ESG, Natural Capital and Ecosystem Services

Professional Learning Modules:
Banking, Insurance and Agri-Food Supply Chains

Dr Jacqueline Williams
July 2023

Farming Together | RegenerativeAg ALLIANCE — Resilience through farming together | Southern Cross University

TABLE OF CONTENTS

Environmental, Social and Governance (ESG)

Module 1

Learning Outcome

This module will provide an understanding of ESG at the global and national level and the implications on the Australian agri-food supply chain to validate sustainability.

Specifically, this module will provide an overview to answer the following questions:

- What is ESG?
- What are the accounting methods for ESG globally and nationally?
- What is the growth and focus of ESG investors (globally and nationally) to achieve sustainability?
- What are the implications on the Australian agri-food supply chain?

1.1 Environmental, Social and Governance (ESG)

ESG is a holistic concept used as a framework to assess how an organisation manages risks and opportunities created by changing market and non-market conditions. ESG is heavily focused on risk management across environmental, social and governance[1] and relies on a set of standards in regard to stewardship of the Earth

[1] BDO Australia (2023) What is ESG and why is it important to your business. https://www.bdo.com.au/en-au/accounting-news/accounting-news-may-2021/what-is-esg

and humanity and has become important as socially-conscious investors use ESG criteria to screen potential investments[2].

The origins of ESG in a formal sense occurred in 2006 through the Principles for Responsible Investment Initiative which founded the six Principles for Responsible Investment (PRI) as a voluntary framework recognising ESG issues can affect the performance of investment portfolios and must be considered by investors to fulfill their fiduciary duty. Over 1,500 investment institutions have become signatories, with approximately US$ 62 trillion assets under management[3]. Since the launch of PRI there has been significant growth in the number of ESG laws and standards, making ESG a priority of the financial services industry's agenda[4]. ESG encompasses all non-financial topics that are not typically captured by traditional financial reporting offering a means for a company to measure its impact on society and the environment based on agreed metrics[5]. Table 1.1 provides an example of various criteria used in ESG reporting.

Table 1.1: Example of ESG criteria[6]

ENVIRONMENTAL	SOCIAL	GOVERNANCE
• Managing carbon and climate change vulnerabilities • Water, waste and pollution management • Transition to a circular economy • Renewable energy and clean technology • Consideration of the unique rights of First Nations peoples to access, maintain and protect their lands	• Human capital development • Health and safety • Ethical supply chain and sourcing • Human rights • Privacy and data security • Community engagement, including a focus on First Nations peoples	• ESG reporting • Risk-mitigation and management • Board diversity • Executive pay • Tax transparency • Business ethics • Policies that enhance corporate behaviour including protection of human rights

[2] Corporate Governance Institute (2023) What is ESG and why is it important? https://www.thecorporategovernanceinstitute.com/insights/news-analysis/what-is-esg-and-why-is-it-important/

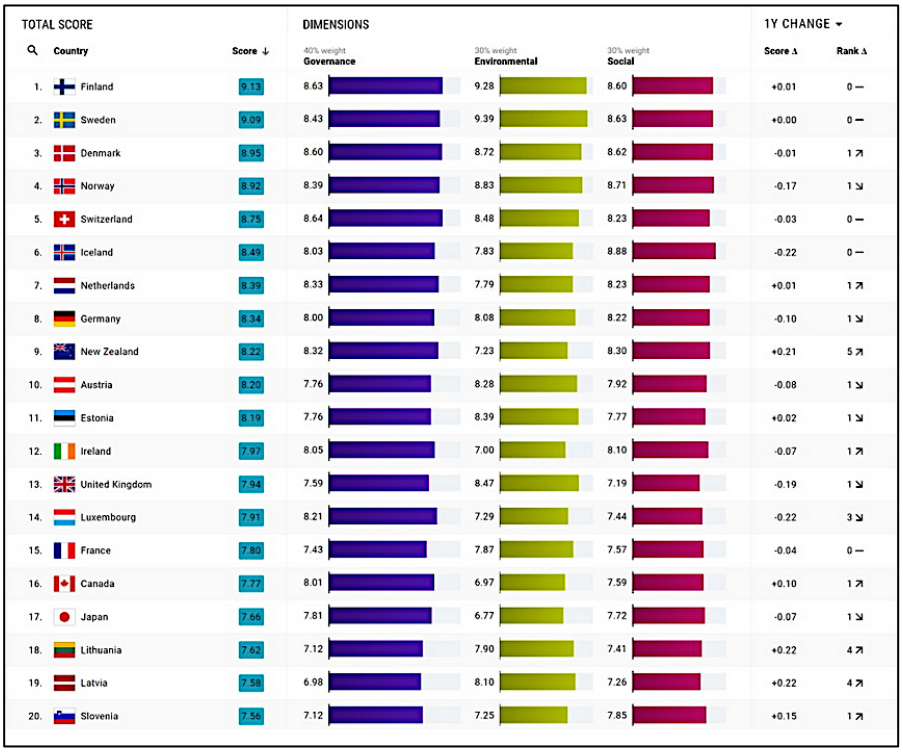
[3] UN Global Compact (2023) Integrate the Principles of Responsible Investment. https://unglobalcompact.org/take-action/action/responsible-investment

[4] Preqin (2023) History of ESG https://www.preqin.com/preqin-academy/lesson-5-esg/history-of-esg

[5] PWC Australia (2023) Environmental, Social and Governance (ESG). https://www.pwc.com.au/environment-social-governance.html

[6] PWC Australia (2023) Environmental, Social and Governance (ESG). https://www.pwc.com.au/environment-social-governance.html

The trends of global ESG are apparent with global ESG assets predicted to reach $53 trillion[7] by 2025 and investors are pushing for new ESG products however, the demand is outstripping the supply[8]. ESG rating agencies are independent organisations employed by a company that examines their ESG policies and practices to measure the positive or negative impact on ESG to determine the company's sustainability performance. ESG ratings can be at a country level and at a company level. The RobecoSAM Country Sustainability Ranking assesses countries spanning emerging and developed economies based on a comprehensive framework for analysing countries' performance on a wide range of ESG metrics. The purpose is to compare countries on the basis of various ESG features considered to be material and financially relevant for investors. The country ESG score is based on 50 indicators, summarized in 15 criteria with a weighting of 30% environmental, 30% social and 40% governance. 150 countries were assessed with the top 20 countries ranked as of April 2023[9] (see Figure 1.1).



TOTAL SCORE			DIMENSIONS			1Y CHANGE	
	Country	Score	40% weight Governance	30% weight Environmental	30% weight Social	Score Δ	Rank Δ
1.	Finland	9.13	8.63	9.28	8.60	+0.01	0 —
2.	Sweden	9.09	8.43	9.39	8.63	+0.00	0 —
3.	Denmark	8.95	8.60	8.72	8.62	-0.01	1 ↗
4.	Norway	8.92	8.39	8.83	8.71	-0.17	1 ↘
5.	Switzerland	8.75	8.64	8.48	8.23	-0.03	0 —
6.	Iceland	8.49	8.03	7.83	8.88	-0.22	0 —
7.	Netherlands	8.39	8.33	7.79	8.23	+0.01	1 ↗
8.	Germany	8.34	8.00	8.08	8.22	-0.10	1 ↘
9.	New Zealand	8.22	8.32	7.23	8.30	+0.21	5 ↗
10.	Austria	8.20	7.76	8.28	7.92	-0.08	1 ↘
11.	Estonia	8.19	7.76	8.39	7.77	+0.02	1 ↘
12.	Ireland	7.97	8.05	7.00	8.10	-0.07	1 ↗
13.	United Kingdom	7.94	7.59	8.47	7.19	-0.19	1 ↘
14.	Luxembourg	7.91	8.21	7.29	7.44	-0.22	3 ↘
15.	France	7.80	7.43	7.87	7.57	-0.04	0 —
16.	Canada	7.77	8.01	6.97	7.59	+0.10	1 ↗
17.	Japan	7.66	7.81	6.77	7.72	-0.07	1 ↘
18.	Lithuania	7.62	7.12	7.90	7.41	+0.22	4 ↗
19.	Latvia	7.58	6.98	8.10	7.26	+0.22	4 ↗
20.	Slovenia	7.56	7.12	7.25	7.85	+0.15	1 ↗

Figure 1.1: Highest 20 Sustainable Countries in the World[10]

[7] Bloomberg (2021) ESG assets may hit $53 trillion by 2025, a third of global AUM. https://www.bloomberg.com/professional/blog/esg-assets-may-hit-53-trillion-by-2025-a-third-of-global-aum/
[8] PWC (2022) Asset and wealth management revolution 2022: Exponential expectations for ESG. https://www.pwc.com/awm-revolution-2022
[9] Robecco (2023) Most Sustainable Countries in the World. https://www.robeco.com/en-int/sustainable-investing/expertise/most-sustainable-countries-in-the-world
[10] Robecco (2023) Most Sustainable Countries in the World. https://www.robeco.com/en-int/sustainable-investing/expertise/most-sustainable-countries-in-the-world

Global companies are ranked by numerous global ESG ratings agencies with different methodologies with the top ten often referenced as presented in Table 1.2.

Table 1.2: Top Global ESG rating agencies

Bloomberg ESG	Disclosure Score
S&P Global Ratings	ESG Evaluation
CDP	FTSE Russell's ESG Ratings
ISS Governance	Quality Score
MSCI	Sustainalytics ESG
Risk Ratings	RobecoSAM Corporate
Sustainability Assessment	Thomson Reuter's
ESG Scores	Vigeo Eiris

An in-depth analysis of the maturity of ESG reporting across Australia's top 200 companies for 2021[11] found that more of the ASX 200 companies are reporting ESG information overall than in prior years, with the gap between the best and worst ESG reporting performers closing (see Figure 1.2).

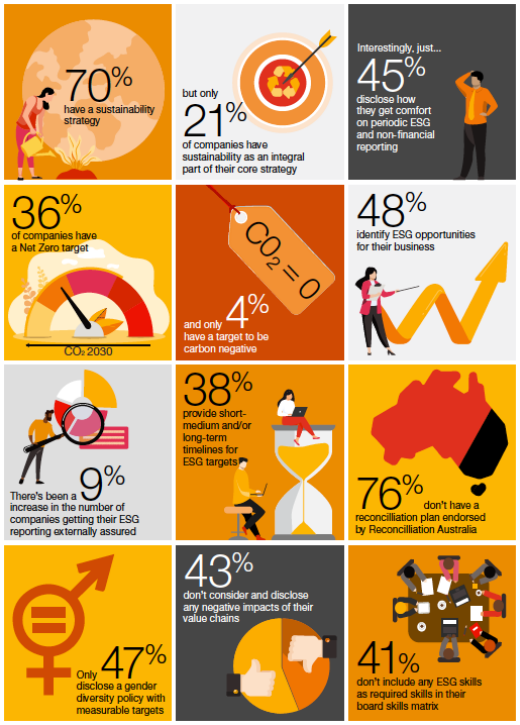


Figure 1.2: ESG reporting Australian companies 2021

[11] PWC (2022). ESG reporting in Australia the full story, or just the good story?

A major global study undertaken in 2022 found that the top 100 Australian listed companies (ASX100) are performing well on climate and ESG reporting. This biannual study of sustainability and ESG reports of 5,800 companies across 58 countries, found that 90% of the ASX100 recognise climate as a financial risk, compared to only 64 % of the largest global 250 companies (G250). There has also been a significant rise in the proportion of the ASX100 reporting carbon targets up to 89% compared to the largest G250 of 80%. The social aspect of ESG reporting found that 90% of the ASX100 reports on social risks to the business, compared to 49% of the G250[12]. There is a positive change in ESG reporting in Australia, however only 33% of the ASX200 have their sustainability report externally assured indicating that many companies would require significant improvements to meet the new global ISSB sustainability standards[13].

Trends in ESG for 2022 -2023[14] to consider include:

- The global move to align capital markets with sustainability goals through standards and regulation;
- Biodiversity and natural capital becoming a greater focus with increasing recognition of risks and opportunities;
- Focus on value chain emissions in climate change related reporting;
- Science based net-zero targets becoming the norm;
- Australian regulators set to legislate ESG standards;
- Sustainability reporting needs to span all levels of an organisation;
- Climate-related financial disclosures are dominating sustainability agendas;
- Expectations for ESG reporting will change with expectations for companies to report on other key areas, and
- Australian Government policies and legislation will impact businesses with global standards agreements and reporting to change the Australian reporting landscape.

[12] KPMG (2022) ASX100 companies performing strongly on climate and ESG reporting. https://kpmg.com/au/en/home/media/press-releases/2022/10/asx100-companies-perfroming-strongly-climate-esg-reporting-19-october-2022.html

[13] PCW Australia (2023) ESG Reporting and Governance Trends, 2023. https://www.pwc.com.au/assurance/esg-reporting/esg-reporting-and-governance-trends-2023.html

[14] PCW Australia (2022) ESG Trends in 2022. https://www.pwc.com.au/assurance/esg-reporting/esg-trends-in-2022.html
PCW Australia (2023) ESG Reporting and Governance Trends, 2023. https://www.pwc.com.au/assurance/esg-reporting/esg-reporting-and-governance-trends-2023.html

1.2 ESG Accounting Methods

There has been significant fragmentation of ESG regulations to date with hundreds of methods to assess corporate ESG without global, standardised corporate disclosure requirements which is considered the top barrier to investment[15]. In recognition of the fragmentation of ESG assessments the International Sustainability Standards Board (ISSB) published two International Financial Reporting Standards (IFRS) in June 2023 which aim to boost transparency in ESG information published by companies. IFRS S1 provides a set of disclosure requirements designed to enable companies to communicate to investors about the sustainability-related risks and opportunities they face over the short, medium and long term. IFRS S2 sets out specific climate-related disclosures and is designed to be used with IFRS S1.

Both sustainability standards IFRS S1 and S2 incorporate the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD)[16]. The Financial Stability Board (FSB) created the TCFD to develop recommendations on the types of information that companies should disclose to support investors, lenders, and insurance underwriters in appropriately assessing and pricing a specific set of risks related to climate change[17]. Under the new sustainability standards companies would report on all relevant sustainability topics (not just on climate-related risks) across governance; strategy; risk management and metrics; and targets. Companies would provide globally consistent sustainability disclosures through reporting that is connected to financial statements and released at the same time[18].

Many countries are expected to adopt the new ISSB sustainability standards through policies and regulation. The Australian Government has proposed to amend parts of the *Australian Securities and Investment Commission Act 2001* (ASIC Act) to deliver sustainability standards to meet the Government's commitment to ensure entities provide Australians and investors with greater transparency and accountability in relation to their climate-related plans, financial risks, and opportunities.

[15] UNDP (2023) Rethinking the Governance of ESG. https://www.undp.org/future-development/signals-spotlight/rethinking-governance-esg
[16] IFRS (2023) ISSB issues inaugural global sustainability disclosure standards. https://www.ifrs.org/news-and-events/news/2023/06/issb-issues-ifrs-s1-ifrs-s2/
[17] FSB (2023) Task Force on Climate-Related Financial Disclosures. https://www.fsb-tcfd.org/about/
[18] KPMG (2023) Get Ready for ISSB Sustainability disclosures https://kpmg.com/au/en/home/insights/2022/04/issb-sustainability-reporting-disclosures-guide.html

The proposed regulatory amendments aim to empower the Australian Accounting Standards Board (AASB) to create sustainability standards allowing the Australian Auditing and Assurance Standards Board (AUASB) to develop auditing and assurance standards for sustainability purposes, and provide the Financial Reporting Council (FRC) with strategic oversight of these new standards which are proposed to largely align with the new ISSB sustainability standards[19]. Coupled with this proposed amendment to the ASIC Act the Australian Government will introduce standardised, internationally-aligned reporting requirements for businesses to make disclosures regarding governance, strategy, risk management, targets and metrics including greenhouse gasses[20]. Table 1.3 provides an overview of the Australian Government's 'Climate Related Financial Disclosure' consultation paper key points.

Table 1.3: Australian Government consultation paper overview[21]

Australian Government Climate Related Financial Disclosure	
Reporting framework	Disclosure on climate governance, strategy, risk management and targets and metrics would be required, in alignment with the TCFD framework. Flexibility would be inbuilt to accommodate the future ISSB standards.
Entities within scope	Initially, large listed companies and large financial institutions, subject to size thresholds. A broader range of entities are expected to be brought within scope over time.
Timing	Possible phased application from 2024, with first reports due for the 2024-25 financial year.
Regulatory mechanisms	Two main options are being consulted on: 1. legislative amendments to the Corporations Act 2001 and Corporations Regulations 2001 would set out the overarching obligations for climate disclosure (governance, strategy, risk management, targets and metrics), with more prescriptive disclosure requirements detailed in regulatory standards or guidance; or 2. existing requirements to disclose material risks as part of an OFR would be broadened, with the overarching obligations for climate disclosure set through regulatory standards or guidance. Three different structures are being consulted on for regulatory oversight: confirm the AASB as the responsible entity; establish a separate board; or reform existing financial reporting bodies into a single entity.

[19] Commonwealth of Australia (2022) Treasury Laws Amendment (Measures for consultation) Bill 2022: Sustainabiity Standards. Exposure Draft Explanatory Materials.
[20] Australian Government (2022) Climate-related Financial Disclosure Consultation Paper.
[21] Herbert, Smith, Freewills (2022) Next Steps for Australia's Mandatory Climate Reporting Regime. https://www.herbertsmithfreehills.com/latest-thinking/next-steps-for-australia%E2%80%99s-mandatory-climate-reporting-regime

Reflection

Consider that the companies Coles and Woolworths command around 60 per cent of fresh food and grocery sales in Australia.

What might be the implications for the Australian agri-food value chain to ensure sustainability given the mandatory implementation of new sustainability standards and climate-related financial disclosures in 2024?

How might this impact farmers market access?

1.3 Growth and focus of ESG Investors

ESG-related assets under management are expected to increase to US$33.9 trillion by 2026 with a projected compound annual growth rate of 12.9% with estimated projections of ESG assets to constitute 21.5% of total global assets under management by 2027[22].

Investing in sustainable agriculture is considered to be in its early days though the potential benefits are being identified given analysis[23] undertaken in 2015 found that industrialised farming practices causes $3 trillion per year in environmental impact globally. Sustainable agriculture offers many solutions and innovations to move away from industrial farming systems with ESG investors turning their interest to sustainable agriculture as a way to fight climate change. US$4.6 trillion was invested in sustainable agriculture of the total US$17 trlllion invested in ESG issues during 2020[24].

[22] PWC (2022) ESG-focused institutional investment seen soaring 84% to US$33.9 trillion in 2026, making up 21.5% of assets under management: PwC report. https://www.pwc.com/gx/en/news-room/press-releases/2022/awm-revolution-2022-report.html

[23] S&P Global (2020) How is agriculture impacted by ESG investing. https://www.spglobal.com/en/research-insights/articles/how-is-agriculture-impacted-by-esg-investing

[24] Market Watch (2021) Sustainable agriculture is the next way ESG investors can fight climate change. https://www.marketwatch.com/story/7-ways-for-esg-investors-to-profit-from-sustainable-agriculture-11616600205

Key findings from the '2022 Responsible Investment Benchmark Report Australia'[25] found:

- Australia's responsible investment market reached $1.54 trillion in 2021, up from $1.28 trillion in 2020 which places responsible investment with a 43% share of the total market;
- Investment managers continue to increase the amount of assets that are managed with responsible investment approaches, growing by $616 billion since last year with the top three responsible investment approaches:
    - ESG integration ($752 billion)
    - corporate engagement and shareholder action ($726 billion)
    - and negative/exclusionary screening ($705 billion).
- Responsible investment products continue to outperform the overall market in the multi-asset category on all timeframes as well as the domestic equity category;
- Corporate engagement and shareholder action saw the greatest dollar value increase with an additional $255 billion assets under management in 2021. 45% of investment managers are now reporting on both their corporate engagement activities and the outcomes achieved. Assets under management in sustainability-themed investing more than doubled to $161 billion (from $76 billion) and now includes $19 billion in sustainability-linked loans;
- The industry continues to innovate and expand their responsible investment activities by launching new types of responsible investment products, including several types of sustainability linked loans and green bonds, and
- Climate continues to be a strong theme for both positive and negative screening.

[25] Responsible Investment Association Australasia (2022) Responsible Investment Benchmark Report 2022 Australia.

Reflection

The FAIRR Initiative (FAIRR) is a collaborative investor network that raises awareness of the environmental, social and governance (ESG) risks and opportunities in the global food sector with a focus on the issues linked to intensive animal production. The **Coller FAIRR Protein Producer Index** is the world's only comprehensive assessment of the largest animal protein producers on critical environmental, social and governance (ESG) issues which assesses 60 of the world's largest protein producers.

Three Australian companies have been identified including Tassal Group (aquaculture) which was listed as medium risk, Inghams (poultry and eggs) listed as high risk, and Australian Agriculture Co (beef) listed as high risk.

See Figure 1.3 for the ESG factors used by the **Coller FAIRR Protein Producer Index**. Consider how these Australian agricultural companies could reduce their ESG risks.

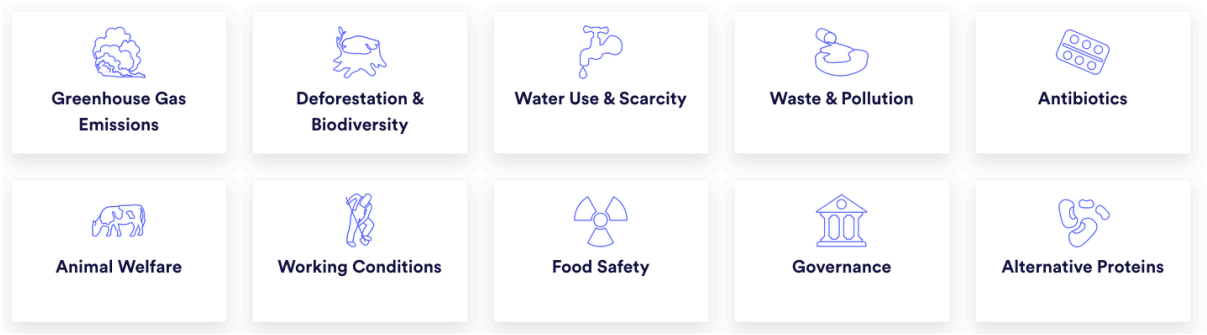


Figure 1.3: Coller FAIRR Protein Producer Index ESG factors

1.4 Implications on the Australian agri-food supply chain

The progress to ensure consistent agreed metrics for ESG to report sustainability at both the country and organisation level has created a clear set of requirements for ESG reporting. However, to date there is no international benchmark defining what "sustainable agricultural production" entails no a universally accepted set of metrics to measure sustainability performance of agriculture at the farm scale.

As '*sustainable agriculture'* is considered to crosscut numerous of the Sustainable Development Goals (SDGs), the Food and Agriculture Organisation of the United Nations (FAO) has developed a methodology inclusive of the economic, social and environmental dimensions of sustainable production, with the data collected for each country via farm surveys to report on their compliance with the SDGs. The metric is known as SDG Indicator 2.4.1 'the proportion of agricultural area under productive and sustainable agriculture' with the metrics presented in Table 1.4[26].

Table 1.4: SDG Indicator 2.4.1

No.	Theme	Sub-indicators
1	Land productivity	Farm output value per hectare
2	Profitability	Net farm income
3	Resilience	Risk mitigation mechanisms
4	Soil health	Prevalence of soil degradation
5	Water use	Variation in water availability
6	Fertilizer pollution risk	Management of fertilizers
7	Pesticide risk	Management of pesticides
8	Biodiversity	Use of agrobiodiversity-supportive practices
9	Decent employment	Wage rate in agriculture
10	Food security	Food insecurity experience scale (FIES)
11	Land tenure	Secure tenure rights to land

[26] FAO (2023) Proportion of agricultural area under productive and sustainable agriculture (SDG Indicator 2.4.1) METHODOLOGICAL NOTE (REVISION 11)

At the Australian level, the only two definitions and potential metrics of sustainable agriculture are from the 1990s being the Natural Heritage Trust Act 1997 which defined sustainable agriculture in '*section 16'* followed by the Standing Committee on Agriculture and Resource Management who published a broad set of indicators in 1998. These dated Australian metrics are no longer in use no relevant in relation to ESG and sustainability validation along the Australian agri-food supply chain.

To respond to the demand for sustainability there are a proliferation of Voluntary Sustainability Standards (VSSs) across the globe with more than 400 VSSs available for use by a farmer to show the value chain the sustainability credentials of agricultural products. VSSs provide manufacturers and retailers with information about reliability and safety; and consumers with information about the sustainability efforts taken in the production and manufacturing, focusing on positive outcomes for the environment and the community[27].

A VSS stipulates a set of social, economic and environmental requirements that farmers can voluntarily comply with in order for their production and processing practices to be recognised as sustainable. This is done through a standard which requires farmers to follow certain practices and procedures and upon verification of compliance with the standard (often through third party audit) the VSS issue a certificate or label demonstrating compliance, which can be useful for market access and price premiums. There are positives and negatives to the impact on trade by VSSs. VSS can enhance trade through several mechanisms (for example market access and price premiums) or can impede trade due to the cost impediments for farmers associated with certification, compliance and monitoring where the value chain does not compensate the farmer for the certification costs referred to as the 'sustainability-driven supplier squeeze' . Coupled with this is the lack of technical resources and the tenuous nature of a price premium. These barriers combined can exclude producers from developing countries from value chains in which certification increasingly is becoming defacto mandatory[28]. Figure 1.4 provides an overview of potential VSS impact on trade.

[27] International Institute for Sustainable Development (2023) Standards and Value Chains. https://www.iisd.org/topics/standards-and-value-chains

[28]

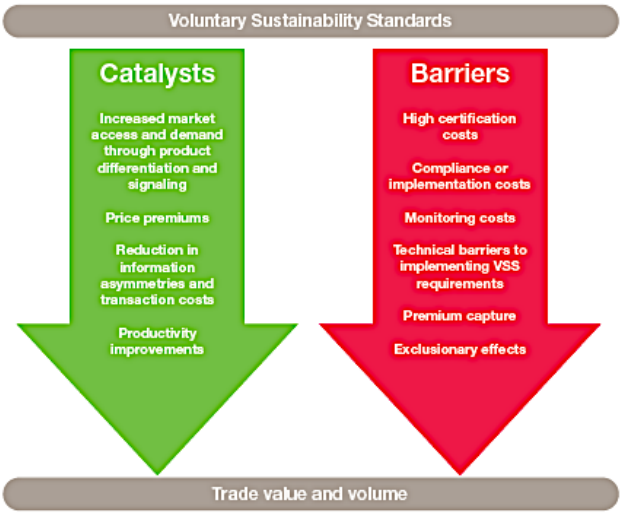


Figure 1.4: Channels of potential VSS impact on trade[29]

There are many private sustainability standards (with different metrics) available to Australian farmers to verify their sustainability credentials, however these standards are operating within a vacuum where the agri-food value chain is not coordinated or having agreement on which standard should be utilised.

Similar to the global proliferation of VSSs this is also occurring in Australia in response to the global market, international obligations and looming regulatory changes in relation to ESG and climate. In Australia many of the Rural Research and Development Corporations (RDCs) each have a sustainability framework for their sector however often these frameworks have not been translated into a farm-scale sustainability assessment except for the Australian Wine sector.

Explore the following case study on the Australian Wine sector sustainability program through the links provided.

[29] United Nations Conference on Trade and Development (2023) Voluntary Sustainability Standards in International Trade

Case Study: Australian Sustainable Wine

Read Wine Australia's commitment to a sector-wide sustainability and ESG strategy for the Australian grape and wine sector.

Visit the Sustainable Wine Growing webpage for an overview of how to become certified under the Sustainable Winegrowing Australia standard.

Visit the feature article Cellar beware: Why ESG matters for Australian wineries

Reflection

From your understanding of ESG gained from this Module, what are your thoughts about the ramifications for farmers that are not compliant with ESG requirements?

Do you agree that banks may not fund farmers, insurers may not want to insure farmers, and consumers may not buy their farm products if they don't have their ESG house in order?

Natural Capital

Module 2

Learning Outcome

This module will provide an understanding of Natural Capital at the global and national level and the implications on the Australian agri-food supply chain to validate sustainability.

Specifically, this module will provide an overview to answer the following questions:

- What is Natural Capital?
- What are the accounting methods globally and nationally?
- What are the banking and insurance sector policies and initiatives?
- What are the implications on the Australian agri-food supply chain?

2.1 Natural Capital

Nature's contribution to the global economy is estimated to be USD$125 trillion per year[30]. Natural Capital includes both natural assets and ecosystems and their services[31] which underpin all economic activities and human well-being making it the world's most important asset. However, humanity's demands on natural capital are unsustainable[32].

[30] Costanza, R., De Groot, R., Sutton, P., Van der Ploeg, S., Anderson, S. J., Kubiszewski, I.,& Turner, R. K. (2014). Changes in the global value of ecosystem services. Global environmental change, 26, 152-158

[31] OECD (2020), How's Life? 2020: Measuring Well-being, OECD Publishing, Paris, https://doi.org/10.1787/9870c393-en.

[32] OECD (2021) Biodiversity, Natural Capital and the Economy. https://www.oecd.org/env/biodiversity-natural-capital-and-the-economy-1a1ae114-en.htm

Natural capital is another term for the stock of renewable and non-renewable resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people. The concept of natural capital extends beyond nature as a source of raw materials for production (e.g. timber) to include the role of the environment and ecosystems in supporting human well-being through the supply of goods and services such as clean water, fertile soils and valuable genetic resources[33].

The World Bank[34] considers natural capital as environmental assets critical for human well-being that provide significant economic and social benefits. Natural capital is the value of everything that comes from nature which gives humanity the essential means for a life-supporting society and economy. The 'capital' part of natural capital refers to the notion that there are resources (or capital) in nature that humanity needs to use to survive that enable the production of more resources. The concept of natural capital reminds society that the world has a limited amount of resources and that overuse and degradation of these natural resources have adverse impacts for humanity and the Earth[35]. Investing in biodiversity makes both environmental and economic sense with the World Economic Forum estimating that protecting nature and increasing biodiversity could generate business opportunities worth $10 trillion a year and create nearly 400 million new jobs[36].

The unsustainable use of natural resources through overexploitation coupled with climate change and pollution has resulted in a state of natural capital deficit globally[37]. The World Economic Forum's '*Global Risks Report 2023'* underpinned by the Global Risks Perception Survey (2022-2023) brings together leading insights from over 1,200 experts across the World Economic Forum's diverse network. This report found that the global risks ranked by severity over the short and long term indicate the predominant risk perceptions are environmental (see Figure 2.1).

[33] United Nations (2023) System of Environmental Economic Accounting. https://seea.un.org/content/natural-capital-and-ecosystem-services-faq
[34] World Bank (2023) Natural Capital. https://www.worldbank.org/en/topic/natural-capital
[35] European Investment Bank (2023) What is Natural Capital https://www.eib.org/en/stories/nature-environment-pollution
[36] United Nations (2022) https://press.un.org/en/2022/dsgsm1798.doc.htm#:~:text=Investing%20in%20biodiversity%20makes%20both,nearly%20400%20million%20new%20jobs.
[37] Deloitte (2023) Banking on Natural Capital. https://www2.deloitte.com/au/en/pages/about-deloitte/articles/banking-natural-capital.html

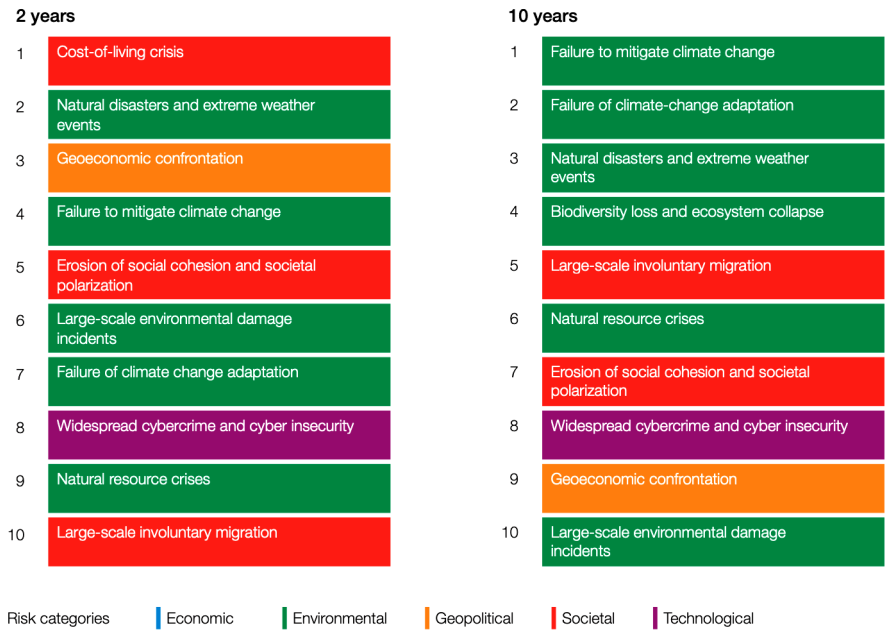


Figure 2.1: Global Risks ranked by severity[38]

The World Economic Forum has estimated that US$44 trillion (more than half the world's economic output) is moderately or highly dependent on the world's natural capital. The World Bank[39] estimates that the global economy could lose $US 2.7 trillion by 2030 (compared to business as usual) if certain ecosystem services collapse (pollination, carbon sequestration and storage, fisheries and timber provision). In low-income countries, GDP could decline 10% annually on average, with higher losses in countries particularly dependent on ecosystem services. Understanding the value of a country's environmental assets is the key to sustainable development and economic growth.

[38] World Economic Forum (2023) The Global Risks Report 2023. https://www.weforum.org/reports/global-risks-report-2023/in-full/1-global-risks-2023-today-s-crisis#1-global-risks-2023-today-s-crisis

[39] "Johnson, Justin Andrew; Ruta, Giovanni; Baldos, Uris; Cervigni, Raffaello; Chonabayashi, Shun; Corong, Erwin; Gavryliuk, Olga; Gerber, James; Hertel, Thomas; Nootenboom, Christopher; Polasky, Stephen; Gerber, James; Ruta, Giovanni; Polasky, Stephen. 2021. The Economic Case for Nature: A Global Earth-Economy Model to Assess Development Policy Pathways.

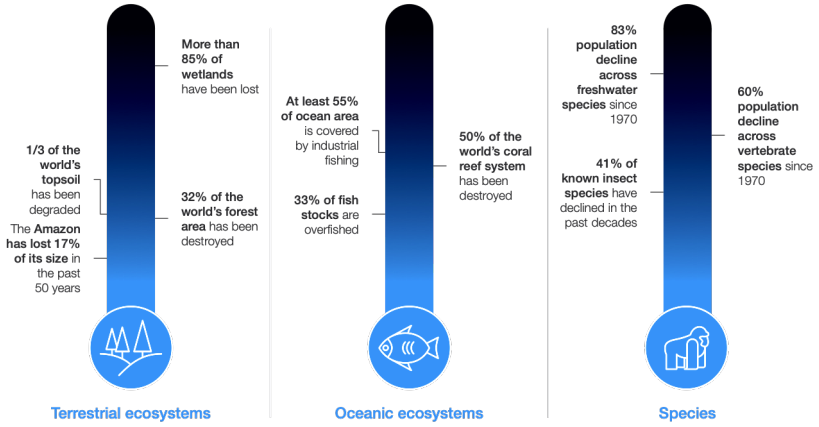


Figure 2.2: Human activity is eroding the world's ecological foundations[40]

The value of Australia's natural assets has risen to $6,562 billion (6.5 trillion) as at 30 June 2018 with land accounting for 90 per cent of the total value of Australia's environmental assets at $5,921 billion (almost 6 trillion)[41]. Despite this growing value Australia's natural capital is at risk. A recent assessment[42] found at least 19 Australian ecosystems have been reported to show signs of collapse or near collapse, although none has yet collapsed across the entire distribution. Ecosystems experiencing collapse span the Australian continent and include Antarctic, and subantarctic ecosystems.

The '*2021 State of the Environment Report'* (SoE 2021)[43] provides an independent, comprehensive and evidence-based assessment of the state of Australia's environment. The findings of this report for the Australian natural assets of soils, native vegetation, biodiversity, inland water and air are presented in brief as follows:

- Soils: Australian soils and the agricultural landscape are degraded and face a number of challenges, including erosion, acidification, salinisation, sodification, soil carbon loss, contamination, and urban and industrial expansion;

[40] World Economic Forum (2020) Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy
[41] Australian Bureau of Statistics (2019) 4655.0 Australian Environmental-Economic Accounts, 2019.
[42] Bergstrom et al (2021) Combating ecosystem collapse from the tropics to the Antarctic. Glob. Change Biol., 27: 1692-1703. https://doi.org/10.1111/gcb.15539
[43] Cresswell ID, Janke T, Johnston EL (2021). Overview: Key findings. In: *Australia State of the environment 2021*, Australian Government Department of Agriculture, Water and the Environment, Canberra, https://soe.dcceew.gov.au/overview/key-findings, DOI: 10.26194/f1rh-7r05, ISBN: 978-0-646-86427-3

- Native vegetation: In many parts of Australia, native vegetation has been cleared or degraded and fragmented by human activity to enable other uses of the land. Despite significant investment Australia's native vegetation continues to decline in extent and condition;
- Biodiversity: finding that Australian biodiversity was poor and deteriorating in comparison to previous assessments with earlier State of the Environment Reports. The main threats for biodiversity are Invasive species, clearing native vegetation, habitat loss, degradation, fragmentation, introduced species and disease;
- Inland Water: Since the 2016 State of the Environment Report, the pressures of climate, development and management, and the resulting state and trends of surface waters, groundwater, water quality, ecological processes and species populations have mostly deteriorated, and
- Air: Australia generally has good air quality however, since the 2016 State of the Environment Report various events have had significant short-term impacts on Australia's air quality, particularly the bushfires of 2019-2020.

The Responsible Investment Association Australasia (RIAA)[44] identified five investor relevant risks through company portfolios based on the dependencies and impacts of those companies on ecosystem services as financially material risks which may arise if those ecosystem services are compromised (see Figure 2.3).

1. Natural capital produces ecosystem services 2. Companies are highly dependent on ecosystem services 3. When natural capital is damaged/destroyed, ecosystem services are compromised 4. When ecosystem services are compromised, these companies become vulnerable to financial losses through the key risk pathways outlined above	5. This vulnerability flows through to investors who have a financial stake in exposed companies, manifesting in: ➢ Credit risk ➢ Reduced liquidity ➢ Market risk ➢ Raised insurance premiums ➢ Investment and capital costs ➢ Reduced business model

Figure 2.3: Natural Capital and Ecosystem Services risk perspective[45]

[44] Responsible Investment Association Australasia (2022) Nature in a nutshell: Natural capital, ecosystem services and nature-based solutions.
[45] Responsible Investment Association Australasia (2022) Nature in a nutshell: Natural capital, ecosystem services and nature-based solutions.

The RIAA advise for investors looking to take the next step in relation to natural capital is to follow the five key actions[46]: collaborate with global and local initiatives; advocate for your institutions to act on more nature conservation activities; use sustainable investment techniques; shift investments into sustainability focused industries or assets, and educate yourself.

Reflection

Consider the value of Australia's natural assets, the '*Australia State of the Environment Report 2021'* findings, and the focus of responsible investors on natural capital. Given agricultural lands encompass 55% of the Australian landscape, what might be the key risks for Australian agricultural enterprises ?

2.2 Natural Capital Accounting Methods

Natural Capital Accounting Systems (based on ecosystem accounting) are in the early stages of development both globally and nationally. The United Nations adopted the SEEA Ecosystem Accounting (SEEA) as the global standard for ecosystem accounting in March 2021[47]. SEEA constitutes an integrated and comprehensive statistical framework for organizing data about habitats and landscapes, measuring the ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity. The conceptual model adopted by the Australian Bureau of Statistics (ABS)[48] is SEEA. Ecosystem accounts track how changes in the environment affect our wellbeing and economy. They build on land accounts to give us the next level of detail. For example, a land account can show changes in forest cover while an ecosystem account can describe the condition of the remaining forest and the effects on local communities. Ecosystem accounts are a reliable way for economic policy to include the value of the natural environment[49].

[46] Responsible Investment Association Australasia (2022) Nature in a nutshell: Natural capital, ecosystem services and nature-based solutions

[47] UN (2023) Ecosystem Accounting https://seea.un.org/ecosystem-accounting/

[48] ABS (2021) The System of Integrated and Environmental Economic Accounting https://www.abs.gov.au/statistics/detailed-methodology-information/concepts-sources-methods/australian-system-national-accounts-concepts-sources-and-methods/2020-21/chapter-23-satellite-accounts/environmental-economic-accounts/system-integrated-environmental-and-economic

[49] Australian Department of Climate Change, Energy, Environment and Water (2023) Ecosystem Accounts https://eea.environment.gov.au/accounts/ecosystem-accounts

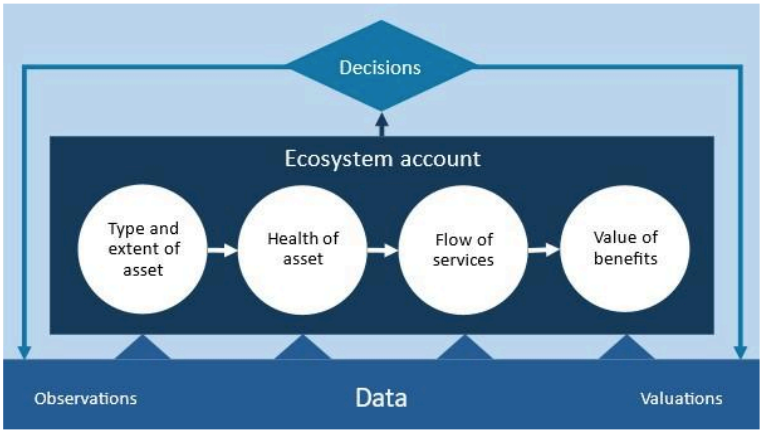


Figure 2.4: Australian Ecosystem Accounts[50]

2.3 Finance and Insurance Sector Natural Capital Initiatives

In response to the urgent issue of protecting global natural assets there are a number of initiatives to incorporate natural capital into the finance sector. The Natural Capital Declaration (NCD) is a finance-led initiative to integrate natural capital considerations into loans, public and private equity, and fixed income and insurance products is a commitment by CEOs from the finance sector to work towards integrating natural capital criteria into their products and services[51]. The NCD will be achieved through the NCD Roadmap via the development of new metrics and tools, and support the development of accounting, disclosure and reporting frameworks that incorporate natural capital factors[52]. To date the NCD has been signed by the CEOs of more than 40 financial institutions globally. For relevance the Australian financially relevant institutions that are signatories to the NCD include National Australia Bank and Rabobank.

The Natural Capital Finance Alliance (NCFA) provides the knowledge and tools to help the financial sector and other partners work together to reduce and manage the risks of environmental impacts and dependencies. NCFA is led by a Steering Committee made up of leading financial institutions and environmental experts who enable banks, investors and insurers to make better decisions by assessing their impacts and

[50] Australian Department of Climate Change, Energy, Environment and Water (2023) Ecosystem Accounts https://eea.environment.gov.au/accounts/ecosystem-accounts
[51] United Nations Environment Program (2012) Natural Capital Declaration. https://www.unepfi.org/publications/natural-capital-declaration/
[52] United Nations Environment Program (2013) Natural Capital Declaration Roadmap. https://www.unepfi.org/news/natural-capital-declaration-roadmap/

dependencies on nature[53]. Another tool that is available to financial institutions to determine natural capital risk assessment is *'Integrating Natural Capital in Risk Assessments'* [54] a step-by-step guide to conduct a rapid natural capital risk assessment enabling financial institutions to understand and assess their exposure to natural capital risks. A recent publication in 2023 '*Banking on nature: What the Kunming-Montreal Global Biodiversity Framework means for responsible banks'* authored by the United Nations Environment Finance Initiative (UNEP FI) and its Principles for Responsible Banking (PRB), presents the key implications for banks of the goals and targets of the Global Biodiversity Framework (GBF) providing practical examples for the various departments of a bank for immediate actions that can be taken[55]. Businesses needs to include natural capital in their decisions due to the accelerating depletion and unsustainable use of natural resources. There are global regulatory and market drivers requiring the degradation of natural capital to be internalised in a business balance sheet.

To support businesses '*The Natural Capital Protocol*' (a decision-making framework) has been developed by the Capitals Coalition that enables businesses to identify, measure and value their direct and indirect impacts and dependencies on natural capital[56].

[53] Natural Capital Finance Alliance (2023) https://naturalcapital.finance/
[54] United Nations Environment Program (2019) Integrating Natural Capital in Risk Assessments. https://www.unepfi.org/publications/integrating-natural-capital-in-risk-assessments/
[55] United Nations Environment Program Finance Initiative (2023) Banking on nature: What the Kunming-Montreal Global Biodiversity Framework means for responsible banks. https://www.unepfi.org/industries/banking/banking-on-nature/
[56] Capitals Coalition (2023) Natural Capital Protocol https://capitalscoalition.org/capitals-approach/natural-capital-protocol/?fwp_filter_tabs=guide_supplement

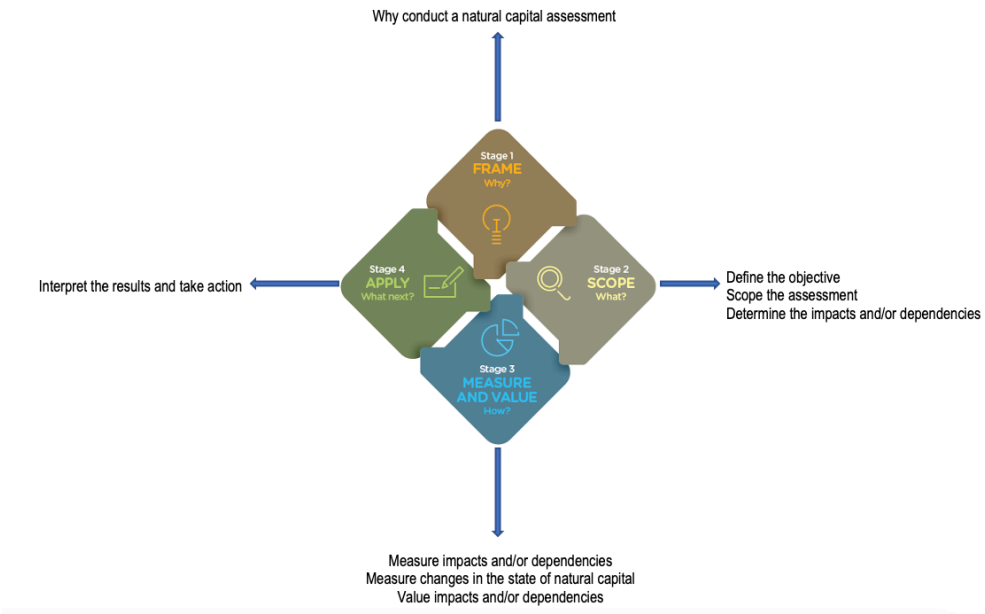


Figure 2.5: The Natural Capital Protocol Process[57]

Similar to the finance sector there have been numerous global initiatives towards sustainable insurance. The United Nations Environment Program Finance Initiative (UNEP FI) launched the '*Principles for Sustainable Insurance'* (PSI) in 2012 which acts as a global framework for the insurance industry to address ESG risks and opportunities. The vision of the PSI Initiative encompasses a risk-aware world where the insurance sector fully engages in its role to enable a healthy, safe, resilient and sustainable society. The Four Principles for Sustainable Insurance are:

- To embed in our decision-making environmental, social and governance issues relevant to our insurance business;
- To work together with our clients and business partners to raise awareness of environmental, social and governance issues, manage risk and develop solutions;
- To work together with governments, regulators and other key stakeholders to promote widespread action across society on environmental, social and governance issues, and
- To demonstrate accountability and transparency in regularly disclosing publicly our progress in implementing the Principles[58].

[57] Adapted from Capitals Coalition (2023) Natural Capital Protocol https://capitalscoalition.org/capitals-approach/natural-capital-protocol/?fwp_filter_tabs=guide_supplement

[58] UNEP FI (2023) The Principles United Nations Environment Finance Initiative. https://www.unepfi.org/insurance/insurance/the-principles/

In June 2020, leading insurers and UNEP launched the first global insurance industry guide '*Managing ESG risks in non-life insurance business*' outlining eight areas of sustainability risks for insurers to manage ESG risks in non-life insurance transactions, focussing on risk assessment and insurance underwriting[59]. The Net Zero Insurance Alliance (NZIA) was launched in 2021 and since that time have developed the foundational concepts and frameworks to support its members work towards decarbonising their insurance and reinsurance underwriting portfolios. These include the NZIA statement of commitment; the NZIA white paper on net-zero insurance; the PCAF Insurance-Associated Emissions Standard, and the NZIA Target-Setting Protocol[60]. A call for greater action was made by the United Nations in June 2022 for sustainable insurance in a planetary crisis through six key tasks for insurers to commit to including as follows: net-zero transition; a nature-positive transition and pollution prevention; climate resilience and adaptation**;** sustainability; accountability, transparency and sustainability expertise; and create sustainable insurance roadmaps[61].

The Allianz Group one of the world's leading insurers and asset managers identified a failure by companies to manage natural resources brings increasing interruption and liability risks for businesses with the sectors of oil and gas, mining, food and beverage and transportation sectors having the highest natural capital risk exposure[62]. With these global initiatives on implementing nature positive insurance, there are expectations that the insurance sector can assist in the protection of natural capital through new insurance products that integrate the impact on, and dependencies of, natural capital[63].

[59] UNEP FI (2023) Managing environmental, social and governance risks in non-life insurance business. https://www.unepfi.org/industries/insurance/managing-environmental-social-and-governance-risks-in-non-life-insurance-business/

[60] UNEP FI (2023) Net-Zero Insurance Alliance. https://www.unepfi.org/net-zero-insurance/

[61] UNEP (2022) Sustainable Insurance in a Time of Planetary Crisis. https://www.unep.org/news-and-stories/speech/sustainable-insurance-time-planetary-crisis

[62] Allianz (2018) Allianz report: Failure to manage natural resources brings increasing interruption and liability risks for businesses. https://www.agcs.allianz.com/news-and-insights/news/natural-capital-risks.html

[63] UNDP Insurance and Risk Finance Facility (2023) Ensuring nature positive insurance - Can the insurance sector help safeguard our natural capital? https://irff.undp.org/blog/ensuring-nature-positive-insurance-can-insurance-sector-help-safeguard-our-natural-capital

The Australian agricultural sector is at risk given to date the condition of natural capital has not been integrated in either agricultural finance or insurance products. If a farmer's natural capital is degrading then access to finance could become an impediment, as would insurance where premiums could become cost prohibitive or insurance not available at all until natural capital issues are addressed.

Activity

ENCORE[64] (Exploring Natural Capital Opportunities, Risks and Exposure) developed by the Natural Capital Finance Alliance is a tool to help users better understand and visualise the impact of environmental change on the economy. By focusing on the goods and services that nature provides to enable economic production, ENCORE assists users in understanding how businesses across all sectors of the economy potentially depend and impact on nature, and how these potential dependencies and impacts might represent a business risk. Open the online tool ENCORE. Experiment by selecting sub-industry then choose 'agricultural products' and then select production process and choose 'large-scale livestock'. You will see nature dependencies (as ecosystem services and natural assets) and impacts (as impact drivers and natural assets). Explore the ecosystem services, natural assets and impact drivers of large-scale livestock agricultural enterprises.

2.4 Natural Capital and the Australian Agri-food Supply Chain

FAO[65] identified sustainable food value chain development encompassing three principles being measuring performance, understanding performance and improving performance (see Figure 2.6).

[64] Natural Capital Finance Alliance (2023) ENCORE. https://encore.naturalcapital.finance/en/about
[65] FAO (2014) Developing sustainable food value chains – Guiding principles. www.fao.org/sustainable-food-value-chains/library/details/en/c/265156/

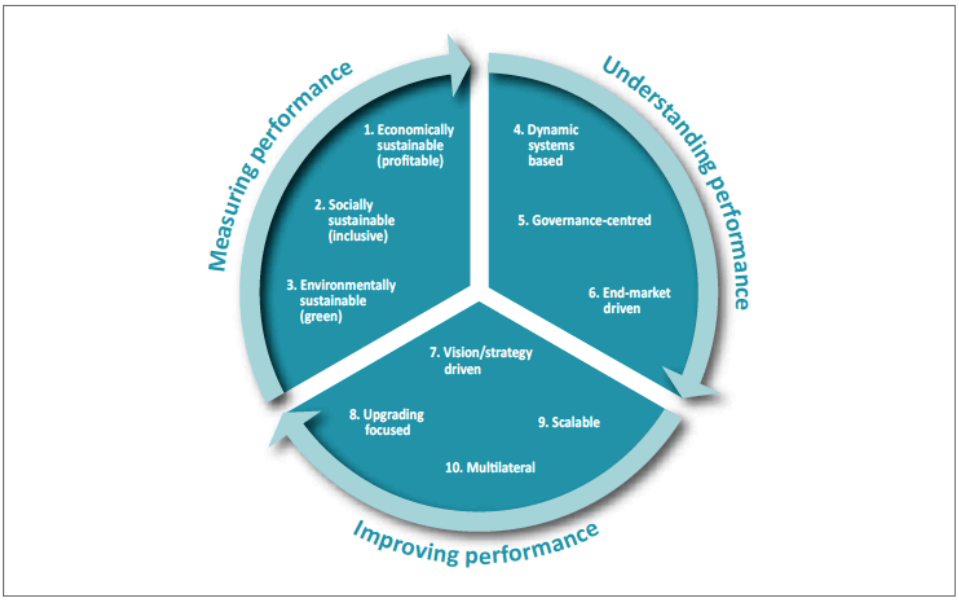


Figure 2.6: Principles of sustainable food value chain development[66]

The unsustainable use of natural resources coupled with climate change and pollution has led to a state of natural capital deficit globally. This deficit is of concern as natural capital risk also becomes a business risk given around half of the world's gross domestic product is highly to moderately dependent on nature either directly or indirectly. Supply chains are also dependent on natural capital with these organisations likely to face significant operational risks as a result of a diminishing source of natural assets not to mention regulatory and reputational risks from their use and impact on natural capital[67].The current food system is not sustainable and is contributing to climate change, biodiversity loss, and social inequality[68] and is responsible for around a quarter of global greenhouse gas emissions and close to 60% of biodiversity loss since the 1970s[69]. Decarbonisation of the agricultural industry is a priority as is the effects on nature and human society given agricultural lands encompass 50% of global habitable land and responsible for 70% of freshwater withdrawals. Food systems are considered the primary driver of global biodiversity

[66] FAO (2014) Developing sustainable food value chains – Guiding principles. www.fao.org/sustainable-food-value-chains/library/details/en/c/265156/

[67] LEK Consulting Sustainability Centre of Excellence (2023) Natural Capital: Assessing Organisational Risks and Uncovering Opportunities. https://www.lek.com/insights/sus/global/ar/natural-capital-assessing-organisational-risks-and-uncovering-opportunities

[68] World Economic Forum (2023) Here's how we can make our food system more sustainable. https://www.weforum.org/agenda/2023/06/making-food-system-more-sustainable/

[69] World Bank (2023) Food Systems 2030. https://www.worldbank.org/en/topic/agriculture/brief/food-systems-2030

loss around the world[70]. Figure 2.7 provides an overview of the types of risk factors that organisations encounter when leveraging different natural capital resources. Lack of mitigation of these risks can result in adverse financial implications and competitive advantage, whereas improvements of the use and impact on natural capital can provide market opportunities due to differentiation and business longevity.

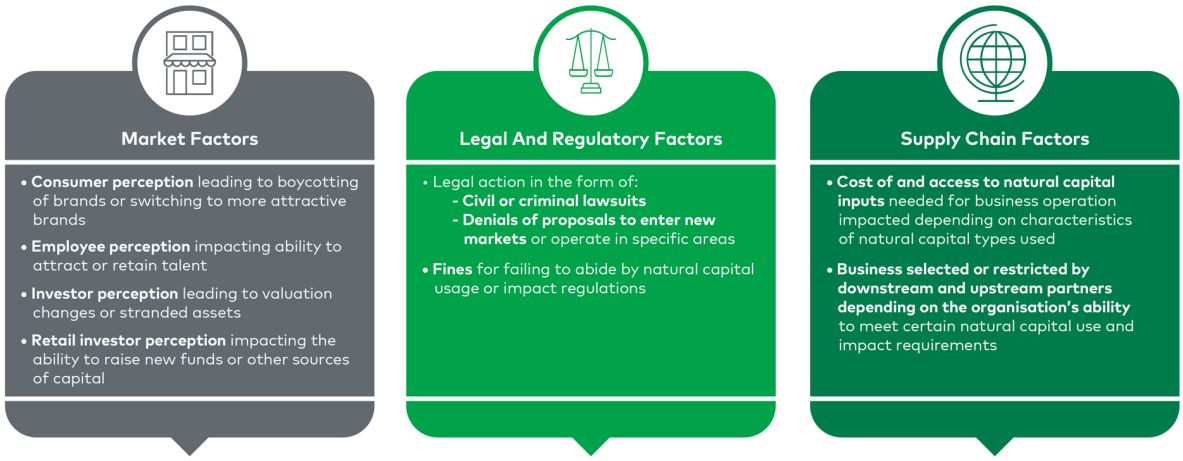


Figure 2.7: Categories influenced by an organisation's use and impact on Natural Capital[71]

2.4.1 Agri-food Environmental Sustainability Supply Chain: Case Study

A study on the "Ecological Balance of Agri-Food Supply Chains—The Case of the Industrial Tomato" assessed the environmental sustainability of an agri-food chain of industrial tomatoes in Puglia, Italy[72] (see Figure 2.8).

[70] McKinsey (2023) The agricultural transition: Building a sustainable future. https://www.mckinsey.com/industries/agriculture/our-insights/the-agricultural-transition-building-a-sustainable-future

[71] LEK Consulting Sustainability Centre of Excellence (2023) Natural Capital: Assessing Organisational Risks and Uncovering Opportunities. https://www.lek.com/insights/sus/global/ar/natural-capital-assessing-organisational-risks-and-uncovering-opportunities

[72] Martella, A.; La Porta, I.M.; Nicastro, M.; Biagetti, E.; Franco, S. Ecological Balance of Agri-Food Supply Chains—The Case of the Industrial Tomato. Sustainability 2023, 15, 7846. https://doi.org/10.3390/su15107846

Figure 2.8: Case Study Location Puglia, Italy

This case study relied on the concept of strong sustainability through the conservation of natural capital and its non-replacement with economic capital assessed by comparing the availability and use of natural capital in economic activities through the ecological footprint method. The results found an overall unsustainability of the entire supply chain with the agricultural phase the only stage of the supply chain to present a positive value which failed to compensate for the impacts of the transport and industrial phases. This case study shows the importance of using the ecological footprint method rather than carbon footprint or Life-Cycle-Assessment (LCA) which do not include the supply of natural capital nor the environmental services provided by agriculture. Sustainability assessment in the agri-food supply chain requires the appropriate methods and tools to encompass the contributions of agriculture. This is the first study to assess the sustainability of the tomato food chain using the ecological footprint method which incorporates the effective environmental impact of human activities on ecosystems to determine actual environmental measures.

A Corporate Needs Assessment Report on '*Measuring the Impact of Agricultural Supply Chains on Biodiversity*'[73] found that a guide for value chain participants was needed to navigate existing biodiversity initiatives and approaches. The guide should be outcome focused and provide actionable advice to businesses with agricultural

[73] Sharon Brooks, Julie Dimitrijevic, Kim Dunn, Kiran Sehra, Yann Verstraeten (2021) Measuring the Impact of Agricultural Supply Chains on Biodiversity'. https://tradehub.earth/2021/03/30/measuring-the-impact-of-agricultural-supply-chains-on-biodiversity-corporate-needs/

supply chains and their existing targets and goals. The guide should facilitate the uptake of biodiversity indicators, measurement and reporting to allow businesses to demonstrate their contributions to global efforts to reverse the current biodiversity crisis. The needs assessment found that the guide should be targeted at supply chain managers and sustainability managers, as this would be the most useful audience within the businesses and ensure that the guide was accessible to all organisations to improve measurement of biodiversity within the supply chain.

Figure 2.9: Target Audience for the Biodiversity Guidance

At the global and national scale, Natural Capital is defined as the natural assets that deliver ecosystem services essential to human health and healthy economies. Whilst there is an agreed method internationally for accounting for Natural Capital at the national scale, there is no agreed method to benchmark and monitor natural capital at the farm scale in Australia.

Reflection

At present Australia does not have an agreed methodology to describe and assess natural capital at the farm scale. Reflecting on the lessons from the Italian tomato case study and the priorities of responsible investors, finance and insurance sectors, what is required to enable sustainable Australian agri-food value chains that incorporates Natural Capital?

Benchmarking On-Farm Natural Capital

Module 3

Learning Outcome

This module will identify and demonstrate the methods for description and assessment of on-farm environmental assets. Awareness of these methods are important particularly to bankers, insurance agents and farmers to understand the processes and resources available to benchmark and report on-farm natural capital within the agri-food value chain.

Specifically, this module will provide an overview to answer the following questions:

- What on-farm natural capital data can farmers, bank managers, insurance agents and the agri-food value chain access through public online GIS mapping resources?
- What environmental assessment methods should a farmer utilize to benchmark and monitor on-farm natural capital?
- What visual assessments can bankers and insurance agents undertake when visiting a farm to determine on-farm natural capital?

3.1 On-Farm Natural Capital

In Module 2 we described Natural Capital (at the global and national scale) as environmental assets that deliver ecosystem services essential to human health and healthy economies. Whilst there is an agreed method internationally for accounting for Natural Capital at the national scale, there is no agreed method to benchmark and monitor natural capital at the farm scale in Australia.

Issues for Australian farmers:

- No agreed farm scale methodology to measure condition of natural capital
- Crowded space of multiple projects and processes NOT at farm scale
- Not farmer/industry driven
- Banks, markets, investment funds are demanding, however farmers and land managers have no support or methods to apply
- Opportunities & Risks: ecosystem services and value chain versus no agreed methodology and high costs of monitoring

REFLECTION

Read this article: The $6.5tn question: How to capitalise on Australia's natural assets?

Reflect on the issues faced by Australian farmers in benchmarking on-farm natural capital and communicating with the agri-food value chain about the farm's sustainability.

What do you consider the innovations and services required to support Australian farmers to benchmark and monitor on-farm natural capital to be recognised in the agri-food value chain?

3.2 Description of On-Farm Environmental Assets

Environmental assets at the farm scale are best described and assessed under the following themes:

- Landscapes
- Geology - Soils
- Native Vegetation
- Biodiversity
- Water bodies

The methods introduced in this Module have been trialled by GLENRAC farmers in Northern Tablelands of NSW during 2021 and 2022 and the methodology assessed

by NSW Local Land Services. As natural resources are governed at the state/territory levels (and there are slight variations of mapping and other resources available) this Module will focus on NSW on-farm natural capital whilst ensuring that the methods utilised align with recognised Australian standards that can easily be applied in other states/territories.

3.2.1 GIS Mapping Public Resources

Prior to a farm visit or assessing a farm's natural capital, desktop analysis can be undertaken via accessing maps of the farm through the open source NSW Government SEED Portal.

SEED is the NSW Government's central resource for Sharing and Enabling Environmental Data developed for the NSW community in a collaborative effort between government agencies to provide an accessible and reliable platform for environmental data[74].

Through the SEED Portal the following relevant farm map layers can be accessed:

- Property information:
    - Cadastral boundaries (Title)
    - Roads (Address)
    - Base map aerial image
- Landscape:
    - IBRA (Interim Biogeographic Regionalization for Australia) regions and sub-regions
    - Mitchell Landscapes
    - Land Use
    - Land and Soil Capability
- Geology
    - Simplified surface geology
- Soils
    - Australian Soil Classification
    - Greater Soils Group
- Native Vegetation
    - Native Vegetation Classes

[74] NSW Government (2023) SEED The Central Resource for Sharing and Enabling Environmental Data in NSW. https://www.seed.nsw.gov.au/

    - Plant Community Types
    - Native Vegetation Regulatory Map
    - Biodiversity Values Map
- Waterbodies
    - Lake,Reservoir,Dam,River,Creek,Channel,Aqueduct,Marsh,Wetland,Estuary,Coastal Waters

Each one of these map layers utilize agreed Australian and NSW scientific descriptions of environmental assets. The SEED map layers provide a broad overview of the natural resources occurring on the farm and provide an invaluable starting point to describe the environmental assets at the farm scale prior to conditional assessment. These maps are often not ground-truthed and can be at a scale that requires validation and further assessment at the farm paddock level to ensure local farm-scale data is included.

Bank managers and insurance agents can download these maps prior to a farm site visit to be more familiar with the environmental assets on the farm from a broad regional perspective. Farmers can download these maps as the foundational base for their farm plan to commence farm scale ground-truthing and conditional assessment of the different environmental assets occurring on the farm to benchmark the farm's natural capital. The information derived from these maps can inform a desktop review broadly describing the environmental assets on the farm; the landscape values; the land-use and land-soil capability; and the native vegetation and biodiversity regulatory requirements.

ACTIVITY

Launch the SEED Map

Using Tocal College Farms in the Hunter Valley as an example to explore SEED maps undertake the following searches to get familiar (utilising the visual guide provided):

- Search for 'Tocal Farms'
- Locate Tocal Farm property boundary
- Apply the Australian Soils Classification map layer
- If you feel confident exploring SEED maps further. Experiment with other environmental asset layers you can locate to view within the Tocal Farm property boundary.

Once you are familiar with SEED it is possible to access the relevant environmental asset layers to utilise for on-farm environmental asset description in a very short timeframe. There are also database point sources within some of the map layers that provides more detailed information if you select these point sources.

3.3 Assessment of On-Farm Environmental Assets

Assessment of on-farm environmental assets can be undertaken using rapid appraisal methods that are recognized by Government, NRM/Landcare sectors, land managers and environmental professionals.

Utilizing the relevant maps obtained through the SEED mapping exercise, farmers can begin to ground-truth the maps and undertake conditional assessment of their environmental assets. The following will provide an overview of rapid appraisal methods that are available for farmers to assess soil health; native vegetation condition, biodiversity, riparian zones and water quality.

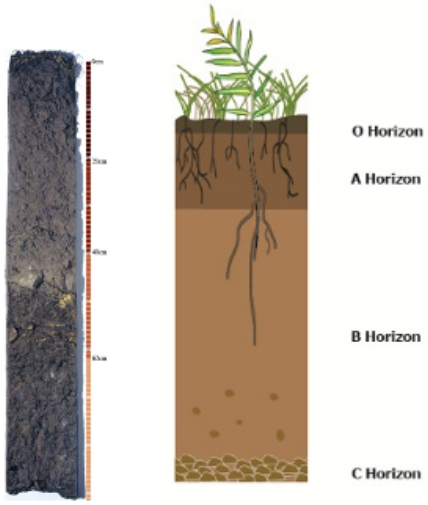
Soils

Australia uses the Australian Soil Classification (ASC) system which uses diagnostic horizons and soil features to group and separate soils[75]. The ASC uses a set of defined attributes, horizons and material to assign a soil profile to a particular class

[75] Soil Science Australia (2023) Soil Classification. https://www.soilscienceaustralia.org.au/about/about-soil/soil-classification/

within the ASC[76]. There are fifteen different 'orders' within the ASC, whereas the subgroup level being the Great Soil Group (GSG) allows further definition through the soil profile characteristics with 49 different GSG's identified within NSW[77].

To describe the soils occurring on the farm prior to conducting soil health assessment activities exposing a soil profile should be undertaken utilising the soils map and farmer knowledge of the different ASC soil types occurring on the farm. Once the different soil types have been identified on the farm, on each soil type choose a location to dig or expose the soil profile to a depth of up to 0.5 to 1 metre (depending on the soil type).



Test the soil profile at each horizon for texture, colour, mottles, structure and pH. Digging the soil profile is the most time-consuming component of this test depending on the site, with the testing of the soil profile (all horizons) taking up to 15 minutes. This method only needs to be undertaken once on the farm.

Soil health is a measure of the sustainability of soil management practices. Standard soil chemical tests are often undertaken to determine nutrient levels. However, these provide very limited information on soil biology and physical properties. The use of relatively simple assessments of soil health can enhance our understanding of the

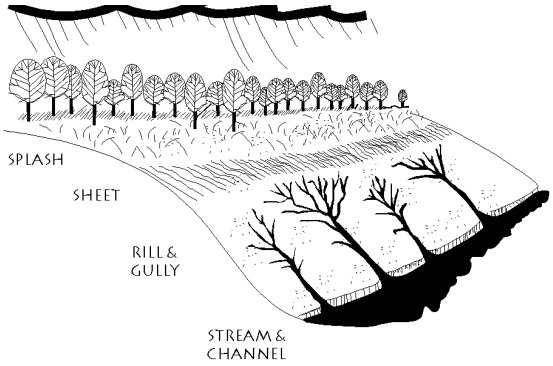
[76] Isbell, R.F (2021) The Australian Soil Classification. https://www.publish.csiro.au/book/8016;SITEKEY=main
[77] Department of Planning, Industry and Environment (2021) *Soil Group (GSG) Soil Type map of NSW* - Version 4.5, Department of Planning, Industry and Environment, Parramatta.

physical, chemical and biological status of the soil and also provide a means of establishing a baseline of the soil health of the farm at a point in time as a benchmark.

The '*Landcare Rapid Assessment Soil Health (RASH) Manual'* is nationally recognised for on-farm soil health assessment including nine soil health indicators being groundcover; infiltration; aggregate stability; sodicity; pH; salinity, root depth, root volume and soil organisms. Based on the soil types found on the property establish a transect on each soil type (the length of the transect depends on the paddock size and land-use) and test the indicators at 5 sites along the transect. This method is more time consuming depending on the number of soil types and land management practice. Allow 30 – 45 minutes for each transect testing (5 sites along each transect). It is recommended to undertake this assessment on an annual basis.

The '*Haney Total Soil Health'* available through the Southern Cross University's Environmental Analysis Laboratory (EAL) is best to provide more detailed laboratory information about the health of the soils collected on the soil transects. The Haney Soil Health Score is a summary of the microbial respiration, Water Extractable Organic Carbon (WEOC) and Water Extractable Nitrogen (WEN) measured by the Haney Test and represents the current health level of your soil based on these indicators. Haney Soil Health Score is aimed at providing a producer a quick reference regarding the health of their soil compared to other soils under different types of management (Ward Laboratories Inc 2022). Samples for the Haney Soil Test are collected at the same time as doing the transect soil assessment and will take up 5 -10 minutes of your time to collect the samples as required by EAL.

There are a variety of types of soil erosion that could occur on the farm as a result of current and/or historic practices and severe weather events (water erosion and wind erosion).



(source: NSW DPI 2023)

Based on the farmer's knowledge from field assessment areas of erosion can be recorded on the SEED farm base map including sheet erosion, rill erosion, gully erosion, tunnel erosion, wind erosion, landslip, and streambank erosion.

Imagine that a banker or insurance agent was to undertake a field visit for one hour as part of financial/insurance considerations about the farm. Rapid appraisal visual assessments of the health of the soils could be undertaken through observation of % groundcover and diversity of pasture plants in the paddocks; presence/absence of bare soil; presence/absence of soil erosion; presence/absence of shelter belts; presence/absence of riparian vegetation; presence/absence of fenced riparian zones; presence/absence of off-stream stock water points; water turbidity (cloudiness) of water bodies; presence/absence of soil piling up against fences or timber, and the presence/absence of native vegetation occurring on the steeper slopes of the farm. Such visual assessments would also need to be considered within the climate variability factors of dry and wet cycles of the La Nina – El Nino patterns.

REFLECTION

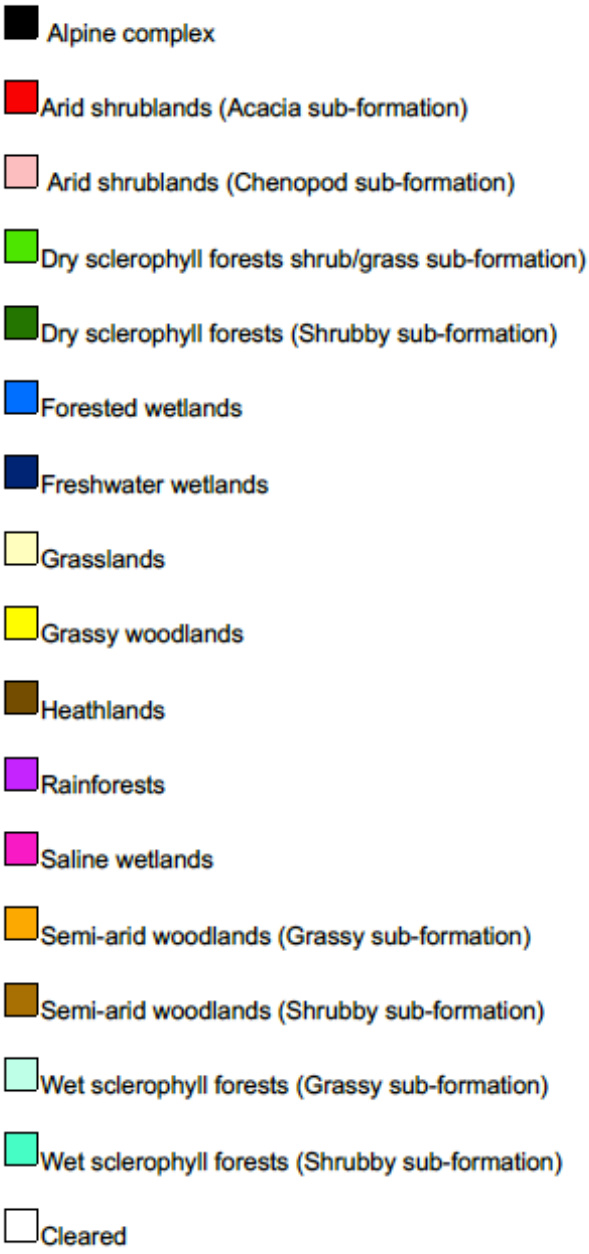
What support may farmers require to describe and assess the soils occurring on the farm? Should this include extension/field assessment and financial support?

What other support could be provided to encourage farmers to collect soil assessment data on an annual basis? Would bankers, insurance agents and the agri-food value chain accept a self-assessment of soil health undertaken by farmers?

Would this self-assessment method need to be validated? If so, by who?

Native Vegetation & Biodiversity

Assessment of on-farm native vegetation and biodiversity is informed and based on the NSW Government's "Biodiversity Assessment Method" and the NSW Local Land Services "Rapid Conservation Assessment Method" to ensure useability and validity at the farm scale. The methods have been synthesised and simplified for on-farm assessment. There are 16 native vegetation formations that occur in NSW as identified in the 'Vegetation Classes of NSW" SEED map layer (with 'cleared' added as an additional optional class).



Utilising the native vegetation map accessed from SEED a farmer can include local knowledge of the different vegetation types occurring on the farm and draw around and label native vegetation. Where there is vegetation that is not native such as modified pastures, crops, tree plantations or cleared areas the farmer can draw around these also and label. For a farmer to describe and assess each native vegetation class requires location in the field of each distinct native vegetation class identified on the SEED native vegetation map then a representative sample selected of the native vegetation class to describe and assess. In the field the farmer can take a photo of that representative sample site ensuring that each layer (upper, mid, lower stratum) is included and a record of coordinates of the sample location can be easily undertaken by iPhone. Native vegetation rapid appraisal includes the assessment of vegetation structure; large trees; non-indigenous woody/vine weeds and groundcover (weediness and native-ness). The same sample site can also be utilised for rapid appraisal of biodiversity through habitat assessment and threats which includes assessment of eleven different habitat features; presence and significance of threats/disturbances, and current management regime of the farm. Once the sample site is located on the farm, assessment of native vegetation and biodiversity takes up to maximum 15 minutes each site. Depending on the number of different native vegetation types occurring on the farm, and the size of the farm itself will determine the overall time required to complete the required assessment. These assessments can be undertaken annually or less often depending on the management practices within the native vegetation areas.

Imagine that a banker or insurance agent was to undertake a field visit for one hour as part of financial/insurance considerations about the farm. Rapid appraisal visual assessments of native vegetation and biodiversity could be undertaken through observation of the native vegetation structure; the presence/absence of large trees; the presence/absence of non-indigenous woody/vine weeds; the presence /absence of groundcover (including weediness and native-ness); the presence/absence of habitat features, and the presence/absence of site threats and disturbances. Desktop review of the native vegetation SEED farm map will also provide an overview of the biodiversity through the presence/absence of native vegetation connectivity, corridors and linkages across the farm and linking to the broader landscape.

Farmers, bank managers and insurance agents can also utilise online searches for occurrence of Threatened Ecological Communities (TECs) and Rare & Threatened Species (R&Ts) that may occur on or near the farm through:

- NSW Government Threatened Species Profile Search
- Australian Government Threatened Species and Ecological Communities

Riparian Zones

A riparian zone refers to the land that runs along rivers, creeks, estuaries, wetlands and lakes. The Rapid Appraisal of Riparian Condition (RARC) Version 2 produced by Land and Water Australia can be used to rapidly assess riparian zones. RARC encompasses measuring the attributes of:

- Longitudinal continuity of riparian canopy vegetation
- Proximity of nearest patch of native vegetation
- Width of riparian canopy vegetation
- Vegetation cover
- Debris
- Features

Once the length of the riparian zone is identified to be assessed and the transect sites are established along the riparian zone, assessment at each site can be undertaken in 10 minutes.

REFLECTION

Read the Report provided from the Mulloon Institute of their baseline rapid appraisal of riparian condition on the Mulloon Farm.

What do Figures 5 – 10 (pages 6-8) tell you about the condition of the riparian zones?

What are the practices changes that could be undertaken to restore the degraded riparian zones?

Water Quality Monitoring

To establish the baseline of the waterbodies on a farm requires consideration and measurement of the biological, chemical and physical attributes of the water.

Biological	Chemical	Physical
Macroinvertebrates Riparian assessment	Available phosphate Dissolved Oxygen	pH Electrical conductivity Temperature Turbidity

Generally, these measurements require the availability of a Waterwatch kit to be available to the farmer and need to be undertaken at least seasonally at strategic locations on the farm to inform about the health of the water bodies and links to farm management practices. NSW Waterwatch may be able to provide guidance and assistance to farmers to undertake on-farm water quality monitoring. Some farmer groups have pooled resources to purchase their own kits (around $2000) to undertake regular on-farm water quality monitoring.

Imagine that a banker or insurance agent was to undertake a field visit for one hour as part of financial/insurance considerations about the farm. Rapid appraisal visual assessments of water bodies could be undertaken through observation of turbidity (cloudiness) of water body; creek/river flow rate; presence/absence of waterholes – variation of channel depths; presence/absence of algae in water body; presence of aquatic life in/on water body; presence/absence of riparian vegetation; presence/absence of streambank erosion; presence/absence of fenced riparian zones; connectivity of native vegetation to riparian zone, and presence/absence of off-stream stock water points.

3.4 GIS Farm Planning Resources

There are a variety of GIS farm planning resources available for farmers who are interested in further development of their farm plans utilizing online GIS mapping products (licensed). Even though there isn't as yet a GIS natural capital focused farm plan, a few have been identified as useful resources for farmers as follows:

- Farm Map 4D
- AgData Australia
- AirAgri
- Australian Mapping
- Farm Plan

REFLECTION

On reflection of Module 3 consider the following questions:

- What data should a farmer document to benchmark and monitor on-farm natural capital?
- What can bankers and insurance agents access about on-farm natural capital prior to visiting a farm?
- What visual assessment of on-farm natural capital can bankers and insurance agents undertake whilst visiting a farm?
- How can the banking and insurance sectors and the agri-food value chain support farmers in benchmarking and monitoring on-farm natural capital?
- What extension, resources and financial support is required to enable farmers to benchmark and monitor on-farm natural capital?

On-Farm Ecosystem Services

Module 4

Learning Outcome

This module will provide an overview of the global and Australian context of the importance of ecosystem services, the definition and categorization of ecosystem services, and how this is applied at the farm scale.

Specifically, this module will provide an overview to answer the following questions:

- What are ecosystem services?
- What is the global and Australian context of the importance of ecosystems services?
- What are the categories of ecosystem services?
- How can these categories be applied at the farm scale?

4.1 What are Ecosystem Services?

In Module 3 we explored what is on-farm natural capital with a focus on the environmental assets of the farm that form part of a larger ecosystem. Following on from benchmarking on-farm natural capital is the exploration of the ecosystem services delivered from the environmental assets on the farm. This requires an understanding of the agreed definitions and categorization of ecosystems and ecosystem services.

An ecosystem is a dynamic community comprising populations of plants, animals, microorganisms and the non-living environment interacting together as a functional unit. An ecosystem functions by continually cycling energy and materials through living organisms that grow, reproduce and then die. Biodiversity, comprising animals, plants and microorganisms, their genetic variation and their organisation into populations that assemble into ecosystems is fundamental to the provision of ecosystem services.

Ecosystem services are the benefits provided to humans through the transformations of resources through ecosystems into a flow of essential goods and services e.g. clean air, water, and food from ecosystems.

Resilience is the key to *sustaining ecosystem services*, described as the the capacity of a system to maintain its equilibrium in the face of impacts or pressures that arise from natural or human-made interactions or events.[78]

Ecosystem Services encompass the benefits people obtain from ecosystems including **provisioning**, **regulating** and **cultural services** that directly affect people and the essential **supporting services** necessary for the production of all other ecosystem services.

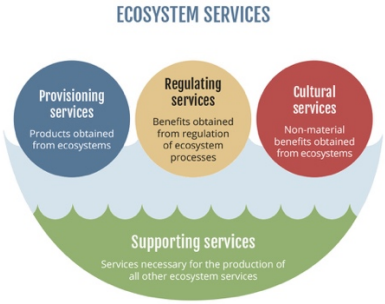


Figure 4.1 [79]

[78] Costanza, R., d'Arge, R., de Groot, R. *et al.* The value of the world's ecosystem services and natural capital. *Nature* **387**, 253–260 (1997). https://doi.org/10.1038/387253a0
Department of the Environment, Water, Heritage and the Arts (2009). *Ecosystem Services: Key Concepts and Applications*, Occasional Paper No 1, Department of the Environment, Water, Heritage and the Arts, Canberra.
[79] https://bonusbasmati.eu/wp-content/uploads/2018/02/BB_ES.jpg
https://climatechange.lta.org/wp-content/uploads/cct/2015/04/Ecowheel_ecosystemservices-e1428235934839.png

4.2 Global Ecosystems

To understand the source of ecosystem services requires an understanding of global ecosystems from a broad Biosphere perspective. There are five broad Realms (terrestrial, freshwater, marine, subterranean, atmospheric) that represent all parts of the Biosphere. Each of these Realms differ fundamentally in ecosystem organisation and function. Each Realm has different broad Biomes and from each Biome is identified different ecosystem types and function. A Biome represents major regional groupings of Earth's ecological systems. The IUCN Global Ecosystem Typology (2023) recently identified 108 Ecosystem Functional Groups within the Biomes occurring on Earth.

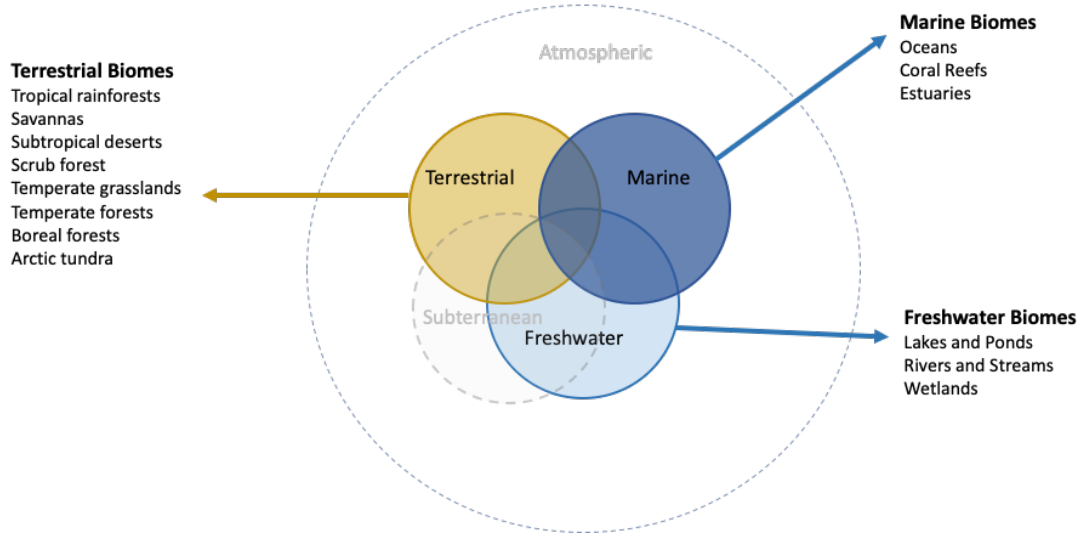


Figure 4.2 [80]

4.2.1 State of Global Ecosystems

Recent global environmental changes have led scientists to propose a new geological epoch called the **Anthropocene.** This new epoch is based on the observation that human impacts on essential planetary processes are so profound that they have driven the Earth out of the human friendly Holocene epoch[81]. If the pressures of the Anthropocene continue there is concern of the potential for rapid destablisation of

[80] Adapted from Global Ecosystem Typology 2023 https://global-ecosystems.org/page/typology

[81] Steffen W, Rockström J, Richardson K, Lenton TM, Folke C, Liverman D, Summerhayes CP, Barnosky AD, Cornell SE, Crucifix M, Donges JF, Fetzer I, Lade SJ, Scheffer M, Winkelmann R, Schellnhuber HJ. Trajectories of the Earth System in the Anthropocene. Proc Natl Acad Sci U S A. 2018 Aug 14;115(33):8252-8259. doi: 10.1073/pnas.1810141115. Epub 2018 Aug 6. PMID: 30082409; PMCID: PMC6099852.

Earth's ecosystems[82]. Recent studies[83] have found that Earth's ecosystems are deteriorating with only 3% of the global ecosystems considered to remain intact. Collapse of ecosystems imperils biodiversity, human health and well-being[84].

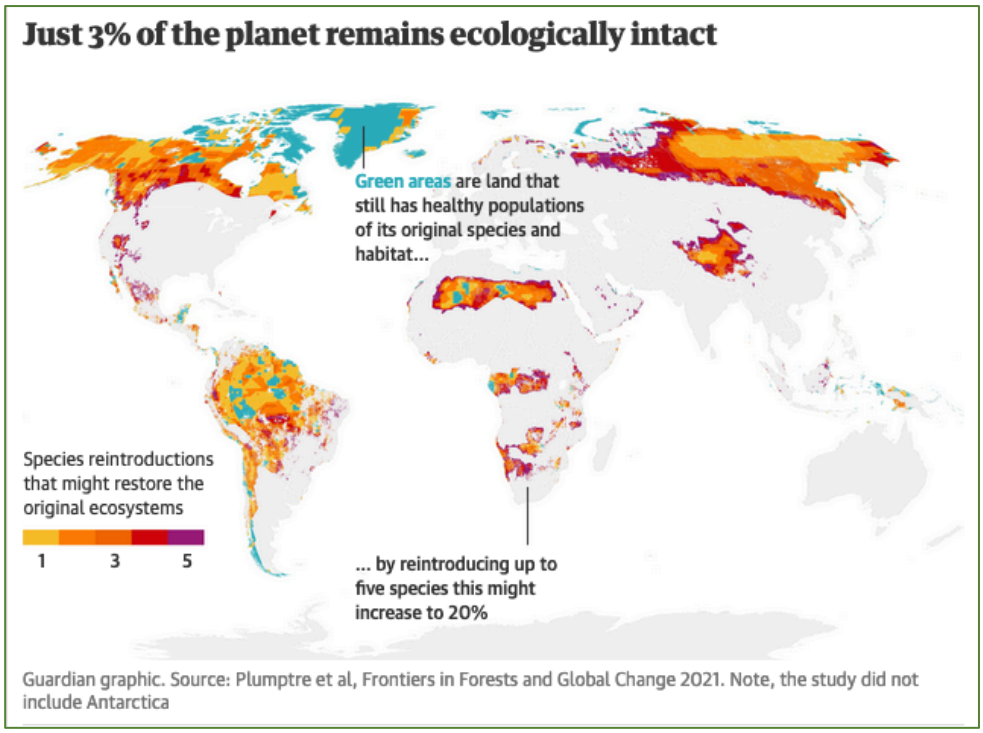


Figure 4.3

In response to the declining state of the global ecosystems the United Nations proclaimed 2021–2030 the '*United Nations Decade on Ecosystem Restoration'* calling for the protection and revival of ecosystems all around the world, for the benefit of people and nature. The UN Decade aims to halt the degradation of ecosystems and restore them to achieve global goals. The United Nations proclaimed the UN Decade following a proposal for action by over 70 countries from all latitudes calling for urgent action to protect and restore global ecosystems[85]. The UN Decade is also in alignment with the deadline for the Sustainable Development Goals (SDGs) and the timeline scientists have identified as the last chance to prevent catastrophic climate change.

---

[82] Willcock, S., Cooper, G.S., Addy, J. *et al.* Earlier collapse of Anthropocene ecosystems driven by multiple faster and noisier drivers. *Nat Sustain* (2023). https://doi.org/10.1038/s41893-023-01157-x

[83] Plumptre et al (2021) Where Might We Find Ecologically Intact Communities? Frontiers in Forests and Global Change Volume 4. https://www.frontiersin.org/articles/10.3389/ffgc.2021.626635/full

[84] Bergstrom et al (2021) Combating ecosystem collapse from the tropics to the Antarctic. Global Change Biology Volume 27 Issue 9 https://onlinelibrary.wiley.com/doi/10.1111/gcb.15539

[85] UN (2023) https://www.decadeonrestoration.org/

4.2.2 The Value of Global Ecosystem Services

A healthy ecosystem needs to be active, resilient to stress and able to maintain organisation and autonomy over time to produce ecosystem services for human wellbeing. Ecosystem health stewardship is a priority to maintain and improve ecosystem services[86].

Swiss Re Institute[87] identified that Biodiversity and Ecosystem Services (BES) underpin all economic activity in human societies globally and should be part of strategy discussions across financial services. They identified that 55% of global GDP is moderately or highly dependent on BES, with the implications of BES decline of growing interest in the finance and insurance sectors. To help assess the risks of biodiversity decline globally, Swiss Re designed a BES Index, which found that in 20% of all countries, ecosystems are in a fragile state for more than 30% of the entire country area. The BES Index provides a process of incorporating insurance and financial relevant BES factors into business decision-making to manage the operational, transitional, and reputational risks connected to BES decline.

[86] Hernández-Blanco, M., Costanza, R., Chen, H., deGroot, D., Jarvis, D., Kubiszewski, I., Montoya, J., Sangha, K., Stoeckl, N., Turner, K., & van 't Hoff, V. (2022). Ecosystem health, ecosystem services, and the well-being of humans and the rest of nature. *Global Change Biology*, 28, 5027– 5040. https://doi-org.ezproxy.scu.edu.au/10.1111/gcb.16281

[87] Swisse Re Institute (2020) Biodiversity and Ecosystem Services: A business case for re/insurance https://www.swissre.com/institute/research/topics-and-risk-dialogues/climate-and-natural-catastrophe-risk/expertise-publication-biodiversity-and-ecosystems-services.html#/

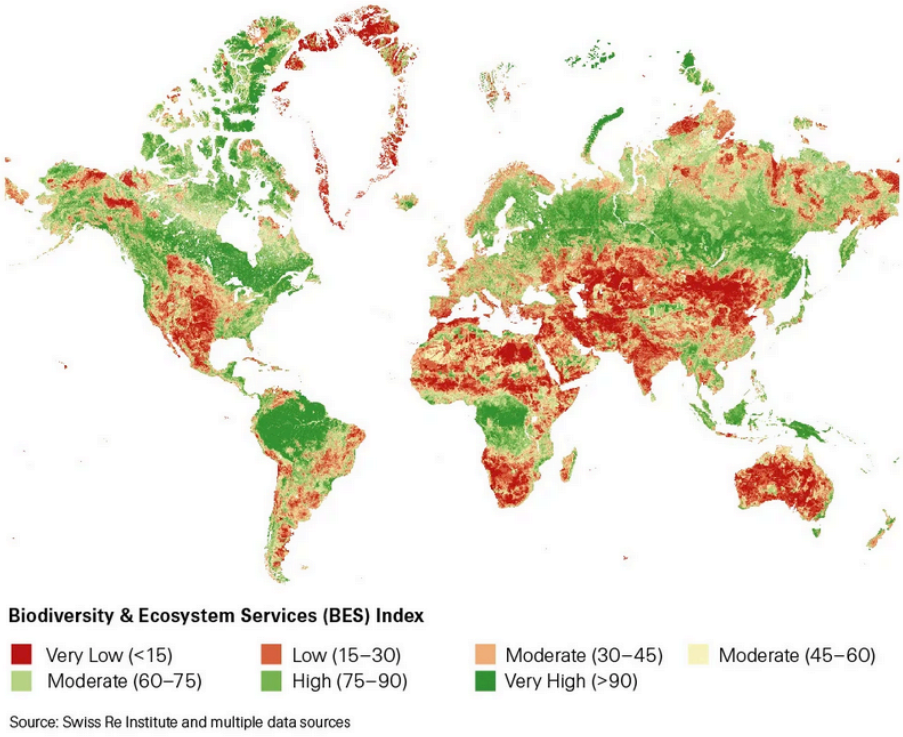


Figure 4.4

A comprehensive framework to evaluate the terrestrial gross ecosystem products (GEP) at the global scale was developed using remote sensing[88]. This study focused on the ecosystem provisioning services, regulating services and tourism services provided by 179 major countries from both biophysical and monetary dimensions. The results found that the range of global terrestrial GEP values was 108–187 trillion USD in 2017, with an average value of 147 trillion USD, and that the ratio of GEP to gross domestic product (GDP) was 1.86. The value of global ecosystem regulating services accounts for about 90%. GEP of the top ten countries are mainly composed of the value of climate regulation service and water conservation service Figure 4.5 provides an example of the global ecosystem service value of water conservation from this evaluation.

[88] Hongqiang Jiang, Wenjun Wu, Jinnan Wang, Weishan Yang, Yueming Gao, Yang Duan, Guoxia Ma, Chunsheng Wu, Jiacheng Shao, Mapping global value of terrestrial ecosystem services by countries, Ecosystem Services, Volume 52, 2021, 101361

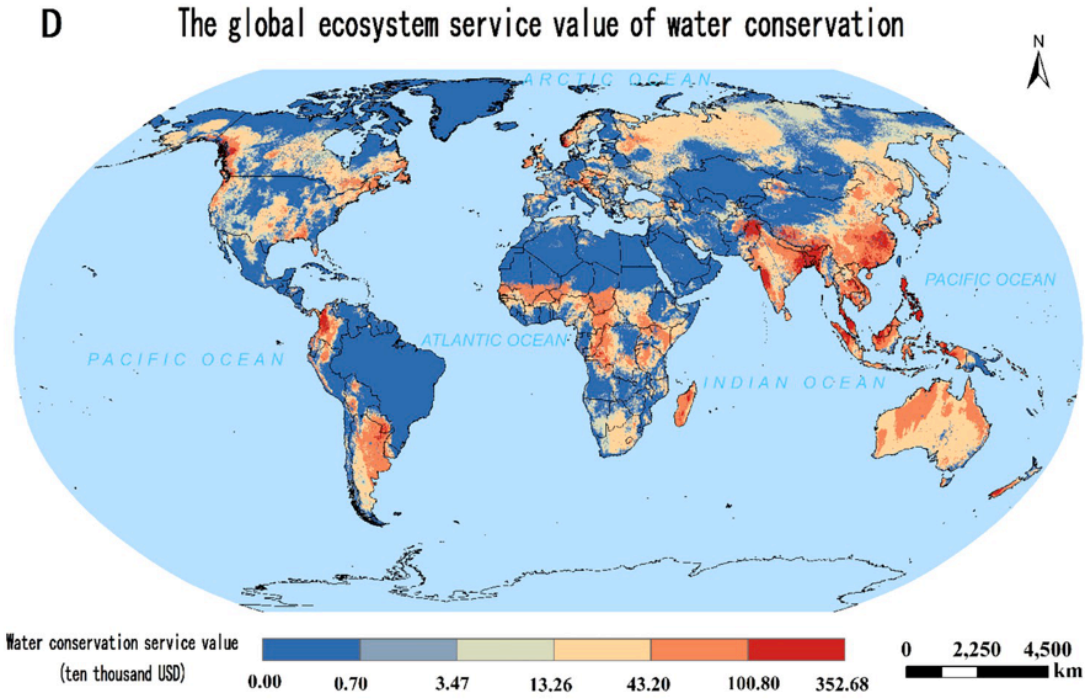


Figure 4.5

The World Bank[89] in their '*Economic Case for Nature'* Report identified that the collapse of select ecosystem services provided by nature (for example wild pollination, provision of food from marine fisheries and timber from native forests) could result in a decline in global GDP of $2.7 trillion annually by 2030. They identified that the global decline of biodiversity and ecosystem services is a development issue with economies unable to afford the risk of collapse in the services provided by nature and recommended nature-smart policies to reduce the risk of ecosystem collapse which can deliver both positive biodiversity and economic outcomes.

ACTIVITY

Watch Johan Rockström's inspiring talk about global change and planetary stewardship during the World Economic Forum 2017

Beyond the Anthropocene

What nature-smart policies could reduce the risk of ecosystem collapse and provide positive outcomes for both nature and economies?

[89] World Bank (2021) Protecting Nature Could Avert Global Economic Losses of $2.7 Trillion Per Year https://www.worldbank.org/en/news/press-release/2021/07/01/protecting-nature-could-avert-global-economic-losses-of-usd2-7-trillion-per-year

4.3 Australian Ecosystems

59 Australian ecosystems were mapped by TERN AusCover in 2017 being the first attempt at mapping the physical drivers of ecosystem formation and providing insight into the ecological facets of Australia. The mapping was largely based on the physical drivers of ecosystem formation being macroclimate, lithology (study of rocks) and landform along with vegetation structural formations as key determinants of current ecosystem type. This new Ecosystem Map can assist with biodiversity conservation and ecosystem services identification and assessment.[90]

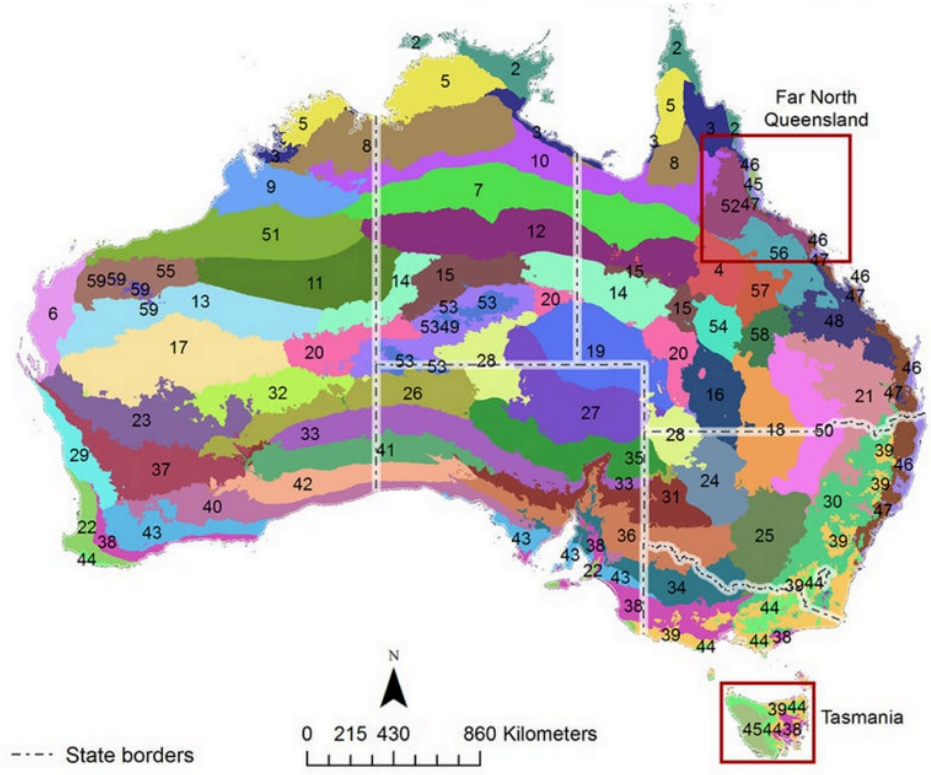


Figure 4.6

[90] TERN AusCover (2017) GEOSS Ecosystem Mapping for Australia

The 'Australia State of the Environment 2021' Report[91] found that Australia's ecosystems were in poor condition and deteriorating with the disruption and degradation of these ecosystems potentially leading to irreversible collapse. Not only do Australia's ecosystems compose of elements to support human-wellbeing through supporting, regulating and provisioning services, they also compose of elements for cultural services being fundamental for Indigenous people's cultural practices (including food, medicine, tools, shelter and ceremonial items).

A recent assessment[92] found at least 19 Australian ecosystems have been reported to show signs of collapse or near collapse, although none has yet collapsed across the entire distribution. Ecosystems experiencing collapse span the Australian continent and include Antarctic, and subantarctic ecosystems.

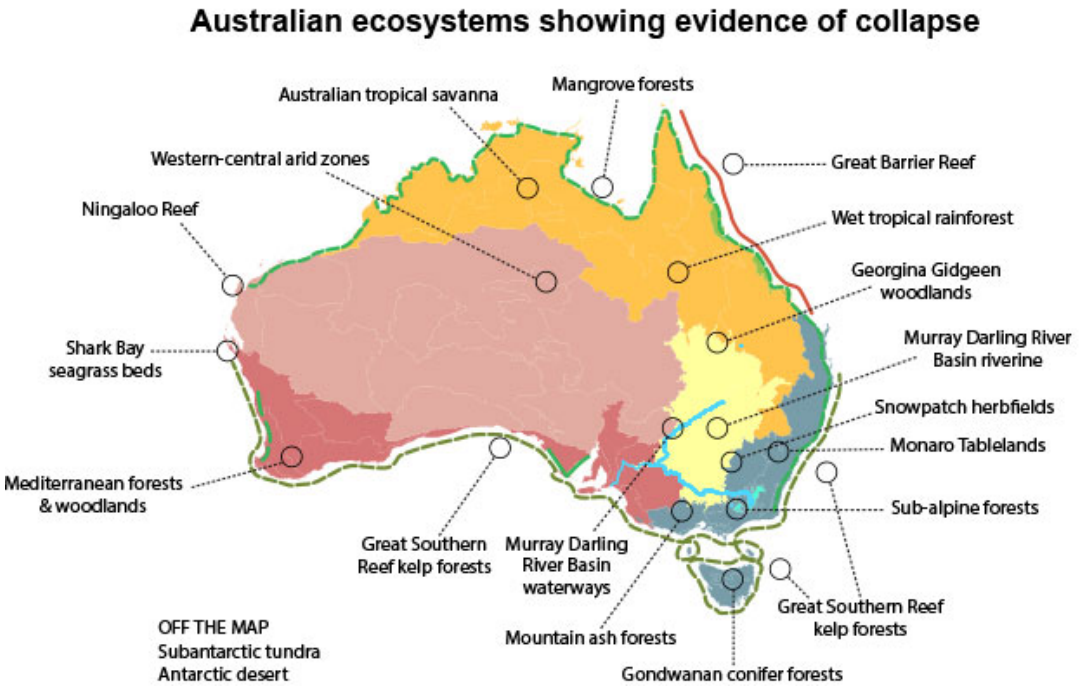


Figure 4.7

[91] Cresswell ID, Janke T, Johnston EL (2021). Overview: Ecosystems. In: Australia State of the environment 2021, Australian Government Department of Agriculture, Water and the Environment, Canberra, https://soe.dcceew.gov.au/overview/environment/ecosystems,

[92] Bergstrom et al (2021) Combating ecosystem collapse from the tropics to the Antarctic. Glob. Change Biol., 27: 1692-1703. https://doi.org/10.1111/gcb.15539

4.3.1 Australian Ecosystem Services

Australian Ecosystem services (delivered from ecosystems) are commonly divided into four categories[93] in alignment with the globally agreed categorisation being:

- *Provisioning services*: the material benefits people get from ecosystems (e.g. supply of food, water, fibres, wood and fuels)
- *Supporting services*: necessary for the production of all other ecosystem services (e.g. by providing plants and animals with living spaces, allowing for diversity of species, and maintaining genetic diversity)
- *Regulating services:* the benefits obtained from the regulation of ecosystem processes (e.g. the regulation of air quality and soil fertility, control of floods or crop pollination)
- *Cultural services:* the non-material benefits people gain from ecosystems (e.g. cultural identity and spiritual well-being)

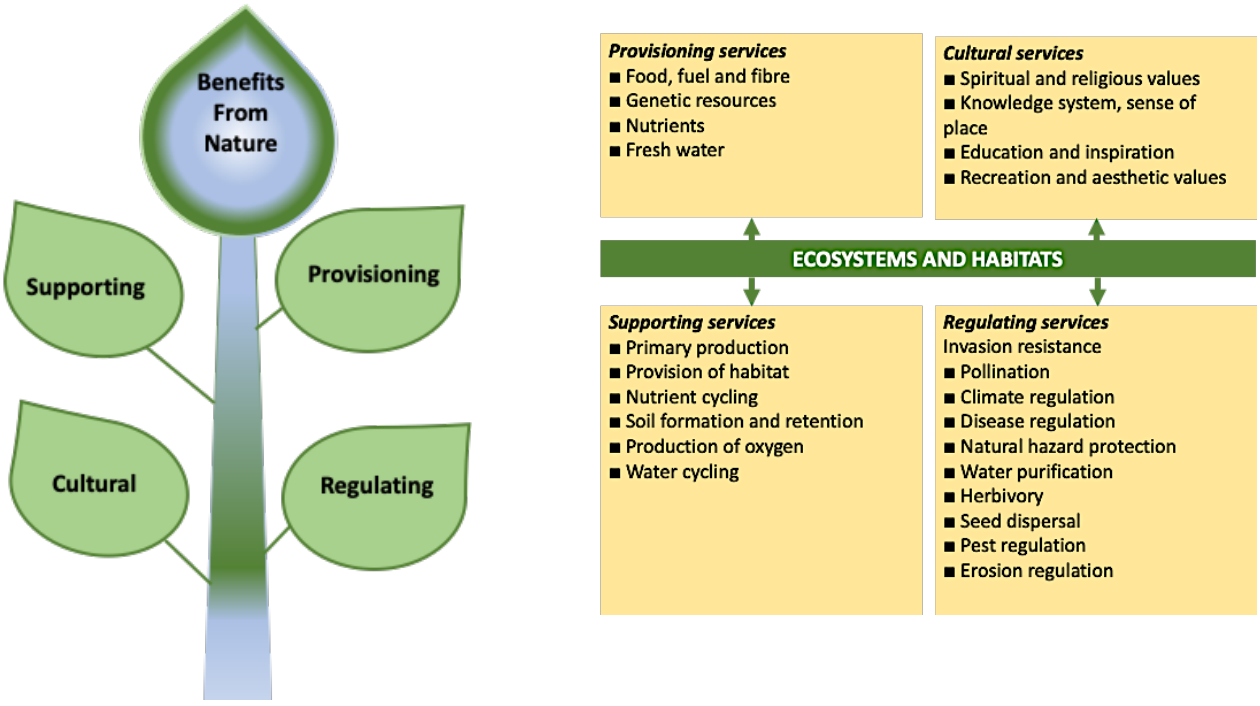


Figure 4.8 [94]

[93] FAO (2023) https://www.fao.org/ecosystem-services-biodiversity/en/

[94] TERN (2023) https://www.tern.org.au/news-quantifying-ecosystem-services/; Department of the Environment, Water, Heritage and the Arts (2009). *Ecosystem Services: Key Concepts and Applications*, Occasional Paper No 1, Department of the Environment, Water, Heritage and the Arts, Canberra.

Agriculture is the dominant land use across the 59 Australian ecosystems accounting for 55% of Australian land use (excluding timber production)[95]

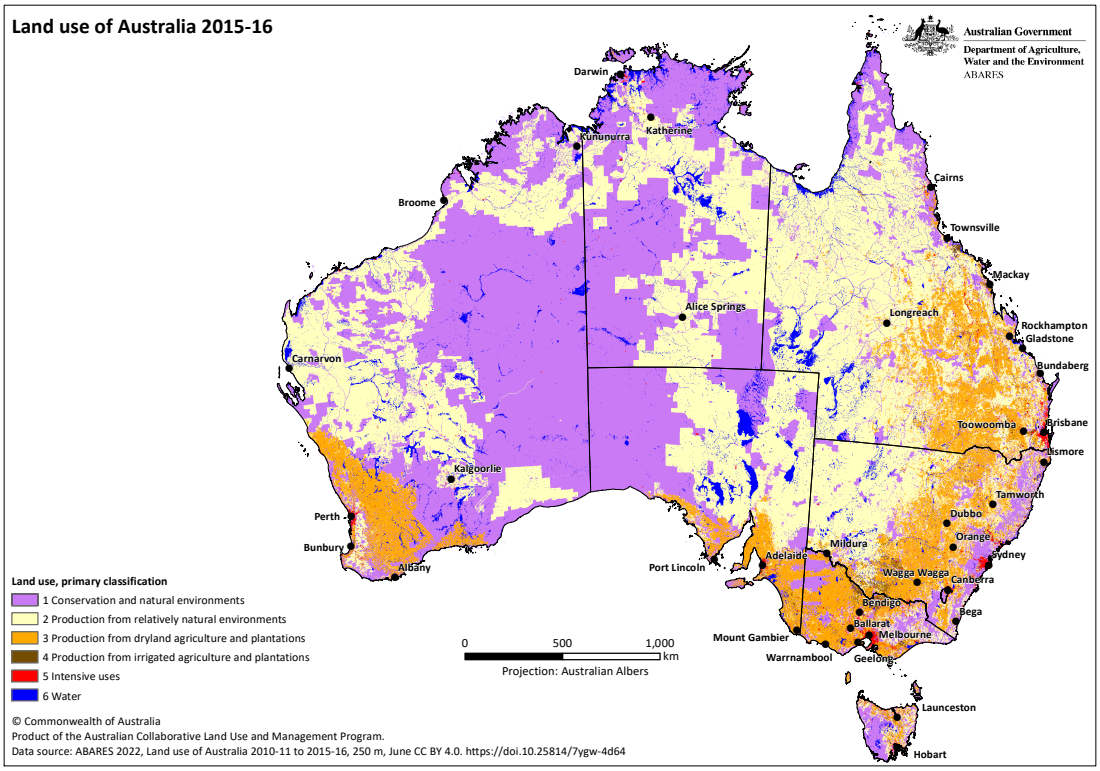


Figure 4.9

Given this dominance of agriculture across the Australian landscape, we need to consider that agricultural land use has both a benefit from, and influence over ecosystem services with both positive and negative impacts. Table 4.1 provides examples of how the different agricultural practices can have a positive or negative impact on ecosystem services.

[95] https://www.agriculture.gov.au/abares/aclump/land-use
https://www.agriculture.gov.au/abares/products/insights/snapshot-of-australian-agriculture

Table 4.1

Positive Impact on Ecosystem Services	Negative Impact on Ecosystem Services
Regenerative Agriculture creates diverse natural habitats through ecologically based practices working in harmony with nature to enhance biodiversity	Industrial Agriculture can destroy natural habitats through land-clearing and a monoculture approach to vegetation that depletes both natural and production biodiversity
Regenerative Agriculture boosts soil fertility through grazing and crop rotation practices and organic – microbial fertilisers	Industrial Agriculture can degrade the soil due to tillage and use of agrochemicals
Regenerative Agriculture sequesters soil carbon through the use of deep-rooted perennial pastures, diverse groundcovers and rotational management of grazing animals and crop-pasture landuse	Industrial Agriculture can deplete soil carbon through tillage, erosion and burning of crop residues and lack of grazing animal rotation and cropping land use.
Regenerative Agriculture improves stream water quality through riparian zone protection and regeneration and exclusion of grazing animals	Industrial Agriculture can cause poor water quality through grazing animals damaging riparian zones and lack of riparian zone vegetation and protection

The Australian Farm Institute[96] identified that much of global agriculture is now sustained by payments for delivery of ecosystem services with the exception of Australia which lags behind with only immature to non-existent agricultural ecosystem services markets currently present. Coupled with the lack of ecosystem service markets is the issue of the ongoing lack of Australian Government support to agricultural producers which is among the lowest in the Organisation for Economic and Cooperative Development (OECD), estimated at 3.1% of gross farm receipts for 2019-21, with total support to agriculture representing 0.2% of GDP[97]. Figure 4.10 provides an overview of how agricultural ecosystem services can have a positive impact on climate change, agricultural production and natural capital.

[96] Australian Farm Institute (2019) Valuing Agriculture's Natural Capital https://www.farminstitute.org.au/event/art-2019/
[97] OECD (2022) Agricultural Policy Monitoring and Evaluation 2022

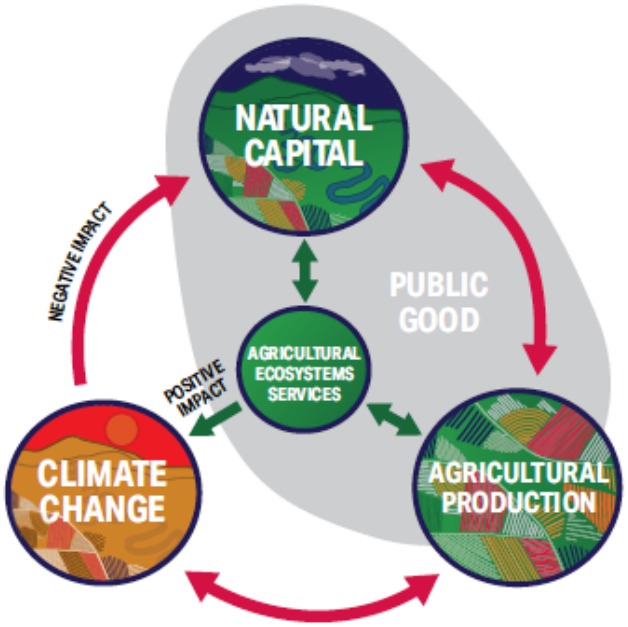


Figure 4.10 [98]

4.3.2 Australian Ecosystem Accounts

Ecosystem accounting is in the early stages of development both globally and nationally. The United Nations adopted the SEEA Ecosystem Accounting (SEEA) as the global standard for ecosystem accounting in March 2021[99]. SEEA constitutes an integrated and comprehensive statistical framework for organizing data about habitats and landscapes, measuring the ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity. The conceptual model adopted by the Australian Bureau of Statistics (ABS)[100] is SEEA. Ecosystem accounts track how changes in the environment affect our wellbeing and economy. They build on land accounts to give us the next level of detail. For example, a land account can show changes in forest cover while an ecosystem account can describe the condition of the remaining forest and the effects on local communities.

[98] Admassu et al (2019) *Lessons from UK on ecosystem service models* Farm Policy Journal Spring 2019
[99] UN (2023) Ecosystem Accounting https://seea.un.org/ecosystem-accounting/
[100] ABS (2021) The System of Integrated and Environmental Economic Accounting https://www.abs.gov.au/statistics/detailed-methodology-information/concepts-sources-methods/australian-system-national-accounts-concepts-sources-and-methods/2020-21/chapter-23-satellite-accounts/environmental-economic-accounts/system-integrated-environmental-and-economic

Ecosystem accounts are a reliable way for economic policy to include the value of the natural environment[101].

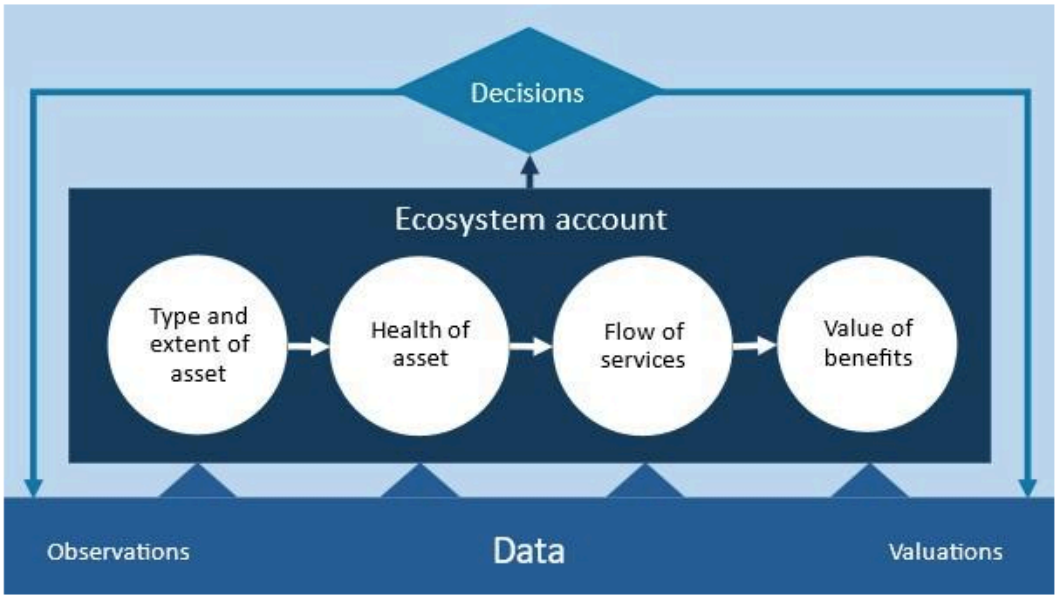


Figure 4.11

REFLECTION

Revisit the state of Australia's ecosystems, the dominance of the Agricultural sector in land use of Australia and lack of government support for agriculture.

What policy changes are required to reverse the degradation of Australia's ecosystems?

[101] Australian Department of Climate Change, Energy, Environment and Water (2023) Ecosystem Accounts https://eea.environment.gov.au/accounts/ecosystem-accounts

4.4 Applying Ecosystem Services at the Farm Scale

Ecosystem Services at the farm scale are best identified using a simplified nested aerial approach from a landscape-to-farm view focusing on landform elements that may occur on the farm and what ecosystem services those landform elements deliver. As a simplified guide Table 4.2 provides an overview of each landform element (and slope class) to help identify these on the farm.

Table 4.2: Simplified description of Landform Elements

Landform element	Definition	Slope Class
Crest	Landform element that stands above all, or almost all	Very Steep
Slope	Upper-slope: Landform element of mountains and hills	Steep
	Mid-slope: low hills	Moderately inclined
	Lower-slope: gentle rises	Gently inclined
Flat - Plain	Landform element that is level to undulating. Can include floodplains, waterbodies, estuaries	Very gently inclined or level
Depression	Landform element that stands below all or almost all (for example wetlands)	Sunken or depressed

To view this in a catchment setting as seen in Figure 4.12[102] the steeper vegetated areas of the catchment are the crests, moving down the landscape are the upper-slopes, mid-slopes and lower-slopes until the flat plains and the estuary occurs. Each of these landform elements provides different types of ecosystem services.

[102] Adapted from Australian Rivers Institute (2023) https://www.griffith.edu.au/australian-rivers-institute

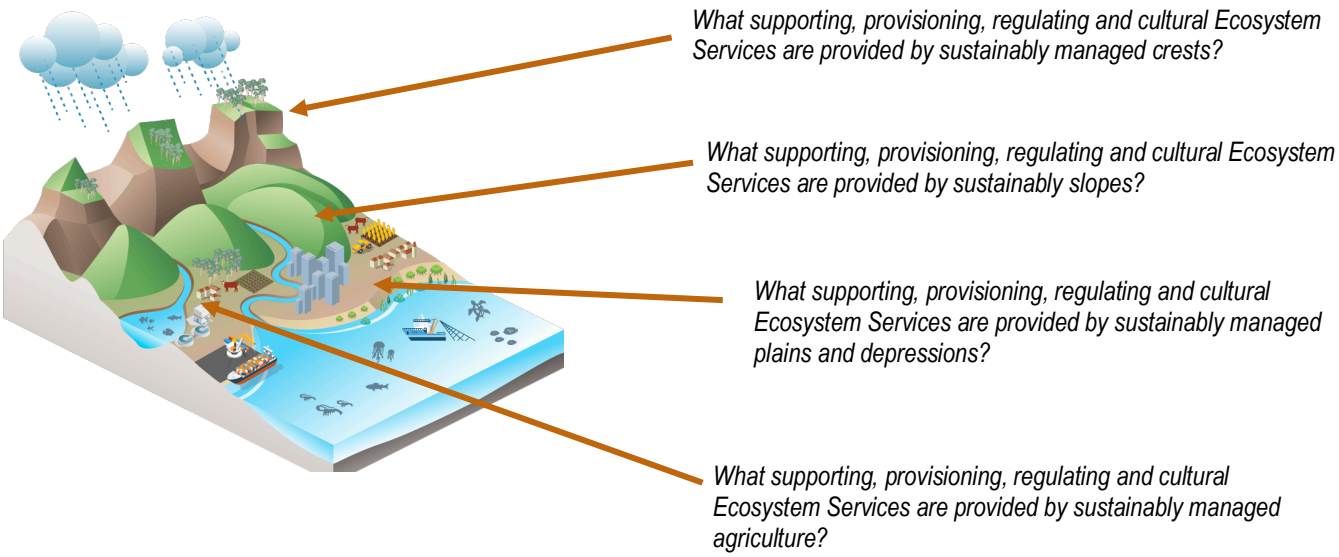


Figure 4.12: Landforms and Ecosystem Services

QUIZ

Revisit Module 3 and consider the importance of environmental assets on the farm in the delivery of ecosystem services

Revisit the four categories of Ecosystem Services and Table 4.2 as a guide for farm-scale landform elements

In the following Quiz select the types of Ecosystem Services that could be provided at the farm scale

QUIZ
(tick the boxes)

Ecosystem Services	Farm-scale Landform Elements						
	Crests	Upper Slope	Mid-slope	Lower slope	Plain	Depression	Agricultural Land-Use
Supporting Services							
Soil formation							
Photosynthesis							
Primary production							
Nutrient cycling							
Water cycling							
Provisioning Services							
Food							
Fibre							
Genetic resources							
Bio-chemicals, natural medicines etc							
Ornamental resources							
Fresh water							
Regulating Services							
Air quality regulation							
Climate regulation							
Water regulation							
Erosion regulation							
Disease regulation							
Pest regulation							
Pollination							
Cultural Services							
Cultural diversity							
Spiritual & religious values							
Recreation and ecotourism							
Aesthetic values							
Knowledge systems							
Education systems							

Soil Carbon Sequestration

Module 5

Learning Outcome

This module will provide an overview of the global and Australian context of the importance of reducing greenhouse gas emissions and the on-farm practices for sequestration of carbon and the potential ecosystem service markets for soil carbon.

Specifically, this module will provide an overview to answer the following questions:

- What is the global and national context of reducing greenhouse gas emissions?
- What is soil carbon and its importance in on-farm sustainability?
- What are Carbon Markets available for Australian farmers?
- What are the monitoring methods for soil carbon?

5.1 Global Trends of Greenhouse Gas Emissions (GHG)

As background to soil carbon sequestration the importance of reducing greenhouse gas emissions needs to be considered. The greenhouse effect of the Earth is a natural process that involves atmospheric gases trapping heat, creating a blanket affect so that the Earth can retain solar heat necessary for life. The main greenhouse gases include carbon dioxide, methane, nitrous oxide, ozone, water vapour and synthetic gases (chlorofluorocarbons and hydrofluorocarbons). Human activities since the industrial revolution in the mid 1700's has contributed to significant increases in greenhouse gases, in particular carbon dioxide from burning of fossil fuels and

deforestation[103]. In response to human-induced greenhouse gas emissions, the Paris Agreement (a legally binding international treaty on climate change) has the overarching goal to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels[104]. Despite the Paris Agreement global surface temperatures recorded between 2011-2020 reached 1.1°C higher than 1850-1900 records with the speed of the warming global surface temperature increasing faster since 1970 than in any other 50-year period over the last 2000 years[105]. The Intergovernments Panel on Climate Change (IPCC) has raised concerns that crossing the 1.5°C threshold risks far more severe climate change impact and there is a need to limit global warming to 1.5°C such that greenhouse gas emissions peak before 2025 at the latest and decline 43% by 2030.

The IPCC Synthesis Report[106] '*Climate Change 2023'* identifies that widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred due to human-induced climate change which is already affecting weather systems around the globe. Reducing emissions alone is now considered inadequate in addressing dangerous climate change. The IPCC (2023) identify that limiting warming to 1.5°C target will only now be achievable with rapid reduction in GHG emissions and the removal of emissions from the atmosphere through storing carbon through sequestration.

Recent statistics for 2023 indicates that carbon dioxide in the atmosphere has reached new record highs, with the expected El Niño potentially pushing 2024's peak even higher with a call for drastic emissions cuts needed each year to limiting warming to the 1.5°C target[107]. See Figure 5.1.

[103] Climate Change in Australia (2023) Greenhouse gases. https://www.climatechangeinaustralia.gov.au/en/overview/climate-system/greenhouse-gases/
[104] United Nations Framework Convention on Climate Change (2023) The Paris Agreement. https://unfccc.int/process-and-meetings/the-paris-agreement
[105] Intergovernmental Panel on Climate Change (2023) Climate Change 2023 Synthesis Report Summary for Policymakers. https://www.ipcc.ch/report/ar6/syr/
[106] Intergovernmental Panel on Climate Change (2023) Climate Change 2023 Synthesis Report Summary for Policymakers. https://www.ipcc.ch/report/ar6/syr/
[107] ABC (2023) Carbon dioxide in atmosphere hits new record high as scientists call for 'every effort to slash carbon pollution https://www.abc.net.au/news/science/2023-06-06/science-atmospheric-co2-hits-record-high/102444412

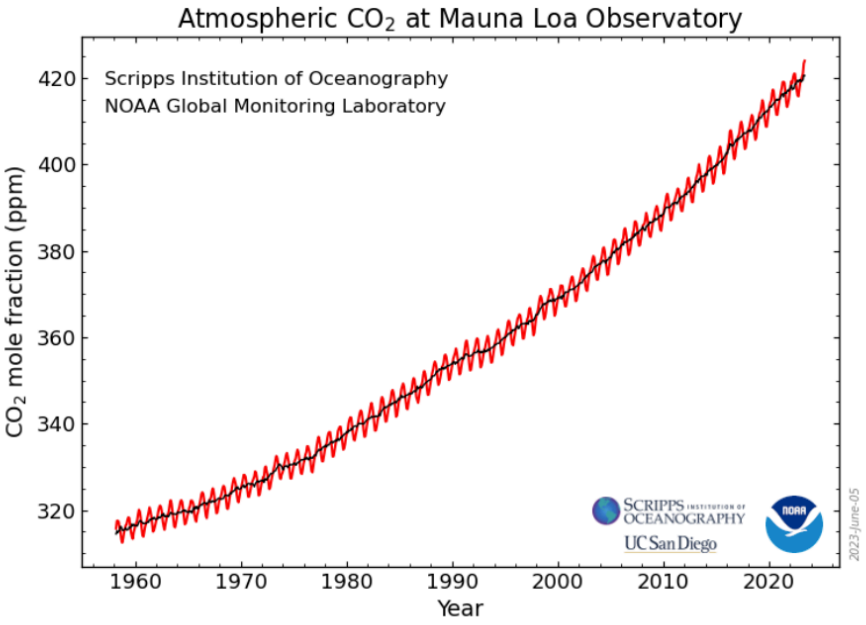


Figure 5.1: Atmospheric carbon Dioxide levels, 2023[108]

Agriculture, forestry and land use contribution to global greenhouse gas emissions, with agriculture's contribution increasing since 1990. See Figures 5.2 and 5.3 for an overview of agriculture's global emissions.

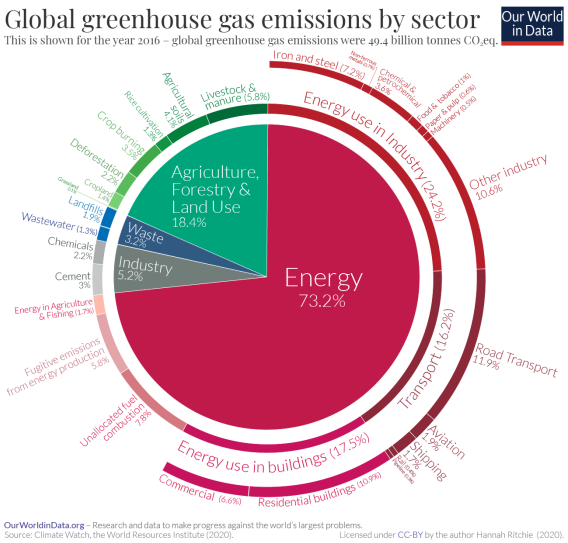


Figure 5.2: Global GHG emissions by sector[109]

[108] ABC (2023) Carbon dioxide in atmosphere hits new record high as scientists call for 'every effort to slash carbon pollution' https://www.abc.net.au/news/science/2023-06-06/science-atmospheric-co2-hits-record-high/102444412

[109] Our World in Data (2023) Emissions by sector https://ourworldindata.org/emissions-by-sector

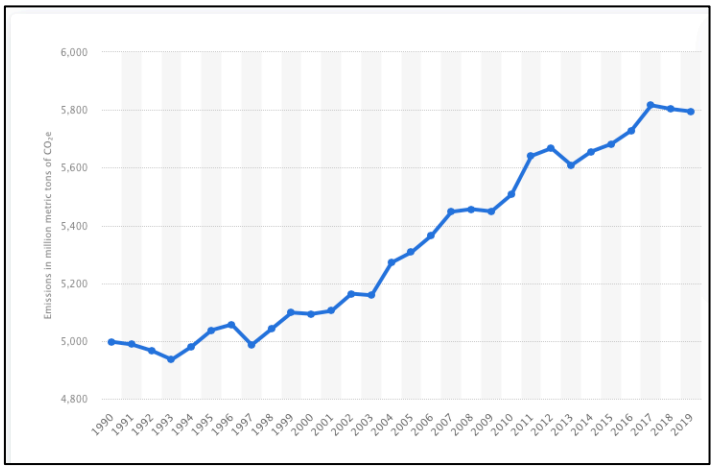


Figure 5.3: Annual Agriculture GHG emissions worldwide 1990-2019[110]

Global data on agrifood supply-chain contributions shows we need to consider the entire agricultural supply chain in lowering GHG emissions (see Figure 5.4).

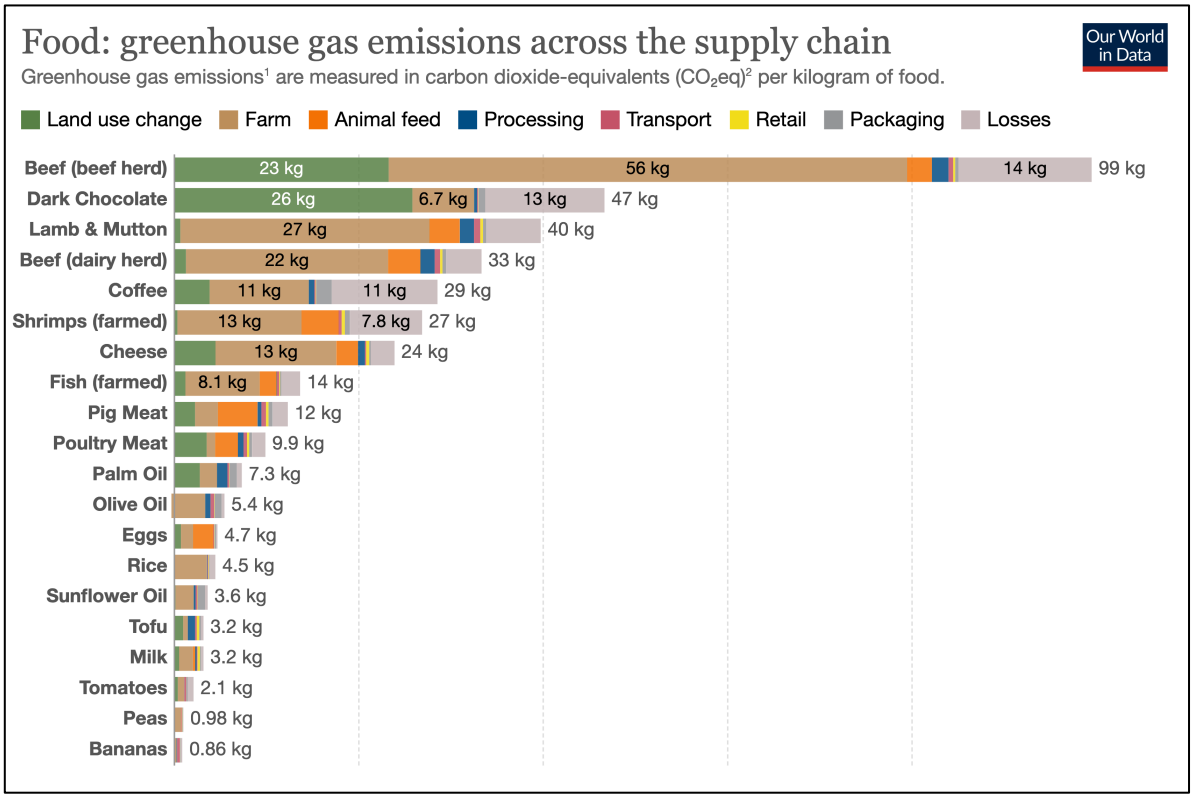


Figure 5.4: Food GHG emissions across the supply chain[111]

[110] Statista (2023) Global Agricultural GHG emissions https://www.statista.com/statistics/1351598/agriculture-ghg-emissions-worldwide/

[111] Our World of Data (2023) Food: Global Greenhouse Gas emissions across the supply chain https://ourworldindata.org/grapher/food-emissions-supply-chain

These global statistics demonstrate the importance of implementing carbon sequestration in the agri-food value chain which contributes significantly to global greenhouse gas emissions.

5.2 Australia's Greenhouse Gas Emissions

In response to the global climate change crisis Australia has committed to numerous international cooperation arrangements on climate change particularly focusing on reducing GHG emissions through the Paris Agreement through Nationally Determined Contributions (NDC) arrangements. The most recent commitment was made in June 2022 where the Australian Government set a new ambitious 2030 target to reduce greenhouse gas emissions by 43 per cent below 2005 levels, putting Australia on track to achieve the net zero emissions by 2050 target. This new target was enshrined into law in September 2022 with the new Climate Change Legislation[112]. Australia's is the 14th highest emitting country for greenhouse gas emissions even though small in the sense of 1% of total global emissions[113] Australia from a per capita GHG emissions is very high (see Figure 5.5).

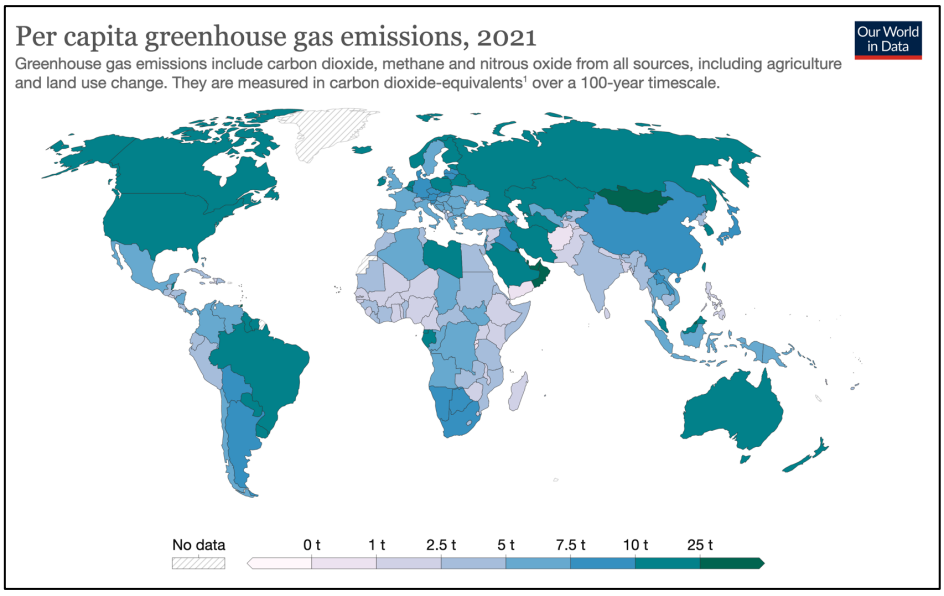


Figure 5.5: Per capital GHG emissions 2021[114]

[112] Australian Government (2023) International Cooperation on Climate Change https://www.dfat.gov.au/international-relations/themes/climate-change/international-cooperation-on-climate-change
[113] CSIRO (2023) What are the sources of Australia's greenhouse gases? https://www.csiro.au/en/research/environmental-impacts/climate-change/Climate-change-QA/Sources-of-GHG-gases
[114] Our World In Data (2023) Per Capita Greenhouse Gas Emissions 2021 https://ourworldindata.org/grapher/per-capita-ghg-emissions

Agriculture is a significant contributor to Australia's GHG emissions as indicated in Figure 5.6 with 17.4% contribution during 2022. Australian agriculture's GHG emissions have not significantly changed between 2005 and 2022 (see Figure 5.7).

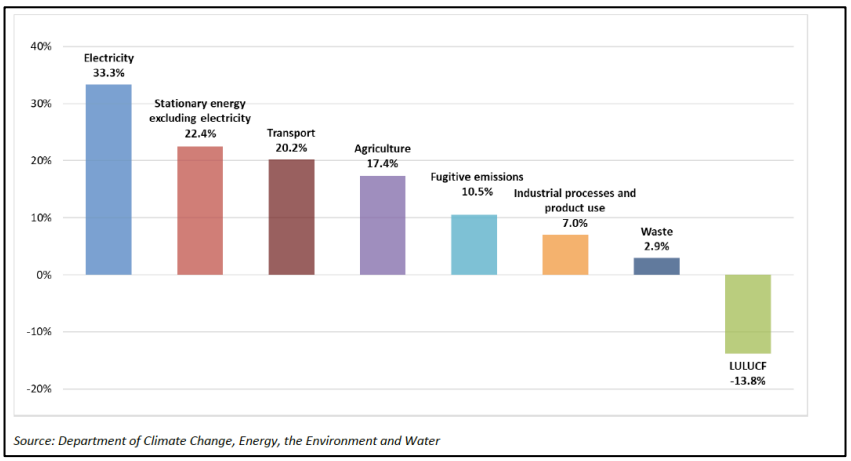


Figure 5.6: Share of total emissions by Sector [115]

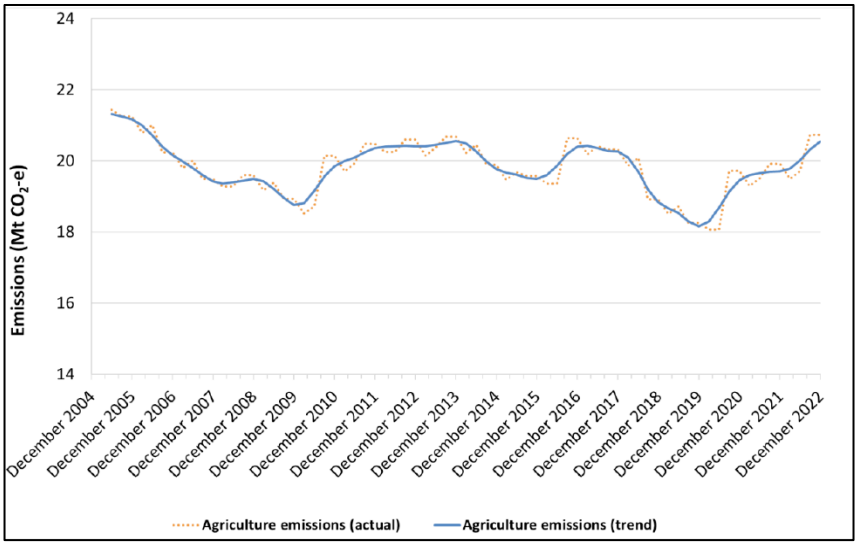


Figure 5.7: Australia's agricultural emissions[116]

As a result of Australia's increased GHG emissions target and the new climate law in 2022, the Australian Government has a number of new funding programs that

[115] Australian Government (2023) National GHG Inventory Quarterly Update December 2022 https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-gas-inventory-quarterly-update-december-2022

[116] Australian Government (2023) National GHG Inventory Quarterly Update December 2022 https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-gas-inventory-quarterly-update-december-2022

commenced in late 2022 to support farmers and land managers with reducing agricultural and land section emissions. These include:

- The Australian Clean Energy Regulator's Emission Reduction Fund: carbon crediting scheme;
- Reducing methane from livestock: programs to support the development and deployment of technologies to reduce methane emissions from livestock;
- Improving soil carbon storage and measurement: funding programs to lower the cost of soil carbon measurement and improve understanding of soil carbon sequestration potential;
- Supporting farmers and land managers through the Carbon Outreach Program: support Australian farmers and land managers, including First Nations peoples, to participate in carbon markets and integrate low emission technologies and practices into their operations, and
- Livestock Emissions Framework for Feed Technologies: provides a consistent approach for estimating emission reductions from the use of feed technologies at the farm, industry, state and national scales

Modules 1 and 2 presented the context of ESG and Natural Capital at the global and Australian scale indicating drivers for regenerative agriculture (including soil carbon) at the farm scale including:

- International climate, sustainability and biodiversity obligations are driving carbon, biodiversity and sustainability credentials from farmers through the agri-food value chain;
- Environmental – Social – Governance (ESG) drivers for sustainable and climate friendly agriculture. Corporations along the agri-food value chain are demanding carbon, biodiversity and sustainability credentials from farmers;
- Commitments by Australian Agricultural Research Development Corporations (RDCs) to carbon emissions reduction;
- Sustainability and ecosystem service market opportunities for farmer, and
- Healthy environmental assets on the farm lead to improved soil health; healthy production systems; healthy landscapes, and healthy people.

In response to these drivers, Australian agricultural sectors are innovating through farm management practice changes and value chain innovations to deliver carbon neutral products through soil carbon management including carbon neutral beef; dairy, wine and grain. Carbon sequestration refers to the capture and storage of carbon which includes carbon dioxide removal and point source carbon capture. Figure 5.8 presents the different avenues of carbon sequestration proposed by the Australian Climate Change Authority (2023) with emissions presented in grey; the blue arrow showing carbon capture, use and storage (CCUS); with the green arrows showing bioenergy with carbon capture and storage (BECCS, Pyrolysis (biochar) and Direct Air Capture (DAC).

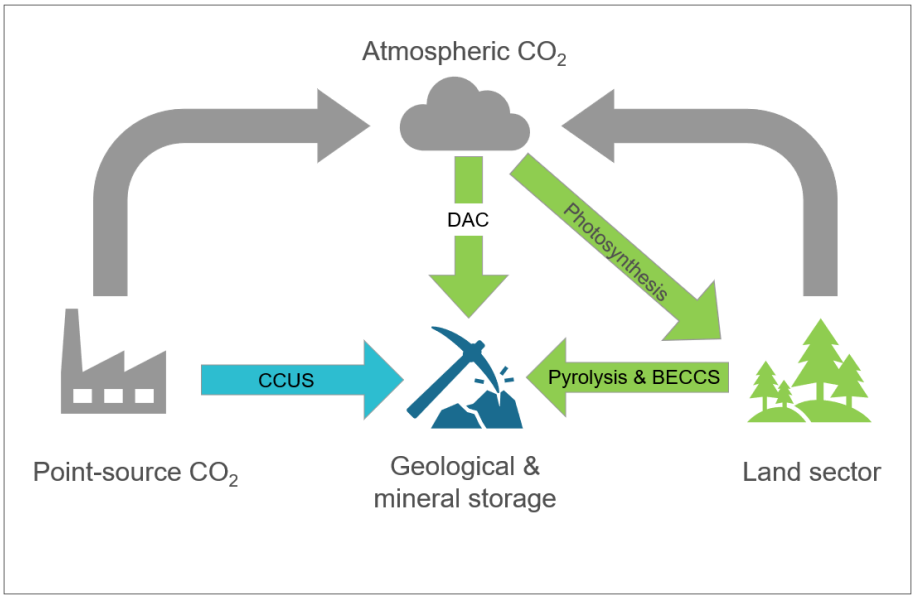


Figure 5.8: Avenues of Carbon Sequestration[117]

Soil is the largest terrestrial reservoir of organic carbon and is central for climate change mitigation[118]. The following components of this module will focus on soil carbon sequestration only including how farmers can sequester carbon contributing to decarbonising Australia through regenerative land management practices which in turn offers access to soil carbon market trading systems.

[117] Climate Change Authority (2023) Reduce, remove and store: the role of carbon sequestration in accelerating Australia's decarbonisation.
[118] Georgiou, K., Jackson, R.B., Vindušková, O. et al. Global stocks and capacity of mineral-associated soil organic carbon. Nat Commun 13, 3797 (2022).

Case Study

Robert Mackenzie runs a cattle farm and has succeeded in tipping the scales to have more carbon under his eight properties than the emissions.

Check out this ABC news article that explains how he achieved carbon neutrality.

5.3 The Carbon Cycle

To understand soil carbon sequestration requires a brief overview of the carbon cycle which is a natural process where carbon is exchanged between the atmosphere, plants, animals, and the soil. This occurs by plants absorbing carbon dioxide through photosynthesis, converting the carbon dioxide to organic carbon then releasing this back into the atmosphere through decomposition. Soils are the largest reservoir of carbon in terrestrial environments and can act as both sources and sinks of carbon[119].

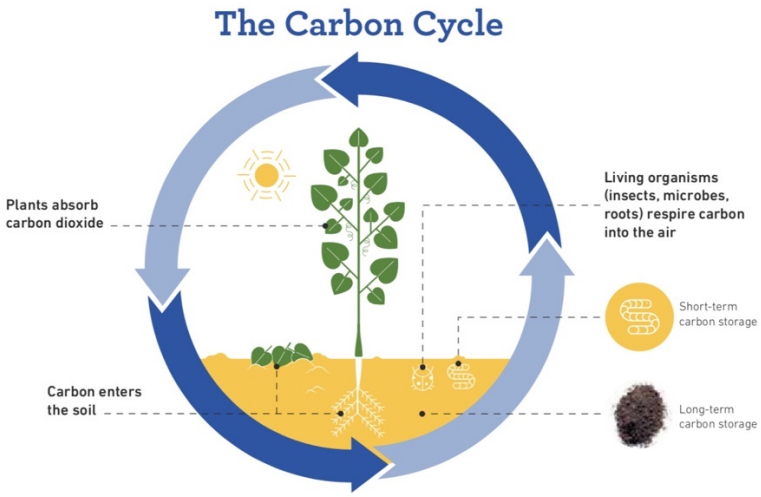


Figure 5.9: The Carbon Cycle[120]

Carbon stored within soil gives soil it's fertility and structure, while also increasing the soil's water holding capacity. Soil organic matter is primarily made up of carbon, with the exchange between plant and soil occurring via mycorrhizal fungi in the rhizosphere (soil surrounding the root). Having a variety of plant species, and therefore root

[119] Williams KJ, Hunter B, Schmidt RK, Woodward E, Cresswell ID (2021). Land: Carbon. In: *Australia State of the environment 2021*, Australian Government Department of Agriculture, Water and the Environment, Canberra, https://soe.dcceew.gov.au/land/environment/carbon, DOI: 10.26194/6EAM-6G50

[120] J. Deaton (2019) A Green New Deal could incentivize farming practices that help remove carbon pollution from the atmosphere.

systems, helps to store carbon in different layers in the soil. Within the soil there are two types of carbon. Soil Organic Carbon (SOC) is relatively available and comes from the decomposition of living organisms and through the exchange within the carbon cycle. Soil inorganic carbon is derived from the mineral forms of carbon, often through weathering[121].

Soil organic matter is primarily made up of SOC (58%) with the remaining mass consisting of water and other nutrients[122]. Soil organic matter contains nutrients that support plant growth and yield, retains water and reduces runoff, and resists erosion[123].

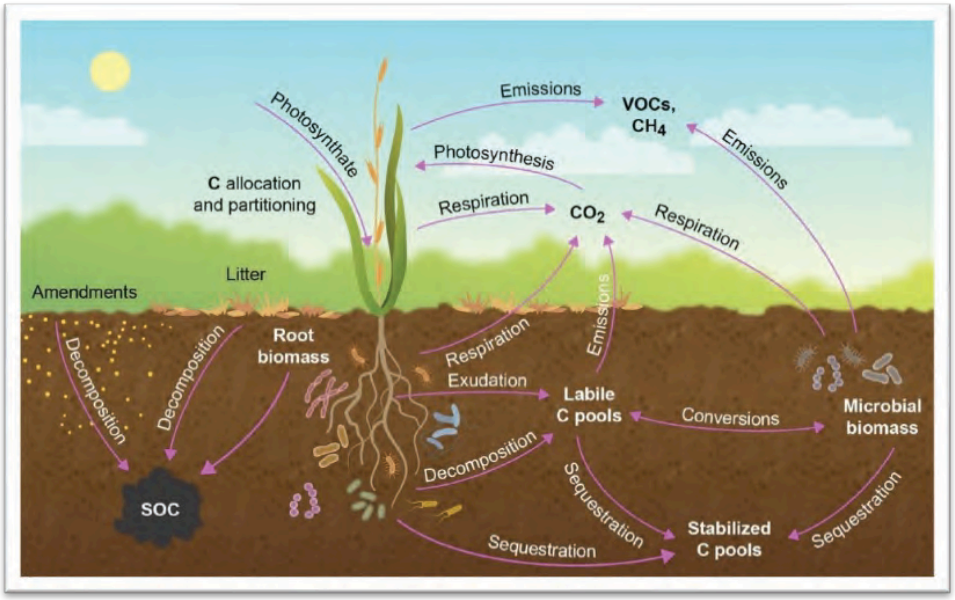


Figure 5.10: Soil Carbon[124]

Distribution of SOC in Australia is influenced by the quantity and quality of organic matter returned to the soil; the soils ability to retain organic carbon (a function of texture and cation exchange capacity), and biotic influences of both temperature and rainfall[125]. Figure 5.11 provides an overview of recent multi-scale mapping of Australia's terrestrial and blue carbon stocks.

[121] Southern Cross University (2022) Regenerative Agriculture Mentoring Program.
[122] Government of Western Australia (2023) Soil organic matter - frequently asked questions (FAQs). https://www.agric.wa.gov.au/soil-carbon/soil-organic-matter-frequently-asked-questions-faqs
[123] Georgiou, K., Jackson, R.B., Vindušková, O. et al. Global stocks and capacity of mineral-associated soil organic carbon. Nat Commun 13, 3797 (2022).
[124] Jansson, C., Faiola, C., Wingler, A., Zhu, X.-G., Kravchenko, A., De Graaff, M.-A., Ogden, A. J., Handakumbura, P. P., Werner, C., & Beckles, D. M. (2021). Crops for carbon farming. Frontiers in Plant Science, 12, 636709
[125] Grace P, Post WM, Hennessy K (2006) The potential impact of climate change on Australia's soil organic carbon resources. Carbon Balance and Management, 1, 14.

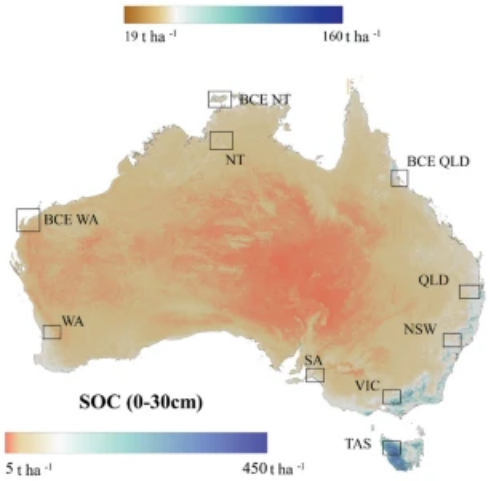


Figure 5.11: Mapping of Australia's terrestrial and blue carbon stocks[126]

SOC is an integral component of terrestrial ecosystems having a crucial role in ecosystem resilience and productivity with SOC containing more carbon than both the atmosphere and vegetation combined. Human land-use and landcover change has contributed to significant losses of soil carbon since the industrial revolution with soil carbon sequestration now a critical factor in reversing and mitigating climate change[127].

SOC can be influenced positively by land management practices, for example the Australian Government Emissions Reduction Fund Program for soil carbon sequestration recognises land management practices to increase SOC (see Table 5.1). Management practices that decrease soil organic carbon that need to be avoided by soil carbon farmers include:

- Soil cultivation
- Soil degradation and erosion
- Land clearing
- Over-grazing
- Removal of plant residues off-site
- Burning of plant residues

[126] Walden, L., Serrano, O., Zhang, M. et al. Multi-scale mapping of Australia's terrestrial and blue carbon stocks and their continental and bioregional drivers. Commun Earth Environ 4, 189 (2023). https://doi.org/10.1038/s43247-023-00838-x

[127] Georgiou, K., Jackson, R.B., Vindušková, O. et al. Global stocks and capacity of mineral-associated soil organic carbon. Nat Commun 13, 3797 (2022).

Table 5.1: Land Management Practices to increase SOC[128]

Apply nutrients to the land	Apply lime to remediate acid soils
Apply gypsum to remediate sodic or magnesic soils	Undertake new irrigation
Re-establish or rejuvenate a pasture by seeding, establishing or pasture cropping	Establishing, and permanently maintaining, a pasture where there was previously no or limited pasture, such as on cropland or bare fallow
Alter the stocking rate, duration or intensity of grazing	Retain stubble after a crop is harvested
Convert from intensive tillage practices to reduced or no tillage practices	Modify landscape or landform features to remediate land
Use mechanical methods to add or redistribute soil	Use legume species in cropping or pasture system
Use a cover crop to improve soil health	Use a cover crop to promote soil vegetation cover

SOC plays a vital role in soil health and fertility through enhancing the soil structure, water holding capacity and nutrient turnover, all of which have benefits for soil health and agricultural productivity. As SOC increases microbial activity also increases, providing further benefits to both soil and plants[129].

Activity

Jo has just inherited a farm that has been subject to overgrazing for many years, the soil is exposed in some places and the groundcover is patchy. There is some soil erosion occurring on the farm and the cattle have access to the waterways. Let's explore some of the activities that Jo could undertake to improve the health of her new farm.

[128] Carbon Farmers of Australia (2023) Landholders Guide to the 2021 Soil Carbon Sequestration Methodology https://carbonfarmersofaustralia.com.au/wp-content/uploads/2023/02/CFA-Soil-Carbon-method-summary-2023.pdf
[129] Queensland Government (2023) Soil Carbon. https://www.qld.gov.au/environment/land/management/soil/soil-properties/carbon

Check Soil

Rest

Plant deep rooted perennial pastures

Plant shelter belts

Apply microbial/ organic fertilizers

Cell Grazing (Paddock Rotation)

Fence off riparian (waterway) zones

Establish off stream watering points

Jo should **rest** the paddocks from grazing animals particularly the zones of the farm where the ground cover is bare and soil erosion is occurring
Jo should take **soil samples** from the different soil types occurring on the farm and send to the laboratory to test test for nutrient and metal deficiencies or toxicities, pH, electrical conductivity, organic carbon, exchangeable cations and cation exchange capacity, soil texture microbial health.
Once the soil samples have been processed by the laboratory Jo should **apply the appropriate microbial and organic fertilizers** to address any deficiencies identified in the soil sample results.
Planting of **deep-rooted perennial pastures** and ensuring a **diverse mix of pasture species** will contribute to healthy soils, improved ground cover, greater soil carbon sequestration and healthier grazing animals.
Cell grazing involves the natural patterns of grazing animals through the landscape. The farm is divided into 'cells' through fencing systems and the grazing animals as a herd have a short period in each cell followed by a long rest period to allow plant recovery.
Riparian zones refer to land alongside creeks, streams, gullies, rivers and wetlands and is often highly fertile. **Fencing off riparian zones** from grazing animals ensures that riparian native vegetation is protected which can support cleaner water, reduce disease and pests, and retain important nutrients and soil.
Shelter belts planted with local native species provide shelter for grazing animals and also provides habitat for native species and linkages in the landscape. They also act as a buffer of wind erosion of soils.
Off stream watering points offer grazing multiple locations for water in each cell on the farm. In particular off stream watering points stop grazing animals from causing erosion on stream banks and stops trampling of young native vegetation regrowth and regeneration in the riparian zones.

5.4 Carbon Markets in Australia

Carbon credits are a mechanism allowing soil carbon farmers to be rewarded with a carbon credit equating to one tonne of carbon dioxide being sequestered or reduced/avoided through a soil carbon project. In Australia, the Commonwealth Government issues Australian Carbon Credit Units (ACCUs) which can be held, sold as offsets or used as in-setting (offsetting the farm's own emissions)[130].

The Clean Energy Regulator administers national Carbon Markets in Australia for the Emissions Reduction Fund. Figure 5.12 provides a snapshot of the Australian ACCU Market in 2022 and Figure 5.13 provides an overview of ACCUs issued by methods between 2019 and 2022.

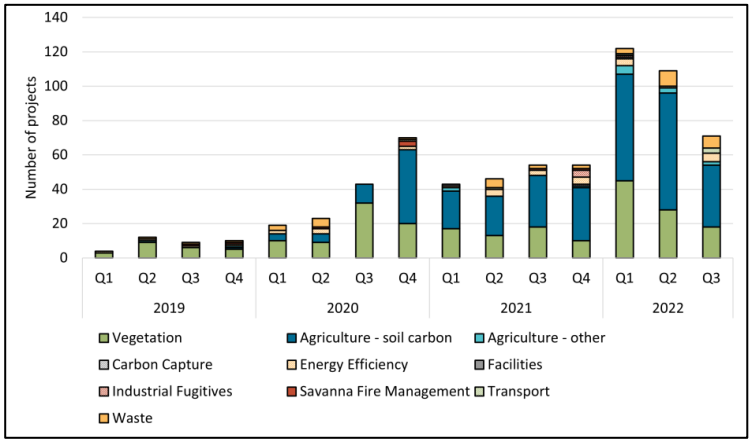


Figure 5.12: Snapshot of Australia's ACCU Market for 2022[131]

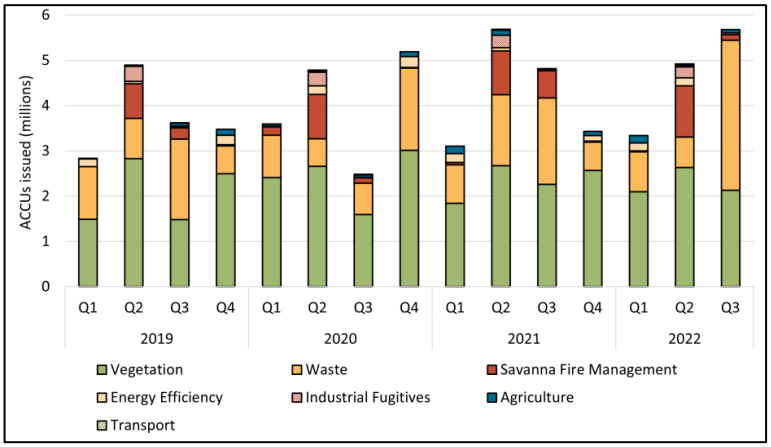


Figure 5.13: ACCUs issued by Method[132] (2019-2022)

[130] Agrifutures (2022) A farmer's handbook to on-farm carbon management.
[131] Australian Government (2022) Clean Energy Regulator: About Carbon Markets https://www.cleanenergyregulator.gov.au/Infohub/Markets/Pages/About-Carbon-Markets.aspx
[132] Australian Government (2022) Clean Energy Regulator: About Carbon Markets

The Australian Academy of Technological Science and Engineering (ATSE, 2021) found that soil carbon has the potential to contribute to an Australian negative emissions strategy by offsetting emissions from high emitting industries. However, the costs of measuring soil carbon change may exceed the returns generated by carbon credits for farmers, who may also face costs associated with a required change in land management. There is a clear need for low-cost, accurate technologies and methods to measure soil carbon. Improvements in the technology and methodology of soil carbon measurement, better understanding of the most effective sequestration practices for each region, and an improved market for ACCUs could see soil carbon abatement become a viable source of income for farmers as Australia moves towards net zero emissions[133].

The 2023 Carbon Farming Scorecard[134] found that the integrity behind Australia's carbon farming scheme is sound and under continual improvement with the strength of systematic demand from new and reformed policies growing. Nature-based climate solutions and abatement are converging and there are opportunities for increased Aboriginal and Torres Strait Islander Peoples participation. The state and territory jurisdictions continue to progress at a different pace with an increased blue carbon ambition. ACCUs with co-benefits command a premium in the carbon market and there is opportunity to build on this momentum with development of a national carbon market strategy. Despite this, there are still barriers that exist to participation and supply. The Australian Carbon Exchange will be launched during 2023 and will operate in a similar way to online stock exchanges where the purchasing, clearing and settlement of ACCUs and potentially other types of carbon units and certificates will be traded[135].

In June 2023 Australia's first soil carbon credits were granted under the new 2021 methodology with two Queensland farming families granted a total of 151,312 ACCUs. The trade value of an ACCU has been around $35 during 2023, which makes these

https://www.cleanenergyregulator.gov.au/Infohub/Markets/Pages/About-Carbon-Markets.aspx

[133] ATSE (2021) Australia's soil carbon opportunities and risks. https://www.atse.org.au/research-and-policy/publications/publication/australias-soil-carbon-opportunities-and-risks/

[134] Carbon Market Institute (2023) 2023 Carbon Farming Scorecard. https://carbonmarketinstitute.org/carbon-farming-scorecard/

[135] Australian Clean Energy Regulator (2023) Australian Carbon Exchange https://www.cleanenergyregulator.gov.au/Infohub/Markets/australian-carbon-exchange

credits a potential total value of $5.3 million. However, the costs of monitoring need to be considered within these credits for example, two soil sample rounds could possibly cost between $200K and $300K based on a 3,000 hectare farm[136].

5.4.1 International Carbon Markets

International Carbon Markets include the UN's Clean Development Mechanism (a cooperative mechanism that allows emission-reduction projects in developing countries to earn certified emissions reduction to be traded, sold and used by industrialized countries) and Voluntary Emissions Reduction Standards administered by non-government organisations. The size of the voluntary carbon market was valued at over 1 billion USD in 2021[137] with the largest major international voluntary market standard in terms of the transacted carbon offset volume being Verra's Verified Carbon Standard (VCS). The Gold Standard for the Global Goals (Gold Standard) is another international voluntary carbon offset standard that enables carbon projects to be registered and generate verified emissions reductions (VERs). Australian soil carbon farmers have the option to trade on the international market through voluntary carbon markets, however there are risks that need to be considered.

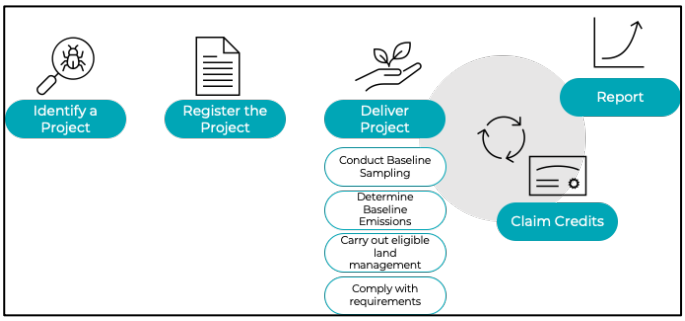
Reflection

Read the article "US scheme used by Australian farmers reveals the dangers of trading soil carbon to tackle climate change". What are your thoughts on trading soil carbon on international voluntary markets versus the Australian Carbon Market?

5.4.2 Soil Carbon Monitoring in Australia

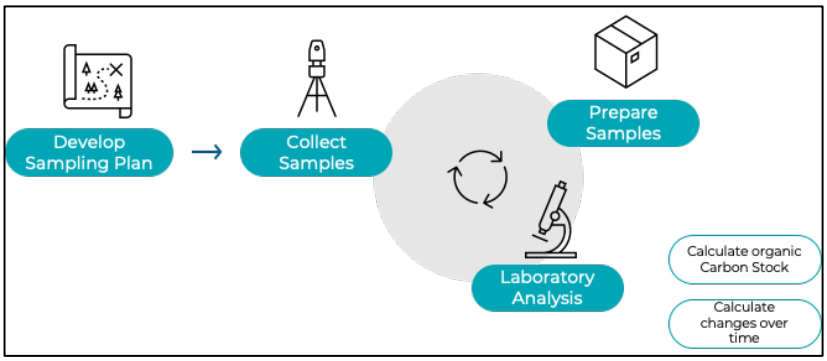
As the Australian Government regulate the Carbon Market in Australia this section focuses on the soil monitoring required to apply and manage an ERF '2021 Soil Carbon Method' Project which encompasses the initial baseline monitoring and the ongoing monitoring required over the life of the project.

[136] ABC (2023) How do you store carbon in the soil in a way that you could make money? https://www.abc.net.au/news/rural/2023-06-24/aus-farmers-to-earn-money-from-soil-carbon-under-new-methods/102213244
[137] DeWitt 2022 "Creating carbon offset units on the voluntary market" published by Norton, Rose and Fullbright https://www.nortonrosefulbright.com/en-au/knowledge/publications/6f326481/creating-carbon-offset-units-on-the-voluntary-market



The following requirements are based on the 'measurement-approach-only method' of the ERF's '2021 Soil Carbon Method' where a farmer can register a soil carbon project that aims to store additional carbon in agricultural soils.

- Identify the Project: identify a Carbon Estimation Area (CEA) on the farm through the development of a Land Management Strategy that is developed with the assistance of a qualified advisor explaining what activities will be undertaken and calculate the expected carbon credits (this includes determining baseline emissions).
- Register the Project: Register the project with the ERF.
- Develop a Baseline Soil Sampling Plan: Based on the Land Management Strategy which includes stratification of the farm a baseline soil sampling plan is developed and sent to the ERF for approval.
- Baseline Soil Sampling: Once the ERF has approved the baseline soil sampling plan, an independent soil expert will collect the soil samples from the farm and send to a Laboratory that is certified for organic carbon analysis by the Australasian Soil and Plant Analysis Council (ASPAC).
- Eligible Land Management: Once the baseline sampling has been undertaken and approved, you can begin carrying out your new or materially different management activity or activities.
- Reporting: There are operating, sampling, reporting and audit obligations in running a soil carbon project with project reports required at least once every five years. Carbon credits are granted each time a report shows increases in soil carbon levels. Your project must store carbon for 25 or 100 years to deliver a long-term benefit to the atmosphere (known as 'permanence') and there are obligations associated with this.
- Ongoing Soil Sampling: Soil sampling is required to be repeated following the same methodology used for the baseline soil sampling at least every five years.



Activity

Watch this short video on the AFI Carbon Opportunity Support Tool designed to assist Australian land managers in better understanding carbon farming opportunities and to identify which might be best suited for their enterprise.

Reflect on the opportunities on offer to Australian land managers.

From your perspective rank the five carbon opportunities in order of best choice.

On-Farm Biodiversity

Module 6

Learning Outcome

This module will provide an overview of the global and Australian context of the importance of biodiversity and an understanding of the on-farm practices for maintenance/enhancement of on-farm biodiversity assets and the potential ecosystem service markets for biodiversity trading. Specifically, this module will provide an overview to answer the following questions:

- What is biodiversity?
- What is the global and Australian context of the importance of biodiversity?
- What is on-farm biodiversity and why is it important for on-farm sustainability?
- On-farm practices to maintain/enhance biodiversity
- Monitoring methods for biodiversity
- Valuing ecosystem services: Biodiversity Markets

6.1 What is Biodiversity?

In Module 3 we explored what is on-farm natural capital with a focus on the environmental assets of the farm that form part of a larger ecosystem. Following on from benchmarking on-farm natural capital is the exploration of the biodiversity delivered from the environmental assets on the farm. This requires an understanding of the definitions of biodiversity and on-farm biodiversity, and the practices to manage and monitor these environmental assets.

Biodiversity is defined by the Convention on Biological Diversity (CBD) as the variability among living organisms (including within species, between species and of ecosystems) is essential to the natural environment, and to human survival, wellbeing and economic prosperity.

The CBD, a multilateral treaty with 196 member states has been in place since 1992 with three main objectives for the planet being:

- The conservation of biological diversity
- The sustainable use of the components of biological diversity
- The fair and equitable sharing of the benefits arising out of the utilization of genetic resources

The CBD is dedicated to promoting sustainable development and considered a practical tool for translating the principles of Agenda 21 into reality. The CBD recognizes that biological diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live[138].

6.2 State of Global Biodiversity

The CBD Global Biodiversity Outlook Report (2020)[139] found that overall biodiversity loss is continuing, despite substantial ongoing efforts for biodiversity conservation and sustainable use. The world is not on track to achieve most of the globally agreed targets for biodiversity (the CBD Targets 2011 - 2020), or for land degradation or climate change, nor the other Sustainable Development Goals (SDGs) for 2030. Biodiversity is declining at an unprecedented rate, and the pressures driving this decline are intensifying, with the world failing to stay on track to achieve the 2050 Vision for Biodiversity '*Living in Harmony with Nature'*.

[138] Convention on Biological Diversity (2023) https://www.cbd.int/convention/)
[139] Secretariat of the Convention on Biological Diversity (2020) Global Biodiversity Outlook 5. Montreal

The Global Biodiversity Outlook Report identified '*Transitions to Sustainable Pathways'* to living in harmony with nature. Each of the following transitions involve recognizing the value of biodiversity, and enhancing or restoring the functionality of the ecosystems:

- Land and Forests Transition
- Sustainable Freshwater Transition
- Sustainable Fisheries and Oceans Transition
- Sustainable Agriculture Transition
- Sustainable Food Systems Transition
- Sustainable Climate Action Transition
- Cities and Infrastructure Transition
- Biodiversity Inclusive One-Health Transition

In response to the state of global biodiversity the *'Kunming-Montreal Global Biodiversity Framework'* (GBF)[140] was adopted in December 2022 and supports the achievement of the SDGs and builds on the CBD's previous Strategic Plans, sets out an ambitious pathway to reach the global vision of a world '*Living in Harmony with Nature by 2050'*. Among the Framework's key elements are 4 goals for 2050 and 23 targets for 2030.

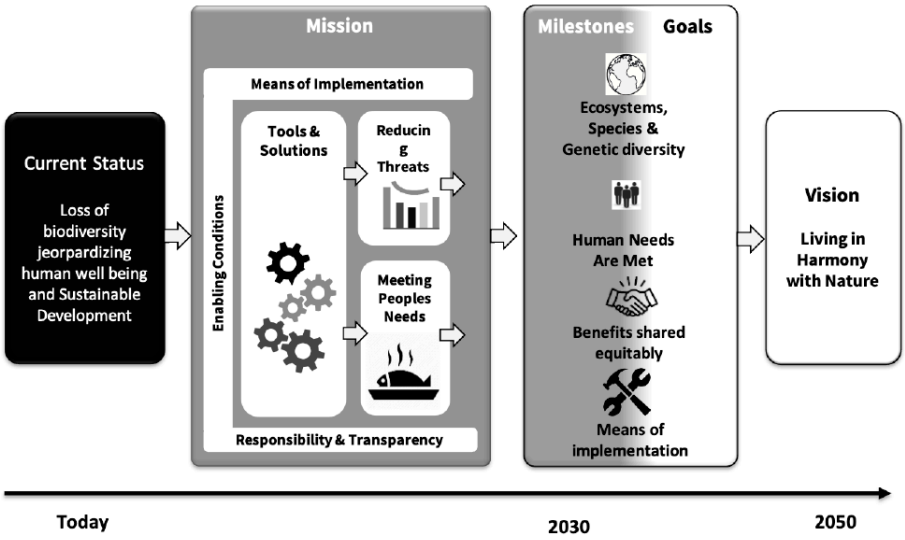


Figure 6.1: GBF Goals and Targets[141]

[140] Convention of Biological Diversity (2022) Kunming-Montreal Global Biodiversity Framework.
[141] Convention of Biological Diversity (2022) Kunming-Montreal Global Biodiversity Framework.

The '*Living Planet Report*' [142] identified that Earth is in the midst of a biodiversity and climate crisis with humanity needing to take urgent action going beyond conservation and focusing on transformations of how humanity produce, consume, governs and finances. The Report identified that land-use change remains the biggest current threat to nature by destruction and fragmentation of natural habitats on land, in freshwater and in the oceans. Coupled with this land-use threat is the issue of climate change. If humanity is unable to limit warming to 1.5°C, climate change is likely to become the dominant cause of biodiversity loss in the coming decades. The Report identifies the biodiversity loss by region (see Figure 6.1)

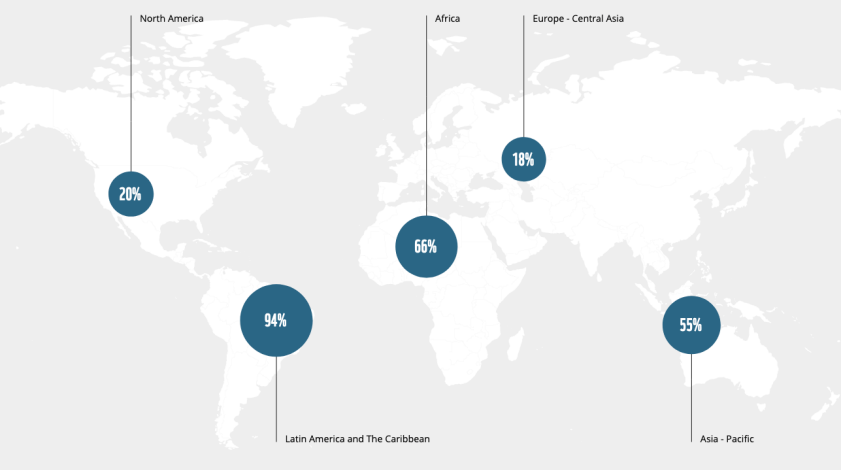


Figure 6.1: Biodiversity by region

Given land-use is considered the largest current threat to nature, it's important to consider the land-use for food production. In 2019 around 50% of the global habitable land was used for agriculture with livestock grazing dominating the agricultural land area (77%) compared to cropping (23%)[143]. From these statistics it is apparent that farmers are managing 50% of Earth's habitable lands. There are more than 608 million farms in the world with more than 90% being family farms which occupy around 70–80% of farmland and produce roughly 80% of the world's food in value terms[144].

[142] WWF (2022) Living Planet Report 2022 – Building a nature positive society. Almond, R.E.A., Grooten, M., Juffe Bignoli, D. & Petersen, T. (Eds). WWF, Gland, Switzerland.
[143] Hannah Ritchie (2019) https://ourworldindata.org/global-land-for-agriculture
[144] Lowder, Sarah & Sánchez, Marco & Bertini, Raffaele. (2021). Which farms feed the world and has farmland become more concentrated? World Development. 142. 105455. 10.1016/j.worlddev.2021.105455.

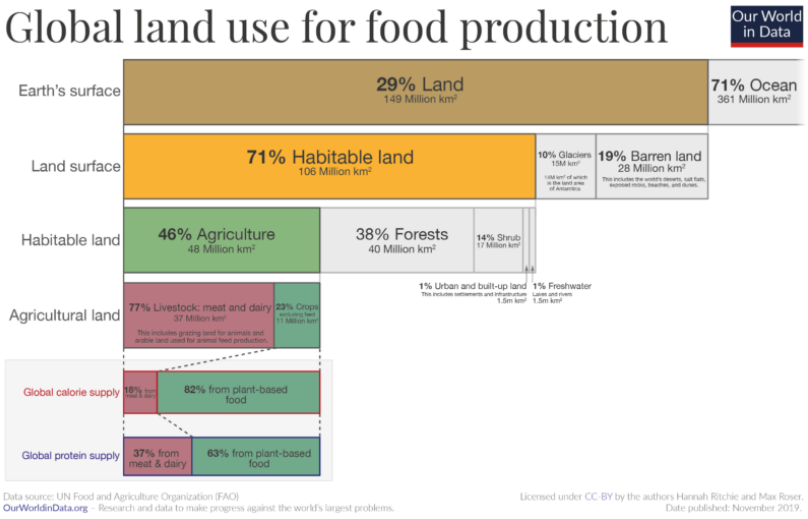


Figure 6.2: Global land-use for food production[145]

Indigenous lands make up around 20% of the Earth's territory, containing 80% of the world's remaining biodiversity[146]. Indigenous Peoples account for 6% of the global population and 19% of the extreme poor[147].

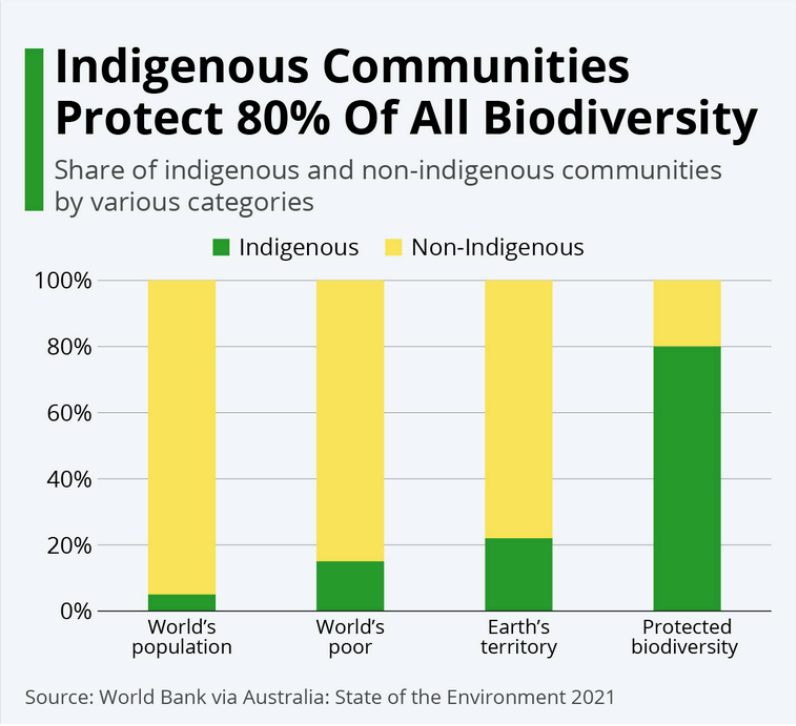


Figure 6.3: Indigenous Peoples and Biodiversity

[145] Hannah Ritchie (2019) https://ourworldindata.org/global-land-for-agriculture
[146] IISD (2022) https://www.iisd.org/articles/deep-dive/indigenous-peoples-defending-environment-all
[147] World Bank (2023) https://www.worldbank.org/en/topic/indigenouspeoples

ACTIVITY

Watch the following short video: Our Planet – What is biodiversity

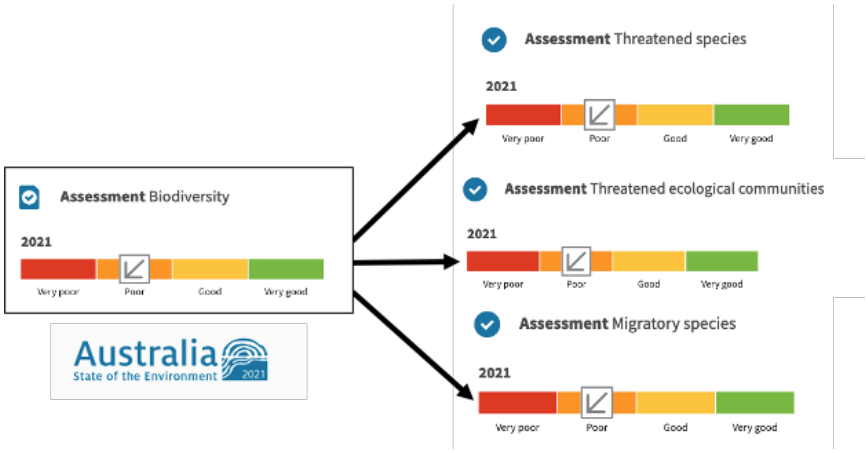
Despite the International Agreements on biodiversity since the 1990s, decline continues globally.

Reflect on why this might be?

Given most of the global habitable lands are managed by Farmers and Indigenous Peoples, what challenges may they face in protecting biodiversity?

6.3 State of Australia's Biodiversity

Australia is biologically rich and diverse and is one of only 17 countries in the world classified as biologically megadiverse, its biodiversity is globally important and remarkable[148]. Australia is a signatory to the CBD and undertakes a biodiversity assessment every 5 years through the '*Australia State of Environment Report'* with the 2021 report[149] finding that Australian biodiversity was poor and deteriorating in comparison to previous assessments.



Over the past two hundred years Australia has lost more mammal species than any other continent in the world and continues to have one of the highest rates of species decline among countries in the OECD. The two pressures causing the most extinction

[148] Taxonomy Australia (2023) https://www.taxonomyaustralia.org.au/australias-biodiversity
[149] Australia State of Environment (2021) https://soe.dcceew.gov.au/overview/environment/biodiversity

of Australian terrestrial species during that time are introduced species, and habitat loss - clearing. For example, in an analysis of all nationally listed threatened terrestrial and aquatic plants and animals in Australia as of July 2018, the same threats were identified being habitat loss; fragmentation; degradation; invasive species, and disease[150]. There are seven main threats to Australia's biodiversity as described in the following table.

Table 6.1: Main threats to Australia's Biodiversity[151]

Threat	Description
Invasive Species	Vertebrate pests, weeds, marine pests and diseases are a key threat to Australia's agriculture, fisheries and forestry industries and the environment. Invasive species are the most common pressure on Commonwealth listed rare and threatened species and are consistently identified as the most prevalent threat to Australian fauna and are a primary cause of extinction.
Clearing Native Vegetation	Depletion and destruction of native vegetation is the biggest cause of biodiversity loss in Australia. Land clearance is listed as a key threatening process for Threatened Species and Ecological Communities under the Commonwealth EPBC Act 1999.
Land Degradation	Depletion and destruction of native vegetation is a primary driver of land degradation. Land degradation as a result of invasive species is recognised through being listed as a key threatening process for Threatened Species and Ecological Communities under the Commonwealth EPBC Act 1999.
Habitat Loss	Native vegetation clearing contributes to habitat loss of Australian terrestrial animal and plant species. Habitat loss and degradation is the primary mechanism through which species are affected by various threats, including logging, mining, urbanisation, transportation, energy production and agricultural activity. As a result, habitat loss and degradation are the most dominant mechanism by which species are threatened in Australia, with nearly 70% of Australian threatened taxa impacted.
Introduced Species	Introduced species are impactful invasive non-native species (i.e. animals, plants, fungi and microorganisms that have been introduced and/or spread outside their natural past or present distribution) that pose huge problems for some commercial sectors and threaten biological diversity. Introduced species now make up a significant proportion of all species recorded in Australia's bioregions.
Fragmentation	Fragmentation is defined as when a large expanse of habitat is transformed into several smaller patches of smaller areas that become isolated from each other. Clearing native vegetation is a major cause of fragmentation and has been implicated in the national listing of most Australia's threatened species.
Disease	Three threatening processes impacting Australia's biodiversity related to pressures from pathogens or disease include: • Dieback caused by the root-rot fungus • Infection of amphibians with chytrid fungus • Beak and feather disease affecting endangered psittacine species

[150] Australia State of the Environment (2021) https://soe.dcceew.gov.au/overview/environment/biodiversity

[151] Australia State of the Environment (2021) https://soe.dcceew.gov.au/overview/environment/biodiversity; Australian Government (2023) https://www.dcceew.gov.au/environment/land/native-vegetation; Australian Government (2023) https://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl

6.3.1 Australian Government Biodiversity Initiatives

To address the threats to Australian biodiversity the Australian Government has a number of initiatives and actions to reverse the trend of biodiversity decline as follows:

- The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) is the Australian Government's central piece of environmental legislation providing a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places. The Australian Government propose to amend the EPBC Act or create new legislation during 2023 to accommodate the new global commitment to protect 30% of Australia's land by 2030;
- Australia's '*Strategy for Nature 2019 – 2030'* is the overarching framework for all national, state and territory and local strategies, legislation, policies and actions that target nature. This Strategy is supported by Australia's Nature Hub, a working group that is responsible for evaluating and reporting on implementation of the strategy to environment ministers every two years.
- '*Nature Positive Plan'* sets out the government's commitment to reform Australia's environmental laws to better protect, restore and manage our unique environment
- To support Environmental Markets the *'Nature Repair Market'* (to be in place late 2023) will establish a transparent framework to issue Australian landholders with tradeable biodiversity certificates for projects that protect, manage and restore nature;
- The *National Stewardship Trading Platform* helps landholders to monetise the biodiversity services they provide by enabling them to connect with buyers, and
- Current funding programs to support protection and rehabilitation of biodiversity include the *National Landcare Program; the Agricultural Biodiversity Stewardship Package, and the National Reserve System.*

6.3.2 Australian Land-Use and Population Distribution

In considering the threats to Australia's biodiversity we need to consider the types of land-use and the distribution of the Australian population. In December 2020 Australian agriculture accounted for 55% of Australian land use[152] (excluding timber production). Despite the gross value of agricultural production in 2022-23 being $92 billion[153] the Australian Government support to agricultural producers is among the lowest in the Organisation for Economic and Cooperative Development (OECD), estimated at 3.1% of gross farm receipts for 2019-21, with total support to agriculture representing 0.2% of GDP[154]. The total area of land in the Indigenous estate in Australia (as at 2016) was 438 million hectares (57%), and the total area of forest in the Indigenous estate as 70 million hectares[155]. From this data it can be estimated around 90% of the Australian landmass is managed for agricultural land use and the Indigenous estate.

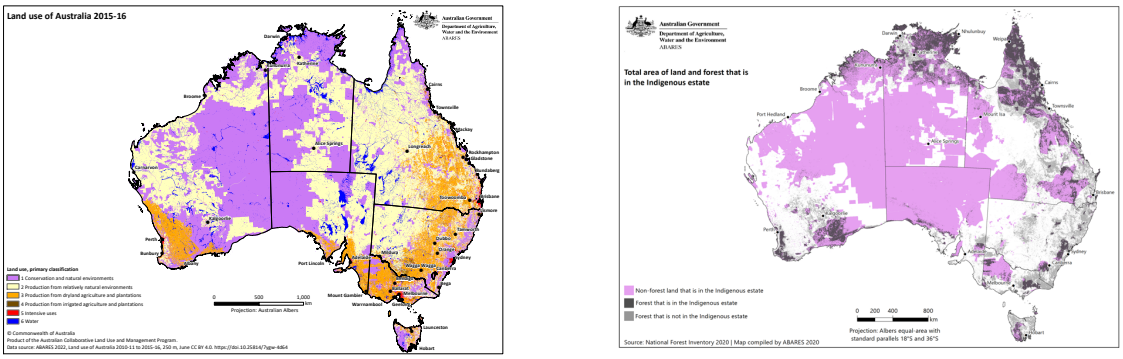


Figure 6.4: Australian Land-Use & Indigenous Estate

Australia is considered one of the most urbanised countries in the world with 96% of the population residing in urban areas and 68% residing within the greater metropolitan areas of Australia's 8 capital cities[156].

[152] Australian Government (2023) https://www.agriculture.gov.au/abares/products/insights/snapshot-of-australian-agriculture
[153] Australian Government (2023) https://www.agriculture.gov.au/abares/research-topics/agricultural-outlook/agriculture-overview#value-of-agricultural-production-to-fall-from-record-high
[154] OECD (2022) Agricultural Policy Monitoring and Evaluation 2022

[155] Jacobsen R, Howell C, Read SM 2020, *Australia's Indigenous land and forest estate: separate reporting of Indigenous ownership, management and other special rights*, ABARES technical report, Canberra, December, DOI: doi.org/10.25814/bqr0-4m20. CC BY 4.0.
[156] Australia State of Environment (2021) https://soe.dcceew.gov.au/urban/environment/livability

The 2021 Census counted 25,422,788 people in Australia[157]. Figure 6.5 shows the distribution of Australia's population classified as remoteness areas ranging from major cities, inner regional, outer regional, remote and very remote.

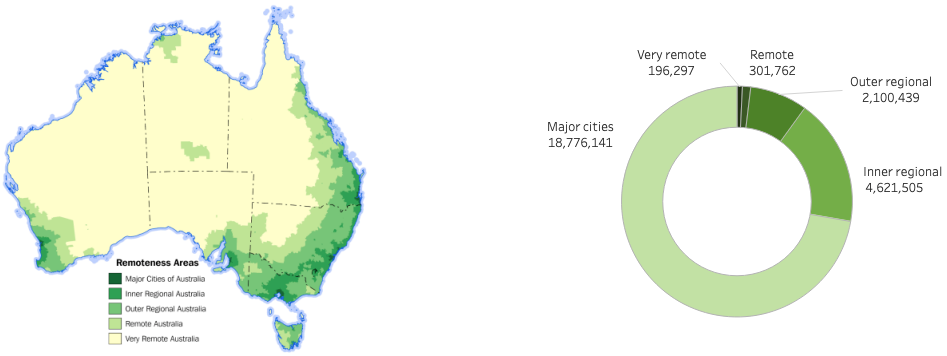


Figure 6.5 [158]

Regional and remote Australian communities are geographically isolated which contributes to poorer health outcomes; poorer access to primary health care service lower incomes; higher prices for goods and services, and lower educational opportunities[159].

Reflection

Compare the maps of Australia's Indigenous Estate, Land-Use and population distribution.

In particular, consider the urban population compared to regional and remote population and the health-income-education issues they face:

- What social-justice and economic issues might act as barriers for biodiversity conservation in rural communities of Australia?

- How could the urban communities share the costs of biodiversity conservation with rural communities given they manage the majority of the Australian landscape?

[157] https://www.abs.gov.au/statistics/people/population/population-census/latest-release
[158] https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/remoteness-structure/remoteness-areas
[159] Australian Institute of Health and Welfare (2023) http: www.aihw.gov.au

6.4 On-farm Biodiversity

On-farm Biodiversity refers to the importance of healthy environmental assets of the farm which play a significant role in supporting the biodiversity and ultimately the ecological systems that underpin farm productivity**.** As was identified in the *'Australia State of the Environment Report 2021'* the main threats for biodiversity are Invasive species, clearing native vegetation, habitat loss, degradation, fragmentation, introduced species and disease. These threats need to be the focus at the farm scale also.

On-farm biodiversity includes the public good biodiversity outcomes delivered from farm management practices that address the main threats to Australian biodiversity such as: native species habitats are preserved and expanded; native vegetation is protected and enhanced; riparian zones are protected and regenerated; invasive and introduced species are reduced; fragmentation is addressed and diminished through regeneration and replanting of native vegetation; any degradation occurring on the farm is rehabilitated, and diseases impacting native species are identified and addressed**.**

A farmer can undertake a biodiversity assessment of the farm through access to SEED mapping layers (as identified in Module 3) for native vegetation, biodiversity values, water bodies, IBRA regions, Mitchell Landscapes and use the maps to guide where biodiversity assessment will occur. Access to the threatened ecological communities and rare and threatened species will also inform the farmer as to if there are any known occurrences on the farm or nearby. This is the desktop part of on-farm biodiversity assessment prior to going into the field to record native vegetation condition, major weeds, soil erosion, habitat features, threats and disturbances and current farm management regime.

Table 6.2 provides an overview of the identification and assessment activities of on-farm biodiversity that is provided in more detail in Module 3.

Table 6.2: On-Farm Biodiversity Assessment

Activity
Prepare a Site and Location Map
Identify & map IBRA bioregions & IBRA subregions
Identify & map rivers, streams, estuaries & wetlands
Identify and map Habitat connectivity
Identify Geological Features of significance
Identify and map areas of outstanding biodiversity value
Identify and map NSW (Mitchell) landscapes
Identify and map Native Vegetation Cover
Identify and map Vegetation Zones
Identify Threatened Ecological Communities and R&T species
Assess Native Vegetation Cover
Assess Native Vegetation Integrity (condition)
Record major weed species present
Record Habitat feature abundance
Record Threats and Disturbances
Record Cultural heritage present
Document Current Management Regime

On-farm management practices[160] that can be adopted to support biodiversity include:

- the importance of connectivity for biodiversity with areas of native vegetation protected as core habitat with buffers around the core habitat as protection
- Use wildlife friendly fencing
- Riparian zones have native vegetation as corridors to other habitat types
- Protecting rivers, creeks and wetlands
- Improving farm dams for habitat and refuge for wildlife
- Paddock trees are retained which act as stepping-stones to larger native vegetation patches with new paddock trees established

[160] ANU (2023) Sustainable Farms https://www.sustainablefarms.org.au/on-the-farm/biodiversity/
Australian Government (2023) What are wildlife corridors?
https://www.dcceew.gov.au/environment/biodiversity/conservation/wildlife-corridors

- Establish new local native plantings to provide links in the landscape
- Establishing local native shelterbelts
- Protecting rocky outcrops
- Plant for pollinators
- Keep fallen timber and dead trees
- Install artificial nest boxes
- ‘Chain of ponds’ wetland systems along the waterways offers habitat for aquatic species and keeps the water in the landscape
- Native grasslands are protected to provide habitat and food sources for native and farming animals.

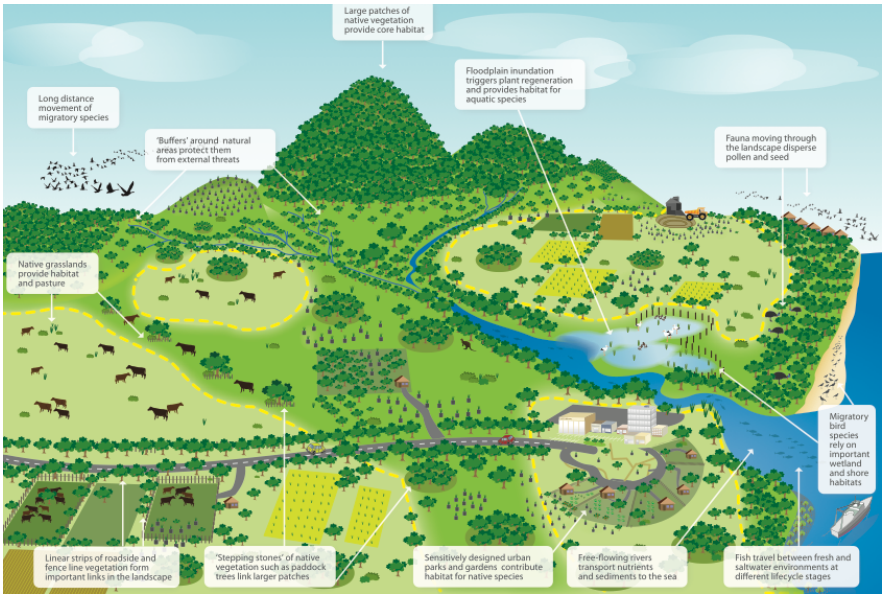


Figure 6.6: Wildlife Corridors[161]

Farmers can undertake monitoring of the on-farm biodiversity through a number of rapid appraisal methods available as identified in Module 3. These include rapid conservation assessment method; biodiversity habitat assessment, rapid appraisal of riparian condition, rapid assessment of soil health and water quality monitoring.

[161] Australian Government (2023) What are wildlife corridors? https://www.dcceew.gov.au/environment/biodiversity/conservation/wildlife-corridors

QUIZ

Taking into considerations the major threats globally and nationally to biodiversity, what do you consider the high priority practice change and monitoring a farmer could undertake to maintain and enhance biodiversity at the farm scale?

6.5 Current Biodiversity Markets in Australia

There are three types of Biodiversity Markets in Australia being offsetting, credits and stewardship agreements.

Offsetting mechanisms have been created by Government regulators as a component of development approvals to achieve a balance between economic growth and biodiversity conservation. Offsetting is now a part of environmental approvals processes to ensure no net loss in biodiversity. Biodiversity offset policies and associated legislation exist at the Australian Government, state and territory levels. These policies vary across the different Australian jurisdictions such as the presence/absence of a market to trade offsets; calculation and purpose of offsets; exemptions from offsets, and types of negotiated outcomes when offsets can't be achieved.

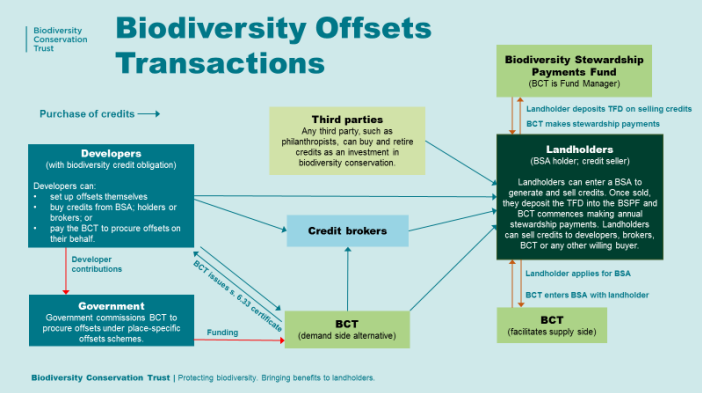


Figure 6.7: NSW BCT Offsets Transactions[162]

Biodiversity credits are used to measure both the unavoidable impacts on biodiversity from development and clearing at a development site; and the predicted improvement in biodiversity condition gain at a stewardship site (see Figure 6.8) An example is the NSW Biodiversity Offset Scheme.

[162] NSW Biodiversity Conservation Trust (2023) https://www.bct.nsw.gov.au/delivering-biodiversity-offsets

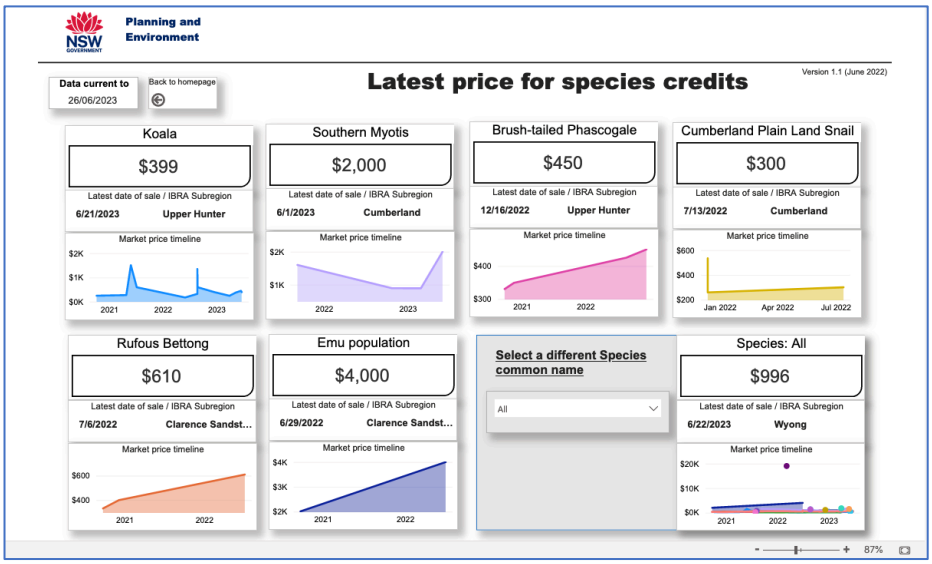


Figure 6.8: NSW Species Credits[163]

In NSW a Biodiversity Stewardship Agreement[164] enables biodiversity credits to be generated, which can be sold to fund the management of weeds, pests, fire, and ecological restoration.

[163] NSW Government (2023) Biodiversity Credits Market Sales Dashboard https://www.seed.nsw.gov.au/biodiversity-credits-market-sales-dashboard
[164] NSW Biodiversity Conservation Trust (2023) Apply for a Biodiversity Stewardship Agreement https://www.bct.nsw.gov.au/apply-biodiversity-stewardship-agreement

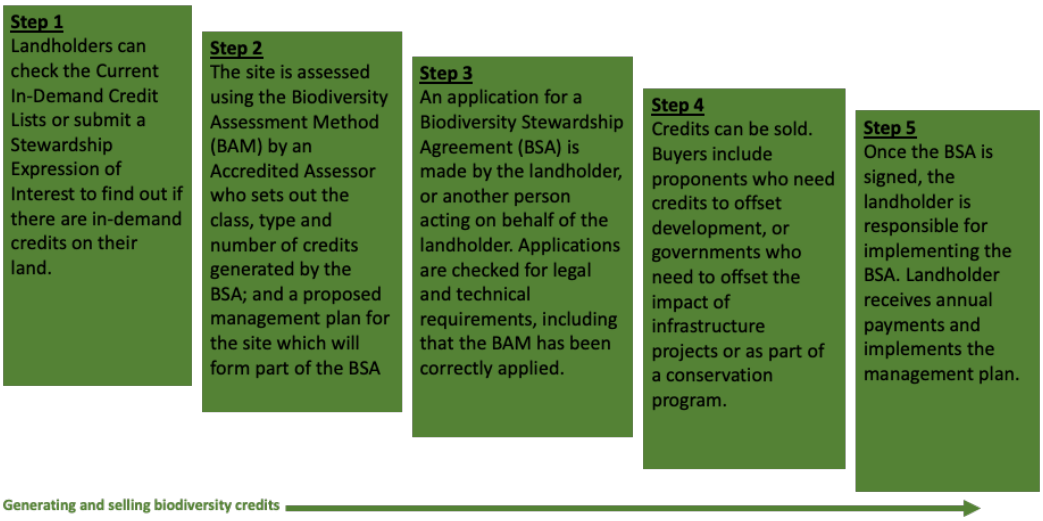


Figure 6.9: NSW Biodiversity Stewardship Process[165]

Income streams from Biodiversity Markets are becoming a reality. A sample NSW Biodiversity Conservation Trust project[166] has been derived from registered assessors operating in western NSW. Table 6.3 provides and overview of this sample project indicating activities, costs, benefits and potential timelines of a generic 400 hectares biodiversity offsets project in the Lower Namoi in NSW.

Table 6.3

Activity	Month	Costs	Benefits
Desktop site assessment (accredited assessor)	January 2021	$2,500	
Site visit, mapping and flora and fauna surveys. BSSAR document for submission	July 2021	$85,000	
BCT Lodgement Fee	August 2021	$2,552	
Legal and Accounting Advices	September 2021	$15,000	
Credit Sales activating Total Fund Deposit (TFD) and annual management fee	February 2022		$950,000
Excess Credit Sales (net value less taxes)	December 2022		$750,000
Interest Cost accrued	Jan 2021 – Jan 2023	$7,750	$2,552
Annual opportunity cost of lost production (100 cows agistment $10wk/52 weeks)		$52,000 p.a	
TOTAL		**($164,802)**	**$1,700,000**

[165] Adapted from NSW Biodiversity Conservation Trust (2023) Biodiversity Stewardship Agreement Information https://www.bct.nsw.gov.au/info/biodiversity-stewardship-agreement-bsa-information
[166] CottonInfo (2021) AgEcon: Biodiversity Offset Schemes: an emerging market for Cotton Growers https://cottoninfo.com.au/sites/default/files/2021-10/Biodiversity%20offset%20schemes.pdf

Case Study: Stewardship Agreement Payments

Greg Rummery farms dryland crops on the flat, clay floodplains of the Namoi River near Walgett in north-western NSW. His 1,000-hectare farm is small by local standards, but in 2019 he decided to retain about a quarter of his property for conservation. The fenced-off area forms a corridor of green along the banks of the river, with a mix of older trees and newer regrowth. Rummery says a common practice in his district would be to farm crops like wheat or lentils on the flat floodplain and run beef cattle along the river, providing farmers with two sources of income.

"But rather than trying to generate a dollar out of that by running stock in there and having them graze down to the waterline on the river and using the river as the boundary, I thought there's got to be a better way."

Greg Rummery says the benefits of conservation are becoming clear and are attractive to landholders. ABC RN Belinda Sommer

When the Biodiversity Conservation Trust called for expressions of interest from landholders in the Walgett district in 2018, Rummery says it struck a chord.

"Maybe there's a better use for [that land] than trying to farm it or trying to flog it with stock. You know, that's the bit that needs incentivising," he says.

Rummery's annual payment of just over $20,000 requires him to allow regrowth to continue, control weeds and keep on top of fox and wild pig numbers. The agreement runs for 15 years.

After extreme drought conditions between 2013-15 and again from 2017-19, Rummery says the benefits of diversifying income became clear.

"Effectively, in those drought years, we didn't have any farm income. So, the income from the biodiversity agreement was valuable. It's only a small contribution, though."

ACTIVITY

The Biodiversity Markets in Australia for farmers and Indigenous land managers are largely focused on offsetting, with the promise of new stewardship markets emerging from 2023 onwards.

Read this news article: **NSW Auditor-General issues stern criticism of state's biodiversity offset scheme**

Should biodiversity be traded from the farm for offsetting development or left as a stewardship contribution to local-regional sustainability and biodiversity validation?