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Environmental Markets and climate Resilience for the GBMCA Region

Practice interviews, literature review and forum results and recommendations

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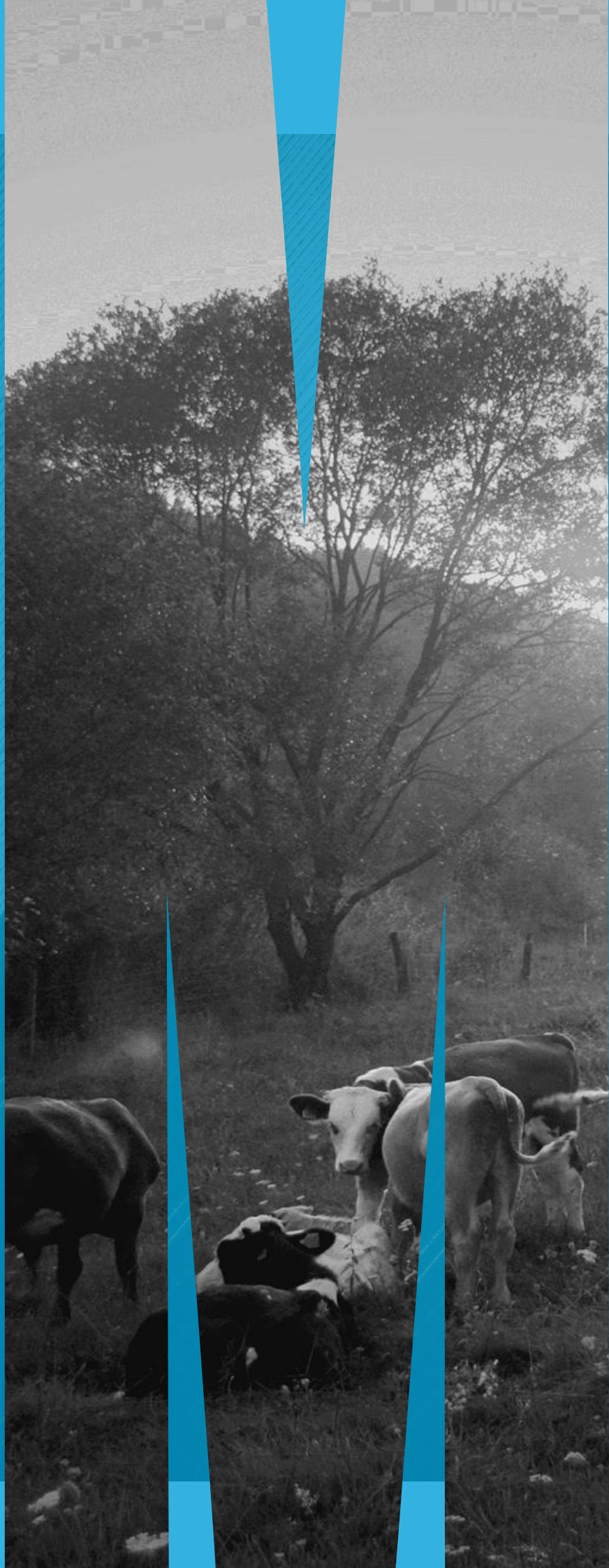

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Declarations of Conflict of Interest

The authors have no conflicts to declare. Where this report cites material from past projects, neither the authors nor BWA has any ongoing financial interest in these initiatives.

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EXECUTIVE SUMMARY

PURPOSE

To better understand the risks and opportunities environmental markets pose for the resilience of the Goulburn Broken region, informing the implementation of the Regional Catchment Strategy 2021-2027and assisting landholders and their supporters to assess the situation and identify actions.

APPROACH

We conducted a scoping review of literature to assess what is known globally on this topic. We have also explored the implications of this situation regionally via practice interviews with 11 NRM facilitators, adaptation professionals and subject matter experts. Initial findings from both research activities were taken to a public forum co-hosted by the Goulburn-Murray Climate Alliance (May 26, 2023), which co-developed the findings and recommendations reported here.

RESULTS

Risks and opportunities at the farm level identified in both interviews, global literature and the forum, reflect, and interact with dynamics at other scales. In particular, the perception that participating in environmental markets may be more risk than opportunity at present reflects a pragmatic view that farm businesses only have so much time and attention to spend on new opportunities, and that these have to be relatively well understood and certain before many land managers will act on them.

The fast moving economic and legislative environment, lack of trust in key mechanisms and intermediary actors and the underlying scientific uncertainty of what actually works, for how long, appear to leave many of our participants very cautious and uncertain about where to start. There was a keen sense of the interdependence of farm and community level interactions – that resilient farms are part of resilient communities and industries – and any transition to a different status quo would need to be just and equitable – at both intra- and inter-generational levels.

Against this, the promise of diversified income, more viable farms and regional communities and economies in the face of a changing climate, and bringing in wider ranges of actors including councils and indigenous corporations was also seen as promising. An overall sense of if not now, sometime soon, and with appropriate support and caution, seems to underline the sentiments expressed in the forum. This includes a commitment to expanding beyond carbon and biodiversity credits, to direct payments for environmental services, certification, and other forms of generating value from verifying and improving environmental services from land.

IMPLICATIONS

These findings can inform the implementation of the regional catchment strategy. At the scale of individual farm managers, and ‘intrapreneurs’ in the region’s institutions attending the forum, there was a clear sense of both individual responsibility to self-educate, learn by doing and act entrepreneurially, and the need to coordinate and support each other. This also had to be underpinned by personal commitment to integrity in monitoring, reporting and verification. These directions reflect the strong preference for peer to peer and learn by doing capability building in the sector. Specific organizational activities highlighted include actively seeking opportunities to participate in trials appropriate to each locality, and share learning with the public directly, and via TAFE and other organisations.

There was also interest expressed in establishing a regional forum to share learning, exchange experience and document practices. On a whole of region basis, there seems to be an appetite for a collective conversation about goals, means and ends. There was a strong sense of wanting to build capabilities in monitoring, verification and reporting within the region, appropriate to local area visions, and facilitate more within region environmental market exchanges. This could be underpinned by investments in forums, training and accreditation and ambitious, as well as facilitating large scale landscape projects linking multiple properties.

INTRODUCTION

Biodiversity offsets and carbon farming are not new in the Goulburn Broken region, with examples going back decades, and guidance from the CMA since at least 2016 (GBCMA, 2016). However, recently there has been increasing 'off farm' demand from polluters, supply chains and governments for land managers to supply verified improvements in carbon, biodiversity and other environmental services. This coincides with a relative mainstreaming of sustainable and 'regenerative' agriculture as a standard of better practice farming (Baumber et al., 2021; Giller et al., 2021), and basis of the social license for agriculture to operate. Both trends have also attracted critical attention on greenwashing in general, and in particular, on the design, functioning and outcomes of market mechanisms intended to reward the production of environmental services such as carbon draw down and increased biodiversity. At present, participation in these markets by Australian landholders is limited and well below demand. As a result, many previously less involved landholders are hearing a lot from a range of interested, 'for-profit' sources, as well as industry and community groups engaging with this area about existing Environmental Markets like carbon, and new ones are emerging, such as a national biodiversity market (AONSW, 2022; Chan, 2023)

At face value, increased off farm investment to produce environmental services COULD accelerate adoption of sustainable land management practices, diversify income, improve farm productivity, and the health of the region's land, water and biodiversity AND in doing so, boost climate resilience. However, Environmental Markets are rapidly evolving, and have many traps for new players. They are not a panacea for climate resilience, and without due diligence, can have negative impacts on farmers and landscapes too. To realise the opportunity, and minimise risks, each region's producers, land managers and their supporters need to consider what these developments mean locally, and decide how they will navigate global shifts in how society values and monitors environmental services. The challenge is making sense of the overlapping costs and benefits, and the risks and opportunities they represent for a given farm, group of farms, and in the context of the region and broader society. The project this document reports aimed to support a regional conversation, across three main questions (Figure 1):

1. Under what conditions does participation in environmental markets build climate resilience?
2. What are the relevant risks and opportunities for land managers in the Goulburn Broken Catchment?
3. What management strategies and support could help to increase the chances of positive outcomes for the region's land managers?

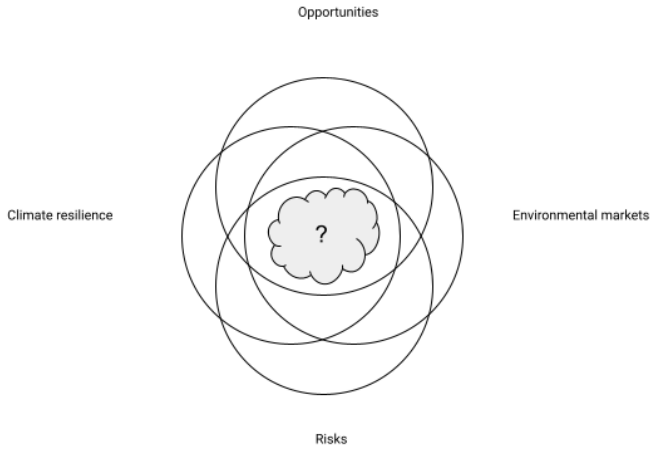


Figure 1: Making sense of the intersecting risks and opportunities of environmental markets for the resilience of GBCMA region.

METHOD

RESEARCH QUESTION AND APPROACH

This project address the following questions:

1.Under what conditions does participation in environmental markets build climate resilience?
2. What are the relevant risks and opportunities for land managers in the Goulburn Broken Catchment?
3. What management strategies and support could help to increase the chances of positive outcomes for the region's land managers?

To detail how we've gone about answering these questions, we firstly clarify key terms and frameworks used, and then introduce research methods – practice interviews, literature review and participatory forum, in the below section.

KEY CONCEPTS AND FRAMEWORKS

Climate resilience

The GBCMA describes Resilience as: *the capacity of a system (people and the environment) 'to absorb a shock or setback and to flourish in spite of it, maybe even because of it*[1] (Béné et al., 2018) . The concept has origins in the natural sciences and is commonly cited as "'the capacity of a system to absorb and utilize or even benefit from perturbations and changes that attain it, and so to persist without a qualitative change in the system's structure' (Holling 1973 cited in McEvoy et al., 2013). A system in this context might be an ecosystem. However, this framing as 'bouncing back' has been argued to be inadequate in the face of the need to change, learn and improve socio-ecological systems impacted by climate change (McEvoy et al., 2013) such as regions, communities, or a given farm. Resilience therefore has close ties to notions of improvement and growth, not just returning to the previous state.

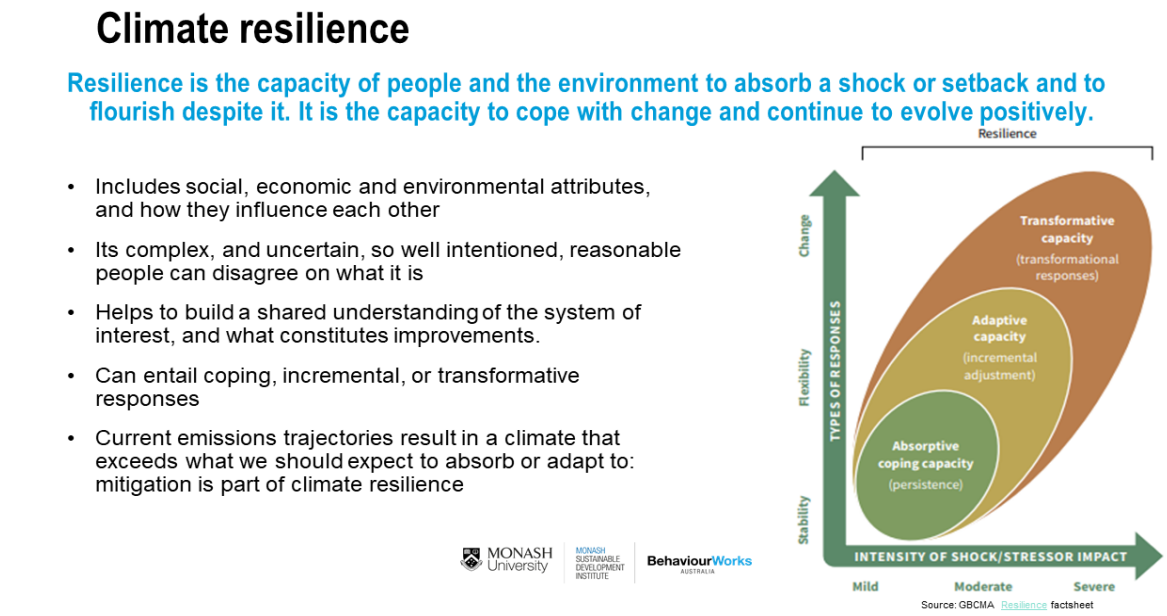


Figure 1: Defining climate resilience

[1] https://www.gbcma.vic.gov.au/downloads/Current_Issues/GBCMA_RCS_Resilience_Factsheet.pdf

Taken together, the notion of climate resilience is an integrated capacity. When used in relation to humans, it must ultimately be about protecting, enhancing and restoring what people value about a given system of interest, not 'simply' maintaining its constituent structure and relationships at a given time. Or as Moser (2021) puts it, people want three things, in order, from adaptation. Adaptation must:

1. *Improve lives, neighborhoods, environment, or economic situation i.e. make things better than they are right now. (if not…)*
2. *keep things at least as good as they are right now (especially if 1 is not possible). (if not…)*
3. *provide a feasible path forward, a dignified way out, an alternative they can feel okay about. (when 2. Is not possible either).*

Moser comments that these three 'wants' reflect people's hope for the future, human resistance to change, and attachment to place and livelihoods, but also that people can accept change providing they can see that there is a greater good, shared costs and benefits and improvements to common assets (2021). This applies as much to environmental market risks and opportunities (below) as other aspects of climate resilience.

Elements of principles 2 and 3 are evident in previous approaches to identifying climate adaptation priorities for the Goulburn Broken NRM region (2016), where an assessment of the vulnerability of the Catchment's natural resources to climate change and consideration of values (environmental, social and economic) was used to identify focus areas for adaptation (see figure below).

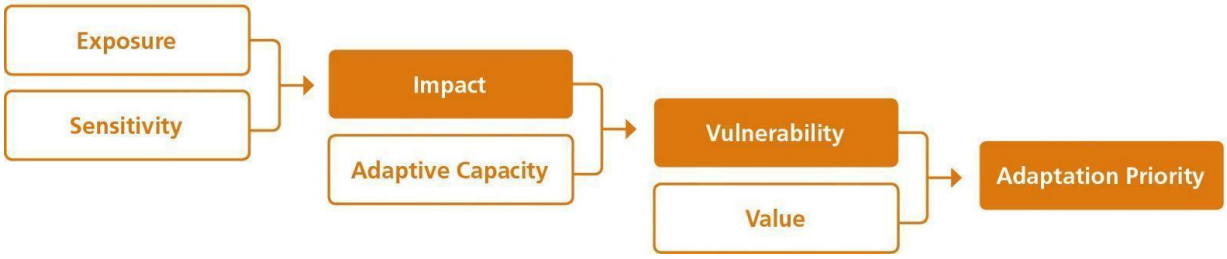


Figure 2: GB NRM region climate change adaptation prioritisation framework (2016)

For example, the criteria used for assessing adaptation priorities in 2016 emphasize economic and environmental dimension over social considerations, and is less about opportunities identifying and adapting to threats based on the level of risk posed (see **Error! Reference source not found.**).

Table 1: Criteria used for assessing adaptation priorities for NRM assets in the GBCMA region (2016)

Exposure	Sensitivity	Adaptive capacity	Value

- Change in maximum annual average temperature
- Change in average spring and autumn rainfall
- Surface water yields - change in mean annual flow
- Waterlogging and salinity – current shallow aquifer depth to water table
- Area currently inundated in a 1 in 100 flood
- Change in annual average minimum temperature
	- Native vegetation connectivity
	- Native vegetation condition
	- Index of stream condition
	- Native vegetation range under current conditions
	- Current land use
	- Land and soil health hazards
	- Proximity to wetlands
		- Tenure
		- Irrigation supply
		- Whole farm planning
		- NRM works
			- Biodiversity value
			- Stream reach and wetland value
			- Consequence of loss:
			  - Environmental
			  - Production
			  - Infrastructure
			- Micro-refugia
			- Land value
			- Floodplain value

Environmental markets

Environmental markets, arguably, add the dimension of improvement and opportunity to the discussion of climate resilience above. They also highlight that farm operations contribute to climate and other resilience risks and problems.

Environmental markets are, most simply, situations where there is a value exchange between actors, based on demonstrating improvements in environmental services (Figure 1). This can happen in many ways, but the focus in this report is on land management practices as the mechanism by why environmental services are improved in such exchanges.

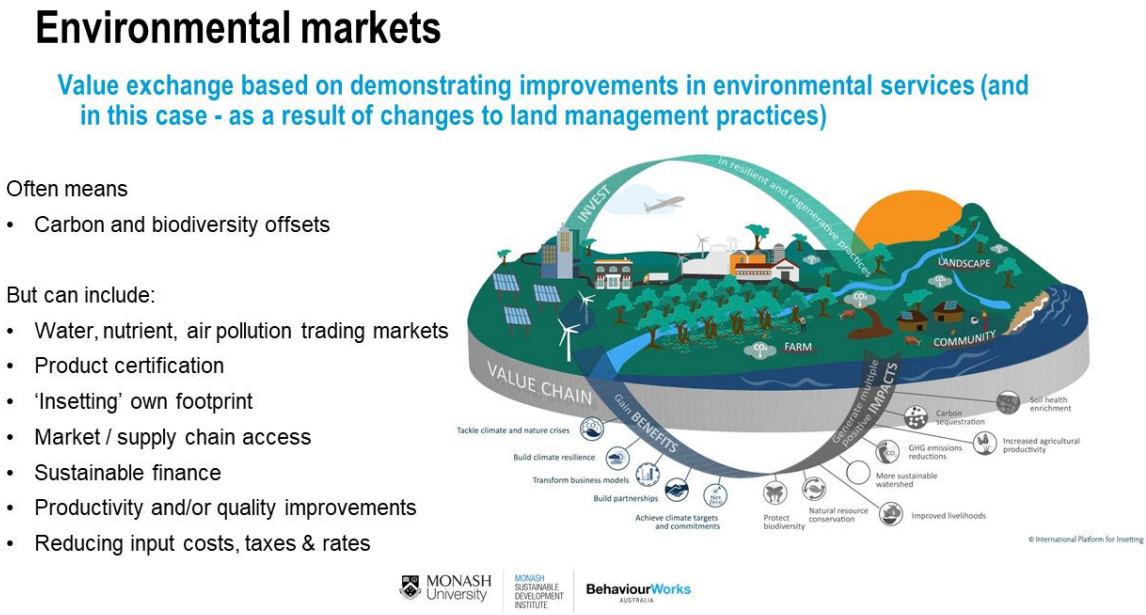


Figure 2: Defining environmental markets

Environmental services are produced by natural capital. As is advanced in Australia by the Environmental Markets Leadership Program[2] and globally by the Natural Capital Coalition (NCC, 2016) natural capital is the biophysical basis of all that sustains us: individuals, families, companies, and society. At the same time, our individual or collective actions can either build or degrade natural capital, depending on how we interact with it. This relationship between the impacts, dependencies and benefits enables market opportunities where individuals, families, companies and society are increasingly willing to economically value and financially reward building up natural capital and producing environmental services - i.e. environmental markets. However, a chain of value creation must take place for this to be realized .

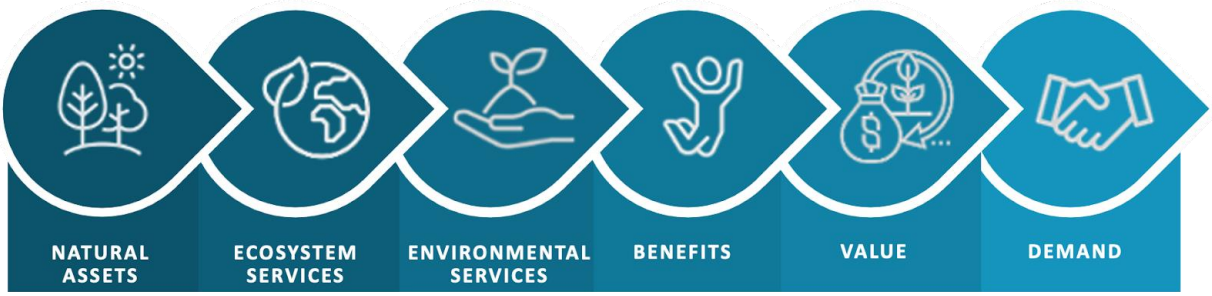


Figure 3: Natural capital value chain. Source EMLP 2022:

[2] https://www.emlp.com.au/ BWA collaborated with Ethical Fields, NSW Local Land Services and JBass Learning in the design, implementation and evaluation of this program.

Natural assets provide critical inputs such as land, raw materials, water and energy. Ecosystem services provide critical regulating services such as natural water filtration and waste decomposition. These dependencies will vary depending on the sector, operations and location:

- Primary sectors depend on and facilitate services such as food, water and fibre.
- Secondary sectors, such as manufacturing and processing, depend on these materials and services to produce quality goods, e.g. the beverage company that depends on sugar production and water filtration to make high-quality beverages.
- For tertiary sectors, the dependencies may be more indirect and arise from supply chain connections and customer relationships.

The graphic below provides some examples of how primary production land management and farming businesses interact with natural capital stocks.

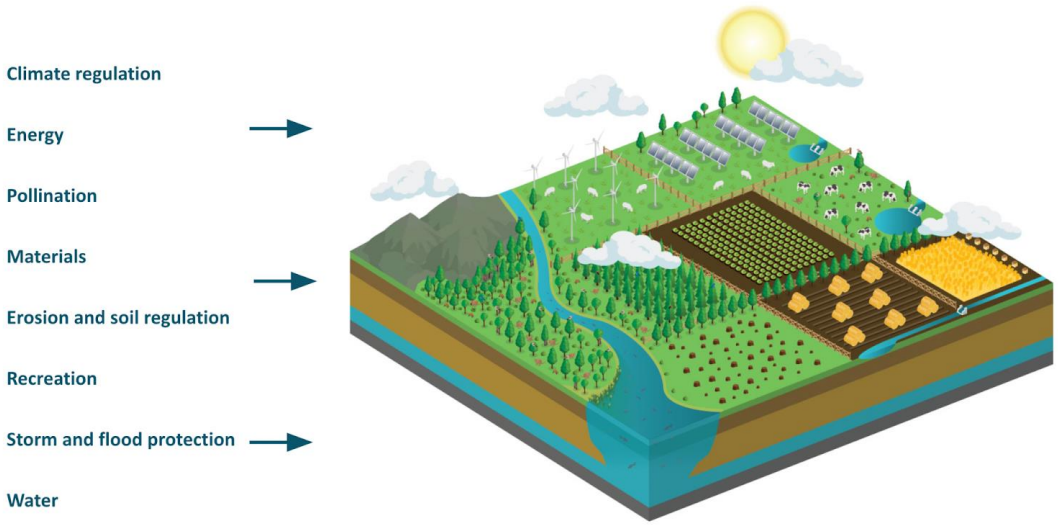


Figure 4: How farm business benefit from natural capital. Source EMLP 2022:Adapted from Natural Capital Protocol, Natural Capital Coalition (2016).

Similarly, farm business and landholders actions can impact upon natural capital. A natural capital impact is an effect that a business's activity has on natural capital. *These impacts can have either a negative or positive effect on natural capital e.g. a negative impact could be land degradation and a positive impact could be ecological recovery due to site rehabilitation*. Natural capital impacts can arise, directly or indirectly, at any point in a business's processes, and can vary depending on the activities and location of operations. (NCC, 2016). The graphic below provides some examples of how land management and farming businesses can impact natural capital.

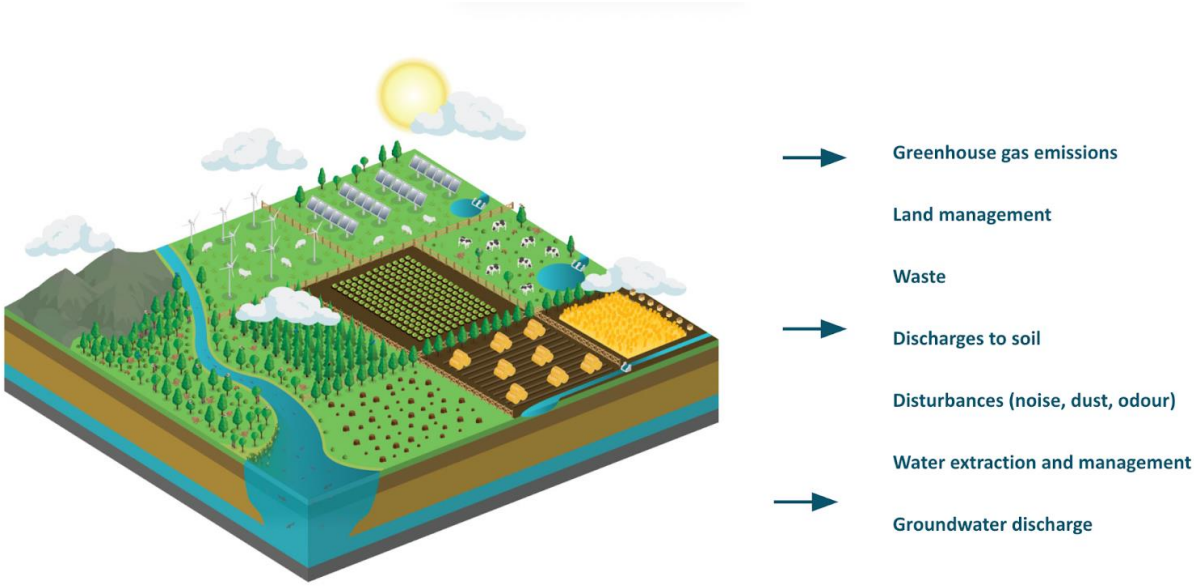


Figure 5: How farm business impact natural capital. Source EMLP 2022.

At present, Australian agriculture, like most around the world, is pushing or exceeding sustainable limits in multiple dimensions of natural capital. In other words, agricultural operations are drawing down on the bank of natural capital at a rate greater than they can recover. Of particular concern are biosphere integrity, land-system change, and biogeochemical flows, and the Australian agricultural sector is rapidly approaching the national-level climate change and freshwater use boundaries (Climateworks Centre, 2022). From this point of view, climate change is at once a pressing and immense challenge for farmers and landholders, and just one of the natural capital assets under threat.

Recent changes societal expectations of agriculture

We are in the midst of a major transition in societal expectations of agriculture: that farmers must monitor, report and improve ecosystem services, and that governments, supply chains, philanthropies, institutional investors and impacting businesses must finance it. In particular, a number of major changes in international agreements and Australian legislation have recently occurred. The Chubb Review of the Emissions Reduction Fund (2023)'s oversight of carbon credits, and the recent amendment of the Safeguard mechanism underline the Australian Government's strong commitment to agricultural carbon sequestration as an emissions reduction option for major polluters in pursuing Australia's commitment to the IPCCC's Paris Targets. The Australian Government has also signed the *2022 UN Global Biodiversity Framework* and established a national biodiversity conservation market mechanism via the *Nature Repair Market Bill 2023* along with a '30 by 30' target to see 30% of Australia's land (and sea) protected by 2030. Globally, the *Task Force on Nature-related Financial Disclosures* framework comes into force in 2024. The industry lead *Australian Agricultural Sustainability Framework* recognises on one hand, an existential threat to farmers' licence to operate, and a business opportunity on the other. Meanwhile, Australia's land use for extractive agriculture exceeds planetary boundaries in biodiversity and climate, amongst others (Climateworks Centre, 2022). It is noteworthy that between 70 and 90% of currently unprotected or poorly protected biodiversity occurs on private land (Ivanova and Cook, 2020), indicating a substantial opportunity for social, economic and environmental improvement.

Making this transition is dependent on farmers changing their behaviour. Few of those applying sticks (threats), carrots (incentives) and tambourines (social normative pressure) to farmers or businesses appear to be engaging with the substantial, though diverse and scattered, evidence base on how to

appropriately, efficiently and effectively encourage farmers to adopt conservation *behaviour change*. Similarly, the evidence on how to avoid *unintended consequences* and *perverse outcomes* are being ignored, for example, the unfair distribution of risks, costs and benefits; tradeoffs between outcomes, e.g. carbon versus biodiversity, depleting rural communities or pre-emptive land clearing or non-reporting of endangered species for fear of restrictive policies.

Amongst this noise, and despite decades of regulation, incentives, trading schemes, cost recovery measures and extension, most mainstream farmers are uninvolved and sceptical of existing schemes. This is despite increasing evidence that actions, such as revegetation, can have direct productivity benefits for farms, as well as providing wellbeing and health benefits for farmers (Giller et al., 2021).

Steering a sustainable pathway through this tangle requires synthesis, and then translation, of evidence and a strong grounding in real places and people, which is what this report aims to support.

Opportunities and risks for whom?

The notion of navigating both opportunities and risks are reflected in GB CMA guidance on carbon farming opportunities, which explores tradeoffs, especially between biodiversity, carbon and impacts on local economies and communities (see Appendix 1). This underlines that an inclusive view of risks and opportunities posed by influencing natural capital stocks and flows must incorporate such social and economic system dynamics.

Thinking through the interactions between society, the economy, business and natural capital, and how the impacts and/or dependencies of these interactions create costs and benefits for society, the economy, business and natural capital is challenging. At the level of a firm (or farm), costs and benefits generate risks and creates opportunities. A helpful framework for considering multiple dimensions of risks and opportunities is presented in the table below, sourced from the Natural Capital Coalition (2016), providing examples of these risks and opportunities for businesses.

Table 2: The natural capital framework (NCC 2016).

Category	Examples - natural capital risks	Examples - natural capital opportunities
Operational Regular business activities, expenditures, and processes	• Higher natural hazard costs e.g., more frequent or severe storm damage due to degraded coastal ecosystems and loss of their natural protection. • Higher security costs e.g., due to social conflict over resources or pollution. • Higher raw material or resource costs e.g. increased water charges. • Deteriorating supply chains due to increased scarcity, or more variable	• Reduced costs through investing in "green" infrastructure e.g., protection against natural hazards or improved water filtration through restoring wetlands. • Minimise or add value to waste and recapture valuable materials that would be discarded otherwise. • Reduced costs for resource inputs e.g., through efficiency gains or switching suppliers. • Ensure the timely and reliable supply of raw materials.

	production, of key natural inputs.	
Legal and regulatory Laws and regulations that affect business performance.	• Higher compliance costs e.g., due to reduce emissions. • Higher capital costs, or production losses, due to permit denials or delays. • Higher fines, penalties, compensation, or legal costs e.g., due to liability for natural capital impacts. • New regulations or license fees e.g., charges for extracting groundwater or for waste disposal.	• Lower compliance costs by using resources more efficiently and reducing waste. • Expedited processes for permits and approval of operations. • Lower fines, penalties, compensation, or legal costs e.g. by anticipating and avoiding negative impacts. • Lower environmental fees and charges. • Inform and influence government policy.
Financing The costs of, and access to, capital, including debt and equity.	• Increased financing costs e.g. Higher interest rates or stricter conditions. • Asset stranding, where assets have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities (public and private equity), and non-performing loans.	• Gain or maintain investor interest and confidence. • Improve access to finance • Reduce financing costs • Improve availability of sustainable (green) funds.
Reputational and marketing Company trust and relationships with direct business stakeholders, such as customers, suppliers, and employees.	• Changing customer values or preferences may lead to reduced market share. • Increased staff turnover, higher recruitment and retention costs. • Reduced loyalty of key suppliers or business service providers.	• Emerging environmental markets may offer new revenue streams e.g., carbon offsets, sale of surplus water rights, habitat credits. • Increasing demand for credibly certified products e.g., eco-labelled wood, seafood, apparel. • Differentiate your products to increase pricing power

		• Improve employee attraction and retention.
Societal Relationships with the wider society e.g., local communities, NGOs, government agencies, and other stakeholders.	• Business activities may reduce the availability of, and local communities' access to, natural capital or related ecosystem services. • People may experience increased health risks as an indirect result of business impacts on natural capital. through the effect of air pollution on respiratory diseases.	• Local communities may benefit from how the business manages natural capital, for example, through improved recreational access to a managed wetland or improved water quality from a managed water catchment.

Behaviours involved in engaging with environmental markets

Thinking through the specific actions a GB region land manager might take that generate costs and benefits relevant to the above frameworks, we can identify 4 main categories of actions.

1. **Environmental market readiness**: such as: initial opportunity identification. More detailed on-site assessments, measurement and business planning to produce environmental goods and services, accessing support and advice
2. **Market entry**: i.e. registering for existing markets, joining associations, approaching funders and commencing negotiations.
3. **Produce environmental goods and services i.e. adopt new or continue with existing practices** – typically via one or more of three types (FAO, 2007, p. 12): **changed production**; where lands remain in agriculture but production activities are modified to achieve environmental objectives (e.g. reduced tillage or leaving more crop residues on fields); **land diversion** e.g. from crop and livestock production to other uses; and, **land maintenance**, avoiding a change in land use (e.g. retaining native vegetation instead of conversion to agriculture).
4. **Market shaping** Given the dynamic nature of environmental markets, **exploring and piloting new and innovative market mechanisms and exchanges,** appropriate for their land, business and region, for example outside of government schemes and in 1:1 arrangements, and also **participating** in shaping the future, e.g. via policy review, development and co-design and co-production of new and emerging markets.

The combination of costs, benefits, risks and opportunities to adopting these behaviours can be thought of as 'barriers and facilitators'. A useful framework for systematically detailing these drivers and barriers is found in the Capability, Opportunity and Motivation = Behaviour model (see Figure 2). Breakdowns of the drivers and barriers land managers experience in engaging with environmental markets can be seen in related research by BWA with the EMLP program[3]. While not the same, many barriers can be represented as risks, and facilitators as opportunities.

[3] https://www.emlp.com.au/resources

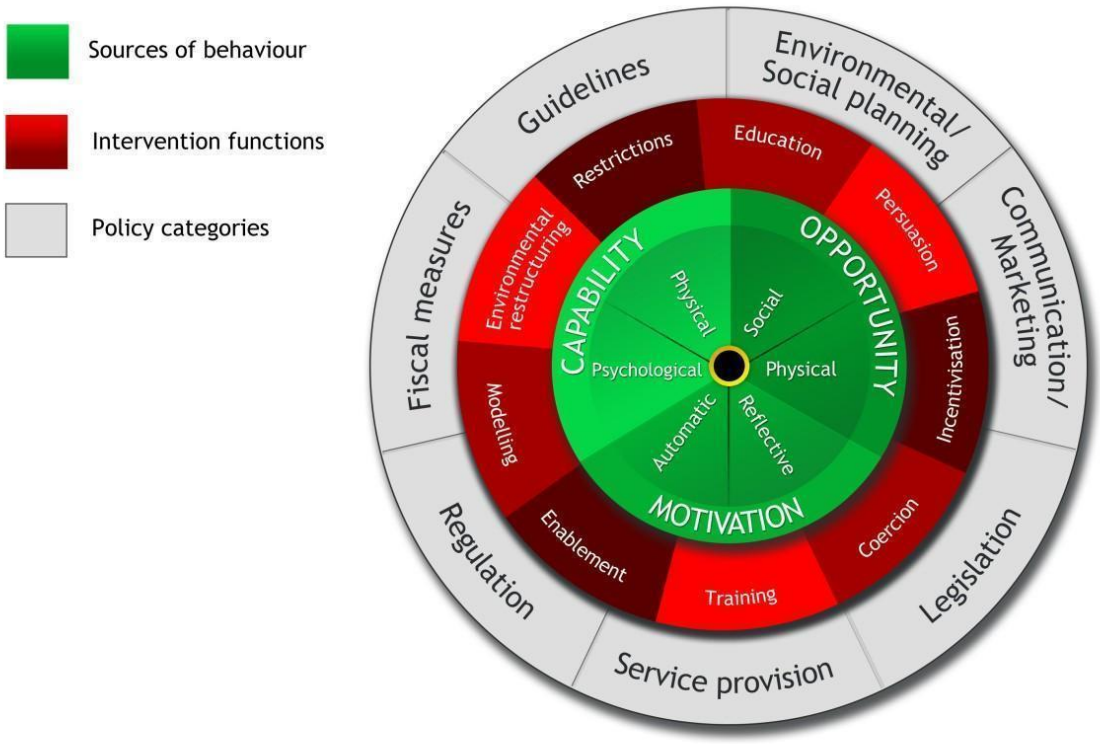
Figure 2: The behavior change wheel and "Capability, Opportunity and Motivation = Behaviour" model (Michie et al., 2014, 2011)

The Behaviour Change Wheel (BCW) was developed from 19 frameworks of behaviour change identified in a systematic literature review. It consists of three layers.

The hub identifies the sources of the behaviour that could prove fruitful targets for intervention. It uses the COM-B ('capability', 'opportunity', 'motivation' and 'behaviour') model. This model recognises that behaviour is part of an interacting system involving all these components. Interventions need to change one or more of them in such a way as to put the system into a new configuration and minimise the risk of it reverting.

Surrounding the hub is a layer of nine intervention functions to choose from based on the particular COM-B analysis one has undertaken.

The outer layer, the rim of the wheel, identifies seven policy categories that can support the delivery of these intervention functions.



We use this framework to consider factors affecting participation in environmental markets for individual farmers and contextualise them in the previous frameworks to consider the implications for successfully navigating the risks and opportunities presented to land managers in the Goulburn Broken Region.

LITERATURE AND PRACTICE REVIEW METHODS

OVERVIEW

This project employs a four-stage research process, with semi-structured interviews and evidence reviews playing a crucial role in answering the research questions. After consulting with the Goulburn Broken Catchment Authority team, the research team recruited participants for semi-structured interviews. These interviews aimed to explore key stakeholders with knowledge and experience in encouraging land managers to participate in environmental markets. Based on the consultation, the research team developed interview guidelines covering various topics, including understanding environmental markets and climate resilience, risks and opportunities, impacts on climate outcomes, and recommendations for management strategies (see Appendix 2).

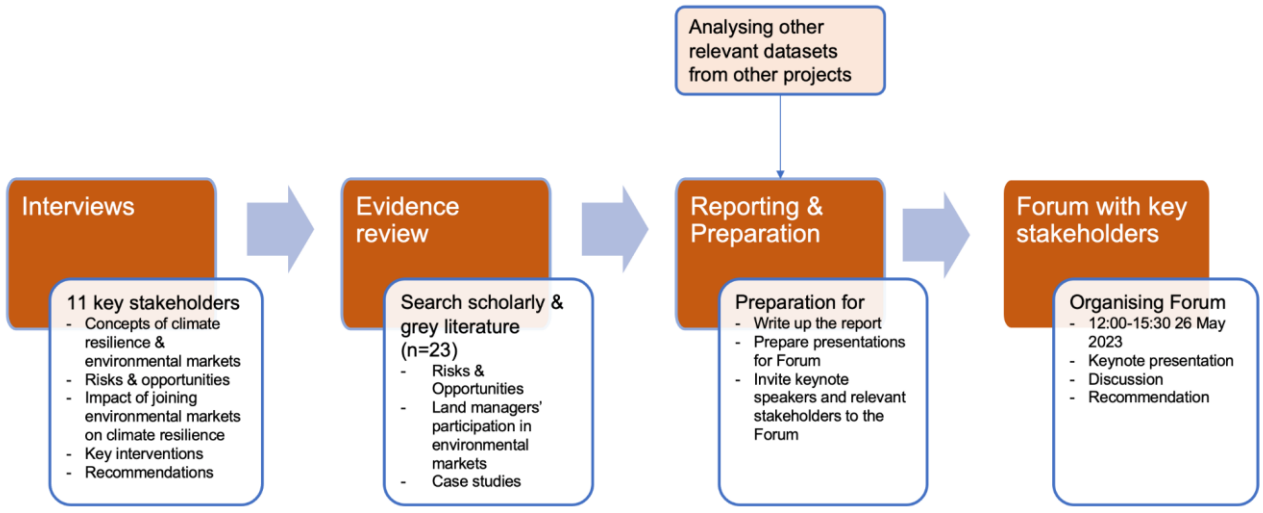


Figure 3: Overview of the research process

Interviews informed the evidence review process, which involved searching scholarly and grey literature databases. In addition to interviews and evidence reviews, the research team analyzed data from relevant projects, such as the Climate Adaptation Mission. Following this, the team focused on report writing and preparing for the Forum, an event for stakeholder consultation.

INTERVIEW METHOD

From November 2022 to February 2023, the research team conducted interviews with 11 different stakeholders via Zoom. They used Zoom's transcription function for transcribing interview recordings, which were then imported into Microsoft Word for data analysis. The research team employed an adapted version of the Template Analysis approach proposed by King et al. (2018) for data analysis from February to March 2023. The qualitative data analysis process involved familiarization with the data, preliminary coding, clustering, developing initial templates, modifying templates, defining the final template, interpreting data, and writing up the findings.

- Familiarization with the data: In this step, researchers listen, re-listen, read, and re-read the interview recordings and transcripts to become familiar with the data.
- Preliminary coding: Researchers use Excel to begin coding with some a priori themes based on the COM-B model (capacity, motivation, opportunity) or the risks and opportunities approach by Natural Capital Coalition (2016). They perform preliminary coding with six interview transcripts.

- Clustering: Researchers import codes from Excel into Miro Board, where they organize emerging themes into meaningful clusters based on the COM-B model (capacity, motivation, opportunity). Using hierarchical coding, they arrange themes and sub-themes, and draw links between them.
- Developing initial templates: Researchers create a template (or codebook) based on the list of themes, sub-themes, and codes, and use it to code the remaining interview transcripts.
- Modifying the template: As researchers code the remaining transcripts, they refine the template to accommodate new findings.
- Defining the final template: Researchers establish the final template, which includes a list of themes and sub-themes, incorporating the COM-B model (capacity, motivation, opportunity) and the risks and opportunities approach by Natural Capital Coalition (2016).
- Using the template to interpret data: Researchers analyze data using the template, selecting relevant quotations for illustration. For example, they present risks and opportunities associated with environmental markets at three levels: business, family and society, and nature.
- Writing up: In this final step, researchers write up their findings and present the data in comparison with evidence review results.

SCOPING REVIEW METHOD

The findings from the interviews informed the evidence review stage, which was conducted from March to April 2023 by two researchers. They searched databases such as Scopus, Proquest, Google Scholar, and Google, and used expert recommendations to identify 196 records. After screening titles and abstracts, they included 63 records for full-text screening and eventually selected 23 studies for data extraction.

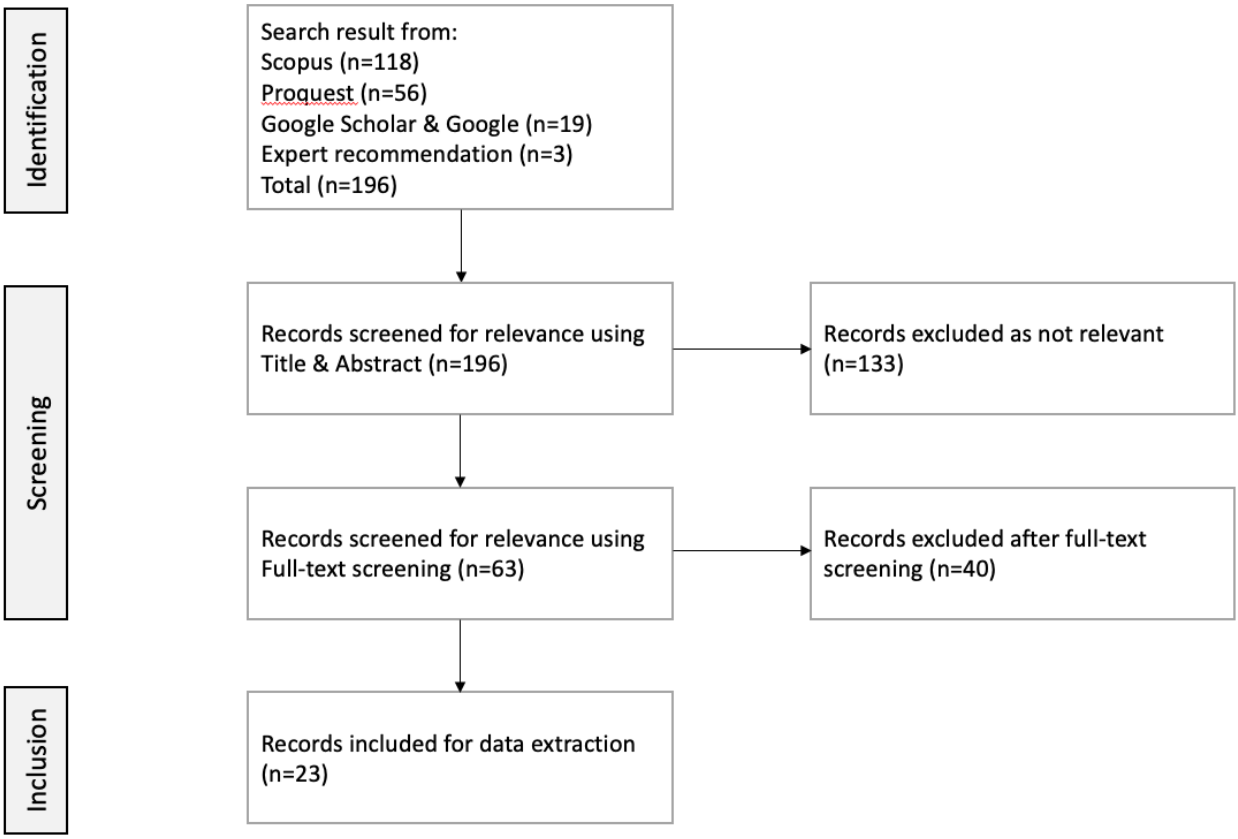


Figure 4: Literature review process map.

Screening took into account the understandings of environmental markets and climate resilience reported by interviewees below. Similarly, we extracted highlights based on what matched, and what was different, in terms of dimensions of cost, benefit, risk and opportunity against the NCF (see Appendix 3) .

RESULTS

BACKGROUND OF INTERVIEWEES

Table 3 below shows the profile of interviewees. While the interviewing sample included some farmers, most of the interviewees can be classified as intermediary actors who work between farmers and higher levels of markets (e.g., buyer) and government (e.g., decision makers, laws).

Table 3: Overview of interviewees

Number	Organisations	Gender	Position/role
1	Goulburn Murray Landcare Network	M	Facilitator & Farmer
2	Murrindindi SC	F	Coordinator & Officer
3	AgBiz Assist	M	Farmer & Rural Financial counsellor
4	Gecko CLaN	M	Facilitator
5	Regen Farmers Mutual	M	Owner Firetail Environments, Landscape Agronomist/farmer
6	Hamilton Environmental Services	M	Consultant, Hamilton Environmental Services
7	Cassinia	M	Founder/Board member
8	Goulburn Broken Catchment Authority	F	Project Coordinator
9	Euroa Arboretum	F	Project Manager
10	MLA CN30 Manager	F	Manager
11	Farmer	M	Farmer

For each of the below headings, we present interview findings first, and then relevant literature review findings

INTERVIEWEES' UNDERSTANDING OF KEY CONCEPTS

The concept of Climate resilience

Our analysis revealed four themes concerning the understanding of 'climate resilience': landscape and biodiversity resilience, farm resilience, farm-landscape resilience, and resilience of community or industry (see Appendix 4 for a summary of these themes). In this section, we will analyze the different perspectives of interviewees and compare their understanding of climate resilience.

Landscape and Biodiversity Resilience

Some interviewees regard climate resilience as landscape resilience in terms of protecting and enhancing biodiversity and the environment. One interviewee stated, "*Biodiversity and climate change should be intrinsically linked, but they are not. Climate change and resilience are reflected in the biodiversity."* Another interviewee emphasized maximizing biodiversity in the landscape to better buffer climate resilience. This

perspective shows a strong emphasis on preserving the natural environment and its species as a way to cope with climate change. In contrast, other interviewees focus more on farm-level resilience.

Farm climate resilience

At the farm level, climate resilience is about effectively managing farms to cope with variable seasons and extreme weather events. One interviewee explained, *"it's all about how you manage your farm to cope with different and variable seasons."* Climate resilience involves both adaptation and mitigation, as landholders and land managers are aware of the impacts of heat and variability on their operations. This perspective differs from the landscape and biodiversity resilience view, as it centers on individual farms and their practices to adapt to climate change.

Farm-Landscape Resilience

Some interviewees show a comprehensive perspective by seeing that it's hard to separate farm resilience and landscape resilience when it comes to the concept of climate resilience. They highlighted the importance of building robust landscapes and farming practices that can withstand extreme weather events. One interviewee mentioned the importance of connecting farm and landscapes in a local area to prepare for climate change effectively. This perspective bridges the gap between the two previous views, recognizing the interconnectedness between farm and landscape in addressing climate change.

Community and Industry Resilience

At the community and industry level, climate resilience is about effectively responding to changing conditions brought about by climate change. While one interviewee emphasized the importance of understanding local conditions and planning accordingly, another interviewee focused on preparing livestock production systems for future climate changes. These different perspectives highlight the various ways in which communities and industries can approach climate resilience.

In conclusion, the understanding of 'climate resilience' varies across different levels, including landscape and biodiversity, farm, farm-landscape, and community or industry. These are useful lens to consider the costs and benefits, risks and opportunities highlighted by the conceptual frameworks suggested earlier.

Recognizing the diverse perspectives on climate resilience can help in developing effective strategies to address the challenges of climate change and enhance resilience in the agricultural sector. By comparing and contrasting these perspectives, it is evident that there is no one-size-fits-all approach to climate resilience, and a comprehensive understanding must encompass the interplay between these different aspects.

The concept of 'Environmental Markets'

Our analysis of the interview data reveals that interviewees' understanding of environmental markets tends to focus on two main types: biodiversity offset programs (BCT) and carbon markets (see Appendix 5 for a summary of these themes). However, some interviewees were able to consider environmental markets more broadly, encompassing not only carbon and biodiversity markets but also other emerging environmental markets. In this section, we will analyze the different perspectives on environmental markets and compare the understanding of these concepts among interviewees.

Biodiversity Offset Programs (BCT)

Some interviewees associate environmental markets with biodiversity offset programs, such as the Biodiversity Offset Programs (BCT). For example, one interviewee explained that "*Environmental markets refer to compensations provided for the environmental benefits that landholders contribute, including roles in native vegetation, water health, and riparian areas*". This perspective highlights the role of environmental markets in incentivizing landholders to contribute to biodiversity conservation.

Carbon Markets

Carbon markets are another key component of environmental markets, as identified by interviewees. For instance, one interviewee mentioned that "*Environmental markets are opportunities for farmers to participate in activities that help store carbon in the soil, such as soil carbon storage and tree planting*." However, some

interviewees expressed concerns about the lack of understanding and advancement of carbon markets, which may limit their potential to contribute to climate resilience outcomes. As one interviewee noted, "*Environmental markets have benefits for funding private activities and income diversification, but the market is not advanced enough, and there is a lack of understanding, particularly in land management."*

Broader Perspective on Environmental Markets

Some interviewees were able to consider environmental markets in broader terms, encompassing both biodiversity and carbon markets. One interviewee stated that "*Environmental markets are a way for land enterprises to care for the environment while also receiving payment for doing so. These markets, such as the carbon market and biodiversity market, result in economic benefits and tangible on-ground impacts*." This perspective recognizes the diverse range of markets that can contribute to environmental conservation and climate resilience.

Comparing and contrasting these perspectives, it is evident that there is a divergence in understanding the concept of environmental markets. While some interviewees focus on specific types of markets like biodiversity offset programs or carbon markets, others adopt a more comprehensive perspective that encompasses various environmental markets, including emerging ones like regenerative agriculture and biodiversity certification schemes. This comprehensive view acknowledges the potential synergies between different environmental markets and their role in addressing environmental challenges and promoting sustainable land management practices.

In conclusion, it appears that interviewees have a representative grasp of the subject. They recognize the importance of biodiversity offset programs and carbon markets and demonstrate an understanding of the broader context that includes both biodiversity and carbon markets. This indicates that the interviewees are aware of the complexity and various components of environmental markets, which is essential for informed decision-making and participation in such initiatives. Also, it is of importance to recognise the diverse perspectives on environmental markets that can help in designing effective policy instruments and market-based approaches to address environmental challenges and promote sustainable land management practices. By comparing and contrasting these perspectives, we can appreciate the complexity and potential of environmental markets in driving positive environmental outcomes. Importantly, this more complicated view, where farmers weigh up a carbon or biodiversity transaction as just one of a range of environmental market options, helps explain the diverse risks and opportunities which are being considered.

RISKS AND OPPORTUNITIES

This section aims to analyze the risks and opportunities associated with environmental markets at different levels: farm business, community, governance and market, and landscape/ nature. We will be using quotations from various interviewees as the basis for our analysis and then extend with findings from the literature. We will compare and contrast the perspectives amongst the interviewees, and in contrast with the literature, to present a comprehensive understanding of the challenges and benefits of participating in environmental markets.

1.1 Risks at the farm business level

1.1.1 Operational Risks

Operational risks are among the main concerns of interviewees when considering the challenges of joining environmental markets. Key points related to operational risks include running costs, contracts and commitment affecting farmers' flexibility.

Interviewees note the cost of participation in the environmental markets. For them, the cost of running a carbon farming business can be costly: *"Implementing environmental actions can be costly, which is also a significant barrier for farmers."* Some raise concerns over the increasing workload if they comply with the requirement of a new farming practice: "*Further to that would be data collection requirements. And I think again, that's about the workload involved, understanding what the income from that is going to be additional to the business that you're already running, and then trying to slot it into what is...often a pretty full workload".* This is opposite to the financial motivation of farmers: *"A lot of farmers I've met don't care much about the*

environment, they are mostly motivated by money." These two perspectives underscore the financial challenges and drivers for farmers considering environmental markets.

While some interviewees are primarily concerned with the impact of environmental markets on flexibility, stating, "*Flexibility is a key factor. Land managers have a lot of factors to manage, and if participating in environmental markets decreases their flexibility, it becomes a big barrier*," others, like Damien, are more focused on the long-term commitment required, "*For example, in the case of carbon markets, the carbon credits last only as long as you implement the new practice. If you don't maintain the new practice, the credits will be lost and the carbon will return to its previous state."*

Our analysis of the literature validates the interviewee's concern about the cost of running a business in accordance with the rules of the new market. Our interviewees' concerns appear to be consistent with those of farmers polled a decade ago, who feared that the expenses of planting and managing trees, such as fencing, would prevent them from participating in carbon markets (Bull & Schirmer, 2012). According to a recent study that compared Australia and Canada, despite the potential benefits of optimising carbon storage practises in agriculture, many land managers do not use these practises because they incur "real, increased costs for implementing better C sequestering practises, in terms of higher input costs (e.g., seed and operations costs for sowing cover crops) and/or increased risk of declines in productivity" (Paustian et al. 2019: 568). A survey of farmers in Australia found that farmers prioritised other issues such as protecting agricultural markets from biosecurity risks (81 percent of landholders considered this a priority), weed management (85 percent), soil conservation and sustainable land use practises (81 percent), and feral animal control (79 percent) over carbon neutrality or reducing emissions (48 percent) (Ipsos, 2021). Similarly, a case study in western New South Wales' rangelands reported the risk of conflicting with their current farming management due to long-term liability for carbon maintenance, including uncertainty over the impacts of carbon farming on resource condition; the possibility that climate change will reduce sequestration rates; and an increase in absentee landholders, reducing capacity to manage pest animals, weeds, and fire (Cowie et al., 2019).

1.1.2 Legal and Regulatory Risks

Interviewees express significant concerns regarding the legal and regulatory risks associated with the complex system of new environmental markets. The risks include being uncertain about the requirements of regular auditing, concerns about low prices, and the lack of networks of trustworthy agencies, are the main issues raised.

One interviewee emphasizes the need for a more simplified system, *"It needs to be a much more simple system to actually understand. For the general lay person."* In contrast, another interviewee discusses the difficulties in measuring services, "*The biggest challenge with soil carbon is that it is difficult to measure, verify, and report*." In addition, interviewees were also concerned about the costs for auditing and measurements. These perspectives highlight different aspects of the legal and regulatory challenges that farmers face in environmental markets.

In the literature, we see several studies of landholders in Australia that demonstrate that low awareness of the ERF system and a lack of understanding of this scheme due to its complexity may be connected with the perceived risks of participating in the carbon market (Cowie et al., 2019; Baumber, 2022). When it comes to adopting a new method, perceived dangers should be seen as a defensive mechanism that farmers have from their current understanding (Ranjan et al., 2019). Evidence reviews confirm the uncertainties in monitoring and assessing carbon storage levels. For example, experience from the European market indicates that the establishment of a carbon market is fraught with the possibility of high and unpredictable monitoring, reporting, and verification (MRV) costs. The reasons were that precise MRV is critical to ensuring that carbon farming delivers actual mitigation, yet it is costly and hence perceived as a major obstacle for funders and farmers (McDonald et al. 2021, 7-8). Although there is evidence that agroforestry can increase soil organic carbon, quantifying soil carbon storage is difficult from a scientific standpoint (Kay et al. 2019: 590).

1.1.3 Financial Risks

Financial risks, including upfront costs, uncertain ROI, and potential economic crises, are also a significant concern for the interviewees. Interviewees stress the importance of financial return as a motivator for farmers. One said: "*Farmers are unsure whether investing in new technologies or practices will provide them with a return on investment. This uncertainty is a major factor that affects their participation in environmental markets."*

Joining the carbon market would increase upfront cost with uncertain ROI and risk decreasing properties' value in future (Cowie et al., 2019, Cross et al., 2019; Kaufman & Meis-Harris 2022). For instance, a survey of farms in western NSW verified farmers' worry regarding large upfront expenses required for launching a carbon farming project (Cross et al., 2019). But, more crucially, they believed that participating in carbon farming would jeopardise their finance since, over the long term (i.e., the 25-year contract obligation), carbon farming would reduce the value of their properties:

> "Having an enterprise that generates income for a ten-year period but has a permanence of 100 years was viewed as a potential negative resulting from the adoption of carbon farming…Participants reasoned that once the crediting period is almost over or finished, properties with carbon farming projects will be less attractive to buyers due to having a portion of the land that comes with restrictions and generates little to no income." (Cross et al., 2019).

According to Sovacool, Baum, and Low (2022), based on an expert survey, the expected costs of carbon removal of natural- and land-based solutions such as soil carbon sequestration, ecosystem restoration, afforestation and reforestation, blue carbon and seagrass, and biochar are the lowest among carbon removal options including enhanced weathering, carbon capture and storage, ocean alkalinization or fertilisation, bioenergy with carbon capture, and biochar. According to the study, the median maximum cost of these natural and land-based solutions is less than $100, the median lowest cost is less than $20, and the majority are at or near $0. In comparison, direct air capture has median anticipated expenses ranging from $100 to $500. According to the IPCC (2018), soil carbon sequestration has the capacity to remove 2.3 to 5 gigatonnes of carbon dioxide from the atmosphere per year. The cost of soil carbon sequestration varies depending on the agricultural practices used, but it is estimated to be between $0 and $100 every tonne of CO2 extracted. This could be less expensive than BECCS ($100-200), increased weathering ($50-200), and charcoal ($30-120).

1.1.4 Reputational and Marketing Risks

Reputational and marketing risks, such as the lack of market credibility and the immaturity of the Australian market compared to European markets, are also identified by the interviewees. Interviewees discuss these risks, albeit from different angles.

One interviewee compares the Australian market to its European counterpart, "*Our market is not mature enough compared to the European market and the government's uncertain attitude towards the market has not allowed it to mature*." On the other hand, another interviewee addresses credibility concerns, "*the carbon market hasn't necessarily had that credibility.*" These perspectives highlight the reputational and marketing challenges that environmental markets face in Australia.

1.2 Opportunities at the farm business level

1.2.1 Legal & Regulatory Opportunities

Interviewees identify opportunities in the legal and regulatory aspects of environmental markets, particularly the presence of trustworthy advisers for navigating them. The following quote highlights the importance of trustworthiness in advisers, *"I've worked really hard at getting a good reputation for giving really clear advice and being trustworthy. And that's why I've got landholders that keep coming back."* The presence of such trustworthy advisers can encourage farmers and landholders to participate in environmental markets, which creates an opportunity for growth in this sector.

The need to resolve legal and regulatory barriers that could limit the deployment of carbon dioxide removal technology, as well as a lack of market demand, are also expressed in an expert report (Sovacool et al. 2022).

1.2.2 Financing Opportunities

Interviewees mention financing opportunities related to environmental markets, such as the potential to diversify income streams and the ability to sell certified products at a premium price. These opportunities can help farmers overcome financial barriers and motivate them to participate in environmental markets, resulting in mutual benefits for both farmers and the environment.

Landholder studies have revealed similar perceived financing opportunities for carbon farming. Cross et al. (2019) investigate landholders' opinions on the benefits of carbon farming, focusing on its role in income diversification and enhancement. According to the study, the primary motive for landholders to participate in carbon farming is the financial incentive it provides. The chance to diversify revenue streams and boost overall earnings adds to this financial drive. Furthermore, carbon farming is viewed as a technique of increasing company resilience, diversifying the enterprise, and mitigating risk. Carbon farming provides stability through constant revenue flow, which is a big motivator for people who already have a carbon farming operation. Cowie et al. (2019) add to these findings by confirming the financial benefits of carbon farming. According to the study, carbon farming increases and diversifies agricultural income, resulting in increased financial security. This increased security has the ability to improve mental health and provide chances for better land resource management. Compared to other groups, landholders involved in carbon farming projects and carbon service providers see significant gains from carbon farming.

1.2.3 Reputational & Marketing Opportunities

Some interviewees discuss the potential for reputational and marketing opportunities within environmental markets. By differentiating their products and increasing pricing power, farmers can leverage their participation in environmental markets to enhance their brand image and attract environmentally conscious consumers. A farmer remarks: "*I'm thinking in the future it'll be more lucrative. Instead of selling those carbon credits, we'll get a premium for our product by being carbon neutral, come positive, even, which is pretty exciting. I think that's what we'll sell food and clothing*". This, in turn, can lead to increased profitability and further incentivize farmers to adopt environmentally friendly practices.

In conclusion, this section shows that our interviewees' main concerns revolve around operational, legal, regulatory, financing, and reputational risks. This aligns with a lack of trust in carbon markets and the ERF programme identified in previous studies (Bull & Schirmer, 2012; Cross et al. 2019). However, there are also significant opportunities in legal and regulatory aspects, financing, and marketing that can help farmers overcome these challenges and benefit from participating in environmental markets.

2 Risks and Opportunities at a Community and intergenerational level

2.1 Risks at the level of Community and intergenerational

One key concern regarding the family and society level is the difficulty in making decisions for future generations. One interviewee states, *"They don't want to feel like they are making decisions for the future generations that will tie up the 'carbon crop' for decades.*" This highlights the challenge for farmers in predicting the long-term consequences of their choices. Another risk is the loss of privacy, as some farmers are uncomfortable allowing outsiders onto their property, which is a requirement of auditing and measuring carbon levels. This resistance can hinder their ability to participate in environmental markets.

Evidence reviews discuss risks at a societal level. The adoption of effective geoengineering technologies might face social backlash due to fears of unknown consequences or potential misuse. Based on expert interviews, Sovacool et al. (2022) conclude that 'the more they are used, at least at the outset, the more people could take note and become frightened of them and begin to resist them.'

2.2 Opportunities at the level of Community and intergenerational

An opportunity at the family and society level is the potential to improve community resilience by increasing farm resilience, which can help buffer climate extremes. One interviewee notes the importance of having a significant number of farmers storing carbon and taking it out of the atmosphere. This can lead to positive outcomes such as reduced atmospheric carbon, as long as farmers perceive the benefits and are comfortable with the audit process. In addition, one farmer expresses enthusiasm for the carbon market projects and notes that events like field days and online education and awareness platforms are opportunities for land managers to join this market since these activities can help raise awareness and interest among farmers. Courses and webinars are available to help farmers learn about ecological

agriculture and take care of the planet, and those who are already part of these groups have chosen to be curious about it. Webinars and online courses are becoming increasingly popular for climate resilience, as people can do it in their own time. Organisers usually do not charge, making them accessible to everyone. Social media platforms are useful for connecting with groups, and field days on farms can influence participation.

It was also claimed in the literature that having the flexibility to reinvest money locally and hire labour on the farm were economic benefits (Cross et al. 2019).

3 Risks and Opportunities at a Landscape level

3.1. Risks at a Nature and Landscape Level

One risk at the nature and landscape level is the potential negative impact on biodiversity and landscape due to inappropriate planting or other activities. One shares concerns about improper planting that can be detrimental to the landscape. There's also a risk of perceived negative outcomes, as some farmers may not participate in environmental markets if they believe their actions will have adverse effects. Another points out that it is not necessary to participate in environmental markets to achieve resilience, as there may be trade-offs involved.

Evidence reviews confirm these risks. First, scientific studies have not been able to confirm certainly the casual relationship between offsetting and overall positivity toward sustainability and emission reductions (Compensate, 2021). For instance, inconsistent results for temperate agroforestry on generating soil carbon storage were reported in Feliciano et al. (2018), who confirmed that different climatic conditions and the previous land management had a higher impact on soil carbon storage than the established agroforestry system. In recently evaluating 100 nature-based, mostly forest conservation and afforestation/reforestration, projects using its own evaluation criteria, Compensate (2021) found that only 9% of these projects successfully passed its evaluation and argued that there is a need to raise the bar in order to achieve actual climate impact. This connects back to the issues of accuracies of and difficulties in measuring and verifying carbon units achieved by a project discussed above.

Second, similar to interviewees' opinion on the true benefit of carbon farming, studies have discussed the argument that offsetting creates 'perverse incentives' where when organizations or individuals have the option to offset their emissions, they may prioritize using offsets to meet their reduction targets rather than taking proactive steps to reduce emissions at the source. This can result in a situation where the offsetting mechanism becomes a substitute for genuine emission reduction efforts (Compensate, 2021).

Third, in terms of the impact on biodiversity, respondents in a survey of various stakeholders including landowners, government officials, financial advisors, carbon service providers, and researchers (Cowie et al. 2019) agreed that carbon farming would increase invasive native species and have negative environmental consequences in terms of biodiversity, erosion, and feral animal numbers.

When evaluating land-based carbon removal options such as bioenergy with carbon capture and storage (BECCS), afforestation and reforestation, enhanced weathering, biochar, and soil carbon sequestration, the IPCC (2018: 270) finds that there is a risk of soil sink saturation when implementing soil carbon sequestration with poor land management practices. This means that soil sinks, or patches of soil with a high ability to store carbon, might become saturated and no longer store any more carbon. If inappropriate management practices, such as deforestation or overgrazing, are resumed, soil sinks can reverse and release the carbon they have retained. This may result in a rise in atmospheric CO2 levels, which may contribute to climate change.

3.2. Opportunities at a Nature and Landscape Level

At the nature and landscape level, one opportunity is to store carbon in the land to help reduce atmospheric carbon. One interviewee highlights the importance of having a significant number of farmers participate in carbon storage practices. This could have positive outcomes, such as decreased carbon in the atmosphere, as long as farmers are comfortable with the process.

Another opportunity is the potential impact on soil-water resilience by addressing harmful practices, such as pesticide usage. An interviewee mentions that by changing farmers' mindsets and encouraging sustainable practices, there could be a significant improvement in soil quality and resilience, with less reliance on harmful inputs.

Lastly, there is an opportunity to improve air quality and biodiversity, as one suggests that farmers could be viewed as stewards of landscapes that deliver agriculture, clean water, clean air, and habitat for various species in the future.

In terms of biodiversity, studies conducted by various stakeholders show that there is widespread agreement that carbon farming may bring biodiversity advantages and may prevent soil loss, although landholders without carbon projects disagreed with these statements (Cowie et al. 2019). Yet, further research on the link between carbon farming and invasive native species is needed. Studies such as IPCC (2018) shows that restoration of natural ecosystems and soil carbon sequestration could be beneficial for biodiversity, soil quality, and local food security.

Adopt carbon farming has been linked with the mitigation potential in literature. The study conducted by McDonald et al. (2021) in the European Union reveals that carbon farming mitigation in Europe has the potential to reduce carbon dioxide equivalent (CO2-e) emissions by 101-444 million metric tons per year. This is equivalent to approximately 3-12% of the EU's total annual GHG emissions. It also implies that even at the low end of estimated potential, carbon farming could offset 26% of the EU's annual agricultural emissions (i.e. including nitrous oxide emissions from soils, manure management, and livestock enteric fermentation but excluding carbon sequestration/release). They compared five carbon farming methods, all of which exhibit significant potential for climate change mitigation. These include peatland management, agroforestry, enhancement of soil organic carbon on mineral soils, livestock and manure management, and nutrient management on croplands and grasslands. For instance, enhancement of soil organic carbon on mineral soils by managing cropland and grassland could potentially mitigate 9-70 Mt CO2-e/yr in the EU, with a per hectare potential of 0.5-7 t CO2-e/ha/yr. The study emphasized that these practices could deliver numerous environmental benefits, enhance agricultural sustainability, and stabilize yields, despite potential initial decreases in agricultural output.

In Canada, the agricultural sector, a significant source of GHG emissions, has been subject to targeted measures to achieve net-zero emissions by 2050. Alberta has implemented a carbon offset market that includes four approved agricultural protocols, contributing to a reduction of 3.2 million tonnes of CO2 equivalent from the atmosphere in 2011. In Saskatchewan, the government has implemented 25 resilience measures and provides incentives for beneficial management practices (Fouli, Hurlbert & Kröbel 2022).

In sum, from experts' opinion and scientific assessment, it seems carbon soil sequestration is among the cheapest carbon dioxide removal options. They also are considered low risks. For instance, Sovacool et al. (2022) conducted a survey asking experts to rate the riskiness of each climate mitigation pathways (negative carbon emission technologies) on a scale of 1 to 10, with 1 being the least risky and 10 being the most risky. The results showed that there were three clusters of riskiness, with some being perceived as low risk, some as moderately risky, and some as most risky. Ecosystem restoration, soil carbon sequestration, afforestation and reforestation belong to the low-risk options (scoring between a median of 0 and 4) along with blue carbon and seagrass, biochar, albedo modification from human settlements, direct air capture, enhanced weathering, ice protection, and carbon capture and storage. These options were seen as low risk because they are either natural processes or technologies that have been tested and proven to be effective. The moderately risky options included albedo modification via grasslands, albedo modification via deserts, bioenergy with carbon capture and storage, and albedo modification via clouds. These options were seen as moderately risky because they are either new technologies or technologies that have not been fully tested. The most risky options included cirrus cloud thinning, marine cloud brightening, ocean alkalinization or fertilization, high-altitude sunshades, space-based reflectors, and stratospheric aerosol injection. These options were seen as most risky because they are experimental technologies that have the potential to cause unintended consequences.

Sovacool et al. (2022) found that all CDR and SRM options had at least some barriers when deployed at a large scale. However, afforestation and reforestation, soil carbon sequestration, biochar, blue carbon and

seagrass, ecosystem restoration, and albedo modification via human settlements, had fewer barriers than others. The most prevalent barrier facing soil carbon sequestration was the need to scale up technology and readiness (2 out of 5, with 5 being the strongest barrier). Other barriers included challenges to system integration, financing, and market demand. Ecosystem restoration faced the barrier of financing (3.0). In addition, it faced legal and regulatory obstacles (2.0), financing (2.0), and market demand (2.0). Afforestation and reforestation faced significant challenges, including other factors (4.0), legal and regulatory obstacles (2.0), challenges to system integration (2.0), financing (2.0), market demand (2.0), and environmental and planetary risks (2.0). As such, ecosystem restoration, afforestation and reforestation, soil carbon sequestration, biochar, blue carbon and seagrass, and BECCS are among the most scalable technologies in comparison with other geoengineering options. Most of these options can be deployed at a large scale between 2030 and 2040, of which, ecosystem restoration and afforestation and reforestation can be deployed at a large scale from as early as around 2025 (Sovacool et al. 2022).

The adverse impact of some carbon markets/ biodiversity markets can be solved by policy and good land management. IPCC (2018: p.180) recommends that: ‘The impacts of large-scale CDR deployment could be greatly reduced if a wider portfolio of CDR options were deployed, if a holistic policy for sustainable land management were adopted, and if increased mitigation efforts were employed to strongly limit the demand for land, energy and material resources, including through lifestyle and dietary changes (medium confidence). In particular, reforestation could be associated with significant co-benefits if implemented in a manner that helps restore natural ecosystems’.

In summary, there are risks and opportunities associated with joining environmental markets at the business, family / society, and nature / landscape levels. Addressing these risks and capitalizing on the opportunities can help ensure that participation in environmental markets brings about positive outcomes for farmers, communities, and the climate/environment.

There are geoengineering options (carbon dioxide removal technologies) that are suitable for land managers to adopt if they want to join Australia's ERF:

- Afforestation and reforestation: Afforestation is the planting of trees in an area that has not previously had trees. Reforestation is the replanting of trees in an area that has been cleared of trees. Both afforestation and reforestation can help to reduce greenhouse gas emissions by absorbing carbon dioxide from the atmosphere.
- Bioenergy with carbon capture and storage: Bioenergy with carbon capture and storage (BECCS) is a technology that captures carbon dioxide from the atmosphere and stores it in biomass, such as wood or agricultural waste. BECCS can be used to reduce greenhouse gas emissions and to generate renewable energy.
- Biochar: Biochar is a type of charcoal that is made from biomass. Biochar can be used to improve soil quality and to store carbon in the soil.
- Soil carbon sequestration or enrichment: Soil carbon sequestration is the process of storing carbon in the soil. Soil carbon enrichment is the process of adding carbon to the soil. Both soil carbon sequestration and enrichment can help to reduce greenhouse gas emissions.
- Ecosystem restoration: Ecosystem restoration is the process of returning an ecosystem to its original state. Ecosystem restoration can help to reduce greenhouse gas emissions by absorbing carbon dioxide from the atmosphere and by providing other benefits, such as improved water quality and biodiversity.
- Blue carbon and seagrass: Blue carbon is carbon that is stored in marine ecosystems, such as mangroves, seagrass meadows, and salt marshes. Seagrass is a type of marine plant that can store carbon in its leaves, stems, and roots. Blue carbon and seagrass can help to reduce greenhouse gas emissions.

SYNTHESIS OF RISKS AND OPPORTUNITIES

To explore what risks and opportunities were most relevant for the GB region, we discussed these findings with a mixed group of 18 stakeholders from the region. Invitees included interviews from the previous step, as well as broader stakeholders of the GBCMA and GMCA. Table X summarises forum participants.

Table 4: List of organisations joining the Goulburn Broken Forum (26 May 2023)

Organisation	Number of participants
Alpine Shire Council	1
Benalla Rural City Council	7
City of Wodonga	1
Consulting firm	1
Farmers/landholders	2
Goulburn Broken Catchment Management Authority	2
Gecko Clan Landcare Network	2
Other Landcare networks	2
Murrindindi Shire Council	1
Parks Victoria	1
Water Sensitive Cities Australia – Monash University	1
BehaviourWorks Australia – Monash University	2
Total	23

Risks and opportunities most relevant to the region

The below Table 5 reports insights from 3 break out groups (A, B, C) on the most relevant risks and opportunities at each scale. Importantly, they also highlighted risks and opportunities not directly considered in the interviews and literature, suggesting locally relevant issues that may be missed elsewhere. Where risks and opportunities align with the previous research, we underline them.

Management actions considered likely to enhance climate resilience

Similarly, participants shared their views on what management actions at the scale of individuals, organisations and the region could help steer towards positive outcomes.

Forum findings are presented in table form below, (Table 6) and discussed and integrated with the previous results in the discussion.

Table 5: Key risks and opportunities identified by group A, B, C organized by four socio-ecological levels

Level	Risks	Opportunities
Farm / Business	1. Uncertainty about whether there can be a mix of carbon and biodiversity benefits on accredited systems (a) 2. The sale of land could be prohibited due to participation in the scheme (a) 3. The strength of credit risk or value (a) 4. Risk of fraud or multiple infractions because the industry is inadequately policed (b) 5. Lack of knowledge to utilize technologies/tools (c) 6. Desire to change but uncertainty about where to start (c)	1. Diversified income with a new "carrot" for biodiversity (A). 2. Premium credits from off-farm values (A). 3. Indigenous Carbon Premium (A). 4. Lot can go for biodiversity market (B). 5. Selling native grass seed (B). 6. Increased offsets for Council through large scale nature aggregating vegetation (C). 7. Employment opportunities in the Green Industry (C).
Community	1. Falling behind adopters due to too much risk (A). 2. Loss of family belonging to smaller farms versus corporate farmers able to assume risk (A). 3. Resistance from the community (C). 4. Having the community understand how the process works and why it's needed (C).	1. Local community/network based projects for carbon benefits (A). 2. Building resilience for land and community (A). 3. Do a pilot with a diverse group of partners including: Landcare networks, councils, farmers, community (B). 4. New Industry to bring into the community (C).
Governance	1. Risk from fire, drought, and paying back the credit (A). 2. Government led market versus "true" market verified (A). 3. Legal barriers (A). 4. Inconsistent and changing funding & Carbon Market systems (A). 5. Fraud or multiple infractions because the industry is inadequately policed (B). 6. Council not acting (C). 7. Lack of opportunity due to limited Council resources: Land, Money, Staff (C).	1. New opportunities to meet RCS targets (A). 2. Carbon Credit Fund (A). 3. Landcare or similar can facilitate baseline tests for farmers (B). 4. Council insetting through local land stewardship (C). 5. Potential to enhance branding to project conscious decisions (C).
Nature	1. Unclear if there can be a mix of carbon & biodiversity benefits on accredited systems (A). 2. Not integrating biodiversity well (A). 3. How we manage carbon loss/release (A). 4. Risk of structuring the outcome of plantings. Emphasize the diversity of grasses, native shrubs, trees instead of monocultures (C).	1. Multiple Carbon Benefits (A). 2. Links with carbon, water, biodiversity, etc (A). 3. "Wood for Good" (ethical firewood) (B). 4. Increase biodiversity opportunities (C). 5. Leverage other programs to showcase productivity and savings (C).

Table 6: Management actions considered likely to lead to positive outcomes.

Level	Action	Group
Individual	Educate yourself, learn from mistakes, keep challenging and asking questions to enhance understanding	A
	Be informed, share knowledge, and understand the benefits for farmers	A, C
	Lead by example, invite early adopters to speak at council meetings to encourage others	A, C
	Design supporting programs to allocate funding to landholders so that the management of money is more efficient	B
	Creatively manage property, use savings innovatively back into property	B
	Care about and share stories, value individuals where they are now, and work proactively to help them	A
	Uphold integrity in management, action, and verification	A
Organisation	Seek opportunities for money/income through pilots or trials, provide information to the public to help them understand the opportunities with carbon markets	A, C
	Create opportunities for the region, facilitate discussions with local organisations such as Winton Recovery or RHE	A, C
	Increase awareness to scale up from pilots, provide education to communities, potentially via TAFE	A, B
	Regular meetings through a Carbon Alliance/forum, document practices	A
	Develop simple extension materials, recognize that the market is only one mechanism; there are many other existing Payment for Ecosystem Services (PES) models	A
	Ensure industries continue to reduce their emissions, consider a Carbon Credit Fund for agriculture	A
Region	Identify what your region/community aims to achieve, manage to adapt to changing climate realities in the catchment	A, C
	Train local people to be accredited assessors on the ground, ensuring truthful monitoring as opposed to virtual	B
	Strive for less profits going outside the region, work to reduce greenwashing, increase transparency, improve accuracy	B
	Provide training for different types of certifications, centered locally and not decentralized	B
	Establish large scale land assets based on projects that provide low emission benefits	C

DISCUSSION

UNDER WHAT CONDITIONS DOES PARTICIPATION IN ENVIRONMENTAL MARKETS BUILD CLIMATE RESILIENCE?

Our interviewees understanding of **climate resilience** underlines that broader landscape, and planetary, values such as carbon and biodiversity are distinct from, but interact with, farm level characteristics. In short, farm that is unviable in the face of climate variability and impacts is not resilient, but at the same time, that same farm must be contributing to carbon and biodiversity values at the landscape scale to be considered resilient. Similarly, these attributes must also be considered in light of their implications for regional communities, and local industries.

Understanding of 'climate resilience' means different, related things, across different levels, including landscape and biodiversity, farm, farm-landscape, and community or industry. These are useful lens to consider the costs and benefits, risks and opportunities highlighted by the conceptual frameworks suggested earlier. Recognizing the diverse perspectives on climate resilience can help in developing effective strategies to address the challenges of climate change and enhance resilience in the agricultural sector. By comparing and contrasting these perspectives, it is evident that there is no one-size-fits-all approach to climate resilience, and a comprehensive understanding must encompass the interplay between these different aspects.

Similarly, views on **environmental markets** highlight that carbon markets and biodiversity offset programs are not yet seen as a high confidence, straight forward way of achieving climate resilience, for all that they have potential. The outlook is more promising in broader perspectives on environmental markets – i.e. the wider ways that verifying and improving production of environmental services might help a farm business outside of formal market transactions. The NCC framework is relevant and applicable at the firm level, but needs to be expanded out to include broader community and landscape outcomes also.

A more comprehensive perspective that places the farmer at the center of decision making encompasses multiple types of environmental market value exchanges, including emerging ones like regenerative agriculture and biodiversity certification schemes. This comprehensive view acknowledges the potential synergies between different environmental markets and their role in addressing environmental challenges and promoting sustainable land management practices.

In conclusion, it appears that participants in the interviews and forums have a nuanced and multi-level grasp of the subject. They recognize the importance of biodiversity offset programs and carbon markets and demonstrate an understanding of the broader context that includes both biodiversity and carbon markets. This indicates that they are aware of the complexity and various components of environmental markets, which is essential for informed decision-making and participation in such initiatives. Also, it is of importance to recognise the diverse perspectives on environmental markets that can help in designing effective policy instruments and market-based approaches to address environmental challenges and promote sustainable land management practices. By comparing these perspectives, we can appreciate the complexity and potential of environmental markets in driving positive environmental outcomes. Importantly, this more complicated view, where farmers weigh up a carbon or biodiversity transaction as just one of a range of environmental market options, helps explain the diverse risks and opportunities which are being considered.

WHAT ARE THE RELEVANT RISKS AND OPPORTUNITIES FOR LAND MANAGERS IN THE GOULBURN BROKEN CATCHMENT?

Our results outline a wide range of risks and opportunities associated with climate resilience and environmental markets at different socio-ecological scales, that cannot be talked about in isolation meaningfully. They are a summarized in the figures below.

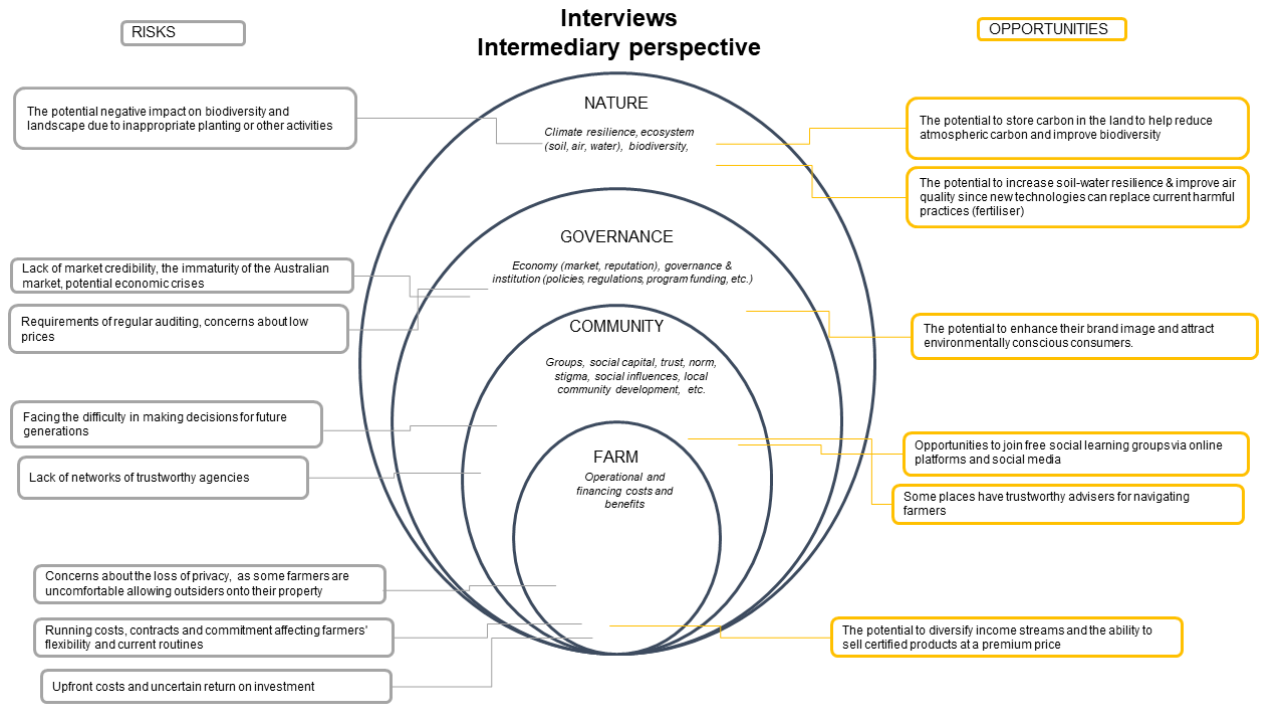


Figure 5: Summary of key themes from interviews across socio-ecological scales.

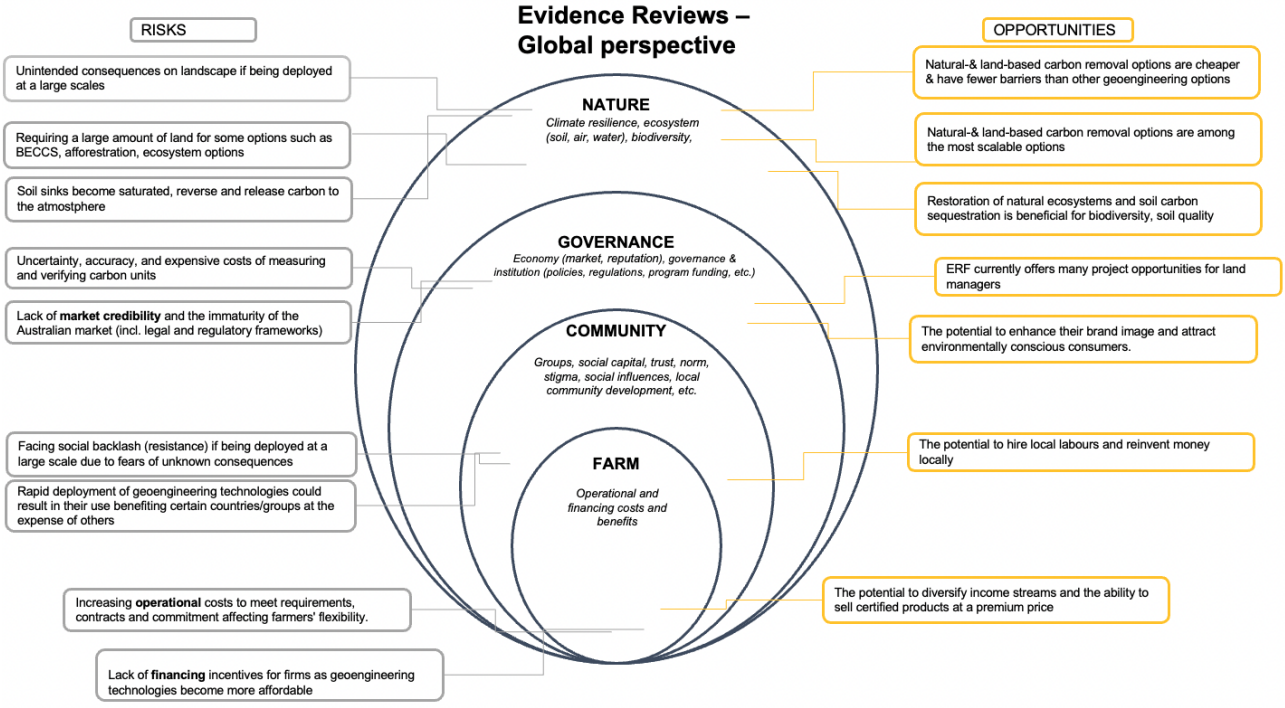


Figure 6: Summary of key themes from evidence review across socio-ecological scales.

While there a number of risks and opportunities at the farm level identified in both interviews, global literature and the forum, it's clear that they reflect, and interact with dynamics at other scales. In particular, the perception that participating in environmental markets may be more risk than opportunity at present, reflects a pragmatic view that farm businesses only have so much time and attention to spend on new opportunities. Furthermore, that these have to be relatively well understood and certain before many land managers will act on them. The fast moving economic and legislative environment, lack of trust in key mechanisms and intermediary actors and the underlying scientific uncertainty of what actually works, and for how long, appear to leave many of our participants very cautious and uncertain about where to start. There was a keen sense of the interdependence of farm and community level interactions – that resilient farms are part of resilient

communities and industries – and any transition to a different status quo would need to be just and equitable – at both intra- and inter-generational levels.

Against this, the promise of diversified income, more viable farms and regional communities and economies in the face of a changing climate, and involvement of a wider range of actors, including councils and indigenous corporations, was also seen as promising. An overall sense of *if not now, sometime soon*, and *with appropriate support and caution*, seems to underline the sentiments expressed in the forum.

WHAT MANAGEMENT STRATEGIES AND SUPPORT COULD HELP TO INCREASE THE CHANCES OF POSITIVE OUTCOMES FOR THE REGION'S LAND MANAGERS?

There is a clear road map emerging from the forum discussion to providing a strategic and 'eyes-open' approach to engaging with environmental markets for climate resilience.

At the scale of individual farm managers, and 'intrapreneurs' in the region's institutions attending the forum, there was a clear sense of both individual responsibility to self-educate and act entrepreneurially, and the need to coordinate and support each other. This also had to be underpinned by personal commitment to integrity in monitoring, reporting and verification. These directions reflect the strong preference for peer to peer and learn by doing capability building in the sector.

Specific organisational activities highlighted include actively seeking opportunities to participate in trials, and share learning with the public directly, via TAFE and other organisations. There was also interest expressed in establishing a regional forum to share learning, exchange experience and document practices. This includes a commitment to expanding beyond carbon and biodiversity credits, to direct payments for environmental services, certification, and other forms of generating value from verifying and improving environmental services from land.

On a whole of region basis, there seems to be an appetite for a collective conversation about goals, means and ends, presumably building on the Regional Catchment Strategy. There was a strong sense of wanting to build capabilities in monitoring, verification and reporting within the region, and facilitate more with region environmental market exchanges. This could be underpinned by investments in forums, training and accreditation and as well as facilitating more ambitious efforts like large scale landscape projects linking multiple properties.

Recommendations

Based on these findings, there are several concrete actions the GBCMA could consider in implementing the Regional Catchment Strategy that could boost these directions from the forum.

1. Given the interdependences of scales of risk and opportunity AND that they can be expected to vary across the region, conduct an analysis for each of the six Local Area Visions in the strategy addressing Nature, Governance, Community and Farm level risks and opportunities. This could start with an overlay and update of the carbon farming guidance geographic information system (GIS) maps (2016), adaptation risk assessments, and local area visions.
2. Continue to experiment and trial pilots in supporting local land managers and networks to learn by doing in this space, consistent with what is appropriate to the vision for each local area in the catchment.
3. Explore the needs of local groups and networks to support and enhance land managers work in this space on a local area basis.
4. Support local groups and networks to build capability in environmental markets, especially establishing baseline natural capital assets and potential to improve environmental services on the one hand, and in how to support land managers to realise that value through diverse environmental market options on the other. Business planning should emphasise that carbon and biodiversity offsets are just one of a range of options, that can be compared on their merits for a given property and farm enterprise. For farmers, the preference is to learn face to face, from peers, and see relevant examples and demonstrations. This can be supported by social media, and static resources such as guidance, videos, training packages etc, but these may be of more benefit to supporters of farmers in local networks rather than the farmers themselves in the absence of direct engagement.

5. Provide or facilitate financial support to smaller land managers (e.g. less than approximately $150,000 annual agricultural production value) to undertake initial assessments and business planning reflecting a holistic understanding of environmental markets, and cooperatively across properties in localities where possible. The upfront costs of rigorous measurement of natural capital potential, and conducting financial, legal and business risk analysis can be prohibitive for family run farms and lifestyle farmers, as is the capability building, learning and decision making. Simply put, they need help. This might take the form of small grants of ~$10,000 distributed via facilitators local networks and groups, and not for profit cooperatives, supported by central funding for facilitators and advisors who are not in it for profit.
6. Recognise that larger land managers and agribusinesses in the region have the resources and capacity to make value rational decisions (whereas smaller land managers may have non-business goals and/or less capacity). With this in mind, continue to support and govern larger and commercial agricultural operations to develop their environmental market opportunities in a manner that is consistent with the social, economic and environmental goals of the regional catchment strategy. These operators, and third party, for profit aggregators and brokers, have different drivers and barriers than small landholders. They can be trusted to act in the best business interests, so establishing sound oversight of rules and obligations, and supporting development that is sensitive to a healthy, thriving region is important. Arguably, current governance arrangements at the global and national scale encourages large scale environmental market activity that is not sensitive to local conditions and priorities and may trigger many of the risks highlighted in the evidence review and interviews.
7. Continue to build connections between land managers, regional centers and Melbourne by;
    a. Exploring the potential of local educational, scientific and research organizations to support the above activities.
    b. building on and supporting the existing groundswell of expectations of increased transparency and communication of the environmental performance of agricultural enterprises. An environment where good performers are recognized and encouraged, and the baseline of performance is steadily raising is to benefit of the whole region.
    c. Supporting local institutions such as councils, educational facilities, health sector, large businesses and other organisations with scope 3 carbon emissions reporting obligations and who are likely to affected by the Task Force for Nature Disclosures to place a higher value on supporting environmental market value creation within the region, rather than offsetting using cheaper but dubious international credits. This boosts both integrity in monitoring, reporting and verification in the region, and the brand, reputation and corporate citizenship benefits for companies reinvesting directly in the area.

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APPENDIX

APPENDIX 1: EG GBCMA GUIDANCE ON CARBON FARMING

GBCMA guidance on carbon farming (2016)

Natural capital risks and opportunities are well considered in specific guidance on carbon farming. The Goulburn Broken CMA supports carbon farming[4] activities that (GBCMA, 2016):

- contribute to mitigation of and adaptation to climate change;
- contribute to the protection and enhancement or restoration of natural resources to increase their resilience; and
- maintain or enhance the resilience and cohesion of regional communities.

This includes ERF methods for Environmental Plantings, Natural Regeneration, Non-environmental plantings, and Mallee plantings. The GBCMA advices that carbon farming proponents should:

- Protect and enhance or restore areas of high biodiversity conservation value (nonenvironmental plantings should be directed away from areas of existing native vegetation and waterways to reduce risks associated with the introduction of new genetic material and water interception).
- Improve landscape resilience through enhancing remnant native habitat and improving connectivity.
• Increase the resilience of soils.
- Prioritise the use of low value agricultural land and degraded landscapes. Carbon farming activities that can support the implementation of the Goulburn Broken Regional Catchment Strategy include:
- Natural regeneration – to assist carbon stocks associated with existing native habitat.
- Environmental plantings – to increase terrestrial carbon stocks through revegetation, especially along waterways, and to buffer and connect high value remnant native vegetation.
- Grazing system change – to increase soil carbon in agricultural systems by implementing management actions such as flexible grazing techniques based on pasture and livestock requirements that maintain productivity and improve ground cover.
- Cropping system change – to increase soil carbon in broadacre cropping systems as a result of implementing management actions such as no-till cropping and retaining organic matter.
- Blue carbon sequestration through the conservation and restoration of wetlands.
- Non-environmental plantings – establishment of a new plantation (trees, shrubs) on land that has not recently supported native vegetation. The new plantation could include environmental plantings, farm forestry, groundwater recharge or discharge management or long rotation hardwood plantations.

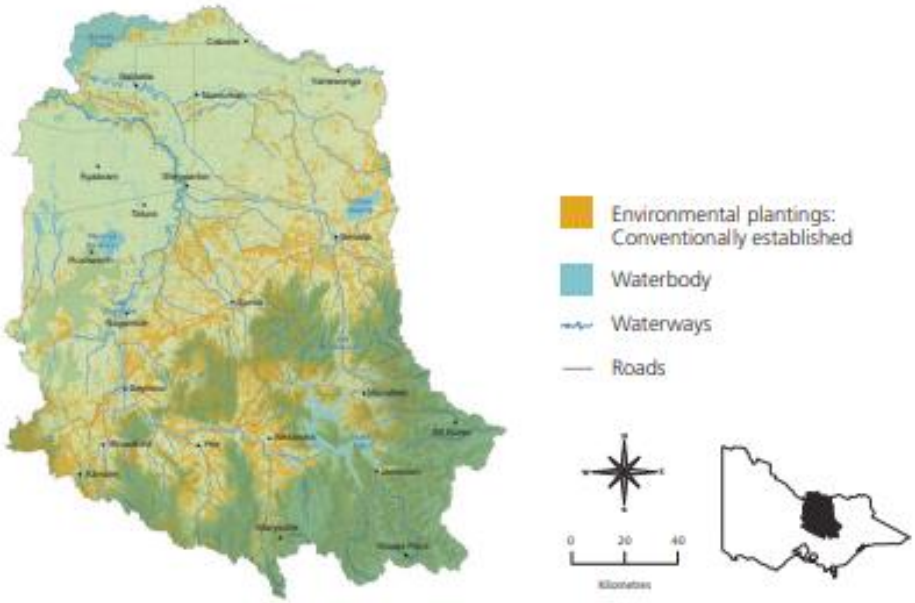
Project proponents should consider:

- Contacting the Goulburn Broken CMA to discuss a proposed project's alignment with regional NRM plans.
- Federal, State and local legislation and regulations regarding such issues including, but not exclusive to, water interception, fire management, native vegetation retention, land use planning, cultural heritage and invasive plants and animals.
- The eligibility of projects under the Emissions Reduction Fund and other carbon markets (e.g. Mallee plantings are only eligible in areas with less than 600mm average annual rainfall).
- The viability of plant species under climate change scenarios.

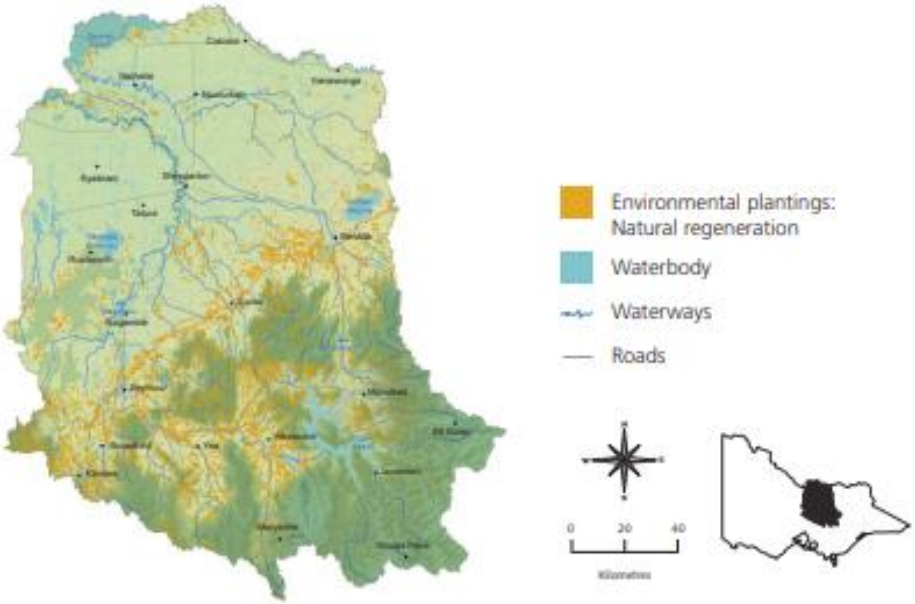
4 https://www.gbcma.vic.gov.au/downloads/ClimateChange/Carbon_Farming_and_NRM_in_the_Goulburn_Broken_Catchment_Summary_Final_Web_version.pdf

Priority areas for environmental plantings for carbon farming

Areas of the Goulburn Broken Catchment that could support environmental plantings for carbon farming whilst aligning with NRM principles



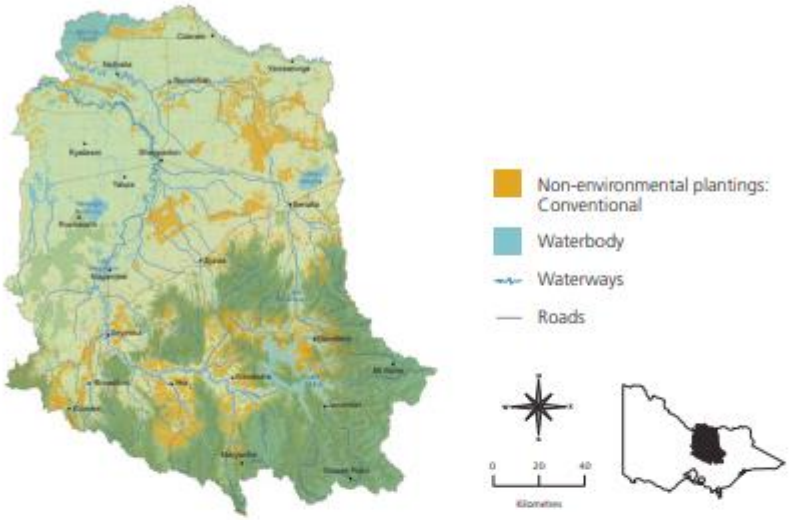
Areas of the Goulburn Broken Catchment that could support natural regeneration for carbon farming whilst aligning with NRM principles



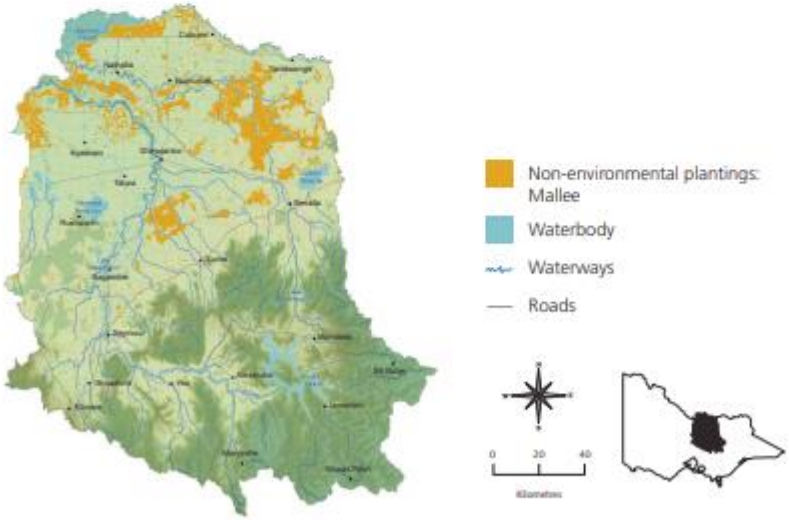
PROMOTION PRINCIPLES	AVOIDANCE PRINCIPLES
Proximity to existing native vegetation	Reduction in water yield with revegetation
Regional priority for improving landscape vegetation connectivity / biodiversity value	Current land use is of high social and/or economic value
Carbon sequestration potential	
Vulnerability to climate change	

Priority areas for non-environmental plantings for carbon farming

Areas of the Goulburn Broken Catchment that could support conventional non-environmental plantings for carbon farming whilst aligning with NRM principles



Areas of the Goulburn Broken Catchment that could support Mallee plantings for carbon farming whilst aligning with NRM principles



PROMOTION PRINCIPLES	AVOIDANCE PRINCIPLES
Carbon sequestration potential	Proximity to existing native vegetation
Vulnerability to climate change	Reduction in water yield with revegetation
	Current land use is of high social and/or economic value

APPENDIX 2. INTERVIEW GUIDE

Project title: ***Does participation in environmental markets build climate resilience?: Goulburn Broken Catchment opportunities, risks and management***

Interview information

Interviewee	
Organisation	
Interviewer / notetaker	
Date of interview	
Link to recording	

Thanks for agreeing to be interviewed, can I just confirm again you have read the explanatory statement and consent for us to record this interview?

1. Could you please say a bit about your background and current role [in relation to environmental participation and climate resilience]?

2. In your opinion, what is climate resilience? What are examples of climate resilience?

3. In your opinion, what are environmental markets? What are examples of participation in environmental markets?

4. In the case of land managers in the Goulburn Broken Catchment, what are factors influencing their participation in environmental markets?
   Probing: If they find it hard to tell about factors, ask them: drivers/ barriers to participation; and why this driver/barrier is important

5. In your opinion, does land managers' participation in the environmental markets lead to increased climate resilience? Could you please provide some examples to illustrate your answer?
   Probing - If they talk about just positive impacts, ask: Is there any negative impact? [and vice versa]

6. What are some interventions or activities that you would expect to help increase participation in environmental markets in the Goulburn Broken Catchment?
   Probing: Ask about the interventions elsewhere they know.

7. Can you tell us about one example of farmers participating in the environmental markets that you have some in-depth understanding of? What were some of the good or bad outcomes of this action (probe: climate impacts)?

8. (Introducing the Forum then ask) what are key players we should invite to the Forum next year and what are topics that are critically relevant to them?

9. Do you have any research, reports or other documents that are relevant to our project that you can share with us for our evidence review later?

APPENDIX 3: EVIDENCE REVIEW PROTOCOL

Motivating questions

Answering these questions is important to ensure that the review can meaningfully inform a practice decision.

Who is the review for?	The Goulburn Broken Catchment Management Authority
What issue and decision are they facing?	The focus is to understand if participation in environmental markets builds climate resilience They need to understand: - 1.Under what conditions does participation in environmental markets build climate resilience? - 2. What are the relevant risks and opportunities for land managers in the Goulburn Broken Catchment? - 3. What management strategies and support could help to increase the chances of positive outcomes for the region's land managers? This review will focus on global research that is capable of answering the questions posed above.
How will the review findings be used for the issue / decision?	The review findings will be included in a final report presented to the CMA and used as the foundation for organising the Forum that involves stakeholders from the Goulburn Broken Catchment and beyond.
What other inputs are there for the issue / decision?	There will be a parallel ● practice interview that will interview subject matter experts, peak bodies, farmers for their perspectives on on-the-ground experiences of farmers and land managers' participation in environmental markets and climate resilience. ● a forum that aims to present the key findings from this review and the interviews as well as seek to facilitate discussions among key stakeholders
Are there any relevant background materials?	Yes, the CMA will provide a list of key documents treated as confidential.
How long do we have to conduct the review?	About 3 weeks

What level of confidence is required in the review findings?	Included studies will be quality assessed against well-articulated criteria for rigour and relevance, and the most reliable and robust findings will be given greater weight than less well rated material. This step will also be gently communicated to organisations sharing research with us as an incentive to share more complete reports and details rather than partial, marketing orientated material - i.e. sources that lack detail on key methodological and analytical choices will be, by necessity, ranked as less reliable. We are aware of a range of privately held, and commercially orientated surveys, however it may be that very few of these will be available for use in this project and by the Office. If this is the case, and public information is scarce, we will describe the key gaps in the state of public knowledge on this issue as we see it based on other elements. This will be followed by recommendations in the latter phases for publicly available research that will enable a wider range of providers and stakeholders to contribute to a collective agenda on needed competencies.

Search strategy

Research question	The search will focus on the following questions 1.Under what conditions does participation in environmental markets build climate resilience? 2. What are the relevant risks and opportunities for land managers in the Goulburn Broken Catchment? 3. What management strategies and support could help to increase the chances of positive outcomes for the region's land managers?
Expertise	The searches will be informed by team members/CMA with content expertise in participation in environmental markets and climate resilience
Approach	The search strategy will be reviewed by CMA's representatives before being piloted in one database. Changes to the protocol search strategy will be made in consultation with the Office. ● a systematic rapid review of publicly available 'grey literature' and university databases incorporating grey literature
Screening	Two research members will perform the screening.
Excluded studies	All decisions taken during screening will be documented and outlined in the final report.

Sources	Electronic databases: Google Scholar, Scopus, ProQuest. As the review focuses on existing risks and opportunities associating with carbon markets and biodiversity markets, the date limit will be in the last 10 years. The search uses inclusion and exclusion criteria to ensure the quality of search results. Grey literature: - Research team will use parallel projects' suggestions of grey literature such as PIPAP and EMLP projects to search for relevant grey literature. - Research team will also search Google to identify list of relevant websites - Google (limit the search option to .gov, .org, and timeframe), and other option - Title and abstract screening to identify relevant studies/documents - Relevant studies will be downloaded and stored in shared folders - Content screening will be undertaken - Data extraction will be undertaken in relation to the research questions

Inclusion and exclusion criteria

	Include	**Exclude**
Study Type	Systematic reviews (including rapid evidence review), narrative reviews, primary studies, research reports (including qualitative, quantitative and mixed methods), project evaluation reports, white papers,	Conference papers/abstracts, commentaries, editorials, review protocols, opinion pieces, case series, case reports, media report, news, essays, annual report, interview transcripts
Population	Farmers or land managers in the world	
Participant characteristics	Age Gender Location Type of farmers	All other characteristics
Study Design	Studies/reports using qualitative and/or quantitative and/or mixed methods to investigate the risks and opportunities associated with environmental markets and climate outcomes	Observational only
Study Setting	Agricultural sector	All other settings

Publication status	Published/accepted by peer review or published as grey literature by reputable organisations, unpublished documents we have permission to include / report.	Not published, confidential
Time period	In the last 10 years (March 1 2013 to March 1 2023)	Prior to March 1 2013 after March 1 2023
Language	English	All other languages

Search terms

Search terms	Strings
participation in environmental markets climate resilience farmers landholders land managers Agricultural sector Agriculture	("participation in environmental market*" OR "carbon market*" OR "carbon offset*" OR "carbon credit*" OR "cap and trade" OR "emissions trading" OR “biodiversity” OR “natural capital” or “environmental services”) AND ("climate resilience" OR "resilience outcomes" OR "resilience benefits" OR "resilience co-benefits" OR "resilience advantages" OR "resilience drawbacks" OR "resilience limitations" OR "resilience trade-offs" OR "incompatible with resilience" OR "not aligned with resilience") AND (determinants OR drivers OR barriers OR facilitators OR challenges OR obstacles OR opportunities OR factors OR enablers OR constraints OR motivations OR disincentives OR requirements OR conditions OR influences OR impacts) AND (interventions OR activities OR strategies OR practices OR approaches OR measures OR initiatives OR policies OR programs OR schemes OR incentives OR support OR frameworks OR guidelines OR best practices OR success factors OR case studies) AND ("report" OR “government report” OR “white papers” OR "peer-reviewed" OR "journal" OR "publication" OR "article" OR "manuscript" OR "research paper") AND ("pdf" OR "Portable Document Format") AND ("farmer*" OR "land manager*" OR "rancher*" OR "grower*" OR "agriculturist*" OR "agricultural producer*") AND (site:gov OR site:edu OR site:org)

Searching

Proquest from 1/03/2013 to 5/03/2023

Final search string	Hits
noft(((noft(determinants) OR noft(drivers) OR noft(barriers) OR noft(facilitators) OR noft(challenges) OR noft(obstacles) OR noft(opportunities) OR noft(factors) OR noft(enablers) OR noft(constraints) OR noft(motivations) OR noft(disincentives) OR noft(requirements) OR noft(conditions) OR noft(influences) OR noft(impacts)) AND (noft("participation in environmental market*") OR noft("carbon market*") OR noft("carbon offset*") OR noft("carbon credit*") OR noft("cap and trade") OR noft("emissions trading") OR noft("biodiversity") OR noft("natural capital")) AND (noft("climate resilience") OR noft("resilience outcomes") OR noft("limitations")) AND (noft("farmer*") OR noft("land manager*") OR noft("rancher*") OR noft("grower*") OR noft("agriculturist*")) AND (noft(interventions OR activities OR strategies OR practices OR approaches OR measures OR initiatives OR policies OR programs OR schemes OR incentives OR support OR frameworks OR guidelines OR best practices OR success factors OR case studies))))	56 hits English only =55

Scopus from 5/03/2013 to 10/03/2023

Final search string	Hits
(TITLE-ABS-KEY(determinants OR drivers OR barriers OR facilitators OR challenges OR obstacles OR opportunities OR factors OR enablers OR constraints OR motivations OR disincentives OR requirements OR conditions OR influences OR impacts) AND TITLE-ABS-KEY("participation in environmental market*" OR "carbon market*" OR "carbon offset*" OR "carbon credit*" OR "cap and trade" OR "emissions trading" OR biodiversity OR "natural capital") AND TITLE-ABS-KEY("climate resilience" OR "resilience outcomes" OR limitations) AND TITLE-ABS-KEY(farmer* OR "land manager*" OR rancher* OR grower* OR agriculturist*) AND TITLE-ABS-KEY(interventions OR activities OR strategies OR practices OR approaches OR measures OR initiatives OR policies OR programs OR schemes OR incentives OR support OR frameworks OR guidelines OR "best practices" OR "success factors" OR "case studies"))	118 Limited type Limited range =81

Google from 1/03/2013 to 3/03/2023

Strings	Hits

pdf ("participation in environmental market*" OR "carbon market*" OR "biodiversity market*" OR "natural capital market*") AND ("climate resilience" OR "resilience outcomes") AND ("farmer*" OR "land manager*" OR "agriculturist*") AND (“determinant” OR “factor”) AND (“intervention”) ("report" OR "white paper") site:(gov OR edu OR org)	4,5k 1/03/2013-1/03/2023 Searched first 5 pages of results 19 results selected and downloaded

Other sources

- Expert recommendation: we sought advices from experts during the interviews, which resulted in 3 key papers

Final results

- Scopus: n=118
- Proquest: n=56
- Google: n=19
- Expert: n=3
- Total: n=196

Screening and Extraction

Title and Abstract screening will be undertaken by two reviewers and conflicts will be resolved by consensus between the two reviewers.

Full text screening will be undertaken by two reviewers and conflicts will be resolved by a third reviewer.

Extraction elements will be developed and shared with the Office for review prior to initiating extraction. Once a final yield of papers is established Monash will advise an approach to quality appraisal, to be confirmed by the client. Given the requirement of speed in this project data extraction and quality appraisal will be undertaken by a single reviewer and 10% of the included studies will be reviewed by a second reviewer for quality control.

Result: excluding irrelevant documents (n=133)

Full text screening was conducted with 63 documents, which resulted in the exclusion of irrelevant studies (n=40).

At the end of this screening phase, total documents used for data extraction were 23.

Documents were extracted in accordance with the following topics:

- Risks and opportunities
- Different levels of risks and opportunities in accordance with the Natural Capital Coalition (2016).

APPENDIX 4: DEFINITIONS OF THE TERM CLIMATE RESILIENCE

Participants' definition of the term climate resilience by schemes

Definition	Scheme
"To me, [climate resilience] means protecting biodiversity and the environment on the ground. This is a functional approach, where we protect what we have and enhance it. Biodiversity and climate change should be intrinsically linked, but they are not. Climate change and resilience are reflected in the biodiversity. It's not just talk, but real."	Landscape & biodiversity
"I'm less focused on climate resilience as I am with maximizing biodiversity in the landscape. So that would generally be my first principle, to maximize biodiversity, whether that be on farm or on public land. In maximizing biodiversity with both vegetation and with animals, we have a better capacity to buffer climate resilience as well."	Landscape & biodiversity
"Climate resilience is about connectivity primarily, and building landscape connectivity so species can adapt to a change in climate is one of the fundamental elements of climate resilience that we are thinking about."	Landscape & biodiversity
"Climate resilience refers to the capacity to reduce and maintain soil nutrition and withstand extreme weather events, such as floods and heavy rainfall, through building more robust landscapes and farming practices. It's not just about the landscape, but also about the farmers and the whole industry being able to adapt and have the ability to cope with changes."	Landscape & farm
"Climate resilience means preparing a land or system to withstand changes in weather patterns and do more with less. This includes increasing shade and shelter, species diversity, better biological cycles and interactions, carbon, and better soil structure, water holding capacity, and planning for water and feeding needs. Connecting farm & landscapes in a local area region is important for overall preparedness for climate change. Industry organizations and farmers' climate action are also important economic aspects to consider."	Landscape & farm
"To put it simply, it's all about how you manage your farm to cope with different and variable seasons. Whether you call it climate change or just variability in seasonal conditions, it's important to be able to respond to events like the Byron floods year on year while managing a profitable and environmentally-friendly farm. To do this, you need to manage water, soil, and plants effectively."	Farm
"Climate resilience is a difficult concept, as it can be seen as just adaptation to future climate, which is a response to climate change. However, it involves both adaptation and mitigation as we have limits to what we can adapt to. Landholders and land managers are aware that heat and variability will likely have a greater impact on their operations than in the past. They understand the effects of heat on livestock, grain, and other aspects of their business. They are talking about these impacts and trying to adapt to them."	Farm

“Climate resilience, in my opinion, is the ability to respond effectively to changing conditions brought about by climate change. It's about having a paradigm shift and valuing nature. For me, it's about the outcomes rather than just responding to co-benefits. Climate resilience can be established at a community level by understanding local conditions and planning accordingly.”	Community
“I would define climate resilience as having a focus on adaptation of livestock production systems to the changes in climate that we can expect in the future, preparing producers to have systems that have good water holding capacity, for example, so that when a drought hits, they can continue to produce for a longer period of time, and so that they can bounce back when rains return.”	Industry system

APPENDIX 5: DEFINITIONS OF THE TERM ENVIRONMENTAL MARKET

Participants’ definition of the term environmental markets by schemes

Definition	Scheme
“Environmental markets are a framework for addressing the loss of natural vegetation and meeting habitat offset requirements. While there are potential carbon markets, there is still a lot of debate around the methodology for soil carbon in agriculture and how to approach it appropriately.”	BCT & carbon
“Environmental markets are a way for land enterprises to care for the environment while also receiving payment for doing so. These markets, such as the carbon market and biodiversity market, result in economic benefits and tangible on-ground impacts.”	BCT & carbon
“The environmental market refers to the trade of carbon credits, measures of biodiversity, and quality of natural resources. It can involve tender processes where farmers receive payments for improving a portion of their farm for biodiversity and meeting targets.”	BCT & carbon
“Environmental markets refer to compensations provided for the environmental benefits that landholders contribute, including roles in native vegetation, water health, and riparian areas.”	BCT
“Environmental markets are opportunities for farmers to participate in activities that help store carbon in the soil, such as soil carbon storage and tree planting. These markets are still in their early days and farmers need more information and opportunities to learn about them.”	Carbon
“Environmental markets have benefits for funding private activities and income diversification, but the market is not advanced enough and there is a lack of	Carbon

understanding, particularly in land management. The market has potential to improve the carbon situation, but may not necessarily lead to climate resilience outcomes”	