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Literature review 3: community adaptation and resilience

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Report to the Independent Panel Assessment of Social and Economic Conditions in the Murray-Darling Basin

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This investigation has been commissioned by the Panel for the Independent Assessment of Social and Economic Conditions in the Murray-Darling Basin. The Panel has made this document available for public scrutiny as part of its commitment to transparency. The views in this report do not necessarily represent the views of the Panel. This is part of a series of literature reviews and research investigations that will help inform the Panel's eventual findings and recommendations.

Contents

Executive summary

We reviewed programs and initiatives that have been implemented in the Murray Darling Basin (MDB) in order to address the question: *What strategies have the greatest potential to enhance the resilience, adaptability and wellbeing of Basin communities?* We interpret the term 'resilience' to encompass a range of responses to change, spanning persistence, incremental adjustment and adaptation, through to transformation.

Our review rests on the following logic:

1. Large, rapid and novel change is inevitable in the Murray Darling Basin, now and into the future.
2. Effective management requires anticipation and acceptance of these changes, otherwise decision-making will not enable resilience or adaptability.
3. Facing change means creating 'future-ready', feasible objectives and building understanding of changing systems.
4. Active, deliberate learning practices allow decisions to be made even in highly uncertain, changing settings.

The review is structured around four themes, informed by the wider literature on resilience and adaptation, and illustrated with examples specific to the MDB.

1. People: values, vision, dialogue
2. Systems analysis and resilience thinking
3. Learning orientation and uncertainty
4. Decision focus and adaptation pathways

Resilience and adaptation planning activities conducted by Catchment Management Authorities (CMA) and NSW Local Land Services (LLS) span all four themes and this work is presented early in the review to provide an overview of the approach and highlight its significance. These local-level participatory planning efforts have been rated highly in evaluations and reviews, and they have been prominent in the international literature as exemplars of successful planning for resilience and adaptation. There are also syntheses of lessons learned by comparing experiences across different CMA case studies.

The theme, 'People: values, vision, dialogue' addresses the need for stakeholder engagement practices that build new skills in preparing for large, unfamiliar future change and high levels of uncertainty. It emphasises the value of methods that make it easier for diverse stakeholders to work cooperatively to discover new ways of seeing and understanding problems and solutions.

'Systems analysis and resilience thinking' is the most substantial theme addressed in the review. We argue that systems analysis is a key over-arching strategy or capability required to create and assess strategies for enhancing resilience, adaptability and wellbeing. This capability is fundamental to anticipating how communities might respond to shocks or other changes. System

analysis is not limited to physical things, and includes understanding of social interactions and dynamics, 'invisible' properties such as people's values, and multiple interdependencies between people and the environment. There are many familiar system properties that can be identified and be used to inform interventions that foster system resilience or adaptability.

The theme 'Learning orientation and uncertainty' gives examples of deliberate learning strategies that have been designed to accommodate and learn from change in robust and adaptive decision-making processes. We provide examples from the MDB where 'multi-level' learning is embedded in CMA and LLS strategies in order to report not only on regular monitoring, evaluations and actions, but to include longer cycles of challenging and revising assumptions, objectives and strategies and even longer cycles of challenging governance arrangements, values and visions.

The theme 'Decision focus and adaptation pathways' describes placing an emphasis on the decisions people will be confronted with in the face of change as opposed to focussing on the impacts of that change. It describes how the concepts of resilience, adaptation and transformation have been used to understand and change decision contexts, enabling new kinds of decisions, and decision-making structures and processes to emerge in anticipation of and preparation for highly uncertain future change. Adaptation pathways open options for future actions without prejudging societal preferences and choices.

The review ends with a summary of gaps and associated opportunities:

1. **Undertake resilience and adaptation planning at scale**
   Most of the examples presented in this review are from catchment-level application of resilience and adaptation planning practices, and there are opportunities to apply these methods at state and national levels (and to include more cross-scale interactions).
2. **Recognise 'no one is in charge' and incentivise distributed efforts**
   Existing institutions could adopt criteria that promote consideration of resilience, adaptability and wellbeing in their programs and impact evaluations. Without active support for these outcomes, they will continue to be undermined by other pervasive institutional cultural norms and incentives.
3. **Accept and expect large change**
   Scenario planning, including preparing for 'greatest plausible change' scenarios, could be used more systematically in planning activities in business, government and community sectors. Program and management goals could be revised to be 'future-ready' according to appropriate criteria.
4. **Stay abreast of legal, financial and insurance developments**
   Legal and financial due diligence requirements for addressing climate risk are changing rapidly and the associated legal, fiduciary and insurance risks can be turned into opportunities by being informed about and at the leading edge of acting on these developments.
5. **Go beyond NRM-based resilience and adaptation planning**
   The natural resource management (NRM) literature holds the most well-developed examples of successful programs for building resilience and adaptive capacity in MDB communities. The problems to be addressed go well beyond NRM, however, and there is a need to better integrate this work with developments in other domains such as health.

1 Introduction

1.1 Framework for review and analysis

The Independent Social & Economic Assessment Panel would like an understanding of factors that contribute to resilience, adaptability and wellbeing in the Murray-Darling Basin, with evidence drawn from past and current programs and initiatives that have been implemented in the Basin. This review is intended to support the Panel in addressing the following question in their Terms of Reference, '*What strategies have the greatest potential to enhance the resilience, adaptability and wellbeing of Basin communities?*' (Sefton et al. 2019).

In undertaking this review, we have assumed the following logic:

1. Our starting position is to acknowledge that unprecedented, large, nonlinear and rapid change is inevitable in the Murray-Darling Basin, driven by demographic, economic, environmental and cultural change occurring at local through to global scales.
2. Current management objectives and understanding will not be effective unless they reflect an acceptance of and need to engage with the magnitudes, rates and consequences of these changes. If that acceptance and understanding is lacking, current ways of making decisions will not enable resilience or adaptability.
3. These assumptions entail a need for processes to create feasible, 'future-ready' objectives, and to build understanding of the changing system. Objectives and understanding will also necessarily evolve and change.
4. Finally, these objectives and understanding need to be used actively in decision making, and in supporting 'triple loop' learning: the first loop considers whether we are 'doing things right'; the second loop considers whether we are 'doing the right things'; and the third loop considers 'how we decide what is right' (Australian Government, Department of Home Affairs 2019a).

A common response to these challenges has been to incorporate resilience and adaptation into goals and other policy responses. There are challenges in translating concepts of resilience, adaptation and transformation into practice and this is an active area of research.

Definitions of resilience, adaptability and wellbeing vary between different communities of practice, and we recognise that different definitions are appropriate for different purposes. We take an inclusive approach that readily accommodates a range of definitions or interpretations. Given the inevitability of the magnitude and nonlinear system change that will occur in the Murray-Darling Basin, interpretations of resilience that seek to keep the system unchanged (or to revert to a past state) are too narrow. Rather, some aspects of the system may be retained in the face of change, and other aspects may need to adapt or transform entirely to enable desired values to persist (Folke et al. 2010) (**[Image removed for copyright reasons. Source is Figure 5.1 from Béné et al. (2012)]**

Figure 1).

We do not treat 'resilience' as a target to be tracked by a measurable indicator. Rather, the science of resilience, adaptation and transformation provides a pragmatic and well-tested basis for designing and evaluating interventions (e.g. policies, decisions, programs and actions) for long-term sustainability and wellbeing goals, in rapidly changing, highly uncertain systems (Walker and Salt 2006, 2012, O'Connell et al. 2016, Quinlan et al. 2016, Maru et al. 2017, Walker 2019).

[Image removed for copyright reasons. Source is Figure 5.1 from Béné et al. (2012)]

Figure 1 Resilience encompasses persistence, incremental adjustment and transformational response.
Figure source: Béné et al. (2012)

Literature Review 1 (Schirmer et al. 2019) similarly accommodates a diversity of definitions, emphasising that when considering communities 'being resilient is about more than trying to maintain current characteristics of a community when a challenge occurs: it is about being able to actively change or transform a community over time so it maintains a positive quality of life'. Furthermore, the authors explain that 'resilience is both a process and a state', and in our review we also consider the processes and capacities that enable resilience, adaptation and transformation. Other concepts framing our review include 'vulnerability', 'adaptation' and 'transformation'; our use of these and other terms are described in the glossary.

Our assumptions led us to structure our review according to a set of emergent themes and principles that characterise effective resilience and adaptation planning for long-term, sustainable wellbeing. This is not a definitive set of themes. It has been informed by our own work in developing the Resilience, Adaptation and Transformation Approach (RAPTA, O'Connell et al. 2016, Maru et al. 2017), understanding vulnerability to disaster (O'Connell et al. 2018), and adaptation to climate change (Wise et al. 2014, Butler et al. 2016, Colloff et al. 2017b, van Kerkhoff et al. 2019) and is consistent with other efforts to distil key elements of resilience and adaptation planning (e.g. Béné et al. 2012, OECD 2014).

Table 1 Themes and principles used to structure this review. These are based on the essential features of the modules and processes in RAPTA. These principles are relevant for initiatives undertaken by individuals, businesses, organisations or different levels of government.

Theme	Principles
People: values, vision, dialogue	Support people to imagine and engage with large and unpredictable changes ahead. Use ethical collaboration processes to include people who bring different perspectives, knowledge, values and visions for the future, and support them to work together to create equitable outcomes.
Systems analysis and resilience thinking	Foster understanding of interacting cascades of cause and effect to avoid perverse outcomes that arise from over-simplifying a problem. Include both physical and social causes and effects operating across multiple geographical scales and time scales.

Learning orientation and uncertainty	Promote 'learning by doing' by operating within accountability frameworks that support 'triple loop learning' so that actions can be taken even in conditions of high uncertainty. Seek multiple perspectives drawing on different knowledge and evidence to identify robust insights, rather than rely on a single 'best' system analysis. Recognise that we don't know how change will play out, nor the best response to it, and so plan to discover these as actions and consequences unfold.
Decision focus and adaptation pathways	Focus on the decisions people will need to make; rapid, novel change may require fundamental shifts in how and where certain decisions are made. Use 'adaptation pathways' approaches to help people take action towards their goals despite uncertainty, with the capacity to choose alternative options and paths as more is learned and conditions change.

We illustrate these themes and principles with examples from the Murray-Darling Basin as a way of demonstrating insights about resilience, adaptation and transformation that can be elicited from the literature. Our review draws on different kinds of literature and perspectives (including published academic journal articles, planning and strategy documents, inquiry or assessment reports, and written experiences by practitioners) to test and illustrate our analysis. We have chosen literature and examples that illustrate core concepts and principles, recognising that a comprehensive review of the rich material available is not feasible for this short piece of work.

1.2 Natural resource management and water reform

The Panel is reviewing the social and economic conditions in Basin communities. Social and economic systems depend on natural resources, and natural resource management in the Basin relies upon healthy social and economic systems. For this reason, reviewing the resilience and adaptability of Basin communities requires us to consider the resilience and adaptability of the broader system of interdependent relationships between nature, people and the economy. We refer to this as a 'social-ecological' system (Folke et al. 2016) or a coupled human and natural system (Liu et al. 2007). We therefore look to the natural resource management literature as a vital source of knowledge for supporting long-term resilience and adaptability in communities.

One aspect of natural resource management is, of course, water governance. The Panel is not conducting a review of the Basin Plan, however it is assessing 'the impact of the Basin Plan on the vulnerability, resilience and adaptive capacity of Basin communities and their development potential' (Sefton et al. 2019). For this reason, we consider aspects of the development and implementation of the Basin Plan, and water reform more generally, to be in scope for our review.

2 Resilience and adaptation in the Murray-Darling Basin

2.1 Resilience and adaptation planning in MDB NRM organisations

There is a rich history of applying resilience concepts and approaches in natural resource management organisations within the Murray-Darling Basin. Founding work undertaken in the Goulburn Broken catchment since the early 2000s has been highly cited in the international resilience and adaptation literature (Anderies et al. 2006, Walker et al. 2009, Folke et al. 2010). It has played a vital part in developing and testing principles of resilience thinking and practice now used around the world.

This earliest work involved characterising issues and drivers of change in the catchment, conducting a resilience assessment, and identifying critical social, economic and biophysical thresholds that, if crossed, could lead to irreversible changes to the goods, services or other values of importance to people within and beyond the catchment (Walker et al. 2009). The resilience assessment considered both 'specified resilience' and 'general resilience'. Assessment of specified resilience characterises the resilience of specified system attributes (e.g. farm financial viability) to identified shocks and other changes (e.g. climate or price shocks). Assessment of general resilience is a broader characterisation of the capacity to cope with all kinds of unspecified disturbances. For example, high levels of social capital and health confer resilience to all kinds of shocks.

[Image removed for copyright reasons. Source is Figure 5 from Sellberg et al. (2018)]

Figure 2 Characteristics of resilience planning approaches that have been used in Murray Darling Basin Catchment Management Authorities. Figure source: Sellberg et al. (2018).

Building on approaches used in the Goulburn Broken, pilot resilience assessments were conducted for developing the Catchment Action Plans by the Namoi and Central West Catchment Management Authorities, assisted by the NSW Natural Resources Commission (NRC). Elements of this approach to resilience planning are summarised by Sellberg et al. (2018) and illustrated in

[Image removed for copyright reasons. Source is Figure 5 from Sellberg et al. (2018)]

Figure 2.

Based on the outcomes and Catchment Action Plans, the NSW NRC recommended a resilience approach be adopted across all NSW catchment management authorities (NRC 2012), noting that doing so:

- *helps develop a holistic picture of how the landscape functions and test assumptions*
- *helps manage complexity by focussing on the few most important things*
- *was a useful concept to engage the community in strategic planning*
- *embraces change and builds capacity to manage for natural variability and extreme events.*

The last point is important: managing catchments as social-ecological systems builds adaptive capacity in both people *and* nature to cope, adapt and have new options in times of change and unexpected events.

Subsequent to the pilots in Namoi and Central West, elements of resilience planning (as shown in

[Image removed for copyright reasons. Source is Figure 5 from Sellberg et al. (2018)]

Figure 2) were adopted by eleven catchment management authorities in NSW, and a further seven organisations in Queensland, South Australia, Victoria and Western Australia (Sellberg et al. 2018). The catchment action plans in NSW were assessed and graded by the NSW NRC. Although the grades given to different CMAs varied considerably, the final conclusion was that all the plans were robust and inclusive, and reflected international best planning practice based on the evaluation criteria in Figure 3 (NRC 2013).

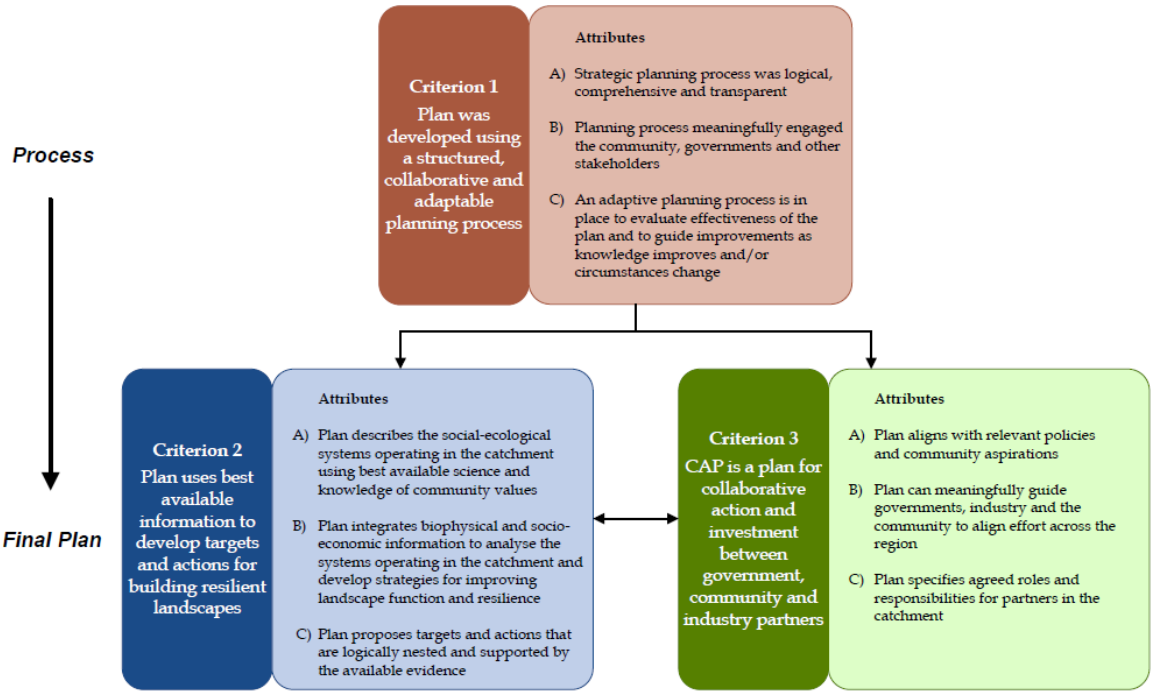

Figure 3 Criteria used by the NSW NRC to assess catchment action plans (NRC 2013).

Despite these successes, resilience has not become mainstream in NRM practices. Some CMAs use contrasting approaches and those that have a history of using resilience have varied over time in the degree to which they implement the principles as staff, CEOs and board members changed.

Subsequent reforms in NSW saw a transition from catchment management authorities to Local Land Services (LLS) in 2014. Before that transition, the NSW NRC published recommendations that the LLS strategic planning should be informed by lessons learned from the previous catchment action planning (Table 2).

Table 2 Recommendations from NRC (2013) for LLS strategic planning, based on lessons learned from CMA catchment action plans.

NSW NRC guidance for LLS strategic planning processes	Description

Leadership and governance	strong leadership and good adaptive governance are critical to developing high quality strategic plans
Regional strategic capacity	the upgraded plans demonstrate there is considerable regional strategic planning capacity to support devolved decision-making
Knowledge of regional systems	systems thinking was demonstrated to be meaningful to land managers, and the sub-regional analysis within the plans can be used and built upon by LLSs to help identify the most effective strategies and actions for local areas
Stakeholder engagement	the joint consideration of social, cultural, economic and environmental values resonated with stakeholders, leading to greater plan ownership
Collaboration	alignment with state and local plans and policies leads to collaborative implementation strategies that are likely to deliver greater returns on investment
Strategic prioritisation and measurability	plans are most effective if they have clearly identified priorities to guide on-ground actions, measurable targets and strong monitoring, evaluation and reporting frameworks
Flexibility and adaptability	plans that recognise uncertainty and are responsive to change are more likely to maintain their relevance and improve over time.

In a separate analysis, Potts (2017) reviewed 22 regional NRM plans in NSW and Queensland. Using a set of evaluation criteria informed by international best practice, one conclusion of the analysis was that 'plans based on a paradigm or underpinning theory had much higher average quality scores compared with plans with no theoretical foundation'. The theoretical foundations were identified as 'systems thinking', 'resilience thinking', 'adaptive management' and combinations of these.

The Goulburn Broken Regional Catchment Strategy (RCS) represents one of the most established examples of what implementation of a resilience-based approach looks like. The concept of social-ecological systems is embedded in the strategy (Figure 4), and the strategic priorities span actions aimed at increasing farm production, strengthening partnerships to improve inclusion and contributions to the whole-of-catchment vision, land use planning, adapting to climate variability and water reform, and adaptive approaches for preparing for uncertain futures (GBCMA 2013). The RCS guiding principles go beyond the Victorian Government legislative requirements in the Catchment and Land Protection Act 1994.

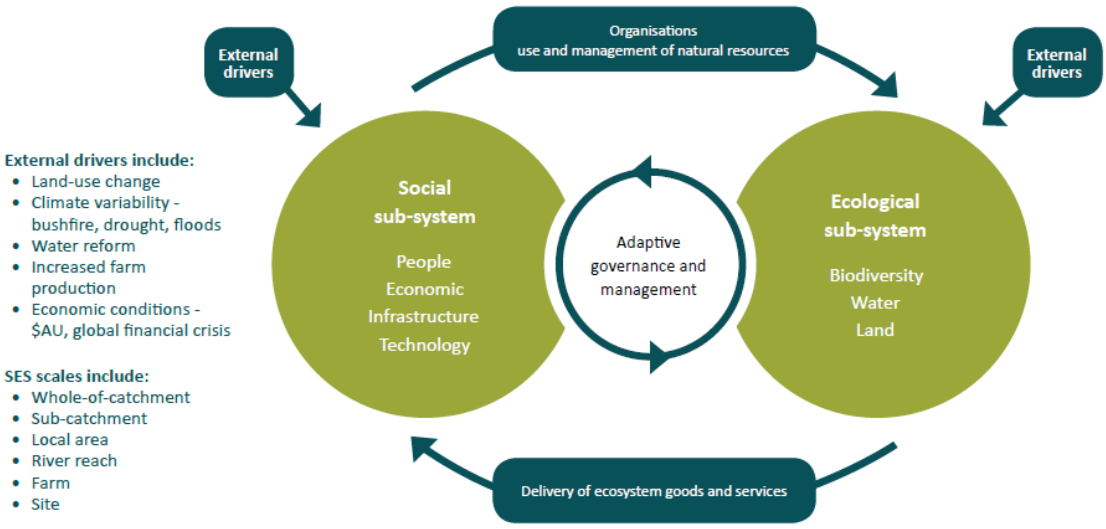

Figure 4 The social-ecological system description at the core of the Goulburn Broken Regional Catchment Strategy (GBCMA 2013) © State of Victoria, Goulburn Broken Catchment Management Authority 2013

Abel et al. (2016) provided a synthesis based on their long experience with resilience and adaptation work in the Murray Darling Basin, and other social-ecological systems around the world. They drew on the concept of 'adaptation pathways' as an effective approach for making decisions in the face of high levels of uncertainty in order to keep future adaptive options open and avoid unwanted transitions. They proposed criteria for building adaptive pathways to bring about transformative change:

> *Seven criteria would enable potential adaptive actions to be sequenced: (1) the feasibility of the action within the current decision-making context; (2) the role of the action in paving the path for other actions; (3) its role in averting transgression of a critical threshold; (4) its robustness or resilience under diverse shocks; (5) its effect on the range of future options; (6) the length of its lead time; (7) and its effects on equity. We propose that these criteria make it possible to lay out coherent proposals for mutually compatible stakeholders' pathways even when stakeholders' values are contested, power is dispersed, and structural change is blocked by current rules. (Abel et al. 2016)*

Sellberg et al. (2018) reviewed two decades of resilience planning in catchments within and outside the Murray Darling Basin, based on interviews with key informants and reviews of strategic planning documents and distilled the following 'lessons for applying and embedding resilience practice in an organisation':

> *1) to connect internal "entrepreneurs" to "interpreters" and "networkers" who work across organizations, 2) to assess the opportunity context for resilience practice, 3) to ensure that resilience practice is a learning process that engages internal and external actors, and 4) to develop reflective strategies for managing complexity and uncertainty. (Sellberg et al. 2018)*

Assessment of the 'opportunity context' is to understand the scope for creating new, enduring institutional and governance practices; this step is needed in order to help resilience planners anticipate challenges, needs and resourcing requirements for resilience-based approaches to be effective.

The above work in MDB CMAs has considered many kinds of shocks and changes. Climate change is one that warrants particular attention. A review across strategy documents from international and regional levels, 21 of which intersected with the MDB, found that none of the strategy objectives fully met 'climate ready' criteria (Dunlop et al. 2013). 'Climate ready' objectives are defined as those that 1) accommodate large change, 2) remain relevant and feasible under the range of possible future trajectories, and 3) conserve multiple dimensions of the system that are valued by society. The authors also developed a prototype tool for developing climate ready objectives, and this has been applied by the Corangamite CMA in consultation with a wide range of stakeholders (Corangamite CMA 2017).

The themes and principles in Table 1 are well represented in all of the work described in this section. In the following sections we elaborate on each theme, giving a brief overview, a rationale for how it relates to resilience and adaptive capacity, and providing relevant examples from the MDB. Clearly, leading practice in applying resilience and adaptation has occurred in many jurisdictions within MDB in the NRM sector. As will be illustrated in Section 2.5.2, we are past the time when it is acceptable for climate and disaster risk to be restricted to the 'environment' or 'NRM' portfolio of any private or public organisation. The risk is systemic and needs to be attended to by central portfolios such as Treasury or budget areas of organisations and distributed across all parts of organisations exposed to these risks so that they can meet financial and legal risk management obligations.

2.2 People: values, vision, collaboration

2.2.1 Overview

Businesses, civil society organisations, communities and individuals who are not familiar with preparing for large, unfamiliar changes and high levels of uncertainty are likely to require support and guidance to be able to do so. For example, the Department of Home Affairs, through the National Resilience Taskforce, has developed guidance for people preparing for climate and disaster risk (https://knowledge.aidr.org.au/resources/strategic-disaster-risk-assessment-guidance/). Providing ethical processes for bringing diverse people together in constructive collaboration is a necessary step for building social networks with the capacity to negotiate equitable outcomes when facing change in contested problem areas. Structured facilitation processes by trusted parties can help address power imbalances and conflicting interests.

Making sense of new experiences, and thinking about challenges and opportunities in new ways, are necessary but sometimes difficult to do in situations where there is a culture of conforming to current norms, be that of knowledge ('science based') or doing ('best practice'). In these situations, creating deliberately different ways to think and express, such as tapping into emotions, held values and artistic expression, have been shown to be highly productive, even for people who typically work in high-responsibility / high-accountability roles, such as chiefs of emergency services agencies. Used appropriately, bringing in these emotional and aesthetic dimensions can help people make sense of new challenges, communicate significant connections to places and things of value, or inspire a common vision for change. Novel breakthroughs can also come from modes of engagement that allow people to engage as themselves, rather than as representatives of their employers' policies or positions.

2.2.2 Rationale for a focus on 'People: values, vision, collaboration'

The MDB is always changing, it will continue to change in many ways, but future change will be rapid and novel. It will increasingly be beyond previous experience and the capability of current decision-making abilities and systems, and future change will need to be accommodated in planning and initiatives. Accommodating large, unprecedented change involves the following:

- anticipating change, through both prediction and imagination
- recognising that change is largely driven by factors outside our control; our ability to alter the course of change is small, and we need to be realistic about what we can alter
- recognising that measures of success, or social and policy objectives, will change as circumstances change, so what is desirable now might not be in the future
- recognising that what works now might not work in the future
- reacting to change as it happens, enabled by preparing to react (practising the future) and monitoring lead indicators
- being proactive in cases where the risk of waiting to react is too great
- working with large uncertainties in our ability to anticipate the nature of change, societal aspirations and preferences in different contexts, and the effectiveness of responses to change and interventions seeking desirable objectives
- emphasising the ability to act in the face of uncertainty and thereby giving people a sense of self-efficacy
- having an increased focus on learning.

Many of these activities are not common in businesses, government or organisations, and can be extremely challenging, so wise and responsible leadership in these sectors will include supporting people to develop necessary skills and capacities.

Navigating change together requires collaborative engagement processes that yield legitimate, accepted outcomes. Collaborative engagement is fostered by:

- Clear terms of engagement, which are especially essential when working in low trust environments.
- Transparency and accountability.
- Inclusion of multiple perspectives, values, knowledge systems and modes of expression.
- Procedural justice.

Supporting authentic listening among diverse stakeholders to engage with profound change creates the prospect of completely re-framing how people make sense of problems and envisage solutions to them.

2.2.3 MDB examples related to 'People: values, vision, collaboration'

The Rivers of Carbon program (http://riversofcarbon.org.au/) program works with landholders to protect and restore their rivers by managing their riparian zones, using approaches tailored to

contribute to their overall farm or land management plans. The program's framework has five components: profit, proof, people, place and promise:

> ***Profit*** *– highlighting the multiple benefits that can be achieved through river restoration (shelter, beneficial wildlife, living haystack, firewood, improved water quality, lovely place to spend time)*
>
> ***Proof*** *– the role of science in providing confidence to act (many years of scientific research and practical testing brought together in real-life situations)*
>
> ***People*** *– valuing the experience and knowledge we all bring, and sharing what we know (taking time to build relationships, listen to each other and develop mutual respect)*
>
> ***Place*** *– recognising and acknowledging our connection to country (acknowledging our 'places' as part of our identity, recognition we are often custodians of a place to be handed to the next generation)*
>
> ***Promise*** *– basing our relationships on trust, mutual respect and a discussion about expectations (realistic, respectful and lasting relationships)*

The program combines 'smarts' (facts, figures, scientific evidence, recommended practices) with 'heart' (connecting with what landholders care about) to bring about multiple benefits from riparian vegetation management, including: improved on-farm productivity and income, improved biodiversity and sustainability, carbon sequestration and climate adaptation options. Their monitoring and evaluation tracks progress in riparian outcomes, in-stream outcomes and social outcomes and their successes have attracted endorsements from leaders in their field e.g.

> *Their focus on the needs and perspectives of the communities they work is the key to their success. They have leveraged the idea of river corridors as rivers of carbon as a starting point for their program, but have built out to even more sophisticated approaches. You can see that the foundation of their work is to unlock the values of rivers and riparian areas – whether that value is carbon, organisms, shade, or spiritual well-being. This approach has great application internationally. (http://riversofcarbon.org.au/about/what-do-people-think-about-rivers-of-carbon/)*

Despite its focus on biophysical vegetation restoration, the outcomes of the work are social, and not just biophysical, creating more benefits and options for landholders. Not only are the outcomes social, but the program is also grounded in social processes, building trusted knowledge-sharing networks and capability:

> *Story telling is an integral part of our project, and this year we have worked with four of our landholders to share their stories about being involved in the RoC project. We love working with landholders who are as passionate about their rivers as we are, but who also bring other goals and ideas about their farm. Though negotiation we aim to get the best outcome for the environment, as well as on-farm sustainability and productivity. Everyone we work with has different motivations for being involved. (Lovett 2014)*

An example of a story told by one of the participants is:

> *We have a responsibility to be proactive about managing the environment and protecting our on-farm resources. It also fits with our production goals of reducing labour costs and improving stock management. Fencing off creeks and riparian areas has provided significant cost savings in running our farms.(Lovett 2014)*

In this way the program has developed effective ways of working with people to help them create positive change on their properties, building both social and ecological resilience.

Head et al. (2016) compared case studies where collaborative approaches were used by NRM organisations to address 'intractable NRM issues arising from socio-ecological relationships', one of which was the Goulburn Broken CMA (the others were the Whealtbelt NRM in WA, the Lake Eyre Basin and SEQ Healthy Waterways in Queensland). Their analysis found common challenges, including competing interests and mandates, the need to navigate significant issues with highly uncertain knowledge, maintaining effort and focus over the long-term, building momentum and continuity while adjusting to changes at other levels of governance, recognising adaptation and collaboration opportunities, and linking science, policy and community leadership through collaborative platforms. Even though the case studies were about the management of natural resources, the challenges are primarily social in nature rather than specific to the site's ecological processes, and confirm the relevance of the themes and principles identified in Table 1. The authors also found the following:

> *The collaborative regional arrangements found in each case study were directed at the particular 'wicked' NRM problems for that region. In all cases, we found that reframing of each wicked problem at the centre of the collaborations occurred periodically. Reframing was linked to the emergence of new relationships, improved or changing processes for dialogue, and new policy directions, as well as to developments in scientific and technical understanding of problems and trends.*

The example from Lake Eyre illustrates this process of reframing particularly well:

> *The critical challenge for water and related natural resource governance in the Lake Eyre Basin was framed and reframed over time, from a focus on environmental conservation of Lake Eyre (Reid, 1994), to building a self-sustaining community-based integrated catchment management process for change focused on keeping the Lake Eyre Basin in good ecological condition, and more recently to include a strategic adaptive management focus that links ecological monitoring and management with collaboration. This reframing of the wicked problem, and emergent entrepreneurship from government, community and scientific actors, proved essential for dealing with conflicts amongst diverse actors and for enabling collaboration and the development of a whole-of-basin governance approach.*

The term, 'wicked problem' comes from a highly-cited paper by Rittel and Webber (1973) where they describe these problems as ones that cannot be definitively described, notions of 'public good' are in dispute, there is no shared understanding of what is equitable, policies designed in response to the problems cannot be judged to be correct or false, and the concept of an 'optimal' solution is intractable. Sustainable stewardship of all the things that diverse people value in the MDB certainly falls into this class of 'wicked problems', and engagement processes that facilitate collective reframing like that described by Head et al. (2016) are vital.

Colloff et al. (2017) recognise this and explore the opportunities for transitioning planning practices away from 'reformist' to 'transformative approaches' for adapting to global change in social-ecological systems. Key to this approach is the adoption of 'co-production' processes that welcome the knowledge, experience and values of diverse people and perspectives, 'unconstrained by discipline and sectoral boundaries, geopolitical polarities, or technical problematization'. The benefits of doing so include: better links between science and governance

because knowledge, values and rules are all recognised parts of the system that need to be understood and managed (e.g. people's values are just as important as measurements and models of the hydrology); more effective changes in people's behaviour by better recognising and connecting with their values in meaningful and relevant ways; and the creation of new options and solutions by placing a deliberate focus on equity and empowering people in the system who are more typically at risk of being excluded. It is a holistic systems approach, and the next section expands on systems analysis as a core element of planning for resilience, adaptation and transformation.

2.3 Systems analysis and resilience thinking

2.3.1 Overview

Systems analysis is central to most work on resilience and adaptation, and Sellberg et al. (2018) identified it as the most common feature of resilience planning conducted in the MDB (see **[Image removed for copyright reasons. Source is Figure 5 from Sellberg et al. (2018)]** Figure 2). Systems analysis involves a focus on multiple and interacting causes and consequences, key feedbacks and thresholds and cross-scale effects in order to avoid perverse outcomes that arise from over-simplifying a problem situation. The interplay between values, formal and informal rules (or institutions), and knowledge are key influences in decision-making for maintaining system resilience and options for adaptation or transformation. Seeking multiple perspectives on what is changing and why can reveal insights that are robust to uncertainty, as well as building system understanding of the multiple values that contribute to people's wellbeing.

2.3.2 Rationale for a focus on systems analysis and resilience thinking

The nature of complex systems

Taking a systems view means accepting the reality that very few impacts result from a single cause. More typically there are multiple causes, and most causes have multiple impacts. Furthermore, cascades of cause and effect unfold in counter-intuitive and surprising ways that lead to unintended consequences (Liu et al. 2007, Dearing et al. 2015). Understanding the nature of complex systems is helpful in building resilience and adaptability for several reasons. First, system understanding helps us anticipate how systems might respond to shocks or other changes, or at least be prepared for the fact that systems may respond in unexpected ways to change. Doing so can help identify interventions that may lead to a more desirable response to anticipated changes. Second, sometimes the shocks that we are worried about are themselves due to intrinsic system dynamics (e.g. boom/bust cycles), and informed system interventions can reduce their likelihood. Whilst small changes in individual factors can results in a much larger increase in emergent systemic risk, on the positive side the converse is also true – many well-considered small interventions at critical places in a system can disproportionately decrease systemic risk. Here we give some descriptions of the sorts of system properties that are helpful to identify.

Time delays between cause and effect can be years, generations or longer, and complicated by other influences (e.g. evidence presented to the Panel that impacts of water buy-backs several years ago are still unfolding). Some future events are already locked in by past decisions and

actions, and options that might otherwise have been available have been closed (e.g. historic institutions of water allocation attached to land tenure were effective initially, but locked in a crisis of over-allocation). Changes in one sector, such as water management, are felt across all other sectors. Changes upstream have downstream impacts, and there are more complex chains of cause and effect where changes in one place have impacts across different geographies (e.g. via changes in commodity prices or legislation). There are interactions across scales, e.g. decisions that can be made at a farm level will be constrained by decisions made at regional, national and even international scales (e.g. via international markets), and to some extent vice versa. Impacts can be distributed disproportionately, with some benefiting from changes while others are worse off.

There are feedback loops that can reinforce and accelerate change (e.g. as more people leave a town it becomes harder for those remaining, so driving further departures). These feedbacks can lead to the crossing of social and biophysical thresholds, or tipping points, where apparently slow changes trigger large, sometimes rapid or irreversible, shifts. Some feedback loops weaken or impede change. For example, changing engine technology to increase fuel efficiency has not led to the reduced demands for petroleum because of the 'rebound effect'; gains made in engine efficiency have been taken up in building larger, heavier and higher performance vehicles, including extras such as air-conditioning and by more people driving further (Foran and Poldy 2002). Rebound effects abound in water management; water savings from increasing the efficiency of water use can prompt an increase in area under production, so failing to deliver any increase in downstream flows.

Understanding and working with these kinds of system dynamics vis systems analysis is one of the most common approaches for building resilience and adaptability because it reveals options for where to intervene in complex systems so that things of value in that system can persist in the face of change.

System analyses

A system analysis can never be comprehensive, but there are ways of operating that recognise key system properties and how they affect resilience and adaptability. For example, there is a range of methods of differing levels of sophistication for seeking evidence for the system properties described above. One powerful and readily accessible approach is to recognise typical complex system patterns, such as feedback loops, rebound effects, critical thresholds and other familiar system phenomena that are common to many different kinds of systems. Kim (1994) outlined several 'system archetypes' that are recognisable in many different systems, one example of which is the 'fixes that fail' pattern: a solution is implemented to alleviate a symptom in the short term, but it has long term unintended consequences that end up exacerbating the problem (e.g. drought relief interventions that provide short-term relief without structural adjustment for building long-term, drought-ready adaptive practices).

System assessments can help stakeholders reframe how they make sense of a problem, so contributing to the stakeholder engagement processes described in Section 2.2. Taking a resilience approach involves describing the system, identifying properties such as critical thresholds and feedbacks and then conducting an assessment of resilience and adaptive capacity (e.g. Walker and Salt 2012, O'Connell et al. 2016). These assessments involve multi-stakeholder deliberations on

what is valued in the system, and what (and whose) values stand to be retained and/or changed in the face of anticipated shocks.

In social-ecological systems causes and effects are both social and biophysical; a drought will affect water availability and commodity prices, which in turn drive social decisions that change land use. A social-ecological systems approach allows us to recognise when ultimate causes of change lie in the social realm. For example, recent work exploring Australia's vulnerability to natural hazards used system approaches to reveal interactions between values, rules and knowledge that underpin societal decisions that put people in harm's way (O'Connell et al. 2018). Such an approach helps us see where the stories we tell and live by (e.g. stories of the importance of economic efficiency) are powerful influences on what does and does not unfold in the world. Values play a particularly crucial role. As part of a system description process, O'Connell et al. (2018) mapped out a set of values tensions, and how decisions that trade off these values are important determinants of Australia's vulnerability to natural hazard events such as floods, cyclones and heat waves (Figure 5). These tensions in values, and the way that they drive the system, are equally relevant in the MDB.

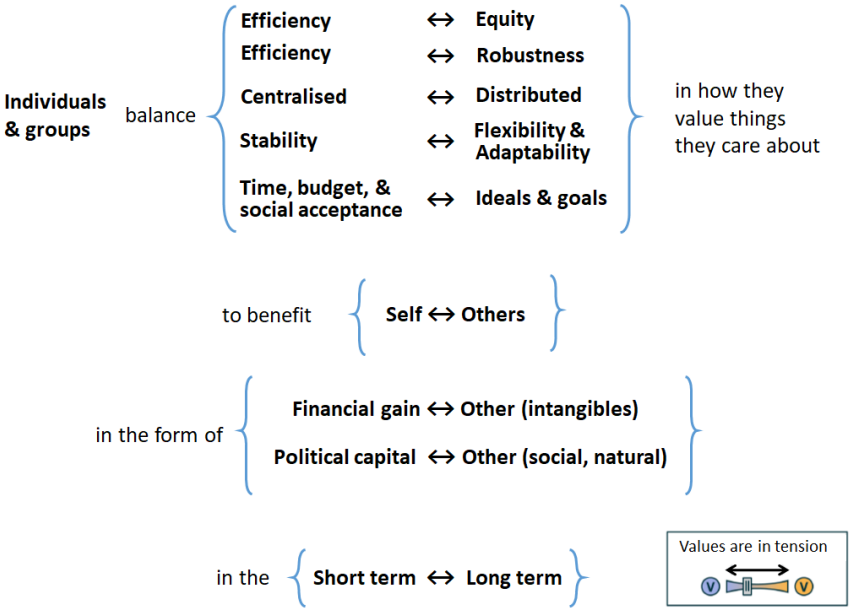

Figure 5 Value tensions that exist within and between individuals and groups that play out in every day decisions but fundamentally shape the vulnerability of society to natural hazard events.
Broadly speaking, values on the left are favoured in times of stability and lead to decisions that create vulnerability in the face of change, the ones on the right would lead to decisions that confer resilience in the face of disaster.
Source: O'Connell et al. (2018)

Mapping out such values tensions is helpful for understanding some of the causes of vulnerability and, consequently, highlighting where there are opportunities for building resilience and adaptive capacity. When combined with approaches such as the 'Values, Rules and Knowledge' framework/rubric (Gorddard et al. 2016), it also provides an excellent basis for framing difficult discussions around contested values and conflict.

2.3.3 MDB examples employing systems analyses and resilience thinking

One of the best-known examples of taking a systems approach to planning in the MDB is the analysis conducted in the Goulburn Broken. An example of one of the outputs from system analysis is shown in **[Image removed for copyright reasons. Source is Figure 7 from Walker and Salt (2012).]**

Figure 6. It brings together an understanding of the biophysical, economic and social processes in the system, drawing attention to key thresholds in each of these domains. Recognising physical, economic and social thresholds then guides actions and the indicators to track for monitoring progress and learning by doing. Social-ecological system thresholds are embedded in the Regional Catchment Strategy (GBCMA 2013) and in the monitoring and evaluation of progress (GBCMA 2016). In this way a system analysis was been able to identify management actions for enabling resilience and adaptability in the face of shocks, and appropriate indicators for monitoring progress. It is an example of how systems analysis and resilience thinking can be been embedded into management strategies and on-ground decisions.

[Image removed for copyright reasons. Source is Figure 7 from Walker and Salt (2012).]

Figure 6 Example output from a system analysis in the Goulburn Broken catchment (Walker and Salt 2012)

Wilson et al. (2013) undertook a combination of quantitative and qualitative methods, and focus groups, to work with two (unnamed) towns in the MDB facing reduced water allocations, increased climate variability and demographic changes. The authors explored future scenarios, community networks and different forms of capital (human, social, built and natural capital), to assess the towns' capacities for resilience and transformation. They found that their approach was a pragmatic and workable way to identify and assess complex system properties, including the system identity, and key feedbacks, structure and functions, and they were also able to identify indicators for assessing adaptive and transformative capacity.

The fundamental dependence of MDB communities on the natural resource base is well understood, as expressed by (Williams 2011):

> *environmental impacts are an early indicator of a loss of resilience in ecosystem function in the natural resources base that underpins our land-based industries — that is, the biophysical processes and systems are moving from the complex to the simple. These changes are foretelling a decline in the natural-resource base and ultimately in economic productivity.*

The concept of ecosystem services has been used to spell out the multiple ways in which good stewardship of ecosystems yields benefits for people. Ecosystem services have been characterised in the MDB (Abel et al. 2003, CSIRO 2012) and underpin the original resilience work conducted in the Goulburn Broken. More recent work has taken the concept further to characterise 'adaptation services' of floodplains and wetlands in the MDB (Colloff et al. 2016). Adaptation services benefit people by enhancing their capacity to adapt and change, and so are particularly relevant for resilience and adaptation. Ecosystem properties that either support the persistence of values or enable transformation are important to recognise because they underpin future options.

Multiple different factors or values contribute to the wellbeing of people in the Murray-Darling Basin. Individuals value many different things and different people value different things. Critically,

people often value different things in different contexts. When experiencing change, people's preferences and priorities are likely to change. Therefore, it is important for initiatives seeking to improve resilience and wellbeing to recognise and accommodate these multiple values and changing contexts as a vital part of the system description. Failure to do so runs the risk of preserving or increasing some values but at the same time allowing others to be diminished, or worse, unwittingly trading off values that are in conflict (e.g. O'Connell et al. 2018). This includes acting on preferences that people have expressed in one situation (such as in times of plenty) which may not apply in a different situation (such as in times of drought). To address this there need to be processes to elicit values from the diversity of people who have a stake in the MDB, to do so in the context of changing circumstances, and to be aware of (and look for) tensions or trade-offs between values that are inherent in decisions.

Grigg et al. (2018) scoped out opportunities to use ecosystem services, combined with an understanding of people's values, to construct evidence-based narratives for supporting resilience and adaptation planning in the MDB. Table 3 is from that report, and lists references that provide helpful insights to characterising some of the more difficult and intangible values that matter the most to us. In doing so it links resilience and adaptability to human wellbeing, by pointing us to what resilience planning is ultimately for, i.e. to help people adapt and change so that what ultimately matters to them (as reflected in their values) can persist. van Kerkhoff et al. (2019) identify a focus on social values and benefits, as opposed to physical attributes and targets, as a key transition to enable adaptability. It opens the possibility of maintaining core values while letting other things change: 'maintaining benefits experienced by people may be different to maintaining the current state of the ecosystems themselves'.

Table 3 References describing methods that would be helpful for characterising values and benefits from ecosystem services. Knowledge of these values is needed in resilience and adaptation planning because it reveals what really matters to people that they would like to be resilient in the face of change. (Table source: Grigg et al. 2018)

References	**Description**	**Potential contribution**
Cast et al. 2008, Raymond et al. 2009, Hatton MacDonald et al. 2013	Semi-structured interviews with open-ended questions with NRM group members about their relationship with a range environmental assets and ecosystems services, and eliciting details about people's actions, goals, attitudes and values. It included spatial mapping, where participants were given green and red dots to mark valued environmental assets and areas of concern.	Detailed characterisation of benefits cascades and people's values, accompanied by spatial maps.
Seymour 2010, Seymour et al. 2010, 2011	Interviews with people representing three different NRM community types (place-based, practice-based and interest based), qualitative data analysis, surveys and structural equation modelling. The methods were used to elicit held and assigned values and infer relationships between values, behaviour and other explanatory factors.	Detailed characterisations of held and assigned values as well as empirically validated predictive models of relationships between values, behaviour and other factors.
Pert et al. 2015	Mapping Indigenous cultural ecosystem services, social and ecological attributes. Categories of biocultural diversity and governance were included as well as more conventional categories of aesthetic and spiritual categories. Provides a different perspective by assessing	Valuable for bringing diverse perspectives to characterisation of ecosystem services. Methods that are

	ecosystem services with different themes and categories to standard approaches.	particularly suited to partnerships with Indigenous peoples.
Raymond et al. 2014	A comparison of instrumental and deliberative approaches to assess social values for cultural ecosystem services, along with a suggested approach for integrating qualities of both.	Valuable for informing what methods are appropriate in what contexts.
Chan et al. 2012	Outlines many of the challenges of characterising cultural services and non-use values that are intangible and incommensurable with economic valuation, and suggests some approaches for addressing these challenges.	Provides a more complex (but perhaps more realistic) alternative to a linear benefits cascade, and relates it to human values, principles and virtues.
Ives and Kendal 2014	Review of approaches to studying values from different disciplines, and also the relationships between values and behaviour, written for NRM managers.	Provides references to more relevant theory and methods.
Taylor et al. 2016, Mendham and Curtis 2018	Characterisation of social perceptions of ecosystem services in order to assess social acceptability of environmental watering practices.	An example of how to relate information about ecosystem services and values to specific questions about environmental watering.
Ruoso et al. 2015	Exploration of social evaluation of ecosystem services in peri-urban farmland, with a particular focus on two categories: 'food production' and 'aesthetic landscape'.	Insights into amenity values farming landscapes with strong interactions between 'natural' and human-induced features.

There is a clear opportunity to do more to bring together systems analysis, including characterisation of values, rules and knowledge, to build evidence-based narratives for guiding decision making across sectors and scales.

In the MDB, the outcomes from any intervention will result from the interplay of a series of different but interacting factors, including reduced water availability; increased demand for environmental water; changing balance between flexible, high-volume, low-value crops and permanent, lower-volume, higher-value crops; irrigation and dryland agriculture; agriculture and non-agriculture industries; economic and lifestyle drivers, etc. Planning and evaluating interventions needs to accommodate the dynamics of these interactions and the way they distribute benefits and disbenefits. Lack of attention to interactions in systems can also lead to incorrect diagnosis of issues, for example blaming the impact of climatically driven reductions in allocations on the Basin Plan (Wheeler et al. 2018). Aither (2019) found that uncertainty in future supply and demand is amplified by interactions, including between complex sets of water allocation rules, change in industries (e.g. increase in cotton in the southern MDB), and the emergence of sophisticated risk management strategies (e.g. carryovers, leasing, forwards and options).

Rebound effects and their implications for water management policy in the Murray Darling are well recognised, with analyses that point to a need for caution in estimating the real water savings that can be generated from infrastructure investment (e.g. Loch and Adamson 2015, Adamson and Loch 2018). Wheeler et al. (2018) highlights that subsidies for irrigation infrastructure can act as a barrier to exit from irrigation and therefore a barrier to the adoption of livelihoods that are less

sensitive to reduced and more variable water availability. Sellberg et al. (2018) also concluded that investments in irrigation infrastructure, combined with a drier climate, has the potential to make the system 'more stable, but not necessarily more sustainable in the longer-term'.

Abel et al. (2016) took a system view to the planning process itself, recognising a familiar system pattern comprising phases of growth (increasing system connections and accumulation or resources), conservation (structure becomes rigid and hard to change), collapse (rigidity of the system leads to brittle fragility and collapse) and reorganisation (redesign and renewal). The authors suggest that, in MDB planning processes by NRM organisations, it can be helpful to recognise that 'adaptations not possible in the conservative stage of the cycle may become so when conservatism ends in a crisis that leads to the release of resources, opening of new opportunities, reorganization, and renewal as values shift, rules change, and new knowledge is generated.' The authors give drought, financial shocks and legislated reform as examples of such crises. They also suggest that opportunities for bottom-up initiated transformation can come from strategic connection and alignment with other groups with intersecting interests.

2.4 Learning orientation and uncertainty

2.4.1 Overview

The uncertainties associated with future changes in the MDB are profound and need to be accommodated into the logic and implementation of management interventions. Operating with a deliberate learning orientation means actions can be taken in conditions of high uncertainty and managed adaptively. A 'triple loop' approach encompasses multiple levels of learning, from learning about implementation, to the effectiveness of actions, right through re-framing of the problem with re-evaluation of underlying values, assumptions and paradigms (Pahl-Wostl et al. 2011). While society and governments may learn regardless as change occurs, they will learn faster and with fewer unwanted outcomes if they set out to learn in a deliberate and structured way.

2.4.2 Rationale for a focus on learning orientation and uncertainty

There are several different kinds of uncertainty that challenge efforts to prepare for future change, including errors of distortion (e.g. via confusion or inaccuracy) and incompleteness (e.g. due to missing or uncertain information). It is natural to seek to reduce uncertainties, but when dealing with complex systems some uncertainty is irreducible. Sometimes uncertainties are ignored and fail to inform decisions, and in some cases, issues are dismissed altogether because they are uncertain. This happens in situations where available decision-making processes are not designed to accommodate uncertainty. Analysis can help *characterise* (as opposed to *reduce*) the nature of uncertainty. This can be helpful if there are processes are available to use that knowledge (e.g. using scenarios to allow stakeholders to explore uncertainties and their consequences for different kinds of decisions) so that they can respond and adapt more rapidly. Such processes include prioritising 'robust' solutions (see below), and developing decision making that is more responsive to emerging information.

The realities of rapid change and complex systems are that decisions need to be made without all the knowledge of consequences. Operating with a learning orientation accepts that reality, rewards acknowledging unwanted outcomes (rather than defending them) and provides processes for changing practices at all levels (triple loop learning). Future trajectories are going to differ from the past and we need to *learn from the future* as well as from the past. This is called anticipatory learning and is a critical priority for capability building, as discussed in the 'Learning into the Future' section of the National Resilience Taskforce Guidance on Vulnerability (Australian Government, Department of Home Affairs 2019a).

Robust decision-making identifies 'decisions that are robust across the range of future possibilities, even if they are not precisely optimal for any and as a consequence may be more costly to implement' (Stafford Smith et al. 2011). Adaptive decision making includes planning for decisions to be revised and collecting the new information needed to inform that revision, including about the effectiveness of initial decisions and changes in the context. The 'pathways' approach to climate adaptation builds on these approaches to emphasise maintaining and creating options for future decision making (see Section 2.5). Where there is uncertainty about future

change it is also important to incorporate multiple sources of evidence to plot possible ways forward.

Learning can happen without deliberately planning to do so. However, explicit, structured learning processes that pay attention to individual and collective (or social) learning, triple-loop learning and anticipatory learning have particular advantages: it is more likely to structure the collection of the relevant and useful data; learning can be faster and more effective if it is a goal that is rewarded; structured learning processes can underpin accountability requirements, quality control and associated reporting; implementing explicit learning practices is a tangible way to foster a culture of active learning; and a learning orientation can allow people with conflicting perspectives to work together constructively to test their assumptions and be open to changing their perspectives.

2.4.3 MDB examples related to learning orientation and uncertainty

Regional NRM has for a long time had an emphasis on Monitoring, Evaluation, Reporting and Improvement (MERI), in part reflecting a reasonable expectation to be able to document the benefits of considerable government investment in regional NRM. This has the potential to enable learning in the face of uncertainty; however, in practice, MERI often becomes an accountability tool ('did we do what we said we would do?') which prioritises the first learning loop of 'did we do things right?' While accountability is important, an approach which is framed only with a compliance mindset can be antagonistic towards deeper forms of learning. Several regional NRM agencies have successfully implemented learning systems in their planning independent of MERI, based on explicitly identifying assumptions behind interventions and targets, and then assessing those assumptions periodically in response to the observed impacts of investments. For example Miles et al. (2010) set targets with the following intention: 'While these targets may be uncertain they provide a platform to monitor progress, evaluate programs, and identify knowledge gaps. They are reported against using data and assumptions, which are continually refined based on the best available information.'

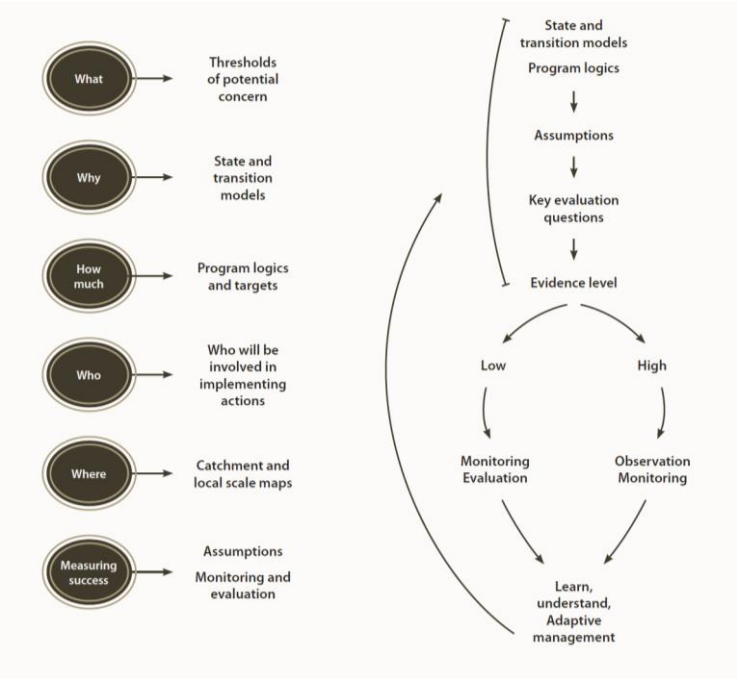

Figure 7 The key concepts in the Central West CMA Catchment Action Plan (left hand side) and a diagram showing the monitoring, evaluation and learning framework used for measuring success and being held to account (CWCMA 2011)

Figure 7 illustrates the approach used in the 2011 Catchment Action Plan for the Central West CMA, which is an example of how participatory systems analysis and resilience thinking can be used to guide ongoing monitoring and learning, and hence to support adaptive management in the face of high levels of uncertainty:

> *In defining our priority actions we make assumptions that these actions are the most appropriate to affect the desired change in the system. We base our assumptions on the best available evidence at the time* ***but this does not mean we are always right****. It is important that we monitor and evaluate our results regularly. Monitoring and evaluation allows us to make adjustments to our actions as we learn from our successes and failures. (CWCMA 2011)*

The NSW Local Land Services 2016-2026 Strategic Plan, which sets out the strategy against which regional strategic plans need to be aligned, has embedded 'triple loop' learning (Figure 8): the first loop involves 'regular monitoring, auditing, evaluating and reporting of actions'; the second loop is about 'challenging, and potentially reframing, strategies and objectives, as well as examining evidence and assumptions'; and the third loop is about 'challenging, and potentially transforming governance arrangements, value systems, vision and mission'.

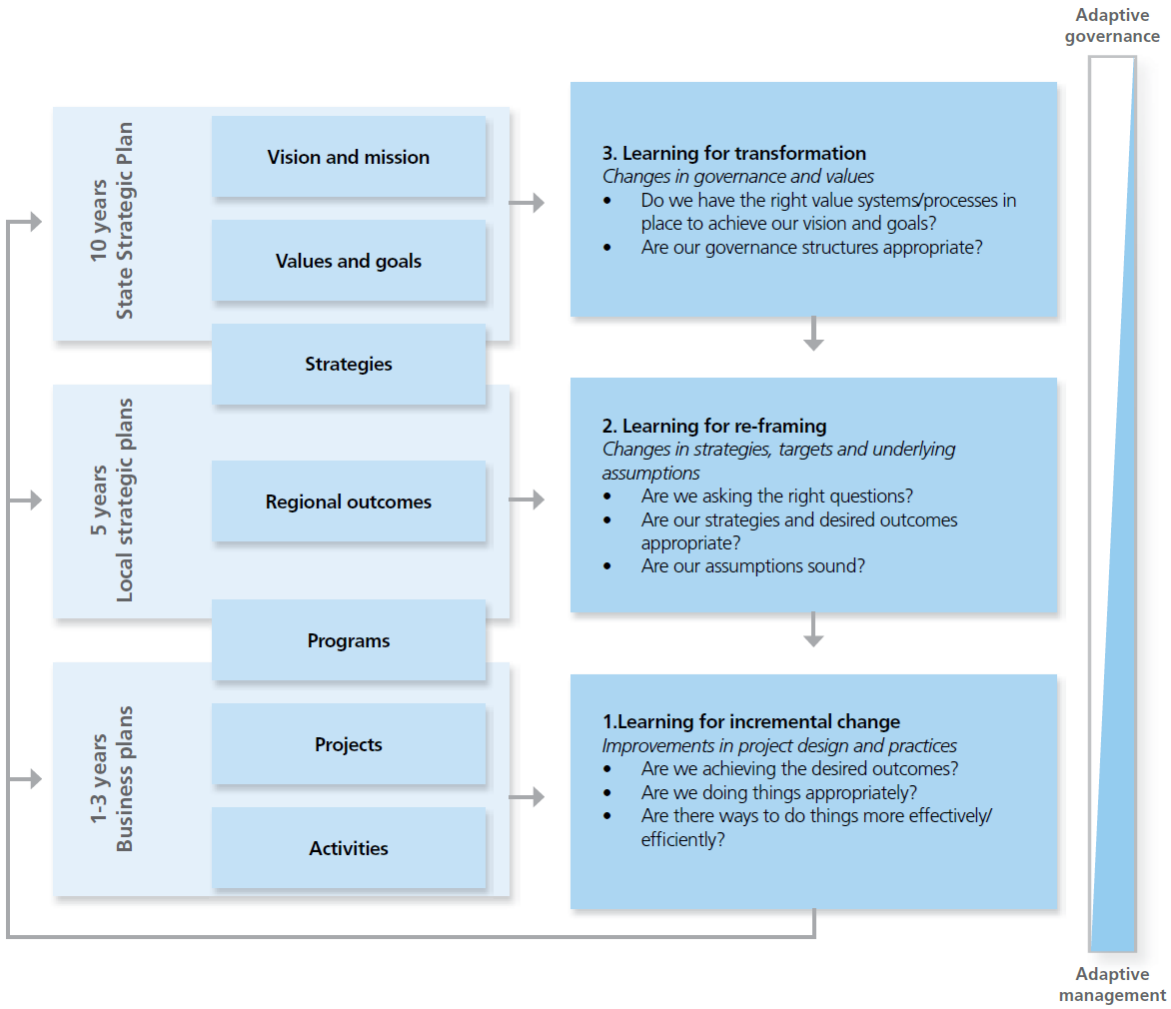

Figure 8 Example of implementing triple loop learning in strategic planning. Source: LLS (2016)

2.5 Decision focus and adaptation pathways

2.5.1 Overview

A focus on the decisions people will need to make is necessary because new kinds of decisions will be required, and current decision-making processes may not work well. Rapid novel change may require fundamental shifts in how and where certain decisions are made. Creating adaptation pathways can enable stakeholders to act towards agreed goals under uncertainty, with the capacity to take alternative options and paths as more is learned and conditions change. It is also beneficial to be able to consider options and pathways that lie beyond the scope or funding duration of the current decision-making context. Design, implementation and assessment of options and pathways needs to be supported by adaptive and polycentric governance.

2.5.2 Rationale for prioritising decision focus and adaptation pathways

Many analyses and plans focus on the impact of change and the physical state of a system. These things are relatively easy to see and monitor, and to some extent model and project. But a focus

on the decisions people will need to make is becoming an imperative, especially with the growing requirement for new kinds of adaptation decisions that have long lead times and play out over many decades, given that there are many social, psychological, governance, institutional and cognitive barriers to successful adaptation (Stafford Smith et al. 2011).

Dealing with climate and other novel future risks is not an 'add on' to current decision-making processes and will require fundamental shifts in how and where certain decisions are made. For example, dealing with climate risk will not start with considering changes to infrastructure specifications, but to the whole objective setting exercise – what is the 'job' or objective of that infrastructure, and will that objective itself be future-ready? As current objectives become implausible or unfit-for-purpose (for example, the conservation objective of maintaining all species where they are today may not be a reasonable possibility under climate change), processes for changing to future-ready objectives will be necessary. Fair, context-sensitive and fit-for-purpose decision making practices will be needed to identify and reach goals for system resilience, adaptation and/or transformation, based on appropriate evidence-based governance principles (e.g. principles that have emerged from research on management of common pool resources in social-ecological systems). An adaptation pathways approach (e.g. Wise et al. 2014, Colloff et al. 2017b) explicitly explores and changes the 'decision context' (a product of interactions between societal rules, values and knowledge) to enable decisions that avoid incremental, short-term, maladaptive decisions and instead opening up new options for future decision points.

There are changes occurring in legal, financial and insurance domains that will have direct implications for decision-making in the MDB. Legal exposure and liability consequences for failing to mitigate, adapt or disclose climate risks are being increasingly recognised internationally and in Australia, and apply to corporations and government agencies (Barker 2019). There are associated fiduciary duty, due care and diligence implications, and emerging accounting and auditing standards required to declare the 'materiality' of climate-risk exposure (Australian Government 2019). Business models underpinning the insurance industry are challenged by implications of climate risk (e.g. if insurance companies' own re-insurance costs increase it can drive up insurance premiums to unaffordable levels), and the Government is finding itself acting as the 'insurer of last resort', funded for example via levies on taxes.

2.5.3 MDB examples employing a decision focus or adaptation pathways

The kinds of change expected in the MDB include reductions in inflows due to climate change and changes in allocations from irrigation to environment. But critically they also involve changes in the irrigation sector, including very significant increases in permanent crops that are not flexible in their water demand (and can afford to pay high prices for water), along with decline and possible exit of lower-value, high-volume irrigators. Increases in the proportion of permanent irrigated crops (e.g. tree crops) is recognised as a critical factor in determining the suit of impacts of various water recovery programs (Aither 2019).

A critical decision in the MDB has been the choice of between buy-back and infrastructure investments for accumulating environmental water. Marshall (2013) used this decision to illustrate the application of a cost effectiveness framework for evaluating such institutional choices. The framework recognises classes of transaction, transition and lock-in costs associated with different

institutions. The authors characterised these different classes of costs for both water buy-back and infrastructure upgrade programs, and used a bounded rationality procedure to conclude that "the buy-back program is the preferred institutional option once all six cost classes in the framework area accounted for". The work illustrates the kinds of approaches that can be used to provide an evidence-based rationale when tackling highly uncertain, 'wicked' problems.

Marshall and Stafford Smith (2010) used the characteristics of MDB drylands to design adaptive governance arrangements for robust natural resource management. They also identified obstacles to transitioning to these alternative governance structures and so proposed practical steps for 'pre-adapting' for that transition (akin to changing the decision context so that decisions that face obstacles now can be made in the future).

The Corangamite CMA worked on developing climate-ready decision-making objectives (Corangamite CMA 2017). The first section of their climate change plan, 'Planning for change and uncertainty', makes explicit the ideas of 'resilience', 'transition' and 'transformation'. In the adaptation chapter (p. 106) it discusses the need to move away from objectives designed for stationary climates and adopt sets of 'climate-ready' objectives that explicitly accommodate large change and implicitly accommodate uncertainty and multiple values. It then presents series of such objectives for native vegetation, streams and rivers, soil, wetlands, coastal assets, and flora and fauna. For example: 'Increase vegetation extent and security as vegetation communities and land use change under climate change'. While the capacity to deliver some of these newly framed objectives in the near-term might be limited, their inclusion in the strategy serves as a stimulus for reflecting on the longevity of existing objectives, and the new knowledge, values and rules that might be needed to actually enable implementation of initiatives that are effective in the face of sustained change.

Prober et al. (2017) applied an adaptation pathways approach for agricultural landscapes in south-eastern Australia where there are trade-offs between agricultural and environmental conservation objectives. The analysis included climate change projections and a variety of methods for characterising possible climate change impacts. Biophysical pathways were developed based on identified points where management choices need to be made, and the cues for recognising such junctures. **[Image removed for copyright reasons. Source is Figure 4 of Prober et al. (2017).]**

Figure 9 shows the adaptation pathway developed for cropping and grazing production decisions. It shows a transition to extensive grazing away from mixed cropping-grazing systems to avoid maladaptive outcomes. Intermediate points along the way identify options for ameliorating declining profitability of grazing systems (e.g. improving livestock genetics) and prolonging the viability of cropping (e.g. precision agriculture advances and improved varieties).

For each decision point the authors identified factors that could lead to maladaptive options or prevent favourable outcomes. These factors were characterised according to whether they related to values, rules or knowledge that define the decision context. They identified fifteen constraints that limit implementation of decisions, most of which involved rules. In doing so the authors were able to connect biophysical analysis with needs for changes in social and governance systems.

[Image removed for copyright reasons. Source is Figure 4 of Prober et al. (2017).]

Figure 9 An example of adaptation pathways developed for production landscape decision points. Blue text indicates potentially maladaptive and desirable outcomes. Decision points are marked with numbered circular

arrows. Black text is used for management options and orange text marks actions for increasing resilience. The blue shading represents maladaptive space. Source: Prober et al. (2017)

Dunlop et al. (2016) conducted an exploratory analysis using case studies to scope the near- and long-term consequence of climate change for decision making in four ecologically challenging and socially contentious issues in the MDB: groundwater resource management and governance, land use transitions in agriculture, balancing asset protection and ecological outcomes in the face of increased bushfire risk, and biodiversity conservation considering changes in ecological communities. They identified those impacts most relevant to decision making and which ones might be more urgent, then scoped barriers to decision making arising from lack of knowledge, diverging values or restrictive rules, and considered the types of learning required to build adaptability and resilience and enable successful transformation.

3 Gaps and opportunities

This review provides some rapid insights into the gaps and opportunities to improve resilience, adaptability and wellbeing in MDB communities. Further review and consultation would be required to provide a systematic assessment of gaps and opportunities.

Undertake resilience and adaptation planning at scale

The resilience and adaptation planning work in Section 2.1 provide excellent examples of work that spans the four themes in Table 1. It is more difficult to find successful larger scale and cross-scale initiatives, or to find successes in highly contested settings. Our review also demonstrated that excellent information exists for the basis of a rich understanding of complex social-ecological systems in the MDB, including economic dynamics, social processes and outcomes, natural resource dynamics and the inter-relationships between them. It is harder to find good data on people's values and how they are changing or being impacted by changes in and beyond the MDB. Understanding what people care about, their values, is a vital part of system understanding because decisions are strongly influenced by values, and in contested settings there can be conflicts between values that need navigating for decisions and outcomes to be trusted and legitimate. This is especially true of adaptability, resilience and wellbeing, as broadly conceived of in this review and by Schirmer et al. (2019). While these outcomes may be valued in communities, people are often confronted with trade-offs between these values and other outcomes (e.g. preserving the status quo, material goods, financial wellbeing and short-term benefits). Lack of understanding about the mechanisms of adaptability and resilience or the increasing need for them, will further bias decisions away from those outcomes. In addition, many cultural norms and institutions explicitly prioritise decision options that reduce adaptability and resilience.

Opportunities that emerge from these gaps include:

1. Develop and test ways to apply the established resilience and adaptation planning processes at larger scales in order to explore new possibilities for living successfully with future change in the Basin, at multiple scales from local to national. This could include deliberately designing appropriate collaborative institutions that can undertake these activities following the principles in Table 1.
2. Learn from and build upon concepts and planning practices being developed and applied at scale by the disaster risk reduction, emergency planning and climate adaptation communities. These include approaches for understanding people's values and associated values tensions that can underpin system vulnerabilities, and participatory processes for developing narratives that enable change.

Recognise 'no one is in charge' and incentivise distributed efforts

While individual programs with a clear owner or sponsor can contribute to resilience, adaptability and wellbeing, these outcomes mostly result from multiple diffuse actions and processes and the outcomes per se do not have a single responsible person or agency ('no one is in charge', Abel et

al. 2016). While lack of a single responsibility or point of intervention may seem to be a barrier, it suggests there are multiple opportunities to take actions to build resilience, adaptability and wellbeing; including opportunities to create governance institutions that coordinate and incentivise distributed efforts to address the issues (e.g. by adopting the design approach demonstrated by Marshall and Stafford Smith 2010).

Many government programs, including grants, include various due diligence criteria, such as efficiency, best-practice, measurable near-term outcomes, that inadvertently *but systematically discount or undermine* long-term resilience, adaptability and a broad perspective on wellbeing. Criteria could be adopted in many policy domains affecting MDB communities that purposefully promote consideration of resilience, adaptability, wellbeing and acting in anticipation of future risks rather than operating in a reactive mode. This could be done comprehensively for example through a process of reviewing all policies in light of resilience, adaptation and transformation, or by incentivising individual themes or principles that will contribute to these outcomes.

Accept and expect large change

Much that is written about the MDB implies change is bad and should be minimised to enable the status quo to persist; but change is inevitable and needs to be accommodated systematically. Change can be anticipated and accommodated in a variety of ways. While resilience is often thought of as the ability to 'bounce back', Brian Walker emphasises that possibly more important is the ability to 'learn *how* to change in order not to *be* changed'(Walker 2019). The systematic use of scenarios of change in planning could mainstream the expectation that change is to be expected and needs to be negotiated successfully rather than being considered as a temporary, undesirable perturbation. Climate Compass, the climate adaptation guidance to Commonwealth Government agencies recommends, for the purposes of exploring the nature of the problem, risks and options, the use of a single 'greatest plausible change' scenario to emphasise the need to be prepared for change and measure success along a change trajectory, as opposed to success being measured by resistance to change (CSIRO 2018). And it recommends that at the point of making a decision there should be a degree of balancing across a range of possible futures, informed by the appetite for risk, and incorporating robustness criteria into the decision making. The Department of Home Affairs has released guidance on developing and using scenarios for climate and disaster risk reduction planning (Australian Government, Department of Home Affairs 2019b). Requiring management objectives that are 'future-ready' according to appropriate criteria would also embed the expectation of large change into decision making (e.g. Dunlop et al. 2013).

Seek specialist advice on legal, financial and insurance developments

Systemic climate and disaster risk means that responsibility for assessing, managing and reporting now falls on a much broader set of portfolios in the public and private sector, and can no longer be relegated to the domain of NRM, environment or emergency management. The requirements for legal and financial due diligence are changing rapidly, as described in Section 2.5.2, and will have profound implications for decision-making. The specifics of these changes are beyond the remit of this review, but will be strong drivers for any resilience or adaptation planning at scales from individual organisations through to local government, private sector corporations, regional organisations, utility providers, state and national governments. These implications are imminent

and we recommend that specialist advice is sought from the legal, financial and insurance sectors. Collaboration with those who do have expertise in these areas would help turn legal, fiduciary and insurance risks into opportunities to act on these developments to promote changes addressing climate and other future risks.

Go beyond NRM-based resilience and adaptation planning

We have drawn primarily on the NRM literature because this holds the most well-developed exemplars of applied programs that have been used to build resilience and adaptive capacity in Basin communities. MDB issues should not be framed narrowly as environmental or NRM issues but as systemic issues that span portfolios, and so there is an imperative to analyse examples of resilience and adaptation planning approaches that better include health, economics and other domains, as well as Traditional Owners and other key stakeholders. More holistic, cross-sectoral approaches across levels will help deal with systemic risk and create the opportunity for more coherent resilience and adaptation planning and better outcomes for current and future MDB communities.

Conclusion

We have reviewed a wide sample of literature relevant to adaptability, resilience and wellbeing in the MDB. This literature spans theory, planning and practice, and reviews the utility of various approaches to enhance resilience and adaptability. It is clear that approaches that deliberately set out to address multiple values, uncertainty, dynamics across sectors and levels and significant change lead, over time, to planning and practice that is different from the business as usual and is better able to deal with the risks associated with change. However, these approaches cannot be expected to be adopted and persist without strong incentives that give priority to the adaptability and resilience outcomes that they enable. We have outlined a range of types of opportunities for strategies that can do this.

We can see that there are clear gaps and opportunities to bring leading practice/contemporary approaches to resilience and adaptation more across sectors and levels in situations of highly distributed roles and responsibilities (where ‘no-one is in charge’). These approaches can provide a strong basis to integrate systems approaches, the needs and values of people who depend on the Basin, and a basis for creating constructive dialogue and making robust ‘future-ready’ plans, programs, investments and decisions at all levels.

Glossary

The terms adaptation, resilience, transformation and vulnerability are used in different ways, by different communities of practice but also by different people, which can create some confusion. We find the terms practical for distinguishing between a set of related and very useful concepts. The definitions we provide here should be seen as labels for these useful concepts, rather claims to authoritative singular definitions of the terms. The references provided are sources for further information on the concepts.

Term	Description of concept
adaptation	Adaptation involves the purposeful adjusting of actions of an individual, community or system to changing circumstances. Adaptation can be proactive in response to anticipated change, or reactive in response to experienced change. It can be in response to external drivers or changing internal processes. The purpose of adaptive actions can be to maintain an existing identity, state or regime or to transform to a new climate-ready identity, state or regime. Adaptation can be achieved through incremental or large-scale rapid changes. (Based on the definition in: Australian Government, Department of Home Affairs. 2019. Climate and disaster risks: what they are, why they matter and how to consider them in decision making. 6 Terms and Concepts. https://www.aidr.org.au/media/6928/06-terms-and-concepts.pdf) Adaptation refers to changing in order to continue to be resilient as circumstances change.
resilience	Resilience refers to the ability of a system to plan, prepare for, absorb, recover from and adapt in the aftermath of systemic threats. (IRGC. 2018. Guidelines for the Governance of Systemic Risks. Lausanne: International Risk Governance Center (IRGC). https://infoscience.epfl.ch/record/257279?ln=en) It is the capacity of a system to absorb disturbance and reorganize so as to retain essentially the same function, structure, and feedbacks – to have the same identity. (Walker, B., and D. Salt. 2012. *Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function.* Island Press) In the context of social-ecological systems, resilience refers to the magnitude of disturbance that can be absorbed before a system changes to a radically different state as well as the capacity to self-organise and the capacity for adaptation to emerging circumstances (Adger, W.N., 2006. Vulnerability. *Global Environmental Change*, 16, 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006)

transformation	Transformation involves a thorough or dramatic change in the identity of an individual community or system as defined by its form, function, process or appearance creating a different identity (IRGC. 2018. Guidelines for the Governance of Systemic Risks. Lausanne: International Risk Governance Center (IRGC). https://infoscience.epfl.ch/record/257279?ln=en) Transformation refers to fundamental changes in structural, functional, relational and cognitive aspects of socio-technical-ecological systems that lead to new patterns of interactions and outcomes. (Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., Barau, A., 2017. Exploring the governance and politics of transformations towards sustainability. *Environmental Innovation and Societal Transitions* 24, 1–16. https://doi.org/10.1016/j.eist.2016.09.001) A transformed system has adapted so much it is no longer the same (identity, process, feedbacks are fundamentally different). Transformation at one scale may enable adaptation or resilience at a higher scale (e.g. resilience to drought at a basin level may be thanks to local enterprises going through transformational change). Transformation can happen purposely (e.g. adoption of minimum tillage) or it can be the cumulative result of numerous incremental changes (e.g. societal change resulting from widespread adoption of smart phones).
vulnerability	The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, community, assets or systems to the impacts of hazards. (UNDRR. 2019. Glossary: https://www.unisdr.org/we/inform/terminology) Factors that influence vulnerability include the resources available to cope with exposure, the distribution of these resources (social, natural and built) across the system, and the institutions that mediate resource use and coping strategies. Where institutions fail to plan for hazards or for changing social conditions and risks, system vulnerability can be exacerbated. (Adger, W.N., 2006. Vulnerability. *Global Environmental Change*, 16, 268–281. https://doi.org/10.1016/j.gloenvcha.2006.02.006)

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