interviews and surveys. Most exercises use alternative states of key drivers as the basis for storylines. The number of drivers of change varies widely but selecting 10 or fewer drivers of change is common. Regularly, most of the drivers identified relate to social aspects, including demographic, governance, economic, and market conditions (Oteros-Rozas et al., 2015).

The following aspects are important to consider when identifying and selecting drivers:

- relevant timeframe (30–50 years)

- strength/Impact/Importance

- likelihood/probability of influence

- contrast

- uncertainty.

### *Identifying key driving forces of change*

Following discussions on the timeline, participants identified key driving forces of land use change in the region. This activity started by researchers providing an explanation of the concepts of driving forces and how they apply to the project. The group was given time to ask questions to clarify and discuss the concepts.

Key remarks made by participants in this discussion included

- *Sometimes we don't have much control on the end state or direction of development initiated by drivers.*

- *Not all driving forces will act in the same direction.*

- *Constraints can be described as driving forces acting in opposite or diverging direction to a driver of interest.*

- *Driving forces will act together to drive us to one scenario and we should discuss what we do if we get there.*

- *Is it possible to give more direction by influencing some drivers?*

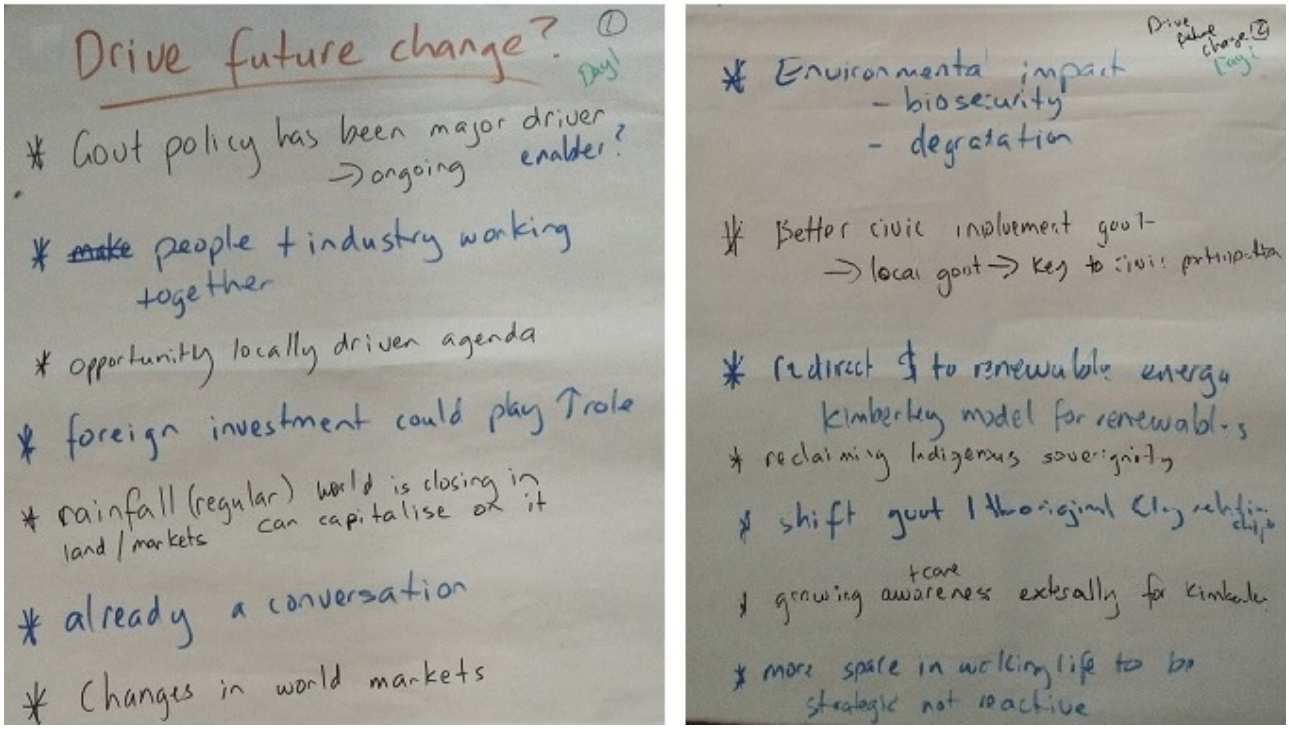
Facilitators then asked questions to start discussions and identify a draft list of driving forces:

- *Looking at the timeline, what do you think is likely to happen that could drive change in the coming 30 years? So, why is that an issue – what is pushing that to happen?*

At each table, participants brainstormed and discussed driving forces that might shape or affect the future of the Fitzroy catchment in the next 30–50 years and came up with a list. Each table shared

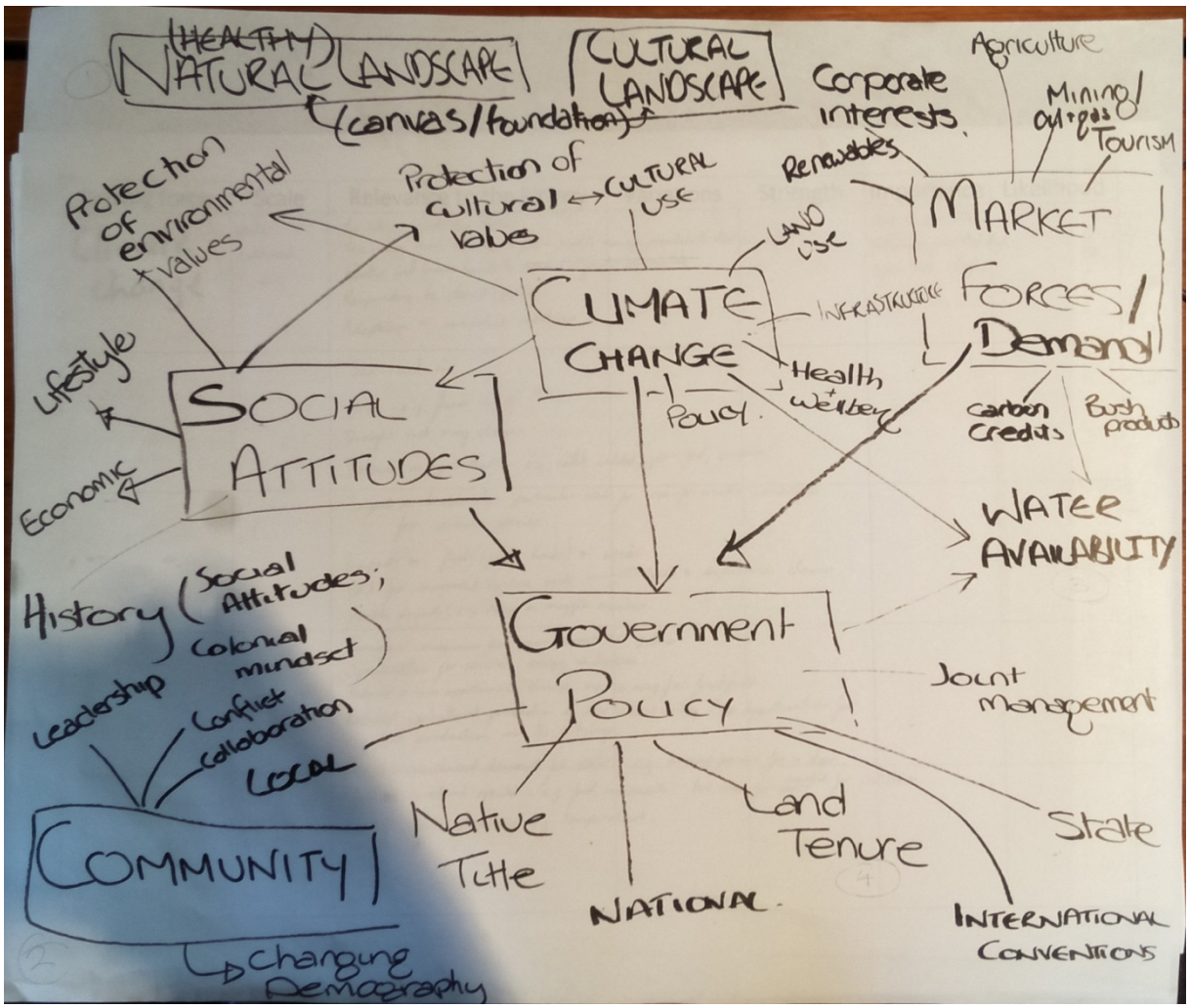
the most important driver of their list and facilitators write them on sticky notes and placed them on the wall (**Figure 6.10**). The activity included a number of rounds, until participants felt the list was comprehensive. Once the list was complete, facilitators asked participants to group (if needed) and to identify the 8–10 most important drivers.

*Figure 6.10. Notes from group discussion regarding driving forces of development affecting the Fitzroy catchment.*




After identifying the key drivers, some groups discussed the possible interactions between drivers and their combined influence on attitudes, decisions and different aspects of society in the region and beyond (**Figure 6.11**). This served to illustrate the complexity of how many driving forces are shaping the region, thus emphasising the need to consider uncertainties when considering future development scenarios.

*Figure 6.11. Notes regarding possible interactions between driving forces of development in the Fitzroy catchment.*




Using the final list of driving forces, participants went back to working in tables to describe key aspects of drivers including: description, geographic scope (global to local), relevance to the Fitzroy catchment and possible broad variations (**Table 6.1**). Proposed variations are presented in broad terms to describe the possible end states for each driver used by participants as starting points to describe the possible states/variations; this were suggested with the intention to have more structured and focused discussions.

*Table 6.1. Summary of the driving forces selected by participants for discussion during workshop 2.*

| Driver | Definition | Relevance to the Fitzroy catchment | Main variations |
|---|---|---|---|
| Business approach | Approach of enterprises to develop and undertake their businesses in the region, in terms of, e.g. the flow-on effects to local communities, if driven by local or foreign enterprises | Different flow of benefits and profits to local community or corporations; influence level of employment; can lead to speculation and uncertainty for investment | Lower → Higher benefits to local communities |
| Climate change | Changes in rainfall conditions and weather patterns linked with increasing temperatures, including associated variations in other weather conditions and extreme events | Droughts, feed for cattle, access to water; biodiversity impacts; shift in production areas; flooding (access, erosion); fire, pest, weed and health risks; may include shift in climate change-related policies (stronger/weaker, renewables vs. fossil fuels) | Wetter → Drier |
| Collaboration | Level of collaboration within and across communities and groups; whether connections include links (or not) among local, regional, national and global actors/organisations | Stronger local vs. external links; potential to influence trust; creation of shared visions, values, understandings and resources; better decisions | Weaker → Stronger connections |
| Education need | Level of literacy and numeracy; support, availability and access to quality education and training suitable to local population, particularly Aboriginal people | Big gap; literacy and numeracy are the basis; adequate skills to engage in the workforce; builds confidence; influence life choices; access funding; engage others; improve livelihoods | Decrease → Increase in literacy/numeracy |
| Employment need | Level and access to suitable and meaningful employment for the local population, influenced by compatibility and workforce skills | Long unemployment history; higher for Aboriginal people; social problems; poor living standards; short-lived jobs; suitability varies across jobs | Lower → Higher level or access to suitable employment |
| Health need | Level and access to quality health services; support for better and suitable health provision for the local population, particularly for Aboriginal households | Impact all aspects of life; serious health problems (e.g. kidney, alcohol, mental); lower health services costs through prevention; affects capacity to learn and engage in workforce | Small → Large increase in access to quality health services |
| Indigenous governance | Strength of Indigenous governance emanating from and supported by recognition of Indigenous rights and self-determination, First Law, PBCs, Fitzroy Declaration, and Martuwarra Council; linked to collaboration among orgs | Locally enable outcomes[13] for Aboriginal peoples; stronger First Law; can support local leadership (e.g. water rights) and new economies; drive/influence equitable decisions; secure tenure and autonomy; growing locally to globally | Weaker → Stronger Indigenous governance |
| Infrastructure | Amount of change in the development and improvement of roads, ports, airports, energy, tourism and waste infrastructure; regional and national (some global) | Unconnected remote areas, gap in telecom and ports; commodity trade; supply local industry; base for local jobs, economic growth, diversification, tourism, etc. | Smaller → Larger changes in infrastructure |
| Leadership | Strength of local (people with knowledge of country and language) and general (with impact on the catchment) leadership as basis to drive change | Foundation for industry development and planning; role models; empowerment; influence people; access to local knowledge & language | Weaker → Stronger leadership[14] |
| Markets | Level of national and global demand of resources (food, minerals, oil, gas, water, carbon, bush food); foreign, national and regional investments; variations in commodity prices | Intensity/scale of exploration, production and extraction of land and water resources; diversification; push tenure reform; drive infrastructure; access to land/water; developing north Australia agenda; external interests; shift in land ownership; varied profits | Lower → Higher demand from external markets |
| Policies | Strength of environmental management policies that regulate access and use of areas/resources by industry and NRM; results in variations in the priority and level of support to different agendas and agreements | Industry checks; protection measures; allocate resources (develop, manage, research); impact thresholds; supported NTD/PBCs; infrastructure; WA State commitments; funding | Weaker → Stronger environmental management policies |
| Technology | Level of access to existing and new technologies by local communities, industry and services, including agriculture, computers, telecoms, etc. | Improve quality of services; efficient and cheap production; help production and environmental monitoring; lower travel costs; remote delivery of various services | Lower → Higher access to technology |
| Tenure reform | Level and type[15] of changes to the tenure system that allow/ constrain the use of land for various uses; links to Indigenous land ownership, control and participation in decisions | Diversification (all industries); housing & services; approval process; land sale; develop local businesses; influence supply chain (e.g. funds); investment certainty | Lower → Higher-level of tenure reform |
| Visitation | Level of visitation and tourism activity in the region, and how they are managed; can vary in the types of visitors and of enterprises: international to local, within/outside parks, traditional/co-managed, etc. | Increasing visitation, limited diversification opportunities, infrastructure gap, variable benefit sharing, and variable management; hospitality industry; diversification; natural and cultural values; telecom and access to areas | Lower → Higher visitation/ tourism activity |

[13] Depends on statutory framework to influence decisions; health of river and country; building tech skills; access to info; tenure policies.

[14] Additional variations emerge from self-interest/community minded; older/younger; established/new leaders; Cultural/Western.

[15] Different forms of land tenure reform and types of agreements; sale, lease and mortgage arrangements; more/less complex/efficient.

### *Identifying development initiatives*

In this final session, participants identified the types of development initiatives (land uses) proposed for the region. Researchers handed out a draft list of development initiatives derived from the interviews and ask participants to identify any missing initiatives, followed by identifying subtypes and grouping if needed (**Table 6.2**). Scenarios aimed to incorporate all initiatives identified by participants, but researchers explored in detail and mapped only those for which there is enough information about their requirements (e.g. spatial characteristics, land and water requirements), which is required for the land use mapping and socioeconomic analyses.

*Table 6.2. Development initiatives considered for alternative scenarios of the Fitzroy catchment.*

| Development initiatives | Types |
|---|---|
| Aquaculture | Prawns, barramundi |
| Bush food | Collection, hunting, enrichment plantings[16] |
| Carbon farming | Savanna burning, carbon sequestration |
| Fishing | Commercial, recreational, subsistence |
| Pastoralism | Dryland (native vegetation only), integrated with irrigation |
| Irrigated agriculture | Cotton, horticulture, cereals, sugarcane, wood plantations |
| Renewable | Solar |
| Tourism | Cultural/bushfood, ecotourism, geoparks[17] |
| Mineral resources | Coal, diamonds, metals (lead, gold, zinc), mineral sands, raw materials (quarries), tech metals |
| Oil and gas | Oil, conventional (gas deposits), unconventional (shale gas) |
| Other | Environmental management (conservation stewardship, ILSM, and ranger programs) |

## 6.4. Workshop 2: Creating alternative development scenarios

The scenarios team built on the interviews and outputs from the first workshop (lists of drivers and development initiatives) to develop scenarios describing possible and contrasting development futures of the Fitzroy catchment. Developing the scenarios required identifying the major drivers of land use change, defined as those that have the potential to generate major changes in future land use (most influential) and that can play out in very different ways (most uncertain), and thus can shift the development of the region in very different directions. Different states of drivers describe the main differences between scenarios and determine how these could influence (promote or constrain) different development initiatives proposed for the catchment. Scenarios were described using diagrams representing the main variations of drivers, narratives summarising key differences and highlighting the main changes associated with variants of drivers, and names that emphasise key features of scenarios. Scenario narratives describe what could happen in and around the region that would result in different land use configurations over the coming 30 years.

To achieve the above-mentioned goals, the workshop included five steps:

1. identifying the most influential drivers for the region (i.e. drivers with the potential to cause major shifts in terms of the extent of land use change in the next 30 years)

2. identifying the drivers that participants are most uncertain in terms of how they will play out in the future and thus could shift development in very different directions

[16] Enrichment planting involves establishing plants for food, medicine or other uses in natural and largely undisturbed landscapes. The establishment of enrichment plantings in bushland settings complements wild harvest and accommodates the social and cultural interactions of value to Aboriginal people in collecting bush food and traditional medicines, while also generating a source of income.

[17] Geoparks are geographical areas where sites and landscapes of international geological significance are managed for protection, education and sustainable development, in a bottom-up approach combining conservation and sustainable development involving local communities; UNESCO lists 140 Geoparks in 38 countries, www.unesco.org/geoparks

3. using the results of both rankings to select drivers that are both highly influential and uncertain, and within those the top-two most influential and uncertain to define the main variations of scenarios

4. describing the possible end states/variations of selected drivers

5. fleshing out scenarios by systematically creating logical, possible, and distinguishable features and narratives describing the main changes and differences between scenarios.

### *6.4.1. Identifying the most influential drivers*

Before identifying the most influential drivers, researchers revisited the concept of driving forces of change and discussions held during the first workshop; this included a summary of drivers selected by the scenarios team to explore during workshop 2. During the first workshop, the scenarios team initially identified about 30 drivers (**Supplementary Material**). Then, during the final session of that workshop, the participants decided to group, delete or add new drivers. This process led to a consolidated list of 14 drivers agreed by the group during workshop 1. A summary table describing the selected drivers was presented and distributed to participants.

First, the team identifies the most influential drivers, i.e. drivers with the potential to cause major shifts in terms of the extent/amount of land use change in the next 30 years. During this session, participants use the list of drivers created during the first workshop and use the table summarising the definitions of drivers. This activity is based on individual and anonymous responses by all participants, using an online survey that is completed with help of table facilitators. The activity starts with a trial run of the survey (using sports) to help people get familiar and comfortable with the online tool and test any technical difficulties. The online survey presents answer options randomly to avoid order bias.

Researchers asked participants to identify and rank the most important drivers based on their perceived potential influence on land use change by identifying the…

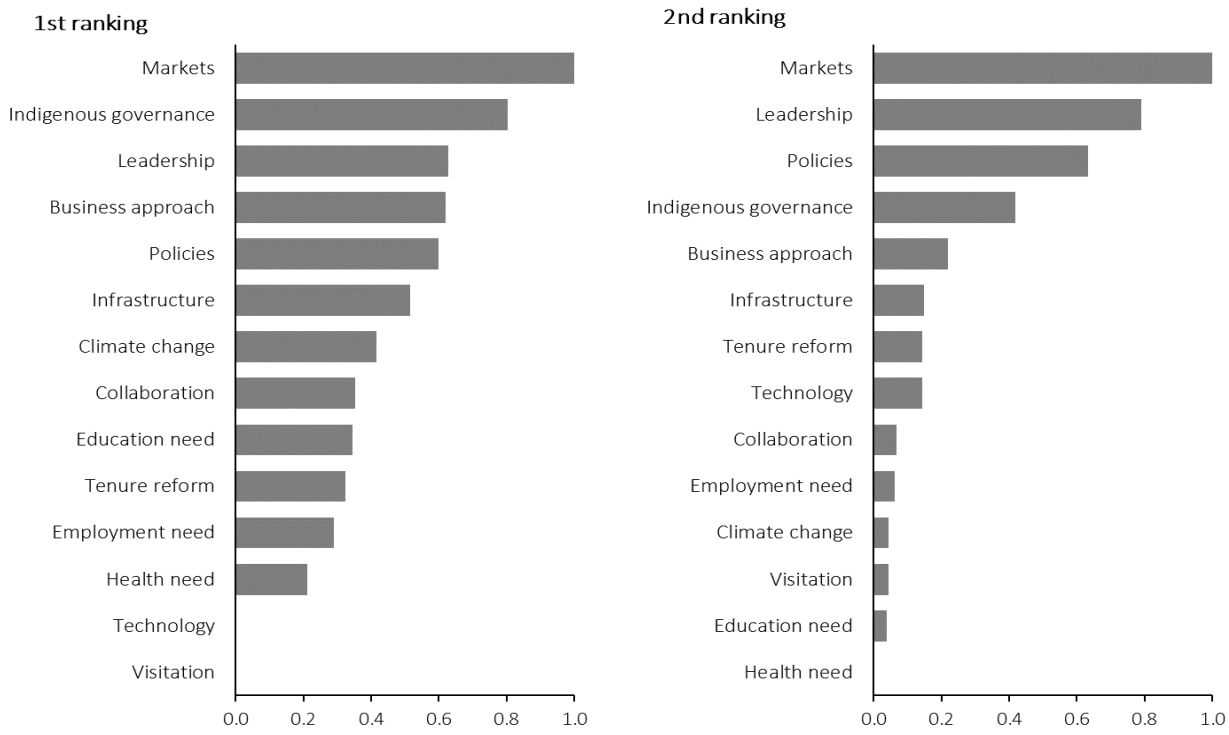
*Top 5 drivers that could influence land-use change over the next 30 years, 1st = most influential*

Before starting the ranking activity, researchers addressed questions regarding the online survey. For example, clarifying that the definition of land use change was broad, including changes to any land uses, not only those commonly discussed like agriculture and mining. Researchers noted that the activity thus aimed to recognise drivers with the potential to cause major shifts in terms of level of change and rate of land use change across the catchment, i.e. drivers that could promote higher and faster change in land use in the next 30 years.

After participants responded the online survey, researchers calculated the weighted average for each driver (based on the number of votes and ranking position assigned to drivers by respondents), which was presented as a summary graph (**Figure 6.12**), for group discussion. Following group and table discussions (focused on surprises and disagreements), participants ranked the drivers a second time with the option of modifying their first response, if desired.

There was general agreement about which drivers were the most influential; the top-five drivers remained the same, but their ranking order varied slightly. Following discussions and the second round of voting, distinction of highly ranked drivers was clearer. Remarks made by participants during the discussions around drivers' influence are summarised in the **Supplementary Material**.

*Figure 6.12. Ranking of drivers based on their potential influence, from highest (top) to lowest (bottom) ranked. The size of horizontal bars represents the normalised weighted average (X-axis), which varied from 0 (least influential) to 1 (most influential).*




### *6.4.2. Identifying the most uncertain drivers*

This activity started with a presentation about the meaning and importance of drivers' uncertainty to build scenarios. Next, the team identified the drivers that are most uncertain in terms of how they will play out in the future and thus could shift development in very different directions. Uncertainty is not about how confident participants are about their judgement, but about the trend of drivers.

This activity was based on individual and anonymous responses by all participants using an online survey completed with help of table facilitators. The online survey presented answer options randomly to avoid order bias. Workshop participants identified and ranked the top-5 drivers based on the perceived uncertainty about the direction the drivers could take.

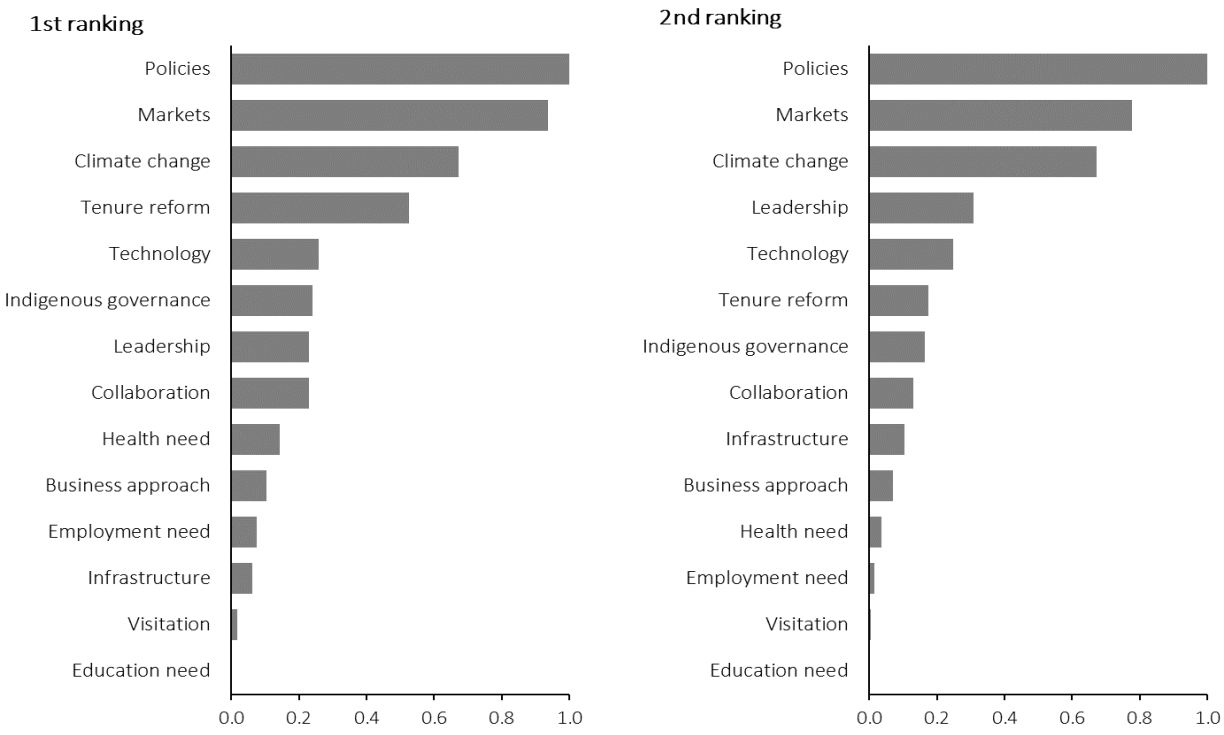
Researchers posed the following questions to guide the ranking exercise:

*Can we see a clear trend in their behaviour or not?*

*Which drivers we are most unsure about the direction they will take over the next 30 years?*

After participants responded the online survey, researchers calculated the weighted average for each driver, which was presented as a summary graph (**Figure 6.13**), for group discussion. Following group and table discussions (focused on surprises and disagreements), participants ranked the drivers a second time with the option of modifying their first response, if desired.

*Figure 6.13. Ranking of drivers based on their uncertainty, from highest (top) to lowest (bottom) ranked. The size of horizontal bars represents the normalised weighted average (X-axis), which varied from 0 (least uncertain) to 1 (most uncertain).*

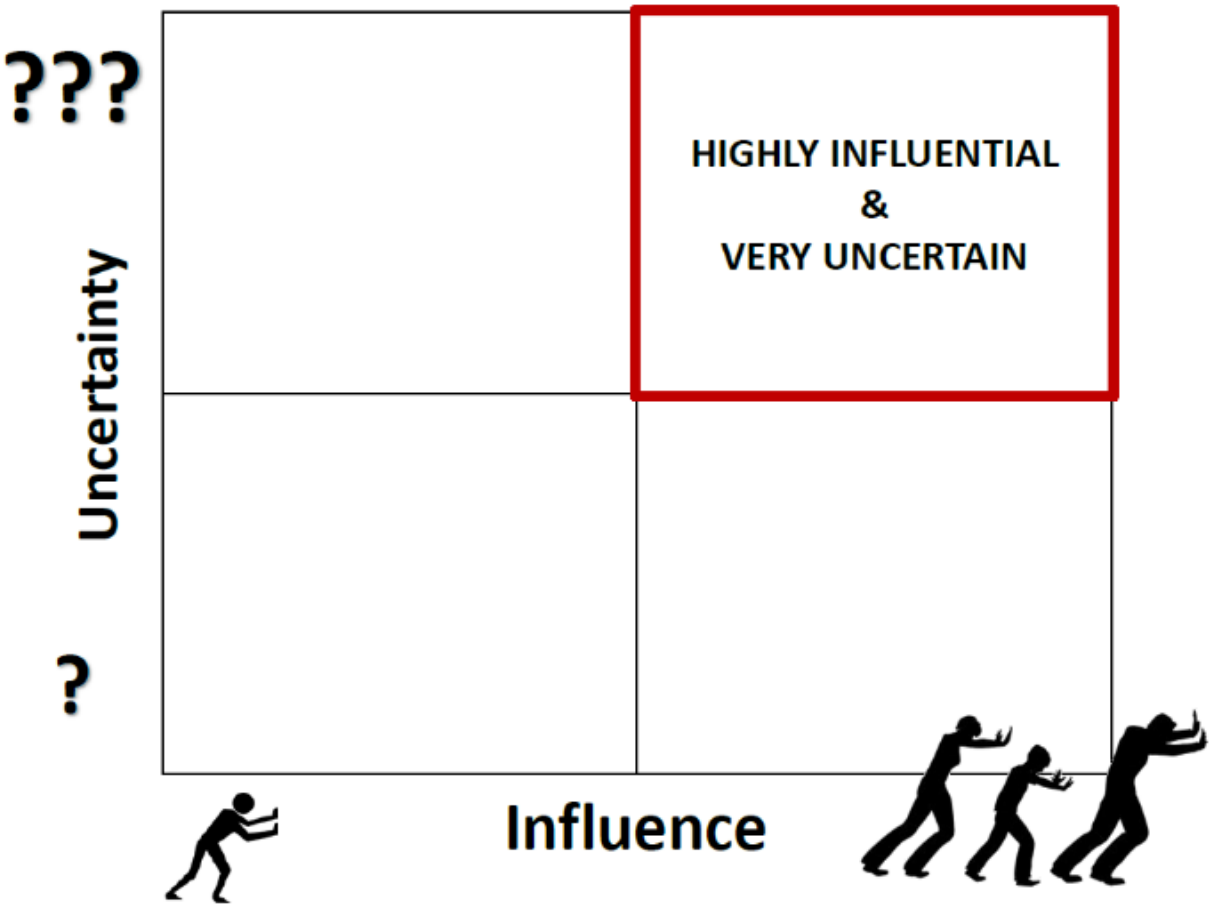



There was strong agreement about policies, markets and climate change being the three most uncertain drivers; the three were ranked in the same order during both rounds of voting. However, from the first to the second round of voting, tenure reform dropped from fourth to sixth place. Leadership remained as the fourth most influential driver but received more votes on the second round. Remarks made by participants during the first and second round of discussions around uncertainty are summarised in the **Supplementary Material**.

### *6.4.3. Selecting primary and secondary drivers to build the logic of scenarios*

The group used the results of the ranking exercises of influence and uncertainty to identify the drivers that will be used to build the scenarios. This activity started with a presentation on how the research team planned to use the results of the previous ranking exercises to identify the drivers that will be used to build the scenarios. **Figure 6.14** illustrates the logic behind this process; the location of a driver along the horizontal axis represents its position (rank) in terms of influence, from lowest (far left) to highest (far right) influence, while its position along the vertical axis represents its position in terms of uncertainty, from least (bottom) to most (top) uncertain. Therefore, drivers falling within the top right corner (red box) are both highly influential and most uncertain, thus are the most useful to build scenarios.

*Figure 6.14. Illustration of the combination of rankings of influence and uncertainty*




The research team created a summary graph integrating the results from the ranking exercises of influence and uncertainty (**Figure 6.15**), which was used to identify the six most important drivers. The top-right box of the graph (marked in dark red) was determined based on the median value of the ranking values, denoted by vertical (influence) and horizontal (uncertainty) dashed lines. Policies and markets were clearly ranked highest for both aspects (red box), while those in the orange box were ranked relatively higher than other drivers for both aspects combined. The graph shows that policies and markets were ranked as highly influential and uncertain (hereafter 'primary drivers'). The group also identified another four drivers that were notably more influential and uncertain that the rest (hereafter 'secondary drivers'); these were leadership, Indigenous governance, technology, and tenure reform.

This analysis was not about numerical precision and was used as visual aid to identify the primary and secondary drivers; the intention is to have transparent and logic way of selecting drivers to be used for building the logic of scenarios.

Researchers explained how the primary drivers would be used to describe the logic of scenarios, which will determine the starting point to build the four scenarios. Exploratory scenario planning exercises, like ours, generally include four scenarios constructed along the two key uncertainties described as end states.

Based on these results, the group agreed to use the primary drivers (i.e. markets and policies) to build the logic of scenarios (**Figure 6.16**) and use the secondary drivers to describe further variations.

*Figure 6.15. Graph showing the relation between drivers' influence and uncertainty.*

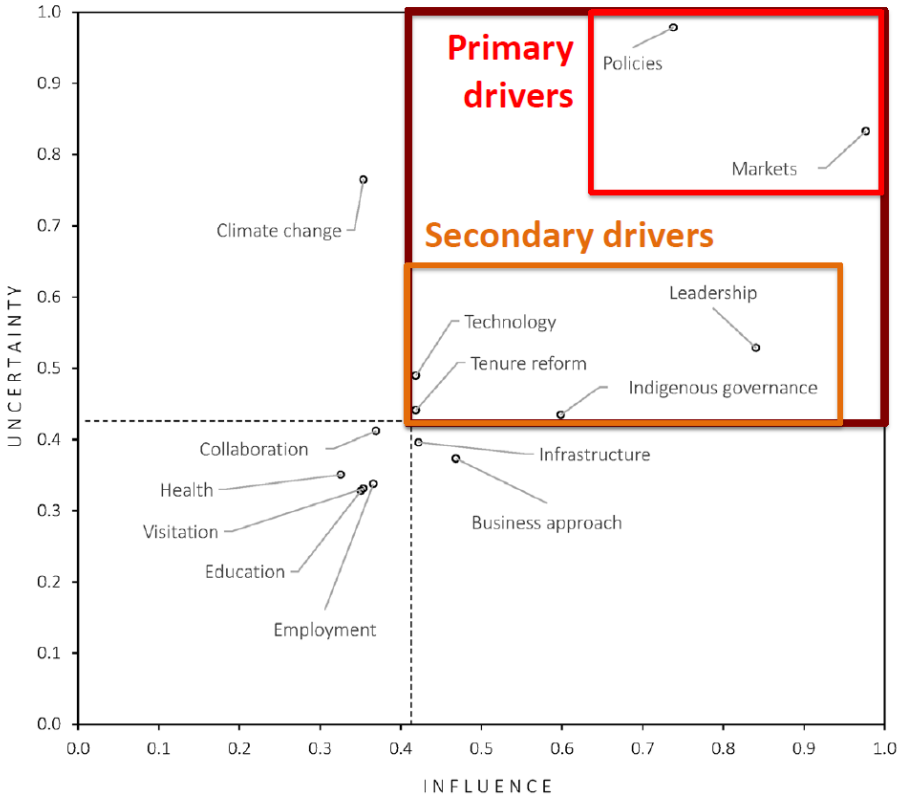
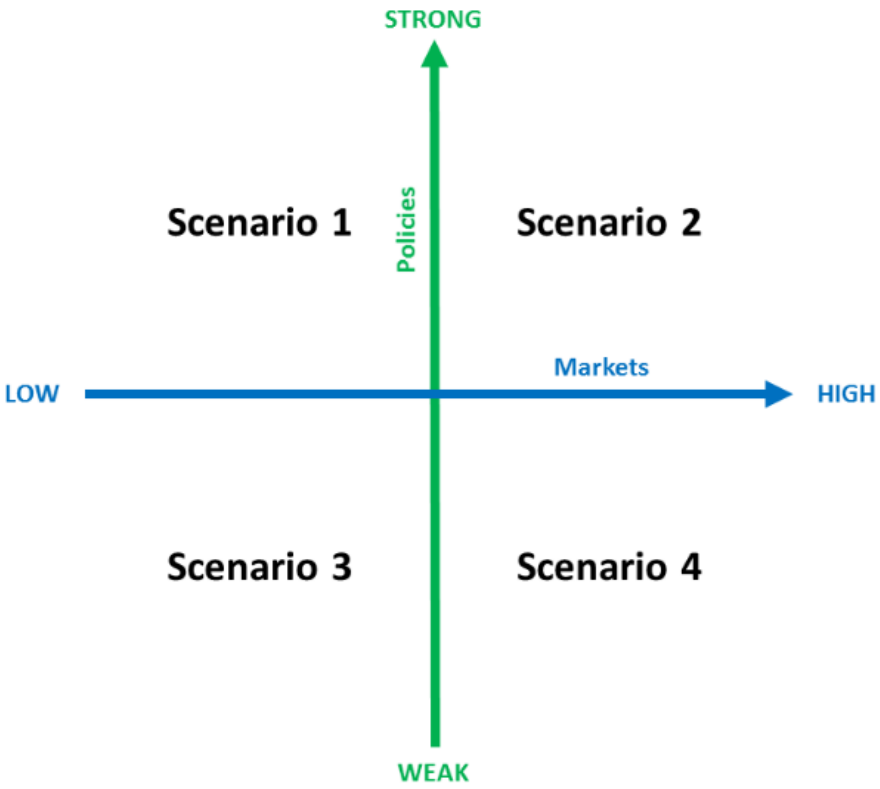



*Figure 6.16. Four possible scenarios based on the combination of the primary drivers.*



### *6.4.4. Describing variations of the primary and secondary drivers*

This activity involved working in six tables with one facilitator from the research team rotating across all tables to describe the range of possible variations of the primary and secondary drivers. The description included defining at least the two end states (e.g. low and high) and, if needed, intermediate states (e.g. low, moderate, high). For each driver, the group wrote brief texts describing how each end state might look like. The information on the possible variations of drivers was used to flesh out the four scenarios, including descriptive tables and narratives.

**Table 6.3** presents a summary of the end states identified by participants for each of the six drivers that will be used to build the scenarios. A summary of key points regarding the variations of the primary and secondary drivers is provided as **Supplementary Material**, including the original definitions and relevance of drivers. The examples of development initiatives that could be associated with either end state (opposite pole) help to illustrate the model of development that we could expect, but they are not comprehensive. Further refinement emerged from discussions with the team when fleshing out scenarios. Examples also illustrate how the different end states can help identify the model of developments (e.g. mass tourism developments vs. small-scale cultural/ecotourism projects), rather than the presence or absence of broad types of development initiatives (e.g. tourism – yes/no).

Following concerns regarding the framing of the 'markets' driver, researchers drafted an alternative description for this driver. A summary of the discussed options is included in the workshop briefing (**Supplementary Material**). The definition and description of variations for the 'markets' driver was refined following discussions with members of the scenarios team. Other aspects not included in the description is how local actors will respond to external markets, for example if they will decide to invest or allow others to invest on their land. Ultimately, the outcomes in terms of the type of investments (and developments) will derive from the combination of all drivers, not only markets.

Following discussions with the scenarios team, the driver related to markets (external demand) and associated investments (local supply) was described in terms of their potential to influence land use change (which was the focus of discussions during the workshop), specifically regarding the level of modification of natural landscapes. This framing focuses on external markets but includes how external and local responses (in the form of investments) could shape developments. The discussions on this driver during the first workshop were around external markets demand, hence this revised framing is faithful to the original intent.

Scenarios built based on the proposed drivers focus on describing the overall balance and how different industries could play out on either end state, rather than exclusion of some industries from a given scenario. Thus, dominance in one state does not mean absence of development initiatives that are more prominent in an alternate state, and *vice versa*. Instead, it implies that the interest and investment in those initiatives could be lower, thus they would be relatively less prevalent across the catchment in terms of frequency and total extent.

For instance, under a scenario under the first state, there could be higher demand and investment in extensive broad acre agriculture developments (which could be associated with damming and high use of agrochemicals), while scenarios under the second state could have more investments in small-scale and low-input agricultural developments (e.g. wild harvest, mosaic organic farms). Likewise, under the second state, scenarios may include some mining developments, but these probably would not be as extensive across the region.

*Table 6.3. Broad description of the variations for the primary and secondary drivers.*

| | Drivers | Summary of drivers' end states |
|---|---|---|
| PRIMARY | Markets | *Higher*[18] *demand/investment*[19] *in development initiatives that modify natural landscapes*[20]: dominant demand and investment in markets that focus on development initiatives (industries) associated with relatively higher modification of natural landscapes.<br><br>*Higher demand/investment in development initiatives that maintain natural landscapes*[21]: dominant demand and investment in markets that focus on development initiatives (industries) based on the use, management, and/or restoration of natural and largely undisturbed landscapes. |
| PRIMARY | Policies | *Strong policy*: in a strong-policy end state, policy is developed and implemented in a way that protects things valued by the local community and provides certainty and clarity for everyone living in the region.<br><br>*Weak policy*: in a weak-policy end state, policy is divisive and does not support the protection of things valued by the local community, resulting in uncertainty for everyone in the region. |
| SECONDARY | Leadership | *Strong leadership*: leaders at all levels (local, regional, national) willing to work collaboratively to achieve an inclusive vision for the catchment; these passionate and motivated leaders are representative of the region and ensure positive outcomes for everyone.<br><br>*Weak leadership*: characterised by a single actor unwilling to collaborate and making self-interested decisions; in a weak leadership end state, leaders are appointed based on nepotism and focus on conflicts, which polarises people living in the catchment. |
| SECONDARY | Indigenous governance[22] | *Strong*: strong governance reflects the empowerment of Indigenous peoples and groups; this would result in equivalent strong social (e.g. employment, heath) outcomes for Indigenous peoples.<br><br>*Weak*: low power of Indigenous people and groups; this would result in equivalent weak social (e.g. employment, heath) outcomes for Indigenous peoples. |
| SECONDARY | Technology | *Higher access to technology*: means improved access to telecommunication, infrastructure (roads, energy), and monitoring systems (remote sensing and GIS). It could support existing industries (agriculture, mining), increasing the efficiency of natural resource use and reducing their footprint; and new industries would benefit from better access to markets and micro processing of niche products.<br><br>*Lower access to technology*: means limited access to telecommunication, infrastructure, and monitoring systems. It could result in lower economic competitiveness and lower participation in global trade. It could also mean less modification of natural environment and enhance attractiveness to certain tourism markets (e.g. nature-based tourism). |
| SECONDARY | Tenure reform | *Higher*: tenure reform is well thought out, transparent, straight forward and communicated to all stakeholders – which generates broad community understanding; it provides a flexible streamlined approach for approvals and certainty around land use planning.<br><br>*Lower*: tenure reform is slow and unwieldy and a politicised non-transparent process; the process lends itself to inconsistency and reform is imposed with limited community engagement. |

Similar to the description of other drivers, social and environmental impacts are not implicit in the definition of the driver related to markets, and neither end estate represents 'good' or 'bad' states

[18] In this context, higher is not relative to the current situation (today), but to the opposite pole.

[19] Including investment implies that, under a higher demand scenario, people may choose to invest or allow others to invest.

[20] Examples of development initiatives on this state may include intensification of pastoral enterprises based on higher stocking rates and/or introduced exotic grasses, broad acre irrigated agriculture, bush food monoculture plantations, mining, unconventional gas, mass tourism, and solar farms (generally grouped with development initiatives that fall within state 2, these initiatives fit better here because they involve vegetation clearing). Development initiatives supported or promoted under this state are not necessarily associated with large-scale footprints (e.g. a mining project could modify a very small surface area of the catchment).

[21] Examples of development initiatives on this state may include extensive low-stocking rate pastoralism aiming to maintain, restore and/or protect natural landscapes, carbon abatement through savanna burning, wild bushfood collection, recreational fishing, bush food enrichment, nature and cultural tourism, and conservation stewardship.

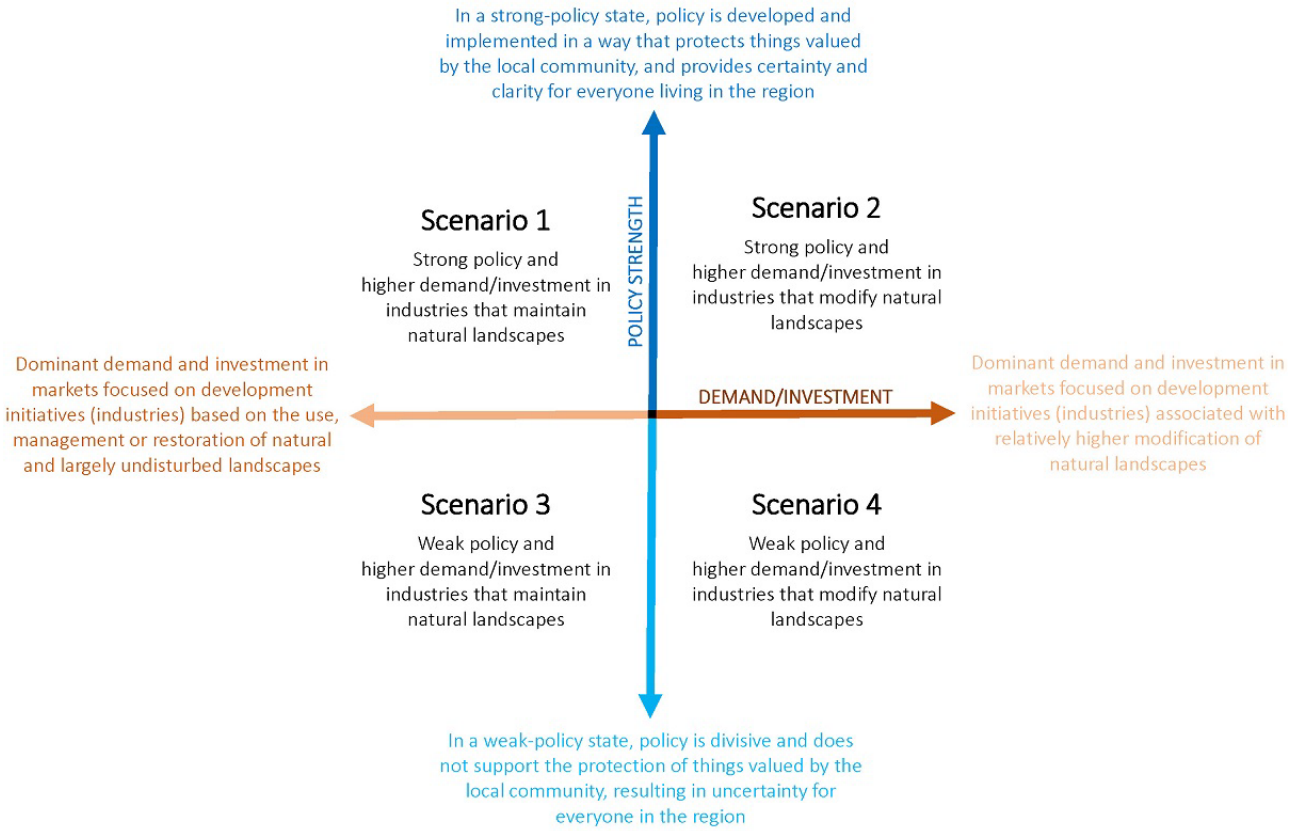
[22] The driver is about empowerment and is related to employment and health (e.g. as outcomes of Indigenous governance).

or paths to development, simply different possibilities. Development initiatives in either side of the spectrum could have small or large environmental and/or socioeconomic impacts, which will be defined based on a combination of location, footprint, risks, and approach of the development initiatives. Therefore, the potential impacts will be explored by the scenarios team during the last workshop, as part of the assessment stage of the project.

## 6.5. Fleshing out scenarios

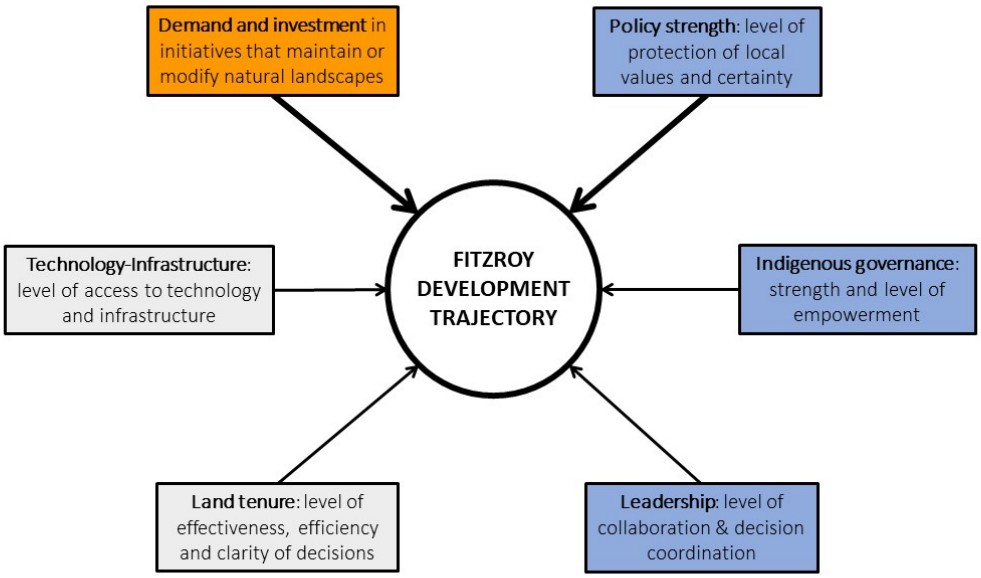
As noted above, during the second workshop, the scenarios team built on outputs from the first workshop to develop the structure of four possible futures for the region. The team identified the drivers with the potential to cause major shifts in terms of the extent of land use change in the next 30 years. The group also identified the most uncertain drivers in terms of how they will play out in the future and thus could shift development in very different directions. Finally, participants described possible end states of the most influential and uncertain drivers to define the main variations of scenarios and identified four possible futures (**Figure 6.17**). Based on the logic of scenarios created by the team, researchers worked with scenario team members to create logical, possible and distinguishable narratives for each scenario. This included desktop work, informed by previous research, expert advice, and feedback from participants, to describe the key features of scenarios, including the landscape and socioeconomic changes associated with each scenario.

*Figure 6.17. Logic of scenarios showing four scenarios based on the combination of the two primary drivers (policies and markets), using the revised framing of the diver related to markets. Each of the four corners represents one possible scenario, which is defined by the corresponding end states of policy strength and market demand/investment.*




A key step to fleshing out scenarios was to elaborate on the ways in which drivers could interact. To do this, researchers prepared graphs and short narratives describing how the primary and secondary drivers could play out under alternative scenarios. These were discussed and refined with members of the scenarios team during small meetings to create the final description of each scenario. **Figure 6.18** depicts the drivers considered in the process of fleshing out scenarios. It shows the three drivers that were closely related and that were treated as a bundle (explained below), hence are represented in the same colour (blue).

*Figure 6.18. Primary (orange and blue) and secondary (grey) drivers described for each scenario.*



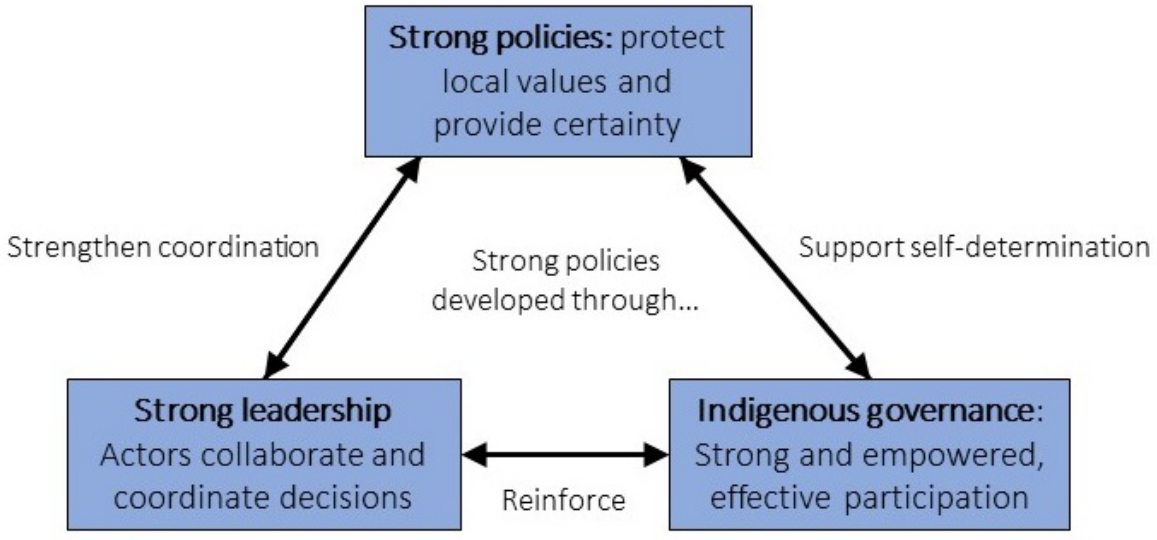

Whilst we did not consider all possible interactions among drivers, we considered that three of them would have strong feedbacks among each other: policy strength, Indigenous governance, and leadership. Following discussions with the scenarios team, researchers described these three drivers as being effectively in lock-step. This means that when one is strong, they all will be, and *vice versa*, independently of other drivers (**Figure 6.19**). This may not be always the case, but the group considered it was a reasonable assumption and simplification to build the scenarios.

Under this assumption, we expect there will be strong policies that protect local values and provide certainty if these are developed through strong and collaborative leadership at local, regional and state levels. In turn, these policies can facilitate and strengthen collaboration between actors at all levels and result in coordinated decision-making.

Further, this arrangement would be in lock-step with Indigenous governance, where stronger governance contributes to developing strong policies and these in turn can support self-determination. Finally, we expect that collaborative leadership and strong Indigenous governance will be mutually reinforcing. Coordinated decisions do not imply individual groups or PBCs will not have independent decisions, but better collaboration may result in a stronger voice across groups.

The outcomes of this situation include strong institutions of governance and regulation, including rule of law. We could also expect that under this situation honesty, care, justice, respect and tolerance would be followed by the different stakeholders involved in decision making.

*Figure 6.19. Three drivers in lock-step, including policy strength, one of the two primary drivers.*




Regarding tenure changes, three features distinguished stronger and weaker land tenure reform and its implementation (including in relation to Native Title):

- *Effective and evidence-based*: appropriate development processes and mechanisms for decision-making and negotiation[23]/agreement[24] making are in place and complied with; this facilitates access to opportunities; under this state, decisions safeguard and take account of cultural protocols, cultural institutions and community interests.

- *Efficient*: decision-making and approval processes are more efficient (e.g. Free Prior Informed Consent) and have lower transaction costs, but not through weakening Native Title holders' procedural rights (i.e. steps taken to enforce legal rights).

- *Clear*: terms and implications of land use agreements are clear to communities, developers, landholders and others involved.

For scenarios with strong Policy-Leadership-Governance bundle, we assumed a link to the approach to tenure reform/system. First, land use approval processes could support Indigenous landowners and native title holders to be proponents or partners in economic development on their land, not just part of a 'tick a box' in approval processes. Second, more effective and efficient decision-making and approvals through increased capacity of Indigenous land holder and PBCs to respond to land use applications.

All these complex relations were summarised as flowcharts, discussed with members of the scenarios team, and used by researchers to present the final scenarios during the assessment. The following graphs (**Figures 6.20–23**) summarise the end states of the primary and secondary drivers, including the main potential interactions. The position and colour scheme follow the ones used to describe the logic of scenarios above, which helped to explore and communicate complex information to the scenarios team. Also note that, as discussed above, the primary driver of policy strength is presented as a bundle with Indigenous governance and leadership.

[23] Better balanced, with real long-term benefits for local communities; developed in good faith, everyone bringing all things on the table, respect for each other.

[24] Clarity on the long-term benefits and costs of the agreements. Currently, several Traditional Owners have expressed concerns about giving land and water away without sufficient discussion or fair agreements.

*Figure 6.20. Key features and graphical representation showing links and end state of drivers for scenario 1.*

*Under this scenario, stronger policies protect local and national values (including those of national and international significance) and give certainty; also, strong collaborative leadership (coordinated decisions) and strong Indigenous governance (Indigenous empowerment and participation, recognized by other stakeholders) enable better planning and management. Higher demand and investment in development initiatives that maintain natural-cultural landscapes Negotiations around development are fairer and take place under equal conditions. Evidence-based decisions and monitoring allow identifying changes and adjusting uses accordingly.*

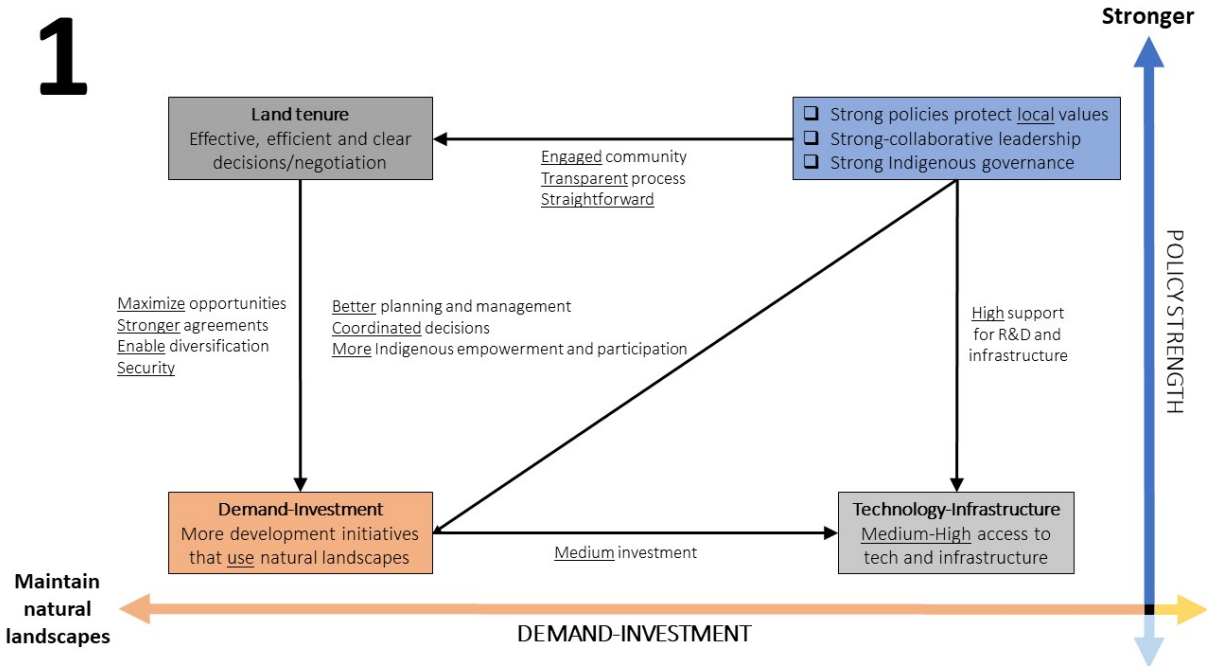



*Figure 6.21. Graphical representation showing links and end state of drivers for scenario 2.*

*Under this scenario, stronger policies protect local and national values (including those of national and international significance) and give certainty; also, strong collaborative leadership (coordinated decisions) and strong Indigenous governance (Indigenous empowerment and participation, recognized by other stakeholders) enable better planning and management. Higher demand and investment in development initiatives that modify natural-cultural landscapes. Negotiations around development are fairer and take place under equal conditions. Evidence-based decisions and monitoring allow identifying changes and adjusting uses accordingly.*

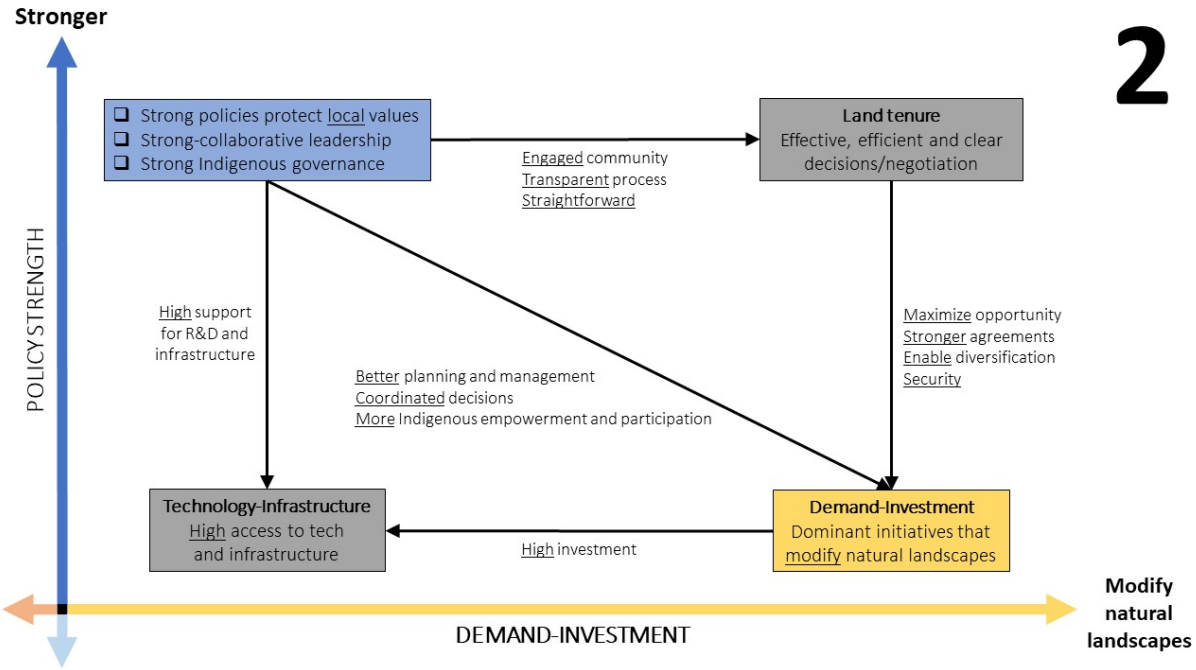


*Figure 6.22. Graphical representation showing links and end state of drivers for scenario 3.*

*Under this scenario, weaker policies favour external interests and result in uncertainty; based on weak individualistic leadership (uncoordinated decisions) and weak Indigenous governance (less Indigenous empowerment and participation) that result in poor planning and management. Higher demand and investment in development initiatives that maintain natural-cultural landscapes. Negotiations around development are less fair and take place under unequal conditions. Decisions are not always evidence-based and monitoring of environmental impacts is limited.*

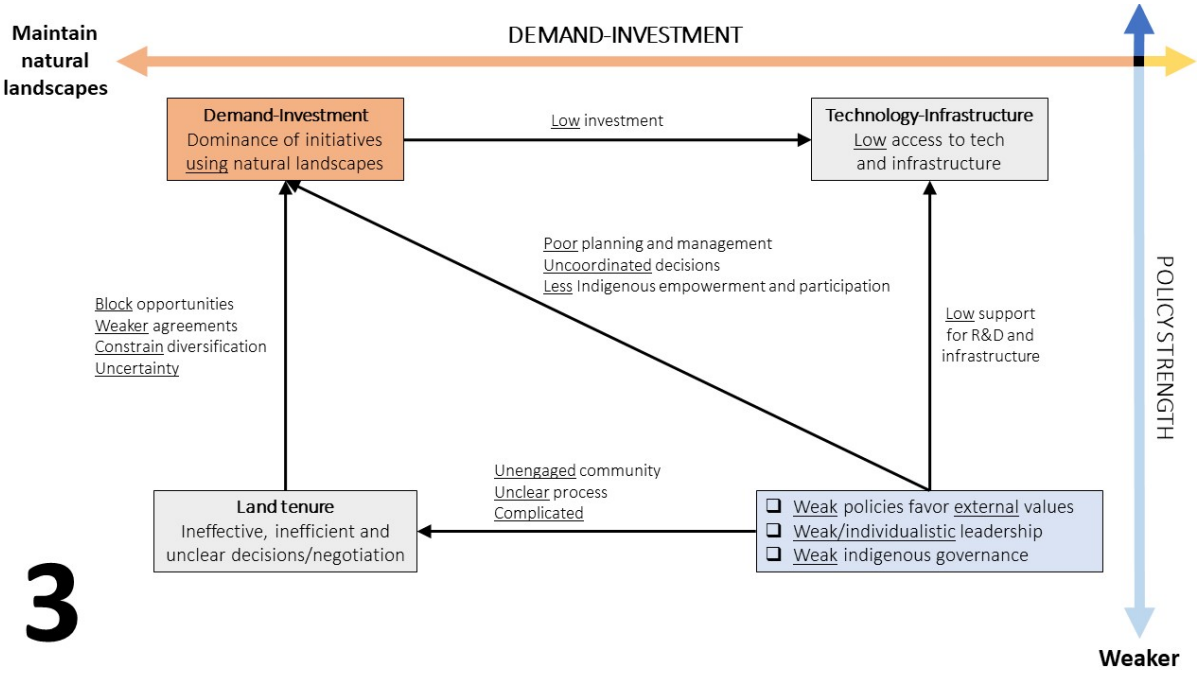
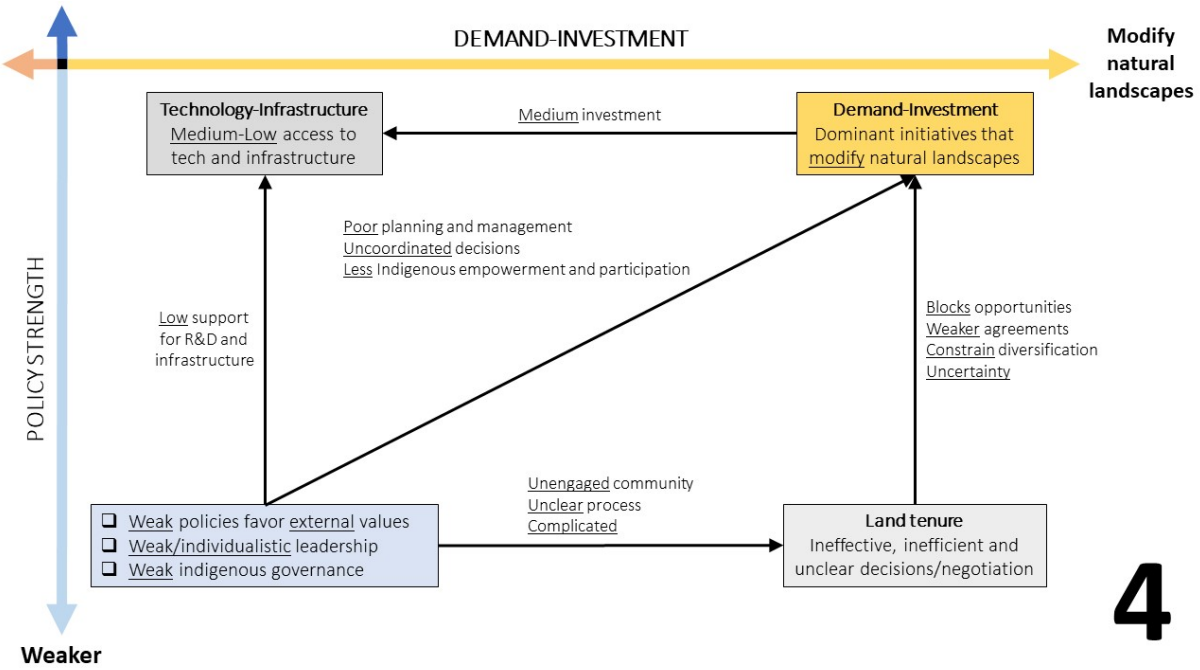



*Figure 6.23. Graphical representation showing links and end state of drivers for scenario 4.*

*Under this scenario, XXXXX*



Researchers also created summaries of the broad patterns of land-water uses and socioeconomic conditions associated with each scenario (e.g. in terms of governance, collaboration and work opportunities for different groups). This included generating biophysical and socioeconomic indicators describing key features of industries such as type of development, used land surface, gross value, direct employment for Aboriginal/non-Aboriginal people, surface and groundwater use, etc. Researchers then used all this information and computer mapping tools to represent each scenario spatially, guided by published research and information provided by members of the scenarios team. Here we summarise the key features of development initiatives explored in detail, including sources of information and selected indicators (also see **Supplementary Material**).

### *6.5.1. Aquaculture*

Scenarios including aquaculture were based on well-known and trialled enterprises in northern Australia. Aquaculture enterprises could generate an internal rate of return >7% despite remoteness of the catchment, assuming efficient operations, infrastructure and investment. The three scenarios including aquaculture developments are based on barramundi aquaculture farms (earthen lined ponds, using local water supply) located near Derby. These type of enterprises are based on well-established land-based culture practices and markets for harvested products. There is a long history of successful barramundi farming in northern Australia, whose relative commercial success is largely due to the species' tolerance to fresh or saltwater, high stocking densities, fast growth, and good market demand. Water use was based on best available information and spatial location based on land suitability, proximity to town, coast (water source), and river (discharge), risks (e.g. flooding), and avoidance of areas of high conservation value. Main sources of information included CSIRO's NAWRA (Irvin et al., 2018; Petheram et al., 2018a; Petheram et al., 2018b) and the Northern Territory barramundi farming handbook (Schipp et al., 2007).

| | **Development type** | **Distribution** | **Employment** | **Other** |
|---|---|---|---|---|
| *Current (2018)* | N/A | N/A | N/A | N/A |
| *Scenario 1* | Coastal, intensive barramundi farm with earthen lined ponds, using local water supply<br><br>Value: $7.3 million | One farm close to Derby; 100 ha (30 x 1 ha ponds, 0.3% of suitable land) | 15 FTE: 1 manager, 4 skilled technicians, 7 trainees, casuals (80% Indigenous farm workers) | Small development considers local values, minimize impact<br><br>Water: 500 ML, 0.01% of annual recharge |
| *Scenario 2* | Coastal, intensive barramundi farm with earthen lined ponds, using local water supply<br><br>Value: $14.6 million | Two farms close to Derby; 200 ha (60 x 1 ha ponds, 0.6% of suitable land) | 30 FTE: 2 managers, 8 skilled technicians, 14 trainees, casuals<br>(80% Indigenous farm workers) | Small development considers local values, minimize impact<br><br>Water: 1 GL, 0.03% of annual recharge |
| *Scenario 3* | N/A | N/A | N/A | N/A |
| Scenario 4 | Coastal, intensive barramundi farm with earthen lined ponds, using local water supply<br><br>Value: $7.3 million | One farm close to Derby; 100 ha (30 x 1 ha ponds, 0.3% of suitable land) | 15 FTE: 1 manager, 4 skilled technicians, 7 trainees, casuals (15% Indigenous farm workers) | Small development with limited consideration of local values (minimize costs)<br><br>Water: 500 ML, 0.01% of annual recharge |

### *6.5.2. Irrigated agriculture*

Potential crops are many and vary significantly in their extent and use of water, so these are hypothetical examples of possible developments based on available information. Scenarios were constructed based on variations of two notable options under consideration: (a) mosaic of irrigated (spray) wet/dry season cotton–mungbean–forage sorghum rotation integrated into existing beef enterprises (groundwater) and (b) multiple irrigated (spray) forage wet season Rhodes grass, integrated into existing beef enterprises. One scenario assumes third-party investment to build a cotton gin in Kununurra. Rhodes grass has a high gross margin and there is an established market for cotton. We assume enterprises on exclusive Native Title determination (NTD) areas would be owned by Indigenous organizations. Our main source of information was CSIRO's NAWRA (Ash et al., 2018; Petheram et al., 2018a; Petheram et al., 2018b), supplemented by relevant publications (e.g. Giovi 2018; Connor et al., 2019) and input from experts and members of the scenarios team.

| | Development type | Distribution | Employment | Other |
|---|---|---|---|---|
| Current (2018) | Irrigated fodder within beef enterprises; mostly surface water extraction, small areas w/groundwater<br><br>Value<br>$2.4 million | Developed land ≈ 4,900 ha (2.7% of usable land), largest proportion (94%) in two main developments (Liveringa, Gogo), 6% within Indigenous stations | Mainly non-Indigenous enterprises; unknown actual FTEs, but possibly include some Indigenous (seasonal) workers<br><br>Labour<br>6 FTE (2 each), 3 Indigenous<br><br>Management<br>3 FTE (1 manager + 1 skilled per enterprise) | Water allocations<br>Surface extraction: 6 GL/year (0.12% of median discharge)<br>Groundwater[25]: 6.4 GL/year (0.18% of median recharge) |
| Scenario 1 | Type<br>Rhodes grass stand and graze (spray irrigation, groundwater) integrated within existing beef enterprises<br><br>Gross value of production[26]<br>$47 million<br><br>Operating costs[27]<br>$44 million/year | Six medium-scale developments (Grant Group-Poole Sandstone); 6 x 1,000 ha = 6,000 ha (3.3% of suitable land, 122% increase); 33% within Indigenous stations | Labour<br>34 FTE[28] (6 each), 29 Indigenous; 2 x Indigenous (100% Indigenous) and 4 x non-Indigenous (~80% Indigenous) stations<br><br>Management<br>12 FTE (1 manager, 1 staff) p/u | Moderate development with consideration of local values (minimize impact)<br><br>Water<br>100 GL/year (~17 each[29]), 2.9% of annual recharge |
| Scenario 2 | Type<br>a) Rotation system (cotton-mungbean-forage sorghum) within beef enterprises, groundwater<br>b) Rhodes grass stand and graze (spray irrigation, off-stream storage)<br><br>Gross value of production<br>a) $84 million<br>b) $125 million<br><br>Operating costs[30]<br>a) $65.4 million/year<br>b) $121.6 million/year | a) Mosaic of six large-scale (2,000 ha) developments: 12,000 ha (6.7% of suitable land, 245% increase); 33% within Indigenous stations<br><br>b) Six large-scale (3,000 ha) developments: 18,000 ha (10% of suitable land, 383% increase); 33% within Indigenous stations | Labour<br>a) 120 FTE[31] (20 each), 104 Indigenous; 2 x Indigenous stations (100% Indigenous) and 4 x non-Indigenous stations (80% Indigenous)<br><br>b) 91 FTE (15 each), 79 Indigenous; 2 x Indigenous stations (100% Indigenous) and 4 x non-Indigenous stations (80% Indigenous)<br><br>Management<br>2 FTE (1 manager + 1 staff) p/u | Large development, but with consideration of local values (minimize impact)<br><br>Water<br>a) 120 GL/year (20 each), 3.4% of annual recharge<br>b) 300 GL/year[32] (50 each), 6.1% of median discharge |
| Scenario 3 | Type<br>Rhodes grass stand and graze (spray irrigation, groundwater) integrated within existing beef enterprises<br><br>Gross value of production<br>$47 million | Six medium-scale developments (Grant Group-Poole Sandstone); 6 x 1,000 ha = 6,000 ha (3.3% of suitable land, 122% increase); 17% within Indigenous stations | 34 FTE (6 each), 10 Indigenous; 1 x Indigenous stations (100% Indigenous) and 5 x non-Indigenous stations (15% Indigenous[33])<br><br>Management<br>2 FTE (1 manager, 1 staff) p/u | Moderate development, with little consideration of local values (minimize costs)<br><br>Water<br>110 GL/year[34] (18.3 each), 3.1% of annual recharge |
| Scenario 4 | Type<br>a) Rhodes grass stand and graze (spray irrigation, groundwater)<br>b) Rhodes grass (spray irrigation, off-stream storage)<br><br>Gross value of production<br>a) $47 million<br>b) $125 million<br><br>Number of enterprises<br>a) Mosaic of 6 developments<br>b) Six large developments | a) Six medium-scale developments (Grant Group-Poole Sandstone); 6 x 1,000 ha = 6,000 ha (3.3% of suitable land, 122% increase); 17% within Indigenous stations<br><br>b) Six large-scale (3,000 ha) developments: 18,000 ha (10% of suitable land, 367% increase); 17% within Indigenous stations | a) 34 FTE (6 each), 10 Indigenous; 1 x Indigenous stations (100% Indigenous) and 5 x non-Indigenous stations (15% Indigenous)<br><br>b) 91 FTE (15 each), 27 Indigenous; 3 x Indigenous stations (50% Indigenous) and 3 x non-Indigenous stations (15% Indigenous) | Large development, with little consideration of local values (minimize costs)<br><br>Water<br>a) 110 GL/year (18.3 each), 3.1% of annual recharge<br>b) 360 GL/year[35] (60 each), 7.3% of median discharge |

[25] Includes all allocations, most used for town/community water supply, road construction and mining; ~28% for irrigation

[26] Consider adjusting beef prices based on Global Outlook.

[27] Includes fertilizer: rotation system is ~550 kg/ha N (cotton: 150 kg at sowing, 100 kg 30 days after, 50 kg 60 days after; Sorghum: 250 kg at sowing), which is similar to Rhodes stand & graze system (500 – 600 kg/season).

[28] On farm, does not include transport or support industries.

[29] Based on conservative estimate of water use of ~16 ML/ha (e.g. Kilto, Mowanjum: 12-16 ML/ha) and some level of inefficiencies.

[30] Includes fertilizer: rotation system is ~550 kg/ha N (cotton: 150 kg at sowing, 100 kg 30 days after, 50 kg 60 days after; Sorghum: 250 kg at sowing), which is similar to Rhodes stand & graze system (500 – 600 kg/season).

[31] ~1 FTE/100 hectares.

[32] Optimal storage with 89% effective volume (due to lower evaporation and seepage).

[33] Current for Kimberley's beef industry.

[34] Assumes 10% additional extraction due to lower compliance and limited monitoring.

[35] Suboptimal storage with 82% effective volume (due to lower evaporation and seepage) and extra 10% due to non-compliance.

### 6.5.3. Carbon farming

Our scenarios explored carbon farming enterprises based on savanna burning. Management regimes that makes extensive use of strategic early dry season burning, with fires deliberately lit at times of mild fire weather, and in parts of the landscape where burnt areas will be most effective as firebreaks; such burning is likely to reduce the occurrence of large/severe late dry season fires (Heckbert et al., 2008; Russell-Smith et al., 2009; Russell-Smith et al., 2013). Scenarios with more extensive savanna burning will likely have additional benefits for pastoral industry by reducing loss of grass and infrastructure (Skroblin et al., 2014). Key sources of information included modelled carbon farming potential for northern Australia (Heckbert et al., 2008; Heckbert et al., 2012; Adams and Setterfield 2013) and successful examples from ongoing savanna burning projects in the Kimberley (Legge et al., 2011b; Legge and Fleming 2012; SIGMA 2015), Northern Territory (Russell-Smith et al., 2015; Robinson et al., 2016; Ansell et al., 2020; Russell-Smith et al., 2020), and Queensland (Crowley 2015).

| | Development type | Distribution | Employment | Other |
|---|---|---|---|---|
| Current (2018) | Small-scale carbon farming area using savanna burning (aerial + ground activities)<br><br>Value: < $0.1 million | Three registered projects in the north, but only one operating covering 1,586 km2 (within the catchment) of Indigenous land (100%) | 5 FTE (Indigenous rangers), project led and managed by Indigenous organizations in IPA; good coordination in the area | Little abatement effort leads to low carbon price ($15) and still limited support for enterprises |
| Scenario 1 | Large-scale<br>Area: 61,694 km$^2$<br>[36]Value: $3.7 million/year | Projects include 19,766 km2 of Indigenous land (32%) and 41,928 km$^2$ managed via ILUAs, inclusive of conservation areas | Managed by Indigenous organizations (185 rangers), via ILUAs within areas where there is no exclusive NTD<br><br>[37]Employ: 185 rangers[38] | Strong abatement effort results in [39] high carbon price ($38) and policies supporting enterprises<br><br>Coordinated projects across large areas reduces costs and maximizes outcomes |
| Scenario 2 | Medium-scale<br>Area: 28,732 km$^2$<br>Value: $2.3 million/year | Projects include 7,291 km2 of Indigenous land (25%) and 21,441 km$^2$ managed via ILUAs, inclusive of conservation areas | Managed by Indigenous organizations (incl. rangers), via ILUAs within areas where there is no exclusive title<br><br>Employ: 86 rangers | Strong abatement effort results in high carbon price ($38) and policies supporting enterprises<br><br>Coordinated projects across large areas reduces costs and maximizes outcomes |
| Scenario 3 | Medium-scale<br>Area: 28,732 km$^2$<br>Value: $1.4 million/year; 0.3 million (22%) by Indigenous organizations | Projects include 7,291 km2 of Indigenous land (25%) and 21,441 km$^2$ managed by non-Indigenous orgs | Mainly driven/managed by non-Indigenous orgs<br><br>Employ: 86 rangers (37 Indigenous rangers) | Moderate abatement effort results in lower carbon price ($23) and weaker policies to support the enterprises<br><br>Limited coordination increases costs and lower effectiveness |
| Scenario 4 | Small-scale<br>Area: 10,047 km$^2$<br>Value: $0.7 million/year; 0.3 million (44%) by Indigenous organizations | Projects include 3,208 km2 of Indigenous land (32%) and 6,839 km$^2$ managed by non-Indigenous orgs | Mainly driven/managed by non-Indigenous orgs<br><br>Employ: 30 rangers (13 Indigenous rangers) | Moderate abatement effort results in lower carbon price ($23) and weaker policies to support the enterprises<br><br>Sparser and independent projects increase cost and reduce effectiveness |

### 6.5.4. Environmental management

Scenarios assume environmental management programs would involve a combination of tools such as national and state parks, Indigenous Protected Areas, private wildlife reserves, and other environmental stewardship programs with diverse goals and contributions to biodiversity conservation (DEC 2011; Crowley 2015; Connor et al., 2019; Gerritsen et al., 2019), which will vary according to the corresponding scenario. National and state parks would be few and relatively

[36] Revenue estimates are conservative and only based on abatement, but it is very likely that in the near future new carbon abatement and sequestration methods will results in higher value.
[37] Based on conservative estimate of required FTEs (0.003) per km2.
[38] Participating in other land management activities/programs, supplementary funding and in coordination with scientists and agencies.
[39] Comparable to Synapse's levelized price estimates, converted to current AUD using 2015 exchange rate (USD x 1.3) and from short (US) ton to metric tonne (x 0.91): $27 (low), $45 (medium), and high $65 (high), which are very conservative.

large parks complementing current conservation estate of the catchment (e.g. including new Fitzroy National Park). Indigenous Protected Areas would have different sizes (e.g. proportional to NTD areas) that complement current and future conservation estate. New IPAs would be located either within areas with exclusive NTD or elsewhere, through ILUAs. Private reserves and other environmental management tools, implemented through stewardship programs, could have very different sizes (e.g. relative to pastoral lease areas) that provide protection to special elements and/or sensitive areas within pastoral stations. New private reserves would be located within pastoral leases, in areas with no NTD or non-exclusive NTD.

Conservation values remaining outside protected areas or private stewardship could be conserved by management and/or protection from threats depending on the scenario. These values include national heritage listed natural and cultural values, listed threatened species dependent on freshwater and terrestrial ecosystems, and listed ecological communities. Assessment of impact on these values is required under all scenarios, but the level of implementation and protection is assumed to be stronger under scenarios 1 and 2. Key sources of information included work led by JCU (Vanderwal et al., 2012; Craigie and Pressey 2018; Graham et al., 2019; Pintor et al., 2019) and Griffith University (Kennard et al., 2010; Kennard 2011).

| | Development type | Distribution | Employment | Other |
|---|---|---|---|---|
| Current (2018) | Variable size parks, two partial overlapping with catchment; total area: 10,215 km$^2$ (10% of the catchment) | Protect key values, but not yet comprehensive; some parks are located opportunistically and some residual reservation (i.e. avoid areas of high production potential); moderately connected | Designed following consultation with TOs; unequal distribution of costs and benefits across TO groups<br><br>Employment: ~40 rangers[40] operating across the catchment (assuming fair funding) | Mainly state management, but joint management with TOs in some areas; limited funding to manage threats (e.g. fire, weeds, feral animals) and monitoring; and some traditional uses |
| Scenario 1 | Conservation areas (national and state parks); high targets maximize protection and complement existing protected areas | Significant increase to 16,459 km$^2$ (17%); high-impact approach (mitigate threats); well connected | Joint management with TOs; Coordination leads to fairer distribution of costs and benefits<br><br>82 rangers across all conservation areas | Collaborative planning and high funding to manage and monitor threats (e.g. fire, weeds, pests)<br><br>Allow traditional uses |
| Scenario 2 | Medium increase to 12,694 km$^2$ (13%), moderate level of protection (medium targets); balanced and complementary to IPAs and private reserves | Comprehensive, adequate, and representative system across the catchment; moderate-impact approach (avoid areas of very high production value); moderately connected | Collaborative planning (co-design w/TOs); Coordinated TOs leads to fairer distribution of costs and benefits across groups; medium funding to manage threats (e.g. fire, weeds, feral animals) and monitoring<br><br>Employment: ~63 rangers operating across the catchment | Joint management with TOs; allow traditional uses |
| Scenario 3 | Medium increase to 14,094 km$^2$ (14%), moderate level of protection (medium targets), but try to minimize conflict with industry; not necessarily complementary of IPAs and private reserves | Aim for representative system across the catchment, but avoid high-value production areas (residual); some connectivity | Limited consultation with TOs; Un-coordinated planning among TOs leads to less fair distribution of costs and benefits across groups; low funding to manage threats (e.g. fire, weeds, feral animals) and monitoring<br><br>Employment: ~56 rangers operating across the catchment | Largely managed by State; restrict traditional uses |
| Scenario 4 | Low increase to 12,356 km$^2$ (12%), low level of protection (low targets) and maximize avoidance of conflict with industry; not necessarily complementary of IPAs and private reserves | Aim for representative system across the catchment, but avoid medium- to high-value production areas (more residual); fragmented | Limited consultation with TOs; Un-coordinated planning among TOs leads to less fair distribution of costs and benefits across groups; low funding to manage threats (e.g. fire, weeds, feral animals) and monitoring<br><br>Employment: ~49 rangers operating across the catchment | Largely managed by State; restrict traditional uses |

[40] Craigie & Pressey (2018) compiled the most comprehensive and reliable data for estimating management costs/FTEs for protected areas (PA); their dataset is a representative sample of QLD's PA system, consisting of 41 PAs (2.8 million ha); based on their data, the mean area managed by 1 ranger was 24,700 hectares (std. dev. 64,100), i.e. 0.004 rangers/km2, which assuming ~7.5% surplus, it could be assume to represent a fair level; possible increase for good management can be 0.005 for field staff, but up to 0.008 FTE/km2, depending on management needs, etc. Similarly, Gerritsen et al. (2019) estimate conservation estate funds ~490 and 65 staff under the WoC and ILSM programs, mainly in northern Australia; ~600 FTE. Considering 154,507 km2 of conservation areas across the north that would correspond to ~0.004 FTE/km2.

### 6.5.5. Cultural and nature tourism

Tourism enterprises may vary in their focus, but we assumed most would incorporate a combination of cultural- and nature-based tourism aspects (Hill et al., 2006; KDC 2015; Petheram et al., 2018a; Connor et al., 2019). The following refer to hypothetical increase in tourism enterprise (extrapolating from current average numbers), which would be predominantly lead and managed by Indigenous organisations.

| Scenario | Scale | Distribution | Management | Other info. |
|---|---|---|---|---|
| Current (2017) | Tourists[41]<br>Domestic: 86,700 visitors[42]<br>International: 10,000 visitors[43]<br><br>Direct expenditure<br>$67 million AUD/year[44] | Mostly focused on Shire of Derby-West Kimberley (SDWK), but some in Halls Creek (SOHC); focused on existing national/state Parks and private conservation areas | Of the 17 tourism businesses, it is uncertain how many are owned and managed by Indigenous organizations[45].<br><br>We estimated ~284 FTE across 17 businesses (5-20 each, 17 average); most operate from main towns and some employ local guides | There are limitations in terms of supply; need investments in marketing and product development, infrastructure, and capacity building of Indigenous organizations |
| Scenario 1 | Tourists (100% increase [46])<br>173,000 domestic<br>20,000 international<br><br>Direct expenditure<br>$134 million AUD/year<br><br>Number of enterprises<br>34 tourism businesses employing 17 people each:<br>578 in total (85% Indigenous workers) | Would cover 100% of new areas with "potential" for cultural and nature-based tourism; visited areas would include the lands of all ten TO groups in the region, including new national parks, IPAs and private conservation areas | 85% of the new tourism enterprises would be indigenous owned/managed (number proportional to area of Native Title Determinations); most can operate from FX, Derby and Halls Creek, but would employ people (guides, etc.) from relevant communities within distributed proportionally within area within each Native Title | Assumes: good investment in maintaining roads and infrastructure in main towns, as well as improve access to communities; high investment in capacity building and governance |
| Scenario 2 | Tourists (50% increase [47])<br>130,050 domestic<br>15,000 international<br><br>Direct expenditure<br>$100.5 million AUD/year<br><br>Number of enterprises<br>26 tourism businesses employing 17 people each:<br>433 in total (75% Indigenous workers [48]) | Would cover 75% of new areas with "potential" for cultural and nature-based tourism; visited areas would include the lands of the five groups with established organizations (and as above, but smaller conservation areas available) | 75% of the new tourism enterprises would be indigenous owned/managed (number proportional to area of Native Title Determinations); most can operate from FX, Derby and Halls Creek, but would employ people (guides, etc.) from relevant communities within distributed proportionally within area within the five NTDs | Assumes: good investment in maintaining roads and infrastructure in main towns, as well as improve access to communities; moderate investment in capacity building |
| Scenario 3 | Tourists (10% increase [49])<br>95,370 domestic<br>11,000 international<br><br>Direct expenditure<br>$73.7 million AUD/year<br><br>Number of enterprises<br>19 tourism businesses employing 17 people each:<br>323 in total (65% Indigenous workers [50]) | Would cover 55% of new areas with "potential" for cultural and nature-based tourism; visited areas would include the lands of the five groups with established organizations (and as above, but even fewer conservation areas available) | 65% of the new tourism enterprises would be indigenous owned/managed (number proportional to area of Native Title Determinations); most can operate from FX, Derby and Halls Creek, and would employ people (guides, etc.) mainly from main towns | Assumes: poor investment in maintaining roads and infrastructure in main towns, as well as limited access to communities; low investment in capacity building |

[41] 2015-17 average of the SDWK, which covers most of the catchment; Connor et al. (2019) report 93,000 domestic visitors; visitors to the SOHC is relatively smaller (~63%), some could be the same visitors.

[42] 487,600 nights (6.2 nights per person)

[43] 85,300 nights (8.6 nights per person)

[44] Based on TRA (2016) average stay and average spend, this equates to approximately $67m in direct expenditure by tourists (Connor et al. 2019). KDC's Blueprint (2015) estimated 250,000 visitors (12.5% international) and total expenditure of $333 million for the Kimberley region; KDC also reports that 83% of international and 66% of domestic visitors to WA are seeking Aboriginal tourism experiences. Based on Connor et al. (2019), we assume no market cap in terms of demand. Overall, visitors for the Kimberley spend around $608m/year, with in-state tourists spending $15.4 each/year across WA (TRA 2016).

[45] According to WAITOC there are 56 Aboriginal tourism businesses in the Kimberley.

[46] Assumes a conservative, but possible, doubling of visitation under the same level of expenditure. However, if international visitation increases more the expenditure could be higher and the number of businesses, rather than size, could double to supply the demand. Broome visitors are ~278% (existing demand), so this number could increase to 300%, which would align with aspirational KDC's estimates.

[47] Assumes moderate increase due to new infrastructure for other industries, which together with strong policies could provide opportunities for growth.

[48] Relatively lower due to lower investment in capacity building limit access to jobs by Indigenous population.

[49] Assumes small increase in response to population increase, with limited investment in infrastructure and weaker policies, which constrain opportunities.

[50] Notably lower due to low investment in capacity building would limit access to jobs by Indigenous population; possibly equal to current.

| | | | | |
|---|---|---|---|---|
| Scenario 4 | Tourists (25% increase [51])<br>108,375 domestic<br>12,500 international<br><br>Direct expenditure<br>$83,750,000 AUD/year<br><br>Number of enterprises<br>21 tourism businesses employing 17 people each: 361 in total (65% Indigenous workers [52]) | Would cover 55% of new areas with "potential" for cultural and nature-based tourism; visited areas would include the lands of the five groups with established organizations (and as above, but even fewer conservation areas available) | 65% of the new tourism enterprises would be indigenous owned/managed (number proportional to area of Native Title Determinations); most can operate from FX, Derby and Halls Creek, and would employ people (guides, etc.) mainly from main towns | Assumes: some investment in maintaining roads and infrastructure in main towns, as well as moderate access to communities; low investment in capacity building |

### 6.5.6. Pastoral use

The Fitzroy River catchment includes 50 stations with predominantly pastoral use, summing 116,795 km2 and covering 83,107 km2 (84%) of the catchment. Eighteen are owned/managed by Aboriginal organizations, covering 27,026 km2 (27%) of the catchment (Appendix). Size of pastoral stations in the catchment vary between 15,919 and 403,189 hectares (230,129 avg.); on average, properties hold 8,179 AE (629 and 21,860), summing 331,067 AE (208,572 head). A recent study estimated that Kimberley pastoral properties sell 92,750 head annually (35% of WA sales) and export 65,853 head (71%) to live trade market. The catchment includes 79,726 km2 of pastoral land (43% of Kimberley: ~185,860 km2), thus – based on theoretical carrying capacity values – we estimate pastoral stations can hold ~208,572 head and sell ~39,883 head (28,317 to live market). We assume most of the current area under grazing of native vegetation will remain as such, but some scenarios include diversification (e.g. irrigated agriculture, carbon farming, tourism) and/or allocate portions to conservation.

| | **Development type** | **Distribution** | **Employment** | **Other** |
|---|---|---|---|---|
| Current (2018) | Extensive grazing of native vegetation, mostly to live trade market (71%)<br><br>Value: $74 million | Average size of 230,129 ha (15,919 - 403,189) and herd of 8,200 AE (629 - 21,860), sum ~331,000 AE (208,600 head) | 152 FTE on-farm worker for the pastoral land portion within the catchment; 58 Indigenous (15% Indigenous, Kimberley average) | Some problems with access; variable control of grazing in sensitive areas (exclusion from few areas) and some areas are being overgrazed |
| Scenario 1 | Extensive grazing of native vegetation, mostly to live trade market (71%)<br><br>Value: $69.3 million | Average size of 230,129 ha (15,919 - 403,189) and herd of 8,200 AE (629 - 21,860), sum ~331,000 AE (208,600 head) | 144 FTE on-farm worker for the pastoral land portion within the catchment; 115 Indigenous (increase to 80% on average) | Better access; improved control of grazing (including exclusion from sensitive areas) and reduction of overgrazed areas |
| Scenario 2 | Extensive grazing of native vegetation, mostly to live trade market (71%)<br><br>Value: $91.4 million | Average size of 230,129 ha (15,919 - 403,189) and herd of 8,200 AE (629 - 21,860), sum ~331,000 AE (208,600 head) | 144 FTE on-farm worker for the pastoral land portion within the catchment; 115 Indigenous (increase to 80% on average) | Better access; improved control of grazing (including exclusion from sensitive areas) and reduction of overgrazed areas |
| Scenario 3 | Extensive grazing of native vegetation, mostly to live trade market (71%)<br><br>Value: $69.3 million | Average size of 230,129 ha (15,919 - 403,189) and herd of 8,200 AE (629 - 21,860), sum ~331,000 AE (208,600 head) | 144 FTE on-farm workers for the pastoral land portion within the catchment; 55 Indigenous (80% in Indigenous and 15% in non-Indigenous stations) | Limited access; no improved control of grazing (e.g. grazing sensitive areas) and limited reduction of overgrazing |
| Scenario 4 | Extensive grazing of native vegetation, mostly to live trade market (71%)<br><br>Value: $69.3 million | Average size of 230,129 ha (15,919 - 403,189) and herd of 8,200 AE (629 - 21,860), sum ~331,000 AE (208,600 head) | 144 FTE on-farm workers for the pastoral land portion within the catchment; 55 Indigenous (80% in Indigenous and 15% in non-Indigenous stations) | Limited access; no improved control of grazing (e.g. grazing sensitive areas) and limited reduction of overgrazing |

### 6.5.7. Resource extraction

Resource extraction projects were incorporated into scenarios as broad areas with varying likelihood of mining. Given the spatial data and available resources we were unable to undertake a detailed analysis or assessment of all the possible resource extraction activities. We estimated the likelihood of mining activities taking place in the region based on public spatial data on current and proposed mining leases and exploration permits (i.e. petroleum, minerals, coal, infrastructure and known mineral occurrences) available from the government of Western Australia

[51] Assumes higher increase due to possible support for other industries, but some infrastructure could provide extra opportunities for growth.

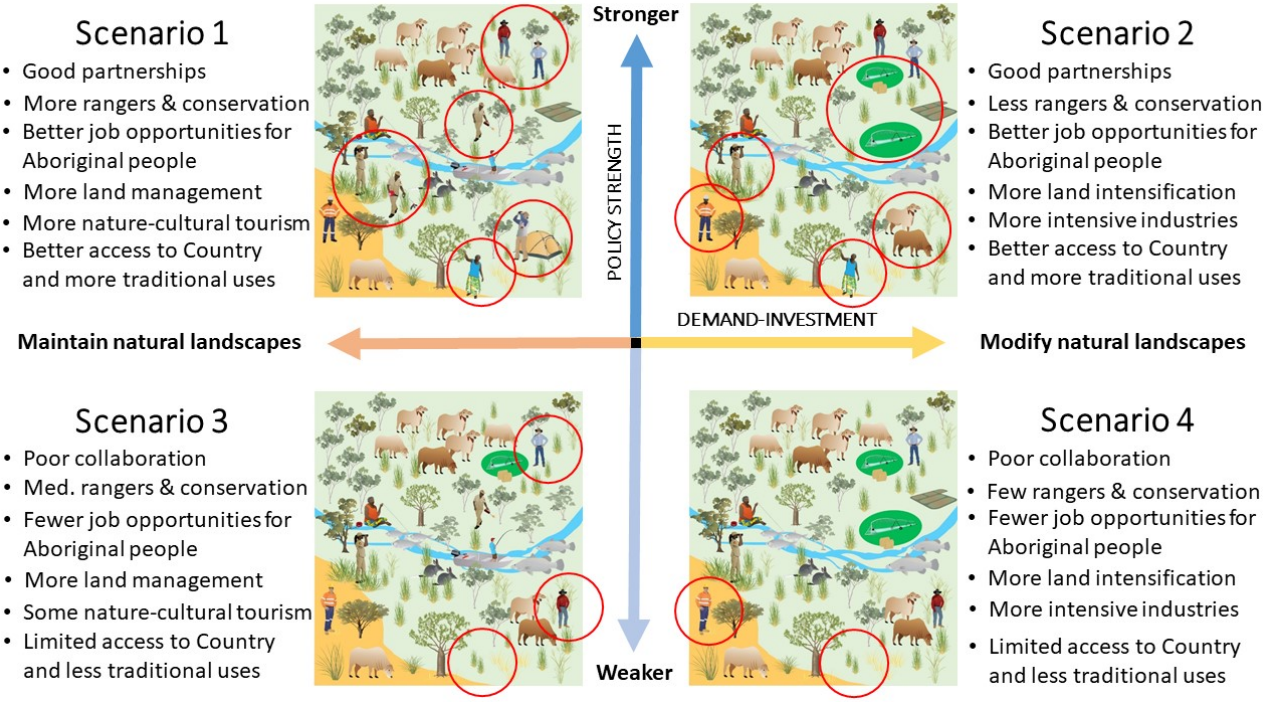
[52] Percentage is the same because both scenarios are under the assumption of weak policies-governance.

(catalogue.data.wa.gov.au/dataset?tags=mining) and GA (www.ga.gov.au/cedda/maps/1085; ecat.ga.gov.au/geonetwork/srv/eng/catalog.search?node=srv#/metadata/104762 ). The data from each source was divided into five classes in order of likelihood of resource extraction. These included proposed mines and applications for mining leases (very high), current exploration permits (high), known resource presences (medium), and applications for exploration permits and areas advertised for exploration (low). This classification is useful to identify broad areas with varying likelihood and, potentially, future intensity of mining activity (Pintor et al., 2019). However, the impact of resource extraction on the environment depends on projects following policy, best practice, and environmental impact guidelines and cannot be estimated without dedicated studies. Therefore, resource extraction initiatives were described based on a combination of these indices and the possible management implications associated with each scenario.

| | **Development type** | **Distribution** | **Employment** | **Other** |
|---|---|---|---|---|
| Current (2018) | Resources in the catchment include coal, diamonds, precious metals, oil and gas, and quarrying<br><br>Value: $500 million | Proposed: 147 km$^2$ (0.15%)<br>Exploring: 26,986 km$^2$ (27.32%)<br>Known: 183 km$^2$ (0.19%)<br>Applications: 7,987 km$^2$ (8.09%) | Highly variable; e.g. 266 people were employed in 2011, compared to 32 in 2016 | A major contributor to the economy, but variable and significant downturn in mining in the last few years, with a number of mine closures |
| Scenario 1 | Potential resources in the catchment include coal, diamonds, precious metals, oil and gas, quarrying, etc. | Proposed: 118 km$^2$ (0.12%)<br>Exploring: 24,232 km$^2$ (24.5%)<br>Known: 178 km$^2$ (0.18%)<br>Applications: 7,638 km$^2$ (7.7%) | Unknown (highly variable) | Expected higher participation of Indigenous people in workforce |
| Scenario 2 | Potential resources in the catchment include coal, diamonds, precious metals, oil and gas, quarrying, etc. | Proposed: 124 km2 (0.13%)<br>Exploring: 25,736 km2 (26.1%)<br>Known: 178 km2 (0.18%)<br>Applications: 7,769 km2 (7.9%) | Unknown (highly variable) | Expected higher participation of Indigenous people in workforce |
| Scenario 3 | Resources in the catchment include coal, diamonds, precious metals, oil and gas, and quarrying | Scattered and small-scale resource extraction (some impact); slight reduction of resource extraction (4%), due to increase in conservation areas across the catchment | Unknown (highly variable) | Expected relatively low participation of Indigenous people in workforce |
| Scenario 4 | Potential resources in the catchment include coal, diamonds, precious metals, oil and gas, quarrying, etc. | Proposed: 147 km$^2$ (0.15%)<br>Exploring: 26,011 km$^2$ (26.34%)<br>Known: 179 km$^2$ (0.18%)<br>Applications: 7,794 km$^2$ (7.9%) | Unknown (highly variable) | Expected lower participation of Indigenous people in workforce |

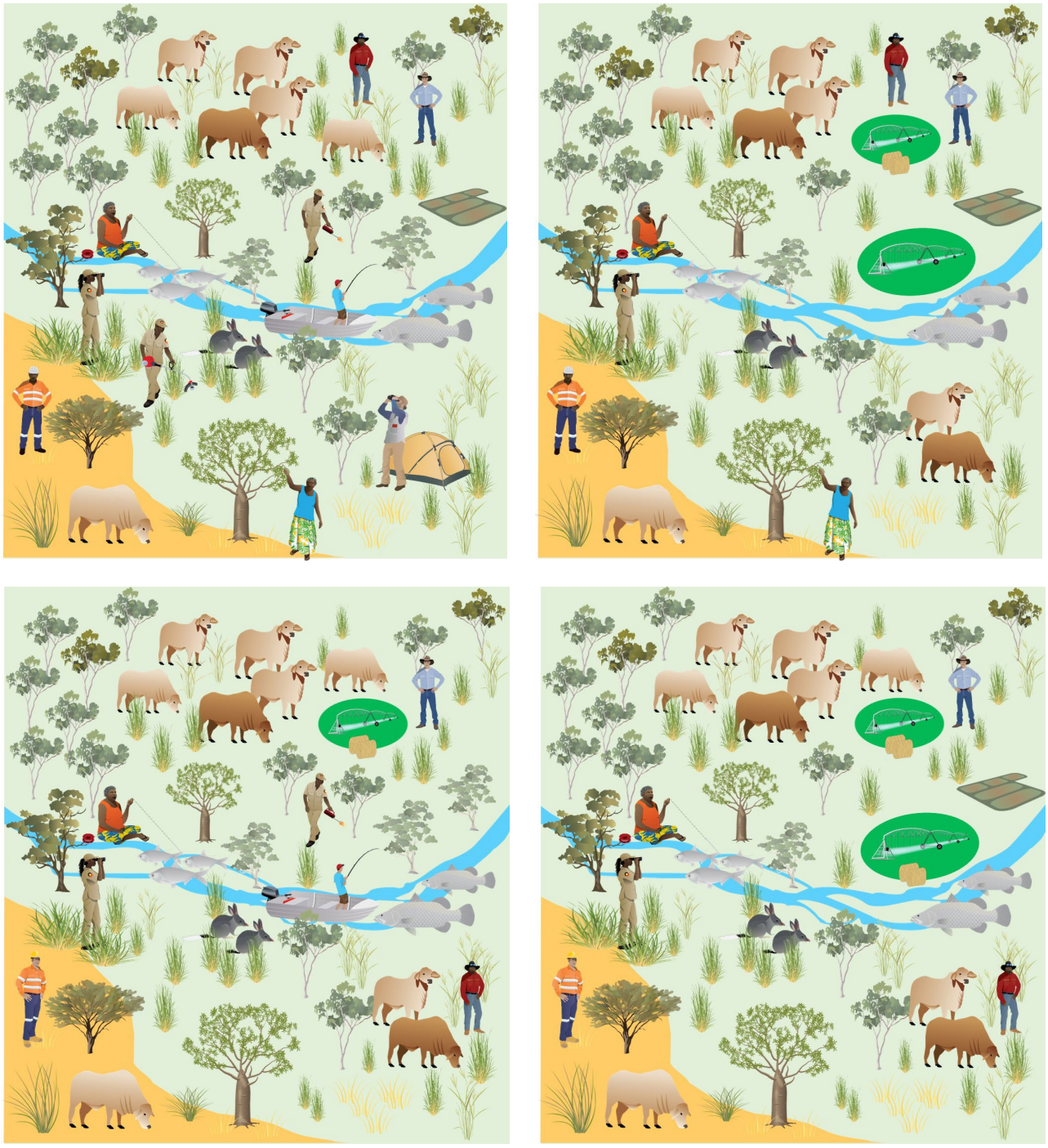
To supplement the previous information, researchers created an illustration for each scenario, which convey key differences and highlights major socioeconomic and land-use changes associated with different development pathways (**Figures 6.24 & 25**). These illustrations can help to compellingly communicate scenarios to the broader community and convey key messages, including potential opportunities and risks associated with different development pathways. The illustrations exaggerate the main features of scenarios to easily convey key differences.

*Figure 6.24. Summary and illustrations of key differences of development scenarios.*




Developing these illustrations required working closely with the NESP-NAERH communications team and an Indigenous advisor to create customised symbols representing key actors and elements of the region. For example, symbols to represent main groups (e.g. Indigenous and non-Indigenous pastoralists and miners, rangers undertaking land management activities, Traditional Owners undertaking traditional uses of land and water).

*Figure 6.25. Summary and illustration of development scenarios of the Fitzroy catchment.*



# 7. Mapping future land uses under alternative scenarios (Module 4)

## 7.1. Summary

The aim of this module was to use the outputs of module 3, including tables and narratives created by the scenarios team, to created possible spatial representation of the scenarios. The result of the module was the creation of five different land use maps representing the distribution of the new land uses that we were able to model using available information. These included aquaculture (barramundi), irrigated agriculture (supplied by both off-stream and groundwater), carbon farming via savanna burning, conservation areas (which could be implemented via new national parks, Indigenous Protected Areas or private conservation areas), and resource extraction. The representation of resource extraction and potential areas with potential for cultural and nature tourism were not linked to specific land use changes but described in terms of their extent and maps representing their potential distribution were presented to support the scenario assessment in the next stage. The resulting land use maps are not predictions of the future, rather one potential spatial representation of scenarios. Whilst this is a desktop exercise, researchers drew on the knowledge of the scenarios team to inform the construction of alternative configurations of land and water uses (including proposed developments, e.g. agricultural precincts). Building future land use maps was guided by spatial analyses using GIS and Marxan, a readily available and widely used spatial optimisation software. Land use allocation analyses used collated spatial information about land use/management constraints (e.g. tenure, Native Title, protected areas, land use agreements) and landscape suitability (e.g. agriculture feasibility, conservation value, carbon abatement potential). Future land use configurations were guided and constrained by defined scenarios and those defined by other relevant projects (e.g. NAWRA's identification of areas with agricultural potential).

## 7.2. Building alternative configurations of land and water uses

Building future land use maps was guided by spatial analyses using GIS and Marxan (only for conservation areas), a readily available and widely used spatial optimisation software. Individual land use allocation analyses were done in GIS using standard modelling suitability analyses based on available spatial data about land use/management constraints (e.g. current protected areas, land tenure, NTDs, ILUAs) and landscape suitability (e.g. agriculture suitability, conservation value, carbon abatement potential, flooding risk). Future land use configurations were guided and constrained by defined scenarios and available spatial data (**Figures 7.1-7.4**).

Based on the scenario features, the maps were constructed sequentially by preferentially allocating each new land use associated with the type of development initiatives expected to be more prominent in the corresponding scenario. We used ArcGIS weighted overlay tool, a method commonly used to inform suitability modelling and multicriteria analyses. In this analysis, each raster layer (e.g. agriculture suitability for a crop expected to occur, flooding risk, distance to roads) is assigned a weight in the suitability analysis. Values in the rasters are reclassified to a common suitability scale. Raster layers are then overlayed, multiplying each raster cell's suitability value by its layer weight (relative percentage) and totalling the values to derive a suitability value. Assigning a weight to each raster in the overlay process allowed us to control the influence of different constraints in the suitability model. The amount of land under new land uses was guided by the scenario narratives and constraints determined based on literature and expert advice. The resulting changes were also described in terms of their potential

### *7.2.1. Aquaculture*

Scenarios were constructed based on barramundi aquaculture farms (earthen lined ponds, using local water supply) located near Derby. These types of enterprises are based on well-established land-based culture practices and markets for harvested products. This initiative was selected based on the long history of farming in northern Australia, commercial success largely due to

tolerance of fresh or saltwater, high stocking densities, fast growth, and good market demand. Water use was based on best available information. The spatial distribution was based on land suitability, proximity to town, coast (water source) and rivers (discharge), risks (e.g. flooding), and avoidance of areas of high conservation value. Scenarios including aquaculture assume these enterprises could generate an internal rate of return >7% despite remoteness of the catchment, assuming efficient operations, infrastructure and investment.

### *7.2.2. Irrigated agriculture*

Scenarios were constructed based on variations of two options under consideration: a mosaic of irrigated cotton–mungbean–forage sorghum rotation (groundwater) and irrigated forage Rhodes grass, both integrated into existing beef enterprises. Rhodes grass has a high gross margin and there is an established market for cotton. We assumed that enterprises within exclusive Native Title areas would be owned by Indigenous organisations. The mosaic option assumes third-party investment to build a cotton gin in Kununurra. The scale of developments was based on best estimates of potential water availability and use for relevant crops. The spatial distribution was based on land suitability, development costs (infrastructure, access), available water options, risk (flooding), and avoidance of areas of high conservation value. We used information from NAWRA, Mowanjum trial, PEW report, literature, researchers, and research team's expertise.

### *7.2.3. Carbon farming*

Scenarios were constructed based on savanna burning, which involves management regimes that makes extensive use of strategic early dry season burning, with fires deliberately lit at times of mild fire weather, and in parts of the landscape where burnt areas will be most effective as firebreaks. Such burning is likely to reduce the occurrence of large/severe late dry season fires. Scenarios with more extensive savanna burning will likely have additional benefits for pastoral industry by reducing loss of grass and infrastructure to wildfires. Well-established practices and growing market, particularly for northern Australia indicated this was a viable industry in the catchment. Revenue estimates are conservative and only based on abatement, but new carbon abatement and sequestration methods could mean higher revenue. Employment and carbon costs were based on best-available information and the scale and spatial distribution was based on fire history, costs (access), and types of vegetation. We used information from wide literature, existing projects (e.g. WALFA), and other researchers.

### *7.2.4. Environmental management*

Scenarios were constructed assuming a combination of national and state parks, IPAs, and managed areas within pastoral properties (including ILSM programs and total/partial exclusion and management of livestock to minimise grazing impacts), which could be funded by public or provate funding. The spatial configuration was determined using a spatial optimisation tool (Marxan) based on representation of features of conservation interest based on their rarity and vulnerability, with representation objectives varying across scenarios. Targeted features included: bioregions; ecosystems (vegetation types, land systems, aquatic systems); water bodies (dry season pools, billabongs, wetlands, etc.); vegetation cover and structure, and species (plants, fish, amphibians, reptiles, birds, mammals, invertebrates). The boundaries of the West Kimberley National Heritage site were used to identify areas more likely to be protected. Due to sensitivity and lack of consistent information on "cultural values", the notional conservation areas do not reflect explicit protection of these values and, within these areas, there are parts where access (e.g. tourists entering new notional conservation parks) could be restricted. Estimates of employment were based on the most comprehensive dataset for management of protected areas in Australia and a literature review. We used information from wide sources, including our own models, models developed together with other NESP projects, available databases, literature review, and expert advice.

### 7.2.5. Resource extraction

To estimate the likelihood of resource extraction taking place within the catchment, we collated all available data on current and proposed mining leases and exploration permits (petroleum, minerals, coal, infrastructure and known mineral occurrences). Linear features (e.g. pipelines) and points (e.g. drill holes, mineral occurrences) were represented by buffering to 250 m. The data from each source was split into five categories in order of likelihood: currently active mine sites; proposed mines and applications for mining leases; current exploration permits; known resource presences; and applications for exploration permits and areas advertised for exploration. In scenarios of strong governance, risk for resource extraction was considered low within the boundaries of the West Kimberley National Heritage site and the boundaries of the conservation areas were used to exclude these areas from the corresponding scenarios. The impact of resource extraction on the environment depends on projects following policy, best practice, and environmental impact guidelines and cannot be estimated without dedicated studies.

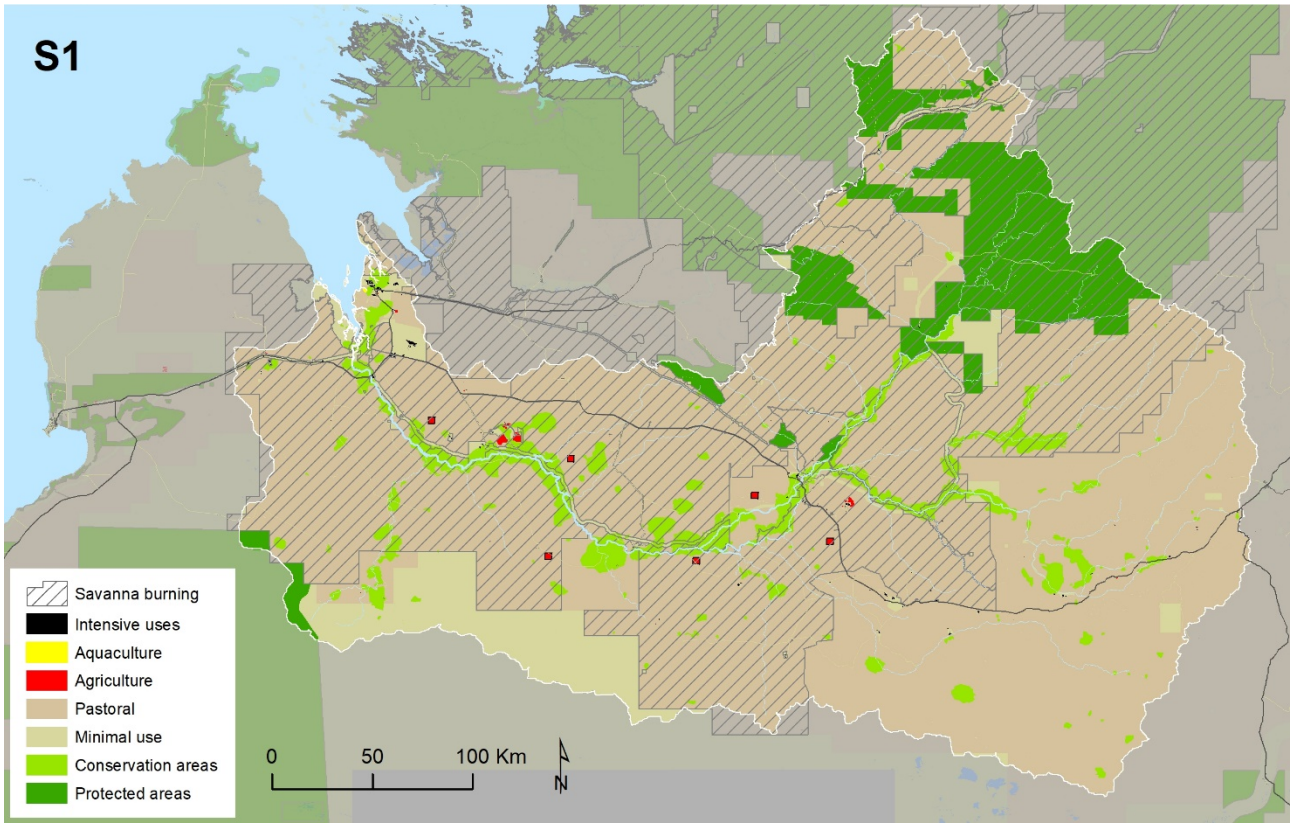
### 7.2.6. Cultural and nature tourism

Scenarios did not include spatially explicit areas for new tourism enterprises but assumed that the existing and new conservation areas (e.g. national Parks, IPAs, private reserves) will be the main focus of these activities. Enterprises would vary in their focus, but we assumed most would incorporate a combination of cultural- and nature-based tourism aspects and, due to its nature, new enterprises would be predominantly (co-)led, (co-)owned, and (co-)managed by Indigenous organisations. Hypothetical increase in tourism visitation (and corresponding number and size of new enterprises) were based on extrapolating from current trends and reported possible values, assuming limited supply (no market cap in terms of demand). Direct expenditure was based on average values for stay and spend. The maximum level of development assumes twice visitation numbers (KDC suggests 300% increase), under the same level of expenditure, but higher international visitors would result in higher expenditure. Variations in enterprise development also considered possible variations in investment in infrastructure and capacity building, which will enable or constrain opportunities for growth. Conservative values for direct expenditure were based on average stay and average spend, Kimberley Blueprint, PEW Study, Shires' publications, and team's expertise.

We did not map areas for new tourism developments/projects, but these would be constrained by remoteness and access difficulties (e.g. rugged terrain, limited roads, flooding during wet season). At the same time, some aspects of landscape complexity (e.g. gorges, rivers, dense vegetation) could be considered features of interest. In this sense, new areas for cultural and nature-based tourism would be constrained by distance to main towns and communities (assuming there will be participation of communities in proximity of areas of attraction, e.g. tour guides) using current road networks, but further adjusted to landscape features and flood risk. Due to lack of information on cultural sensitivity of areas (e.g. no-go areas), mapping areas would be limited to broad areas of potential interest and within these there will be areas that are not accessible to tourists. New areas of interest could be determined by a combination of the following factors: (a) distance to current (and future 2050 scenarios) conservation areas (e.g. national and state parks, IPAs, private conservation areas) and identified features of interest (e.g. gorges, hills); (b) landscape complexity (preference for areas with rugged terrain); (c) presence of water bodies (preference for river sections with permanent water, billabongs, wetlands, etc.); (d) vegetation cover (preference for areas with higher woodland/forest cover); (e) variety of wildlife (calculated as richness of birds, mammals, reptiles, amphibians and fish); (f) presence of preferred fishing species (e.g. cherabin, barramundi); and (g) naturalness (measured as inverse of pastoral use, which is in turn determined by factors like grazing potential and watering points).

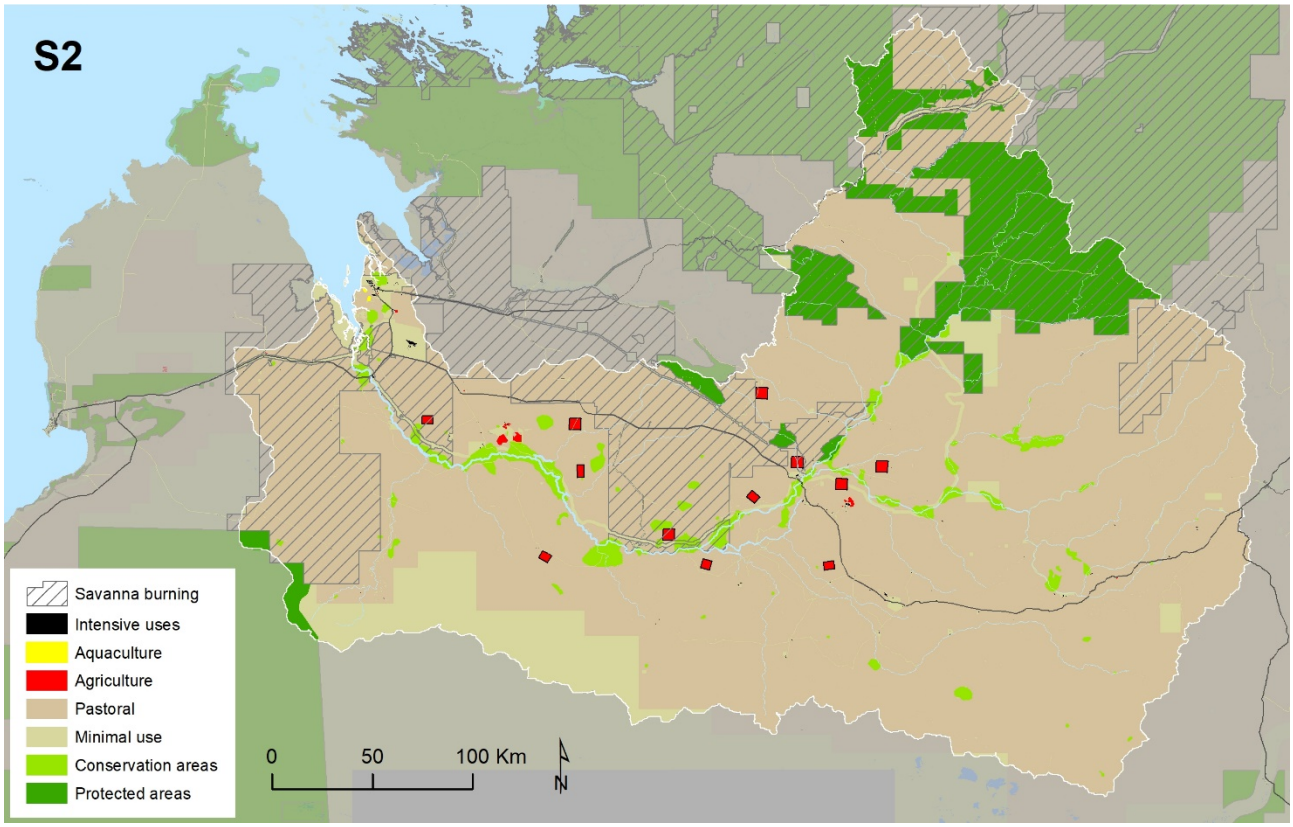
Below we present a map and summary of the main land- and water-use changes associated with each development scenario. These include information about the dominant land uses, land management, access to traditional uses and major changes in selected development initiatives.

*Figure 7.1. Key features and land use map of the Fitzroy catchment in 2050 under scenario 1.*



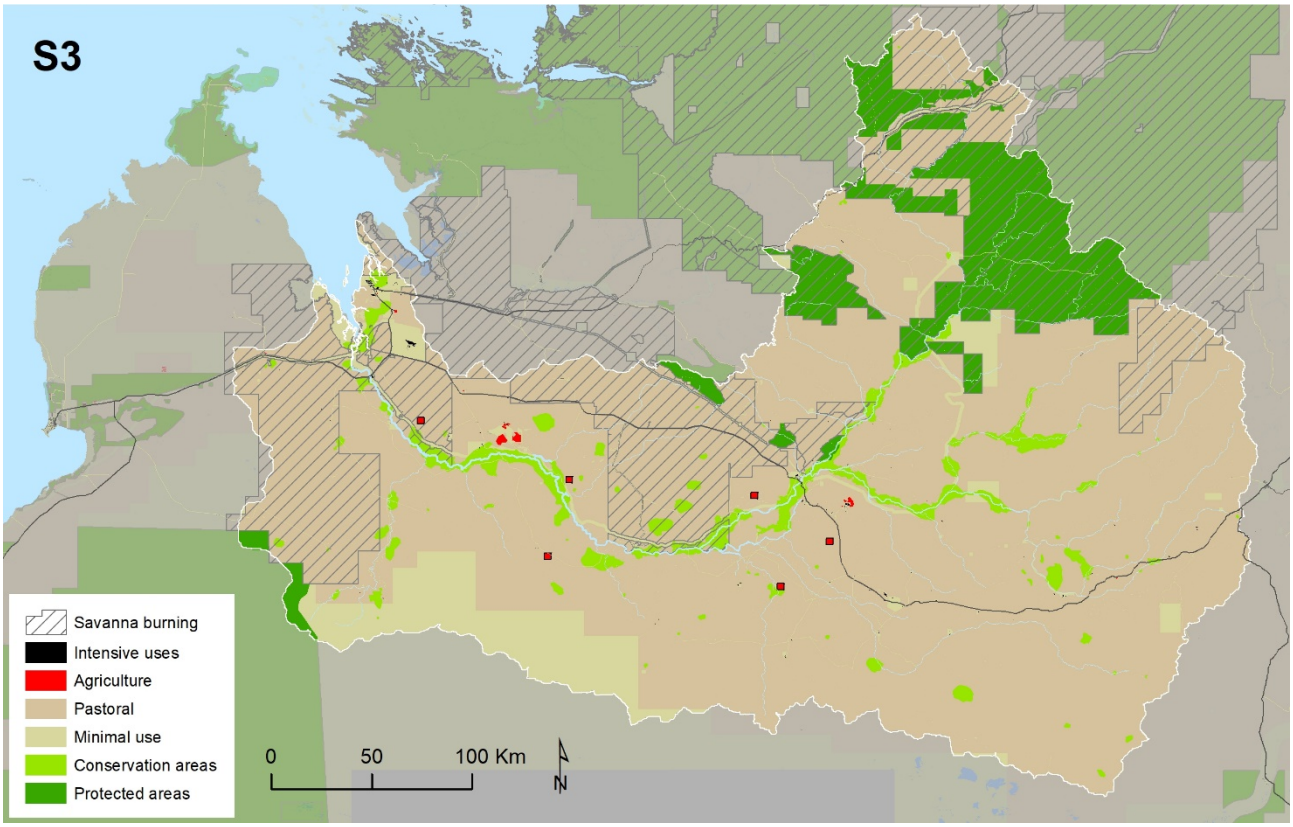

- land use dominated by grazing natural vegetation (improved grazing practices)
- better land and water management, including managing key threats in sensitive areas
- better access to Country, including for recreation, subsistence and cultural activities
- extensive investment in carbon farming using savanna burning (less wrong-way fire)
- large increase in the number and extent of new conservation areas (17%), managed through joint management
- large (100%) increase in cultural- and nature-based tourism (85% Indigenous enterprises)
- one new small-scale coastal barramundi farm
- similar level of resource extraction (low impact)
- six new medium-scale irrigated agriculture based on groundwater (100 GL, 2.9% of recharge).

*Figure 7.2. Key features and land use map of the Fitzroy catchment in 2050 under scenario 2.*



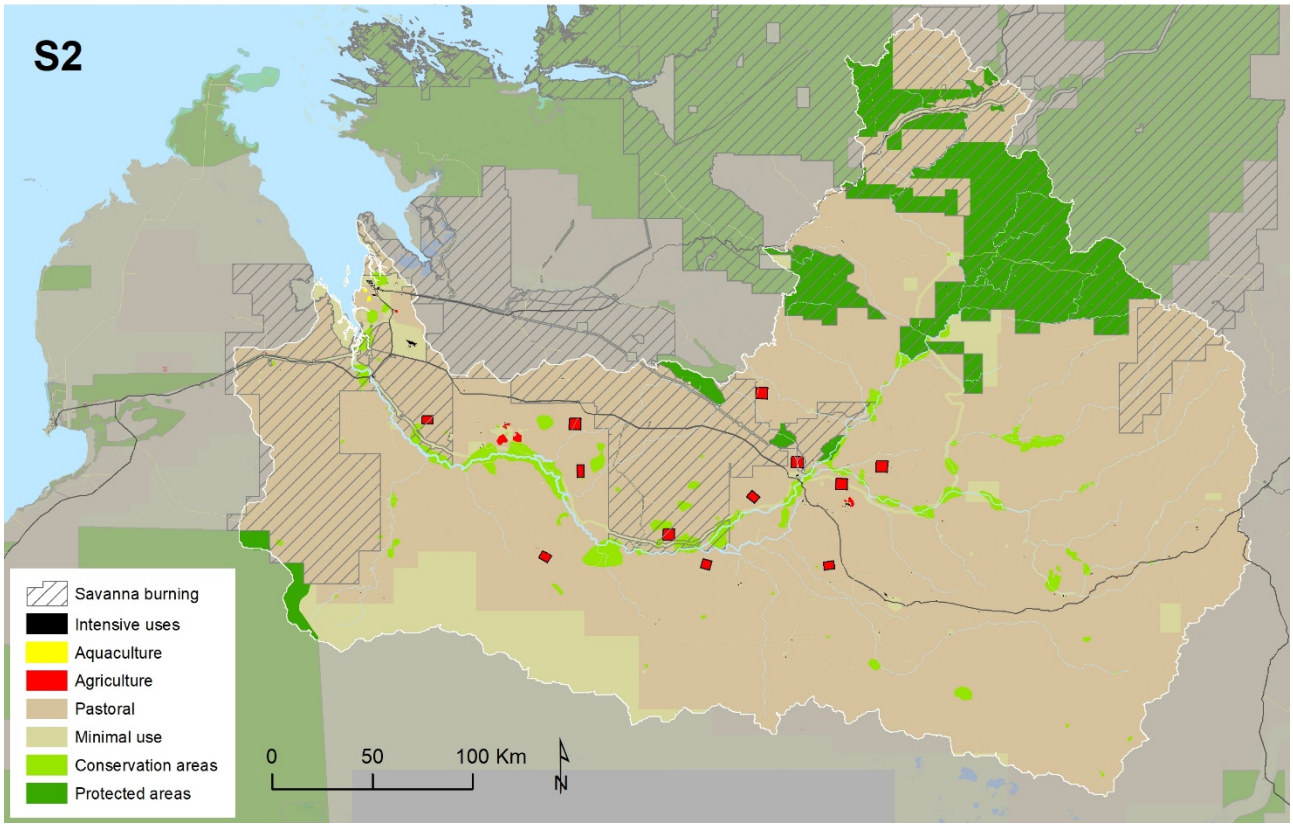

- land use dominated by grazing natural vegetation (improved grazing practices)
- better land and water management, including managing key threats in sensitive areas
- better access to Country, including for recreation, subsistence and cultural activities
- extensive carbon farming using savanna burning (less wrong-way fire)
- medium increase in the number and extent of new conservation areas (13%), including joint management
- medium (50%) increase in cultural- and nature-based tourism (75% Indigenous businesses)
- two new small-scale coastal barramundi farms
- medium increase in resource extraction (low impact)
- 12,000 ha of irrigated rotation system (groundwater: 120 GL, 3.4% of recharge) and 18,000 ha of Rhodes grass (300 GL, 6.1% of median discharge).

*Figure 7.3. Key features and land use map of the Fitzroy catchment in 2050 under scenario 3.*




- land use dominated by grazing natural vegetation (current practices)
- land and water management – including cattle control and reduced overgrazing – does not improve, limited investment in controlling key threats to sensitive areas
- access to Country remains limited, including for recreation, subsistence and cultural activities
- moderate carbon farming using savanna burning (some improvement vs wrong-way fire)
- moderate increase in the number and extent of conservation areas (14%), with limited joint management with Traditional Owners
- little (10%) increase in cultural- and nature-based tourism (65% Indigenous)
- no coastal barramundi farms
- similar level of resource extraction (some impacts)
- six 1000-ha stand and graze farms (6,000 ha) based on groundwater (110 GL, 3.1% of recharge).

*Figure 7.4. Key features and land use map of the Fitzroy catchment in 2050 under scenario 4.*




- land use dominated by grazing natural vegetation (current practices)
- land and water management – including cattle control and reduced overgrazing – does not improve, limited investment in controlling key threats to sensitive areas
- access to Country remains limited, including for recreation, subsistence and cultural activities
- small-scale carbon farming using savanna burning (little improvement vs wrong-way fire)
- low increase in number and extent of conservation areas (12%), limited joint management with Traditional Owners
- modest (25%) increase in cultural- and nature-based tourism (65% Indigenous)
- one new small-scale coastal barramundi farm
- high increase of resource extraction (higher impact)
- 6,000 ha of groundwater (110 GL, 3.1% of recharge) and 18,000 ha off-stream (360 GL, 7.3% of median discharge) irrigated Rhodes grass.

# 8. Assess the effects of alternative scenarios (Module 5)

**Citation**: When referencing information from this section, please cite the full report (see details on the back cover) and the following publications:

Kiatkoski Kim, M., Álvarez-Romero, J.G., Wallace, K., Pannell, D., Hill, R., Pressey, R.L., 2021. Preliminary assessment of the potential changes in wellbeing of key interest groups in the Fitzroy catchment under alternative development scenarios: Traditional Owners' workshop, Fitzroy Crossing, Western Australia, September 10-12. The University of Western Australia, Perth, WA, Australia.

Kiatkoski Kim, M., Álvarez-Romero, J.G., Wallace, K., Pannell, D., Douglas, M., Pressey, R.L., 2021. Preliminary assessment of the potential changes in wellbeing of key interest groups in the Fitzroy catchment under alternative development scenarios: Scenario team's workshop 3 Broome, Western Australia, October 15-16. The University of Western Australia, Perth, WA, Australia.

## 8.1. Summary

Traditional Owners and the scenarios team members assessed the potential effects of future land and water uses on the wellbeing of people in the region. Eliciting stakeholder responses to scenarios, focusing on wellbeing, can increase the legitimacy, relevance and applicability of PSP, especially in politically contested areas. The assessment described in this section systematically explored possible changes in people's wellbeing under each scenario. We held two scenario assessment workshops: a multi-stakeholder workshop with the scenarios team, and a workshop with Traditional Owners (Aboriginal Australians) only. We asked participants how people currently satisfy nine wellbeing categories in the catchment. Participants then used a scale to rate the level of worsening or improvement of each wellbeing category in each scenario against the current situation. Participants discussed the rationale behind their scores throughout the process. Participants' ratings followed a similar pattern in both workshops, except for the scenario with increased large-scale irrigation, which was scored mostly positively by the multi-stakeholder group, and mostly negatively by Traditional Owners. Our approach to systematically assess the potential effects of alternative scenarios on wellbeing, focusing on stakeholders' perceptions of changes in wellbeing, can complement and improve the current use of objective wellbeing indicators in scenario planning. The methodology produced rich and nuanced results that can support ongoing planning initiatives. Moreover, its application in a cross-cultural and contested landscape reinforce its usefulness in a range of contexts.

## 8.2. Introduction

The aim of this module was to develop and implement a method to identify and assess the potential effects of alternative development pathways on the wellbeing of different social groups. We held preliminary discussions on the method with research participants and peers, and received formal feedback from four PSP participants, all related to Traditional Owners' interests, at a preliminary workshop in Derby (August 2019).

In this project, Traditional Owners (TOs) and pastoralists residing in the catchment were considered primary interest groups because their interests and wellbeing will be most likely (and directly) affected by future land and water use changes in the catchment. We also acknowledge that Traditional Owners are subject to structural disadvantage, amplifying impacts of any changes in their wellbeing. For these reasons, we decided to run two scenario assessment workshops: one with Traditional Owners (10 and 11 September 2019 in Fitzroy Crossing; henceforth 'TOs' workshop') and one with the scenarios team (15 and 16 October 2019 in Broome; henceforth scenarios team workshop). The TOs' workshop was developed and implemented together with NESP project 5.4 (Showing and Sharing Knowledge in the Fitzroy catchment, led by Dr Rosemary Hill). A workshop with pastoralists was planned for April 2020, but that was not progressed due to the travel restrictions associated with COVID-19 border-crossing restrictions.

The broad aim of the workshops was to develop a way to identify and assess the potential positive and negative effects of different future scenarios on the wellbeing of different social groups with interests in the Fitzroy catchment. The question guiding the assessment of scenarios is:

How could changes associated with future scenarios affect (positively or negatively) the wellbeing of people who live in or have significant interests in the Fitzroy catchment?

The specific goals of the workshops were to:

1. Develop a common language around wellbeing that can be used by different groups in the Fitzroy catchment. This can help, for example, future negotiations, planning and decision-making processes related to future land and water uses in the region.

2. Develop shared understandings among participants about the ways in which people's wellbeing may be satisfied from the catchment today. Note that 'understanding' in this context does not mean 'agreement'.

3. Document, for each future scenario, the views of participants on how changes could affect the wellbeing of different interest groups.

At the start of the workshop, the following points about *'scenarios and the scope of the scenario assessment'* were reiterated for participants:

- scenarios are not about what should happen, they are about what could happen
- scenarios do not represent the plans of any particular organisation/group; they combine ideas from everyone
- scenarios are not alternative plans that we need to compare and choose from
- scenario assessment is not about agreeing on which is the best or worse scenario
- scenario assessment is not a social or environmental impact assessment
- this and previous workshops are not to be interpreted as *de facto* consultation for current and future planning initiatives in the region.

## 8.3. Method of the scenario assessment

The assessment method has adapted elements of different participatory scenario development and evaluation methodologies, including Daw et al. (2015), Liswanti et al. (2017), Mitchell et al. (2016a; 2016b), and Wallace et al. (Wallace et al., 2016). Developing the method took over a year of intense collaboration between the research team and other NESP researchers[53]. The categories of wellbeing used during the workshops were based on a set of end-state values defined for group deliberations on environmental management, henceforth 'wellbeing categories' (**Table 8.1**) (Wallace et al., 2020; Wallace et al., 2021). The classification system provided a structure and common language for the assessment process and allowed a comparison of changes in wellbeing associated with scenarios as assessed by different groups.

We adjusted the language and culturally translated the wellbeing categories to the context of enquiry to suit our target groups. This included adding the Aboriginal term 'Liyan' (a culturally tailored synonym) when referring to wellbeing. The cultural translation and refinement of our methods required working closely with an Aboriginal interpreter, Ms Olive Knight, and the continuous advice and support of a Regional Research Coordinator employed by the research hub within which this project was conducted. Four project participants, all related to Traditional Owners' interests, also provided feedback on the method at a preliminary workshop (Derby, August 2019).

[53] The development of the method was led by Milena Kim in collaboration with Ken Wallace, Jorge Álvarez-Romero and David Pannell. Ro Hill, Natalie Stoeckl, Vanessa Adams and Karen Dayman provided invaluable feedback on the method. Michael Douglas contributed to the implementation stage.

The use of the Aboriginal language word 'Liyan'[54] to accompany wellbeing, for example, came out of this workshop.

The main differences between the TOs' and the multi-stakeholder workshops were: (1) all scenarios were rated by the multi-stakeholder group, while only scenarios 1, 2 and 4 were assessed in the TOs' workshop (due to time constraints); (2) the multi-stakeholder workshop, as well as workshops 1 and 2, were aided by two professional facilitators who guided the group; (3) the TOs' workshop included a Kriol language interpreter; and (4) following lessons learned from the TOs' workshop, researchers created additional supporting material for the multi-stakeholder group workshop (**Supplementary Material**).

Below we describe the steps we took in the assessment.

[54] "The Yawuru people are the native title holders of the land in and around Broome in the West Kimberley. *Mabu liyan* is a Yawuru concept that means 'strong spirit', 'good feeling' and 'positive wellbeing'. Personal to an individual and also connected to the wider community and country, *mabu liyan* is the heart of the Yawuru social development agenda." [downloaded 27 August 2019 from: jawun.org.au/2019/03/building-a-future-of-strong-spirit-mabu-liyan]. During the Derby workshop to test concepts and approach, 'liyan' was equated with 'wellbeing' by the indigenous participants, and it was suggested that the two words be linked.

*Table 8.1. Definitions of the wellbeing-liyan categories for the scenario assessment. Adapted from Wallace et al. (2020) with detailed re-wording and interpretation by Olive Knight (Aboriginal interpreter from the study area) and the Derby preliminary workshop participants.*

| Categories include having: | Description and example |
|---|---|
| *Enough food and water to drink* | Having enough food and drinking water. Having wood or power to cook food. Includes beef, fish, bushfood, and food from the supermarket. |
| *Satisfying work* | Work that makes you feel good. Includes paid, unpaid, full time, part time, and casual work. |
| *Knowledge of country and culture* | Knowledge that comes from country/nature and knowledge that comes from special places, such as dreamtime places, water places and historic sites such as station homesteads, cattle yards, and rock art. |
| *Safety/security* | Living in country where you are safe from:<br>• disease and injury<br>• feral animals, mosquitoes and their diseases<br>• poisonous and other dangerous plants and animals.<br>Living in country where you are safe from people with altered behaviour (e.g. people affected by drugs and alcohol). |
| *Healthy country and river* | Having a good, comfortable environment where you are not too hot, not too cold. An environment where you are not affected by heavy dust, fire/smoke, or poisons like pesticides. Includes wood for warmth, clothes to wear, good houses and air conditioning, and shade from trees. |
| *Fun – recreation, leisure* | The happiness you get from having a good time. Includes recreation such as camping, fishing, boating, having a picnic. |
| *Strong family and community relationships* | Family fulfilment (contentment): includes belonging to a family (e.g. a kinship or skin group) that provides:<br>• harmonious and supportive relationships<br>• sense of family belonging<br>• some close friendships, not necessarily within the immediate kinship group.<br><br>Community fulfilment (contentment): includes belonging to a group, or groups, that provide harmonious and supportive relationships at a group level. Leads to a sense of social belonging and influences self-respect and dignity. |
| *Places and things that make you feel good* | Having places or things that are beautiful; that you will never get sick of looking at; that you can look at day in and day out and you still like it. Affects all the senses – touch, taste, smell, hearing, seeing. Examples include a beautiful landscape, boomerang, painting; or the smell of plants and the ground after rain. |
| *Inner peace, spiritual fulfilment* | The peace you get from living a life that is in harmony with your beliefs and having a strong spiritual connection with your environment. |

### *8.3.1. Introduction and presentation on the catchment today*

The workshops began with presentations on (1) the aim of the assessment, including an overview of proposed workshop activities and expected outputs from the workshop; and (2) how the scenarios were developed, including a description of the current situation in the catchment. The descriptions of the current catchment situation included a summary of the overall land use (main industries) and broad socioeconomic conditions (e.g. in terms of policies and collaboration). The presentation used supporting information such as a map representing the current distribution of land uses, and broad selected biophysical and socioeconomic indicators describing key features of

industries (e.g. type of development, used land surface, gross value, potential direct employment for Aboriginal/ non-Aboriginal people, surface and groundwater use). This description of the current situation specified the baseline for scenario comparisons. It also provided the basis for exploring the definitions of the wellbeing categories.

Researchers presented an overview of the current state of the catchment, including the broad socioeconomic conditions and main industries (**Box 8.1**). The group used the current situation to explore the definitions of the wellbeing categories and as the baseline to assess scenarios.

*Box 8.1. Summary of current situation of the Fitzroy catchment.*

- Native title exists over 96% of the catchment, but there are some problems in access to country, including for recreation, subsistence, and cultural activities
- Overall, the regional visioning and objective setting in the catchment is fragmented among stakeholders, but there are opportunities for improved collaborative leadership and strengthening of Indigenous governance
- Existing policies protect local and national values (including those of national and international significance)
- Most enterprises in the catchment are based on industries that maintain natural vegetation
- Negotiations around development are not always seen as fair or taking place under equal conditions

- Land use dominated by grazing natural vegetation
- Cattle can access some sensitive areas and there is some level of overgrazing in others
- Some problems in access to country, including for recreation, subsistence, and cultural activities
- Some interest in investment in carbon farming using savanna burning (one new project registered)
- Parks, IPAs and private reserves of variable size, mainly in northern catchment (10% protected)
- Some cultural- and nature-based tourism on existing national/state Parks and private conservation areas
- No commercial aquaculture developments
- Small-scale resource extraction (low impact)
- Irrigated fodder within beef enterprises uses surface water extraction (6 GL, 0.12% of median discharge), small areas w/groundwater

The description of how the wellbeing factors are currently satisfied in the catchment (i.e. the current situation) by participants is important because (1) it provides concrete meaning for each wellbeing factor used when assessing future scenarios, and (2) all the scenarios are compared with the current situation during the assessment, that is, the scores for each scenario may be directly compared given that they are all rated against a consistent baseline. In addition, discussions among the workshop group should encourage sharing of information and ideas, thus contributing to group knowledge as a whole. Ideally, this leads to more informed assessments and a valuable learning experience for all involved, whether as participants or facilitators/researchers.

### *8.3.2. Definition of wellbeing categories and description of current wellbeing*

Researchers presented the wellbeing categories (Wallace et al. 2020, **Table 8.1**) using pictures and practical examples; images to illustrate the categories were slightly different to suit the

participants. The wellbeing categories provided a guiding structure to the assessment and allowed for comparison of the positive and negative effects of future scenarios among different groups of people.

After the presentation of the wellbeing categories, participants allocated themselves to tables with a researcher, to discuss a series of questions (**Table 8.2**) about how people satisfy their wellbeing from the catchment today. The groups discussed all the wellbeing categories in relation to the elicitation questions, followed by a managed plenary session in which groups provided examples for each wellbeing category, and these examples were captured in writing and displayed on butchers' paper. There was no rating of the current situation, only a narrative description of the above. The session was audio recorded with the consent of participants. The information from groups on the wellbeing categories remained on display throughout the workshop to allow participants to use or refer to the knowledge generated by the group during the evaluation of scenarios.

*Table 8.2. Standard questions used during the workshops to elicit how people satisfy their wellbeing from the catchment today.*

| Categories include having: | Questions in the TOs workshop | Questions in the multi-stakeholder workshop |
|---|---|---|
| *Enough food and water to drink* | How do you get your food and water today? | How do people get food and water from the catchment today? |
| *Satisfying work* | What are your opportunities for meaningful work today? | What are the opportunities in the catchment for meaningful work today? |
| *Knowledge of country and culture* | What ways can you connect to your country and culture today? | The catchment is a library of knowledge and heritage. In what ways do people connect to this important resource today? |
| *Safety, feeling safe and secure* | What are the things that make you feel safe or not safe on your country today? | What are the living things that make people feel safe or not safe in the catchment today? |
| *Fun – recreation, leisure* | What sorts of things do you do to have fun today? | What are the things that are healthy and unhealthy about the physical environment of the catchment today? |
| *Strong family and community relationships* | What are the ways that you connect to your family and community today? | How do people have fun/recreate in the catchment today? |
| *Healthy river country* | What are the things that are healthy and unhealthy about your country today? | How do people connect to their families and communities today? What is it about the catchment that helps these relationships? |
| *Places and things that make you feel good* | Are there special places and things that make you feel good when you see, touch, taste, smell, or feel them? | Are there special places and things that make people feel good when they see, touch, taste, smell, or feel them? |
| *Inner peace, spiritual fulfilment* | How do you keep your Liyan strong today? | How do people find inner peace and spiritual fulfilment in the catchment today? |

### *8.3.3. Rating of wellbeing changes in future scenarios*

Participants were asked to select the groups of people and the places or general areas (hereafter 'places') they were thinking about when assessing the scenarios (to which they were given a series of options – see **Supplementary Material**).

During both workshops, researchers presented an overview of each scenario, including the broad socioeconomic conditions and main industries, as well as a pictorial description of the key differences (**Boxes 8.2–8.6**).

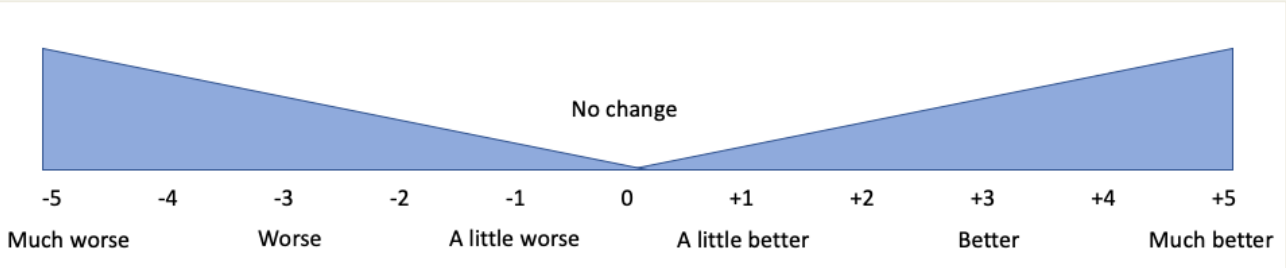
Then, after each scenario was presented, participants rated each scenario in terms of the potential positive and negative changes in each wellbeing category compared with the current situation in the catchment. The process followed for each scenario assessed was the following:

1. The scenario was described in a presentation that included maps, diagrams, and a description of key indicators (described above). A hard copy description summarising each scenario (including a summary table with key indicators; **Supplementary Material**) and a large-format map depicting a possible configuration of land uses was given to groups for their use during assessments.

2. The question addressed for each wellbeing category was: 'if this scenario happens, compared to the way things are now, you/your group's wellbeing for each of the following categories will be…'. Participants discussed, in their tables, the wellbeing changes they thought could happen if the given scenario became true.

3. Participants were asked to rate changes from 'much worse' to 'much better' with the option of 'no change' in comparison with the current situation using **Figure 8.1**.

*Figure 8.1. The 10-point scale used to rate the changes in each of the nine wellbeing categories for each scenario. Source: Kiatkoski Kim et al. (2021a, b).*




Participants could choose to remain anonymous when completing the worksheet. The discussion on step (2) was audio-recorded with the consent of participants. Facilitators took notes of the discussion. Participants could also include written notes in the worksheet explaining the rationale behind their ratings.

### *8.3.4. Quantitative analyses of participants' ratings*

To provide a broad overview of the participants' ratings the scores for each participant for each scenario were summed, taking into consideration whether the score was positive or negative. The scores for each participant were then added for each scenario – again taking into consideration whether the scores were positive or negative. The following calculations were then made:

a) total scores for each scenario

b) mean score per participant per scenario

c) median, standard deviation and range of scores for each scenario.

These calculations provide a useful, overall sense of participants' ratings and the variability among participants. However, these calculations assume that: (a) there is equal information among participants and responses are unaffected by any bias in the group situation; (b) all participants were thinking about the same area and people when making their assessments; and (c) all participants equally understood the rating process.

It is clear from the People and Places results (i.e. TOs' workshop described below) that assumption (b), at least, does not hold. Additionally, the participants are experts, knowledgeable of their places and people; however, the quantitative results cannot be generalised as a

representative sample of TOs in the catchment. Therefore, the summary statistics should be taken as broad indication of the whole group's responses and need to be used/interpreted together with the additional, qualitative information presented in the results. Together, the numerical and qualitative information provide an overview of the potential impacts on TOs' wellbeing associated with the land and water use changes presented in the scenarios. This overview is based on the knowledge of participants, who were selected based on their expertise of such matters.

It is worth noting that, when answering the question about each scenario and wellbeing changes in section 6.2.3. (step #2 and **Figure 8.1**. above), participants may have implicitly attributed different weights to different wellbeing categories. However, we did not attribute further weightings to different categories when calculating the aggregate values, i.e. all categories were weighted equally at that stage. These calculations provide a useful, overall sense of participants' ratings and the variability among participants. However, the quantitative results cannot be generalised as a representative sample of key interest groups in the catchment. Therefore, the summary statistics should be taken as a broad indication of the whole group's responses and need to be used and interpreted together with the additional, qualitative information presented in the results. Together, the numerical and qualitative information provide an overview of the potential impacts on people's wellbeing associated with the land- and water-use changes associated with each future scenario. This overview is based on the knowledge of participants, who were selected based on their expertise and lived experience of such matters.

## 8.4. Results

### *8.4.1. General workshop information*

The TOs' workshop was attended by 23 participants from the Bunuba, Gooniyandi, Jaru, Kija, Yi-Martuwarra, Nyikina Mangala, Tiya Tiya, Warrwa, and Wanjina-Wunggurr peoples. There was a language interpreter (Mr Ronnie Jimbidie) and five researchers (Dr Jorge Álvarez-Romero, Dr Ro Hill, Mr Ken Wallace, Ms Karen Dayman, Ms Pia Harkness). Participants allocated themselves to four tables for group discussion. The resulting four tables had between 4 and 6 people from different Aboriginal groups, mostly divided by gender with a few exceptions. Scenarios 1,[55] 2 and 4 were assessed, in that order. There was insufficient time to assess scenario 3. The order was selected on the basis that they represented the most useful comparisons in terms of informing participants; in particular, they were contrasting.

The scenarios team workshop was attended by 18 people from 15 organisations, across all key interest groups, including government agencies, pastoral industry, mining, environmental groups, and representatives from Bunuba, Nyikina Mangala, and Wanjina-Wunggurr peoples (for a full list of organisations represented see **Supplementary Material**). There were two professional facilitators, (Elizabeth Brown and David Munday), who have facilitated workshops 1 and 2. There were also five NAERH researchers (Jorge Álvarez-Romero, Michael Douglas, Pia Harkness, David Pannell, and Ken Wallace), supported by the NESP Regional Coordinator (Karen Dayman).

### *8.4.2. People and places*

#### *Traditional Owners*

Participants identified between 1 and 5 groups of people that they would be thinking about when assessing scenarios. The most frequently selected groups were 'all TOs in the catchment' (selected by 19 participants), 'family group' (12), 'your TO group' (9), and 'community group' (9) (**Table 8.3**). One participant included the 'future generations and general population'.

Participants selected between 1 and 4 places they were thinking about when assessing scenarios. Most (18 participants) thought about the 'river and its total catchment', while 12 selected 'river

[55] Scenario 1 in this workshop is equivalent to scenario 1A in the subsequent workshops

country' and 8 selected 'hill country' (**Table 6.3**). Five participants selected 'other places', which included: Nyikina Mangala country; living waters inland; Jaru and Bunuba Ranges; all community along river + catchment + tributaries; Yurriurigum; Bayulu, Leopold, Brooking Spring, town.

*Table 8.3. 'People' and 'place' selected by the TOs' workshop participants. Participants could select more than one group of people and place. Source: Kiatkoski Kim et al. (2021a).*

| People | Total |
|---|---|
| All TOs in the catchment | 19 |
| Family group | 12 |
| Your TO group(s) | 9 |
| Community group | 9 |
| As an individual | 2 |
| **Place** | **total** |
| River and its total catchment | 18 |
| River country | 12 |
| Hill country | 8 |
| Community group area(s) | 6 |
| Others | 6 |
| Desert country | 5 |
| Particular station(s) | 2 |

### *Multi-stakeholder group*

Participants identified between 1 and 6 groups of people that they would be thinking about when assessing scenarios. The most frequently selected groups were 'all TOs in the catchment' (selected by 12 participants), the 'Fitzroy catchment community' (9), and the pastoral industry (6) (**Table 8.4**). The participant's TO group was selected by 5 participants, and the agricultural industry by 3 participants. Eight participants lived in the catchment, 8 did not live in the catchment, 1 lived part-time and 1 did not respond this question.

Regarding the places participants were thinking about when assessing scenarios, they identified between 1 and 4 places per individual. Most (14 participants) thought about the river and its total catchment, while 6 selected 'river country' and 6 referred to specific communities or towns where they lived (**Table 8.4**).

*Table 8.4. 'People' and 'place' selected by the scenarios team workshop participants. Participants could select more than one group of people and place. Source: Kiatkoski Kim et al. (2021b).*

| **People** | **Total** |
|---|---|
| All Traditional Owners in the catchment | 12 |
| Fitzroy catchment community | 9 |
| Pastoral industry | 6 |
| Your Traditional Owner group(s) | 5 |
| Family group | 5 |
| Agricultural industry | 3 |
| Community group | 3 |
| As an individual | 3 |
| Australia government and/or people of Australia | 2 |
| State government and/or WA people | 2 |
| Global community | 1 |
| Mining industry | 1 |

| Place | Total |
|---|---|
| River and its total catchment | 14 |
| River country | 6 |
| Community group area(s) | 6 |
| Particular station(s) | 4 |
| Hill country | 2 |
| Desert country | 1 |

### *8.4.3. Current wellbeing situation*

Researchers presented an overview of the current state of the catchment, including the broad socioeconomic conditions and main industries (**Box 8.1**). The **Supplementary Material** includes a map representing the current distribution of land uses and selected indicators describing key features of industries. As noted above, the group used the current situation to explore the definitions of the wellbeing categories and as the baseline to assess scenarios.

The full outputs from each of the workshop groups are described in the **Supplementary Material**. **Table 8.5** exemplifies participant responses against wellbeing categories from the assessment workshops. Participants generally had no difficulty relating to the wellbeing categories. However, some categories had significantly different interpretations by the participants of each workshop; notably 'fun-recreation, leisure' and 'places and things that make you feel good' (**Table 8.5**). For example, while the multi-stakeholder group generally associated fun with typically western activities such as sports, camping and relaxing, TOs' workshop participants emphasised activities that promoted connection with Country and transmission of culture. These differences are explored in detail elsewhere (Wallace et al in prep).

*Table 8.5. Examples of participant responses against wellbeing categories from the assessment workshops. These comments were generated from facilitated discussions of the current situation during the multi-stakeholder and TOs' workshops and were selected only to provide a sense of the type of items discussed, not to provide a thorough analysis. Source: Kiatkoski Kim et al. (in review).*

| Wellbeing category | Traditional Owners | Multi-stakeholder group |
|---|---|---|
| *Enough food and water to drink (A)* | People mainly rely on getting their food from the supermarket, but regularly get food from the bush and rivers. Drier rivers mean less fish, less often. Wrong way fire reduces the abundance of bush food and feed for animals that are important for hunting, such as bush turkey. | Ways of obtaining food ranged from the local grocery shops and other stores through to hunting and gathering bush foods. In the case of water, one source is bore water – public or private supplier – but quality and volumes can be concerns. |
| *Satisfying work (B)* | Working on Country is important, e.g. as rangers or in the pastoral industry. However, the types of jobs and continuity of employment are important issues. | Wide variety of activities listed, including rangers working on Country, tourism, government services and arts and culture. |
| *Knowledge of country and culture (C)* | Importance of being on Country, connecting through places and telling stories, teaching kids, maintaining cultural activities. | Continuing connection to the land is important, but also need to learn from history and videos and film as a way to connect with the past. |
| *Safety, feeling safe and secure (D)* | Extensive comments ranging from the importance of the Rainbow serpent for feeling safe, through to having housing and own space, clean communities, and people working together. | Issues raised included crocodiles, mosquitoes and viruses, poisonous plants and animals, other people, and access to medical services. |
| *Fun – recreation, leisure (E)* | People talked about bush camps etc. as important opportunities for connecting with family, practicing cultural and traditional activities, intergenerational teaching and learning knowledge. However, restrictions on the ability to continue these activities, e.g. lack of access to country (locked gates), were often mentioned. | Items ranged from active recreation such as fishing, swimming, camping, football and hunting, through to astronomy, and sitting around relaxing and eating and drinking. |
| *Strong family and community relationships (F)* | Camping and fishing, family catch-ups were seen as important, as were connection to Country and cultural links. | A very wide range of items listed from social media and digital communication, through to hunting and fishing, rodeos and family bands. |
| *Healthy river country (G)* | Wrong way fire, a dirty river, dust storms, and overfishing were examples of issues arising from unhealthy Country. | Diverse fish and birds and good water quality represent health. River pools filling in with sediment and historical chemical use were some of the unhealthy aspects of Country identified. |
| *Places and things that make you feel good (H)* | This was not a category related to by the group in discussion of the current situation, although most participants scored wellbeing changes in this category when assessing scenarios. | Remoteness and untouched landscapes, the sweet smell after rain, Boab trees, wildlife, green grass and fed cattle, were some of the things mentioned. |
| *Inner peace, spiritual fulfilment (I)t* | Connection with Country was a central theme to inner peace and spiritual fulfilment and returned to in various forms. Loss of language and connection between language groups was a major issue and affects the capacity of groups along the river to interact effectively. Camping in the river on sand with family/community, under the milky way, was an opportunity for old people to pass knowledge down to the young people. | Connecting with nature/country, cultural flows, seeing the stars, storytelling and watching Aboriginal artists were some of the items mentioned in this category. |

### 8.4.4. Assessments of scenarios

Despite some common patterns emerging from both workshops, the assessment of scenarios highlighted important differences between the two groups (Traditional Owners and scenarios team). **Table 8.6** summarises participants' ratings across all wellbeing categories for each scenario. These results indicate only the aggregated views of workshop participants, due to the relatively small number of responses due to a purposeful rather than a probabilistic sampling strategy. The ranges and standard deviations indicate important differences between the individual ratings of each scenario in each workshop (**Table 8.6**, **Figure 8.2**). Scenarios with 'strong policy' (Scenarios 1 and 2) had generally higher scores than scenarios with 'weak policy' in both workshops. In the scenarios team workshop, scenario 1 had the highest total score (not far ahead of scenario $1_b$), with only positive scores. The positive total score for scenario 1 in the TOs' workshop was substantially lower than that from the scenarios team workshop. Scenario 2 was also mostly positively scored in the scenarios team workshop, while it was negatively scored by TOs. Scenario 4 was the most negatively scored scenario in both workshops, but much more so in the TOs' workshop.

*Table 8.6. Summary statistics of participants' ratings across all wellbeing categories for each future scenario. ST = scenarios team workshop, TOs' = Traditional Owners' workshop. Total scores are the sum of individual ratings for all wellbeing categories in a given scenario. Ratings are in comparison with the current situation, and each of the nine wellbeing categories was rated between -5 and +5, where negative numbers are worse than the current situation, and positive numbers represent an improvement. Source: Kiatkoski Kim et al. (in review).*

| | Workshop | Scenario 1 | Scenario $1_b$ | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|---|---|
| No. participants | ST | 18 | 18 | 17 | 18 | 17 |
| | TOs | 21 | - | 19 | - | 16 |
| Mean/participant | ST | 20.9 | 18.0 | 12.1 | -3.11 | -14.4 |
| | TOs | 1.5 | - | -12.9 | - | -29.6 |
| Std. deviation | ST | 10.5 | 17.4 | 15.7 | 14.73 | 22.16 |
| | TOs | 16.7 | - | 13.2 | - | 14.2 |
| Range | ST | 3 to 45 | -27 to 45 | -24 to 36 | -40 to 18 | -45 to 45 |
| | TOs | -26 to 36 | - | -14.5 to 3 | - | -45 to 0 |
| Total score | ST | 377 | 323.5 | 206 | -56 | -245.5 |
| | TOs | 31 | - | -245.5 | - | -474 |

This simple method for aggregating ratings across wellbeing categories, with no weighting of categories, shows that scenarios 1, $1_b$ and 2 were assessed by most participants of the scenarios team workshop as representing potential improvements across most wellbeing categories compared to the current situation. Conversely, scenarios 3 and 4 were generally seen as having potential to worsen wellbeing.

TOs' workshop participants had mixed views of scenario 1, while scenarios 2 and 4 were seen as potentially worsening the wellbeing of Traditional Owners in the basin. This could be explained by the concerns expressed by some participants that the scenarios seemed to be broadly grounded in an old pro-development paradigm based on agriculture and mining, with limited room for new and emerging industries and development models. They also mentioned that none of the scenarios represented an Aboriginal view of a positive future and future possibilities. This is possibly a result of the project focus on developing realistic, rather than aspirational scenario development.

*Figure 8.2. Variation in participants' responses per workshop. Letters correspond with Table 8.5.*

*The boxplots show the variation in individual ratings provided by participants from the scenarios team (left panels) and TO (right panels) workshops. Ratings varied between -5 (much worse) to 5 (much better), all compared with the current situation. The letters on top of each plot (A to I) correspond with Table 8.5, which describes each wellbeing category. Each plot correspond to the responses of participants for the corresponding scenario, from scenario 1 (top two panels) to scenario 4 (bottom two panels).*

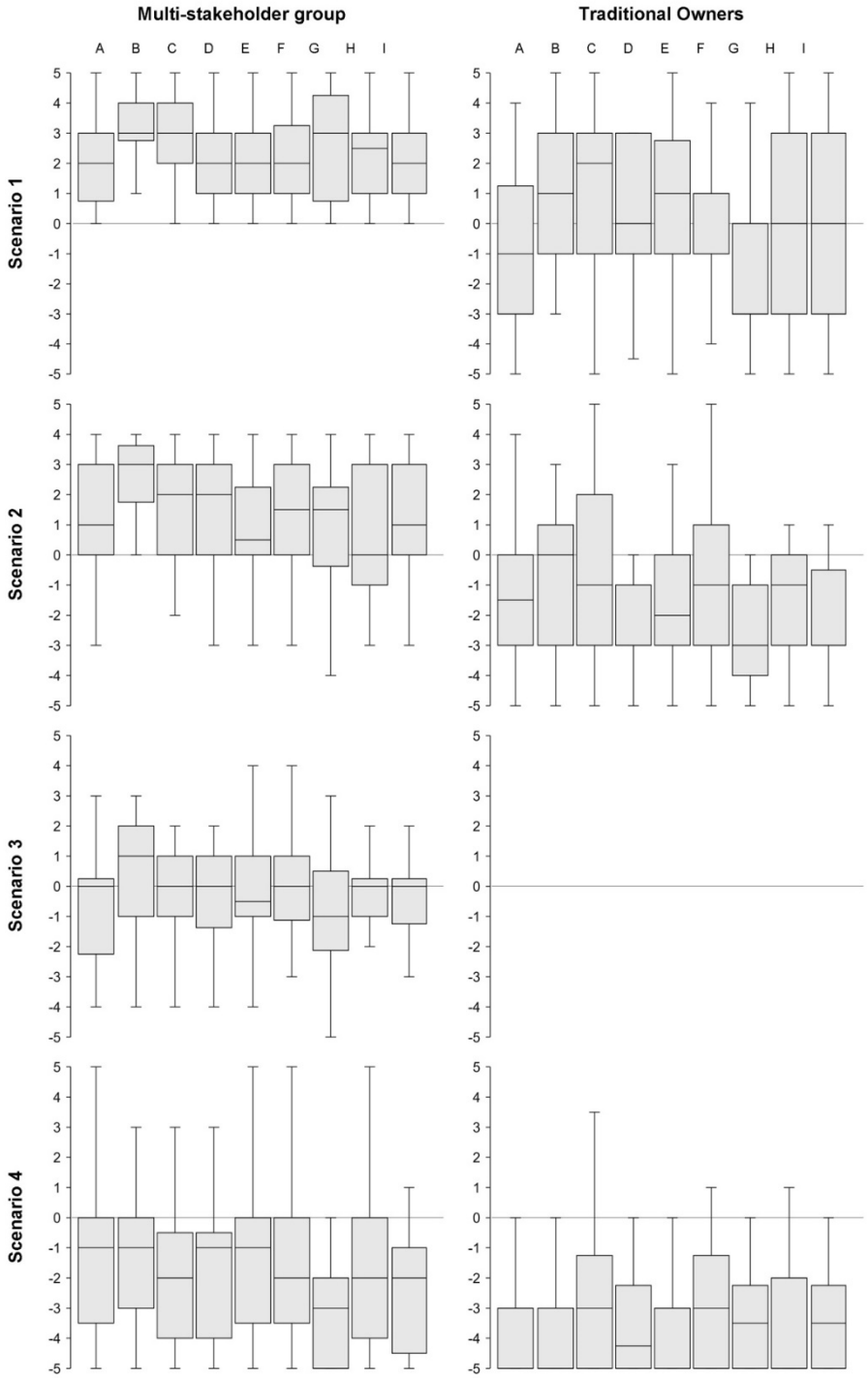



**Table 8.7** summarises the main themes on the factors affecting wellbeing improvement or worsening, per workshop. It presents the themes associated with the three most positively and most negatively scored wellbeing categories per scenario, per workshop. The qualitative information in the sections below, and summarised in **Table 8.7,** was sourced mainly from audio records, facilitators' notes and participants' written comments in the worksheets.

*Table 8.7. Summary of main themes for factors affecting wellbeing improvement or worsening, per workshop. This table focuses on the themes associated with the three most positively and most negatively scored wellbeing categories per scenario per workshop. MS = multi-stakeholder workshop, TOs' = Traditional Owners' workshop. Source: Kiatkoski Kim et al. (in review).*

| | Scenario 1 | Scenario 1b | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|---|
| Factors affecting wellbeing improvement | MS<br>Higher Indigenous workforce participation in resource sector, as rangers, and in tourism<br>New jobs could help address social issues<br>Maintaining the health of the river would depend on irrigated agriculture being well regulated and monitored<br><br>TOs'<br>Young people working on Country could improve their knowledge of Country and culture<br>Additional jobs, especially as rangers<br>Less dependence on welfare programs<br>Better partnerships between Indigenous people and landholders | MS<br>Knowledge of Country and culture enhanced by people working on Country (and thus spending more time on Country)<br>Increase in the conservation estate could improve the health of the Country<br>Maybe less threats to the river, but not necessarily a healthier river<br>Higher Indigenous employment in carbon farming and tourism | MS<br>Jobs in cultural tourism, and as rangers managing Country<br>Increased employment could stabilise families and contribute to food security<br>Access to Country, Indigenous enterprises, and increased household income and security<br><br>TOs'<br>Increase in jobs in parks could improve Traditional Owners' knowledge<br>More money might bring infrastructure and social facilities that benefit communities<br>Potential for Indigenous-owned agricultural enterprises | MS<br>More work, but maybe not totally satisfying | MS<br>More food from supermarket only<br>More jobs, but higher likelihood of jobs being filled from outside catchment<br><br>TOs'<br>(no positive comments) |
| Factors affecting wellbeing worsening | MS<br>Not applicable<br><br>TOs'<br>Withdrawal of water could impact the river adversely<br>Contamination by pests and weeds<br>Limited access to Country<br>Increased burning could mean loss of bushfood | MS<br>Increase in woody weeds affecting the availability of bushfoods<br>Insufficient jobs leading to social problems | MS<br>Withdrawing water from the river could affect its health<br><br>TOs'<br>Intensification of agriculture leading to water contamination and scarcity<br>No change to the current feeling of lack of safety due to social issues e.g. violence and vandalism<br>Outside workers worsening social problems<br>Fear of bushfood contamination<br>Limited access to Country<br>Water extraction, pollution, weeds | MS<br>Limited reduction of grazing<br>Limited consultation and joint management<br>Low funding for conservation<br>Limited threat management<br>Water extraction<br>Limited access to Country, less access to bushfoods, less traditional uses of the land | MS<br>Poorer environmental management and regulations leading to environmental impacts<br><br>TOs<br>Fewer ranger jobs<br>Uncertainty regarding the sufficiency of these jobs and who would get them<br>If Traditional Owners are not allowed to go to Country, then Country won't be healthy<br>Poor governance means less collective action to solve problems |

## *Scenario 1*

Researchers presented an overview of scenario 1, including the broad socioeconomic conditions and main industries (**Box 8.2**). This scenario is based on strong policies protecting local and national values, and a higher demand and investment in development initiatives that maintain natural and cultural landscapes.

*Box 8.2. Summary of the potential conditions in the Fitzroy catchment under scenario 1.*

- Stronger policies protect local and national values (including those of national and international significance) and give certainty; also, strong collaborative leadership (coordinated decisions) and strong Indigenous governance (Indigenous empowerment and participation, recognized by other stakeholders) enable better planning and management
- Higher demand and investment in development initiatives that maintain natural-cultural landscapes
- Negotiations around development are more fair and take place under equal conditions
- Evidence-based decisions and monitoring allow identifying changes and adjusting uses accordingly

- Land use dominated by grazing natural vegetation
- Better land and water management, including cattle control and reduced overgrazing
- Better access to country, including for recreation, subsistence, and cultural activities
- Good investment and extensive carbon farming using savanna burning (less large & hot fires)
- Large increase in the number and extent of new conservation areas (17%), managed through joint management
- Large increase (+100%) in cultural- and nature-based tourism (85% Indigenous businesses)
- One new small-scale coastal barramundi farm
- Similar level of resource extraction (low impact)
- Six new medium-scale irrigated agriculture based on groundwater (100 GL, 2.9% of recharge)

### Traditional Owners

Some participants felt that this scenario presented positive changes, especially in relation to access to country; in some cases, unlocked gates would mean more opportunities to go fishing, hunting, camping, etc. However, others expressed concerns that this, as with the other scenarios, provided limited scope for TOs aspirations in relation to development in the catchment.

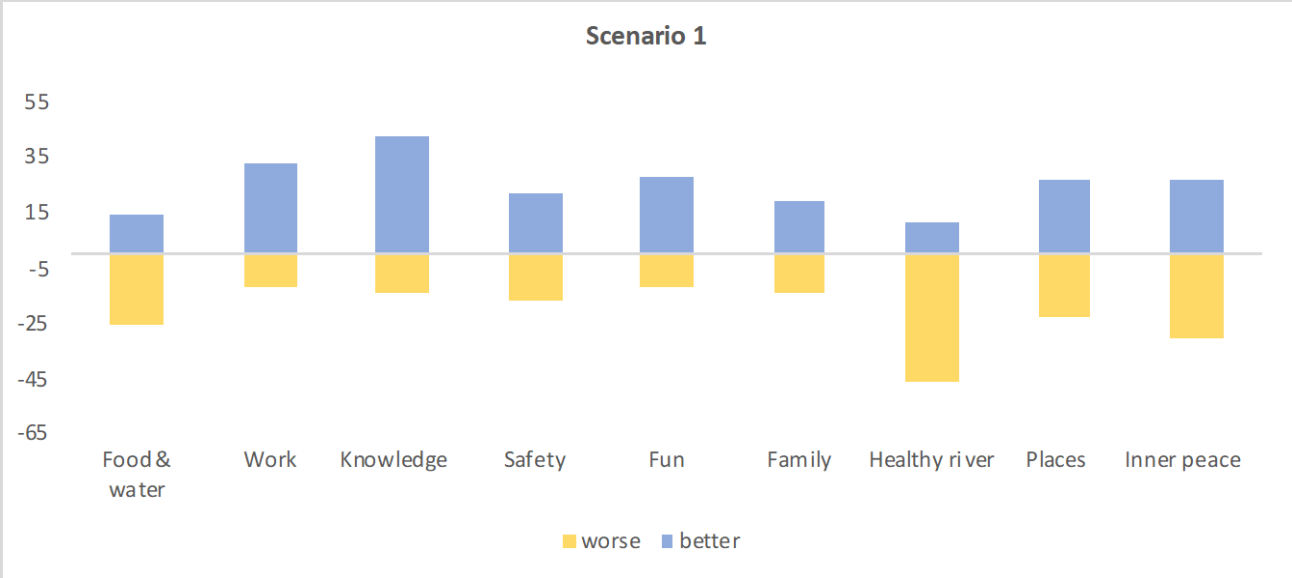
Participants' ratings show that 'knowledge of country and culture', 'satisfying work' and 'having fun' would improve the most, as compared with today, if scenario 1 came true (**Figure 8.3**). Some participants thought that this scenario could mean a lot of young people going out to country, and getting out of town. This could improve their knowledge of country and culture.

Regarding 'satisfying work', some participants praised the additional jobs under this scenario. There could be, for example, less dependency on welfare programs. Nevertheless, an increase in jobs could also mean more people moving into towns. New national parks would mean more rangers, which was considered as desirable to some groups. However, consistency of funding is essential. Rangers would need to have paid courses between other jobs, so that they are consistently employed. Cultural

activities should be associated with employment programs, but those would need to be in addition to rangers' work. This will also improve the knowledge of country and culture.

'Having fun' was sometimes associated with going fishing or camping, in special places, with family and friends. Thus, access to country and special places is very important. While some participants thought that there would be generally better partnerships between Aboriginal people and landholders, others considered that access to their special places could be lost, for example to new tourist enterprises, thus affecting opportunities to have fun. One participant also mentioned that more '9 to 5' jobs would also make it more difficult for people to go out to bush and have fun. Another important point was the negative association between the current notions of 'fun', like playing football, drinking and socialising, especially because they compete with a more desirable idea of fun such as going to the bush. Some participants said that this scenario did not seem to affect people's opportunity to drink or socialise, and this would mean no improvement of these issues. Other participants thought that more money circulating due to the increase in jobs could actually amplify these issues since it could be spent on alcohol or other undesirable social activities.

*Figure 8.3. Scenario 1, TOs' workshop. Sum of the positive ('better') and negative ('worse') ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021a).*




The most negatively-rated categories, i.e. those where most participants saw potential for worsening as compared with today, were 'healthy river country', 'inner peace and spiritual fulfilment', and 'enough food and water'. The concerns regarding 'healthy river country' were associated with the withdrawal of water (**Figure 8.3**). As a participant puts it, even if only ground water was used, all living water is connected and thus it would impact the river. Another source of concern was contamination by pests and weeds such as toads and Buffel grass, which could be related to land use intensification.

Participants' concerns regarding 'inner peace' were mostly linked to their access to country. People need to have access to country in order for their Liyan to be good, and depending on where development happens this could mean the loss of access to important areas. There were few comments regarding 'enough food and water' but these were mostly related to the increase in carbon farming and the associated burning of country. Despite good fire management, a single bad fire can change some areas notably, which could mean the loss of bush food completely for large areas.

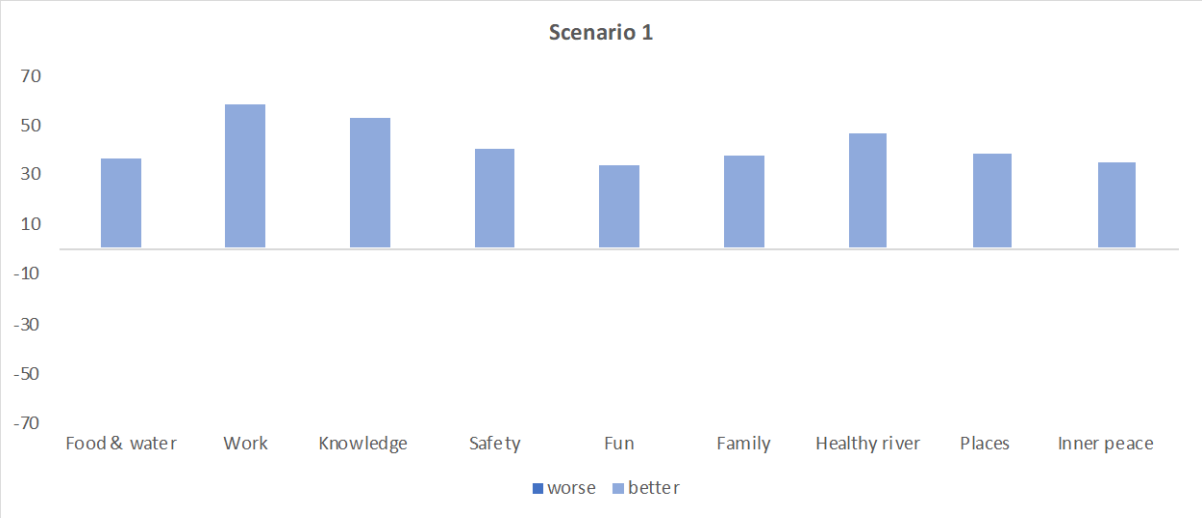
The category with the highest number of 'no change' ratings was 'places and things that make you feel good' (4 ratings).

**Multi-stakeholder group**

Researchers presented an overview of scenario 1, including the broad socioeconomic conditions and main industries (**Box 8.2**). Scenario 1 had only positive and 'no change' ratings from participants. All participants considered that there would be at least some wellbeing improvements if this scenario came true, while two participants, both from a Traditional Owner perspective, rated most categories as 'no change' when compared with today.

The categories with the highest improvement were 'satisfying work', 'knowledge of country and culture', and 'healthy river country' (**Figure 8.4**). One participant, working for government, commented on the potential for higher Aboriginal workforce participation in the resources sector, more rangers working on country, and new tourism enterprises. Another participant from government stated that he hoped that the current government planning initiatives could create new jobs that could help address the social issues in the catchment.

*Figure 8.4. Scenario 1, scenarios team workshop. Sum of the positive ('better') and negative ('worse') ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021b).*




Although there were no negative ratings, one participant, speaking from a Traditional Owner's perspective, was concerned that *"more work more $, may result in more alcohol, drugs, etc"*

Another participant, working for government, stated that maintaining the health of the river in scenario 1 depended on irrigated agriculture being well regulated and monitored. This would prevent water extraction during years of low flows, which would affect recharge. On the other hand, a participant working in the pastoral and agriculture industry rated this category positively but noted concerns regarding the likelihood that groundwater extraction opportunities could be limited to a few properties.

### *Scenario 1b*

Researchers presented an overview of scenario 1b, including the broad socioeconomic conditions and main industries (**Box 8.3**). This scenario is also based on strong policies protecting local and national values, and a higher demand and investment in development initiatives that maintain natural and cultural landscapes, but it assumes increment in irrigated agriculture will be negligible. The **Supplementary Material** includes a map representing one potential configuration of land uses in 2050 and selected indicators describing key features of industries.

*Box 8.3. Summary of the potential conditions in the Fitzroy catchment under scenario 1b.*

- Stronger policies protect local and national values (including those of national and international significance) and give certainty; also, strong collaborative leadership (coordinated decisions) and strong Indigenous governance (Indigenous empowerment and participation, recognized by other stakeholders) enable better planning and management
- Higher demand and investment in development initiatives that maintain natural-cultural landscapes
- Negotiations around development are more fair and take place under equal conditions
- Evidence-based decisions and monitoring allow identifying changes and adjusting uses accordingly

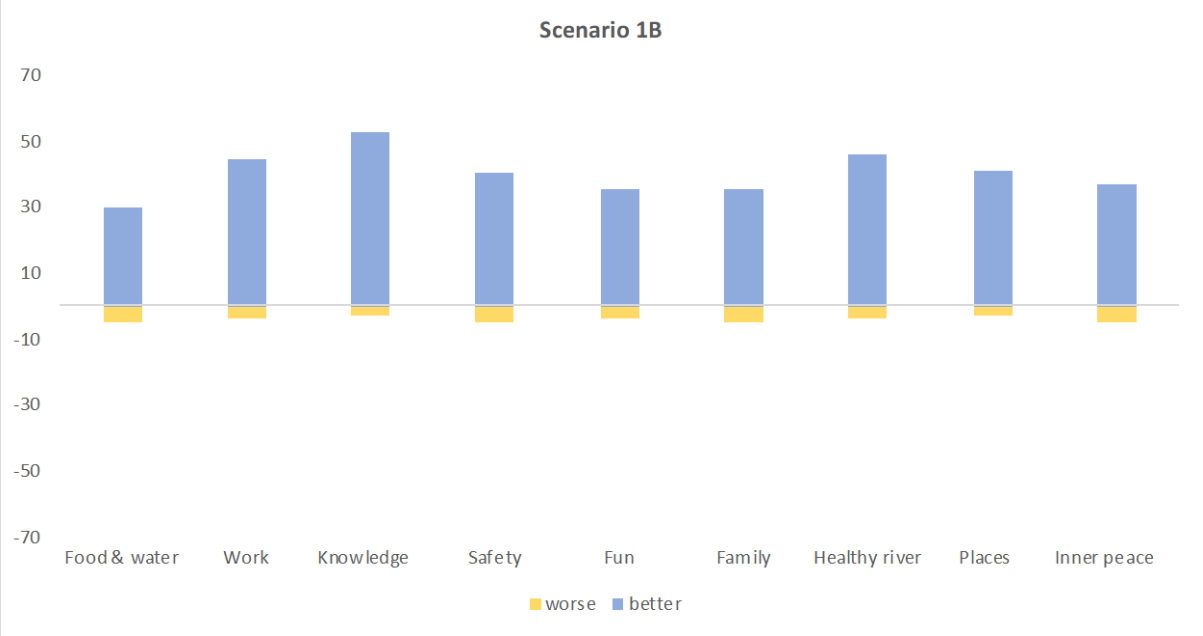
- Land use dominated by grazing natural vegetation
- Better land and water management, including cattle control and reduced overgrazing
- Better access to country, including for recreation, subsistence, and cultural activities
- Good investment and extensive carbon farming using savanna burning (lower large & hot fires)
- Large increase in the number and extent of new conservation areas (17%), managed through joint management
- Large increase (+100%) in cultural- and nature-based tourism (85% indigenous businesses)
- One new small-scale coastal barramundi farm
- Similar level of resource extraction (low impact)
- No new irrigated agriculture developments

Scenario 1b was only assessed in the scenarios team workshop. Scenario 1b had mostly positive and 'no change' ratings; all the negative ratings came from two participants, who scored most categories as worsening. The categories with highest improvement were 'knowledge of country and culture', 'healthy river country', and 'satisfying work' (**Figure 8.5**). Participants generally agreed that spending more time on country, by working on parks, tourism and land management, would increase the knowledge of country and culture. Some considered that the increase in the conservation estate could improve the health of the country; while others thought that there would be less threats to the river in this scenario, but this would not necessarily improve its current state.

Participants discussed the potential for carbon farming and tourism in the catchment. Some participants perceived that work in those industries, as well as the increased opportunities for joint management, could lead to higher Aboriginal employment. However, participants who rated this scenario negatively thought that the picture presented in the scenario 'is going backwards' and there would be insufficient employment, which could lead to an aggravation of social problems.

The wellbeing categories with the highest negative ratings were 'enough food and water' (which was also the category with the highest number of 'no change' ratings); and 'safety', 'strong family and community', and 'inner peace, spiritual fulfilment' (all tied). The rationale presented by a participant for those ratings was that the insufficiency of jobs would lead to further social problems, and an increase in woody weeds would affect the availability of bushfoods. Inner peace would be affected because it is *"Depressing thinking things will not improve for [the] majority of population".*

*Figure 8.5. Scenario 1b, scenarios team workshop. Sum of the positive ('better') and negative ('worse') ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021b).*



## *Scenario 2*

Researchers presented an overview of scenario 2, including the broad socioeconomic conditions and main industries (**Box 8.4**). This scenario is based on strong policies protecting local and national values, and a higher demand and investment in development initiatives that modify natural and cultural landscapes. The **Supplementary Material** includes a map representing one potential configuration of land uses in 2050 and selected indicators describing key features of industries.

*Box 8.4. Summary of the potential conditions in the Fitzroy catchment under scenario 2.*

- Stronger policies protect local and national values (including those of national and international significance) and give certainty; also, strong collaborative leadership (coordinated decisions) and strong Indigenous governance (Indigenous empowerment and participation, recognized by other stakeholders) enable better planning and management
- Higher demand and investment in development initiatives that modify natural-cultural landscapes
- Negotiations around development are more fair and take place under equal conditions
- Evidence-based decisions and monitoring allow identifying changes and adjusting uses accordingly

- Land use dominated by grazing natural vegetation
- Better land and water management, including cattle control and reduced overgrazing
- Better access to country, including for recreation, subsistence, and cultural activities
- Medium-level investment in carbon farming using savanna burning (moderate reduction in fires)
- Medium increase in the number and extent of new conservation areas (13%), incl. joint management
- Medium increase (+50%) in cultural- and nature-based tourism (75% indigenous businesses)
- Two new small-scale coastal barramundi farms
- Medium increase in resource extraction (low impact)
- 12,000 ha of irrigated rotation system (groundwater: 120 GL, 3.4% of recharge) + 18,000 ha of Rhodes grass (300 GL, 6.1% of median discharge)

### Traditional Owners

There was a general concern, reported in all groups of participants, regarding the relatively high level of irrigated agriculture development in this scenario. Extensive areas of agriculture were not viewed favourably, and this seemed to cut across all wellbeing categories. Some participants worried about the high level of uncertainty regarding the impacts of agriculture, while others referred to the historical impacts of development (e.g. weeds and water pollution) in the region. An increase in agriculture could also mean limited access to country, which would in turn affect connection to country and continuation of culture with consequent impacts on wellbeing.

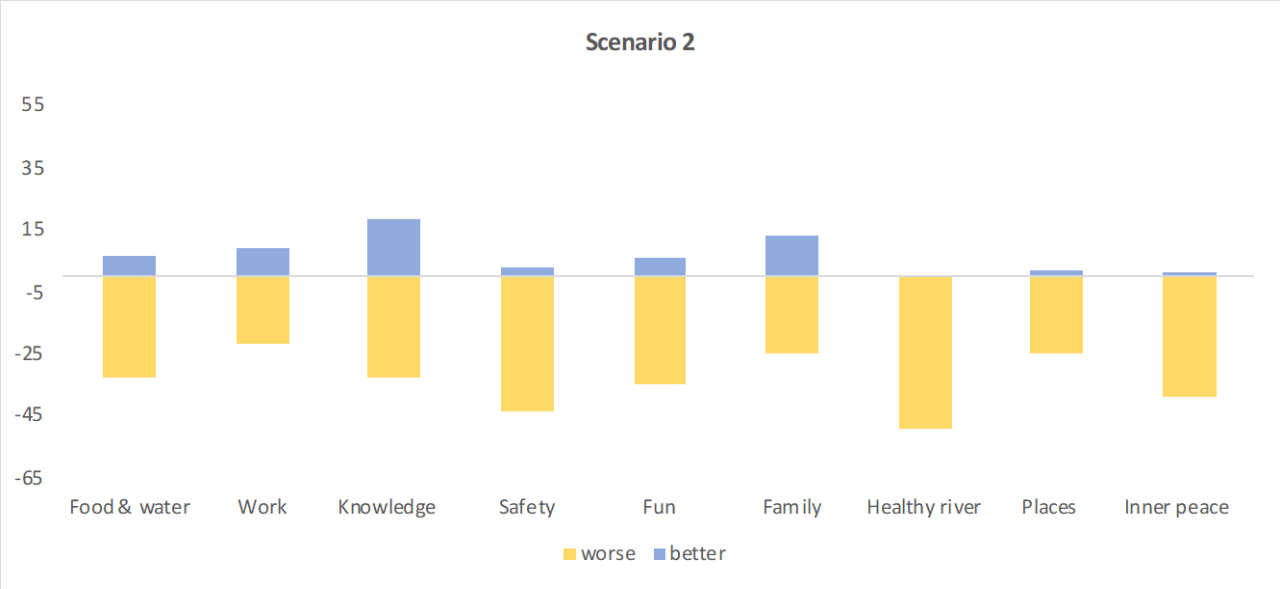
There were also concerns specific to water being withdrawn from either the river or aquifers. Participants in one group emphasised that water is deemed the source of life for everybody and everything, and the river is considered a living being, having its own right to life. Participants described the current scarcity of water; for example, when going out on trips for collecting medicine plants they have to carry water because there is limited water available in the environment, negatively impacting on their ability to go on country and keep their connection to country strong. They feared that an intensification of irrigated agriculture would worsen this situation and significantly affect their wellbeing. As a participant stated,

“I feel like I’m approving a gravitational pull to sterile country. Like I can look out the plane window to a patchwork country. Looking to a future like the Murray Darling.”

Participants also considered that an increase in tourism would not necessarily be desirable. At times, tourists want information about things they are not allowed to know, or they may try to access sacred and important sites that should not be visited.

Participant ratings showed some potential improvements in a few aspects of their wellbeing, especially ‘knowledge of country and culture’, ‘strong family and community’, and ‘satisfying work’ (**Figure 8.6**). ‘Satisfying work’ was also the category that received the most ‘no change’ ratings (6). However, overall negative changes are assessed as outweighing positive changes for each category.

*Figure 8.6. Scenario 2, TOs’ workshop. Sum of the positive (‘better’) and negative (‘worse’) ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021a).*




A participant thought that the increase in jobs in parks could improve TOs’ knowledge of country and culture; however, the additional jobs in tourism may not significantly increase knowledge of country for local communities (beyond those that are directly involved in those jobs). A group of participants felt that knowledge of country and culture, as well as other aspects of TOs’ wellbeing, would worsen because of the uncertain effects of more extensive agriculture and related changes to river. Others considered that their inability to practice cultural awareness could negatively affect knowledge of country.

Regarding family and community relationships, some female participants considered that more money might bring more roads, infrastructure, houses, health centres, which would benefit communities. However, more money and the way it is distributed can also cause arguments and increase conflict.

Despite the positive ratings for ‘satisfying work’, many participants questioned whether the additional jobs presented in this scenario would actually be fulfilled by Aboriginal people. A group of participants viewed positively the potential for Aboriginal owned agricultural enterprises, but they questioned whether and how the skills to run such enterprises would be developed. They also had reservations regarding the compatibility between Aboriginal people managing or working in large-scale agriculture and continuing to meet cultural obligations, practicing cultural activities, and passing knowledge on. Some perceived that this scenario had increased jobs for people on country but also pollution in the river, and they questioned how these things could be balanced.

The categories perceived as potentially being most negatively impacted were ‘healthy river country’, ‘safety’, and ‘inner peace, spiritual fulfilment’ (**Figure 8.6**). Most groups suggested that the health of

river country has already been affected by agriculture, for example water pollution by chemical runoff. Participants were concerned that the intensification of agriculture could have negative impacts on drinking water from soaks in the river. Soaks are an important water source when the river runs dry. They were also worried about contamination of the aquifer and the lack of water due to extraction mentioned previously.

Participants in both a male and a female group described feeling unsafe today due to social issues, and they stated that scenario 2 provides no indication that people would feel safer in that situation. Conversely, people would be frightened to get bushfood because it could be contaminated. Additionally, the intensification of agriculture could bring more outside workers, which are normally men, who could bring negative experiences (e.g. looking for grog and women). Similarly, the issues related to water extraction, pollution, weeds and specially access to country were associated with negative effects in TOs' inner peace and spiritual fulfilment.

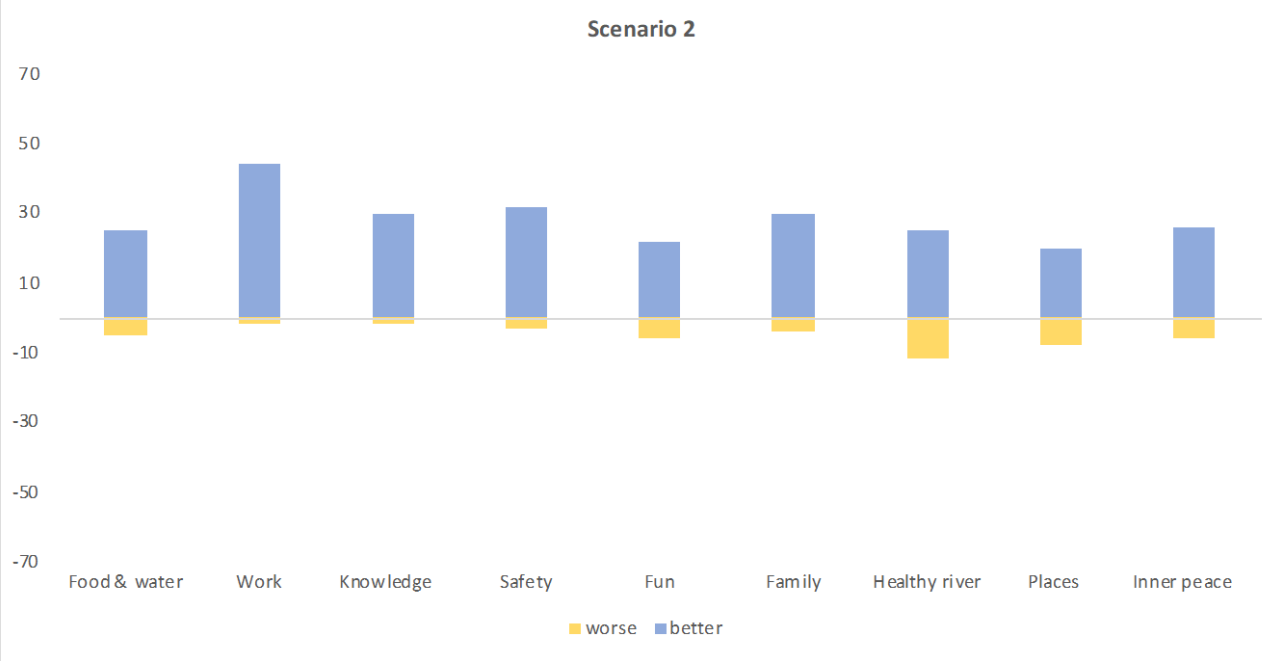
**Multi-stakeholder group**

The categories with most positive ratings were 'satisfying work', 'safety', and 'strong family and community' (**Figure 8.7**). 'Satisfying work' was possibly influenced by the higher number of jobs than the previous scenario, but one participant from government viewed positively the jobs in cultural tourism, and as rangers managing country. One participant, from an agricultural-pastoral perspective stated that safety would improve under this scenario because the increased employment could stabilise families and contribute to food security. Another participant perceived that increased land and fire management could contribute to better safety. Access to country, Aboriginal enterprises, and increased household income and security would contribute to 'strong family and community'.

The level of negative ratings in this scenario was slightly higher than in scenario 1b. The categories with the most negative impacts on wellbeing were 'healthy river country', 'places and things that make you feel good', and 'having fun' (which also had the most 'no change' ratings). One participant from government was concerned about the potential environmental impacts:

"Predicated on that strong governance, which I am very sceptical of, because I cannot see human nature changing in 30 years… But predicated that everybody has a wonderful epiphany tomorrow morning and we all start changing, then… I am very concerned about the river and drawing water off the river, but I think we are smart enough people to bring some agriculture in and get it right, not destroy everything. But we have to be very firm and strict about what are our environmental priorities, identify them and mark them as untouchable. (…) [Unfortunately] there is an overlap between some of the most valuable environmental assets and the most suitable country for agriculture. But those assets need to be protected."

*Figure 8.7. Scenario 2, scenarios team workshop. Sum of the positive ('better') and negative ('worse') ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021b).*



## *Scenario 3*

Researchers presented an overview of scenario 3, including the broad socioeconomic conditions and main industries (**Box 8.5**). This scenario is based on weak policies that favour interests external to the catchment, and a higher demand and investment in development initiatives that maintain natural and cultural landscapes. The **Supplementary Material** includes a map representing one potential configuration of land uses in 2050 and selected indicators describing key features of industries.

*Box 8.5. Summary of the potential conditions in the Fitzroy catchment under scenario 3.*

- Weaker policies that favor external interests and result in uncertainty; based on weak individualistic leadership (uncoordinated decisions) and weak Indigenous governance (less Indigenous empowerment and participation) that result in poor planning and management
- Higher demand and investment in development initiatives that maintain natural-cultural landscapes
- Negotiations around development are less fair and take place under unequal conditions
- Decisions are not always evidence-based and monitoring of environmental impacts is limited

- Land use dominated by grazing natural vegetation
- Land and water management, including cattle control and reduced overgrazing does not improve
- Access to country remains limited, including for recreation, subsistence, cultural activities
- Moderate investment in carbon farming using savanna burning (some reduction of fires)
- Moderate increase in the number and extent of conservation areas (14%), with limited joint management with TOs
- Small increase (+10%) in cultural- and nature-based tourism (65% Indigenous)
- No coastal barramundi farms
- Similar level of resource extraction (some impacts)
- Six 1000-ha stand & graze farms (6000 ha) based on groundwater (110 GL, 3.1% of recharge)

Scenario 3 was only assessed in the scenarios team workshop. It received the highest amount of ‘no change’ ratings. This is explained by participants’ comments that this is the closest to a ‘business as usual’ scenario, and that it “seems like where we are heading if nothing changes”. A key feature of this scenario is poor governance and weak policies. Negative ratings may have been associated with participants’ perceptions that weak policies leave things open to contention, and that ultimately “everything comes down to governance”.

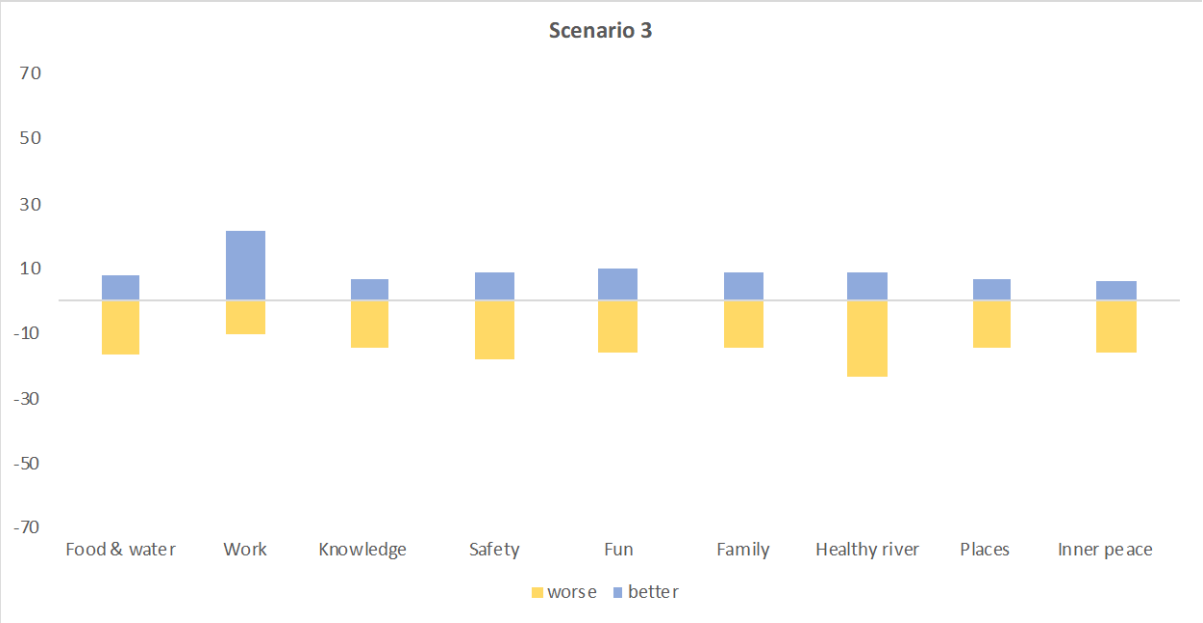
The categories most contributing to wellbeing improvements were ‘satisfying work’ and ‘having fun’ (**Figure 8.8**). However, several participants considered that the region would not achieve its potential for job generation due to poor governance, planning and management. The lack of joint management would likely result in low participation of Aboriginal people in the workforce, and all these factors could lead to unsatisfying work. A participant explained that, for example, some types of jobs may take people so far away from their family that they may be better off not taking those jobs.

The categories most negatively impacted were ‘healthy river country’, ‘safety’ and ‘enough food and water’ (which also received the most ‘no change’ ratings). A participant stated that the health of the river country would be compromised by several factors, such as

“Limited reduction of grazing, limited consultation, low funding for conservation, impacts of water extraction unknown, limited joint management.”

It was perceived that the limited funding to manage threats (e.g. fire, weeds, pests) could affect both the health of the river and feelings of safety. The extraction of water could also impact the health of the river, and the availability of drinking water and food. Further, the limited access to country could result in less access to bushfoods and hinder the traditional uses of the land.

*Figure 8.8. Scenario 3, scenarios team workshop. Sum of the positive (‘better’) and negative (‘worse’) ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021b).*



## *Scenario 4*

Researchers presented an overview of scenario 4, including the broad socioeconomic conditions and main industries (**Box 8.6**). This scenario is based on weak policies that favour interests external to the catchment, and a higher demand and investment in development initiatives that modify natural and cultural landscapes. The **Supplementary Material** includes a map representing one potential configuration of land uses in 2050 and selected indicators describing key features of industries.

*Box 8.6. Summary of the potential conditions in the Fitzroy catchment under scenario 4.*

- Weaker policies that favor external interests and result in uncertainty; based on weak individualistic leadership (uncoordinated decisions) and weak Indigenous governance (less Indigenous empowerment and participation) that result in poor planning and management
- Higher demand and investment in development initiatives that modify natural-cultural landscapes
- Negotiations around development are less fair and take place under unequal conditions
- Decisions are not always evidence-based and monitoring of environmental impacts is limited

- Land use dominated by grazing natural vegetation
- Land and water management, including cattle control and reduced overgrazing does not improve
- Access to country remains limited, including for recreation, subsistence, and cultural activities
- Small-scale investment in carbon farming using savanna burning (little improvement in fire mgmt.)
- Low increase in number and extent of conservation areas (12%), limited joint management with TOs
- Modest increase (+25%) in cultural- and nature-based tourism (65% Indigenous)
- One new small-scale coastal barramundi farm
- High increase of resource extraction (higher impact)
- 6,000 ha of groundwater (110 GL, 3.1% of recharge) and 18,000 ha off-stream (360 GL, 7.3% of median discharge) irrigated Rhodes grass

### Traditional Owners

This scenario had the least participants rating it, and the least positive ratings overall. This could be due to the extensive agricultural development in the catchment portrayed in this scenario, which had already attracted negative ratings in scenario 2, but intensified by the perceptions that TOs would have less power in a weak policy-governance scenario. Another potential issue was that this was the last scenario rated, and the energy levels of participants were low at this stage.

Participants generally commented on the potential to further limit access to country associated with this scenario, and the need for outsiders to be culturally aware and ensure TOs are involved in decision-making. One participant wrote in the rating form the following comment regarding scenario 4:

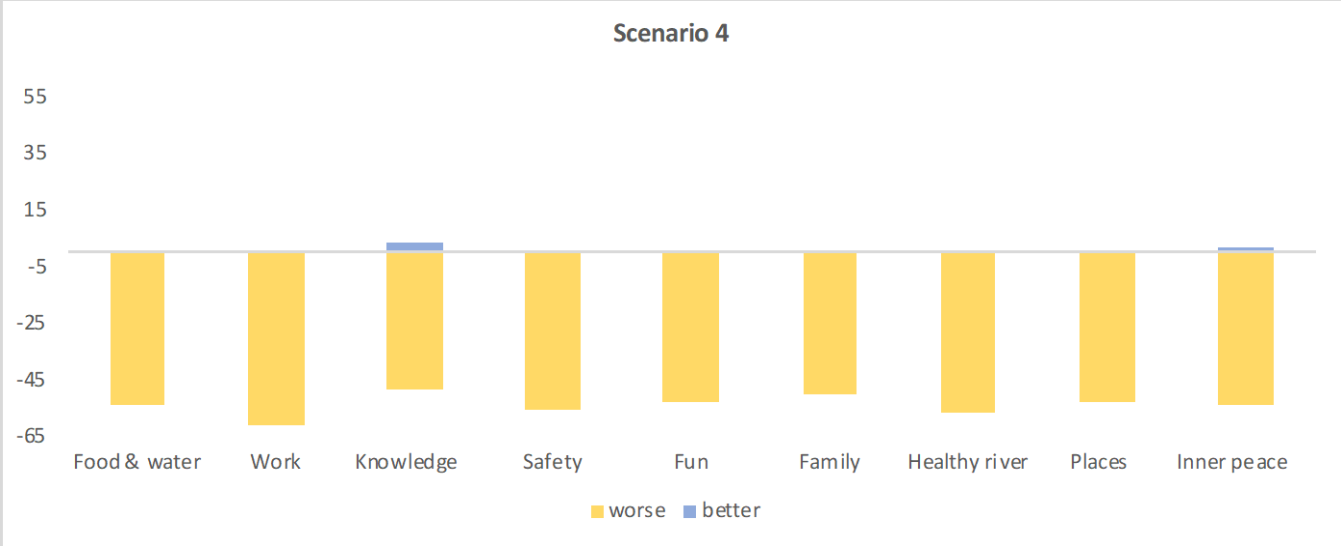
“It will affect from the top of the river catchment along the Fitzroy, also along the rivers from the top, also side coming into the river, it **will** affect the river.” (bold in the original)

The categories where some potential improvement was detected included ‘knowledge of country and culture,’ followed by ‘inner peace, spiritual fulfilment’ (**Figure 8.9**), but note that those categories were rated positively by one participant each. Also, ‘Satisfying work’, ‘strong family and community’ and ‘places and things that make you feel good’ scored 1 point each. However, there were no positive comments registered in association with this scenario.

The wellbeing categories most negatively impacted were ‘satisfying work’, ‘healthy river country’, and ‘safety’ (**Figure 8.9**). Participant’s comments regarding ‘satisfying work’ were mostly related to ranger jobs – that there would be less ranger jobs in this scenario, and questions regarding how many ranger jobs there will be relative to the unemployed population of all communities along the river, and who would get those jobs. Regarding ‘healthy river country, some participants considered that this would be similar to today, while a female thought that if TOs are not allowed to go onto country, then country won’t be healthy. Another female participant stated that:

“If there is poor governance people will have less respect, so there will be more rubbish and no organisation to get it cleaned up. These are the problems that no one can get it together or they will just be fighting about how to fix it. Instead of finding ways to get better or work together.”

*Figure 8.9. Scenario 4, TOs' workshop. Sum of the positive (‘better’) and negative (‘worse’) ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021a).*




There were no significant comments on ‘safety’ and this was also the category with most ‘no change’ ratings, with 2 ratings. Interestingly, all the other ‘no change’ ratings came from the same participant, who scored ‘no change’ in all categories, presumably to state that scenario 4 would have the same effect as today in the wellbeing of TOs in the catchment.

**Multi-stakeholder group**

This scenario had the highest negative ratings. Nevertheless, two participants rated it positively. Some participants considered that scenario 4 is not very different from the current situation:

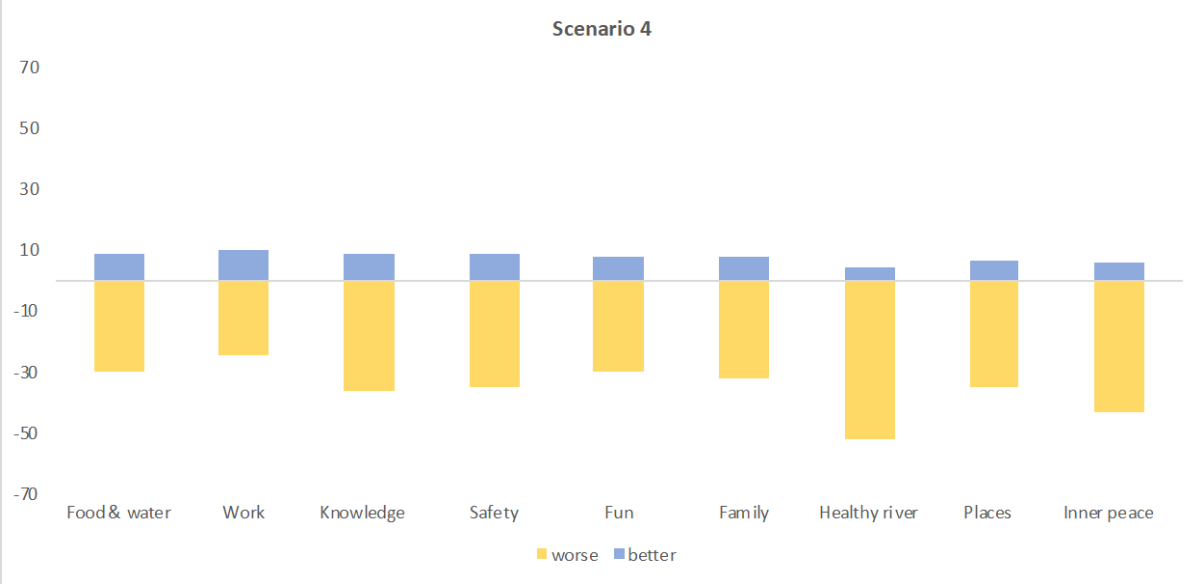
“This is pretty much how we have done things in this country. The people with the money going out and taking what they want.”

Others considered that the scenario portrayed is worse than now, and “not a picture anyone would want to see”.

The categories with the most positive ratings were ‘satisfying work’; and ‘enough food and water’, ‘knowledge of country and culture’, and ‘safety’ (all tied). The most negatively impacted categories were ‘healthy river country’, ‘inner peace, spiritual fulfilment’, and ‘knowledge of country and culture’ (**Figure 8.10**). Some participants considered that poor governance could mean lower emphasis on

ensuring benefits from development are accrued locally, e.g. more 'fly-in-fly-out' workers, jobs for tourists or backpackers, and seasonal jobs. Poor governance would also mean poorer environmental management and regulations, leading, for example, to impacts of chemicals and nutrients into the river. These points could converge, meaning that the local community would bear the consequences of poor environmental management, lack of regulations and compliance on food security and water quality. However, the industries causing those issues would not necessarily benefit the local community.

*Figure 8.10. Scenario 4, scenarios team workshop. Sum of the positive ('better') and negative ('worse') ratings per wellbeing category. Comparisons are with the current situation. Source: Kiatkoski Kim et al. (2021b).*




## 8.5. Discussion

### *8.5.1. Assessing future changes on the wellbeing of different social groups*

The workshops successfully achieved all goals. Nevertheless, there were several areas of improvement suggested by participants in regard to the use of the wellbeing categories (see **Supplementary Material**). Overall, this workshop was an important step towards developing a way to assess future changes on the wellbeing of different social groups. Importantly, it allows identifying which areas of people's wellbeing can be more/less affected (either positively or negatively) under different scenarios. This is important to allow a more nuanced assessment of the potential trade-offs associated with ongoing land/water use decisions. Another key lesson is that having a common language around wellbeing that allows for discussions between different groups interested in the Fitzroy catchment is critical and can facilitate discussions and negotiations regarding ongoing and future planning. Moreover, most participants liked the fact that conversations went beyond the potential of new jobs and monetary benefits towards understanding how future development can affect various aspects of wellbeing.

This indicates the importance of undertaking more comprehensive assessments (like the one developed under this project) to facilitate meaningful discussions and negotiations around land and water use in the catchment (including as part of the ongoing planning initiatives). This way to talk about what could happen in the future and how it affects people's wellbeing may assist organisations and individuals to discuss important matters that could be affected by future land- and water-use decisions. Last, we recommend that future research could explore aspirational scenarios since there seemed to be an interest in that approach to future scenario development by workshop participants.

### *8.5.2. Developing a common language and shared knowledge around wellbeing*

The workshop achieved the goal of developing a framework that allowed participants from different cultures and representing different interests to discuss the potential changes in wellbeing associated

with alternative futures for the catchment. Overall, participants were able to relate to most wellbeing categories. They were comfortable in using these categories to discuss key aspects of wellbeing and in using them to assess the effects of future scenarios. Based on participants' quantitative assessments of the scenarios, the different categories of wellbeing are all positively or negatively affected by change, and, on that basis and the group evaluation, are relevant. During the initial discussions on the current situation in the catchment and on how people satisfy the wellbeing categories, items have been allocated to categories in a way that is largely consistent with the definitions. The workshop produced a very comprehensive set of data that encompasses not only ways in which wellbeing is fulfilled, but also some of the major concerns of the group. Based on participants' ratings of the scenarios, the different categories of wellbeing are all positively or negatively affected by change, and, on that basis and the group evaluation, are relevant. However, the quantitative assessments highlighted 'healthy river country' and 'knowledge of culture and country' as those categories of wellbeing that contribute most to the assessment of change in this region. In the TOs' workshop, inner peace-spiritual fulfilment' was also a prominent category, as 'satisfying work' was in the scenarios team workshop.

In contrast to the quantitative outputs, group discussions of the current situation in the catchment suggested that 'having fun' and 'places and things that make you feel good' (aesthetics) are not seen as important to TOs' workshop participants, at least in the form presented. This almost certainly reflects the need to further rework the categories to ensure they are more culturally appropriate. Despite this, it should be noted that the quantitative results show that these categories had similar 'weight' in the scenario analyses to many other categories. Participants scored them highly (either positive or negatively), which mean that they may contribute significantly to the wellbeing of the groups they were thinking of when assessing the scenarios. Another interesting point is that 'spiritual fulfilment/inner peace' may be seen by participants more as a summary statement, i.e. affected, to some extent, by all the other wellbeing categories. Additionally, some participants suggested, during the workshop evaluation, that there were important aspects of wellbeing not covered, such as holistic relationships with nature and customary law (see **Supplementary Material**).

As noted in the **Supplementary Material**, matters such as customary law and skin/totem relationships are part of the broader conceptual framework that includes the wellbeing categories. For example, customary law can be treated as 'principles' (ethical properties of human behaviour) that instrumentally contribute to human wellbeing (see Wallace et al. 2020). Nevertheless, the evaluation highlight important points in that aspects of wellbeing, particularly the role of principles-customary law and overall system relationships, were not sufficiently covered. This reflects the need for application of the full framework, which would have required additional resources. To do this would also require consultation to ensure categories and concepts are culturally appropriate. Other issues, like poverty, housing and water quality should, with more detailed investigation, readily map to one or more of the wellbeing categories. Also these, and 'threatening processes', would be considered fully under a broader planning process (e.g. Wallace 2012), but were outside of the scope of the assessment of scenarios.

Also in the TOs' workshop there were important cross-cutting themes revealed when participants discussed the holistic nature of Aboriginal wellbeing in regards to how it is currently satisfied within the catchment (**Supplementary Material**). Some of these relate to threats/problems, such as issues surrounding illegally locked gates that denied access to native title lands, and trust among various groups; but other themes are of a higher order. For example, being on and looking after country, maintaining culture including language, and maintaining knowledge and related activities. Although in all cultures a single activity may contribute towards a number of wellbeing categories, for the TOs, the threads of wellbeing seem more tightly integrated with country, both within and across lives.

The **Supplementary Material** includes the range of participants' comments on the wellbeing categories that are generally supportive of the approach used, plus a number of suggestions to improve the method. A number of the suggestions, e.g. those relating to the capitals (particularly financial), and physical and mental health, would be clarified with a more complete set of definitions and more time to explain the complete systems approach that underlies the wellbeing classification used in the methodology. The detailed participant comments also capture important cross-cutting themes concerning relationships to country and culture, including issues such as solastalgia.

Solastalgia describes a form of emotional or existential distress caused by environmental change impacting on people while they are directly connected to their home environment (Albrecht et al., 2007). It can be described as the lived experience of negatively perceived environmental change. Aboriginal Australians feel particularly distressed by such changes (Williamson et al., 2020).

### *8.5.3. Participants views on changes in wellbeing under alternative scenarios*

The workshops achieved the goal of assessing changes in wellbeing associated with future scenarios. Most scenarios were assessed – minus scenarios 1b and 3 in the TOs' workshop. Scenario 4, the last one, was assessed by less people. Participants' ratings followed a broadly similar pattern in both workshops, with scenarios 1, 1b and 2 (strong policies) being rated positively by the majority of participants across most categories, and scenarios 3 and 4 (weak policies) being rated mostly negatively. There were a few exceptions to these patterns (**Figure 6.2**).

In the TOs' workshop, the negative ratings seem to be linked with an aversion to large-scale irrigated agriculture and its perceived potential impacts, especially the withdrawal of water (mainly from the river but also groundwater) and pollution. Another important cross-cutting theme, also considered as a potential impact of large-scale agriculture, was the loss of access to country, which seemed to impact particularly 'inner peace and spiritual fulfilment', as well as other aspects of wellbeing. 'Knowledge of country and culture' seemed to improve in scenarios 1 and 2 (and 3, but it was rated positively by only one participant), being mostly related to an increase in ranger jobs, and to better access to country in scenario 1. 'Satisfying work' was also positively assessed in scenarios 1 and 2, mainly due to an increase in ranger jobs and the potential for Aboriginal owned enterprises. However, participants emphasised that these jobs and enterprises could only be fulfilled by TOs, and thus be considered as satisfactory, if there were training initiatives in place to build TO's capacity. Likewise, 'satisfying work' was the most negatively affected category in scenario 4 due to limited ranger jobs and uncertainty regarding who would be able to fulfil those vacancies.

In the scenarios team workshop, participants emphasised the importance of good governance, strong policies, and regulation of economic activities so that residents can benefit from such activities. Conversely, in weak-policy scenarios there could be negative social and environmental impacts that would affect residents and communities; and the eventual economic benefits could be reaped by a few locals, or by non-residents (e.g. temporary workers and corporations). 'Satisfying work' improved in all scenarios, but especially in scenarios 1, 1b and 2; and 'knowledge of country and culture' improved in scenarios 1 and 1b, possibly linked to improved access to country and employment that could allow people to spend time on country. Conversely, 'healthy river country' worsened in scenarios 2, 3 and 4, possibly linked to the larger potential expansion of irrigated agriculture and associated potential impacts from, for example, the extraction of water and the use of pesticides.

## 8.6. Conclusion

Whilst we emphasise results cannot be generalised as a representative sample of TOs in the catchment, they provide an indication of key aspects of wellbeing that could be affected (positively or negatively) under alternative development scenarios and their associated changes in land and water uses. The assessment thus provides valuable information for Traditional Owners, pastoralists, government agencies, and other organisations with interests in the future of the region to identify key aspects that need further discussion and consideration during ongoing and future land and water use planning initiatives. In this sense, we encourage research partners to build on the proposed assessment approach and results to further explore these aspects. Additionally, groups and organisations can use the broad structure of scenarios to create alternative scenarios (e.g. as part of aspirational planning led by interested organisations) and include other development initiatives (e.g. bush foods, service and retail, and renewable energy), which we were unable to incorporate due to data and time constraints.

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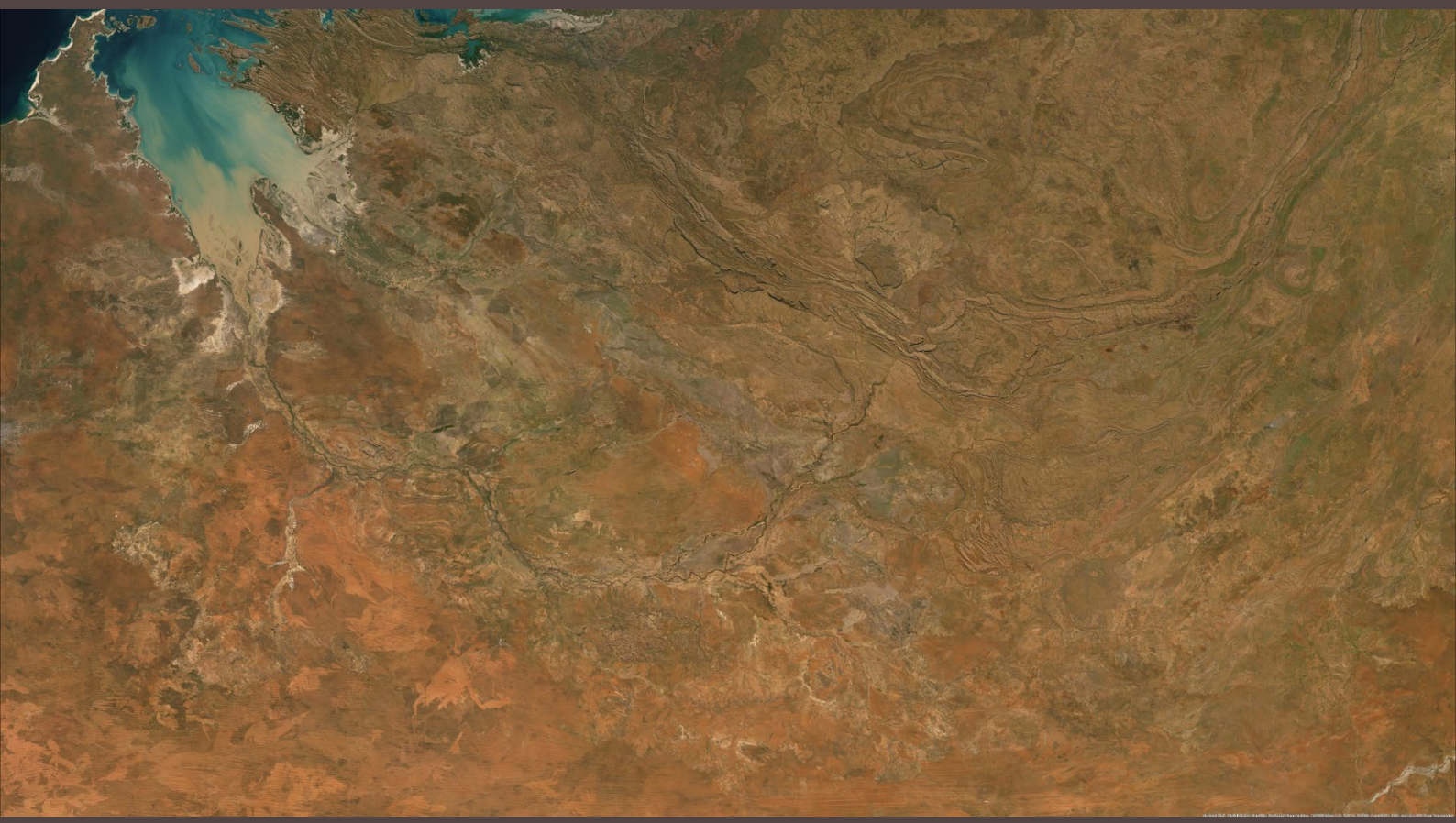

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