Resilient Landscapes

National Environmental Science Program

Supporting knowledge sharing, natural resource management and regional planning: identifying similar regions through integrated data analysis

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Cover photograph

Sunset from Mt Tibrogargan, Glass House Mountains, Australia. Photo: Martin Valigursky.

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Acknowledgement of Country

We acknowledge the Traditional Owners of Country throughout Australia and their continuing connection to and stewardship of land, sea and community. We pay our respects to them and their cultures and to their Ancestors, Elders and future leaders.

Our Indigenous research partnerships are a valued and respected component of National Environmental Science Program research.

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Acknowledgements

This project is supported with funding from the Australian Government under the National Environmental Science Program's Resilient Landscapes Hub.

Executive summary

Funding for environmental research and on-ground action, such as restoration, is limited. Likewise, there are limited resources available to support the development of regional-scale plans for on-ground action. To achieve the greatest outcomes (such as knowledge gains and, ultimately, protection of ecosystems and biodiversity), the funds allocated to research, planning and on-ground environmental action must be spent cost-effectively. This means being able to translate knowledge across regions in sensible ways to use the available evidence to build the most impactful environmental programs.

This project focused on 2 different types of regions: natural resource management (NRM) regions and Interim Biogeographic Regionalisation for Australia (IBRA) sub-regions. Bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features, and plant and animal communities. Thus, they are useful regional units for this analysis, as they already capture many underlying characteristics critical for environmental management and planning. Bioregional boundaries are also used for many environmental decisions and are used to track progress for building a comprehensive, adequate and representative reserve network (based on the National Reserve Strategy). NRM boundaries are jurisdictional boundaries marking the areas for which NRM bodies are tasked with strategic planning and supporting management of natural resources. NRM bodies also contribute to water-planning processes, particularly in Victoria, New South Wales, South Australia and Queensland. Thus, NRM and IBRA regional units were nominated by decision-makers as the essential regional units to consider.

Our work generates insights that can be used by natural resource managers to consider the extent to which knowledge gleaned in one NRM or IBRA region can be transferred to another region. Such knowledge might include what type of planning and decision-making is most suited to a particular problem, scientific evidence from NESP research (e.g. the most effective method of controlling cats) or observed successes from NRM work by on-ground managers (e.g. whether a restoration effort successful). Given that NRM outcomes are noted to be frequently context-dependent based on both social and ecological factors, being able to ‘match’ regions that have shared context enables managers to more carefully consider what knowledge or evidence transfers to their context and to inform their planning and implementation of NRM efforts.

Importantly, we capture our results with simple-to-interpret mapped regions that share social and ecological attributes and thus are likely to support similar interventions (Figure 1) as well as regions that share attributes best matched to a particular planning approach (Figure 2). This fundamentally allows natural resource managers to identify and share knowledge with their peers in regions with similar characteristics and provides opportunities for collaboration that would otherwise have been unavailable. This mutually improves conservation outcomes and creates the potential to scale up interventions by expanding across multiple regions.

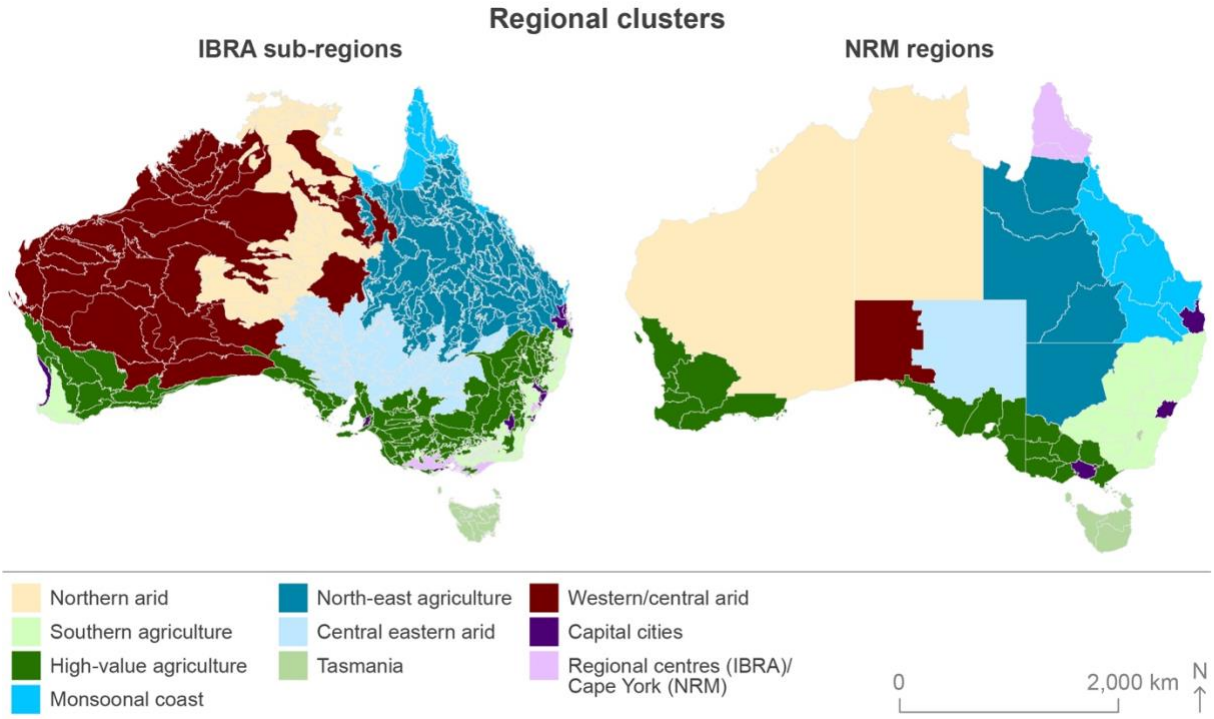

Figure 1. Regional clusters that are similar to each other. IBRA sub-regions (214 variables, 10 clusters); NRM regions (270 variables, 10 clusters).

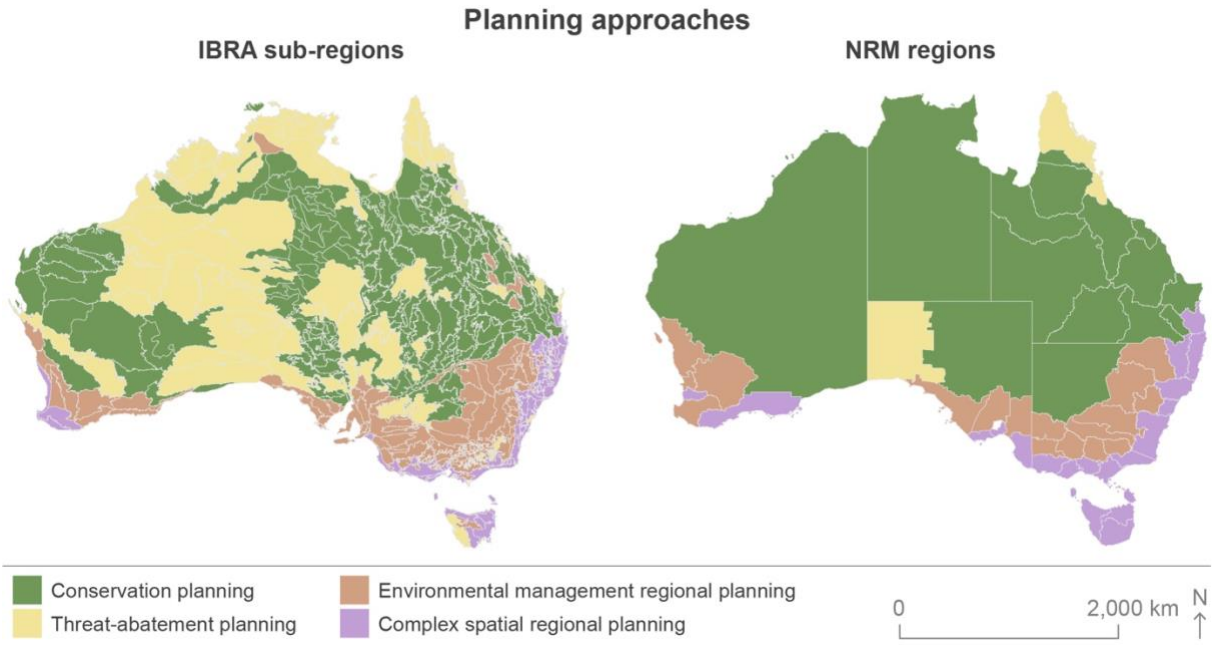

Figure 2. Planning groups that have shared traits based on the regional-planning decision tree.

We also generated tables that describe core social, ecological and interactive variables for different regional clusters. These summaries are intended to support natural resource managers who want to identify similar regions but who feel that their particular sub-region or location is somewhat ‘unique’ to the rest of their cluster. For example, they may be working in a mangrove pocket that sits within a large cluster that is mostly grasslands. The tables can be used to identify clusters that have characteristics that more closely match their ‘unique’

location – thus linking to potentially more relevant peers with whom to share knowledge and scale up interventions.

Our datasets do not include detailed descriptors of the marine/coastal environment, underground aquifers or stream flows, but managers who are responsible for coastal and marine systems will still find the existing material useful, given the need for them to understand the systems (including the people) that impact coastal and marine environments. For these managers, matching regions will help identify similar coastal areas that could benefit from shared knowledge about land use or shared practices for behaviour change to improve coastal environments. Similarly, our dataset could identify regions that share social and environmental characteristics relevant to water use and planning – since people and, in particular, their land uses, must be considered. Moreover, it could be possible to build upon this work by adding more freshwater and marine data and to use approaches like those used here, to re-analyse using different regional boundaries.

Outcomes and outputs

We created 2 datasets to use in identifying regions that are similar. The first describes each of Australia's 56 NRM regions and the other describes each of 419 IBRA sub-regions. The datasets considered a total of 424 variables to compare similarities between regions. These variables reflect relevant human (e.g. household characteristics), socio-economic (e.g. economic sector, employment statistics, landuse), and ecological data (e.g. vegetation types, surface water extent) that are available at a national scale. Our analysis of the type of data collected suggests that both integrated databases provide sufficient information across a range of social and ecological/natural indicators to describe and characterise different regions using consistent measures across the continent. Although the IBRA dataset does not contain as much information as the NRM dataset, it does contain information about the human/social system, the natural/environmental system and interactions between the 2 systems.

We used the data to identify regions that are similar, generating maps which visualise the findings, tables that list the regions that cluster together, and tables that describe core social, ecological and interactive variables for different regional clusters. One must always be cautious if aiming to generalise findings/outcomes from studies or programs that have been undertaken at just one or 2 locations. But findings/outcomes are more likely to be generalisable across areas that are similar. These maps (and tables) thus allow people to, for example, look for their region – or other regions (e.g. priority places, protected areas) – and identify other regions that are similar. Managers can then look to these similar regions for transferable insights – for example, what land-management practices may be adopted or adapted from similar regions, knowledge of conservation outcomes that can be in those practices, and opportunities to collaborate with other regions to scale-up interventions.

Using the data for each region, **we also tested a decision tree to support managers** (Figure 3) to match their region (based on observable and summarised characteristics) to appropriate planning approaches. We explore the extent to which these groups of regions matched to particular planning approaches reflect the plans currently in play for these regions, and how these groupings of regions also relate to our socioeconomic clusters

above. While we tested the decision tree for terrestrial regional planning, we note that the underlying planning theory and types are the same as those used in the marine environment. Thus, the decision tree can be used by both marine and terrestrial managers for matching their planning approaches to the planning context. Similarly, our regional data – particularly for coastal regions – can be used by marine planners who need to consider the social characteristics of their marine users who reside within the coastal zone.

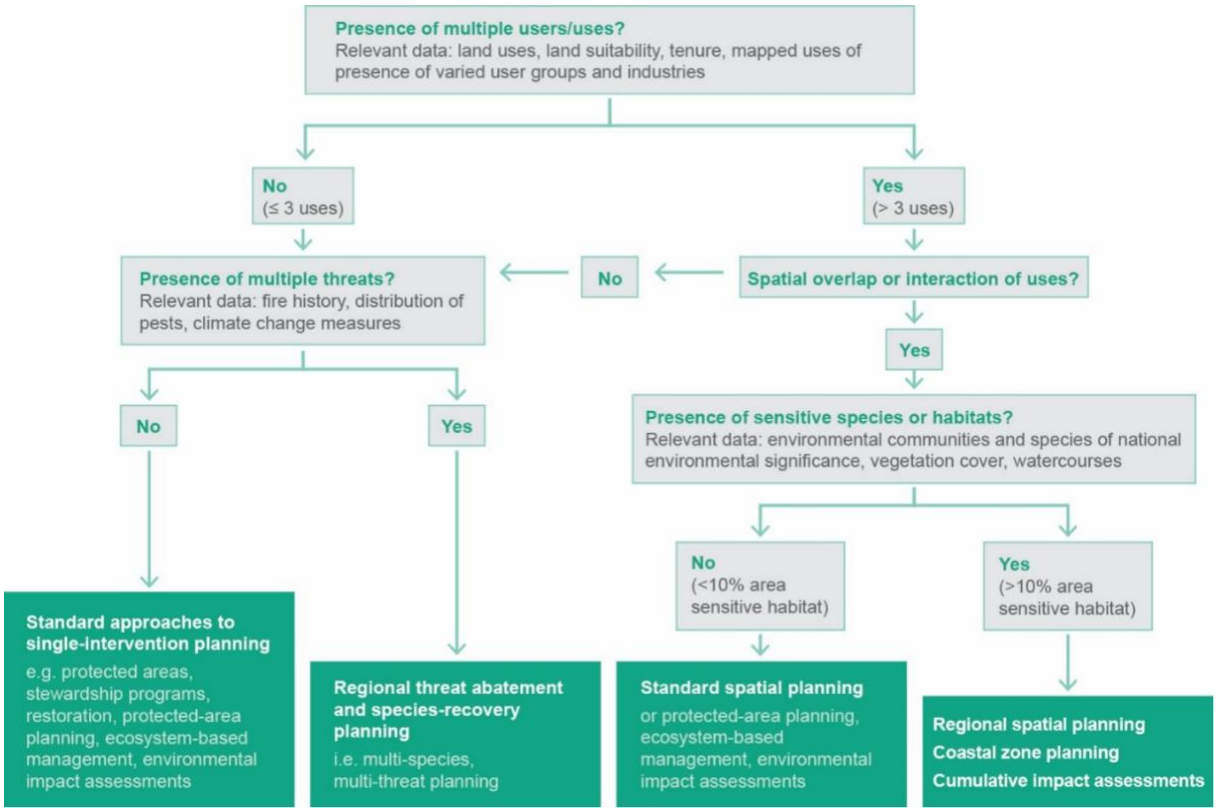

Figure 3. Regional-planning decision tree.

To produce these outputs, our analysis was undertaken in steps.

1) We added data relevant to climate and threatened species to an existing integrated **dataset**, assembled in the National Environmental Science Program's (NESP's) Resilient Landscapes Hub (RLH) **Socioeconomic insights for resilient landscapes** project, including basic environmental, social and economic attributes (e.g. land cover, land clearing, vegetation type, species, population characteristics, household income) (Section 2.2.1). We redressed the problem that arises when different agencies collect data at different geographic scales by writing bespoke algorithms within a GIS (geographic information system) to 'convert' data that had been collected at one geographic scale into indicators that could be used at other scales – ensuring consistent measures across the continent (Section 2.2.1).

   Our dataset includes variables and data collated from 33 data providers, of which 4 had multiple versions we accessed to compile data at 2 time-steps (2016, 2021), resulting in 37 unique data sources. It also included 2 time-steps for 6 datasets: census data, households, lower-house and upper-house elections, vegetation, and habitat condition.

From these, we calculated 7 change variables. The regional databases (IBRA and NRM) contain a total of 424 variables, although not all variables could be populated for some of the remote IBRA sub-regions. Drawing from the most recent time step (2021), we removed hierarchical data structures and considered only data that was complete for all regions we had available for our analysis. This resulted in the following.

- The NRM dataset provides information on 63 NRM regions. Omitting island NRM regions for which we do not have data, the dataset provides complete information on 56 regions using 270 variables.
- The IBRA dataset provides information on 419 IBRA sub-regions. Many of those regions had numerous variables for which data were 'missing' – mostly in rural/regional areas where data from the Household, Income and Labour market dynamics (HILDA) project are not generally collected. If we omit the variables that do not have data in rural/regional areas, we can describe 409 IBRA sub-regions using 214 variables – these are a subset of the larger group of variables that are available for NRM regions.[1] If we, instead, omit regions that have many missing datapoints, we can fully describe 268 IBRA sub-regions using the single-observation variables that are available for NRM regions.[2]

2) We described and analysed the variables contained within the dataset (Section 2.2.2) to ensure there was sufficient breadth and depth to adequately characterise regions. We did this by categorising the variables, according to:

   - whether they described the extent/condition or changes in the 'natural' (physical or biological) system or the 'human' (social or economic) system, or whether they instead described an interaction between the systems (see Table 2)
   - the people/segment of society that is described, where applicable (see Table 3)
   - temporal availability – specifically, whether the data that underpin core variables is a single or repeat measure, and if a repeat measure, how frequently data are updated.

   We looked for data gaps, noting the extent to which there was sufficient information across all parts of the system (social, natural and interactions between them). We concluded that while it is always possible to add more data, the set that we compiled provides a balanced look at social and ecological variables that are relevant to environmental and natural resource managers (Section 3.1, see also Appendix B for a full list of variables and the categories used in the assessment).

3) We used hierarchical cluster analysis to identify groups of regions that were 'similar' to one another – Section 2.3.1 (methods) and Section 3.2.1 (results). We did this once for the NRM regions and once for the IBRA sub-regions. Noted above, data limitations in remote areas meant that we did not have data for all variables for all IBRA sub-regions. We thus had to choose between using fewer variables to describe all IBRA sub-regions or using the full set of variables to describe only a subset of IBRA sub-regions. We chose the former (formally, 'variable-wise deletion') to ensure that our results/maps provided information across most of the continent. We also undertook some analysis using the full set of variables, with fewer regions (formally, 'list-wise deletion'), providing results in the

[1] In the statistical analysis, this is called 'variable-wise' deletion.
[2] In the statistical analysis, this is called 'list-wise' (or case-wise) deletion.

appendices. We used 2 common statistical techniques for determining the optimal number of clusters: ‘silhouette’ analysis (Rousseeuw 1987) and the ‘elbow’ method, but we did not only focus on the statistically optimal number of clusters. Instead, we looked out how regions grouped together if dividing them into different numbers of groups. First, we looked to see which regions were ‘similar’ to each other if only dividing them into 2 (large) groups. We then looked to see how the regions grouped if dividing them into 3 groups, then 4, then 5, up to a maximum of 10. We chose this range because it included the optimal number of clusters identified through the statistical analysis. We generated maps that show the results of these analyses (18 in total – 2 different regions [NRM regions and IBRA sub-regions] and 9 different numbers of clusters).

4) We used the spearman rank correlation coefficient to identify core variables that determine the cluster membership – Section 2.3.2 (methods) and Section 3.2.2 (results) and then summarised the mean values of those variables across clusters – effectively describing the clusters (Section 3.2.3).

We developed a decision tree to support regional planners in rapidly assessing the socioeconomic and environmental context of their region and matching that to relevant planning approaches (Section 2.4). We populated the decision tree with data from our data compilation and then validated the decision-tree outputs by comparing the regional-planning approach assignments to the types of planning approaches currently employed in NRM and IBRA regions (Section 3.3).

1. Introduction

The overarching aims of this work were to generate information to:

- help decision-makers identify ‘similar’ regions – reasoning that it may be possible to amplify the impact and relevance of place-based work by sharing knowledge with other ‘similar’ places/regions (e.g. transferring findings from research or lessons from on-ground work that has been undertaken in one place/region)
- identify areas that are most suited or least suited to different regional-planning approaches.

The term 'regional planning’ is frequently used to describe numerous different ‘planning’ approaches which include: planning for protected areas, stewardship programs, restoration, ecosystem-based management, environmental impact assessments, regional threat abatement planning (multi-species, multi-threat), standard spatial planning, regional land-use planning, coastal-zone planning and cumulative-impact assessments. Their utility as tools to support and protect biodiversity is evident and there have been explicit calls for regional approaches to planning in the review of the Australian *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) – with recent investments by the Australian Department of Climate Change, Energy, the Environment and Water (DCCEEW) in a pilot trial of regional planning, and by the NESP RLH in one of the newly proposed projects associated with the ‘Threatened and migratory species and threatened ecological communities’ cross-cutting research initiative.

However, the amount of funding available for environmental research and on-ground action, such as restoration, is limited. Likewise, there are limited resources available to support the development of regional-scale plans for on-ground action. To achieve the greatest outcomes (such as knowledge gains and, ultimately, protection of ecosystems and biodiversity), the funds allocated to research, planning and on-ground environmental action must be spent cost-effectively. This means being able to translate knowledge across regions in sensible ways to use the available evidence to build the most impactful environmental programs.

Understanding and matching areas that share similar attributes allows for translation of research findings from one place to others that are similar. Likewise, understanding regions allows for the selection of planning approaches that meet, but do not exceed, contextual needs and thus avoids either expending scarce resources on unnecessarily complex plans or, conversely, implementing approaches that are under-resourced and likely inadequate, unsuitable or insufficient.

The first step in addressing this is to understand the attributes of regions based on the data available. The project built upon a nation-wide assemblage of data, comprising 121 datasets describing the ecological (natural) system, the human (social) system and interactions between them, and the associated framework/decision tree for thinking about appropriate regional-planning approaches for different contexts (NESP RLH project 1.4: **Socioeconomic insights for resilient landscapes**). We expanded this dataset to consider multiple time steps where data has been collected in a standard way (e.g. vegetation cover, census data)

and to include further ecological values (e.g. water assets) and threats to ecological values where possible. We then used this data to consider 2 key questions.

- Which regions are similar (sharing key attributes) to each other or to other (priority) places? This allows researchers to ensure transferability and scalability of findings. Equally it allows practitioners to search for areas that look and feel like ‘their’ regions to facilitate connections and the sharing of knowledge, between similar parts of Australia.
- What regional-planning approaches are most suited to or most needed in a particular region as a function of observable data signals captured in our dataset (e.g. presence of multiple, possibly competing land uses, threatening processes or conservation measures in place to address threats, and ecosystems and species that might need management)?

In answering question one, we consider how to use existing data to match regions, taking and natural values into account. We discuss how these regionalisations might be used.

To answer the second question, we use the dataset and planning theory to explore which regions are most suited to particular planning contexts. In the planning literature, there are a range of regional-planning approaches that are distinguished by the planning and policy context in which they are deployed. This influences the purpose or objectives of their approach and therefore their statutory obligations and how they are implemented. As a starting point, we review key planning approaches and summarise, by definition, the question the approach is designed to solve, key attributes and available tools for common regional-planning approaches (Table 1).

Table 1. Summary of planning approaches, including rough decadal emergence of approach, discipline, definition and management question it seeks to address.

Planning approach	Date	Discipline	Definition	Question designed to address
Regional land-use planning	1960s	Planning	Regional land-use and development planning considers the spatial placement for future land uses at a regional scale (and often in the peri-urban to rural zone, differentiating from urban planning). Historically focused on zoning overlays but in contemporary application has considered optimal allocaiton of uses given both benefits and costs.	What is the best allocation and configuration of land uses now and into the future?
Environmental-impact assessment (EIA)	1960s	Environmental management/planning	Process of evaluating the likely environmental impacts of a proposed project or development, taking into account interactions (positive and negative) across environmental values (highly place specific and asset specific).	Should a planned project proceed, taking into account environmental impacts, and what constraints should be placed on the development to manage impacts?
Systematic conservation planning	1980s	Conservation planning	Spatial-planning approach for designing networks of protected areas (or other single conservation interventions such as restoration) that meet explicit objectives and associated conservation targets.	What areas should be prioritised for conservation?
Ecosystem-based management	2000s	Conservation planning/environmental management	Holistic approach to environmental management and conservation planning, taking into account connections across ecosystems and uses but often remaining asset-specific in considerations (primary extension from EIA being consideration of broader connections).	Planning for environmental and development outcomes taking into account the interconnections between humans and ecosystems?
Marine spatial planning	2010s	Marine planning and management	Marine spatial planning takes the principles of land-use planning and applies them to the marine environment, aiming to zone the marine environment to indicate allowable uses or activities in particular areas (an extension of land-based regional planning to the marine environment).	What is the best allocation and configuration of uses in the sea now and into the future?
Coastal-zone planning	2010s	Planning	Coastal-zone planning is a particular case of regional planning in which considerations of the particulars of the coastal zone and the connections from land to sea are taken into account.	What is the best allocation and configuration of land and sea uses now and into the future?
Cumulative impact assessment	2010s	Environmental management/planning	Extends standard EIA to account for cumulative impacts across projects and across domains/values.	Should planned project(s) proceed, taking into account complex cumulative interactions and impacts across projects and accounting for multiple values?
Multiple species/multiple threat abatement planning	2010s	Conservation planning	Spatial conservation planning that seeks to assign specific sets of management actions to places to maximise conservation outcomes for a suite of species.	Where should we prioritise management actions for threatened species?

The most recent developments in regional planning (since the 2010s) have focused on increasing levels of complexity in the definition of environmental-management problems as well as the type of tools applied. For example, spatial regional planning is an extension of historic regional land-use planning which would apply zoning overlays to indicate the types of uses appropriate for an area given social and environmental constraints. Recent applications seek to optimise single uses to areas (rather than a flexible zoning which recommends a range of uses). Similarly, cumulative-impact assessment expands upon environmental-impact assessment, which considers single places and single developments, to incorporate multiple interacting uses or developments and their spatial connections which may be diffuse over large spatial scales. These applications thus require increased data inputs and improved understanding of natural and social systems and how they interact. While some regions are characterised by many competing uses and users, and thus likely require more complex planning tools to support good decision-making, many regions will not require these tools. Given the additional investment in data and technical support to deploy such planning approaches, selecting when to use them is critical to avoid unnecessary planning investment. But likewise, in complex planning environments, not spotting the need for additional technical support can compromise the planning outputs, so it can be useful to have a prior sense of needing highly technical planning approaches to deliver on planning objectives.

This report focuses on providing guidance to decision-makers to better understand the characteristics of regions that define this complexity and thus which regions ‘match’ to better scale lessons learned across regions (by using our regionalisation outputs which match regions based on data attributes) as well as choosing the appropriate type of planning to match that context (which matches regions to planning approaches using theory and our dataset).

2. Methods

2.1 Overview

We focused on 2 different types of regions: NRM regions and IBRA sub-regions. Our choice of regional units based on discussions held with relevant decision-makers.

Our analysis was undertaken in steps.

- We added data relevant to climate and threatened species to an existing integrated **dataset**, assembled in the NESP RLH **Socioeconomic insights for resilient landscapes** project, including basic environmental, social and economic attributes (e.g. land cover, surface water extent, land clearing, vegetation type, species, population characteristics, household income) (Section 2.2.1).
- We used GIS to create a dataset that provides 270 descriptors relating the socioeconomic and biophysical characteristics of different regions (Section 2.2.1).
- We described the variables contained within the dataset (Section 2.2.2 and Section 3.1) to ensure there was sufficient breadth and depth to adequately characterise regions and to identify knowledge/data gaps.
- We analysed the integrated regional datasets to identify groups of regions that share 'similar' social and/or ecological characteristics (Section 2.3 [methods] and Section 3.2 [results]).
- We identified core variables driving cluster membership and focused on these variables to describe the social and ecological characteristics of regional clusters (Section 2.3.2 [methods] and Section 3.2.2 [results]).
- We generated maps to show regions that are similar (the clusters) (Section 3.2.2) and produced tables of descriptive statistics (focusing only on core drivers of cluster membership) to describe the characteristics of the 'clusters' (Section 3.2.3).
- We created a decision tree designed to capture key decision points for a manager defining a planning problem and the planning region (Section 2.4). The decision tree allows the manager to navigate these definition points to match their region and planning problem to relevant regional-planning approaches.
- We populated the decision-tree data and key thresholds based on the characteristics of the NRM and IBRA planning clusters to identify regions most/least suited to different types of planning (Section 3.3). We validated the decision-tree outputs with a desktop review of existing NRM plans and the approaches they used.

2.2 Construction and assessment of integrated dataset

2.2.1 Collation of data and construction of dataset

The NESP RLH project **Socioeconomic insights for resilient landscapes** had assembled **data** relating to a broad range of environmental, social and economic attributes (e.g. land cover, land clearing, vegetation type, species, population characteristics, household income). The dataset also included core variables of conservation interest (e.g. plant species richness, EPBC-listed species richness).

We updated the dataset to include the most recent Australian Bureau of Statistics (ABS) census data and land-cover data, and computed changes in these variables across the 2 time-steps (2016, 2021). We also added variables that describe climate (for temperature and precipitation), fire (calculated as fire frequency), variables relating to water availability (proportion of region that has surface water, number of bores, maximum wet-surface areas between 1987 and 2020), habitat condition (a good proxy of over-grazing and other impacts on land resources), overexploitation and variables from the Household, Income and Labour Dynamics in Australia (HILDA) survey dataset.[3] The subset of variables we used from the HILDA data are those focusing on responses to questions that describe a range of variables known to describe or influence the way in which people interact with the environment (e.g. health, financial stress, social/institutional capital), their wellbeing/life-satisfaction and whether the individuals had been impacted by a weather disaster within the previous 12 months. Including the data sourced during the previous project, we found 37 unique datasets that provided data across the entire continent.

The data had been compiled by numerous different agencies, often using different geographic scales. We redressed the problem that arises when different agencies collect data at different geographic scales by writing bespoke algorithms within a GIS to 'convert' data that had been collected at one geographic scale into indicators that could be used at other scales, ensuring consistent measures across the continent. We used those algorithms to create 2 different integrated datasets pertaining to 2 different, non-nested, geographic regions: one describing each of Australia's 56 NRM regions and the other describing each of the 409 IBRA sub-regions (excluding island sub-regions where spatial data does not have coverage).

This resulted in data collated for 2 regional boundaries (NRM and IBRA), with data from 37 additional datasets. Six of these were repeat measures from 2016 and 2021. For each regional data summary, there are 423 unique data variables collated by region from 37 datasets. When considering only the most recent time step of 2021 and removing hierarchical data structures, we had 270 unique variables for NRM regions and 214 for IBRA sub-regions. See Appendix A for a complete list and Stoeckl et al. 2023 data record for full datasets.

2.2.2 Describing and assessing the utility of the dataset

We categorised the variables according to:

- whether they described the extent/condition or changes in the social system, the ecological system, or whether they instead described an interaction between 2 sub-systems (see Table 2 to understand the principles used to guide this categorisation)
- the people/segment of society that is described, where applicable (see Table 3 to understand the principles used to guide this categorisation)

[3] This dataset uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, RESTRICTED RELEASE 20 (Waves 1–20) conducted by the Australian Government Department of Social Services (DSS). The findings and views reported in our spatial dataset and report, however, are those of the authors and should not be attributed to the Australian Government, DSS, or any of DSS's contractors or partners. DOI: 10.26193/YP7MNU, ADA Dataverse. Pursuant to the license terms for the restricted release data, we have only summarised to NRM regions. IBRA sub-regions are at a scale smaller than postcode for some states and thus cannot be summarised or reported, as the dataset is not representative at this level.

- temporal availability – specifically, whether the data that underpin core variables is a single or repeat measure and, if a repeat measure, how frequently data are updated.

Appendix B provides a complete listing of the variables within the dataset and the categories into which we assigned them. We used that categorisation to consider what types of environmental-management problems publicly available datasets are equipped to inform and what additional data or analytics are required to inform other problems. We specifically looked for data gaps, noting the extent to which there was sufficient information across all parts of the system (social/human, natural/ecological and interactions between) to adequately 'describe' regions and to use techniques such as clustering to identify 'similar' regions.

Table 2. General descriptions and principles used to describe interactions. Variables described in the Appendix but not included in this table were considered to focus entirely on either the ecological or the social system.

General description of variables and interactions	Interaction symbol
Land uses for industry[4] (multiple types of agriculture, manufacturing/industrial, services, utilities, transport/communication) were considered to describe a 2-way interaction between the social (S) and ecological (E) systems. So, too, were variables describing the number of people working in nature-based industries, the number of bores, or variables flagging land set aside for reservoirs/dams, aqueducts and mines, and variables describing the adaptive capacity, coping capacity and disaster resilience of communities.	S ↔ E
Indicators of grazing impact risk and overexploitation were considered to describe the impacts of the human system (S) on the environment. So, too, were variables describing the proportion of a region set aside for conservation and of conservation grants flowing to a region (total and per square kilometre)	S → E
Measures of land capacity and of ecosystem services were considered to describe benefits that flow from the ecological system to the social system. We also included a HILDA variable that captures people impacted by extreme weather events in this category.	E → S

[4] Variables that pertain to land uses for conservation were considered to be simple descriptors of the ecological/natural system.

Table 3. General descriptions and principles used to link variables to segment of society that is described.

Overview	Segment of society
Variables that describe or are relevant to all but do not describe or relate to a particular segment of society, for example: • Variables that give background contextual information about the natural environment (e.g. variables relating to climate, fire history, habitat condition, area, water availability [proportion of region that has surface water and maximum wet-surface areas between 1987 and 2020], vegetation type; land set aside for conservation or water [excluding reservoirs and other 'man-made' water-related land uses]; and indicators of species richness). We also include variables that describe the estimated annual monetary value of various ecosystem services which are supplied within a region, and variables describing the amount of money that granting bodies have provided to the region, to support and protect natural resources. • Variables that describe the infrastructure that supports the regional economy and society more generally (e.g. area of land given over to different uses; presence/absence of airports; number of bores; land set aside for utilities, transport/communications, hospitals and schools; land 'at risk' from over-grazing; remoteness classification). • Variables that describe legislative arrangements, most of which describe governance of land.	NA: contextual
Variables that relate to data collected directly from individuals and which help analysts to understand the state/condition/mindset of individuals. Some ABS census variables are also included here – specifically, those that report data about individuals (e.g. average individual income).	Individuals
Variables that describe households or families. Most of these variables were obtained from ABS census data, so has been collected from individuals, but the way in which data is reported means that variables describe households (e.g. average household size, average persons per bedroom, median mortgage payment, median household income).	Households/families
Variables that describe communities. This data has also often been collected from ABS census, so was obtained from individuals, but the way in which data are reported means that variables describe communities (e.g. total number of people within the region; total number of Aboriginal or Torres Strait Islanders; proportion of dwellings [within the region] that are owned outright; proportion of families without a motor vehicle or with no children; membership of community groups; volunteering; median age of residents; proportion of residents with degree, or who are unemployed, or married). Indicators of adaptive capacity, coping capacity and resilience also describe characteristics of communities.	Communities
Variables that describe the region's workforce. Most of this data has also been collected from ABS census, so was obtained from individuals, but the way in which data are reported means that variables describe communities (e.g. proportion of the workforce employed in different Industries).	Workforce
These variables count and describe the political parties which have been elected to represent members of the region's community.	Political representatives

2.3 Identifying and describing similar regions

2.3.1 Statistical clustering

We used hierarchical cluster analysis[5] to identify groups of regions that were similar to one another (see Larson et al. 2013 for an Australian application). We did this once for NRM regions and once for the IBRA sub regions.

In layman's terms, hierarchical clustering sorts regions into groups (clusters) – the aim being to ensure that (i) regions that are grouped together are similar to each other (they are 'homogenous' in that they look and feel the same) and (ii) regions which are placed in different groups are 'heterogenous' in that they look and feel quite different (Landau and Chis Ster 2010).[6] The technique produces hierarchical dendrograms which divide regions into an ever-increasing number of clusters (much like a tree with large branches at the base, and many more branches/twigs at the top). The larger the number of clusters, the smaller the number of regions within – but it is difficult to know how many clusters one should work with.

Various statistical techniques are available to help select an optimal number (simplistically, aiming to maximise the things that regions within a cluster have in common, and also maximising the differences between clusters) and we selected 2 of the most common: silhouette analysis[7] (Rousseeuw 1987) and the elbow method.[8] But different natural resource managers must deal with problems/questions at different scales (e.g. property, local government area, NRM, state), so their views about what constitutes an optimal number of clusters may not always align with the views of others (including the views of statisticians). As such, we decided not to focus solely on the statistically optimal number of clusters. Instead, we generated several different maps using different numbers of clusters. The first showed which regions are similar if only dividing them into 2 (large) groups, the second showed similarities if dividing the regions into 3 groups, then 4, then 5, up to a maximum

[5] We used the 'hclust' command in the stats library in R. Regions were clustered based on the descriptor variables using Ward's agglomeration method. We also used other methods, including complete-link and the average link method – all yielding similar results. Given these similarities, we only present the results obtained from the hierarchical clustering using Ward's agglomeration method.

[6] Hierarchical clustering focuses on 'Euclidean distance' when assessing (dis)similarities (Landau et al. 2011), and there are different algorithms that can be used to define groups (single linkage, complete linkage, average linkage, or Ward's method). Similar to previous studies (Kuentz et al. 2017, Jehn et al. 2020, Tomalski et al. 2021), we used Ward's method (Ward Jr 1963). This method is considered to be particularly useful for exploratory work (Antonenko et al. 2012) and has an objective function that aligns well with other common statistical methods since it aims to minimise within-cluster variance (Aldenderfer and Blashfield 1984); see also an applied example from (Varol et al. 2012). Noting that measures of Euclidean distance are sensitive to the way in which variables are measured (Antonenko et al. 2012), we standardised all variables using Z-scores before proceeding with the hierarchical clustering analysis. The Z-score transformation has been frequently used to standardise data and it allows the comparison of data independent of the original intensities (Cheadle et al. 2003). This eliminates the influence of different units of measurement and renders data dimensionless (Varol et al. 2012).

[7] This method computes what is termed a 'silhouette coefficient' which, for a given number of clusters, compares the average intra-cluster (Euclidean) distance of one cluster, with the average intra-cluster distance of the next-most similar cluster. Silhouette coefficients lie between 1 and −1 – the higher the value, the more 'dissimilar' the first cluster is from the other. Low silhouette scores thus indicate that clusters are quite similar to each other (akin to suggesting that you have climbed too high up the tree and may be better with a lower number of clusters that are better differentiated from each other).

[8] The elbow method uses the within cluster sums of squares by analysing the total within-cluster sum of square as a function of the number of clusters. In this method, the presence of a knee or elbow in the plot is often interpreted as an indicator of the optimal number of clusters (Zambelli 2016).

of 10. We chose this range because it included the optimal number of clusters identified through the statistical analysis.

2.3.2 Understanding the variables that make regions similar

We used the spearman rank correlation coefficient to identify core variables that determine the cluster membership, categorising them according to whether they relate to the ecological system or interactions between the sub-system. We used insights from the literature (Liu et al. 2003, Khadr et al. 2020) to describe the importance of a variable in determining membership as weak, moderate or strong, for correlation coefficients that were, respectively, < 0.5, 0.5–0.75 and > 0.75. We also conducted factor and principal-component analysis to check the robustness of results, with consistent results.

2.3.3 Describing regional clusters

We sought to improve the utility of our work by not only providing maps which show regions that are similar to each other but by also providing tables that summarise core characteristics of each cluster – the core characteristics being the variables that drive cluster membership. The intention is for people to be able to use either the maps or the tables/descriptors in conjunction with the maps to identify other regions that are 'similar' to each other, as shown in Figure 4. These descriptions are also important in validating our regional clusters and supporting managers to interpret and interrogate where they sit in a cluster and how they can use the clustering for perhaps peer-to-peer learning or transferring approaches from other regions to their own to scale up interventions.

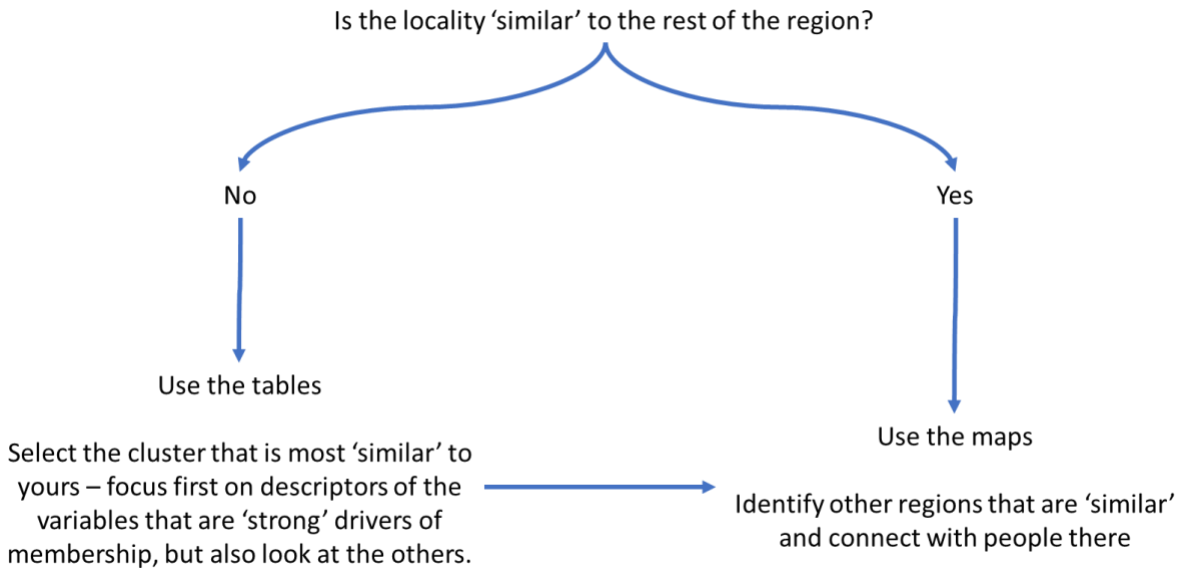

Figure 4. Schematic for identifying regions that are similar to a particular location.

When selecting variables for inclusion in the tables, we used those that had been identified as having either a strong or moderate influence on cluster membership to describe the regional clusters, estimating the mean value of each, for all regions within a cluster. We worked with 10 clusters – the number that we feel is likely to be the uppermost limit to the number of clusters that the dataset adequately distinguishes.

2.4 Matching regional clusters to appropriate planning approaches

Matching the right planning approach to the context is driven by the planning question as well as the overall context. These represent strong planning 'signals' around the type of planning context and thus the level of complexity that the chosen approach must be equipped to deal with. Where there are not multiple complicating factors, the policy context is likely to be simple enough to support site-based or single-intervention traditional planning. Where multiple complicating factors co-exist, regional approaches with more sophisticated analyses and more extensive stakeholder-engagement processes are warranted. We draw upon the planning literature in Table 1 as well as planning theory to develop a decision tree which allows planners to define their planning context and ultimately choose an appropriate set of approaches to draw upon. The decision points are in the first instance defined based upon the theory and underlying attributes of the planning approach (Figure 5).

The decision tree captures key binary choices that a planner will have to make in differentiating contexts. The context can be defined based on the data summarised in this report, demonstrating the power of the data that we have assembled. It is possible to use commonly available data to identify regions that are most suited for each type of regional-planning approach identified in the decision tree. This will allow managers to readily identify the type of planning approach most suited to their region and planning context (Figure 5).

Decision point 1: level of complexity in terms of users or overlapping/competing land and sea uses. This decision point is about the relative complexity of competition in the system for finite resources, which could be captured by the number of users or uses and the extent to which they overlap and are competing for limited resources.

This decision point is about both the volume of uses and the extent to which they conflict. This might be captured through 2 separate data points to characterise these independently or instead might be captured through a single variable or presence of a particularly conflicting type of use. We display these as 2 separate data signals for the theory driven-decision tree but note that these may be readily captured in one step by decision-makers.

Decision point 2: level of complexity in the environmental context, in particular the presence of multiple interacting (and unabated) threats or presence of sensitive species interacting with threats. This decision point is about the relative environmental complexity of what must be managed and where. We characterise this with different data signals specific to whether you are on the 'low' socioeconomic branch of the decision tree or the 'high' complexity branch.

For the low socioeconomic complexity branch, the theory-driven planning question is about the extent to which there are multiple interacting threats which are not sufficiently abated by traditional conservation measures like protection. Data signals that support this decision point are the level of protection or area under conservation or the number of threats overlapping with threatened species. Where the overall socioeconomic context is relatively simple and protection levels are low, then standard single-intervention conservation planning is suitable with an overall objective to plan for locations for protection to abate threats. Where the overall socioeconomic context is relatively simple and protection levels are high but threats

persist, the problem is one about threat abatement and the spatial location of those actions (including actions undertaken in one location that may impact other areas – this often plays out for freshwater and coastal systems; Adams et al. 2014; Alvarez-Romero et al. 2015).

For the high socioeconomic complexity branch, the theory-driven planning question is about the extent to which there are sensitive ecosystems and species present (typically ones listed as threatened or highly sensitive to particular use or development in question) and likely to be physically overlapping with or threatened by land uses of relevance to the planning context (i.e. those identified in the first decision point). Where the socioeconomic context is complex but the land uses present (and in conflict with one another) do not threaten ecological values, this can be addressed through other standard planning approaches such as land-use zoning or ecosystem-based management (EBM) planning for specific assets of interest. Where the socioeconomic context is complex and the land uses present directly interact with and threaten the environmental values of interest, then planning methods designed to capture this complexity, such as spatial land-use planning with decision-support tools, are likely needed. The data included in our regional datasets were limited to surface-water measurements due to limitations in spatial extent and interpretation of data. However, we note that the signals of 'complexity' that dictate the types of regional planning needed to navigate land-use, water-use and marine-use planning are often similar regardless of key domain of interest. We return to this point in the results section with examples.

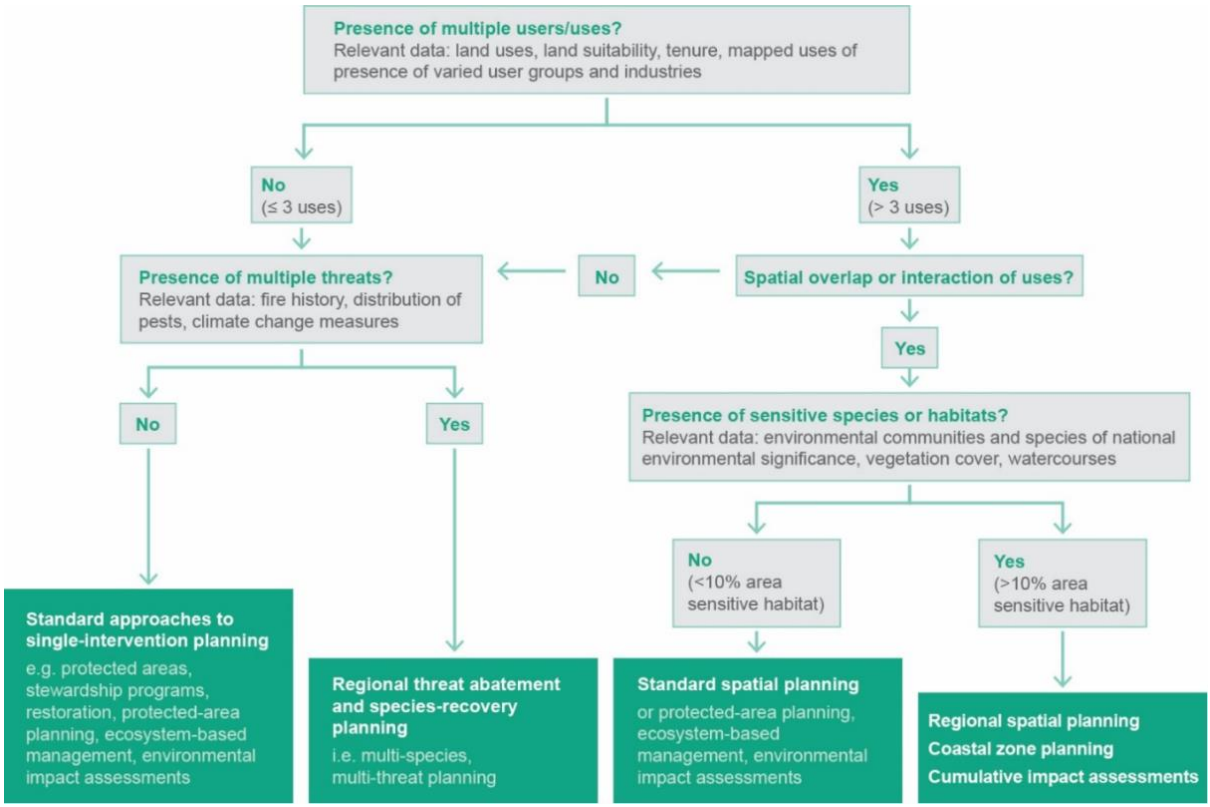

Figure 5. Regional-planning decision tree.

The decision tree is conceptualised where individual regions can articulate spatial overlaps and interactions in specific data. Decision points are thus a function of the presence of a

volume of users or values but also the level of spatial overlap. However, this is often not the practical reality for planners who, rather, know ‘flat’ details or single data points about the region such as percentage of gross domestic product from a particular sector or total number of listed threatened species but not the location of the sector or species or the extent to which they interact.

Thus, at this practical level, the theory of matching regions to planning approaches may not be fit for purpose. We, therefore, test the extent to which the decision tree can be applied to large scales and multiple regions based on data that is summarised at a regional scale and thus indicates the number of uses or number of values but not necessarily their spatial interactions. In doing so, we further refine the decision tree for specific application to our datasets and regional clusters. We draw upon the specific variables that our regionalisation identified as key characteristics of regions to guide our choices in populating the decision points alongside the underpinning theory for each point. We then use the populated decision tree to map to regional-planning approaches and validate the decision-tree results by reviewing a sample of NRM plans from each planning approach.

Lastly, we contrast how our statistical matching of regions varies to the decision-tree outputs and explore how each complement one another.

3. Results

3.1 Describing and assessing the utility of the dataset

The compiled dataset contains a broad range of contextual variables that consistently describe the ecological system, the human system and interactions between systems across the continent, and many observations are available at more than one point in time (Appendix B, **this integrated dataset** and Stoeckl et al. 2023). Notably, the finer the desired geographic resolution, the fewer the available variables to describe multiple regions consistently across space. A relatively large number of the variables that describe the human system are collected annually through the HILDA survey administered through the University of Melbourne, but that does not sample many people outside urban and peri-urban areas, so we were unable to generate HILDA measures for 84 variables. Similar problems existed for some of our variables relating to water (specifically, counts of the number of bores and estimates of the proportion of regions with surface water) – although this only affected 13 IBRA sub-regions. Data limitations in remote areas thus mean that we could not fully populate all variables for all IBRA sub-regions. We have a complete set of descriptors (using the 270 variables available for the NRM regions) for 268 IBRA sub-regions. The dataset can describe up to 409 IBRA sub-regions using 214 variables.

Figure 6 provides a visual count of available data, categorised according to which part of a connected social-ecological system they describe (human or natural or interactions) and, where applicable, by the segment of society they describe.[9] It clearly reveals that some parts of the system are well described and some are not. This is in line with findings of other researchers in other regions (ten Brink et al. 2011).

Figure 7 shows the number of variables that describe components of the human/social system, the natural/ecological system or interactions between them, differentiated according to the temporal availability of underlying data. The overwhelming majority of variables are updated at infrequent intervals, being either single measures or updated at intervals of more than 2 or 5 years. Data collected in the HILDA survey are updated annually, but – noted above – these variables are not available at small geographic resolution across the entire Australian continent. Most variables that describe parts of the human system are collected by the ABS for census. Consequently, more than 50% of variables that describe people, or the economy are updated less than once every 5 years. Finer-resolution data that has been collected at relatively small time-steps appears to be more broadly available for the ecological system than for the human/social system, and 77% of variables that describe interactions are either single measures or are only updated once every 5 years.

While there are gaps in the dataset – discussed in more detail in Section 4.1 – it is nevertheless clear that our dataset provides sufficient information to adequately characterise the social, ecological and interactive parts of a social–ecological system at a given point in time (2021), and it does so across multiple NRM regions and IBRA sub-regions. We stress that dataset provides contextual information – it is not sufficient to inform specific place-based problems but could be supplemented to do so (e.g. for local water planning, one might

9 Appendix B provides a full list of variables, identifying how each has been categorised.

add layers to show underground aquifers and stream flows, for coastal zone planning connectivity of freshwater plumes to marine environment might be required).

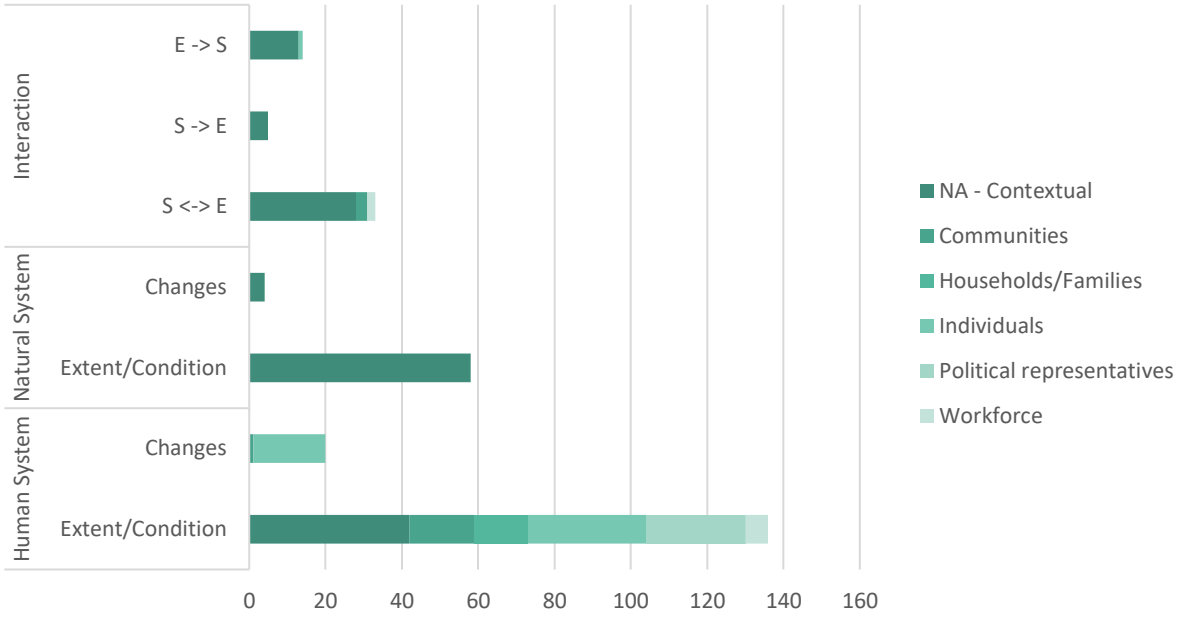

Figure 6. Number of variables describing various parts of the social–ecological system (human, natural or interaction) and segment of society that is described (where applicable). The figure counts variables where data are reportable for all 56 NRM regions – data deficiencies prevented us from being able to describe all variables for the smaller IBRA sub-regions.

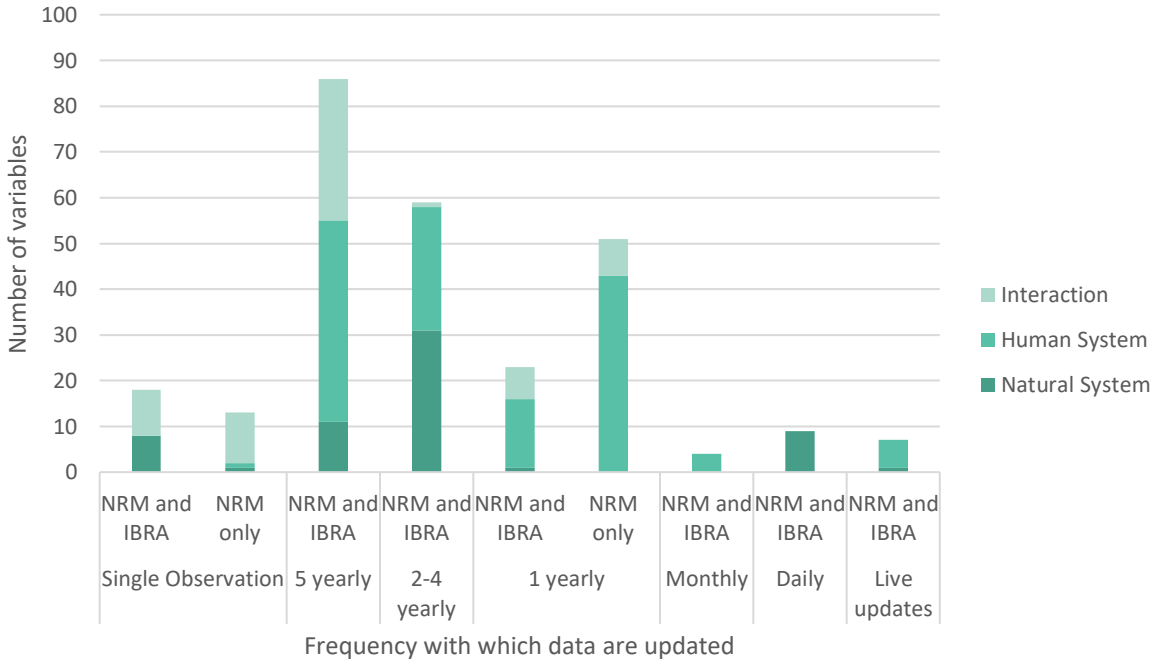

Figure 7. Frequency with which data underpinning core variables are updated. Counts are for the data that are available for all 56 NRM regions.

3.2 Identifying and describing similar regions

We focused on the most recent data, also including 7 variables that measure 'change' from one period to the others. The 'most recent' data is that which is most closely aligned to the 2021 ABS census data. The 'change variables' calculated for change from 2016 to 2021 are: change in total persons; change in average household size; change in median total personal weekly income; change in proportion of total population that is Indigenous; change in proportion of workforce employed in agriculture, forestry or fishing; change in elected representatives to the lower house between the 2016 and 2019 elections; change in habitat condition (Habitat condition assessment system [HCAS] epochs 2006–15 to 2001–10).

3.2.1 Statistical clustering

We used hierarchical cluster analysis (Section 2.3.1) to identify groups of regions that were similar to one another. We did this once for the NRM regions and once for the IBRA sub-regions – providing information to suit decision-makers who tend to work at different regional scales. Noted above, data limitations in remote areas meant that we could not fully describe all IBRA sub-regions. We thus had to choose between using fewer variables to describe all IBRA sub-regions or using the full set of variables to describe only a subset of IBRA sub-regions. We chose the former (formally, 'variable-wise' deletion) to ensure that our results/maps provided information across most of the continent – although we also undertook some analysis using the full dataset, with fewer regions (formally, 'list-wise' deletion), providing results in the appendices.

One of the outputs from a hierarchical clustering analysis is a dendrogram, which shows the way in which regions divide – firstly into just 2 clusters and then into an ever-increasing number of smaller clusters. A dendrogram relevant to the NRM analysis is shown in Figure 8 – there are many more IBRA sub-regions so the dendrograms are too cluttered to readily reveal patterns; however, results are available on request.

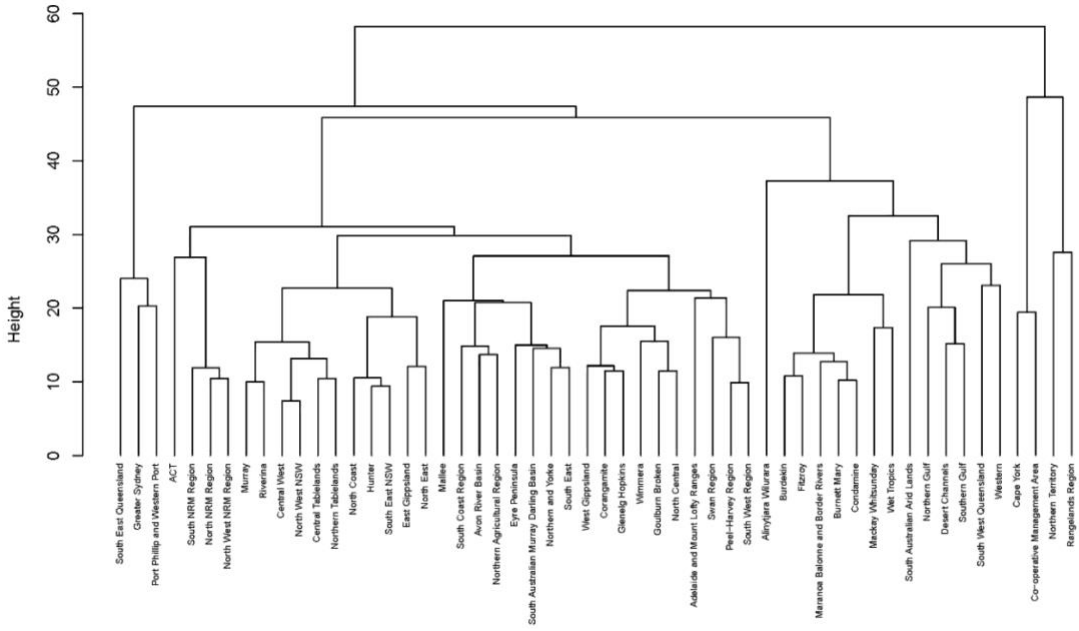

Figure 8. Dendrograms for the NRM regions using the full dataset.

We used both silhouette analysis and the elbow method to identify the optimal number of clusters for the analyses of both the NRM regions and the IBRA sub-regions. For NRM regions, the analysis suggested an optimum of '3 or 4' and '5, 6 or 7' using silhouette scores and the elbow method, respectively. The suggested optimal number of clusters for IBRA sub-regions were '2' and '5, 6 or 7' using silhouette scores and the elbow method, respectively. Conversations with some end-users suggested there may be appetite to consider up to 10 separate clusters. We thus used the full dataset and generated 9 different maps to show how the regions are divided into groups as one progresses from just 2 clusters up to 10.

Figure 9 shows the maps for NRM regions while Table 10 in Appendix C provides the names of the NRM regions that cluster together, depending upon the number of clusters (from 2 to 10) into which regions are divided. Figure 10 shows similar maps for the IBRA sub-regions and Table 11 in Appendix D lists the names of IBRA sub-regions and the clusters into which they group. Results relevant to the analysis undertaken for IBRA sub-regions using the list-wise deletion approach are provided in Appendix I.

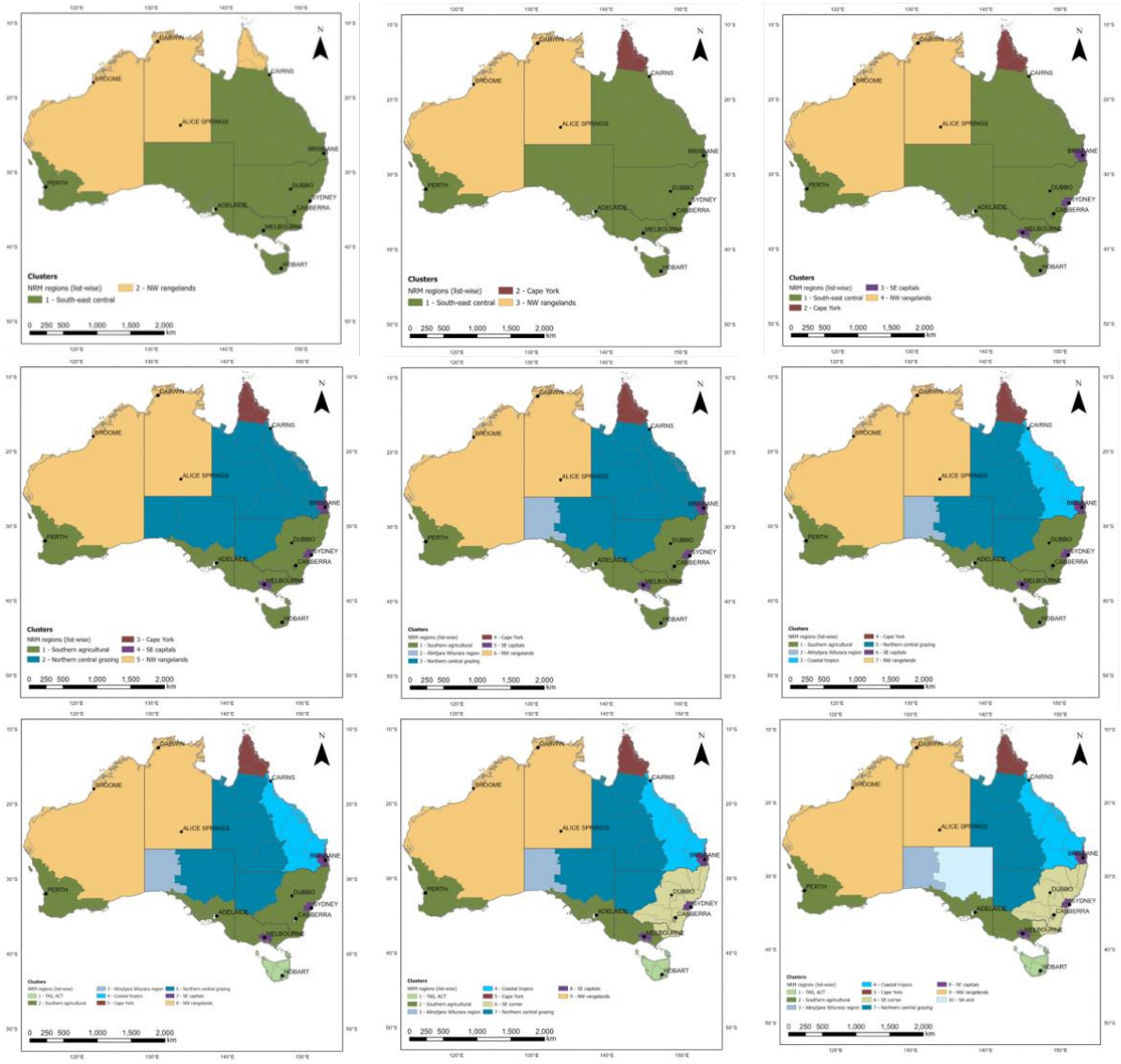

Figure 9. NRM regions that are similar to each other, by number of clusters (2–10).

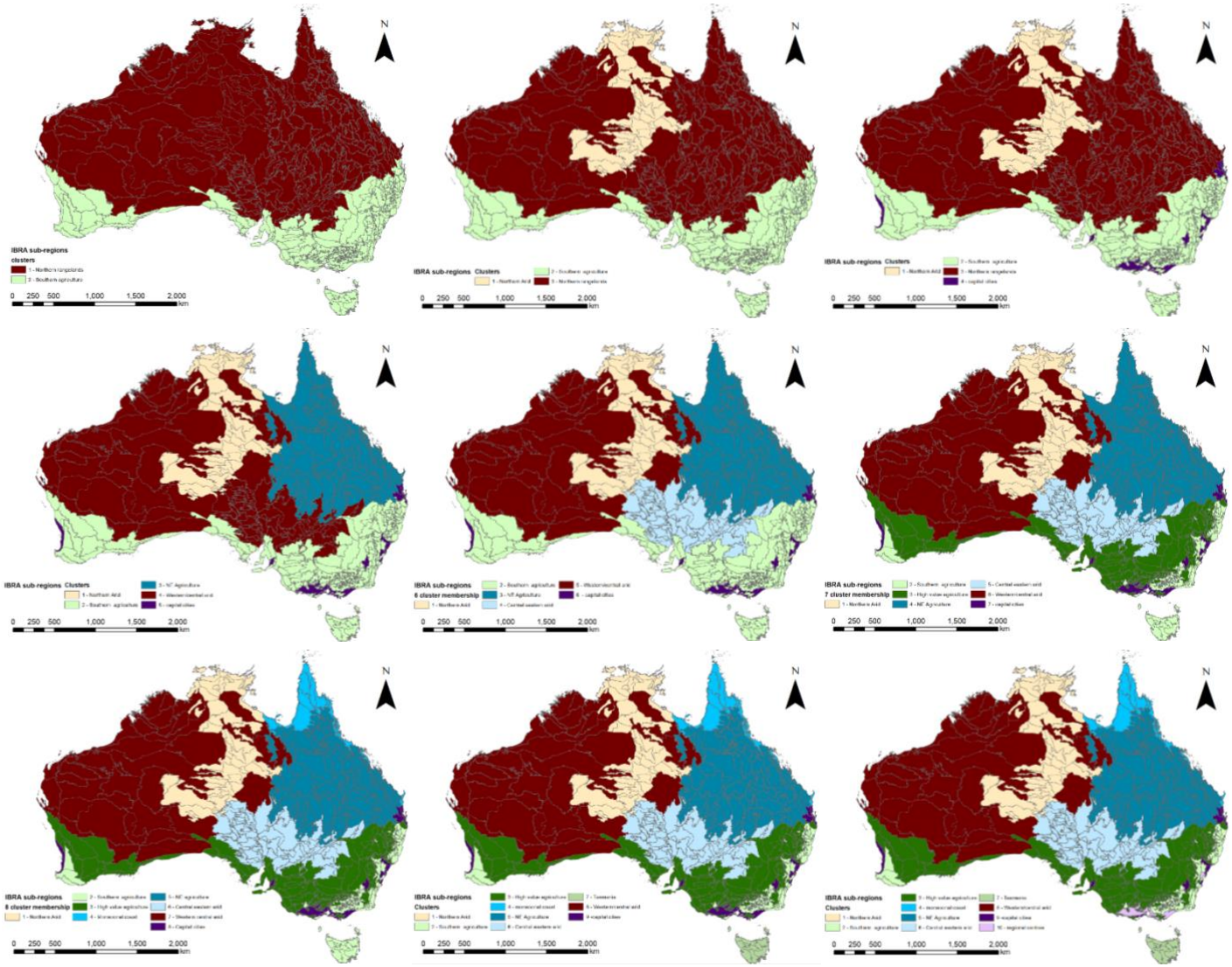

Figure 10. IBRA sub-regions that are similar to each other, variable-wise deletion, 2–10 clusters.

3.2.2 Understanding the variables that drive cluster membership

We used the spearman rank correlation coefficient to identify core variables that determine cluster membership, categorising them according to whether they relate to the ecological system or interactions between the sub-system, and whether they have a 'strong' or 'moderate' influence on cluster membership (Section 2.3.2).

Different variables drive cluster membership – the larger the number of clusters, the larger the number of variables. Some variables reveal themselves as core drivers when dividing regions into 2 – the importance of other variables is often not apparent until considering a larger number of clusters. For example, when describing NRM regions, there are only 2 types of variables that broadly determine the first hierarchical 'split' – the proportion of a region where the major vegetation group is Tropical Eucalypt Woodlands and Grasslands, and the proportion of a region that is Indigenous owned, managed or subject to other special rights. When moving from 2 to 3 clusters, 3 other variables are identified as core determinants of membership – the proportion of region with a vegetation type that is 'unclassified forest' and the political representation from the Country Liberal party.[10] At the next hierarchical 'split' (moving from 3 to 4 clusters), other variables start to drive membership – particularly those that describe the social system (individuals, households, communities, economy and infrastructure).

Variables that have been identified as having either a strong or moderate influence on cluster membership for the first few hierarchical splits in our NRM region analysis are shown in Figure 11. Table 4 provides a more complete overview of core drivers for NRM region cluster membership. It lists the number of clusters into which NRM regions are divided (2–10) in the left-most column. The second and third columns identify variables with a strong or moderate influence on cluster membership, respectively, the first time they are revealed as important determinants of membership (noting that some variables first appear as having a moderate influence and later appear as having strong influence). A complete listing of the variables that determine NRM membership of each cluster, for all 2–10 hierarchies is provided in Appendix E. Notably, a variety of variables determine cluster members – including those that describe the natural/ecological system, the social/human system and interactions between the 2 systems (Table 4).

Table 5 provides an overview of core drivers for IBRA sub-region cluster membership, for our analysis that used variable-wise deletion (409 regions; 214 variables).[11] A complete listing of the variables that determine IBRA region membership of each cluster for all 2–10 hierarchies is provided in Appendix F. This analysis also clearly shows that a variety of variables are required to adequately describe regions and delineate clusters. Notably, the number of variables required to do this for IBRA sub-regions is much higher than when working with the larger NRM regions – even if only describing 2 or 3 clusters. Evidently, the smaller the geographic scale at which one wants to work, the more nuanced and detailed the data required to describe it adequately.

[10] Formally, the proportion of the region where the federal political representative in the upper house is a member of the Country Liberal party; the proportion of the region where the federal political representative in the senate is a member of the Liberal party.
[11] Table 16 in **Error! Reference source not found.** provides a similar overview, when using list-wise deletion.

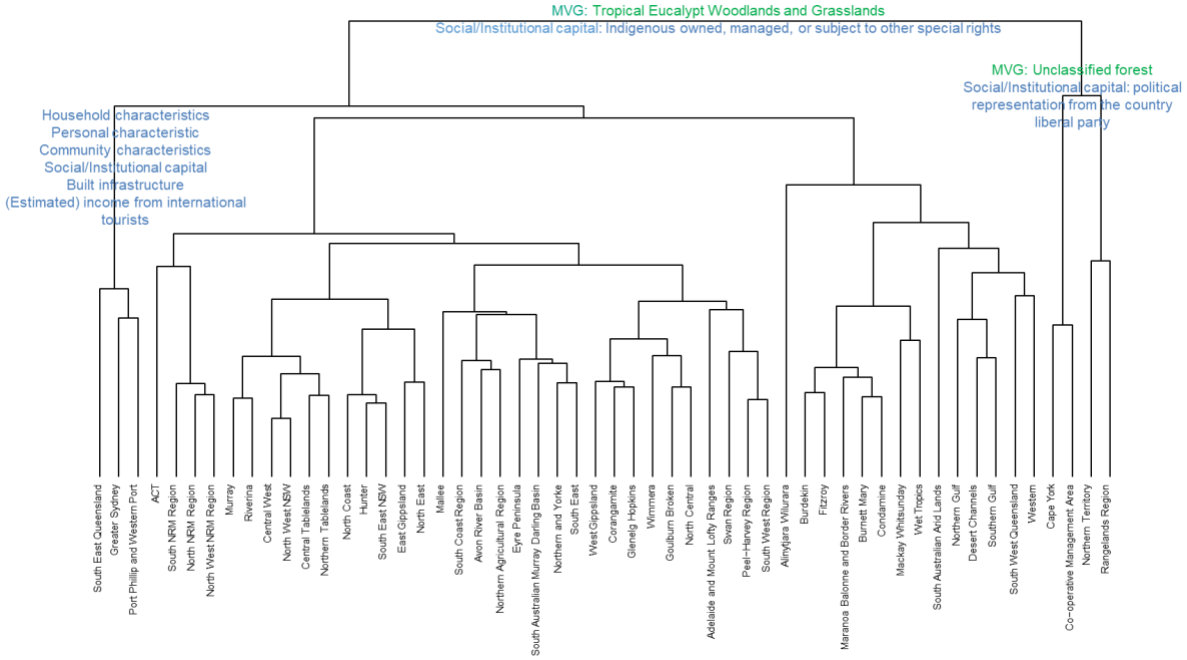

Figure 11. Variables with a strong or moderate influence on NRM region cluster membership, linked to dendrogram for if dividing regions into 2, 3 or 4 clusters. Green indicates a variable that describes the natural/ecological system; blue indicates a variable that describes the social/human system.

Table 4. Cluster in which variables first distinguish NRM regions (56 regions, 267 variables). Green indicates a variable that describes the natural/ecological system; blue indicates a variable that describes the social/human system; red indicates a variable that describes an interaction between subsystems.

Number of clusters	Variables exerting strong influence on cluster membership	Variables exerting moderate influence on cluster membership
2		Major vegetation group (MVG): Tropical Eucalypt Woodlands and Grasslands Indigenous governance: Indigenous owned, managed or subject to other special rights
3	MVG: Tropical Eucalypt Woodlands and Grasslands	MVG: Unclassified forest Politics: federal upper-house incumbent – Country Liberal Party; federal senate – Country Liberal Party
4	Built infrastructure: large airports (presence)	Household characteristics (proportion of homes without motor vehicle, persons per bedroom, dwellings owned, proportion families no children, proportion female with 3 or more children) Personal characteristics: median age Community characteristics: proportion of population speaking only English at home, proportion population who volunteer) Politics: federal lower-house rep – Australian Greens Built infrastructure: airports – closed; special schools present Economic descriptor: income from international tourists (estimate)
5	Climate: mean temperature Land use: grazing modified pastures	Extreme events: proportion of region impacted by fire 1969–2018 MVG: Acacia Forests and Woodlands; Heathlands; Mangroves Climate: mean, maximum and minimum temperature Indigenous governance: Native Title (exclusive, non-exclusive, extinguished) Land tenure: proportion of land crown leasehold; Politics: federal upper-house incumbent – Liberal National Party of Qld (LNP), Pauline Hanson's One Nation (PHON); federal senate – Australian Labor Party (ALP), LNP, PHON; federal lower house – % change in LNP representation 2016–19 Economy characteristics: proportion workforce in manufacturing Built infrastructure: remoteness – proportion of region classified as outer regional or very remote Adaptive capacity Land use: managed for resource protection, grazing native vegetation, plantation forests, grazing modified pastures, cropping, land in transition, transport and communication, waste treatment and disposal Ecosystem services: income from forestry logging (estimate) Land capacity: high Disaster resilience
6	Politics: federal upper-house incumbent – LNP, PHON; federal senate – PHON	Built infrastructure: remoteness – proportion of region classified as major city
7		MVG: Acacia Open Woodlands; Hummock Grasslands; Rainforests and Vine Thickets Stewardship: grant value ($/km^2)
8	Politics: federal upper-house incumbent – Jacquie Lambie	Extreme events: proportion of region impacted by fire 1969–2018 MVG: cleared, non-native vegetation, buildings Social/institutional capital: land tenure freehold
9	Politics: federal senate – Jacquie Lambie, LNP	Water: land-use river MVG: Eucalypt Tall Open Forests; regrowth, modified native vegetation Community characteristics: proportion of population with no religious affiliation Politics: federal upper house – senators (Liberal Party, National Party, ALP); incumbents – Australian Greens) Ecosystem services: estimated annual value of carbon sequestration; gene pool; non-use value of residents; toxin mediation; water purification
10	Politics: federal senate – National Party	

Table 5. Cluster in which variables first distinguish IBRA sub-regions, variable-wise deletion (409 regions; 214 variables). Green indicates a variable that describes the natural/ecological system; blue indicates a variable that describes the social/human system; red indicates a variable that describes an interaction between subsystems.

Number of clusters	Variables exerting strong influence on cluster membership	Variables exerting moderate influence on cluster membership
2	Climate: max temperatures, median temperature Extreme events: proportion of region affected by fire: 2019–20 Adaptive capacity Disaster resilience Land use: grazing modified pastures	Climate: minimum temperature (min_tem_min) Major vegetation group (MVG): Eucalypt Open Forests; Eucalypt Tall Forests; Heathlands; cleared, non-native vegetation, buildings EPBC-listed: ecological community richness (max, median); species richness (max, median) Habitat condition: HCAS_2001–10 Extreme events: proportion of region affected by fire:1969–2018; 2004–18; 2014–18 Personal characteristics: median age Household characteristics proportion dwellings owned with mortgage Community characteristics: persons total; population density; proportion with degree or higher; proportion Indigenous Economy characteristics median rent; persons employed, proportion workforce in manufacturing Built infrastructure: remoteness – proportion of region classified as inner regional, outer regional, or very remote Indigenous governance: ilf_non-Indigenous; ilf_proportion_estate; Native Title exists (non-exclusive) Social/institutional capital/land tenure: leasehold Politics: federal upper-house incumbent – Australian Labor Party (ALP); federal upper-house senators – ALP, National Party Stewardship: grant value (dollars and $/km^2) Land use: grazing native vegetation; production native forests; plantation forests, cropping, perennial horticulture, seasonal horticulture, intensive animal production, residential and farm infrastructure, transport and communication Overexploitation Estimated annualised value of infrastructure that is ‘at risk’ from pests Ecosystem services: estimated annual value of; erosion control; forestry/logging
3	Politics: federal upper-house incumbent – Country Liberal Party (CLP); federal senate – CLP	MVG: Acacia Forests and Woodlands Community characteristics: proportion of population speaking only English at home Indigenous governance: ilf_indigenous_owned_and_managed; Native Title extinguished Social/institutional capital/land tenure: freehold Politics: federal lower house – ALP, National Party; federal upper-house incumbent – Australian Greens; federal upper-house senate – Australian Greens Coping capacity
4		Built infrastructure: large airports (presence/absence); remoteness – proportion of region classified as major city
5	Politics: federal lower house – Liberal National Party of Qld (LNP); federal upper-house incumbent – LNP, Pauline Hanson’s One Nation (PHON); federal upper-house senators – LNP, PHON	Climate: median, minimum and max annual precipitation Politics: federal upper-house incumbent – Liberal; federal upper-house senate – Liberal Party
6		Indigenous governance: ilf_indigenous_managed_subject_to_other_special_rights
7		Habitat condition: HCAS_2006–15
8		MVG: Sea and Estuaries
9	Politics: federal upper-house incumbent – Jacqui Lambie; federal upper-house senators – Jacqui Lambie	
10	Politics: federal lower house – Australian Greens	Built infrastructure: special schools (presence/absence)

3.2.3 Describing regional clusters

We used the variables that drive NRM cluster membership (Table 4) to describe the regional clusters, estimating the mean value of each, for all regions within a cluster – full results are provided in Table 14, Appendix G and a qualitative overview is given in Table 6. We worked with 10 clusters – the membership of which is summarised in Table 10. Descriptors for the IBRA sub-region clusters that were derived using the variable-wise deletion approach are provided in Table 15, Appendix H. A qualitative overview provided in Table 7. Full details of means for variables identified from list-wise approach are provided in Table 18 in Appendix I.

When constructing these qualitative overviews, we describe all variables that have a strong influence on cluster membership. Other variables are a subset, drawn from a much larger selection, of variables that exert a moderate influence on cluster membership. Readers are encouraged to consult the appendices for a more comprehensive overview.

Table 6. Qualitative overview/description of NRM region clusters. **Bold** variables indicate strong influence on cluster membership. Other variables mentioned here are a subset, drawn from a much larger selection, of variables that exert a moderate influence on cluster membership. Consult the appendices for a more comprehensive overview.

	Cluster	Natural system	Human system	Interactions
1	SE urban (Sydney, Melbourne, Brisbane)	**Avg temp: 17–19°C** Much land cleared non-native vegetation – buildings Fire impacted: 1969–2018	**Large airports** Relatively little Native Title Mostly freehold Major city	**~15% land grazing modified pastures** Some cropping Moderate land capacity Very high $ grants/km^2 (> $7,000)
2	Tasmania and ACT	**Avg temp: 14°C** Some cleared, non-native vegetation, buildings Tall Eucalypt Open Forests Fire impacted: 1969–2018	**Jacqui Lambie** **Some large airports** Relatively little Native Title > 80% speak only English at home	**< 2% land grazing modified pastures** Some cropping $ grants/km^2 ($418)
3	South-east corner (eastern NSW, NE Vic)	**Avg temp: 17–19°C** Much land cleared, non-native vegetation, buildings Fire impacted: 1969–2018	Relatively little Native Title Mostly freehold Outer regional > 80% speak only English at home	**~25% land grazing modified pastures** Some cropping Moderate land capacity
4	Southern agriculture (SE WA, SW SA, SW Vic)	**Avg temp: 17–19°C** Some cleared, non-native vegetation, buildings Fire impacted: 1969–2018	Some Native Title Mostly freehold > 80% speak only English at home	**~2.5% land grazing modified pastures** Much cropping (16%) Much 'land in transition' High land capacity $ grants/km^2 ($124)
9	Cape York	**Avg temp: 27°C** Mangroves	**Liberal National Party of Qld (LNP); Pauline Hanson's One Nation (PHON)** Some Native Title Mostly leasehold Very remote Low vehicle ownership Few dwellings owned outright Relatively young	**~45% land grazing of modified pastures** Much land grazing native vegetation Low grants/km^2 (< $3) Some grazing modified pastures
6	Coastal tropics (Qld)	**Avg temp: 20–25°C** Some cleared, non-native vegetation, buildings Mangroves	**LNP; PHON** Some Native Title	**~50% land grazing modified pastures** Moderate land capacity
8	Northern central grazing (W Qld, W NSW)	**Avg temp: 20–25°C** Acacia Forests and Woodlands	**LNP; PHON** > 80% speak only English at home Some Native Title Mostly leasehold Very remote	**> 80% land grazing of modified pastures** Very low grants/km^2 (< $0.50)
10	NW rangelands (NT, rangelands)	**Avg temp: 29°C** **Tropical Eucalypt Woodlands and Grasslands**; Acacia Forests and Woodlands	Much Native Title Very remote Few dwellings owned outright Relatively young	**~40% land grazing modified pastures** > 80% land used for grazing native vegetation Low grants/km^2 (< $3) Some grazing modified pastures
5	Alinytjara Wilurara	**Avg temp: 20–25°C** Acacia Open Woodlands	Some Native Title Mostly freehold Very remote Low vehicle ownership Few dwellings owned outright Relatively young Few speak only English at home	**< 2% land grazing modified pastures** > 65% land managed for resource protection 25% land grazing native vegetation $ grants/km^2 (< $3)
7	South Australia Arid Lands	**Avg temp: 20–25°C** Acacia Open Woodlands Moderate Indigenous	Some Native Title Mostly leasehold Very remote	**Approx. 75% land grazing of modified pastures** $ grants/km^2 (< $0.50)

Table 7. Qualitative overview/description of IBRA sub-region clusters. **Bold** variables indicate strong influence on cluster membership. Other variables mentioned here are a subset, drawn from a much larger selection, of variables that exert a moderate influence on cluster membership. More details are in the appendices.

	Cluster	Natural system	Human system	Interactions
9	Capital cities	**Avg max temp: 16–18°C** Much land cleared, non-native vegetation, buildings HCAS < 0.5	10%–25% Indigenous owned/managed land Mostly freehold Weekly rent: > $400/wk > 5% workforce in manufacturing	**~8% land grazing modified pastures** Very high $ grants/km^2 (≈ $9,000)
4	Tasmania	**Avg max temp: ~13°C** Some land cleared, non-native vegetation, buildings HCAS ~0.6	10%–25% Indigenous owned/managed land > 80% speak only English at home Weekly rent: $200–$300/wk	**~5% land grazing modified pastures** $ grants/km^2 ($100)
10	Regional coastal	**Avg max temp: 16–18°C** Much land cleared, non-native vegetation, buildings HCAS < 0.5	< 20% Indigenous owned/managed land Mostly freehold Weekly rent: > $400/wk > 5% workforce in manufacturing	**> 40% land grazing modified pastures** Very high $ grants/km^2 (≈ $3,000)
2	Southern agriculture	**Avg max temp: 16–18°C** Tall Eucalypt Open Forests Eucalypt Open Forests HCAS < 0.5	10%–25% Indigenous owned/managed land > 80% speak only English at home Weekly rent: $200–$300 pw 4%–5% workforce in manufacturing	**~7% land grazing modified pastures** $ grants/km^2 ($80–$100)
3	High value agriculture	**Avg max temp: 16–18°C** Moderate land cleared, non-native vegetation, buildings	10%–25% Indigenous owned/managed land Mostly freehold > 80% speak only English at home Weekly rent: $200–$300/wk >5% workforce in manufacturing	**~25% land grazing modified pastures** $ grants/km^2 ($50)
5	Monsoonal coast	**Avg max temp: > 25°C** HCAS ~0.6 Cluster with most Sea and Estuaries/Mangroves	**Liberal National Party of Qld (LNP); Pauline Hanson's One Nation (PHON)** ≈ 60%–70% Indigenous owned/managed land Weekly rent: $200–$300/wk	$ grants/km^2 ($80–$100)
6	NE agriculture	**Avg max temp: ~23°C** Some land cleared, non-native vegetation, buildings HCAS ~0.7	**LNP; PHON** ≈ 50% Indigenous owned/managed land > 80% speak only English at home Weekly rent: $100–$200/wk	>80% land used for grazing native vegetation Low $ grants/km^2 (≈ $4)
8	Western/ central arid	**Avg max temp: > 25°C** HCAS ~0.8	≈ 60%–70% Indigenous owned/managed land ≈ 50% leasehold Relatively young Weekly rent: $100–$200/wk	Low $ grants/km^2 (≈ $2)
1	Northern arid	**Avg max temp: > 25°C** HCAS ~0.8	**Country Liberal Party** > 80% Indigenous owned/managed land ≈ 50% freehold/leasehold Relatively young Few speak only English at home Weekly rent < $100/wk	Low $ grants/km^2 (≈ $5) **Low adaptive capacity** **Low disaster resilience**
7	Central eastern arid	**Avg max temp: ~20°C** HCAS ~0.8	≈ 50% Indigenous owned/managed land > 80% leasehold Weekly rent: $100–$200/wk	>80% land used for grazing native vegetation Low $ grants/km^2 (< $0.50)

3.3 Matching regions to planning approaches based on the regional-planning decision tree

We drew upon our final dataset to populate the decision tree. Because the regions are large, they all have many land uses (all > 3), many users (e.g. defined as economic sectors, or households, or towns) and many threats (e.g. all had invasive plants, invasive animals, climate change impacts and fire regime changes) that must be managed. Thus, our decision tree had to be modified to take into account that all NRM planners face the same challenges in terms of presence of multiple users and multiple threats.

Decision point 1: To differentiate regions in terms of relative complexity, we therefore explored which variables (of our many summarised) best explained differences in socioeconomic complexity. We used the spearman rank correlation coefficient to identify core variables that determine how regions might cluster, focusing in the first instance on socioeconomic variables.

Different variables drive how regions cluster based on shared socioeconomic attributes such as the proportion of a region that is Indigenous owned, managed or subject to other special rights, political representation from the Country Liberal party, presence of a major airport and proportion of region under modified pasture grazing. Considering these strong socioeconomic variables that predict regional clustering, we chose to focus on modified pasture grazing, as this relates to our first decision point of whether land uses and production systems capture multiple competition uses in rural regions and presence of major airports as a signal for economic activity and supply chain connectivity for urban regions.

Thus our data signal for decision point one is areas that have increased socioeconomic complexity are characterised by the presence of grazing on modified pasture (i.e. intensified animal production systems) or major airports (thus connecting larger urban centres to economies). The additional indicators from suggests that the clusters can almost be placed on a continuum of socioeconomic complexity – thus while we categorise for our decision-tree regions as low complexity or high complexity, we note that managers may use the cluster diagnostics presented in the above section alongside our decision-tree results for a more nuanced understanding of where they sit in the levels of complexity and approaches they should consider.

Decision point 2: We chose indicators for decision point 2 based on theory. For low complexity areas (data input 2 in Figure 12; this is area formally under protection (< 17% area protected as per previous protected-area coverage targets). We chose a threshold of 17% of area protected, as this was the protected area target that states and territories were committed to protecting at the time of data analysis (noting that the global target that Australia is a signatory to is now 30%). Where area protected is less than this threshold standard protected-area planning is likely to be effective in first instance to abate threats, while regions that have met this target may instead focus on more nuanced spatial planning for threat management.

For regions with high socioeconomic complexity, we considered EPBC-listed species. In exploring the structure of our data, all regions had more than 10% of area with at least one EPBC-listed species present. Thus, we focused on the number of listed species within the

region (both maximum number of listed species in an individual 10 km^2 grid and mean number of species across the full region). Thresholds were chosen based on natural breaks (which reflect statistical methods to capture the points in a dataset that identify breaks in data that are internally consistent) to capture the top 25% of regions (data input 3).

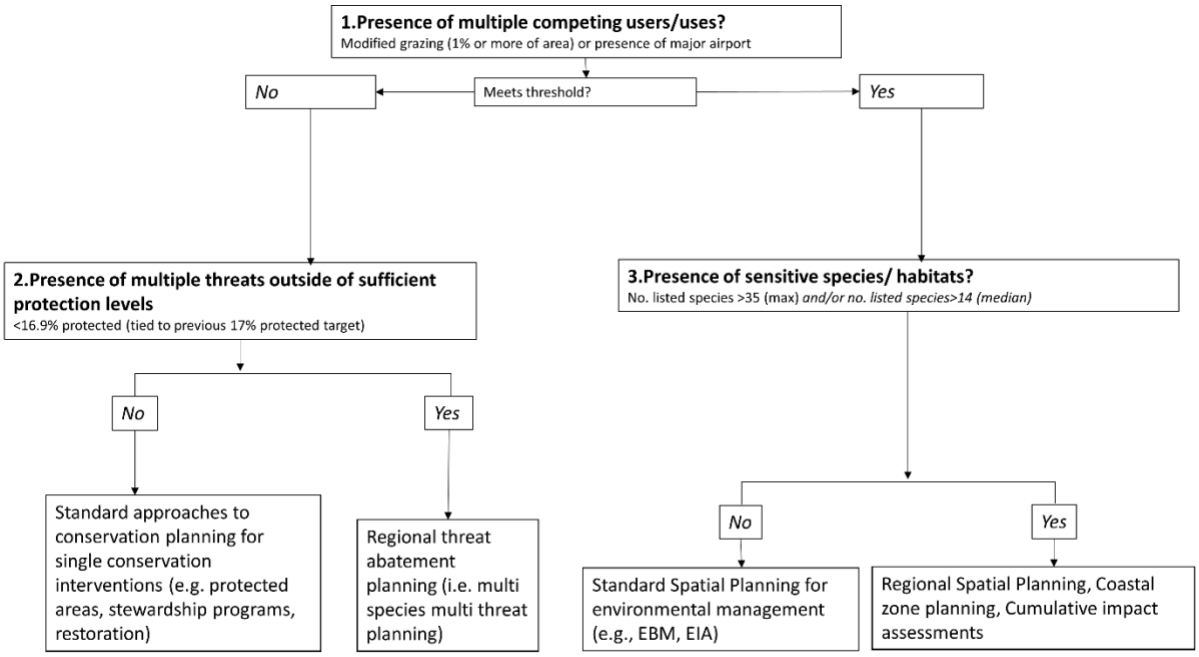

Figure 12. Regional-planning decision tree customised to our regional dataset.

Using the updated decision tree (Figure 12), we map IBRA sub-regions and NRM regions based upon the decision tree (Figure 13). These largely align with the clusters as identified in previous sections.

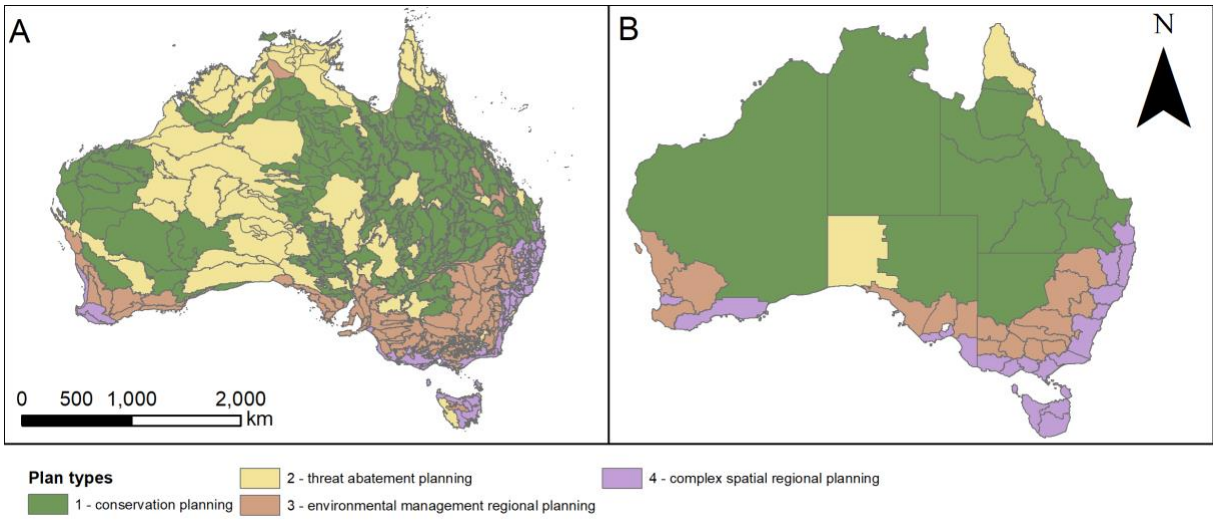

Figure 13. (A) IBRA sub-regions and (B) NRM regions matched to planning approach using the decision tree.

IBRA sub-regions are the planning regions by which Australia plans for and tracks progress of land-use decisions, such as building the national reserve system. These planning regions might also be logical choices for regional land-use planning where the Australian and state/territory governments are planning for future developments and zoning landscapes for specific uses. Based upon our database and decision tree, IBRA sub-regions with lower socioeconomic complexity are in planning types 1 and 2 and represent the majority of the continent in particular the rangelands. Planning type 1 regions are those that do not yet have sufficient levels of protection and thus would be best suited to classic conservation planning to expand reserve systems. Planning type 2 regions are those that have adequate levels of protection but still have persistent threats in landscape and thus would benefit from spatial threat abatement planning. The sub-regions identified by our decision tree for planning types 1 and 2 match Commonwealth protected area strategies (e.g. National Reserve System strategy [Commonwealth of Australia 2009] and Australian Protected Areas dashboard [DCCEEW 2009]). Furthermore, those areas in planning type 2 align with areas that have been the focus of past spatial threat-abatement planning exercises (e.g. Kimberley and Pilbara; Carwardine et al. 2012, Chades et al. 2015).

IBRA sub-regions with high socioeconomic complexity were largely those in high-value agricultural regions. Sub-regions recommended for standard spatial environmental management planning approaches (e.g. regional zoning, EBM; planning type 3) are those with more homogenous agricultural uses in rural zones, while areas recommended for complex spatial regional-planning approaches (planning type 4) tend to be coastal in nature with higher population density, competing land use values and larger volumes of threatened species. It is important to note that the signals of complexity captured here, while focused on terrestrial planning, are relevant for other domains of planning including water planning and coastal-zone planning. For example, our decision tree highlights the Daly River IBRA subregion in the Northern Territory as an area that may require regional planning specific to particular assets. In this region, both surface-water planning and groundwater planning using complex models and decision support have been undertaken and supported by previous NESP and National Environmental Research Programme research (e.g. Stoeckl et al. 2013; Adams et al. 2016). These planning approaches used both the coarse spatial datasets captured in our dataset and locally relevant datasets sourced specific to the planning needs, such as data on groundwater (e.g. aquifers), the relationships between local land uses and downstream impacts and socioeconomic data. This demonstrates our decision-tree maps regions to appropriate planning approaches for various environmental planning matters (freshwater, terrestrial, coastal), but local data and models are needed to formally undertake such planning.

Our second planning region type are NRM regions. NRM bodies are tasked with regional planning and these plans act as a vehicle by which to guide strategic investment into priority areas. NRM regions are thus a relevant unit by which to consider and match appropriate planning approaches. While the spatial pattern of plan approach groups is similar across IBRA sub-regions and NRM regions (Figure 13), NRM regions are larger and so some NRM regions are assigned lower socioeconomic complexity relative to IBRA sub-regions contained within them. This is the primary source of differentiation between the 2 groupings in Figure 13.

NRM regions characterised by high socioeconomic complexity (decision point 1) and presence of a large number of sensitive species (EPBC species richness – decision point 3) are largely southern regions in coastal zones with higher population densities and multiple land uses, as well as presence of large numbers of threatened species with legislated obligations to manage. These require more complex regional-planning approaches such as coastal-zone planning, cumulative-impact assessment, spatial regional land-use planning (Figure 13, group 4). We reiterate here the purpose of the decision tree is to support decision-makers in navigating the challenging first stage of a planning process in choosing the right planning approach for the right planning region. However, once a planning approach is chosen and scoped, the natural next step is for planners to choose the correct decision-making tools and data (Stoeckl et al 2016). It is likely that in these areas requiring more complex approaches to planning, so too will the resources in terms of data, planning support, and overall timelines and financial support for appropriate planning (Adams et al 2016).

Conversely, regions characterised by largely homogenous environments and land uses and low levels of existing protection are best matched to standard conservation-planning approaches such as spatial conservation planning for single interventions like protected areas (planning approach group 1 – conservation planning, Figure 13). A small number of areas (3) were identified as having relatively simple socioeconomic context and sufficient levels of protection and thus were best matched to threat-abatement planning which spatially plans for threat management specific to species needs (group 2, threat-abatement planning, Figure 13). Lastly, southern areas that had complex socioeconomic settings but smaller volumes of sensitive species were matched to standard environmental-management approaches such as EBM or environmental-impact assessment (group 3, Figure 13).

Reviewing sub-samples of NRM plans in these regions suggests that, while there is variability in specific planning approaches, they do largely conform to these planning types. For example, in group 2, the planning approaches employed were specific to threat management through methods such as Healthy Country Planning and planning adaptation pathways. In group 4, plans were often displayed in web platforms or documents that were simple and easy to interact with, but were supported by underlying models (e.g. conceptual models) and mapping tools. Plans in group 1 were typically simple, asset-based planning that identified values and threats or management needs for these. These are different to recommended spatial conservation planning which might focus on planning for future protection or conservation measures like stewardship. However, the asset-based management approach is more consistent with the types of plans and interventions an NRM body might influence and thus match the problem and policy scope that NRM bodies operate within. Lastly, group 3 also typically employed asset-management approaches but typically with further data or models underlying the prioritisation of assets within the plans relative to group 1, where plans were relatively simple in their characterisation of the underlying problem or threats to assets.

4. Discussion and applications

4.1 The database

Our database provides good contextual information that describes the natural/environmental systems, social/human sub-systems and interactions between them. It is thus well suited to the task of describing and characterising regions and identifying regions most suited to different planning approaches.

The dataset does, however, lack information about the effectiveness of prior environmental interventions or about other factors known to drive, moderate or mediate behaviours that impact the environment. Neither does it have variables which describe organisations, institutions or businesses. Future research could usefully aim to fill those gaps so that the database could better support natural resource managers who wish to devise policies to influence environmental behaviours and outcomes.

Data are stored in a GIS, which records information at the smallest geographic resolution available. Different data are collected for different geographic regions/boundaries, so we used bespoke algorithms to create variables that describe (i) NRM regions and (ii) IBRA sub-regions. This allowed us to create 2 spreadsheets: the first having one row per NRM region and one column per variable, and the second having one row per IBRA sub-region. Notably, the finer the desired geographic resolution, the fewer the available variables to describe multiple regions consistently across space. As such, the table that describes IBRA sub-regions has many missing variables[12] – particularly in rural and remote regions.

- The NRM region dataset provides information on 270 variables across 56 regions.
- If we omit the variables that do not have data in rural/regional areas, we can describe 409 IBRA sub-regions using 214 variables – these are a subset of the larger group of variables that are available for NRM regions.
- If we, instead, omit regions that have many missing datapoints, we can fully describe 268 IBRA sub-regions using all the 259 single-observation variables that are available for NRM regions.

The dataset lacks information about the effectiveness of prior environmental interventions or about other factors known to drive, moderate or mediate behaviours that impact the environment. Neither does it have variables which describe organisations, institutions or businesses. Future research could usefully aim to fill those gaps so that the database could

[12] For example, our dataset uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, RESTRICTED RELEASE 20 (Waves 1–20) conducted by the Australian Government Department of Social Services (DSS). The findings and views reported in this spatial dataset, however, are those of the authors and should not be attributed to the Australian Government, DSS, or any of DSS' contractors or partners. DOI: 10.26193/YP7MNU, ADA Dataverse. Pursuant to the license terms for the restricted release data we have only summarised to NRM regions. IBRA sub-regions are at a scale smaller than postcode for some states and thus cannot be summarised or reported as the dataset is not representative at this level; this means we exclude variables from our analyses for 84 HILDA variables.

Similar problems existed for some of our variables relating to water (specifically, counts of the number of bores, estimates of the proportion of regions with surface water) – although this only affected 13 IBRA sub-regions.

better support natural resource managers who wish to devise policies to influence environmental behaviours and outcomes.

Nonetheless, the dataset has good coverage of variables that describe the socioeconomic and demographic characteristics of individuals, families, and communities. Some other variables which are commonly used within the literature to describe social–ecological systems are not formally listed in our dataset but could be constructed from other measures. For example, indicators of poverty or social equity could be estimated from data pertaining to incomes. Missing from our dataset are variables that measure corruption or conflict – although these indicators are arguably of less importance in Australia than some other parts of the world. If wishing to make cross-national comparisons, this gap would be an important one to fill, but the gap is likely to be relatively unimportant if only seeking to make inter-regional comparisons within Australia.

Variables that describe the ecological system are also well presented across the dataset, in particular, those pertaining to land use, vegetation, climate. Although we have a few coarse indicators relevant to surface water and the presence of bores, we do not have information about the amount of water extracted across the landscape, nor about which areas might be impacted by the extraction. The dataset could be usefully supplemented with, for example, data relating to groundwater-dependent ecosystems. We do not have continental-scale measures of nitrogen deposition, soil phosphorus availability, nitrogen fixation, soil water infiltration, net primary productivity (variables cited by other scholars as being potentially important to describe social–ecological systems). But we do have indicators of land suitability, overexploitation and grazing-impact risk, so we arguably do capture these types of variables, albeit in a different way. We have measures relating to fire and fire risk, but do not have indicators of pests and invasive species – although measures of ecosystem-service values could be used as (admittedly coarse) indicators of vulnerability to pests, since different ecosystem services are more or less susceptible to different types of pests (Stoeckl et al. 2023).

Indicators that describe interactions between the ecological and social systems include variables relating to land use (e.g. for grazing, irrigated agriculture, services or other industries), water extraction, reservoirs, aqueducts, mines, grazing impacts and the value of several different ecosystem services. We also have measures of the ways in which humans respond to and adapt to changes in the environment, including adaptive and coping capacity and (community) disaster resilience. We do not have direct indicators for variables such as people's ability to access natural and seminatural areas, but we do have numerous indirect indicators describing land use and land tenure, and hence, indirectly, access. We also do not have direct indicators of water use and water management, but we do have several indicators of water supply (e.g. presence/absence of surface water, rivers/wetlands) and of water infrastructure (land used for reservoirs, aqueducts/channels, the number of bores). Similarly, indicators of access to drinking water, environmental quality, and water scarcity, could be constructed or inferred from data that describe vegetation cover, habitat condition, overexploitation and grazing impact risk, water supply and the distribution of population.

Although the IBRA dataset does not contain as much information as the NRM dataset, it does contain information about the human/social system, the natural/environmental system and interactions between the 2 systems. So, too, does our NRM database, and our analysis of the dataset suggests that it provides good contextual information that describes the

natural/environmental and social/human sub-systems and interactions between them. In other words, the dataset is able to inform several natural resources management concerns, enabling managers to complete a number of tasks. For example, this dataset enables managers to describe and compare regions using consistent indicators across the entire continent. This could help identify regions that may need resources to redress specific problems (e.g. where degradation is evident or where threatening processes are prevalent) that may warrant specialised conservation attention (e.g. areas with endemic species or endangered species) or that are likely to require formal planning processes to help negotiate competing interests (e.g. regions with both conservation and development values). It is thus well suited to the task of describing and characterising regions.

Specifically, we feel able to use it to

- identify regions that 'look and feel' the same
- identify regions that are suited to different types of planning.

Harmonisation of data allows one to describe different regions using similar metrics, thus enabling cross-site comparisons. It also allows one to identify sites that are similar or different to each other (Larson et al. 2013; Václavík et al. 2016; Pacheco-Romero et al. 2022). This information can be used to assess the extent to which initiatives or research findings that have been generated at one site can be transferred to another or otherwise generalised (Magliocca et al. 2018). It can also be used to set up networks for natural resource managers that enables and supports the sharing of insights and learnings across similar regions (whether located close or far apart geographically) so they can share information to enhance environmental outcomes (Mahyuni and Syahrin 2021). Benefits of facilitation and mediation processes by a bridging organisation, in support of cross-scale communications, have been reported (Leys et al. 2011). The compiled dataset could also be used to develop or parameterise transfer functions that could be used to better contextualise results if wishing to transfer findings from one area to another (Richardson et al. 2015; Stoeckl et al. 2023; Rosenberger and Loomis 2017) – although we do not demonstrate those applications here.

In this report, we demonstrate how to use our data to identify regions that look and feel the same (clustering) and in matching regions to planning approaches.

4.2 The clusters

Our clustering methods allow us to identify regions that 'look and feel' the same, and the general location of these clusters appears robust – irrespective of whether the clustering is undertaken for NRM regions or IBRA sub-regions.

Our analysis clearly indicated that the regions can be grouped into clusters that 'look and feel' the same. We presented maps and summaries for up to 10 clusters but note that it may not be necessary to use more than 6 or 7 clusters to adequately describe and categorise regions. There is certainly little to be gained by forcing the dataset to distinguish a much

larger number of (geographically) smaller regions – our analysis suggests that the data would not clearly differentiate between groups beyond about 10.

The maps that pertain to NRM regions and IBRA sub-regions show clear differences related to boundaries, but the way in which regions cluster are similar and this gives confidence in the robustness of results. For example, different areas of Australia are consistently identified as being ‘similar’, irrespective of whether one looks at the maps generated for NRM regions or for IBRA sub-regions. The boundaries for the maps in Figure 14 have different ‘shapes’, but regions group in similar locations – and the general descriptors of each (Table 6 [NRM regions] and Table 7 [IBRA sub-regions]) are consistent.

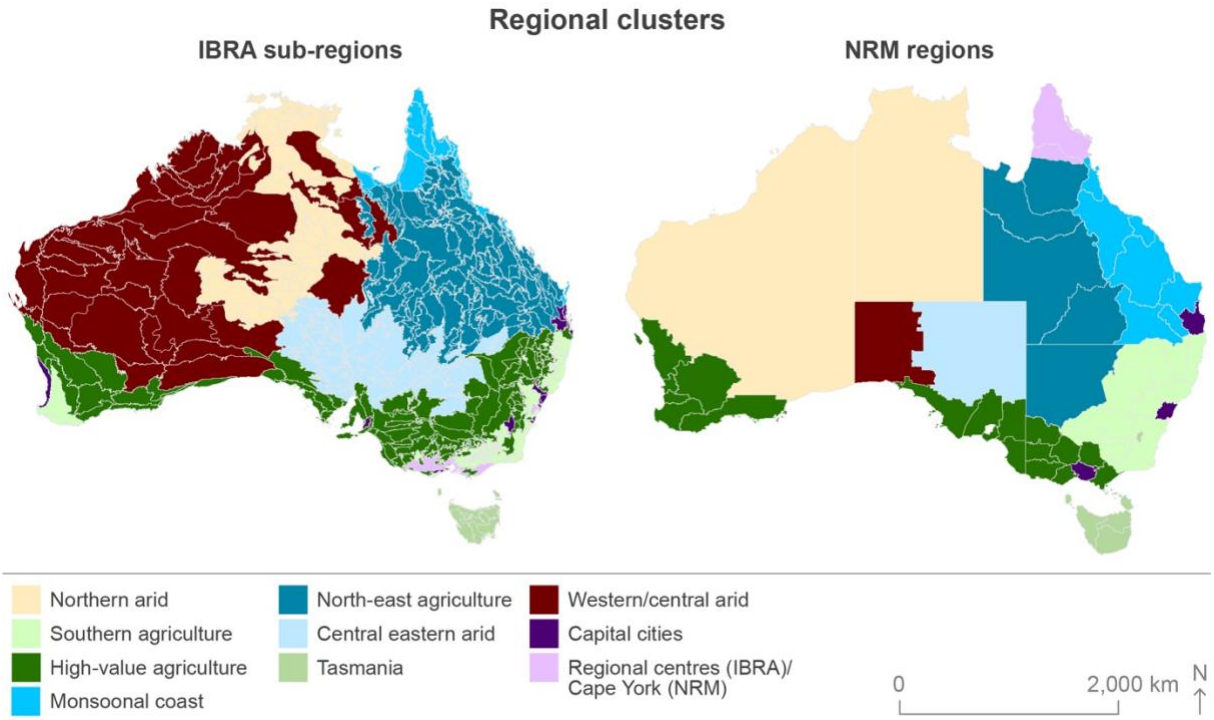

Figure 14. Ten cluster regions for (A) IBRA sub-regions (using 214 variables) and (B) NRM regions (using 267 variables).

Developing effective policies for the management of natural resources and land necessitates better understanding of the people who manage these resources, including their socioeconomic circumstances and value systems. Our clusters support this argument – that similar places can learn from each other – the key challenge being to establish which areas are similar to each other (Václavík et al. 2016). The top-down data integration approach similar to the one presented here allows for bundling of regions that are, by characteristics, similar to each other. Natural resource and land managers and policy-makers can then explore experiences of similar regions and learn what has or has not worked there. Importantly, they can form social networks and knowledge-exchange hubs among the ‘theoretically’ similar regions to further explore the potential transferability of knowledge in more targeted ways. A natural next step in this work would be to explore with managers the extent to which they already have peer networks within their identified clusters or to what extent new knowledge-exchange networks would have to be built to connect regions with shared attributes.

4.3 The cluster descriptions

Different variables drive cluster membership – although in all cases, it seems that a proper characterisation of regions requires one to use variables that describe the natural system, the social system and interactions between them. Moreover, the larger the number of clusters, the larger the number of variables required to distinguish clusters. When working with the smaller geographic regions (IBRA), it is evident that a larger number of variables are required to effectively describe regions and delineate clusters.

Evidently the smaller the geographic scale at which one wants to work, the more nuanced and detailed the data required to describe it adequately.

Our analysis identified a range of variables that usefully describe and distinguish clusters (formally, they have a strong or moderate influence on cluster membership). A relatively large number of variables have a moderate influence, but even if focusing only on those with strong influence, it is clear that one needs to describe parts of the natural/ecological system, parts of the social/human system and also interactions between the systems (Table 8).

Table 8. Variables having a strong influence on cluster membership.

Part of system described	NRM clusters	IBRA clusters
Natural/ecological system	MVG: Tropical Eucalypt Woodlands and Grasslands Climate: mean temperature	Climate: max temperatures, median temperature Extreme events: proportion of region affected by fire: 2019–20
Social/human system	Built infrastructure: large airports (presence) Politics: (numerous)	Politics: (numerous)
Interaction	Land use: grazing modified pastures	Adaptive capacity Disaster resilience Land use: grazing modified pastures

The clusters are located in approximately the same parts of Australia, so it is not surprising to see that the core variables the general descriptors of clusters, using ‘core variables’ are similar (Table 6 [NRM regions] and Table 7 [IBRA sub-regions]) are consistent.

4.4 Using the maps and tables to identify similar regions

It is possible to use either the maps, or the cluster description in conjunction with the maps, to identify regions that are ‘similar’. Regions that are ‘similar’ are those that are most amenable to the intent of knowledge-sharing which includes but is not limited to building networks and/or transferring findings from research and on-ground work between similar regions.

One of our overarching aims was to produce outputs that could help decision-makers identify ‘similar’ regions, reasoning that it may be possible to amplify the impact of work by transferring findings from research or lessons from on-ground work that has been undertaken in one region to other similar regions.

The easiest way to do this is to use the maps – first finding the core region that you are interested in, and then finding other regions that are a similar colour. Regions of a similar colour are those that are most amenable to the intent of transferring findings from research or other on-ground work.

As noted earlier, however, there will be much intra-regional variation and, in some cases, a particular (small) location that sits within a larger region may not be well described by the characteristics of that larger region. We therefore sought to improve the utility of our work by not only providing maps which show the (large) regions that are similar to each other but by also providing tables that summarises core characteristics of each cluster – the core characteristics being the variables that drive cluster membership. These can be used to help identify places that may be more similar to a particular location than to the larger region in which that location is embedded. An example is given below.

- Land managers may have, as their primary interest, mangrove areas along the coast of the Northern Territory.
- Our clustering mostly places those areas within the ‘North-west rangelands’ NRM region cluster or the ‘Central eastern arid’ IBRA sub-region cluster.
- Land managers who are interested in mangrove areas may find it more useful to connect with others who are working in other areas with mangroves that share social characteristics. Either the general/qualitative descriptions of clusters (Table 6 [NRM regions] and Table 7 [IBRA sub-regions]) or the more detailed data contained in Table 14 and Table 15 could be used to identify the ‘Cape York’ (NRM region) or ‘Coastal tropics (Qld)’ (IBRA sub-region) cluster as a likely candidate for knowledge sharing or transfer. The coastal regions of the Northern Territory, Cape York and the Coastal tropics (Qld) IBRA sub-region clusters both have mangroves. But the other variable descriptors of IBRA sub-region clusters (Table 7 and Table 15) suggest that people/communities living along the coast of the Northern Territory may have more in common with the people/communities of the Cape York IBRA sub-region cluster than the ‘Monsoonal’ IBRA sub-region cluster – the core insight being that the coastal/mangrove communities of the Northern Territory may be able to share more learnings with Cape York, than with the Coastal Tropics (Qld).

4.5 Identifying regions most suited to different types of planning

We use the data in conjunction with the regional-planning decision tree, also developed within NESP RLH project 'Socioeconomic insights for resilient landscapes', to test the planning-approach decision tree, refine it and identify regions that are most suited for each type of regional-planning approach identified in the decision tree. An important first finding in operationalising the original decision tree is that managers may first need to characterise their region based on 'flat' data descriptors that cannot support decision points around calculating extent or interactions between data. Thus, our revision of the decision tree makes it a more easily navigated tool for decision-makers.

The decision-tree outputs match expectations that more complicated regions (based on socioeconomic and environmental data signals) require more complicated planning. These are largely areas with more intensive agricultural production systems (captured by the data signal of presence of grazing on modified pastures) and higher population densities as well as sensitive ecosystems and threatened species. Planning for these areas thus requires more in-depth planning processes and tools that can account for the spatial overlaps and competing needs of the social, economic and environmental, as well as how each system responds to the other (Adams et al. 2014, Alvarez-Romero et al. 2015, Adams et al. 2016, Bonnevie et al. 2016).

The outputs of the decision tree demonstrate strong similarities to the clusters identified through statistical analyses above but with some important differentiations (Figure 15 and Figure 16). This highlights an important feature of planning approaches which is that they must be tailored to the particular planning needs in addition to the local contextual features.

Our results across methods (clustering and decision tree) signal the potential to identify regional archetypes to support decision-making. The concept of regional clusters or 'land system archetypes' has received increasing attention, in response to the calls for frameworks that incorporate multiple dimensions of land-use intensity (Václavík et al. 2013). Archetypes are based on identification of patterns of land-use intensity, environmental conditions and socioeconomic factors that appear repeatedly across the terrestrial earth surface (Václavík et al. 2013). Our clustering approaches and regional decision tree present 2 methods by which to define regional land system archetypes (Figure 15, Figure 16). These can be used in further analyses to test and deploy decision support e.g. through system dynamics modelling and participatory scenario development (Voinov et al. 2018).

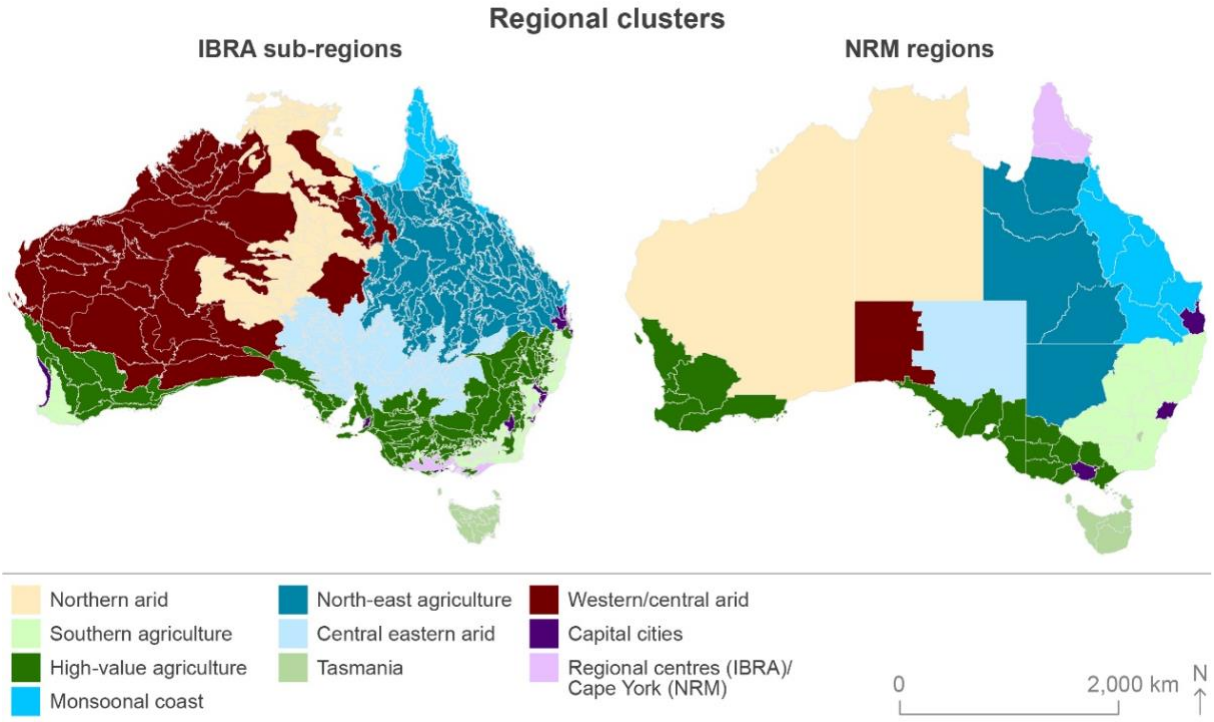

Figure 15. Regional clusters that are similar to each other. IBRA sub-regions (214 variables, 10 clusters); NRM regions (270 variables, 10 clusters).

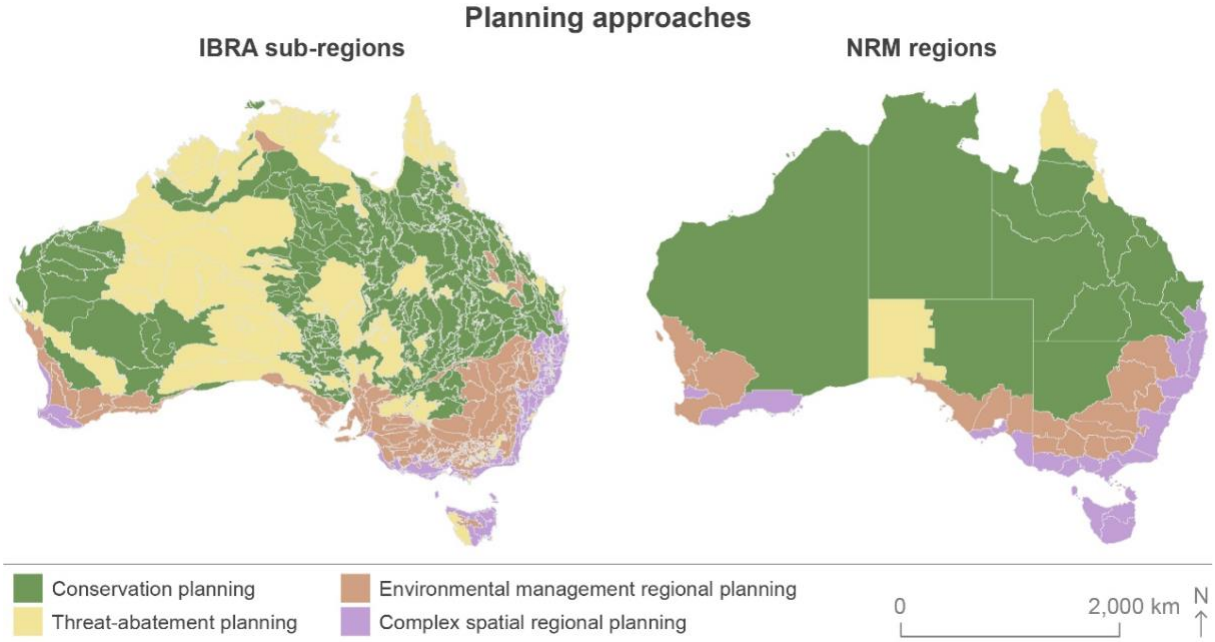

Figure 16. Planning groups that have shared traits based on the regional-planning decision tree.

5. Conclusions and directions for future research

The amount of funding available for environmental research and on-ground action, such as restoration, is limited. Likewise, there are limited resources available to support the development of regional-scale plans for on-ground action. To achieve the greatest outcomes (such as knowledge gains and, ultimately, protection of ecosystems and biodiversity) the funds allocated to research, planning and on-ground environmental action must be spent cost-effectively. This means being able to translate knowledge across regions in sensible ways to use the available evidence to build the most impactful environmental programs. This project focused on 2 different types of regions: NRM regions and IBRA sub-regions. Our choice of regional units is based on discussions held with relevant decision-makers. Our work generates insights that help us understand the extent to which knowledge gleaned in one region can be transferred to another region. It also helps us identify regions most or least suited to particular planning approaches. Importantly, we capture these results with simple-to-interpret mapped regions that share social and ecological attributes. These allow planners to consider areas that best match a particular planning approach as well as regions that share attributes and thus are likely to support similar interventions. This fundamentally allows natural resource managers to identify their planning peers to share knowledge and scale up interventions.

While our data compilation is an important asset for natural resource managers, planners and researchers, we identified notable data gaps. These include variables describing organisations (business, community or other), the outcomes from previous environmental management interventions, and measures of social norms and values – although the variables that describe the political representatives from different regions arguably work as (coarse) proxies for some social norms and values. Future research could aim to fill some of those gaps, greatly enhancing our ability to analyse the data revealing, for example, core factors that correlate with successful environmental management interventions.

Our regionalisation, based on the data and statistical methods, provide interesting groupings of regions that provide insights into which regions are most similar and or different and why. However, these require further testing and interrogation by decision-makers that might use these, for example, to connect with their regional peers to share knowledge, adopt practices from other regions to scale up interventions, or improve upon practices already in place by ‘tweaking’ them to match regions that have demonstrated success stories. The next step would be to explore these issues with managers to better understand how they might use these regionalisations.

Similarly, using the data our decision tree provides groups of regions with shared attributes that best match the overall data needs and theoretical underpinnings of particular regional-planning approaches. We have done a desktop validation of these groupings and the decision-tree methods by reviewing the existing NRM planning approaches. The plans employed by NRM regions largely match the regional-planning approaches we assigned them based on the decision tree but with some nuanced variability. The next step would be to further test the decision tree and outputs with planners.

Lastly, our statistical matching of regions provides similar, but slightly different, groupings of regions to that of our regional-planning decision tree. This is a reasonable result given matched regions may still have different planning needs; however, the 2 products can be used in tandem to give regional planners and natural resource managers an elevated understanding of the types of attributes and complexities present in their regions. We discuss how these products can be used together to demonstrate the individual and collective power of each.

6. Glossary

ABS..... Australian Bureau of Statistics

DCCEEW.. Australian Department of Climate Change, Energy, the Environment and Water

EBM..... ecosystem-based management

EIA..... environmental-impact assessment

EPBC Act.. *Environment Protection and Biodiversity Conservation Act 1999*

GIS..... geographic information system

HILDA..... Household, Income and Labour Dynamics in Australia

IBRA ..... Interim Biogeographic Regionalisation for Australia

MVG..... major vegetation group

NESP..... National Environmental Science Program

NRM..... natural resource management

RLH..... Resilient Landscapes Hub

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Appendix A: Description of variables

Natural Resource Management regions
nrm_id nrm_name state nrm_area_km2

ABS: 2016 Census

abs_2016_persons_total abs_2016_persons_aboriginal
abs_2016_persons_torres_strait_islander
abs_2016_persons_employed_aged_15_and_over
abs_2016_population_densityin persons/km2; computed as the ratio of persons_total to nrm_area_km2
abs_2016_population_median_age abs_2016_average_household_size
abs_2016_average_persons_per_bedroom
abs_2016_median_total_family_income_weekly
abs_2016_median_total_household_income_weekly
abs_2016_median_total_personal_income_weekly
abs_2016_median_mortgage_repayment_monthly abs_2016_median_rent_weekly
abs_2016_proportion_families_no_children
abs_2016_proportion_females_three_or_more_children denominator is number of females aged 15 and over
abs_2016_proportion_families_one_parent
abs_2016_proportion_married denominator is persons aged 15 and over
abs_2016_proportion_indigenous
abs_2016_proportion_lived_different_address_5_years_ago
abs_2016_proportion_unemployment abs_2016_proportion_employment
abs_2016_proportion_workforce_agriculture_forestry_fishing denominator for this and other workforce figures is persons employed aged 15 and over
abs_2016_proportion_workforce_construction
abs_2016_proportion_workforce_education_training
abs_2016_proportion_workforce_utilities
abs_2016_proportion_workforce_healthcare_social_assistance
abs_2016_proportion_workforce_manufacturing
abs_2016_proportion_workforce_mining
abs_2016_proportion_dwellings_owned_outright
abs_2016_proportion_dwellings_owned_with_mortgage
abs_2016_proportion_degree_or_higher includes Bachelor's degree, postgraduate degree and graduate diploma; denominator is persons aged 15 and over
abs_2016_proportion_year_10_or_below denominator is persons aged 15 and over not attending school
abs_2016_proportion_no_schooling denominator is persons aged 15 and over not attending school abs_2016_proportion_dwellings_rented_real_estate_agent
abs_2016_proportion_dwellings_rented_community_org
abs_2016_proportion_dwellings_no_internet_connection
abs_2016_proportion_homes_no_motor_vehicles
abs_2016_proportion_population_born_australia
abs_2016_proportion_population_english_only
abs_2016_proportion_no_religious_affiliation abs_2016_proportion_volunteer denominator is persons aged 15 and over

ABS: 2021 Census
Note that the question concerning internet connection is removed for the 2021 census.

abs_2021_persons_total abs_2021_persons_aboriginal
abs_2021_persons_torres_strait_islander

abs_2021_persons_employed_aged_15_and_over
abs_2021_population_density in persons/km2; computed as the ratio of persons_total to nrm_area_km2
abs_2021_population_median_age abs_2021_average_household_size
abs_2021_average_persons_per_bedroom
abs_2021_median_total_family_income_weekly
abs_2021_median_total_household_income_weekly
abs_2021_median_total_personal_income_weekly
abs_2021_median_mortgage_repayment_monthly
abs_2021_median_rent_weekly abs_2021_proportion_families_no_children
abs_2021_proportion_females_three_or_more_children denominator is number of females aged 15 and over
abs_2021_proportion_families_one_parent
abs_2021_proportion_married denominator is persons aged 15 and over
abs_2021_proportion_indigenous
abs_2021_proportion_lived_different_address_5_years_ago
abs_2021_proportion_unemployment abs_2021_proportion_employment
abs_2021_proportion_workforce_agriculture_forestry_fishing denominator for this and other workforce figures is persons employed aged 15 and over
abs_2021_proportion_workforce_construction
abs_2021_proportion_workforce_education_training
abs_2021_proportion_workforce_utilities
abs_2021_proportion_workforce_healthcare_social_assistance
abs_2021_proportion_workforce_manufacturing
abs_2021_proportion_workforce_mining
abs_2021_proportion_dwellings_owned_outright
abs_2021_proportion_dwellings_owned_with_mortgage
abs_2021_proportion_degree_or_higher includes Bachelor's degree, postgraduate degree and graduate diploma; denominator is persons aged 15 and over
abs_2021_proportion_year_10_or_below denominator is persons aged 15 and over not attending school
abs_2021_proportion_no_schooling denominator is persons aged 15 and over not attending school abs_2021_proportion_dwellings_rented_real_estate_agent
abs_2021_proportion_dwellings_rented_community_org
abs_2021_proportion_homes_no_motor_vehicles
abs_2021_proportion_population_born_australia
abs_2021_proportion_population_english_only
abs_2021_proportion_no_religious_affiliation abs_2021_proportion_volunteer denominator is persons aged 15 and over

Remoteness Index

Proportion of region in each of 6 remoteness index categories

remoteness_proportion_inner_regional_australia
remoteness_proportion_major_cities_of_australia
remoteness_proportion_outer_regional_australia
remoteness_proportion_remote_australia remoteness_proportion_unclassified
remoteness_proportion_very_remote_australia

Land use

Proportion of region in each of 6 primary land use categories (not used in clustering analysis – since the secondary land-uses, below, are nested within these)

land_use_1_conservation_and_natural_environments
land_use_2_production_from_relatively_natural_environments
land_use_3_production_from_dryland_agriculture_and_plantations
land_use_4_production_from_irrigated_agriculture_and_plantations

land_use_5_intensive_uses
land_use_6_water

Proportion of region in each secondary land use category

land_use_1.1_nature_conservation land_use_1.2_managed_resource_protection
land_use_1.3_other_minimal_use land_use_2.1_grazing_native_vegetation
land_use_2.2_production_native_forests land_use_3.1_plantation_forests
land_use_3.2_grazing_modified_pastures land_use_3.3_cropping
land_use_3.4_perennial_horticulture land_use_3.5_seasonal_horticulture
land_use_3.6_land_in_transition
land_use_4.0_production_from_irrigated_agriculture_and_plantations
land_use_4.1_irrigated_plantation_forests
land_use_4.2_grazing_irrigated_modified_pastures land_use_4.3_irrigated_cropping
land_use_4.4_irrigated_perennial_horticulture
land_use_4.5_irrigated_seasonal_horticulture
land_use_4.6_irrigated_land_in_transition land_use_5.0_intensive_uses
land_use_5.1_intensive_horticulture land_use_5.2_intensive_animal_production
land_use_5.3_manufacturing_and_industrial
land_use_5.4_residential_and_farm_infrastructure land_use_5.5_services
land_use_5.6_utilities land_use_5.7_transport_and_communication
land_use_5.8_mining land_use_5.9_waste_treatment_and_disposal
land_use_6.0_water
land_use_6.1_lake land_use_6.2_reservoir_dam land_use_6.3_river
land_use_6.4_channel_aqueduct land_use_6.5_marsh_wetland
land_use_6.6_estuary_coastal_waters

Climate

Mean annual air temperature (deg C) (mean annual daily mean air temperatures averaged over 1 year)

climate_chelsa_bio1_mean_temp_max
climate_chelsa_bio1_mean_temp_median

Mean daily minimum air temperature of the coldest month (deg C) (lowest temperature of any monthly daily mean maximum temperature)

climate_chelsa_bio6_min_temp_min
climate_chelsa_bio6_min_temp_median

Mean daily maximum air temperature of the warmest month (deg C) (highest temperature of any monthly daily mean maximum temperature)

climate_chelsa_bio5_max_temp_max
climate_chelsa_bio5_max_temp_median

Annual precipitation amount (mm) (Accumulated precipitation amount over 1 year)

climate_chelsa_bio12_ann_precip_min
climate_chelsa_bio12_ann_precip_max
climate_chelsa_bio12_ann_precip_median

Heritage

Count of heritage places in region

heritage_national_place_count
heritage_commonwealth_place_count

Mines

Count of mines in region, by type

mines_under_development_care_and_maintenance
mines_mineral_deposit
mines_operating_mine
mines_all_types sum of 3 previous categories (not used in clustering analysis)

Land tenure

Proportion of region by land tenure type

land_tenure_crown_leasehold
land_tenure_crown_other l
and_tenure_freehold
land_tenure_unknown

Land capacity

Proportion of region by land capacity category (high = 1–4; medium = 5–6)

land_capacity_high
land_capacity_medium

NVIS Major Vegetation Groups 6.0 [2020]

Proportion of region in each Major Vegetation Group

nvis_mvg_60_acacia_forests_and_woodlands
nvis_mvg_60_acacia_open_woodlands
nvis_mvg_60_acacia_shrublands
nvis_mvg_60_callitris_forests_and_woodlands
nvis_mvg_60_casuarina_forests_and_woodlands
nvis_mvg_60_chenopod_shrublands_samphire_shrublands_and_forblands
nvis_mvg_60_cleared_non-native_vegetation_buildings
nvis_mvg_60_eucalypt_low_open_forests
nvis_mvg_60_eucalypt_open_forests
nvis_mvg_60_eucalypt_open_woodlands
nvis_mvg_60_eucalypt_tall_open_forests
nvis_mvg_60_eucalypt_woodlands
nvis_mvg_60_heathlands
nvis_mvg_60_hummock_grasslands
nvis_mvg_60_inland_aquatic_freshwater_salt_lakes_lagoons
nvis_mvg_60_low_closed_forests_and_tall_closed_shrublands
nvis_mvg_60_mallee_open_woodlands_and_sparse_mallee_shrublands
nvis_mvg_60_mallee_woodlands_and_shrublands
nvis_mvg_60_mangroves
nvis_mvg_60_melaleuca_forests_and_woodlands
nvis_mvg_60_naturally_bare_sand_rock_claypan_mudflat
nvis_mvg_60_other_forests_and_woodlands
nvis_mvg_60_other_grasslands_herblands_sedgelands_and_rushlands
nvis_mvg_60_other_open_woodlands
nvis_mvg_60_other_shrublands
nvis_mvg_60_rainforests_and_vine_thickets
nvis_mvg_60_regrowth_modified_native_vegetation
nvis_mvg_60_sea_and_estuaries
nvis_mvg_60_tropical_eucalypt_woodlands_grasslands
nvis_mvg_60_tussock_grasslands
nvis_mvg_60_unclassified_forest
nvis_mvg_60_unclassified_native_vegetation

NVIS Major Vegetation Groups 4.2 [2016]

Proportion of region in each Major Vegetation Group

nvis_mvg_42_acacia_forests_and_woodlands
nvis_mvg_42_acacia_open_woodlands
nvis_mvg_42_acacia_shrublands
nvis_mvg_42_callitris_forests_and_woodlands
nvis_mvg_42_casuarina_forests_and_woodlands
nvis_mvg_42_chenopod_shrublands_samphire_shrublands_and_forblands
nvis_mvg_42_cleared_non-native_vegetation_buildings
nvis_mvg_42_eucalypt_low_open_forests

nvis_mvg_42_eucalypt_open_forests
nvis_mvg_42_eucalypt_open_woodlands
nvis_mvg_42_eucalypt_tall_open_forests
nvis_mvg_42_eucalypt_woodlands
nvis_mvg_42_heathlands
nvis_mvg_42_hummock_grasslands
nvis_mvg_42_inland_aquatic_freshwater_salt_lakes_lagoons
nvis_mvg_42_low_closed_forests_and_tall_closed_shrublands
nvis_mvg_42_mallee_open_woodlands_and_sparse_mallee_shrublands
nvis_mvg_42_mallee_woodlands_and_shrublands
nvis_mvg_42_mangroves
nvis_mvg_42_melaleuca_forests_and_woodlands
nvis_mvg_42_naturally_bare_sand_rock_claypan_mudflat
nvis_mvg_42_other_forests_and_woodlands
nvis_mvg_42_other_grasslands_herblands_sedgelands_and_rushlands
nvis_mvg_42_other_open_woodlands
nvis_mvg_42_other_shrublands
nvis_mvg_42_rainforests_and_vine_thickets
nvis_mvg_42_regrowth_modified_native_vegetation
nvis_mvg_42_sea_and_estuaries
nvis_mvg_42_tropical_eucalypt_woodlands_grasslands
nvis_mvg_42_tussock_grasslands
nvis_mvg_42_unclassified_forest
nvis_mvg_42_unclassified_native_vegetation

Plant species richness

Number of native plant species in region (modelled)
plant_species_richness

EPBC-listed species and communities (DCCEEW)

Maximum and median richness of EPBC-listed species across region
epbc_listed_species_richness_max
epbc_listed_species_richness_median
Maximum and median richness of EPBC-listed ecological communities across region
epbc_listed_ecological_community_richness_max
epbc_listed_ecological_community_richness_median

Protected areas (CAPAD; Collaborative Australian Protected Areas Database)

Proportion of region protected
capad_proportion_protected

Water

Proportion of region that has surface water (Note: breakdown by surface water type is available) surface_water_proportion

Fire (recent impact)

Proportion of region within the NIAFED footprint of the 2019/2020 bushfires (restricted to DCCEEW's Preliminary Analysis Area)
fire_niafed_paa_2019_2020_proportion_affected

Fire (history)

Proportion of region affected by bushfire in historic periods (restricted to DCCEEW's Preliminary Analysis Area) fire_history_paa_1969_2018_proportion_affected
fire_history_paa_2004_2018_proportion_affected
fire_history_paa_2014_2018_proportion_affected

Airports (interim data)
Count of airports in region, by size
airports_closed
airports_large
airports_medium
airports_small
airports_total sum of 4 previous categories (not used in clustering analysis)

Value of Ecosystem services, Million $ per annum
value_of_assets_non_use_value_residents
value_of_assets_recreation_use_value_residents
value_of_assets_use_value_international_tourists
value_of_assets_agriculture
value_of_assets_forestry_logging value_of_assets_carbon_sequestration
value_of_assets_water_purification value_of_assets_erosion
value_of_assets_flood_control value_of_assets_genepool
value_of_assets_toxin_mediation
value_of_assets_infrastructure which is vulnerable to pests

Political parties
2019 federal election
Proportion of region represented by political party (lower house) (based on proportion of Commonwealth Electoral Division within region)
federal_lower_house_proportion_2019_election_australian_labor_party
federal_lower_house_proportion_2019_election_centre_alliance
federal_lower_house_proportion_2019_election_independent
federal_lower_house_proportion_2019_election_katters_australian_party
federal_lower_house_proportion_2019_election_liberal
federal_lower_house_proportion_2019_election_liberal_national_party
federal_lower_house_proportion_2019_election_the_greens
federal_lower_house_proportion_2019_election_the_nationals
Count of senators by political party, with representation based on the state in which the region is located (from 2019 federal election results; includes only the 40 seats up for re-election in 2019)
federal_upper_house_num_senators_2019_election_australian_labor_party
federal_upper_house_num_senators_2019_election_country_liberal_party
federal_upper_house_num_senators_2019_election_jacqui_lambie_network
federal_upper_house_num_senators_2019_election_liberal
federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland
federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation
federal_upper_house_num_senators_2019_election_the_greens
federal_upper_house_num_senators_2019_election_the_nationals
Count of incumbent senators by political party, with representation based on the state in which the region is located (includes 75 senators in total, with one casual vacancy as of 2022)
federal_upper_house_incumbent_post_2019_election_australian_labor_party
federal_upper_house_incumbent_post_2019_election_centre_alliance
federal_upper_house_incumbent_post_2019_election_country_liberal_party
federal_upper_house_incumbent_post_2019_election_independent
federal_upper_house_incumbent_post_2019_election_jacquie_lambie_network
federal_upper_house_incumbent_post_2019_election_liberal
federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland
federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation

federal_upper_house_incumbent_post_2019_election_the_greens
federal_upper_house_incumbent_post_2019_election_the_nationals

2016 federal election

Proportion of region represented by political party (lower house) (based on proportion of Commonwealth Electoral Division within region)

federal_lower_house_proportion_2016_election_australian_labor_party
federal_lower_house_proportion_2016_election_independent
federal_lower_house_proportion_2016_election_katters_australian_party
federal_lower_house_proportion_2016_election_liberal
federal_lower_house_proportion_2016_election_liberal_national_party
federal_lower_house_proportion_2016_election_nick_xenophon_team
federal_lower_house_proportion_2016_election_the_greens
federal_lower_house_proportion_2016_election_the_nationals

Count of senators by political party, with representation based on the state in which the region is located (from 2016 federal election results; all 76 seats up for re-election in 2016 due to double dissolution)

federal_upper_house_num_senators_2016_election_australian_labor_party
federal_upper_house_num_senators_2016_election_country_liberal_party
federal_upper_house_num_senators_2016_election_derryn_hinchs_justice_party
federal_upper_house_num_senators_2016_election_family_first
federal_upper_house_num_senators_2016_election_jacqui_lambie_network
federal_upper_house_num_senators_2016_election_liberal
federal_upper_house_num_senators_2016_election_liberal_democrats
federal_upper_house_num_senators_2016_election_liberal_national_party_of_queen sland
federal_upper_house_num_senators_2016_election_nick_xenophon_team
federal_upper_house_num_senators_2016_election_pauline_hansons_one_nation
federal_upper_house_num_senators_2016_election_the_greens
federal_upper_house_num_senators_2016_election_the_nationals

Native title

Count of native title outcomes in region

native_title_outcome_native_title_does_not_exist
native_title_outcome_native_title_exists_exclusive
native_title_outcome_native_title_exists_non_exclusive
native_title_outcome_native_title_extinguished

Indigenous Land and Forest Estate

Proportion of region having status as per the IND_DESC variable

ilf_indigenous_co_managed
ilf_indigenous_co_managed_subject_to_other_special_rights
ilf_indigenous_managed_subject_to_other_special_rights
ilf_indigenous_owned_and_managed
ilf_indigenous_owned_and_managed_subject_to_other_special_rights
ilf_non_indigenous
ilf_subject_to_other_special_rights ilf_indigenous_managed
ilf_indigenous_owned_and_co_managed
ilf_indigenous_owned_and_co_managed_subject_to_other_special_rights

Proportion of region having status based on raw binary 0/1 codes

ilf_proportion_owned ilf_proportion_managed
ilf_proportion_comanaged ilf_proportion_other_special_rights ilf_proportion_estate

Disaster resilience, coping capacity and adaptive capacity

Mean value (0–1) for region
disaster_resilience
coping_capacity
adaptive_capacity

Grazing Impact Risk (Anna Pintor)
Mean grazing impact score for region
grazing_impact_risk

Overexploitation (Anna Pintor)
'Euclidean distance from population centres raster, modelled as an exponential function.?
overexploitation

Habitat Condition Assessment System
Mean across region for two epochs: 2001–10 and 2006–15
hcas_2001_2010
hcas_2006_2015

Grants
Grant value in dollars aggregated from postal areas using sum weighted by area
grant_value_dollars
grant_value_dollars_per_sqkm

Schools
Schools per region by type
schools_primary
schools_secondary
schools_combined
schools_special
schools_total
sum of Primary + Secondary + Combined + Special (not used in cluster analysis)

Hospital beds
Summarised from hospital bed data for state/remoteness
mean_hospital_beds_per_1000

Groundwater/bores
From Australian Groundwater Explorer [Bureau of Meteorology].
Each bore has status attribute that may be relevant
num_bores
count of bores in region

DEA (Digital Earth Australia) Waterbodies
Remotely sensed data, includes water bodies of 2,700m2 or greater.
The baseline data included here represents the maximum observed wet surface area of each waterbody between 1987 and 2020. Additional time series data is available for each waterbody, giving the wet surface area as a percentage of this maximum, each year from 1988 onwards.
proportion_wet_surface_area_maximum_1987_2020

HILDA Wave 16
This dataset uses unit record data from The Household, Income and Labour Dynamics in Australia (HILDA) Survey, RESTRICTED RELEASE 20 (Waves 1–20) (https://dataverse.ada.edu.au/dataset.xhtml?persistentId=doi%3A10.26193%2FPI5LPJ) conducted by the Australian Government Department of Social Services (DSS). The findings

and views reported in this spatial dataset, however, are those of the authors and should not be attributed to the Australian Government, DSS, or any of DSS' contractors or partners. DOI: 10.26193/YP7MNU, ADA Dataverse. Pursuant to the license terms for the restricted release data we have only summarised to NRM regions. IBRA sub-regions are at a scale smaller than postcode for some states and thus cannot be summarised or reported as the dataset is not representative at this level.

Proportion data refers to the proportion of respondents giving the relevant response; other variables generally are means of scores (e.g. 0–10, 0–7, etc.)
The HILDA variable names (e.g. fiemerf) are also included for clarity. Marked up questionnaires which include these variable names are available from the HILDA website.

wave_16_fiemerf_ability_to_raise_4000_dollars
wave_16_fiprbeg_proportion_not_pay_bills_on_time
wave_16_fiprbfh_proportion_asked_for_financial_help_friends_family
wave_16_fiprbmr_proportion_not_pay_mortgage_rent_on_time
wave_16_fiprbps_proportion_pawned_or_sold_something
wave_16_fiprbuh_proportion_unable_to_heat_home
wave_16_fiprbwm_proportion_went_without_meals
wave_16_fiprbwo_proportion_asked_for_financial_help_welfare
wave_16_gh1_general_health_rating
wave_16_helth_proportion_long_term_health_condition
wave_16_herca_proportion_long_term_health_condition_carer
wave_16_iclike_like_more_children
wave_16_jbhrcpr_proportion_working_too_few_hours
wave_16_jbmsall_satisfaction_job_overall
wave_16_jbmssec_satisfaction_job_security
wave_16_lebth_proportion_last_12_months_gave_birth
wave_16_ledfr_proportion_last_12_months_death_close_friend
wave_16_ledhm_proportion_last_12_months_weather_disaster
wave_16_ledrl_proportion_last_12_months_death_other_close_relative
wave_16_ledsc_proportion_last_12_months_death_spouse_or_child
wave_16_lefni_proportion_last_12_months_financial_improved
wave_16_lefnw_proportion_last_12_months_financial_worse
wave_16_lefrd_proportion_last_12_months_fired_or_redundant
wave_16_leinf_proportion_last_12_months_serious_injury_illness_family_member
wave_16_leins_proportion_last_12_months_serious_illness_injury
wave_16_lejlf_proportion_last_12_months_family_member_detained_jail
wave_16_lejls_proportion_last_12_months_detained_jail
wave_16_lejob_proportion_last_12_months_changed_jobs
wave_16_lemar_proportion_last_12_months_got_married
wave_16_lemvd_proportion_last_12_months_changed_residence
wave_16_lepcm_proportion_last_12_months_victim_property_crime
wave_16_leprg_proportion_last_12_months_pregnancy
wave_16_leprm_proportion_last_12_months_promoted_at_work
wave_16_lercl_proportion_last_12_months_rejoined_partner
wave_16_lertr_proportion_last_12_months_retired
wave_16_lesep_proportion_last_12_months_separated_partner
wave_16_levio_proportion_last_12_months_victim_of_violence
wave_16_losat_satisfaction_life_overall
wave_16_losateo_satisfaction_employment_opportunities
wave_16_losatfs_satisfaction_financial_situation
wave_16_losatft_satisfaction_free_time wave_16_losathl_satisfaction_home
wave_16_losatlc_satisfaction_part_of_local_community
wave_16_losatnl_satisfaction_neighbourhood
wave_16_losatsf_satisfaction_safety wave_16_losatyh_satisfaction_health

wave_16_lscar_hours_caring_for_disabled_or_elderly_relative
wave_16_lsocd_hours_looking_after_other_peoples_children
wave_16_lssupsh_can_find_someone_to_help_out
wave_16_lsvol_hours_volunteer_or_charity_work

HILDA Wave 20

wave_20_fiemerf_ability_to_raise_4000_dollars
wave_20_fiprbeg_proportion_not_pay_bills_on_time
wave_20_fiprbfh_proportion_asked_for_financial_help_friends_family
wave_20_fiprbmr_proportion_not_pay_mortgage_rent_on_time
wave_20_fiprbps_proportion_pawned_or_sold_something
wave_20_fiprbuh_proportion_unable_to_heat_home
wave_20_fiprbwm_proportion_went_without_meals
wave_20_fiprbwo_proportion_asked_for_financial_help_welfare
wave_20_gh1_general_health_rating
wave_20_helth_proportion_long_term_health_condition
wave_20_herca_proportion_long_term_health_condition_carer
wave_20_iclike_like_more_children
wave_20_jbhrcpr_proportion_working_too_few_hours
wave_20_jbmsall_satisfaction_job_overall
wave_20_jbmssec_satisfaction_job_security
wave_20_lebth_proportion_last_12_months_gave_birth
wave_20_ledfr_proportion_last_12_months_death_close_friend
wave_20_ledhm_proportion_last_12_months_weather_disaster
wave_20_ledrl_proportion_last_12_months_death_other_close_relative
wave_20_ledsc_proportion_last_12_months_death_spouse_or_child
wave_20_lefni_proportion_last_12_months_financial_improved
wave_20_lefnw_proportion_last_12_months_financial_worse
wave_20_lefrd_proportion_last_12_months_fired_or_redundant
wave_20_leinf_proportion_last_12_months_serious_injury_illness_family_member
wave_20_leins_proportion_last_12_months_serious_illness_injury
wave_20_lejlf_proportion_last_12_months_family_member_detained_jail
wave_20_lejls_proportion_last_12_months_detained_jail
wave_20_lejob_proportion_last_12_months_changed_jobs
wave_20_lemar_proportion_last_12_months_got_married
wave_20_lemvd_proportion_last_12_months_changed_residence
wave_20_lepcm_proportion_last_12_months_victim_property_crime
wave_20_leprg_proportion_last_12_months_pregnancy
wave_20_leprm_proportion_last_12_months_promoted_at_work
wave_20_lercl_proportion_last_12_months_rejoined_partner
wave_20_lertr_proportion_last_12_months_retired
wave_20_lesep_proportion_last_12_months_separated_partner
wave_20_levio_proportion_last_12_months_victim_of_violence
wave_20_losat_satisfaction_life_overall
wave_20_losateo_satisfaction_employment_opportunities
wave_20_losatfs_satisfaction_financial_situation
wave_20_losatft_satisfaction_free_time wave_20_losathl_satisfaction_home
wave_20_losatlc_satisfaction_part_of_local_community
wave_20_losatnl_satisfaction_neighbourhood wave_20_losatsf_satisfaction_safety
wave_20_losatyh_satisfaction_health
wave_20_lscar_hours_caring_for_disabled_or_elderly_relative
wave_20_lsocd_hours_looking_after_other_peoples_children
wave_20_lssupsh_can_find_someone_to_help_out
wave_20_lsvol_hours_volunteer_or_charity_work.

Appendix B: Categorised list of variables

Table 9. Variables by geographic scale, temporal availability, part of system described, type of variable and segment of society described.

Variable	Geographic scale available	Temporal availability	Broad classification (natural system, human system, interaction)	Description of system or interaction	Segment of society described
abs_2021_average_household_size	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_average_persons_per_bedroom	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_median_mortgage_repayment_monthly	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_median_rent_weekly	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_median_total_family_income_weekly	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_median_total_household_income_weekly	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_median_total_personal_income_weekly	NRM and IBRA	5 yearly	Human System	Extent/Condition	Individuals
abs_2021_persons_aboriginal	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_persons_employed_aged_15_and_over	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_persons_torres_strait_islander	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_persons_total	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_population_density	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_population_median_age	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_degree_or_higher	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_dwellings_owned_outright	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_dwellings_owned_with_mortgage	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_dwellings_rented_community_org	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_dwellings_rented_real_estate_agent	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_employment	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_families_no_children	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_families_one_parent	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_females_three_or_more_children	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_homes_no_motor_vehicles	NRM and IBRA	5 yearly	Human System	Extent/Condition	Households/Families
abs_2021_proportion_indigenous	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_lived_different_address_5_years_ago	NRM and IBRA	5 yearly	Human System	Changes	Communities
abs_2021_proportion_married	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_no_religious_affiliation	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_no_schooling	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_population_born_australia	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_population_english_only	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_unemployment	NRM and IBRA	5 yearly	Human System	Extent/Condition	Workforce
abs_2021_proportion_volunteer	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
abs_2021_proportion_workforce_agriculture_forestry_fishing	NRM and IBRA	5 yearly	Interaction	S <-> E	Workforce
abs_2021_proportion_workforce_construction	NRM and IBRA	5 yearly	Human System	Extent/Condition	Workforce
abs_2021_proportion_workforce_education_training	NRM and IBRA	5 yearly	Human System	Extent/Condition	Workforce
abs_2021_proportion_workforce_healthcare_social_assistance	NRM and IBRA	5 yearly	Human System	Extent/Condition	Workforce
abs_2021_proportion_workforce_manufacturing	NRM and IBRA	5 yearly	Human System	Extent/Condition	Workforce
abs_2021_proportion_workforce_mining	NRM and IBRA	5 yearly	Interaction	S <-> E	Workforce

Variable	Geographic scale available	Temporal availability	Broad classification (natural system, human system, interaction)	Description of system or interaction	Segment of society described
abs_2021_proportion_workforce_utilities	NRM and IBRA	5 yearly	Human System	Extent/Condition	Workforce
abs_2021_proportion_year_10_or_below	NRM and IBRA	5 yearly	Human System	Extent/Condition	Communities
adaptive_capacity	NRM and IBRA	Single Observation	Interaction	S <-> E	Communities
airports_closed	NRM and IBRA	Monthly	Human System	Extent/Condition	NA – Contextual
airports_large	NRM and IBRA	Monthly	Human System	Extent/Condition	NA – Contextual
airports_medium	NRM and IBRA	Monthly	Human System	Extent/Condition	NA – Contextual
airports_small	NRM and IBRA	Monthly	Human System	Extent/Condition	NA – Contextual
capad_proportion_protected	NRM and IBRA	2–4 yearly	Interaction	S -> E	NA – Contextual
climate_chelsa_bio1_mean_temp_max	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio1_mean_temp_median	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio12_ann_precip_max	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio12_ann_precip_median	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio12_ann_precip_min	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio5_max_temp_max	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio5_max_temp_median	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio6_min_temp_median	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
climate_chelsa_bio6_min_temp_min	NRM and IBRA	Daily	Natural System	Extent/Condition	NA – Contextual
coping_capacity	NRM and IBRA	Single Observation	Interaction	S <-> E	Communities
disaster_resilience	NRM and IBRA	Single Observation	Interaction	S <-> E	Communities
epbc_listed_ecological_community_richness_max	NRM and IBRA	Single Observation	Natural System	Extent/Condition	NA – Contextual
epbc_listed_ecological_community_richness_median	NRM and IBRA	Single Observation	Natural System	Extent/Condition	NA – Contextual
epbc_listed_species_richness_max	NRM and IBRA	Single Observation	Natural System	Extent/Condition	NA – Contextual
epbc_listed_species_richness_median	NRM and IBRA	Single Observation	Natural System	Extent/Condition	NA – Contextual
federal_lower_house_proportion_australian_labor_party	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_lower_house_proportion_centre_alliance	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_lower_house_proportion_independent	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_lower_house_proportion_katters_australian_party	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_lower_house_proportion_liberal	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_lower_house_proportion_liberal_national_party	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_lower_house_proportion_the_greens	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_lower_house_proportion_the_nationals	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_australian_labor_party	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_country_liberal_party	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_jacqui_lambie_network	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_liberal	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_liberal_national_party_of_queensland	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_pauline_hansons_one_nation	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_the_greens	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_2019_election_the_nationals	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_australian_labor_party	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_centre_alliance	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_country_liberal_party	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_independent	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_jacquie_lambie_network	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_liberal	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps

Variable	Geographic scale available	Temporal availability	Broad classification (natural system, human system, interaction)	Description of system or interaction	Segment of society described
federal_upper_house_incumbent_liberal_national_party_of_queensland	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_pauline_hansons_one_nation	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_the_greens	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
federal_upper_house_incumbent_the_nationals	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	Political reps
fire_history_paa_1969_2018_proportion_affected	NRM and IBRA	Single Observation	Natural System	Changes	NA – Contextual
fire_history_paa_2004_2018_proportion_affected	NRM and IBRA	Single Observation	Natural System	Changes	NA – Contextual
fire_history_paa_2014_2018_proportion_affected	NRM and IBRA	5 yearly	Natural System	Changes	NA – Contextual
fire_niafed_paa_2019_2020_proportion_affected	NRM and IBRA	5 yearly	Natural System	Changes	NA – Contextual
grant_value_dollars	NRM and IBRA	Single Observation	Interaction	S -> E	NA – Contextual
grant_value_dollars_per_sqkm	NRM and IBRA	Single Observation	Interaction	S -> E	NA – Contextual
grazing_impact_risk	NRM and IBRA	Single Observation	Interaction	S -> E	NA – Contextual
hcas_2001_2010	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
hcas_2006_2015	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
heritage_commonwealth_place_count	NRM and IBRA	Live updates	Human System	Extent/Condition	NA – Contextual
heritage_national_place_count	NRM and IBRA	Live updates	Human System	Extent/Condition	NA – Contextual
indigenous_co_managed	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
indigenous_co_managed_subject_to_other_special_rights	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
indigenous_managed	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
indigenous_managed_subject_to_other_special_rights	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
indigenous_owned_and_co_managed	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
indigenous_owned_and_co_managed_subject_to_other_special_rights	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
indigenous_owned_and_managed	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
indigenous_owned_and_managed_subject_to_other_special_rights	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
land_capacity_high	NRM and IBRA	Single Observation	Interaction	E -> S	NA – Contextual
land_capacity_medium	NRM and IBRA	Single Observation	Interaction	E -> S	NA – Contextual
land_tenure_crown_leasehold	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
land_tenure_crown_other	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
land_tenure_freehold	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
land_tenure_unknown	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
land_use_1.1_nature_conservation	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
land_use_1.2_managed_resource_protection	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
land_use_1.3_other_minimal_use	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
land_use_2.1_grazing_native_vegetation	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_2.2_production_native_forests	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_3.1_plantation_forests	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_3.2_grazing_modified_pastures	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_3.3_cropping	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_3.4_perennial_horticulture	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_3.5_seasonal_horticulture	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_3.6_land_in_transition	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_4.1_irrigated_plantation_forests	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_4.2_grazing_irrigated_modified_pastures	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_4.3_irrigated_cropping	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_4.4_irrigated_perennial_horticulture	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_4.5_irrigated_seasonal_horticulture	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual

Variable	Geographic scale available	Temporal availability	Broad classification (natural system, human system, interaction)	Description of system or interaction	Segment of society described
land_use_4.6_irrigated_land_in_transition	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.1_intensive_horticulture	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.2_intensive_animal_production	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.3_manufacturing_and_industrial	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.4_residential_and_farm_infrastructure	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.5_services	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.6_utilities	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.7_transport_and_communication	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.8_mining	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_5.9_waste_treatment_and_disposal	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_6.1_lake	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
land_use_6.2_reservoir_dam	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_6.3_river	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
land_use_6.4_channel_aqueduct	NRM and IBRA	5 yearly	Interaction	S <-> E	NA – Contextual
land_use_6.5_marsh_wetland	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
land_use_6.6_estuary_coastal_waters	NRM and IBRA	5 yearly	Natural System	Extent/Condition	NA – Contextual
mean_hospital_beds_per_1000	NRM and IBRA	Single Observation	Human System	Extent/Condition	NA – Contextual
mines_mineral_deposit	NRM and IBRA	1 yearly	Natural System	Extent/Condition	NA – Contextual
mines_operating_mine	NRM and IBRA	1 yearly	Interaction	S <-> E	NA – Contextual
mines_under_development_care_and_maintenance	NRM and IBRA	1 yearly	Interaction	S <-> E	NA – Contextual
native_title_outcome_native_title_does_not_exist	NRM and IBRA	Live updates	Human System	Extent/Condition	NA – Contextual
native_title_outcome_native_title_exists_exclusive	NRM and IBRA	Live updates	Human System	Extent/Condition	NA – Contextual
native_title_outcome_native_title_exists_non_exclusive	NRM and IBRA	Live updates	Human System	Extent/Condition	NA – Contextual
native_title_outcome_native_title_extinguished	NRM and IBRA	Live updates	Human System	Extent/Condition	NA – Contextual
non_indigenous	NRM and IBRA	1 yearly	Human System	Extent/Condition	Communities
nrm_area_km2	NRM and IBRA	Live updates	Natural System	Extent/Condition	NA – Contextual
num_bores	NRM only	1 yearly	Interaction	S <-> E	NA – Contextual
nvis_mvg_acacia_forests_and_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_acacia_open_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_acacia_shrublands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_callitris_forests_and_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_casuarina_forests_and_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_chenopod_shrublands_samphire_shrublands_and_forblands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_cleared_non-native_vegetation_buildings	NRM and IBRA	2–4 yearly	Human System	Extent/Condition	NA – Contextual
nvis_mvg_eucalypt_low_open_forests	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_eucalypt_open_forests	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_eucalypt_open_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_eucalypt_tall_open_forests	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_eucalypt_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_heathlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_hummock_grasslands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_inland_aquatic_freshwater_salt_lakes_lagoons	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_low_closed_forests_and_tall_closed_shrublands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_mallee_open_woodlands_and_sparse_mallee_shrublands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_mallee_woodlands_and_shrublands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual

Variable	Geographic scale available	Temporal availability	Broad classification (natural system, human system, interaction)	Description of system or interaction	Segment of society described
nvis_mvg_mangroves	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_melaleuca_forests_and_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_naturally_bare_sand_rock_claypan_mudflat	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_other_forests_and_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_other_grasslands_herblands_sedgelands_and_rushlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_other_open_woodlands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_other_shrublands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_rainforests_and_vine_thickets	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_regrowth_modified_native_vegetation	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_sea_and_estuaries	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_tropical_eucalypt_woodlands_grasslands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_tussock_grasslands	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_unclassified_forest	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
nvis_mvg_unclassified_native_vegetation	NRM and IBRA	2–4 yearly	Natural System	Extent/Condition	NA – Contextual
overexploitation	NRM and IBRA	Single Observation	Interaction	S -> E	NA – Contextual
plant_species_richness	NRM and IBRA	Single Observation	Natural System	Extent/Condition	NA – Contextual
proportion_comanaged	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
proportion_estate	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
proportion_managed	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
proportion_other_special_rights	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
proportion_owned	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
proportion_wet_surface_area_maximum_1987_2020	NRM only	Single Observation	Natural System	Extent/Condition	NA – Contextual
remoteness_proportion_inner_regional_australia	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
remoteness_proportion_major_cities_of_australia	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
remoteness_proportion_outer_regional_australia	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
remoteness_proportion_remote_australia	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
remoteness_proportion_unclassified	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
remoteness_proportion_very_remote_australia	NRM and IBRA	5 yearly	Human System	Extent/Condition	NA – Contextual
schools_combined	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
schools_primary	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
schools_secondary	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
schools_special	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
schools_total	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
subject_to_other_special_rights	NRM and IBRA	1 yearly	Human System	Extent/Condition	NA – Contextual
surface_water_proportion	NRM and IBRA	Single Observation	Natural System	Extent/Condition	NA – Contextual
value_of_assets_agriculture	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_carbon_sequestration	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_erosion	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_flood_control	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_forestry_logging	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_genepool	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_infrastructure	NRM only	Single Observation	Human System	Extent/Condition	NA – Contextual
value_of_assets_non_use_value_residents	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_recreation_use_value_residents	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_toxin_mediation	NRM only	Single Observation	Interaction	E -> S	NA – Contextual

Variable	Geographic scale available	Temporal availability	Broad classification (natural system, human system, interaction)	Description of system or interaction	Segment of society described
value_of_assets_use_value_international_tourists	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
value_of_assets_water_purification	NRM only	Single Observation	Interaction	E -> S	NA – Contextual
wave_20_fiemerf_ability_to_raise_4000_dollars	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_fiprbeg_proportion_not_pay_bills_on_time	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_fiprbfh_proportion_asked_for_financial_help_friends_family	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_fiprbmr_proportion_not_pay_mortgage_rent_on_time	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_fiprbps_proportion_pawned_or_sold_something	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_fiprbuh_proportion_unable_to_heat_home	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_fiprbwm_proportion_went_without_meals	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_fiprbwo_proportion_asked_for_financial_help_welfare	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_gh1_general_health_rating	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_helth_proportion_long_term_health_condition	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_herca_proportion_long_term_health_condition_carer	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_iclike_like_more_children	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_jbhrcpr_proportion_working_too_few_hours	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_jbmsall_satisfaction_job_overall	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_jbmssec_satisfaction_job_security	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_lebth_proportion_last_12_months_gave_birth	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_ledfr_proportion_last_12_months_death_close_friend	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_ledhm_proportion_last_12_months_weather_disaster	NRM only	1 yearly	Interaction	E -> S	Individuals
wave_20_ledrl_proportion_last_12_months_death_other_close_relative	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_ledsc_proportion_last_12_months_death_spouse_or_child	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lefni_proportion_last_12_months_financial_improved	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lefnw_proportion_last_12_months_financial_worse	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lefrd_proportion_last_12_months_fired_or_redundant	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_leinf_proportion_last_12_months_serious_injury_illness_family_member	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_leins_proportion_last_12_months_serious_illness_injury	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lejlf_proportion_last_12_months_family_member_detained_jail	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lejls_proportion_last_12_months_detained_jail	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lejob_proportion_last_12_months_changed_jobs	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lemar_proportion_last_12_months_got_married	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lemvd_proportion_last_12_months_changed_residence	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lepcm_proportion_last_12_months_victim_property_crime	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_leprg_proportion_last_12_months_pregnancy	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_leprm_proportion_last_12_months_promoted_at_work	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lercl_proportion_last_12_months_rejoined_partner	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lertr_proportion_last_12_months_retired	NRM only	1 yearly	Human System	Changes	Individuals
wave_20_lesep_proportion_last_12_months_separated_partner	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_levio_proportion_last_12_months_victim_of_violence	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losat_satisfaction_life_overall	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losateo_satisfaction_employment_opportunities	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losatfs_satisfaction_financial_situation	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losatft_satisfaction_free_time	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losathl_satisfaction_home	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losatlc_satisfaction_part_of_local_community	NRM only	1 yearly	Human System	Extent/Condition	Individuals

Variable	Geographic scale available	Temporal availability	Broad classification (natural system, human system, interaction)	Description of system or interaction	Segment of society described
wave_20_losatnl_satisfaction_neighbourhood	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losatsf_satisfaction_safety	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_losatyh_satisfaction_health	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_lscar_hours_caring_for_disabled_or_elderly_relative	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_lsocd_hours_looking_after_other_peoples_children	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_lssupsh_can_find_someone_to_help_out	NRM only	1 yearly	Human System	Extent/Condition	Individuals
wave_20_lsvol_hours_volunteer_or_charity_work	NRM only	1 yearly	Human System	Extent/Condition	Individuals

Appendix C: NRM region cluster membership

Table 10. NRM region membership within cluster groups, by number of clusters (2–10).

Number of clusters/cluster number									
2	3	4	5	6	7	8	9	10	NRMs
1	1	1	1	1	1	1	1	1	Greater Sydney
									Port Phillip and Western Port
									South East Queensland
		2	2	2	2	2	2	2	ACT
									North NRM Region
									North West NRM Region
									South NRM Region
						3	3	3	Central Tablelands
									Central West
									East Gippsland
									Hunter
									Murray
									North Coast
									North East
									North West NSW
									Northern Tablelands
									Riverina
									South East NSW
							4	4	Adelaide and Mount Lofty Ranges
									Avon River Basin
									Corangamite
									Eyre Peninsula
									Glenelg Hopkins
									Goulburn Broken
									Mallee
									North Central
									Northern Agricultural Region
									Northern and Yorke
									Peel-Harvey Region
									South Australian Murray Darling Basin
									South Coast Region
									South East
									South West Region
									Swan Region
									West Gippsland
									Wimmera
			3	3	3	4	5	5	Alinytjara Wilurara
				4	4	5	6	6	Burdekin
									Burnett Mary
									Condamine
									Fitzroy
									Mackay Whitsunday
									Maranoa Balonne and Border Rivers
									Wet Tropics
					5	6	7	7	South Australian Arid Lands
								8	Desert Channels
									Northern Gulf
									South West Queensland
									Southern Gulf
									Western
2	2	3	4	5	6	7	8	9	Cape York
									Co-operative Management Area
	3	4	5	6	7	8	9	10	Northern Territory
									Rangelands Region

Appendix D: IBRA sub-region cluster membership – variable-wise deletion

Table 11. IBRA sub-region cluster membership variable-wise deletion, by number of clusters

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
1	Murgenella	1	1	1	1	1	1	1	1	1
2	Maningrida	1	1	1	1	1	1	1	1	1
3	Nhulunbuy	1	1	1	1	1	1	1	1	1
4	Groote	1	1	1	1	1	1	1	1	1
5	Wessels	1	1	1	1	1	1	1	1	1
6	Alligator	1	1	1	1	1	1	1	1	1
7	Mainoru	1	1	1	1	1	1	1	1	1
8	Snowy Mountains	2	2	2	2	2	2	2	2	2
9	Victorian Alps	2	2	2	2	2	2	2	2	2
10	Merredin	2	2	2	2	2	3	3	3	3
11	Katanning	2	2	2	2	2	3	3	3	3
12	Townsville Plains	1	3	3	3	3	4	4	4	4
13	Bogie River Hills	1	3	3	3	3	4	5	5	5
14	Cape River Hills	1	3	3	3	3	4	5	5	5
15	Beucazon Hills	1	3	3	3	3	4	5	5	5
16	Wyarra Hills	1	3	3	3	3	4	5	5	5
17	Northern Bowen Basin	1	3	3	3	3	4	5	5	5
18	Belyando Downs	1	3	3	3	3	4	5	5	5
19	Upper Belyando Floodout	1	3	3	3	3	4	5	5	5
20	Anakie Inlier	1	3	3	3	3	4	5	5	5
21	Basalt Downs	1	3	3	3	3	4	5	5	5
22	Isaac-Comet Downs	1	3	3	3	3	4	5	5	5
23	Nebo-Connors Ranges	1	3	3	3	3	4	5	5	5
24	South Drummond Basin	1	3	3	3	3	4	5	5	5
25	Marlborough Plains	1	3	3	3	3	4	5	5	5
26	Claude River Downs	1	3	3	3	3	4	5	5	5
27	Woorabinda	1	3	3	3	3	4	5	5	5
28	Boomer Range	1	3	3	3	3	4	5	5	5
29	Mount Morgan Ranges	1	3	3	3	3	4	5	5	5

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
30	Callide Creek Downs	1	3	3	3	3	4	5	5	5
31	Arcadia	1	3	3	3	3	4	5	5	5
32	Dawson River Downs	1	3	3	3	3	4	5	5	5
33	Banana-Auburn Ranges	1	3	3	3	3	4	5	5	5
34	Buckland Basalts	1	3	3	3	3	4	5	5	5
35	Carnarvon Ranges	1	3	3	3	3	4	5	5	5
36	Taroom Downs	1	3	3	3	3	4	5	5	5
37	Southern Downs	1	3	3	3	3	4	5	5	5
38	Barakula	1	3	3	3	3	4	5	5	5
39	Dulacca Downs	1	3	3	3	3	4	5	5	5
40	Weribone High	1	3	3	3	3	4	5	5	5
41	Tara Downs	1	3	3	3	3	4	5	5	5
42	Eastern Darling Downs	1	3	3	3	3	4	5	5	5
43	Inglewood Sandstones	1	3	3	3	3	4	5	5	5
44	Moonie-Commoron Floodout	1	3	3	3	3	4	5	5	5
45	Moonie-Barwon Interfluve	1	3	3	3	3	4	5	5	5
46	Northern Basalts	2	2	2	2	2	3	3	3	3
47	Northern Outwash	2	2	2	2	2	3	3	3	3
48	Pilliga Outwash	2	2	2	2	2	3	3	3	3
49	Pilliga	2	2	2	2	2	3	3	3	3
50	Liverpool Plains	2	2	2	2	2	3	3	3	3
51	Liverpool Range	2	2	2	2	2	3	3	3	3
52	Talbragar Valley	2	2	2	2	2	3	3	3	3
53	Narrandool	1	3	3	4	4	5	6	6	6
54	Ben Lomond	2	2	2	2	2	2	2	7	7
55	Barrier Range	1	3	3	4	4	5	6	6	6
56	Mootwingee Downs	1	3	3	4	4	5	6	6	6
57	Scopes Range	1	3	3	4	4	5	6	6	6
58	Barrier Range Outwash	1	3	3	4	4	5	6	6	6
59	Bimbowrie	1	3	3	4	4	5	6	6	6
60	Curnamona	1	3	3	4	4	5	6	6	6
61	Yuendumu	1	1	1	1	1	1	1	1	1
62	Atartinga	1	1	1	1	1	1	1	1	1
63	Mount Chapple	1	1	1	1	1	1	1	1	1
64	Dulcie	1	1	1	1	1	1	1	1	1
65	Cape Range	1	3	3	4	5	6	7	8	8
66	Wooramel	1	3	3	4	5	6	7	8	8

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
67	Wilton	1	1	1	1	1	1	1	1	1
68	Parson	1	1	1	1	1	1	1	1	1
69	Pentecost	1	3	3	4	5	6	7	8	8
70	Hart	1	3	3	4	5	6	7	8	8
71	Mount Eliza	1	3	3	4	5	6	7	8	8
72	Mann-Musgrave Block	1	1	1	1	1	1	1	1	1
73	Watarru	1	1	1	1	1	1	1	1	1
74	Everard Block	1	1	1	1	1	1	1	1	1
75	Toko Plains	1	1	1	1	1	1	1	1	1
76	Sturt Stony Desert	1	3	3	3	3	4	5	5	5
77	Goneaway Tablelands	1	3	3	3	3	4	5	5	5
78	Diamantina-Eyre	1	3	3	3	3	4	5	5	5
79	Cooper-Diamantina Plains	1	3	3	3	3	4	5	5	5
80	Coongie	1	3	3	4	4	5	6	6	6
81	Lake Pure	1	3	3	3	3	4	5	5	5
82	Noccundra Slopes	1	3	3	3	3	4	5	5	5
83	Core Ranges	1	3	3	4	4	5	6	6	6
84	Bulloo	1	3	3	3	3	4	5	5	5
85	Bulloo Dunefields	1	3	3	3	3	4	5	5	5
86	Central Depression	1	3	3	4	4	5	6	6	6
87	Whitsunday	1	3	3	3	3	4	4	4	4
88	Proserpine-Sarina Lowlands	1	3	3	3	3	4	4	4	4
89	Clarke-Connors Ranges	1	3	3	3	3	4	5	5	5
90	Byfield	1	3	3	3	3	4	5	5	5
91	Manifold	1	3	3	3	3	4	4	4	4
92	Debella	1	3	3	3	3	4	5	5	5
93	Mardabilla	2	2	2	2	2	3	3	3	3
94	Southern Cross	2	2	2	2	2	3	3	3	3
95	Eastern Goldfield	1	3	3	4	5	6	7	8	8
96	Boorindal Plains	1	3	3	4	4	5	6	6	6
97	Barnato Downs	1	3	3	4	4	5	6	6	6
98	Canbelego Downs	1	3	3	4	4	5	6	6	6
99	Nymagee	2	2	2	2	2	3	3	3	3
100	Lachlan Plains	2	2	2	2	2	3	3	3	3
102	Coen-Yambo Inlier	1	3	3	3	3	4	4	4	4
103	Starke Coastal Lowlands	1	3	3	3	3	4	4	4	4
104	Cape York-Torres Strait	1	3	3	3	3	4	4	4	4

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
105	Jardine-Pascoe Sandstones	1	3	3	3	3	4	4	4	4
106	Battle Camp Sandstones	1	3	3	3	3	4	4	4	4
107	Laura Lowlands	1	3	3	3	3	4	4	4	4
108	Weipa Plateau	1	3	3	3	3	4	4	4	4
109	Northern Holroyd Plain	1	3	3	3	3	4	4	4	4
110	Coastal Plains	1	3	3	3	3	4	4	4	4
111	Daly Basin	1	1	1	1	1	1	1	1	1
112	Darwin Coastal	1	1	1	1	1	1	1	1	1
113	Fitzroy Trough	1	3	3	4	5	6	7	8	8
114	Pindanland	1	3	3	4	5	6	7	8	8
115	Prairie-Torrens Creeks Alluvials	1	3	3	3	3	4	5	5	5
116	Alice Tableland	1	3	3	3	3	4	5	5	5
117	Cape-Campaspe Plains	1	3	3	3	3	4	5	5	5
118	Jericho	1	3	3	3	3	4	5	5	5
119	Ashburton Range	1	1	1	1	1	1	1	1	1
120	Davenport	1	1	1	1	1	1	1	1	1
121	Barkly	1	1	1	1	1	1	1	1	1
122	Culgoa-Bokhara	1	3	3	4	4	5	6	6	6
123	Warrambool-Moonie	1	3	3	4	4	5	6	6	6
124	Castlereagh-Barwon	2	2	2	2	2	3	3	3	3
125	Bogan-Macquarie	2	2	2	2	2	3	3	3	3
126	Louth Plains	1	3	3	4	4	5	6	6	6
127	Wilcannia Plains	1	3	3	4	4	5	6	6	6
128	Menindee	1	3	3	4	4	5	6	6	6
129	Great Darling Anabranch	1	3	3	4	4	5	6	6	6
130	Pooncarie-Darling	1	3	3	4	4	5	6	6	6
131	Georgetown-Croydon	1	3	3	3	3	4	5	5	5
132	Kidston	1	3	3	3	3	4	5	5	5
133	Hodgkinson Basin	1	3	3	3	3	4	5	5	5
134	Broken River	1	3	3	3	3	4	5	5	5
135	Undara-Toomba Basalts	1	3	3	3	3	4	5	5	5
136	Herberton-Wairuna	1	3	3	3	3	4	5	5	5
137	Fitzgerald	2	2	2	2	2	3	3	3	3
138	Recherche	2	2	2	2	2	3	3	3	3
139	Southern Yorke	2	2	2	2	2	3	3	3	3
140	St Vincent	2	2	2	2	2	3	3	3	3
141	Eyre Hills	2	2	2	2	2	3	3	3	3

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
142	Talia	2	2	2	2	2	3	3	3	3
143	Eyre Mallee	2	2	2	2	2	3	3	3	3
144	Henbury	1	1	1	1	1	1	1	1	1
145	Finke River	1	1	1	1	1	1	1	1	1
146	Tieyon	1	1	1	1	1	1	1	1	1
147	Pedirka	1	3	3	4	4	5	6	6	6
148	Mount Lofty Ranges	2	2	4	5	6	7	8	9	9
149	Broughton	2	2	2	2	2	3	3	3	3
150	Olary Spur	1	3	3	4	4	5	6	6	6
151	Southern Flinders	2	2	2	2	2	3	3	3	3
152	Northern Flinders	1	3	3	4	4	5	6	6	6
153	Central Flinders	1	3	3	4	4	5	6	6	6
155	Flinders	2	2	2	2	2	2	2	7	7
156	Ashburton	1	3	3	4	5	6	7	8	8
157	Carnegie	1	3	3	4	5	6	7	8	8
158	Augustus	1	3	3	4	5	6	7	8	8
159	Myall Plains	1	3	3	4	4	5	6	6	6
160	Gawler Volcanics	1	3	3	4	4	5	6	6	6
161	Gawler Lakes	1	3	3	4	4	5	6	6	6
162	Arcoona Plateau	1	3	3	4	4	5	6	6	6
163	Kingoonya	1	3	3	4	4	5	6	6	6
164	Torrens	1	3	3	4	4	5	6	6	6
165	Roxby	1	3	3	4	4	5	6	6	6
166	Commonwealth Hill	1	3	3	4	4	5	6	6	6
167	Geraldton Hills	2	2	2	2	2	3	3	3	3
168	Lesueur Sandplain	2	2	2	2	2	3	3	3	3
169	McArthur	1	3	3	4	5	6	7	8	8
170	Nicholson	1	1	1	1	1	1	1	1	1
171	Lateritic Plain	1	3	3	4	5	6	7	8	8
172	Dune Field	1	1	1	1	1	1	1	1	1
173	McLarty	1	3	3	4	5	6	7	8	8
174	Mackay	1	3	3	4	5	6	7	8	8
175	Ehrenberg	1	1	1	1	1	1	1	1	1
176	Amedeus	1	1	1	1	1	1	1	1	1
177	Lake Bennett	1	1	1	1	1	1	1	1	1
178	Lake Lewis	1	1	1	1	1	1	1	1	1
179	Limmen	1	1	1	1	1	1	1	1	1

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
180	Pellews	1	1	1	1	1	1	1	1	1
181	Karumba Plains	1	3	3	3	3	4	4	4	4
182	Armraynald Plains	1	3	3	3	3	4	5	5	5
183	Woondoola Plains	1	3	3	3	3	4	5	5	5
184	Mitchell-Gilbert Fans	1	3	3	3	3	4	4	4	4
185	Claraville Plains	1	3	3	3	3	4	5	5	5
186	Holroyd Plain-Red Plateau	1	3	3	3	3	4	5	5	5
187	Doomadgee Plains	1	3	3	3	3	4	4	4	4
188	Donors Plateau	1	3	3	3	3	4	5	5	5
189	Gilberton Plateau	1	3	3	3	3	4	5	5	5
190	Wellesley Islands	1	3	3	3	3	4	4	4	4
191	Shield	1	3	3	4	5	6	7	8	8
192	Central	1	3	3	4	5	6	7	8	8
193	Maralinga	1	3	3	4	5	6	7	8	8
194	Kintore	1	1	1	1	1	1	1	1	1
195	Tallaringa	1	3	3	4	4	5	6	6	6
196	Yellabinna	2	2	2	2	2	3	3	3	3
197	Hampton	2	2	2	2	2	3	3	3	3
201	Northern Jarrah Forest	2	2	2	2	2	2	2	2	2
202	Southern Jarrah Forest	2	2	2	2	2	2	2	2	2
203	Kangaroo Island	2	2	2	2	2	3	3	3	3
204	Fleurieu	2	2	2	2	2	3	3	3	3
205	King	2	2	2	2	2	2	2	7	7
206	Rudall	1	3	3	4	5	6	7	8	8
207	Trainor	1	3	3	4	5	6	7	8	8
208	McDonnell	1	1	1	1	1	1	1	1	1
209	Watarrka	1	1	1	1	1	1	1	1	1
210	Hartz Range	1	1	1	1	1	1	1	1	1
211	Eastern Mallee	2	2	2	2	2	3	3	3	3
212	Western Mallee	2	2	2	2	2	3	3	3	3
213	South Olary Plain	2	2	2	2	2	3	3	3	3
214	Murray Mallee	2	2	2	2	2	3	3	3	3
215	Murray Lakes and Coorong	2	2	2	2	2	3	3	3	3
216	Lowan Mallee	2	2	2	2	2	3	3	3	3
217	Wimmera	2	2	2	2	2	3	3	3	3
218	Darling Depression	1	3	3	4	4	5	6	6	6
219	Braemer	1	3	3	4	4	5	6	6	6

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
220	Sylvester	1	1	1	1	1	1	1	1	1
221	Barkly Tableland	1	3	3	4	5	6	7	8	8
222	Georgina Limestone	1	1	1	1	1	1	1	1	1
223	Southwestern Downs	1	3	3	3	3	4	5	5	5
224	Kynuna Plateau	1	3	3	3	3	4	5	5	5
225	Northern Downs	1	3	3	3	3	4	5	5	5
226	Central Downs	1	3	3	3	3	4	5	5	5
227	Southern Wooded Downs	1	3	3	3	3	4	5	5	5
228	Southwestern Plateaus and Floodouts	1	3	3	3	3	4	5	5	5
229	Thorntonia	1	3	3	3	3	4	5	5	5
230	Mount Isa	1	3	3	4	5	6	7	8	8
231	West Balonne Plains	1	3	3	3	3	4	5	5	5
232	Eastern Mulga Plains	1	3	3	3	3	4	5	5	5
233	Nebine Plains	1	3	3	3	3	4	5	5	5
234	North Eastern Plains	1	3	3	3	3	4	5	5	5
235	Warrego Plains	1	3	3	3	3	4	5	5	5
236	Langlo Plains	1	3	3	3	3	4	5	5	5
237	Cuttaburra-Paroo	1	3	3	3	3	4	5	5	5
238	West Warrego	1	3	3	3	3	4	5	5	5
239	Northern Uplands	1	3	3	3	3	4	5	5	5
240	West Bulloo	1	3	3	3	3	4	5	5	5
241	Urisino Sandplains	1	3	3	4	4	5	6	6	6
242	Warrego Sands	1	3	3	4	4	5	6	6	6
243	Kerribree Basin	1	3	3	4	4	5	6	6	6
244	White Cliffs Plateau	1	3	3	4	4	5	6	6	6
245	Paroo Overflow	1	3	3	4	4	5	6	6	6
246	Paroo-Darling Sands	1	3	3	4	4	5	6	6	6
247	Eastern Murchison	1	3	3	4	5	6	7	8	8
248	Western Murchison	1	3	3	4	5	6	7	8	8
249	Nandewar Northern Complex	2	2	2	2	2	3	3	3	3
250	Inverell Basalts	2	2	2	2	2	3	3	3	3
251	Kaputar	2	2	2	2	2	2	2	2	2
252	Peel	2	2	2	2	2	3	3	3	3
253	Bridgewater	2	2	2	2	2	3	3	3	3
254	Glenelg Plain	2	2	2	2	2	3	3	3	3
255	Lucindale	2	2	2	2	2	3	3	3	3
256	Tintinara	2	2	2	2	2	3	3	3	3

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
257	Bundarra Downs	2	2	2	2	2	3	3	3	3
258	Beardy River Hills	2	2	2	2	2	3	3	3	3
259	Walcha Plateau	2	2	2	2	2	3	3	3	3
260	Armidale Plateau	2	2	2	2	2	3	3	3	3
261	Wongwibinda Plateau	2	2	2	2	2	3	3	3	3
262	Deepwater Downs	2	2	2	2	2	3	3	3	3
263	Glenn Innes-Guyra Basalts	2	2	2	2	2	3	3	3	3
264	Ebor Basalts	2	2	2	2	2	3	3	3	3
265	Moredun Volcanics	2	2	2	2	2	3	3	3	3
266	Severn River Volcanics	2	2	2	2	2	3	3	3	3
267	Northeast Forest Lands	2	2	2	2	2	2	2	2	2
268	Tenterfield Plateau	2	2	2	2	2	3	3	3	3
269	Yarrowyck-Kentucky Downs	2	2	2	2	2	3	3	3	3
270	Binghi Plateau	2	2	2	2	2	2	2	2	2
271	Stanthorpe Plateau	2	2	2	2	2	3	3	3	3
272	Eastern Nandewars	2	2	2	2	2	3	3	3	3
273	Tingha Plateau	2	2	2	2	2	3	3	3	3
274	Nightcap	2	2	2	2	2	3	3	3	3
275	Round Mountain	2	2	2	2	2	2	2	2	2
276	Washpool	2	2	2	2	2	2	2	2	2
277	Cataract	2	2	2	2	2	2	2	2	2
278	Dalmorton	2	2	2	2	2	2	2	2	2
279	Chaelundi	2	2	2	2	2	2	2	2	2
280	Yuraygir	2	2	2	2	2	2	2	2	2
281	Coffs Coast and Escarpment	2	2	2	2	2	2	2	2	2
282	Macleay Hastings	2	2	2	2	2	2	2	2	2
283	Carrai Plateau	2	2	2	2	2	2	2	2	2
284	Macleay Gorges	2	2	2	2	2	2	2	2	2
285	Upper Manning	2	2	2	2	2	2	2	2	2
286	Comboyne Plateau	2	2	2	2	2	2	2	2	2
287	Mummel Escarpment	2	2	2	2	2	2	2	2	2
288	Barrington	2	2	2	2	2	2	2	2	2
289	Tomalla	2	2	2	2	2	3	3	3	3
290	Ellerston	2	2	2	2	2	3	3	3	3
291	Upper Hunter	2	2	2	2	2	3	3	3	3
292	Karuah Manning	2	2	2	2	2	2	2	2	2
293	Rocky River Gorge	2	2	2	2	2	2	2	2	2

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
294	Guy Fawkes	2	2	2	2	2	2	2	2	2
295	Mitchell	1	3	3	4	5	6	7	8	8
296	Berkeley	1	3	3	4	5	6	7	8	8
297	Inland Slopes	2	2	2	2	2	3	3	3	3
298	Lower Slopes	2	2	2	2	2	3	3	3	3
299	Capertee Valley	2	2	2	2	2	3	3	3	3
300	Carlisle	1	3	3	4	5	6	7	8	8
301	Nullarbor Plain	1	3	3	4	5	6	7	8	8
302	Yalata	2	2	2	2	2	3	3	3	3
303	Purnululu	1	3	3	4	5	6	7	8	8
304	South Kimberley Interzone	1	3	3	4	5	6	7	8	8
305	Gregory	1	1	1	1	1	1	1	1	1
306	Camfield	1	1	1	1	1	1	1	1	1
307	Pine Creek	1	1	1	1	1	1	1	1	1
308	Chichester	1	3	3	4	5	6	7	8	8
309	Fortescue	1	3	3	4	5	6	7	8	8
310	Hamersley	1	3	3	4	5	6	7	8	8
311	Roebourne	1	3	3	4	5	6	7	8	8
314	Lachlan	1	3	3	4	4	5	6	6	6
315	Murrumbidgee	2	2	2	2	2	3	3	3	3
316	Murray Fans	2	2	2	2	2	3	3	3	3
317	Victorian Riverina	2	2	2	2	2	3	3	3	3
318	Robinvale Plains	2	2	2	2	2	3	3	3	3
319	Murray Scroll Belt	2	2	2	2	2	3	3	3	3
322	Gippsland Plain	2	2	4	5	6	7	8	9	10
323	Otway Plain	2	2	4	5	6	7	8	9	9
324	Warrnambool Plain	2	2	2	2	2	3	3	3	3
325	East Gippsland Lowlands	2	2	2	2	2	2	2	2	2
326	South East Coastal Ranges	2	2	2	2	2	2	2	2	2
327	Bateman	2	2	2	2	2	2	2	2	2
328	Highlands-Southern Fall	2	2	2	2	2	2	2	2	2
329	Highlands-Northern Fall	2	2	2	2	2	2	2	2	2
330	Otway Ranges	2	2	2	2	2	2	2	2	2
331	Strzelecki Ranges	2	2	2	2	2	3	3	3	3
332	Murrumbateman	2	2	4	5	6	7	8	9	9
333	Bungonia	2	2	2	2	2	3	3	3	3
334	Kanangra	2	2	2	2	2	2	2	2	2

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
335	Crookwell	2	2	2	2	2	3	3	3	3
336	Oberon	2	2	2	2	2	3	3	3	3
337	Bathurst	2	2	2	2	2	3	3	3	3
338	Orange	2	2	2	2	2	3	3	3	3
339	Hill End	2	2	2	2	2	3	3	3	3
340	Bondo	2	2	2	2	2	2	2	2	2
341	Kybeyan-Gourock	2	2	2	2	2	2	2	2	2
342	Monaro	2	2	2	2	2	3	3	3	3
343	Capertee Uplands	2	2	2	2	2	3	3	3	3
344	Burnett-Curtis Hills and Ranges	1	3	3	3	3	4	5	5	5
345	Moreton Basin	2	2	4	5	6	7	8	9	9
346	Burringbar-Conondale Ranges	2	2	4	5	6	7	8	9	9
347	Sunshine Coast-Gold Coast Lowlands	2	2	4	5	6	7	8	9	9
348	Brisbane-Barambah Volcanics	1	3	3	3	3	4	5	5	5
349	South Burnett	1	3	3	3	3	4	5	5	5
350	Gympie Block	1	3	3	3	3	4	5	5	5
351	Burnett-Curtis Coastal Lowlands	1	3	3	3	3	4	5	5	5
352	Great Sandy	1	3	3	3	3	4	4	4	4
353	Scenic Rim	2	2	2	2	2	3	3	3	3
354	Woodenbong	2	2	2	2	2	2	2	2	2
355	Clarence Sandstones	2	2	2	2	2	2	2	2	2
356	Clarence Lowlands	2	2	2	2	2	2	2	2	2
358	Andado	1	1	1	1	1	1	1	1	1
359	Simpson Desert	1	3	3	4	5	6	7	8	8
360	Dieri	1	3	3	4	4	5	6	6	6
361	Warriner	1	3	3	4	4	5	6	6	6
362	Strzelecki Desert	1	3	3	4	4	5	6	6	6
363	Breakaways	1	3	3	4	4	5	6	6	6
364	Oodnadatta	1	3	3	4	4	5	6	6	6
365	Murnpeowie	1	3	3	4	4	5	6	6	6
366	Peake-Dennison Inlier	1	3	3	4	4	5	6	6	6
367	Macumba	1	3	3	4	4	5	6	6	6
368	Witjira	1	3	3	4	4	5	6	6	6
369	Baltana	1	3	3	4	4	5	6	6	6
370	Renehan	1	1	1	1	1	1	1	1	1
371	Newcastle	1	1	1	1	1	1	1	1	1
372	Birdum	1	1	1	1	1	1	1	1	1

		Number of clusters								
Number	ibra_name	2	3	4	5	6	7	8	9	10
373	Victorian Volcanic Plain	2	2	4	5	6	7	8	9	10
374	Mount Gambier	2	2	2	2	2	3	3	3	3
375	Dandaragan Plateau	2	2	2	2	2	3	3	3	3
376	Perth	2	2	4	5	6	7	8	9	9
377	Kerrabee	2	2	2	2	2	2	2	2	2
378	Hunter	2	2	4	5	6	7	8	9	9
379	Wollemi	2	2	2	2	2	2	2	2	2
380	Yengo	2	2	2	2	2	2	2	2	2
381	Wyong	2	2	4	5	6	7	8	9	9
382	Pittwater	2	2	4	5	6	7	8	9	9
383	Cumberland	2	2	4	5	6	7	8	9	10
384	Burragorang	2	2	2	2	2	2	2	2	2
385	Sydney Cataract	2	2	2	2	2	2	2	2	2
386	Moss Vale	2	2	2	2	2	3	3	3	3
387	Illawarra	2	2	4	5	6	7	8	9	9
388	Ettrema	2	2	2	2	2	2	2	2	2
389	Jervis	2	2	2	2	2	2	2	2	2
390	Tanami Desert	1	3	3	4	5	6	7	8	8
391	Wycliffe	1	1	1	1	1	1	1	1	1
392	Sandover	1	1	1	1	1	1	1	1	1
393	Central Highlands	2	2	2	2	2	2	2	7	7
394	Tiwi	1	1	1	1	1	1	1	1	1
395	Cobourg	1	1	1	1	1	1	1	1	1
396	Northern Midlands	2	2	2	2	2	2	2	7	7
397	Northern Slopes	2	2	2	2	2	2	2	7	7
398	South East	2	2	2	2	2	2	2	7	7
399	Southern Ranges	2	2	2	2	2	2	2	7	7
400	West	2	2	2	2	2	2	2	7	7
401	Keep	1	3	3	4	5	6	7	8	8
402	Hermit Creek	1	1	1	1	1	1	1	1	1
403	Angalarri	1	1	1	1	1	1	1	1	1
404	Goldfields	2	2	2	2	2	3	3	3	3
405	Central Victorian Uplands	2	2	2	2	2	3	3	3	3
406	Greater Grampians	2	2	2	2	2	2	2	2	2
407	Dundas Tablelands	2	2	2	2	2	3	3	3	3
408	Warren	2	2	2	2	2	2	2	2	2
409	Herbert	1	3	3	3	3	4	4	4	4

Appendix E: Variables driving NRM region cluster membership

Table 12. Strong and moderate variables determining NRM region cluster membership.

		Strong	Moderate
2 clusters	C1	None	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands ilf_indigenous_managed_subject_to_other_special_rights ilf_indigenous_owned_and_co_managed_subject_to_other_special_rights
	C2	None	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands ilf_indigenous_managed_subject_to_other_special_rights ilf_indigenous_owned_and_co_managed_subject_to_other_special_rights
3 clusters	C1	None	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands ilf_indigenous_managed_subject_to_other_special_rights ilf_indigenous_owned_and_co_managed_subject_to_other_special_rights
	C2	None	None
	C3	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	nvis_mvg_60_unclassified_forest federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party
4 clusters	C1	None	abs_2021_population_median_age abs_2021_average_persons_per_bedroom abs_2021_proportion_families_no_children abs_2021_proportion_females_three_or_more_children abs_2021_proportion_dwellings_owned_outright abs_2021_proportion_homes_no_motor_vehicles abs_2021_proportion_population_english_only abs_2021_proportion_volunteer airports_closed value_of_assets_use_value_international_tourists ilf_indigenous_owned_and_co_managed_subject_to_other_special_rights
	C2	None	None
	C3	airports_large	remoteness_proportion_major_cities_of_australia federal_lower_house_proportion_2019_election_the_greens schools_special
	C4	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	nvis_mvg_60_unclassified_forest federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party
5 clusters	C1	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_median	abs_2021_population_median_age abs_2021_average_persons_per_bedroom abs_2021_proportion_workforce_manufacturing abs_2021_proportion_volunteer remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_1.2_managed_resource_protection land_use_2.1_grazing_native_vegetation land_use_3.1_plantation_forests

	Strong	Moderate
		land_use_3.3_cropping land_use_5.7_transport_and_communication climate_chelsa_bio1_mean_temp_max climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold land_capacity_high nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_mangroves fire_history_paa_1969_2018_proportion_affected value_of_assets_forestry_logging changefederal_lower_house_proportion_202116_election_liberal_national_party federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive native_title_outcome_native_title_extinguished ilf_indigenous_owned_and_managed_subject_to_other_special_rights disaster_resilience adaptive_capacity
C2	None	remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_3.1_plantation_forests land_use_3.2_grazing_modified_pastures land_use_3.6_land_in_transition land_use_5.7_transport_and_communication land_use_5.9_waste_treatment_and_disposal climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_heathlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal

		Strong	Moderate
			federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive native_title_outcome_native_title_extinguished disaster_resilience adaptive_capacity
	C3	None	None
	C4	airports_large	remoteness_proportion_major_cities_of_australia federal_lower_house_proportion_2019_election_the_greens schools_special
	C5	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	nvis_mvg_60_unclassified_forest federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party
6 clusters	C1	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_median	abs_2021_population_median_age abs_2021_average_persons_per_bedroom abs_2021_proportion_workforce_manufacturing abs_2021_proportion_volunteer remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_1.2_managed_resource_protection land_use_2.1_grazing_native_vegetation land_use_3.1_plantation_forests land_use_3.3_cropping land_use_5.7_transport_and_communication climate_chelsa_bio1_mean_temp_max climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold land_capacity_high nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_mangroves fire_history_paa_1969_2018_proportion_affected value_of_assets_forestry_logging changefederal_lower_house_proportion_202116_election_liberal_national_party federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland

		Strong	Moderate
			federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive native_title_outcome_native_title_extinguished ilf_indigenous_owned_and_managed_subject_to_other_special_rights disaster_resilience adaptive_capacity
	C2	None	None
	C3	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	land_use_2.1_grazing_native_vegetation land_use_3.2_grazing_modified_pastures land_use_5.7_transport_and_communication climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_median land_tenure_crown_leasehold nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive native_title_outcome_native_title_extinguished adaptive_capacity
	C4	None	None
	C5	airports_large	remoteness_proportion_major_cities_of_australia federal_lower_house_proportion_2019_election_the_greens schools_special
	C6	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	remoteness_proportion_major_cities_of_australia remoteness_proportion_major_cities_of_australia remoteness_proportion_major_cities_of_australia
7 clusters	C1	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_median	abs_2021_population_median_age abs_2021_average_persons_per_bedroom abs_2021_proportion_workforce_manufacturing abs_2021_proportion_volunteer remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_1.2_managed_resource_protection land_use_2.1_grazing_native_vegetation land_use_3.1_plantation_forests land_use_3.3_cropping land_use_5.7_transport_and_communication climate_chelsa_bio1_mean_temp_max climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold

	Strong	Moderate
		land_capacity_high nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_mangroves fire_history_paa_1969_2018_proportion_affected value_of_assets_forestry_logging changefederal_lower_house_proportion_202116_election_liberal_national_party federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive native_title_outcome_native_title_extinguished ilf_indigenous_owned_and_managed_subject_to_other_special_rights disaster_resilience adaptive_capacity
C2	None	None
C3	None	nvis_mvg_60_rainforests_and_vine_thickets federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation
C4	None	None
C5	None	remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_5.9_waste_treatment_and_disposal land_tenure_crown_leasehold nvis_mvg_60_acacia_open_woodlands nvis_mvg_60_hummock_grasslands grant_value_dollars_per_sqkm
C6	airports_large	remoteness_proportion_major_cities_of_australia federal_lower_house_proportion_2019_election_the_greens schools_special
C7	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	nvis_mvg_60_unclassified_forest federal_upper_house_num_senators_2019_election_country_liberal_party

		Strong	Moderate
			federal_upper_house_incumbent_post_2019_election_country_liberal_party
8 clusters	C1	federal_upper_house_num_senators_2019_election_jacqui_lambie_network federal_upper_house_incumbent_post_2019_election_jacquie_lambie_network	None
	C2	None	abs_2021_population_median_age abs_2021_average_persons_per_bedroom abs_2021_proportion_workforce_manufacturing abs_2021_proportion_homes_no_motor_vehicles remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_1.2_managed_resource_protection land_use_3.2_grazing_modified_pastures land_use_3.3_cropping climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_median land_tenure_freehold land_capacity_high nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_rainforests_and_vine_thickets fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive native_title_outcome_native_title_extinguished disaster_resilience adaptive_capacity
	C3	None	None
	C4	None	nvis_mvg_60_rainforests_and_vine_thickets federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation

		Strong	Moderate
	C5	None	None
	C6	None	remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_5.9_waste_treatment_and_disposal land_tenure_crown_leasehold nvis_mvg_60_acacia_open_woodlands nvis_mvg_60_hummock_grasslands grant_value_dollars_per_sqkm
	C7	airports_large	remoteness_proportion_major_cities_of_australia federal_lower_house_proportion_2019_election_the_greens schools_special
	C8	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	nvis_mvg_60_unclassified_forest federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party
9 clusters	C1	federal_upper_house_num_senators_2019_election_jacqui_lambie_network federal_upper_house_incumbent_post_2019_election_jacquie_lambie_network	None
	C2	None	abs_2021_average_persons_per_bedroom abs_2021_proportion_no_religious_affiliation land_use_1.2_managed_resource_protection land_use_2.1_grazing_native_vegetation land_use_3.3_cropping land_use_6.3_river land_capacity_high nvis_mvg_60_eucalypt_tall_open_forests value_of_assets_non_use_value_residents value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_genepool value_of_assets_toxin_mediation federal_lower_house_proportion_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_the_greens
	C3	None	None
	C4	None	nvis_mvg_60_rainforests_and_vine_thickets federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation
	C5	None	None
	C6	federal_upper_house_num_senators_2019_election_the_nationals	remoteness_proportion_outer_regional_australia

		Strong	Moderate
			climate_chelsa_bio6_min_temp_min nvis_mvg_60_regrowth_modified_native_vegetation fire_niafed_paa_2019_2020_proportion_affected federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party
	C7	None	remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_5.9_waste_treatment_and_disposal land_tenure_crown_leasehold nvis_mvg_60_acacia_open_woodlands nvis_mvg_60_hummock_grasslands grant_value_dollars_per_sqkm
	C8	airports_large	remoteness_proportion_major_cities_of_australia federal_lower_house_proportion_2019_election_the_greens schools_special
	C9	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	nvis_mvg_60_unclassified_forest federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party
10 clusters	C1	federal_upper_house_num_senators_2019_election_jacqui_lambie_network federal_upper_house_incumbent_post_2019_election_jacquie_lambie_network	None
	C2	None	abs_2021_average_persons_per_bedroom abs_2021_proportion_no_religious_affiliation land_use_1.2_managed_resource_protection land_use_2.1_grazing_native_vegetation land_use_3.3_cropping land_use_6.3_river land_capacity_high nvis_mvg_60_eucalypt_tall_open_forests value_of_assets_non_use_value_residents value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_genepool value_of_assets_toxin_mediation federal_lower_house_proportion_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_the_greens
	C3	None	None
	C4	None	nvis_mvg_60_rainforests_and_vine_thickets federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland

	Strong	Moderate
		federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation
C5	None	None
C6	federal_upper_house_num_senators_2019_election_the_nationals	remoteness_proportion_outer_regional_australia climate_chelsa_bio6_min_temp_min nvis_mvg_60_regrowth_modified_native_vegetation fire_niafed_paa_2019_2020_proportion_affected federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party
C7	None	remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation nvis_mvg_60_acacia_open_woodlands
C8	airports_large	remoteness_proportion_major_cities_of_australia federal_lower_house_proportion_2019_election_the_greens schools_special
C9	nvis_mvg_60_tropical_eucalypt_woodlands_grasslands	nvis_mvg_60_unclassified_forest federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party
C10	None	None

Appendix F: Variables driving IBRA sub-region cluster membership – variable-wise deletion

Table 13. Strong and moderate variables determining IBRA sub-region cluster membership, variable-wise deletion.

		Strong	Moderate
2 clusters	C1	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio5_max_temp_median fire_niafed_paa_2019_2020_proportion_affected disaster_resilience adaptive_capacity	abs_2021_persons_total abs_2021_persons_employed_aged_15_and_over abs_2021_population_density abs_2021_population_median_age abs_2021_median_rent_weekly abs_2021_proportion_indigenous abs_2021_proportion_workforce_manufacturing abs_2021_proportion_dwellings_owned_with_mortgage abs_2021_proportion_degree_or_higher remoteness_proportion_inner_regional_australia remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_2.2_production_native_forests land_use_3.1_plantation_forests land_use_3.3_cropping land_use_3.4_perennial_horticulture land_use_3.5_seasonal_horticulture land_use_5.2_intensive_animal_production land_use_5.4_residential_and_farm_infrastructure land_use_5.7_transport_and_communication climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max land_tenure_crown_leasehold nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests nvis_mvg_60_heathlands epbc_listed_species_richness_max epbc_listed_species_richness_median epbc_listed_ecological_community_richness_max epbc_listed_ecological_community_richness_median fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected value_of_assets_infrastructure value_of_assets_forestry_logging

	Strong	Moderate
		value_of_assets_erosion federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party native_title_outcome_native_title_exists_non_exclusive ilf_non_indigenous ilf_proportion_estate overexploitation hcas_2001_2010 grant_value_dollars grant_value_dollars_per_sqkm
C2	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median fire_niafed_paa_2019_2020_proportion_affected disaster_resilience adaptive_capacity	abs_2021_persons_total abs_2021_persons_employed_aged_15_and_over abs_2021_population_density abs_2021_population_median_age abs_2021_median_rent_weekly abs_2021_proportion_indigenous abs_2021_proportion_workforce_manufacturing abs_2021_proportion_dwellings_owned_with_mortgage abs_2021_proportion_degree_or_higher remoteness_proportion_inner_regional_australia remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_2.2_production_native_forests land_use_3.1_plantation_forests land_use_3.3_cropping land_use_3.4_perennial_horticulture land_use_3.5_seasonal_horticulture land_use_5.2_intensive_animal_production land_use_5.4_residential_and_farm_infrastructure land_use_5.7_transport_and_communication climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median land_tenure_crown_leasehold nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests nvis_mvg_60_heathlands epbc_listed_species_richness_max epbc_listed_species_richness_median epbc_listed_ecological_community_richness_max epbc_listed_ecological_community_richness_median fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected value_of_assets_infrastructure value_of_assets_forestry_logging

		Strong	Moderate
			value_of_assets_erosion federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party native_title_outcome_native_title_exists_non_exclusive ilf_non_indigenous ilf_proportion_estate overexploitation hcas_2001_2010 grant_value_dollars grant_value_dollars_per_sqkm
3 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed disaster_resilience coping_capacity adaptive_capacity
	C2	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio5_max_temp_median fire_niafed_paa_2019_2020_proportion_affected disaster_resilience adaptive_capacity	abs_2021_persons_total abs_2021_persons_employed_aged_15_and_over abs_2021_population_density abs_2021_population_median_age abs_2021_median_rent_weekly abs_2021_proportion_indigenous abs_2021_proportion_workforce_manufacturing abs_2021_proportion_dwellings_owned_with_mortgage abs_2021_proportion_degree_or_higher remoteness_proportion_inner_regional_australia remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_2.2_production_native_forests land_use_3.1_plantation_forests land_use_3.3_cropping land_use_3.4_perennial_horticulture land_use_3.5_seasonal_horticulture land_use_5.2_intensive_animal_production land_use_5.4_residential_and_farm_infrastructure land_use_5.7_transport_and_communication climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max land_tenure_crown_leasehold nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests

		Strong	Moderate
			nvis_mvg_60_heathlands epbc_listed_species_richness_max epbc_listed_species_richness_median epbc_listed_ecological_community_richness_max epbc_listed_ecological_community_richness_median fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected value_of_assets_infrastructure value_of_assets_forestry_logging value_of_assets_erosion federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party native_title_outcome_native_title_exists_non_exclusive ilf_non_indigenous ilf_proportion_estate overexploitation hcas_2001_2010 grant_value_dollars grant_value_dollars_per_sqkm
	C3	None	land_use_2.1_grazing_native_vegetation land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median land_tenure_crown_leasehold land_tenure_freehold nvis_mvg_60_acacia_forests_and_woodlands fire_niafed_paa_2019_2020_proportion_affected federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_extinguished grant_value_dollars_per_sqkm
4 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed disaster_resilience coping_capacity adaptive_capacity
	C2	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median	abs_2021_population_density abs_2021_population_median_age abs_2021_proportion_workforce_manufacturing

		Strong	Moderate
			remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_3.1_plantation_forests land_use_3.3_cropping land_use_3.4_perennial_horticulture climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_heathlands epbc_listed_ecological_community_richness_max fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected value_of_assets_forestry_logging federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_australian_labor_party disaster_resilience adaptive_capacity overexploitation grant_value_dollars_per_sqkm
	C3	None	land_use_2.1_grazing_native_vegetation land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median land_tenure_crown_leasehold land_tenure_freehold nvis_mvg_60_acacia_forests_and_woodlands fire_niafed_paa_2019_2020_proportion_affected federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_extinguished grant_value_dollars_per_sqkm
	C4	None	remoteness_proportion_major_cities_of_australia airports_large
5 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed

		Strong	Moderate
			disaster_resilience coping_capacity adaptive_capacity
	C2	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median	abs_2021_population_density abs_2021_population_median_age abs_2021_proportion_workforce_manufacturing remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_3.1_plantation_forests land_use_3.3_cropping land_use_3.4_perennial_horticulture climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_heathlands epbc_listed_ecological_community_richness_max fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected value_of_assets_forestry_logging federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_australian_labor_party disaster_resilience adaptive_capacity overexploitation grant_value_dollars_per_sqkm
	C3	federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal
	C4	None	climate_chelsa_bio12_ann_precip_min climate_chelsa_bio12_ann_precip_max climate_chelsa_bio12_ann_precip_median land_tenure_freehold nvis_mvg_60_cleared_non-native_vegetation_buildings
	C5	None	remoteness_proportion_major_cities_of_australia airports_large
6 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens federal_upper_house_incumbent_post_2019_election_australian_labor_party

		Strong	Moderate
			federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed disaster_resilience coping_capacity adaptive_capacity
	C2	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median	abs_2021_population_density abs_2021_population_median_age abs_2021_proportion_workforce_manufacturing remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_3.1_plantation_forests land_use_3.3_cropping land_use_3.4_perennial_horticulture climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_heathlands epbc_listed_ecological_community_richness_max fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected value_of_assets_forestry_logging federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_australian_labor_party disaster_resilience adaptive_capacity overexploitation grant_value_dollars_per_sqkm
	C3	federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal
	C4	None	climate_chelsa_bio12_ann_precip_max climate_chelsa_bio12_ann_precip_median
	C5	None	ilf_indigenous_managed_subject_to_other_special_rights
	C6		remoteness_proportion_major_cities_of_australia airports_large
7 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens federal_upper_house_incumbent_post_2019_election_australian_labor_party

		Strong	Moderate
			federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed disaster_resilience coping_capacity adaptive_capacity
	C2	None	land_use_2.2_production_native_forests nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected
	C3	None	land_use_3.2_grazing_modified_pastures land_use_3.3_cropping climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median nvis_mvg_60_cleared_non-native_vegetation_buildings hcas_2001_2010 hcas_2006_2015
	C4	federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal
	C5	None	climate_chelsa_bio12_ann_precip_max climate_chelsa_bio12_ann_precip_median
	C6	None	ilf_indigenous_managed_subject_to_other_special_rights
	C7	None	remoteness_proportion_major_cities_of_australia airports_large
8 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed disaster_resilience coping_capacity adaptive_capacity
	C2	None	land_use_2.2_production_native_forests nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected fire_history_paa_2014_2018_proportion_affected
	C3	None	land_use_3.2_grazing_modified_pastures land_use_3.3_cropping climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median

		Strong	Moderate
			nvis_mvg_60_cleared_non-native_vegetation_buildings hcas_2001_2010 hcas_2006_2015
	C4	None	nvis_mvg_60_sea_and_estuaries
	C5	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	nvis_mvg_60_acacia_forests_and_woodlands federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal
	C6	None	climate_chelsa_bio12_ann_precip_max climate_chelsa_bio12_ann_precip_median
	C7	None	ilf_indigenous_managed_subject_to_other_special_rights
	C8	None	remoteness_proportion_major_cities_of_australia airports_large
9 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed disaster_resilience coping_capacity adaptive_capacity
	C2	None	nvis_mvg_60_eucalypt_tall_open_forests fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected
	C3	None	land_use_3.2_grazing_modified_pastures land_use_3.3_cropping climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median nvis_mvg_60_cleared_non-native_vegetation_buildings hcas_2001_2010 hcas_2006_2015
	C4	None	nvis_mvg_60_sea_and_estuaries
	C5	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	nvis_mvg_60_acacia_forests_and_woodlands federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal
	C6	None	climate_chelsa_bio12_ann_precip_max climate_chelsa_bio12_ann_precip_median
	C7	federal_upper_house_num_senators_2019_election_jacqui_lambie_network federal_upper_house_incumbent_post_2019_election_jacquie_lambie_network	None
	C8	None	ilf_indigenous_managed_subject_to_other_special_rights
	C9	None	remoteness_proportion_major_cities_of_australia airports_large
10 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	abs_2021_proportion_population_english_only federal_lower_house_proportion_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_the_greens

	Strong	Moderate
		federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_greens ilf_indigenous_owned_and_managed disaster_resilience coping_capacity adaptive_capacity
C2	None	nvis_mvg_60_eucalypt_tall_open_forests fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected
C3	None	land_use_3.2_grazing_modified_pastures land_use_3.3_cropping climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median nvis_mvg_60_cleared_non-native_vegetation_buildings hcas_2001_2010 hcas_2006_2015
C4	None	nvis_mvg_60_sea_and_estuaries
C5	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	nvis_mvg_60_acacia_forests_and_woodlands federal_lower_house_proportion_2019_election_liberal_national_party federal_upper_house_num_senators_2019_election_liberal
C6	None	climate_chelsa_bio12_ann_precip_max climate_chelsa_bio12_ann_precip_median
C7	federal_upper_house_num_senators_2019_election_jacqui_lambie_network federal_upper_house_incumbent_post_2019_election_jacquie_lambie_network	None
C8	None	ilf_indigenous_managed_subject_to_other_special_rights
C9	None	remoteness_proportion_major_cities_of_australia airports_large
C10	federal_lower_house_proportion_2019_election_the_greens	schools_special

Appendix G: Quantitative descriptors of the 10 NRM region clusters

Table 14. Mean values of core variables that drive cluster membership for each of 10 NRM region clusters. Vertical lines show groups of regions if using 6 clusters instead of 10. Variables with a strong influence when dividing into 10 clusters shaded grey; variable name in **bold** if strong influence if dividing into 6 clusters.

	Variable	Cluster 1	2	3	4	5	6	7	8	9	10
Variables describing ecological (natural) system	MVG; % of region covered in										
	Tropical Eucalypt Woodlands and Grasslands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.39
	Unclassified forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Acacia Forests and Woodlands	0.04	0.00	0.30	0.15	0.73	1.57	0.98	6.85	0.84	6.65
	Heathlands	1.24	2.53	0.59	1.78	0.00	0.06	0.00	0.10	1.32	0.11
	Acacia Open Woodlands	0.00	0.00	0.01	0.01	26.15	0.14	15.15	2.50	0.00	2.95
	Mangroves	0.28	0.00	0.01	0.04	0.00	0.58	0.00	0.10	0.63	0.17
	Rainforests and Vine Thickets, Grasslands	1.33	6.05	0.05	0.06	0.00	4.79	0.00	0.06	1.68	0.10
	Cleared, non-native vegetation buildings	43.39	18.37	42.00	52.00	0.01	43.16	0.22	6.96	0.40	0.35
	Eucalypt Tall Open Forests	2.56	17.13	6.46	0.28	0.00	0.54	0.00	0.01	0.04	0.00
	Regrowth modified native vegetation	0.00	1.85	3.36	0.00	0.00	0.00	0.05	0.00	0.00	0.00
	Hummock Grasslands	0.00	0.00	0.01	0.01	4.65	0.01	14.25	1.93	0.00	33.91
	Water: Land-use river	0.55	0.16	0.87	0.07	0.02	0.21	0.30	0.19	0.37	0.27
	Extreme events: % of region fire-impacted 1969–2018	28.58	23.71	30.11	22.22	0.51	10.67	0.03	3.53	0.00	1.66
	Climate										
	Avg maximum temperature (mean_temp_max)	18.67	14	18.36	17.39	22	23	24	25.2	27	29
	Annual avg temperature (max_temp_median)	17	11.75	15.46	15.83	20	21.29	21	23.4	26.5	25
	Highest max. monthly temperature (max_temp_max)	28.67	23.75	31.182	30.94	37	32.86	39	37.2	36	40.5
	Coolest min. monthly temperature (min_temp_median)	7	4	4.27	6.17	6	10.86	6	10	19	10.5
Variables describing social (human) system	Indigenous governance:										
	% of region Indigenous owned and co_managed subject to other special rights	0.02	0	0.003	0.04	1.64	0.18	1.68	0.80	19.93	8.32
	Native title – outcomes in region										
	Exclusive	1.33	0.00	0.36	0.28	5.00	5.43	4.00	6.20	8.50	56.50
	Non-exclusive	2.00	0.00	1.91	1.28	9.00	11.29	35.00	13.80	13.00	109.50
	Extinguished	1.00	0.00	0.36	0.28	1.00	2.86	9.00	3.60	2.00	14.50
	Land tenure										
	% of land crown leasehold	0.15	5.938	1.77	3.60	0.011	19.44	80.56	79.79	50.57	42.70
	% of land freehold	56.98	22.69	66.05	61.88	74.80	50.51	1.19	13.43	31.23	23.43

Variable	Cluster 1	2	3	4	5	6	7	8	9	10
Politics										
Federal upper house incumbents (count)										
Australian Labor Party (ALP)	3.67	3.25	4.64	3.61	4.00	3.00	4.00	3.40	3.00	2.50
Country Liberal Party	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Jacquie Lambie	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liberal	3.67	4.00	5.00	5.33	5.00	1.00	5.00	1.80	1.00	3.00
Liberal National Party of Queensland	1.33	0.00	0.00	0.00	0.00	4.00	0.00	3.20	4.00	0.00
One Nation	0.67	0.00	0.00	0.00	0.00	2.00	0.00	1.60	2.00	0.00
Australian Greens	1.33	1.50	1.18	1.72	1.00	1.00	1.00	1.00	1.00	1.00
Federal upper house – no. of senators										
ALP	1.67	1.75	2.00	2.00	2.00	1.00	2.00	1.20	1.00	1.50
Country Liberal Party	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Jacquie Lambie	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liberal	1.67	1.75	2.18	3.00	3.00	0.00	3.00	0.40	0.00	1.50
Liberal National Party of Qld (LNP)	1.00	0.00	0.00	0.00	0.00	3.00	0.00	2.40	3.00	0.00
One Nation	0.33	0.00	0.00	0.00	0.00	1.00	0.00	0.80	1.00	0.00
National Party	0.33	0.00	0.82	0.00	0.00	0.00	0.00	0.20	0.00	0.00
Federal lower house % of region represented by political party										
Liberal Party	28.32	25.33	14.53	58.20	99.40	0.00	99.95	3.73	0.00	48.01
Australian Greens	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
National Party	0.01	0.00	63.59	20.71	0.00	0.01	0.00	16.27	0.00	0.00
Federal lower house – % change LNP representation 2016–19	-2.66	0.00	0.00	0.00	0.00	-13.35	-0.01	-0.01	-12.07	0.00
Built infrastructure										
Large Airports (presence/absence)	1.00	0.25	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Airports – closed	3.33	0.75	0.55	0.33	0.00	0.29	0.00	0.40	2.00	2.50
Special schools present	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Remoteness – % of region classified as										
Major city	24.78	6.23	0.41	2.39	0.00	0.00	0.00	0.00	0.00	0.00
Outer regional	5.67	31.16	65.26	40.10	0.00	35.09	1.00	0.67	0.00	0.11
Very remote	0.00	2.74	0.24	5.36	99.40	9.54	85.97	89.26	81.14	91.92
Household characteristics										
% homes no motor vehicle	8.35	5.73	5.23	4.92	33.13	5.00	7.85	7.28	26.00	9.69
Average persons per bedroom	0.86	0.80	0.75	0.74	1.37	0.78	0.76	0.83	1.17	0.98
% dwellings owned outright.	28.33	34.87	38.77	37.61	8.80	32.81	30.49	34.98	12.71	15.02
% families no children	36.40	43.75	44.72	45.10	27.27	43.47	42.61	43.72	28.07	35.09
% females 3 or more children	20.58	24.75	30.48	30.05	21.47	29.32	27.23	30.97	23.68	22.19

	Variable	Cluster 1	2	3	4	5	6	7	8	9	10
	Personal characteristics: median age	38.77	41.73	43.75	44.03	30.30	41.29	39.84	40.44	31.12	33.96
	Community characteristics										
	% population speaks only English at home	65.90	83.22	86.56	84.74	18.24	84.52	79.04	81.67	66.45	62.57
	% population no religious affiliation	36.46	48.03	36.01	44.98	29.17	36.60	47.88	33.89	24.57	40.14
	% population volunteering	12.48	17.90	17.15	19.21	8.76	15.74	15.91	18.83	8.98	14.05
	Economic descriptors										
	Income from international tourists (estimate)	1142.53	54.23	36.92	51.33	36.00	62.84	48.00	124.34	145.10	241.85
	% workforce manufacturing	6.00	5.55	6.34	7.03	0.02	5.61	2.01	2.69	2.02	2.40
Variables describing interactions between social and ecological systems	Land use – % of region										
	Managed for resource protection	0.71	7.80	0.21	0.10	65.67	0.97	0.69	1.33	23.16	25.30
	Grazing native vegetation	0.15	14.80	14.80	1.55	25.58	2.26	0.03	53.00	75.74	87.91
	Grazing modified pastures	14.80	1.55	25.58	2.26	0.03	53.00	75.74	87.91	45.43	37.77
	Plantation forests	0.83	3.88	0.73	2.16	0.00	0.47	0.00	0.00	0.00	0.02
	Cropping	10.75	12.30	16.24	22.45	0.00	0.18	0.48	0.11	0.00	0.04
	Land in transition	1.32	0.11	14.94	24.33	0.00	7.73	0.04	0.40	0.02	0.01
	Transport and communication	0.43	0.19	0.03	0.08	0.00	0.01	0.00	0.00	0.02	0.00
	Waste treatment and disposal	1.62	0.81	0.45	1.14	0.11	0.12	0.13	0.05	0.01	0.10
	Ecosystem services – estimated $M per annum										
	Non-use values residents	455.55	33.50	29.90	41.85	14.49	47.10	38.24	167.00	52.44	29.05
	Forestry logging	29.20	22.77	96.93	35.72	76.14	0.00	36.93	0.00	2.16	1.05
	Carbon sequestration	5169.40	80.97	128.73	196.01	79.27	729.40	240.33	1320.10	768.44	303.85
	Water purification	3567.60	55.40	89.50	132.20	61.19	387.20	157.47	1725.50	474.80	206.70
	Gene pool	4691.65	54.90	82.93	130.24	60.54	653.60	190.80	1355.80	693.18	293.80
	Toxin remediation	499.20	29.40	47.78	66.31	20.72	31.80	55.73	281.10	39.56	34.15
	Land capacity – % of region with high land capacity	36.89	9.75	46.27	60.58	0.01	34.98	0.26	12.33	12.37	8.32
	Adaptive capacity	0.57	0.46	0.54	0.48	0.21	0.31	0.29	0.23	0.22	0.16
	Disaster resilience	0.55	0.38	0.48	0.43	0.14	0.34	0.31	0.25	0.20	0.12
	Stewardship: Grant value ($/km^2)	7563.96	418.56	49.96	123.98	2.38	21.80	0.21	0.24	2.86	2.52

Appendix H: Quantitative descriptors of the 10 IBRA sub-region clusters

Table 15. Mean values of core variables that drive cluster membership for each of 10 IBRA sub-region clusters, variable-wise deletion (409 regions, 214 variables). Vertical lines show clustering if using 6 clusters instead of 10. Variables with a strong influence when dividing into 10 clusters shaded grey; variable name in **bold** if strong influence if dividing into 6 clusters.

	Variable	Cluster									
		Northern arid	Southern agriculture	High-value agriculture	Tasmania	Monsoonal coast	NE agriculture	Central eastern arid	Western/ central arid	Capital cities	Regional centres
Variables describing ecological (natural) system	MVG; % of region covered in										
	Acacia_forests_and_woodlands	1.33	0.04	0.40	0.00	1.61	6.14	2.87	6.75	0.07	0.01
	Cleared_nonnative_vegetation_buildings	0.66	17.75	54.01	28.69	14.17	32.19	2.80	0.39	60.33	79.37
	Eucalypt_open_forests	10.89	37.93	7.88	13.05	7.52	2.01	1.80	0.11	12.61	3.31
	Eucalypt_tall_open_forests	0.00	19.43	1.33	11.36	1.61	0.13	0.00	0.00	6.77	0.06
	Heathlands	0.00	1.86	1.65	3.63	1.53	0.07	0.01	0.66	1.12	0.51
	Sea_and_estuaries	0.00	0.03	0.01	0.00	0.58	0.03	0.00	0.00	0.30	0.00
	EPBC-listed										
	Ecological community richness (max)	0.17	4.16	3.81	3.00	1.11	3.17	1.35	0.15	4.73	6.00
	Ecological Community richness (median)	0.17	2.40	2.38	1.67	0.67	1.88	0.92	0.15	2.55	3.67
	Species richness (max)	8.96	29.09	19.64	36.33	25.22	11.65	6.37	10.03	40.91	46.00
	Species richness (median)	4.41	17.32	10.08	12.56	14.19	5.50	2.37	2.49	20.95	18.00
	Habitat condition										
	Hcas_2001_2010	0.82	0.73	0.43	0.57	0.61	0.66	0.78	0.82	0.41	0.22
	Hcas_2006_2015	0.81	0.73	0.45	0.57	0.61	0.67	0.77	0.82	0.42	0.23
	Extreme events										
	% of region fire impacted 1969 2018	0.00	59.86	14.13	9.22	4.15	9.91	2.59	2.29	19.95	13.08
	% of region fire impacted 2004 2018	0.00	30.86	8.57	8.49	4.07	9.74	0.47	1.77	9.07	7.25
	% of region fire impacted 2014 2018	0.00	10.33	2.99	4.47	2.06	3.94	0.10	0.30	3.44	2.51
	% of region fire impacted 2019–2020	0.00	47.84	4.21	0.56	0.40	0.69	0.00	0.31	2.85	0.51
	Climate										
	Annual_precip_max	893.23	1,382.69	831.19	1,874.89	2,294.48	820.38	306.92	656.64	1,337.00	1,097.67
	Annual_precip_median	714.73	1,038.18	615.36	1,147.56	1,663.91	610.30	244.77	459.23	952.45	756.33
	Annual_precip_min	591.77	755.02	491.79	697.89	1,108.67	488.05	209.37	334.33	705.55	587.67
	Min_temp_min	10.50	0.82	2.88	-1.11	13.78	7.52	5.08	8.36	4.18	4.00
	Mean_temp_max	25.69	16.96	17.07	13.00	25.22	23.33	20.90	26.13	18.18	16.00

	Variable	Cluster									
		Northern arid	Southern agriculture	High-value agriculture	Tasmania	Monsoonal coast	NE agriculture	Central eastern arid	Western/ central arid	Capital cities	Regional centres
	Mean_temp_median	24.75	14.51	15.49	10.78	24.07	22.28	19.88	24.62	17.00	14.67
	Max_temp_median	35.81	25.44	28.01	19.11	30.52	33.49	34.48	37.67	26.73	25.67
Variables describing social (human) system	Indigenous governance										
	% of region not part of the Indigenous estate	19.41	76.91	83.31	81.67	34.67	51.38	53.42	33.26	89.74	91.99
	% region in Indigenous estate	80.59	23.09	16.69	18.33	65.33	48.62	46.58	66.74	10.26	8.01
	% of region Indigenous owned and co-managed	3.81	0.14	0.00	0.01	4.41	0.00	0.22	0.57	0.00	0.02
	% of region Indigenous managed subject to other special rights	0.14	0.00	0.00	0.00	0.70	0.00	0.13	3.90	0.00	0.03
	Native Title – outcomes in region										
	Non-exclusive	3.65	0.78	0.72	0.00	4.78	2.67	2.71	7.92	0.73	1.00
	Extinguished	0.06	0.13	0.13	0.00	0.85	0.70	0.88	1.38	0.27	0.00
	Social/institutional capita/land tenure										
	% of land leasehold	44.52	0.36	4.96	0.01	24.43	53.39	84.08	50.46	1.11	0.01
	% of land freehold	51.09	36.78	76.28	47.23	43.94	37.58	6.64	9.91	74.85	89.55
	Politics										
	Federal upper house – count of incumbents (mean)										
	Australian Labor Party (ALP)	1.32	4.61	4.40	3.97	2.98	3.06	4.42	3.56	3.93	3.66
	Liberal Party	0.54	5.04	5.06	4.97	0.99	1.14	4.88	4.98	3.87	4.99
	Australian Greens	0.15	1.21	1.25	1.99	0.99	1.00	1.00	1.66	1.14	1.66
	Country Liberal Party (CLP)	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
	Jacquie Lambie	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00
	Liberal National Party of Qld (LNP)	0.06	0.00	0.07	0.00	3.97	3.86	0.11	0.15	1.03	0.00
	Pauline Hanson's One Nation (PHON)	0.03	0.00	0.04	0.00	1.98	1.93	0.05	0.07	0.51	0.00
	Federal upper house – count of senators (mean)										
	ALP	1.10	1.99	1.98	1.99	0.99	1.03	1.97	1.83	1.68	2.00
	CLP	0.30	2.21	2.41	1.99	0.00	0.08	2.46	2.49	1.69	2.66
	Australian Greens	0.11	0.99	1.00	0.99	0.99	1.00	1.00	0.87	0.96	1.00
	National Party	0.00	0.78	0.53	0.00	0.00	0.02	0.45	0.00	0.43	0.33
	Country Liberal	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
	Jacquie Lambie	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00
	LNP	0.05	0.00	0.06	0.00	2.97	2.90	0.08	0.11	0.77	0.00
	PHON	0.02	0.00	0.02	0.00	0.99	0.97	0.03	0.04	0.26	0.00
	Federal lower house % of region represented by political party										
	ALP	88.40	21.88	3.98	54.24	0.31	0.51	0.24	13.35	49.38	27.78

	Variable	Cluster									
		Northern arid	Southern agriculture	High-value agriculture	Tasmania	Monsoonal coast	NE agriculture	Central eastern arid	Western/ central arid	Capital cities	Regional centres
	National Party	0.00	60.29	49.58	0.00	0.00	2.50	39.56	0.00	1.97	19.21
	LNP	0.00	0.02	1.86	0.00	57.48	73.01	2.69	0.35	20.60	0.00
	Australian Greens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
	Built infrastructure										
	Large airports (presence/absence)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.33
	Special schools (presence/absence)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
	Remoteness - % of region classified as										
	Major city	0.00	0.96	0.06	0.00	0.02	0.00	0.00	0.00	26.13	33.48
	Inner regional	0.00	25.20	16.96	4.14	2.18	3.73	0.00	0.00	63.68	44.43
	Outer regional	0.21	72.52	57.80	60.04	30.32	19.06	1.74	0.01	6.99	21.68
	Very remote	90.51	0.00	9.35	7.30	47.33	51.44	69.11	98.52	0.00	0.00
	Household characteristics										
	% of dwellings owned with mortgage	5.06	28.33	27.42	30.75	19.67	21.36	15.44	6.94	35.89	35.52
	Personal characteristics: median age	30.08	48.81	45.11	45.28	39.61	41.68	41.33	33.79	39.93	37.93
	Community characteristics										
	% population Indigenous	61.09	5.40	7.04	6.86	31.62	9.11	13.95	36.27	3.00	1.08
	% population degree or higher	6.79	16.81	13.19	15.78	10.78	9.46	9.36	9.30	27.05	31.18
	% population speaks only English at home	32.83	85.43	85.49	87.37	72.45	83.81	78.89	51.21	79.07	56.34
	Total population	4,242	40,083	31,523	61,586	23,790	10,718	1,491	4,417	917,907	2,687,406
	Population density (persons/km^2)	0.21	10.65	4.86	8.93	8.30	1.08	0.12	0.12	266.68	484.65
	Economic descriptors										
	Median weekly rent	95.26	290.13	239.66	249.21	239.99	188.44	128.83	140.04	427.83	428.84
	Persons >15 years, employed	1993	18255	14356	11050	4567	632	28162	2029	452933	1262842
	% workforce manufacturing	0.37	4.45	5.11	6.84	3.42	2.70	1.36	1.08	5.37	6.65
Variables describing interactions between social and ecological	Land use – % of region										
	Grazing native vegetation	38.41	11.51	25.27	2.79	26.12	80.92	81.33	45.47	16.30	1.88
	Plantation forests	0.10	1.30	1.86	5.60	1.05	0.27	0.00	0.00	1.66	2.09
	Production native forests	0.00	17.49	2.18	12.77	1.57	3.23	0.18	0.00	2.81	1.34
	Grazing modified pastures	0.09	7.27	23.97	15.42	0.11	0.20	0.91	0.00	18.17	40.91
	Cropping	0.02	1.49	19.05	0.21	2.96	3.15	1.60	0.05	1.92	6.58
	Perennial horticulture	0.00	0.10	0.08	0.00	0.01	0.01	0.00	0.00	0.41	0.21
	Seasonal horticulture	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.24
	Intensive animal production	0.00	0.04	0.09	0.08	0.04	0.02	0.00	0.00	0.39	0.95
	Residential and farm infrastructure	0.06	1.43	1.48	2.76	1.35	0.38	0.05	0.01	13.74	18.78
	Transport and communication	0.20	0.41	0.88	0.74	0.10	0.08	0.23	0.04	2.60	5.23
	Ecosystem services – estimated $ million/yr										

Variable	Cluster									
	Northern arid	Southern agriculture	High-value agriculture	Tasmania	Monsoonal coast	NE agriculture	Central eastern arid	Western/ central arid	Capital cities	Regional centres
Annual value of forestry/logging	0.55	11.74	11.07	42.05	0.99	2.99	0.24	1.02	9.81	71.76
Erosion control	120.46	13.60	42.63	31.97	72.50	98.37	93.66	475.64	13.04	35.77
Estimated annualised value of infrastructure that is 'vulnerable' to pests (e.g. termites)	3.06	173.99	54.92	55.62	17.90	25.57	2.20	8.05	476.96	1,420.24
Overexploitation	8.63	1.75	2.94	2.28	4.10	5.71	7.47	10.92	0.61	0.71
Adaptive capacity	0.07	0.55	0.47	0.44	0.25	0.26	0.31	0.25	0.58	0.60
Disaster resilience	0.05	0.49	0.43	0.36	0.28	0.29	0.30	0.19	0.56	0.55
Coping capacity	0.05	0.39	0.36	0.26	0.30	0.35	0.27	0.14	0.51	0.46
Stewardship: grant value ($ million/region)	0.07	0.28	0.31	0.70	0.17	0.03	0.01	0.13	49.59	13.29
Stewardship: grant value ($/km^2)	5.24	86.52	47.87	102.58	89.47	3.81	0.49	1.94	8,975.97	2,738.88

Appendix I: Results for the clustering analysis undertaken on IBRA sub-regions, using the listwise-deletion approach

We used both silhouette analysis and the elbow method to identify the optimal number of clusters: '2' and '5, 6 or 7' using silhouette scores and the elbow method, respectively.

Table 16. Cluster in which variables first distinguish IBRA regions, listwise deletion. Green indicates a variable that describes the natural/ecological system; blue indicates a variable that describes the social/human system; red indicates a variable that describes an interaction between subsystems.

Number of clusters	Variables exerting 'strong' influence on cluster membership	Variables exerting moderate influence on cluster membership
2		Climate: max temperature, min annual precipitation MVG: Acacia Open Woodlands; Acacia Shrublands; Hummock Grasslands EPBC-listed: ecological community richness (max, median); species richness (median) Personal characteristics: median age Community characteristics: proportion of population speaking only English at home, Economy characteristics: proportion workforce in manufacturing Built infrastructure: remoteness – proportion of region classified as outer regional or very remote; MVG: cleared, non-native vegetation, buildings Politics: federal upper-house incumbent – Country Liberal Party (CLP), National Party; federal senate – CLP Adaptive capacity Land capacity – high Disaster resilience Overexploitation Coping capacity Ecosystem services: estimated annual value of agriculture, carbon sequestration; erosion; flood control; gene pool; non-use value of residents; toxin mediation; water purification
3	Climate: max and median temperature Politics: federal upper-house incumbent – Liberal National Party of Qld (LNP); Pauline Hanson's One Nation (PHON); federal senate – LNP, PHON Adaptive capacity Land use: grazing modified pastures	MVG: Acacia Forests and Woodlands; Heathlands; Rainforests and Vine Thickets Extreme events: proportion of region affected by fire:1969–2018; 2004–18; 2014–18; 2019–20 Community characteristics: proportion with degree or higher; population density Social/institutional capital/land tenure: leasehold Indigenous governance: Indigenous owned, managed, or subject to other special rights Politics: federal lower house – Bob Katter's Australian Party, National Party; federal upper-house incumbent – Australian Labor Party, Liberal Party, LNP, PHON, National Party Built infrastructure: remoteness – proportion of region classified as inner regional. Land use: production native forests; plantation forests, cropping, intensive animal production, residential and farm infrastructure, reservoir/dam Stewardship: grant value ($/km^2) Land use: grazing native vegetation, perennial horticulture, seasonal horticulture, transport and communication
4		Household characteristics: average persons per bedroom Built infrastructure: large airports (presence/absence) Built infrastructure: remoteness – proportion of region classified as major city
5	Politics: Federal upper-house incumbent and senate – CLP	Politics: Federal lower house – Liberal Party
6	Politics: federal upper-house senators and lower house – National Party	
7		
8		MVG: Eucalypt Open Forests; Eucalypt Tall Forests; regrowth/modified native vegetation
9		Politics: federal upper house – Centre Alliance; Independent
10	Politics: federal upper-house incumbent – Jacquie Lambie	

Table 17. Strong and moderate variables determining IBRA sub-region cluster membership, listwise deletion.

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
2 clusters	C1	None	abs_2021_population_median_age abs_2021_proportion_workforce_manufacturing abs_2021_proportion_population_english_only remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.2_production_native_forests land_use_3.1_plantation_forests land_use_3.3_cropping land_use_5.2_intensive_animal_production land_use_5.4_residential_and_farm_infrastructure land_use_6.2_reservoir_dam climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median climate_chelsa_bio12_ann_precip_min land_capacity_high nvis_mvg_60_acacia_open_woodlands nvis_mvg_60_acacia_shrublands nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_hummock_grasslands epbc_listed_species_richness_median epbc_listed_ecological_community_richness_max epbc_listed_ecological_community_richness_median value_of_assets_non_use_value_residents value_of_assets_agriculture value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_erosion value_of_assets_flood_control value_of_assets_genepool value_of_assets_toxin_mediation federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_the_nationals disaster_resilience coping_capacity adaptive_capacity overexploitation
	C2	None	abs_2021_population_median_age abs_2021_proportion_workforce_manufacturing abs_2021_proportion_population_english_only remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
			land_use_2.2_production_native_forests land_use_3.1_plantation_forests land_use_3.3_cropping land_use_5.2_intensive_animal_production land_use_5.4_residential_and_farm_infrastructure land_use_6.2_reservoir_dam climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median climate_chelsa_bio12_ann_precip_min land_capacity_high nvis_mvg_60_acacia_open_woodlands nvis_mvg_60_acacia_shrublands nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_hummock_grasslands epbc_listed_species_richness_median epbc_listed_ecological_community_richness_max epbc_listed_ecological_community_richness_median value_of_assets_non_use_value_residents value_of_assets_agriculture value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_erosion value_of_assets_flood_control value_of_assets_genepool value_of_assets_toxin_mediation federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_the_nationals disaster_resilience coping_capacity adaptive_capacity overexploitation
3 clusters	C1	None	abs_2021_population_median_age abs_2021_proportion_workforce_manufacturing abs_2021_proportion_population_english_only remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.2_production_native_forests land_use_3.1_plantation_forests land_use_3.3_cropping land_use_5.2_intensive_animal_production land_use_5.4_residential_and_farm_infrastructure land_use_6.2_reservoir_dam climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
			climate_chelsa_bio12_ann_precip_min land_capacity_high nvis_mvg_60_acacia_open_woodlands nvis_mvg_60_acacia_shrublands nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_hummock_grasslands epbc_listed_species_richness_median epbc_listed_ecological_community_richness_max epbc_listed_ecological_community_richness_median value_of_assets_non_use_value_residents value_of_assets_agriculture value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_erosion value_of_assets_flood_control value_of_assets_genepool value_of_assets_toxin_mediation federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_the_nationals disaster_resilience coping_capacity adaptive_capacity overexploitation
	C2	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median adaptive_capacity	abs_2021_population_density abs_2021_proportion_degree_or_higher remoteness_proportion_inner_regional_australia remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_3.1_plantation_forests land_use_3.3_cropping land_use_3.4_perennial_horticulture land_use_3.5_seasonal_horticulture land_use_5.4_residential_and_farm_infrastructure land_use_5.7_transport_and_communication climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_heathlands fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected fire_history_paa_2004_2018_proportion_affected

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
			fire_history_paa_2014_2018_proportion_affected value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_erosion value_of_assets_flood_control value_of_assets_genepool federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive ilf_non_indigenous ilf_subject_to_other_special_rights ilf_proportion_other_special_rights ilf_proportion_estate disaster_resilience overexploitation grant_value_dollars_per_sqkm
	C3	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_rainforests_and_vine_thickets federal_lower_house_proportion_2019_election_katters_australian_party federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_liberal
4 clusters	C1	None	abs_2021_population_median_age abs_2021_proportion_workforce_manufacturing abs_2021_proportion_population_english_only remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.2_production_native_forests land_use_3.1_plantation_forests land_use_3.3_cropping land_use_5.2_intensive_animal_production

Number of clusters	Cluster	Variables with strong influence		Variables with moderate influence
				land_use_5.4_residential_and_farm_infrastructure land_use_6.2_reservoir_dam climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median climate_chelsa_bio12_ann_precip_min land_capacity_high nvis_mvg_60_acacia_open_woodlands nvis_mvg_60_acacia_shrublands nvis_mvg_60_cleared_non-native_vegetation_buildings nvis_mvg_60_hummock_grasslands epbc_listed_species_richness_median epbc_listed_ecological_community_richness_max epbc_listed_ecological_community_richness_median value_of_assets_non_use_value_residents value_of_assets_agriculture value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_erosion value_of_assets_flood_control value_of_assets_genepool value_of_assets_toxin_mediation federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_the_nationals disaster_resilience coping_capacity adaptive_capacity overexploitation
	C2	adaptive_capacity	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median	abs_2021_population_median_age abs_2021_average_persons_per_bedroom remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_3.1_plantation_forests land_use_3.4_perennial_horticulture climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_heathlands fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected value_of_assets_carbon_sequestration

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
			value_of_assets_water_purification value_of_assets_erosion value_of_assets_genepool federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive ilf_non_indigenous ilf_subject_to_other_special_rights ilf_proportion_other_special_rights ilf_proportion_estate disaster_resilience
	C3	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_rainforests_and_vine_thickets federal_lower_house_proportion_2019_election_katters_australian_party federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_liberal
	C4	None	remoteness_proportion_major_cities_of_australia airports_large
5 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	None
	C2	land_use_3.2_grazing_modified_pastures climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median adaptive_capacity	abs_2021_population_median_age abs_2021_average_persons_per_bedroom remoteness_proportion_outer_regional_australia remoteness_proportion_very_remote_australia land_use_2.1_grazing_native_vegetation land_use_3.1_plantation_forests land_use_3.4_perennial_horticulture climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median climate_chelsa_bio5_max_temp_max

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
			climate_chelsa_bio5_max_temp_median land_tenure_crown_leasehold nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_heathlands fire_niafed_paa_2019_2020_proportion_affected fire_history_paa_1969_2018_proportion_affected value_of_assets_carbon_sequestration value_of_assets_water_purification value_of_assets_erosion value_of_assets_genepool federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation native_title_outcome_native_title_exists_exclusive native_title_outcome_native_title_exists_non_exclusive ilf_non_indigenous ilf_subject_to_other_special_rights ilf_proportion_other_special_rights ilf_proportion_estate disaster_resilience
	C3	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_rainforests_and_vine_thickets federal_lower_house_proportion_2019_election_katters_australian_party federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_liberal
	C4	None	federal_lower_house_proportion_2019_election_liberal
	C5	None	remoteness_proportion_major_cities_of_australia airports_large
6 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	None
	C2	federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_the_nationals	climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_min

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
			climate_chelsa_bio6_min_temp_median fire_niafed_paa_2019_2020_proportion_affected federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_nationals ilf_subject_to_other_special_rights ilf_proportion_other_special_rights disaster_resilience adaptive_capacity
	C3	None	land_use_2.1_grazing_native_vegetation
	C4	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	climate_chelsa_bio1_mean_temp_max climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median nvis_mvg_60_acacia_forests_and_woodlands nvis_mvg_60_rainforests_and_vine_thickets federal_lower_house_proportion_2019_election_katters_australian_party federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_liberal
	C5	None	federal_lower_house_proportion_2019_election_liberal
	C6	None	remoteness_proportion_major_cities_of_australia airports_large
7 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	None
	C2	federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_the_nationals	climate_chelsa_bio1_mean_temp_median climate_chelsa_bio6_min_temp_min climate_chelsa_bio6_min_temp_median fire_niafed_paa_2019_2020_proportion_affected federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_australian_labor_party federal_upper_house_incumbent_post_2019_election_the_nationals ilf_subject_to_other_special_rights ilf_proportion_other_special_rights disaster_resilience adaptive_capacity
	C3	None	land_use_2.1_grazing_native_vegetation
	C4	None	None
	C5	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	land_use_2.1_grazing_native_vegetation nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
	C6	None	federal_lower_house_proportion_2019_election_liberal
	C7	None	remoteness_proportion_major_cities_of_australia airports_large
8 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	None
	C2	None	nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests fire_niafed_paa_2019_2020_proportion_affected
	C3	None	land_use_2.1_grazing_native_vegetation
	C4	None	None
	C5	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	land_use_2.1_grazing_native_vegetation nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal
	C6	None	nvis_mvg_60_regrowth_modified_native_vegetation federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party
	C7	None	federal_lower_house_proportion_2019_election_liberal
	C8	None	remoteness_proportion_major_cities_of_australia airports_large
9 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	None
	C2	None	nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests fire_niafed_paa_2019_2020_proportion_affected
	C3	None	land_use_2.1_grazing_native_vegetation
	C4	None	None
	C5	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	land_use_2.1_grazing_native_vegetation nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal
	C6	None	nvis_mvg_60_regrowth_modified_native_vegetation federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party
	C7	None	ilf_indigenous_managed_subject_to_other_special_rights
	C8	None	federal_upper_house_incumbent_post_2019_election_centre_alliance federal_upper_house_incumbent_post_2019_election_independent federal_upper_house_incumbent_post_2019_election_centre_alliance

Number of clusters	Cluster	Variables with strong influence	Variables with moderate influence
	C9	None	remoteness_proportion_major_cities_of_australia airports_large remoteness_proportion_major_cities_of_australia
10 clusters	C1	federal_upper_house_num_senators_2019_election_country_liberal_party federal_upper_house_incumbent_post_2019_election_country_liberal_party	None
	C2	None	nvis_mvg_60_eucalypt_open_forests nvis_mvg_60_eucalypt_tall_open_forests fire_niafed_paa_2019_2020_proportion_affected
	C3	None	land_use_2.1_grazing_native_vegetation
	C4	None	None
	C5	federal_upper_house_num_senators_2019_election_liberal_national_party_of_queensland federal_upper_house_num_senators_2019_election_pauline_hansons_one_nation federal_upper_house_incumbent_post_2019_election_liberal_national_party_of_queensland federal_upper_house_incumbent_post_2019_election_pauline_hansons_one_nation	land_use_2.1_grazing_native_vegetation nvis_mvg_60_acacia_forests_and_woodlands federal_upper_house_num_senators_2019_election_australian_labor_party federal_upper_house_num_senators_2019_election_liberal federal_upper_house_incumbent_post_2019_election_liberal
	C6	None	nvis_mvg_60_regrowth_modified_native_vegetation federal_lower_house_proportion_2019_election_the_nationals federal_upper_house_num_senators_2019_election_the_nationals federal_upper_house_incumbent_post_2019_election_australian_labor_party
	C7	federal_upper_house_num_senators_2019_election_jacqui_lambie_network federal_upper_house_incumbent_post_2019_election_jacquie_lambie_network	
	C8	None	ilf_indigenous_managed_subject_to_other_special_rights
	C9	None	federal_upper_house_incumbent_post_2019_election_centre_alliance federal_upper_house_incumbent_post_2019_election_independent
	C10	None	remoteness_proportion_major_cities_of_australia airports_large

Table 18. Mean values of core variables that drive cluster membership for each of 10 IBRA sub-region clusters, listwise deletion.

	Cluster									
	1	2	3	4	5	6	7	8	9	10
Acacia Forests and Woodlands	0.22	0.04	0.07	1.21	3.45	0.52	0.00	9.48	6.65	0.02
Acacia Open Woodlands	9.91	0.00	0.00	0.00	0.51	0.02	0.00	3.05	25.49	0.00
Acacia Shrublands	12.73	0.04	1.31	0.27	0.13	1.50	0.04	26.12	13.89	0.61
Cleared Non-Native vegetation Buildings	0.40	21.73	58.63	27.69	38.52	48.64	28.69	0.78	2.40	65.39
Eucalypt Open Forests	6.83	37.89	8.82	10.87	2.91	10.11	13.05	0.00	0.00	9.44
Eucalypt Tall Open Forests	0.00	18.30	2.37	2.91	0.19	1.98	11.36	0.00	0.00	2.31
Heathlands	0.01	1.78	3.07	0.65	0.03	0.53	3.63	0.00	0.07	0.73
Hummock Grasslands	21.57	0.00	0.02	0.00	0.16	0.00	0.00	37.18	1.57	0.00
Rainforests and Vine thickets	0.19	0.23	0.18	23.62	1.34	0.00	8.10	0.00	0.00	0.96
Regrowth Modified Native Vegetation	0.00	0.12	0.19	0.00	0.00	4.89	0.92	0.00	0.10	0.00
	0.22	4.11	3.41	2.20	3.75	4.65	3.00	0.22	0.53	5.50
	0.22	2.44	1.66	1.13	2.30	3.08	1.67	0.22	0.35	3.00
	3.04	17.76	9.75	18.87	6.92	11.48	12.56	2.44	2.35	22.13
	0.00	54.13	24.19	7.46	14.36	12.97	9.22	0.74	4.16	20.02
	0.00	25.02	14.88	7.33	14.15	6.54	8.49	0.38	3.72	11.32
	0.00	8.06	4.83	3.71	5.75	2.77	4.47	0.08	1.11	4.08
	0.00	48.01	1.86	0.72	1.00	4.76	0.56	0.07	0.06	2.09
	453.74	763.08	448.04	1175.00	547.63	562.65	697.89	238.56	191.59	712.13
mean_temp_max)	25.52	16.94	16.96	23.73	23.27	17.22	13.00	26.44	20.24	18.38
max_temp_median)	36.39	25.36	27.48	28.53	32.66	28.47	19.11	39.00	33.06	27.13
max_temp_max)	37.65	28.08	29.87	30.67	34.09	30.39	21.78	40.67	34.76	29.38
	11.13	4.25	6.35	14.33	9.96	3.61	3.67	10.44	6.53	8.13
	24.50	79.55	74.48	47.09	51.03	94.69	81.67	43.32	17.47	87.75
	1.93	0.01	0.05	0.64	0.37	0.02	0.00	5.53	2.88	0.01
	75.50	20.45	25.52	52.91	48.97	5.31	18.33	56.68	82.53	12.25
	1.48	0.03	0.20	2.27	1.20	0.06	0.00	4.44	0.71	0.63
	5.78	0.92	1.02	4.27	3.09	0.22	0.00	9.33	3.53	1.25
	52.83	0.36	2.26	8.20	44.48	10.83	0.01	62.22	57.99	0.31

	Cluster									
	1	2	3	4	5	6	7	8	9	10
ALP	1.63	4.71	3.83	2.98	3.00	4.90	3.97	4.00	3.98	3.61
Country Liberal	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Independent	0.13	0.00	0.31	0.00	0.00	0.01	0.00	0.00	0.85	0.00
Jacquie Lambie	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00
Liberal	1.00	4.97	5.21	0.99	1.00	4.90	4.97	5.99	5.11	3.65
Liberal National	0.19	0.01	0.03	3.98	3.99	0.10	0.00	0.00	0.00	1.41
One Nation	0.10	0.00	0.02	1.99	2.00	0.05	0.00	0.00	0.00	0.71
The Nationals	0.05	0.99	0.40	0.99	1.00	0.99	0.00	0.00	0.00	0.86
ALP	1.18	1.99	1.98	0.99	1.00	1.97	1.99	2.00	1.99	1.62
Country Liberal	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Liberal	0.54	2.12	2.82	0.00	0.00	1.98	1.99	3.00	2.98	1.64
Liberal Nationals	0.14	0.01	0.02	2.98	2.99	0.08	0.00	0.00	0.00	1.06
One Nation	0.05	0.00	0.01	0.99	1.00	0.03	0.00	0.00	0.00	0.35
The Nationals	0.00	0.86	0.13	0.00	0.00	0.94	0.00	0.00	0.00	0.26
Centre Alliance	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Bob Katters Australian Party	0.05	0.00	0.00	0.52	0.29	0.00	0.00	0.00	0.00	0.00
Liberal party	0.18	0.05	0.69	0.00	0.00	0.13	0.45	1.00	0.98	0.42
The Nationals	0.00	0.65	0.13	0.00	0.00	0.79	0.00	0.00	0.00	0.07
	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.50
	0.00	0.17	3.70	0.03	0.00	0.00	0.00	0.00	0.00	32.51
	0.48	72.01	42.66	57.39	27.14	65.70	60.04	0.00	5.02	13.65
	86.01	0.00	8.73	4.45	35.82	7.08	7.30	96.55	83.90	0.00
	1.25	0.79	0.75	0.81	0.84	0.76	0.78	0.91	0.84	0.85
	30.60	49.80	44.50	44.54	41.23	44.08	45.28	35.35	39.23	38.78
% Population speaks only English at home	40.51	86.19	85.42	83.24	83.72	85.82	87.37	60.32	72.32	68.16
% Workforce manufacturing	0.67	4.47	5.54	5.50	3.19	5.10	6.84	1.34	2.19	5.87
	46.73	16.05	3.66	20.45	78.09	44.35	2.79	59.41	55.92	13.62
Plantation forests	0.00	1.18	3.63	1.92	0.38	0.32	5.60	0.00	0.00	2.17
Production Native forests	0.00	16.75	4.77	3.04	4.65	2.74	12.77	0.00	0.00	2.54

	Cluster									
	1	2	3	4	5	6	7	8	9	10
Grazing modified pastures	0.05	9.02	26.75	0.20	0.27	20.31	15.42	0.00	2.25	18.54
	0.01	0.52	23.21	5.35	4.14	13.26	0.21	0.11	0.49	3.84
	0.00	0.10	0.16	0.01	0.01	0.04	0.00	0.00	0.00	0.45
	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.14
	0.00	0.05	0.12	0.07	0.02	0.09	0.08	0.00	0.00	0.59
	0.08	1.37	3.15	2.48	0.51	1.45	2.76	0.02	0.11	17.06
	0.05	0.04	0.24	0.35	0.40	0.12	0.14	0.10	0.00	0.62
	0.24	0.36	1.72	0.17	0.10	0.43	0.74	0.04	0.26	3.24
Annual value of agriculture	538.89	778.77	1451.31	1279.21	1364.66	1263.66	491.93	649.03	334.33	1381.25
Non-use values residents	407.69	57.11	26.47	47.24	55.66	41.21	36.60	415.62	171.52	32.84
Flood control	2260.38	112.47	234.62	140.63	232.07	177.33	123.54	6429.17	3852.61	66.99
Erosion control	8397.29	99.33	337.76	295.16	878.77	385.53	93.34	13196.53	4401.84	68.97
Carbon sequestration	4186.91	238.24	186.91	273.06	489.02	269.60	157.85	5353.75	1743.15	98.39
Water purification	2651.95	145.71	148.31	176.69	306.47	181.76	110.38	3998.71	1695.01	67.59
Gene pool	3669.88	146.48	157.76	217.03	414.20	205.12	102.14	5034.91	1696.84	67.37
Toxin remediation	465.01	90.49	36.48	70.40	69.30	59.58	58.35	426.86	236.57	34.82
	13.65	25.53	65.40	29.66	30.49	44.06	14.39	0.07	3.11	47.47
	0.09	0.55	0.50	0.31	0.26	0.49	0.44	0.32	0.29	0.55
	0.07	0.49	0.45	0.36	0.30	0.45	0.36	0.25	0.28	0.53
	0.06	0.39	0.37	0.43	0.36	0.37	0.26	0.17	0.25	0.48
Stewardship: Grant value (ave dollars per sq km)	5.80	73.22	198.00	119.45	5.48	24.78	102.58	0.30	8.01	12700.96