Australian Government
Bureau of Meteorology

Guide to environmental accounting in Australia

Contributing to the Australian Government National Plan for Environmental Information initiative

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no. 1 The environmental accounts landscape
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Foreword

I am pleased to present the *Guide to environmental accounting in Australia*, a key achievement and milestone under the National Plan for Environmental Information initiative.

The *Guide to environmental accounting in Australia* (the Guide) provides an informative introduction to environmental accounting in Australia and sets directions for broad-based implementation. The capacity to repeatedly and robustly quantify changes to Australia's natural capital and the flow of services from ecosystems is at the heart of environmental accounting. The Guide strongly promotes the development of coherent, standardised accounting practice.

Environmental accounting is undergoing rapid development nationally and internationally. The most noteworthy of these developments is the System of Environmental-Economic Accounting, an international statistical standard developed through the United Nations. Sustainable development and natural resources management requires accounting approaches that intersect with economics, statistics, human culture, and environmental condition.

The Guide recommends that Australia adopt the System of Environmental-Economic Accounting as the framework for environmental accounting.

It is important to acknowledge the long history of developing and delivering environmental–economic accounting by the Australian Bureau of Statistics. Similarly, the Bureau of Meteorology (the Bureau) brings an equally long history of serving the Australian people through collecting and delivering high quality information about fundamental physical processes in the environment, underpinned by excellence in science.

In recent years, the Bureau's role has been broadened from the weather and climate to encompass water. The extension into environmental accounting requires an integrated approach in partnership with statistical and environmental information agencies across Australia. During the development of the Guide, and related experimental work, these partnerships have been established.

I am very excited to see the emerging environmental accounting capability for Australia and the strength of the partnerships already formed. I commend the Guide to you.

Graham Hawke
Deputy Director (Environment and Research)
Bureau of Meteorology
December 2013

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Abbreviations

Abbreviation	Description
ABS	Australian Bureau of Statistics
AG EIAG	Australian Government Environmental Information Advisory Group
ANZSIC	Australian and New Zealand Standard Industrial Classification
BSU	basic spatial unit
CICES	Common International Classification of Ecosystem Services
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GDP	gross domestic product
GVA	gross value added
ha	hectare
ISO	International Organization for Standardization
m	metre
NPEI	National Plan for Environmental Information
NRM	Natural Resource Management
OECD	Organisation for Economic Co-operation and Development
PMSEIC	Prime Minister's Science, Engineering and Innovation Council
SEEA	System of Environmental-Economic Accounting
SEEA-AE	System of Environmental-Economic Accounting Applications and Extensions
SEEA-CF	System of Environmental-Economic Accounting Central Framework
SEEA-EEA	System of Environmental-Economic Accounting Experimental Ecosystem Accounting
SEQ	South East Queensland
SNA	System of National Accounts
TEEB	The Economics of Ecosystems and Biodiversity
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNSD	United Nations Statistics Division
WASB	Water Accounting Standards Board
WAVES	Wealth Accounting and Valuation of Ecosystem Services

Executive summary

Australians have an opportunity to improve the way environmental information is organised and presented through the use of environmental accounts. Accounts, in general, organise highly complex information to produce more readable and understandable information and, in doing so, have made substantial contributions to human well-being through the economic system. New environmental accounting methods are poised to make similar contributions to a diverse range of human endeavours, from the environmental (ecosystems and biodiversity) to the social and economic.

Key messages

- The *Guide to environmental accounting in Australia* (the Guide) presents a powerful way for Australians to better factor our country's unique natural estate and its immense contribution to our well-being into policy and decision-making.

- Accounting is a long-established and well understood format for organising information with built-in checks and balances. It is used for tracking value through time and space. While national accounts report on the economy, on the whole measures of human, social, and natural capital do not register in these accounts. Fortunately, advances in theory and practice across many disciplines, along with advances in information technology, are allowing accounting methods to be applied to the environment and ecosystems, providing a broader frame of reference for policy.

- A powerful and flexible accounting framework called the System of Environmental-Economic Accounting (SEEA) has been identified that meets the needs of Australia's environmental policy makers and managers. The SEEA has recently been reviewed, revised and extended to cover integrated environmental and ecosystem accounting, and enjoys a widespread international consensus of endorsement and adoption.

- The SEEA provides clear pathways to account for ecosystems in non-monetary (physical) terms without requiring a reference to the economic system or monetary valuation. This opens the way to accounting for ecosystems from an entirely environmental perspective and for a range of non-monetary values. While such accounts are valuable for many purposes, the SEEA framework provides the added advantage of enabling strong links to the economic system.

- A range of complex challenges could benefit from an environmental accounting approach, including those related to social and economic issues. Benefits flow from improved information exchange leading to increased understanding, reduced risk and increased trust and confidence. This generally leads to increased accountability, reduced costs and increased investment in environmental management activities.

- Australians value the environment and over the last two decades have committed and invested significantly through programmes including Landcare, Water for the Future, and Caring for our Country. Through the provision of structured information that tracks change over time, environmental accounts can contribute to improvements in efficiency and effectiveness, leading to reduced costs and increased returns on investment in such programmes.

- The opportunity for environmental accounting is to design systems that integrate information, rather than generating unlinked, discrete silos of information. In this way, disparate sources of information can be jointly viewed and compared.

- The next steps in Australia are to establish clear governance for prioritising and producing environmental accounts and ensuring that the necessary knowledge, skills and capability are available for their efficient and effective production and use. Towards this end, the Bureau of Meteorology (the Bureau) is working with key partners to develop an environmental accounts capability that can deliver environmental accounts to meet policy and decision-making needs.

- Despite some inherent challenges, taking an accounting approach to managing and reporting environmental change is achievable. Existing work already provides a foundation that can be systematically built upon to achieve this aim.

General recommendations

The Guide recommends that environmental accounting be considered a solid and efficient platform for delivering improved information about Australia's environment and its relationship to human well-being. The following principles should be used:

1. Ecosystems are fundamental to human well-being. Human cultural systems, including the economic system, are embedded in ecosystems and the living world.

2. For environmental accounts, all air, land, marine and water environments are in scope as are all ecosystems, including human ecosystems (rural and urban areas).

3. Biodiversity is a fundamental characteristic of ecosystems, including within and between species diversity as well as ecosystem diversity.

4. Each environmental account should properly discern the account subject, noting that:

    a. Account subjects can be individual components of ecosystems and the environment, or for ecosystem accounting[1] the subject is the integrated functioning of ecosystems (i.e., measures of ecosystem characteristics are used to gain an integrated view of ecosystem functioning).

    b. Ecosystems are challenging to define and map precisely as they exist at overlapping spatial and temporal scales; therefore, measures and indicators are used to infer their condition at specified scales.

    c. Ecosystem services are not independent of each other; they are always combined and interconnected.

5. Environmental accounts should be based on the best available scientific knowledge and clearly defined descriptions (conceptual models), supported by an evidence base produced with best practice principles.

6. Environmental accounts should enable tracking of value (quantity and quality) through time, across space, and between entities. This depends on the characteristics of environmental accounting, including that:

    a. The account subject and its valuation (meaning) depends on the worldview adopted by the valuer.

[1]. Ecosystem accounting is a subset of environmental accounting described in the SEEA Experimental Ecosystem Accounting (European Commission et al. 2013).

b. The measures of value used for the account depends on the perspective taken (e.g., physical Earth, living, human cultural, or economic).

c. Value can be defined using monetary or non-monetary methods. Non-monetary (biophysical) environmental accounting should draw on knowledge domains including biology, ecosystem science, physics and chemistry. Independent scientific accreditation of the measures and methods applied is essential.

d. Non-monetary valuation is often the only way to obtain information about the environment as it is impracticable or not possible to value many aspects of ecosystems and the broader environment by monetary methods.

e. Continuous improvement is required in the ways non-monetary and monetary information are presented, separately and in combination, to ensure their relevance and to assist in their use.

f. For ecosystem accounting, relationships between ecosystems are fundamental to their quality and value; therefore, the location of ecosystems is a fundamental organising principle.

g. Temporal data are an essential requirement of environmental accounts.

h. To support the legitimacy and credibility of the account, independent accreditation and assurance are essential contributors to any environmental accounting system.

7. Environmental accounts (including ecosystem accounts) and account-ready environmental data are useful in their own right and, where required, should also clearly link to environmental–economic accounts and, through them, to economic accounts.

Specific recommendations

The Guide provides the following specific recommendations for environmental accounting in Australia:

1. Adopt the SEEA as the fundamental framework for Australian environmental accounting, noting that:

    a. The SEEA framework is the international standard and provides a flexible basis for environmental and ecosystem accounting from an environmental perspective, considering such topics as water quality, soil health, vegetation extent and condition, and biodiversity.

    b. The SEEA framework also provides an important bridge to the economic accounting system and produces information about interactions between the economy, society and the environment that influence human well-being.

    c. In some circumstances, it may be practical and beneficial to translate existing accounts into the SEEA framework.

2. Implement a programme to produce environmental accounts and account-ready data and statistics that will:

    a. Improve tracking of Australia's natural capital (i.e., environmental and ecosystem assets) in monetary and non-monetary terms. For example:

        i. The programme should produce accounts that are useful at the scale at which

management decisions are being made and implemented: that is, at regional and national scales. The regional scale is where many on ground investments are made to maintain natural capital, for example within Natural Resource Management (NRM) regions. National-scale accounting is important to provide an improved frame of reference for guiding Australia's overall performance in maintaining and enhancing its natural capital and sustainability;

b. Provide the basis for a more integrated view of living systems through ecosystem accounts. The ecosystem accounting programme should address the following requirements:

    i. The first basic environmental accounts to produce should be land, biocarbon, water, energy, and biodiversity—some of which are already being produced. This is consistent with, and building towards, integrated ecosystem accounting. The land account represents a key link between environmental and economic accounts.

    ii. The primary focus of the programme should be on producing asset (stock) accounts and account-ready data from an environmental perspective, that is, from a living system (ecosystem) and physical Earth perspective. This information, in turn, will then contribute to improved measures of ecosystem services and natural capital (i.e., environmental and ecosystem assets) and estimates and measures of sustainability.

    iii. The production of environmental accounts should be broadened beyond the terrestrial to include aquatic ecosystems, particularly wetland, coastal, estuarine and marine ecosystems.

3. Continue to develop the enabling environment for environmental accounting through the following:

    a. Develop institutional collaboration agreements that maximise the efficiency of account production and the value of the accounts through:

        i. recognition that environmental accounts are at the intersection of a wide range of domains (economy, society and the environment) and jurisdictional arrangements (local, regional, State and national);

        ii. coordination of Australian environmental account production conducted through a collaborative governance mechanism, subject to statutory obligations; and

        iii. production of environmental accounts by key organisations (including the Australian Bureau of Statistics [ABS], the Bureau, Victorian Department of Environment and Primary Industries, and regional NRM organisations) joining with others from government, the corporate and research sectors, and non-government organisations in the future.

    b. Address the fundamental data requirements of accounts by increasing temporal and spatial resolution and coverage via:

        i. expansion of evidence-based long-term environmental, ecosystem and biodiversity monitoring programmes;

        ii. increased the frequency of standardised land cover, land use, and land management practice mapping to at least annual; and

        iii. production of long-term environmental datasets using hindcasting methods

(e.g., for biocarbon).

c. Build capacity, knowledge and skills to produce, assure and use credible and legitimate environmental accounts by:

   i. maintaining openness and transparency in accounting concepts, sources and methods and by enabling independent accreditation and assurance;

   ii. developing guidance to produce standardised conceptual models that capture and present the best available scientific knowledge about the environmental account subject;

   iii. identifying standardised environmental accounting assurance procedures;

   iv. training and certifying assurers of environmental accounts; and

   v. including the use of accounts in professional development for individuals in government and corporations, including media commentators.

d. Ensure continuous improvement of the enabling environment through:

   i. iterative improvements and refinement of the relevant methods and datasets including through substantial engagement with the research sector;

   ii. ongoing engagement with the international community-of-practice; and

   iii. further development and maintenance of the Australian community-of-practice.

About the *Guide to environmental accounting in Australia*

Why has the Guide been produced?

The Guide aims to improve environmental outcomes in Australia and contribute to the country's long-term sustainability through the implementation of environmental accounts. It is intended as a bridging document for policy makers, scientists and accounting practitioners.

Given the vast range of topics and issues associated with the environment and thus environmental accounting, the Guide summarises the current state of knowledge and offers direction to those considering the use of environmental accounts, from getting the right concepts in place through to accounting practicalities. It provides pointers to existing technical material.

The outlook for successfully applying the Guide is greatly enhanced by substantial advances in knowledge of the continent's ecology, coupled with continuous improvements in information technology and the unfolding of a new generation of environmental accounting methods.

Who is the Guide for?

The Guide is for those deciding whether an environmental account will be of benefit and, if so, what is needed and how to go about creating it. In other words, it is for a broad audience of users and compilers of environmental accounts and those involved in producing and using biophysical information.

There are careful choices to be made when using environmental accounting. The Guide and associated *Environmental account framing workbook* will help identify critical decision points and offer strategies to optimise benefits.

How is the Guide structured?

The Guide is in three parts.

Part A is an introduction to environmental accounting for anyone interested in producing environmental accounts or deciding if environmental accounts are appropriate for their needs. It describes environmental accounts (Chapters 1 and 2), their purpose (Chapter 3) and possible risks and issues (Chapter 4).

Part B describes the pathways for implementing accounts. Together, Chapters 5, 6, 7 and 8 provide a practitioner with guidance on designing environmental accounts, while Chapter 9 describes institutional and capability considerations for senior managers considering implementing an environmental accounts programme. Many organisations will already have the prerequisites for producing or using accounts and this chapter will assist in determining feasibility. Chapter 10 explains the role and value of standards in environmental accounting.

Part C is a compendium of supplementary technical reference material in the form of appendices to support the purpose, concepts and fundamentals of environmental accounting described in parts A and B. The technical references include a glossary, typology of environmental accounts, a listing of environmental frameworks, and further information on the process for prioritising accounts and developing a standard.

Part A: An introduction to environmental accounting

Part A of the Guide introduces environmental accounting and provides important background and context to its value and use.

Box 1. What are environmental accounts?

Environmental accounts are strongly structured tables that provide organised information for a clearly defined decision-making purpose. They are systematic and comparable, and use standard definitions based on accepted measurement and accounting theory.

Environmental accounts use physical measures (such as area, volume or weight), derived or composite measures (such as an index) or, where appropriate, monetary measures. Specific types of accounts can be developed depending on the perspective and requirements of the account user.

Environmental accounts can be used for a variety of purposes:

- From an economic point of view, they can measure natural inputs to the economy and how the economy impacts on the environment (e.g., pollution and waste).
- From a social point of view, they can contribute to measuring human well-being.
- From an environmental point of view, they can be used to track changes in the environment, ecosystems, and their functioning.

Terminology associated with environmental accounts includes 'ecosystem goods and services' and 'natural capital'.

Ecosystem goods and services contribute to the benefits that flow to people from the environment, for example, clean water, timber, habitat for fisheries, ingredients for medicines, and pollination of agricultural crops. Other ecosystem goods and services include carbon sequestration, flood mitigation, educational opportunities, and a sense of identity and well-being associated with natural places (e.g., the coast or bush) and the existence of life forms (e.g., blue whales).

Natural capital is, in general terms, the productive natural resource base, including land, air, water, ecosystems, and living organisms that yield a flow of valuable environmental and ecosystem goods or services into the future.

1. Background

The call for Australian environmental accounts

Australians live in a unique and rich continent surrounded by a vast marine estate; these are the living and non-living environments upon which we depend. These natural sources of wealth, or natural capital, are fundamental to the country's common and collective wealth. There are opportunities and challenges associated with living in Australia, not least the challenge of providing sound stewardship for our natural capital. It is this natural capital, together with human, social and economic capital, that provides the basis for the well-being of all Australians, now and into the future.

Australians need better tools for evaluating the impact of their decisions as we grapple with improving human well-being in the present, while securing and maintaining the capital base necessary for a prosperous and sustainable future. To these ends, the Australian people (2020 Summit) and the highest levels of Australian Government (through the establishment of the National Plan for Environmental Information (NPEI) initiative in 2010) have called for improvements in the way environmental information is organised, including a need for enhanced environmental accounts (Wentworth Group 2008; Department of the Prime Minister and Cabinet 2009).

Organising environmental information is challenging, not least due to the complexity of living systems. In addition, there are many different types of interactions between people and the natural environment, ranging from non-material interactions (such as a sense of identity and place) to direct physical interactions (such as the production of food, fibre and timber). Some interactions are measurable in monetary terms while others are not or only partially so.

Specifically designed to meet these needs, environmental accounting offers contemporary solutions for organising and presenting information. The solutions are based on extensions to financial and national accounting methods to track change and understand reasons for change. To respond to the call for an accounting format to produce consistent, reliable, and structured information on our natural environment for policy and decision makers, we need to expand and enhance existing accounting systems.

Accounting solutions for tackling national challenges

The power of the accounting format

The organisation of data into an accounting format is one of the oldest human record-keeping activities. Double-entry accounting emerged during the Italian Renaissance (14th–16th centuries) and has underpinned the development of the modern economic system (Gleeson-White 2013). The power of the accounting format is realised by double-entry bookkeeping where a series of nested journals and ledgers is balanced through symmetrical entries of debits and credits. The conceptual basis is one of defining capital (stocks) and transfers (flows) of things we value and the purpose is to record the transfer of value through time and space (e.g., from year to year) or between entities (e.g., people or businesses).

National accounting delivers economic gains but partial information

The power of the accounting approach is demonstrated by national economic accounting, which was first implemented in the 1930s. Organised national accounts helped support a much more stable and steadily growing economy, as useful feedback was captured about its functioning; however, a proportion of the value measured in the economy cannot be explained by the known inputs to production (i.e., by produced capital and labour). In other words, a large part of the value recorded

by gross domestic product (GDP) each year is generated from parts of the capital base that are currently unaccounted for in the national accounts. Though accurate estimates are not readily available, the unexplained value is understood to be produced by combinations of social, natural and human capital.

For example, national accounts do not account for many inputs from the environment to the economy (such as the use of water in production or pollination by bees in agriculture) and nor do they account for many of the impacts of the economy on the environment (such as the costs of pollution). As a result, one well-documented issue with national economic accounts is that economic growth may be over-stated while natural capital is run down or degraded (see Stiglitz et al. 2009 for a synopsis).

From the beginnings of national economic accounting, the natural environment was included in founding concepts (e.g., Kuznets and Keynes in the 1930s) but often not in practice. For example, the idea of natural capital was included in the definition of economic production but then, largely due to practical difficulties and the relative abundance of natural resources, was left out of the actual calculations. Today Australia's national accounts include some limited information about Australia's natural capital base (ABS 2012a).

Addressing natural capital in national accounting

Sustainability, by definition, involves preserving the capital base. To make informed decisions, policy makers need more comprehensive information about Australia's natural capital base upon which to judge the sustainability of the systems they manage and the best mix of economic, social, human and environmental policies.

The national economic accounts offer a highly structured basis on which to build a new generation of account formats, including environmental accounts of natural capital. Internationally, efforts have been directed at extending national accounts to incorporate natural capital, enabling better-informed decisions. Responding to this considerable challenge—extending and developing existing accounting formats to account for the environment—is a major purpose of this Guide (see Chapter 3).

The challenge of environmental accounting

Vigorous efforts around the world to improve the quality and scope of information about the status of natural capital are producing advances in all facets of accounting. This includes corporate ecosystem valuation techniques (World Business Council for Sustainable Development [WBCSD] 2011), environmental statistics (United Nations Statistics Division [UNSD] 2013a), environmental and ecosystem accounting methods (European Commission et al. 2012), natural capital accounting (Wealth Accounting and Valuation of Ecosystem Services [WAVES] 2013) and ecosystem services accounting (The Economics of Ecosystems and Biodiversity [TEEB] 2013). Australia has made a substantial contribution to this new generation of accounting methods and practice, including through its participation in the development of the UNSD SEEA framework. A number of environmental accounts are currently being produced in Australia, for example, greenhouse gas emissions, water and land accounts (the Bureau 2013a). While there are inherent complexities in using an accounting approach to track environmental value, methods continue to develop and be implemented.

To be credible and effective over the long term, environmental accounting needs to be built on sound theoretical foundations. A parallel can be made with the economic theory underpinning economic accounts.

The choice of the accounting conceptual model is a crucial step as it can enable, or disable, solutions and progress; for example, to tackle wicked problems such as climate change, or securing a sustainable future.[2] The links between environmental, societal and economic perspectives in the practice of accounting must be considered.

Principles and prerequisites for Australian environmental accounting

To continue developing a sound basis for environmental accounting in Australia, it is necessary to identify the principles and prerequisites for producing and understanding environmental accounts. The Guide describes the principles, explains the importance of considering an account from different perspectives, and guides the production of environmental accounts.

An expanded role for the Bureau of Meteorology

The Bureau has a long history of serving Australians through excellence in science and a focus on collecting and delivering high quality information about fundamental physical processes in the environment. In recent years, this role has been broadened from the weather and climate to encompass water, the oceans and ecosystems, and includes a water accounting capability (the Bureau 2010).

Of particular relevance for tackling the challenges of environmental accounting, the Bureau is implementing the NPEI initiative. Working jointly with the Australian Government Department of the Environment, the Bureau's role focuses on operational activities and on implementing the technical components of an environmental information infrastructure, including the development of national environmental accounts.

[2]. Wicked problems are complex issues that are highly resistant to solutions (Australian Public Service Commission [APSC] 2007). There may be disagreement about the causes of these problems, and understanding and responding may go beyond the capacity of one organisation. A prominent example is global climate change.

2. The basics: What are environmental accounts?

This chapter introduces the basic concepts around accounting and environmental accounting to provide a common language for the Guide.

Accounts

Accounts are a structured, systematic way of organising data into information for a clearly defined decision-making purpose. They track flows and stores of value (stocks) over a set period of time. Accounts present comparable information in a systematic fashion, using standard definitions based on a sound conceptual framework. They encourage the development of comprehensive and consistent data and provide a platform for producing a range of accounting reports and analyses.

There are two commonly recognised forms of accounting: business or financial accounting, and national accounting. The first generally deals with an individual business's assets, liabilities, income, expenses, and equity while the second deals with the economic activity of a nation and tracks macroeconomic variables such as national income, investment, production, consumption, assets and liabilities, inflation, and international trade. Both forms are based on the same fundamental accounting principles: organising data about stocks and flows of value using double-entry bookkeeping methods to ensure that changes in flow accounts are equal to the change in the related stock account.

Accounts depend on clear definitions of the account subject (e.g., cars, fish, water, waste, or energy) and of the organising units for accounting (e.g., a business or household). As accounts are strongly concerned with changes in the account subject over time, much attention is paid to when transactions and measurements take place and which units are involved.

As measurement of the account subject is central to any accounting, standard measurement methods and classifications are required. When it is not possible to observe or record every transaction, as for many national accounting purposes, changes in the subject of the account are estimated using robust statistical sampling methods, such as surveys. An account organises data about the subject that allow comparisons across time and space and between entities. This is powerfully enabled when a common currency is available, such as money. In addition, an account can then be used to produce indicators such as GDP.

Accounts support forecasting by providing structural data to better understand relationships between the elements being measured (e.g., saving, investment, or productivity). An account can also be used as a platform to develop specific analyses such as scenarios and other future-oriented assessments.

Accounting systems must adhere to standards as they are designed to provide information to interested parties beyond the accounting system (such as investors). To be credible and legitimate, accounting information must be generated in an open and transparent manner (e.g., using accepted standard methods) and be subject to independent assurance.

Environmental accounts

As with other forms of accounting, the essential purpose of environmental accounts is to track the transfer of value through time, between locations, and between owners (including households, businesses, and governments). For example, an account could be used to track whether the value associated with the account subject (such as a national park, an ecosystem, a measure of biodiversity, or sequestered carbon) has increased or decreased over a certain time period, or has reduced or expanded in extent.

Like all accounts, environmental accounts apply basic accounting principles. The main difference to environmental accounting and the System of National Accounts (SNA) is the range of non-market values that can be accounted for. In practice, SNA national accounts are generally only produced for account subjects with a market price or a close equivalent. For example, timber has a market value and is included; however habitat for threatened species or fresh air does not and hence is not included. An important aim of environmental accounting is to capture the value of such non-market environmental assets.

The extension of monetary valuation techniques to environmental accounting subjects is an active area of experimentation and trials. Similarly, the definition and measurement of value in the absence of a market is a vital and on-going challenge. Both are frequent themes in this Guide.

While economic accounts describe stocks and flows of economic goods and services, the subject of environmental accounts is natural capital and flows of environmental and 'ecosystem services'.[3]

Natural capital and ecosystem goods and services

Natural capital and the associated flows of ecosystem services are central concepts in environmental accounting. This includes environmental assets, such as timber and minerals, ecosystem assets, and the goods and services that flow from the assets. The concepts have been translated from economic theory and provide a bridge between the economic, social, and environmental domains. For example, measures of economic, social, human, and natural capital form the basis for assessing sustainability and human well-being in Australia (Australian Treasury 2011) and for assessing the wealth of nations (World Bank 2011). Natural capital is usually referred to, more precisely, in the Guide as environmental assets, of which ecosystems assets are a subset (see Box 2 and the Glossary).

[3]. Ecosystem services 'are the contributions of ecosystems to benefits used in economic and other human activity' (European Commission et al. 2013).

Box 2. Definitions of the environment, ecosystems, assets and services

Term	Definition
Environment	The naturally occurring living and non-living components of the Earth, together comprising the biophysical environment (European Commission et al. 2012, SEEA Central Framework [SEEA-CF]).
Environmental asset	The naturally occurring living and non-living components of the Earth, together comprising the biophysical environment that may provide benefits to humanity (SEEA-CF). Environmental assets include ecosystem assets and are part of natural capital.
Ecosystem	An area containing a dynamic complex of biotic communities (e.g., plants, animals and micro-organisms) and their non-living environment that interact as a functional unit (European Commission et al. 2013, SEEA Experimental Ecosystem Accounting [SEEA-EEA]). Ecosystems are taken to include human ecosystems such as agricultural systems. Biodiversity is a characteristic of ecosystems.
Biodiversity	The variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and ecosystems (United Nations 1992, 'Use of Terms', Convention on Biological Diversity, Article 2). The SEEA-EEA regards biodiversity as an ecosystem characteristic.
Ecosystem asset	An area containing a dynamic complex of biotic communities (e.g., plants, animals, and micro-organisms) and their non-living environment interacting as a functional unit to provide environmental structures, processes and functions, that may provide benefits to humanity (derived from SEEA-CF; SEEA-EEA; and 'Use of Terms', Convention on Biological Diversity, Article 2). Ecosystem assets are a subset of environmental assets and part of natural capital.
Ecosystem services	The contributions of ecosystems to benefits used in economic and other human activity (SEEA-EEA).
Natural capital	A relatively broad term that refers to the stock of environmental assets, ecosystem assets, and natural resources in the environment that yields a flow of valuable ecosystem goods or services into the future. Natural capital includes land, air, water, ecosystems, and living organisms. For example, an ecosystem with a stock of trees or fish provides a flow of new trees or fish. Wetlands and rivers can provide regulating services that moderate floods, now and into the future. Natural capital is sometimes defined to be the monetary valuation of natural resources. In this Guide, a more inclusive non-monetary stock of ecosystems is assumed, some of which may be valued with money.

See the Glossary for more terms and definitions.

System of Environmental-Economic Accounting

The most comprehensive framework for environmental accounting is the SEEA (System of Environmental-Economic Accounting). It is an extension to the SNA and is designed to track transactions within and between the economy and the environment. The SEEA Central Framework (SEEA-CF) is an international standard focusing on measures of stocks and flows (European Commission et al. 2012). It is used to account for individual natural assets (such as land, water, timber, and fish), environmental degradation, depletion, and expenditure on environmental protection or restoration.

The SEEA Experimental Ecosystem Accounting (SEEA-EEA) extends this approach further to enable accounting based on an integrated view of ecosystem functioning (European Commission et al. 2013). See also 'Valuing environmental assets and ecosystem services' below.

The third companion volume to the SEEA, the Applications and Extensions volume (SEEA-AE), addresses the way the accounts created with the SEEA-CF and SEEA-EEA can be analysed and presented to account users (UNSD 2013b).

The SEEA provides a conceptually sound framework for environmental and ecosystem accounting, and for many other accounting frameworks that share similarities with the SEEA framework. For example, Australia's National Greenhouse Accounts use the standards outlined in the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol for the compilation of greenhouse gas accounts, and the information can be translated into SEEA-consistent formats due to the underlying concepts that are applied.

While there are various accounting methods in use, many use the basic concepts presented in the SEEA, such as stock and flow accounting in both non-monetary (physical) and monetary terms. The non-monetary accounting approach of the SEEA provides the substantive basis for environmental and ecosystem accounting. Where appropriate, monetary valuation techniques can also be applied. The structures of the SEEA framework provide a crucial link, or bridge, between non-monetary physical environmental and ecosystem accounting, and the monetary economic accounting of the SNA (see Appendix 2 for more detail).

Chapter 8 provides for some examples of environmental accounts. Detailed examples are presented in the ABS publications *Completing the picture* (2012a) and *Towards the Australian environmental-economic accounts, 2013* (2013b).

Ecosystem accounts

Ecosystem accounts are a new type of environmental account presented in the SEEA-EEA.[4] Essential to the ecosystem accounting conceptual model is the focus on ecosystems as an integrated whole, rather than treating them as a number of separate components such as water, food, or timber. For example, while the SNA and the SEEA-CF consider timber as a product of native forest ecosystems, an ecosystem account would consider the forest as an integrated, functioning ecosystem, as well as accounting for the ecosystem services and associated benefits that flow to people from the forest, such as regulation of the water supply to streams and erosion and flood protection. Further, this type of account allows for tracking the flows within and between ecosystems (known as 'intra-ecosystem' and 'inter-ecosystem' flows respectively) and is being investigated, for example, in the Victorian Department of Environment and Primary Industries' Experimental Ecosystem Accounts (Eigenraam et al. 2013).

The SEEA-EEA provides a clear direction towards accounting for ecosystems in physical terms without necessary reference to the economic system or monetary valuation. This opens a pathway to accounting for ecosystems from an entirely environmental perspective with the added advantage

[4]. The SEEA-EEA is known as 'experimental' to reflect the relatively new approach of bringing together ecosystem science, economic knowledge, and accounting practice. The United Nations Statistics Commission encourages its adoption and use and has proposed a research agenda to support its progress to operational status.

of enabling strong links into the economic system. This is a key advantage of the system as it allows changes in ecosystems (both positive and negative) to be linked with the people and economic activity responsible for those changes.

Valuing environmental assets and ecosystem services

Accounting methods and definitions depend on understanding and measuring what is valuable. In economic theory, a market price encapsulates the value of goods or services of interest because it is agreed based on a particular combination of private and public information held by the buyer and seller about the costs and benefits. The revealed preference of the buyer is captured by the price and becomes available for accounting purposes.

However, a functioning market that provides a monetary price for environmental and ecosystem accounting subjects (including public goods) is often absent, hence the full costs and benefits associated with ecosystems are not known (Nordhaus 2005).

There are a number of ways that value can be defined in the absence of direct market signals. For monetary valuation methods, see Chapter 5 in this Guide, and the comprehensive summary of current best practice in Chapters 5 and 6 of SEEA-EEA (European Commission et al. 2013). With improved environmental information flowing from these forms of accounting activity, many environmental costs and benefits currently excluded from the SNA and classed as externalities will be subject to accounting, using money. Note that monetary valuation methods, while useful, should only be employed where strict valuation criteria are achieved.

Another approach to measuring value in the absence of market signals is to use non-monetary valuation (see Chapter 5 in this Guide and Chapters 2, 3 and 4 in SEEA-EEA). This is achieved through the use of non-monetary or physical measures, such as counts, hectares, tonnes or cubic metres. Physical measures also include a range of ecosystem characteristics, as explained in Chapter 2 of the SEEA-EEA. Further, compared with monetary accounting, there is an emphasis on the measures related to the spatial location of the asset, because the relationship between the asset and its surroundings is central to its value. Responding to this issue is a major thrust of the new forms of environmental accounting, particularly ecosystem accounting.

A further approach to non-monetary valuation is to assign value to the account subject via chains of logic, based on established knowledge and evidence bases (see Chapter 7 for more information). For example, the value of biodiversity to human well-being is recognised for multiple well-documented reasons. Another link to value can be revealed through social and political actions. For example, the long-term social and political support for national parks and reserves reveals enduring shared social values.[5]

A particular concern of environmental accounting is to measure changes in the value of natural capital, including consumption of natural capital, through degradation or depletion. Economic methods for measuring change in capital value are based on measuring the flow of value produced by the capital over its expected lifespan, for example, by using net present value methods. These methods generally depend on establishing a market price for goods and services and an estimate of the expected lifespan of the flow.

In environmental accounting, however, there are fewer markets for ecosystem goods and services with which to establish a price. Further, estimation of the expected lifespan is difficult for self-regenerating (renewable) systems, so innovative methods must be developed that allow accounting to take place. There are promising methods emerging that directly measure the condition and extent of environmental and ecosystem assets and their capacity to provide ecosystem services,[6] or that use economic instruments to create new kinds of markets.[7]

5. For more information on shared social values, see Appendix 3.

6. For example, the Wentworth Group's Natural Resource Management Regional Environmental Accounting Trials.

7. For example, the Victorian Department of Environment and Primary Industries' EcoMarkets, BushTender and EcoTender programmes.

For example, progress is being made on methods for measuring gains or losses (e.g., depreciation or degradation) of environmental assets; that is, measuring ecological sustainability (Weber 2011). Significant work is also being done on identifying and valuing environmental and ecosystem assets (i.e., natural capital). See for example, the United Kingdom Natural Capital Committee's *The state of natural capital* report (Natural Capital Committee 2013). More examples illustrating the depth and breadth of current environmental accounting activity are provided in the next section.

Current environmental accounting activity

Existing environmental accounts take many forms, although most are variations on the national accounting approach. There are exceptions, for example, the Bureau's National Water Account takes a General Purpose Accounting approach,[8] including, for example, the use of accrual accounting, which is more aligned to financial accounting methods.

Where monetary valuation methods are available for environmental assets, typical national accounting aggregate measures can also be adjusted to account for depletion or damage to the environment. For example, the term Green GDP is sometimes used when the value of GDP is adjusted for natural resource depletion. The Organisation for Economic Co-operation and Development (OECD) Green Growth initiative is another example where this type of measure is used.

There are also national and international efforts that go beyond standard measures of economic activity (such as GDP) and establish robust assessments of national wealth that include measures of natural capital and ecosystem services (see Stiglitz et al. 2009 for a thorough discussion of these ideas). Examples of these efforts (mostly focused on monetary valuation) include TEEB an assessment that focuses on the relationship between ecosystem services and biodiversity and attempts to value ecosystem services in monetary terms (TEEB 2013), and the WAVES project initiated by the World Bank which aims to incorporate natural capital into national accounts so the value of natural resources and ecosystems can be considered in government policy decisions (WAVES 2013).

A number of environmental accounts are produced both in Australia and internationally. The various types of accounts are differentiated on their perspective (economic or environmental), scale (regional or national), measurement units (monetary or physical) and account organisational units (unit or entity for which the account subject is measured, such as a grid cell, catchment or ecosystem). Table 1 lists examples of operational and experimental environmental accounts using the SEEA framework, and Table 2 lists examples of other types of environmental accounting approaches.

[8]. For information on the General purpose accounting approach, visit www.bom.gov.au/water/standards/wasb/wasbFAQ.shtml (the Bureau 2013b).

Table 1. Examples of environmental accounts using the SEEA.

Account	Agency	Account subject	Scale	Measurement units	Account statistical units
Energy Account	Australian Bureau of Statistics	energy supply and use within the economy	national	petajoules, dollars	enterprises (businesses), households
Land Account	Australian Bureau of Statistics	land use and cover	regional, State	area, dollars	cadastral parcels, grid cells, NRM regions
Waste Account	Australian Bureau of Statistics	generation and disposal of waste and waste management services industry activity	national	tonnes, dollars	enterprises (businesses), households
Water Account	Australian Bureau of Statistics	water supply and use within the economy	national, State	gigalitres, dollars	enterprises (businesses), households
Victorian Experimental Ecosystem Accounts	Department of Environment and Primary Industries, Victoria	ecosystem functioning	local–statewide	Environmental Benefits Index, spatio-temporal; hectares per year	grid cell (spatial unit)
Measuring Ecosystem Goods and Services	Statistics Canada	ecosystems	local, national	area, dollars	grid cell (spatial unit), ecosystems
WAVES	World Bank	monetary valuation of ecosystem services	national	monetary	various

Table 2. Examples of environmental accounts using other frameworks.

Account	Agency	Account subject	Scale	Measurement units	Account statistical units
Land Account; Ecosystem Capital Account	European Environment Agency	land use, land cover, ecosystem capability	local to continental	area, ecosystem capability unit	social-ecological land cover units, 1-km grids
National Greenhouse Accounts	Department of the Environment	greenhouse gas emissions	national	tonnes of carbon equivalent	land-based industry sectors
National Water Account	Bureau of Meteorology	available water resource	regional, national	gigalitres	water management regions
Regional Environmental Accounts Trials	Wentworth Group and NRM regions	environmental asset condition	local, regional	Econd (condition score)	environmental asset

Why is an account not an assessment?

Environmental accounts share many characteristics with environmental assessments. Data and information are collated, analysed and then reported in ways designed to inform policy and practice. Examples range from the State of the Environment reports to assessments of specific risks, such as those posed by introduced marine pests.

Accounts are a form of organised information focused on time-series and are a relatively simple and robust presentation of environmental information upon which a variety of analyses can be built. The key defining elements of accounts are that they have a mechanism to crosscheck or reconcile changes through time, and are structured to enable information to be aggregated and analysed.

With the inclusion of a well-designed monitoring programme, the environmental assessment process has an important similarity to an environmental account: the periodic gathering of data in a way that allows comparison from one cycle to the next, so changes in environmental variables can be tracked. Such an assessment would be a potential candidate to be translated into an account format if that were deemed beneficial.

An important difference, however, is that an assessment is usually targeted at a specific purpose for an area or subject of interest. Information is likely to be collected only for the target of the assessment during the assessment period and organised specifically to meet the assessment purpose. Accounts on the other hand use consistent data structures that enable the connection of multiple sources of information (e.g., monetary and

physical measures). As such, the accounts are multi-purpose and create an information platform that can be reconfigured to meet new purposes.

Another difference between an assessment and an account is the maturity of the scientific evidence base behind the two processes. Monitoring programmes are ideally carried out in the context of an adaptive management cycle, with a view to updating current understanding of the system being monitored once the monitoring data has been gathered. In contrast, accounts are often based on mature current understanding and largely settled science.

The purpose of an account may also differ from that of an assessment. With an assessment, the organisation undertaking the monitoring will often also be the organisation using the data to inform management, whereas an account is generated when external parties are the main audience for the account (the Bureau 2013a). In other words, accounts are generally made when being accountable to others (e.g., investors).

Further differences between assessment and monitoring, and accounts, are presented in Table 3.

Table 3. Environmental accounts compared with environmental assessments.

Characteristic	Environmental accounts	Environmental assessment and monitoring
Purpose	**Systematic, consistent.** Created when compelling reasons with strong consequences require a consistent flow of information to enable comparisons and change to be detected, and/or there is a need to be accountable to others. Can be considered a relatively simple, but carefully structured, base or platform upon which more complex analyses and scenarios can be built.	**One-off, targeted.** Many have one-off specific purposes (targeted assessments), including building the fundamental environmental information base.
Method	**Accounting structure, crosscheck.** Data are organised into an account format (e.g., SEEA framework) producing highly structured information using standards, statistical units, accounting periods, opening and closing balances, and cross-checking (e.g., double-entry methods). Data are often in the form of environmental statistics.[9]	**Multiple methods, hard to aggregate.** A very large range of techniques including inventory, census, snapshot survey, degree of modification, vulnerability assessment, risk assessment, scenario, and outlook assessments. Multiple assessment methods generate considerable challenges in aggregating or synthesising the results.
Coverage	**Complete.** Complete coverage of the account subject is required either as observations (e.g., as in a census) or as an estimate (e.g., via a sample survey) for each accounting period. Standardised classifications.	**Partial.** Typically only partial coverage of the subject (e.g., case studies), particularly through time, but also across space. Tailored classifications.
Temporal	**Regular accounting period.** Focused on the current accounting period (e.g. change over one year). Time-series are expressed through a wide range of account types enabling reporting on change in stocks and flows.	**Mixed, multiple ages.** Range from single snapshot survey to collation of sources of mixed-age data.
Spatial	**Consistent, statistical unit.** Tightly defined organising (statistical) units are matched to management needs and the nature of the account subject. Spatial relationships are a key characteristic of environmental accounts.	**Variable.** Spatial characteristics vary considerably depending on assessment purpose. Some national systems exist (e.g., bioregionalisations) although much is driven by the resolution of available data. Often data are collected at specific site locations or collated from disparate data sources of varying scale.

Table 3 (continued).

Characteristic	Environmental accounts	Environmental assessment and monitoring
Interested parties	**Regular part of decision making, link to economics.** Either providing regular broad overviews that provide a frame-of-reference to policy makers or focused on reporting for accountability purposes.	**Wide range of users.** Dependent on the purpose of the assessment, and could range from commercial-in-confidence assessments to a very wide range of stakeholders (e.g., a government policy initiative).
Independence	**Standards and assurance.** Credibility and legitimacy derive from use of standards, accreditation procedures and independent assurance (verification and assurance).	**Peer reviewed, assurance uncommon.** Assessments may have a scientific peer review process or will be based on scientific peer-reviewed methods. Assurance is not common.
Economic links	**Close links.** Accounts are closely linked to economic theory. Environmental accounts may be integrated to economic accounts where appropriate and there are existing methods for doing this in the SEEA. Economic theory has substantial limitations when dealing with environmental subjects, so other perspectives are needed to gain a fuller understanding of the current status of natural capital.	**Weak or limited links.** Environmental assessments are usually conducted in environmental and ecological terms and have weak or limited meaning within economic domains. New forms of assessment are increasingly incorporating economic links.

[9]. For example, as defined in the *Framework for the Development of Environment Statistics* (UNSD 2013) and the National Statistical Service's Essential Statistical Assets (ABS 2013a).

3. Purpose of environmental accounts

This chapter addresses the purpose of environmental accounts, and identifies policy and decision-making issues that could be supported by environmental accounts.

Societal issues and opportunities

Given that environmental accounts are a unique and successful platform for organising data to produce valuable information, there are a large number of purposes for which they can be used.

In summary, accounts are useful because they:

1. credibly track the transfer of value (temporally, spatially and between entities);
2. enable the production of a very large range of internally consistent information;
3. increase information flow between interested parties, thereby reducing risk and uncertainty and consequently reducing costs and increasing investment effectiveness; and
4. incorporate standards and enable assurance, thus increasing confidence, credibility and legitimacy.

There is, however, a cost to producing environmental accounts and challenges in the application of valuation techniques. This means that environmental accounts may not track all the value of interest. The following sections show how these advantages and disadvantages relate to some of the bigger societal challenges and opportunities facing us today.

Issue: Levels and targeting of capital investment for the environment

Identifying the location and amount of capital to invest or maintain is one of the most fundamental challenges for society. An arena where the value of accounting for meeting this challenge is thoroughly tested is in financial accounting where one of its most important benefits is to increase the flow of capital to productive ventures. Accounts reduce uncertainty and hence risk, giving the investor more predictability about returns on the capital. This, in turn, reduces the cost of capital including insurance and finance.

The issue of capital allocation (i.e., whether to invest resources in one activity or another) is felt strongly in environmental management. For example, the audit of the Natural Heritage Trust by the Australian National Audit Office (2008) identified that it was difficult to quantify improvements to the environment as a result of investment. It also identified that it was difficult to assess value for money and identify the most cost-effective environmental management options.

Because the benefits of environmental investment are difficult to track, investors are reluctant to direct money towards environmental management, and sustainable development is put at risk through degradation or depletion of natural capital. The challenge for environmental accounting is to find effective ways to produce the information flow needed to increase investment in environmental management.

Issue: Quantifying the impacts of environmental risk on economic activity

From an economic perspective, one aspect of the increasing significance of environmental information in global capital markets was recently highlighted by the United Nations Environment Programme (UNEP) report about integrating environmental risk into sovereign credit analysis (UNEP and Global Footprint Network 2012). Sovereign bonds are issued by a country to another government or corporation, and form approximately 40% of the global bond market. They are considered a reliable investment; however the UNEP report explains that investors are increasingly concerned about the impact of environmental risks such

as natural resource scarcity, climate change and environmental degradation on the reliability of sovereign bonds. The Global Footprint approach was used to assess the risks and demonstrate how environmental accounting can contribute to investment decisions in the global economy.[10]

The relatively undeveloped approach used in the UNEP report is indicative of the role environmental information can play in economic decision-making on a global scale. Substantial improvements are needed to bring this to an operational level. Examples of operational and near-operational approaches relevant to Australia and based on the SEEA are presented in ABS publications *Completing the picture: environmental accounting in practice* (ABS 2012a) and *Towards the Australian environmental-economic accounts* (ABS 2013b).

Issue: Integrated views of carbon, water and energy

A challenge in managing our natural environment is access to integrated information that allows the full impact of management decisions to be assessed. The interconnections between the carbon, energy, and water cycles need to be taken into account to ensure that management actions do not result in perverse outcomes and compromise efforts to achieve sustainable development. In 2010, the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) released a report that argued that understanding the links between carbon, water, and energy is fundamental to making decisions that address the sustainable use of fossil fuels and a limited water resource in Australia into the future (PMSEIC Expert Working Group 2010). The report recommends that comprehensive accounts of energy, water and carbon stocks are critical in managing resilience and sustainability in natural and built landscapes.

[10]. For more information on the Global Footprint Approach, visit www.footprintnetwork.org. See Appendix 1 and the section 'Partial representation of reality' in Chapter 4.

Contributing to this is the development of more complete carbon accounts that complement the existing greenhouse gas emissions accounts. These carbon stock accounts use the SEEA framework to account for carbon in the geosphere, biosphere, atmosphere, and the ocean (see also Ajani et. al. 2013).

Issue: Intergenerational burden shifting and sustainability

Another key issue facing society is how to avoid shifting the burden of impacts produced by today's activities into the future, in particular, how to ensure intergenerational equity regarding the environment. Sustainable development can be defined in a number of ways but, in economic terms, it can be considered as the maintenance of the various capitals or assets that support the production of goods and services. The types of capital include produced (e.g., machinery, buildings), financial, human, social and natural capital. It is essential that policy makers have access to information on all kinds of capital to inform decisions on sustainability, whether the aim is for strong sustainability (maintenance of all capitals) or weak sustainability (where one type of capital can be substituted for another, e.g., natural resources can be replaced with produced materials) (Stiglitz et al. 2009).

However, there is currently limited information available about the nation's natural capital. For example, the ABS produced a SEEA account to estimate the monetary value of Australia's natural capital base (ABS 2012a). The estimates exclude marine and most freshwater environments, such as wetlands, rivers and groundwater, biodiversity, and carbon storage. Further, any consideration of non-monetary values of natural capital such as aesthetic, cultural, or scientific values is also excluded.

Insufficient information about the environment generates a risk of intergenerational burden-shifting if practices are unsustainable. In other words, Australia's natural capital may be eroded through

degradation with no systematic way to track this loss of value. Consistent evidence presented in the national State of the Environment reports indicates that such degradation is indeed occurring. Pressures on the environment are growing and the risks of negative impacts continue to increase. It has been argued that 'maintaining aggregate stocks [of natural capital] represents a "no regrets" approach in the absence of certainty about future well-being. This provides a practical basis on which to focus effort…' (Carmody 2012).

The opportunity for environmental accounting is to contribute to improved ways of tracking Australia's natural capital including its air, water (inland and marine), land, and habitats (ecosystems, biodiversity). This can be done with improved monetary and non-monetary (physical) valuation methods and accrual accounting. An example of where financial accounting methods have contributed to realising intergenerational equity was through the introduction of accrual accounting to the public sector in the 1990s.[11] Through this process, large unfunded pension liabilities were identified that would have been a burden on future generations, and subsequently policies were introduced to reduce the burden-shifting (Macquarie University 2011). Similarly, improved accounting for natural capital has the potential to improve decision-making and reduce the burden on future generations.

Issue: Social relations

A key challenge for society is management of conflict and disagreement over environmental resource allocation. As one example, the forest debate in Tasmania over the multiple uses of forests has resulted in substantial conflict management costs. The issue of coal seam gas in Australia is also generating social tensions. The burden is not only felt socially: there are political, economic, and ecological impacts as well.

The opportunity for environmental accounting is to produce relevant, credible and legitimate information about the actual state of natural assets and the flows of value produced by those assets. There is evidence that social relationships are improved through increased use of credible and legitimate financial accounting practice as a result of increased trust in the shared information base (Carnegie 2009). This indicates that there is strong potential for environmental accounting to contribute to reducing the social burden of conflict management.

Issue: Measuring a diverse and vast environment

There are many scales at which people interact with the environment in Australia, ranging from the on-ground local scale to regional, State and national scales. Similarly, there is variation in time scales and the complexity of interactions, from day-to-day farm-scale management issues through to protecting Australia's biodiversity. At each scale and level of complexity, information is used to make decisions about how to act (Chesson 2013). Consequently, the management and effective use of the environmental information base underpinning day-to-day life in Australia is already an enormous task and growing rapidly; yet, for many purposes the environmental information available remains inadequate. For example, the *2011 State of the environment* report highlights the critical importance of improving long-term environmental datasets in Australia (State of the Environment 2011 Committee 2011).

In response to this challenge, accounting offers methods for organising data that are highly structured and that can be used for multiple purposes and scales, thus providing efficiencies for information management. For example, while national-level accounting focuses on aggregated

[11]. Accrual accounting is a method that records the timing of economic events (e.g., when goods are exchanged) regardless of when cash transactions occur (e.g., when payment is made).

information about overall levels of natural capital and productivity and provides a broad frame of reference, regional-level accounting is required to support investment decisions at the scale where the majority of interactions with the environment take place (such as on-farm management, forestry, soil management, water management, conservation, and biodiversity management).

The challenge for emerging environmental accounting systems is to be able to operate at multiple scales and match the account outputs (such as data, reports and indicators) to the scale relevant to management and investment. A prominent example of this capability is the Victorian Department of Environment and Primary Industries' Experimental Ecosystem Accounts (Eigenraam et al. 2013). These accounts are based on data with a resolution of a hectare or less yet can be aggregated for regional and statewide analyses to prioritise investment in environmental management from local to State scales.

Issue: International relations

It is important that Australia is well-placed to meet the challenges and opportunities of living in a global community. This means continuing to contribute to relationships with other nations, both in terms of trade and meeting mutual obligations. For example, the Australian Government's *Australia in the Asian Century* White Paper provides a roadmap for how Australia can become a more prosperous and resilient nation, fully part of the Asian region and open to the world (Department of the Prime Minister and Cabinet 2012). It highlights the need for a productive and resilient economy through actions such as sustainably managing the economy and environmental assets, building trust, and developing stronger and more comprehensive relationships.

Environmental accounting could play a useful role in these and other international objectives. Australia has committed to achieving targets at both the international and national levels (e.g., biodiversity targets) and environmental accounting will help Australia track progress towards meeting these targets. In particular, it can strengthen the capacity of Australia to become an open, outward-looking society and assist in reducing cross-border barriers while enhancing its comparative advantages. For example, recognised certification, accountability and assurance processes can increase confidence in the sustainability and reliability of Australia's land management practices by the agricultural and forestry sector with increased investment likely to flow as a result.

Recognised benefits flowing from the international harmonisation of national accounting practice through the use of the SNA (Macquarie University 2011) include reduction of the cost of capital, administrative benefits, enhanced comparability and transparency, facilitation of cross-border investment, reduction of investment risk and benefits to firms and capital markets (UNEP and Global Footprint Network 2012). Use of internationally harmonised environmental accounting frameworks, such as the SEEA, is expected to provide similar benefits.

Issue: The well-being of Australians, now and into the future

One of the most important overall challenges facing society is how to maintain and improve the well-being of all Australians, both now and into the future. The Australian Treasury has set out a strategic framework that places the well-being of the Australian people at its centre (Gorecki and Kelly 2012; Australian Treasury 2013). In this, well-being is considered to consist of five dimensions:

- the set of opportunities available to people;
- the distribution of those opportunities across the Australian people;
- the sustainability of those opportunities available over time;

- the overall level and allocation of risk borne by individuals and the community; and
- the complexity of choices facing individuals and the community.

There are vital contributions to each of those dimensions made by the environment and natural world. One way to produce information targeted to each dimension is to use environmental accounting.

Meeting the challenges

For the next generation of environmental accounting to contribute to addressing these societal issues, there are a series of important challenges to be considered, related to the effective and responsible use of environmental accounting. The risks and issues associated with environmental accounting implementation and practice are discussed in Chapter 4. Part B of the Guide presents a pathway to implementing effective and reliable environmental accounts.

4. Environmental accounting practice risks and challenges

This chapter discusses some of the risks and challenges associated with the production and use of environmental accounts, for example, the partial representation of reality due to limitations in accounting conceptual models, unintended consequences, and fragmentation of accounting standards and approaches.

Partial representation of reality

The primary risk involved in environmental accounting is the presentation of incomplete information due to limitations created when applying an accounting framework to the complexity of the environment. For example, the current national accounting system provides a view of the wealth of the nation that is based on market exchange valuation; however, this excludes much of what is actually important to people in terms of their happiness, satisfaction, and meaning in life. While considerable progress is underway to address this (ABS 2013b), on the whole, measures of human, social, and natural capital do not register in the national accounts. This means that their value as a frame of reference for policy is reduced.

To illustrate, there are limitations on the current estimation of the natural capital base of Australia, imposed by practicalities of applying accounting concepts to natural capital. The natural capital base of Australia as published by the ABS is largely made up of land valuations (86% in 2011–12) recorded by the Valuers-General of each State and Territory (see Table 4). The rest is subsoil assets (minerals) and native standing timber.

This estimation method excludes major environmental assets such as national parks and reserves (because they do not have a monetary land value) and wetland and marine ecosystems (because they are not a marketable asset in the same way as timber). As such, the value of natural capital is underestimated. A map of the results would show the centre of Australia's largest cities to be high-value natural capital, although this is clearly not the case.

Another example of how a limited conceptual basis for an account is similarly compromised in applicability relates to the Ecological Footprint. The Ecological Footprint method is a well-known

Table 4. Estimation of Australia's natural capital base, 2013 ($billions).

Capital estimate	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Produced capital	*3,668*	*3,813*	*3,978*	*4,131*	*4,278*	*4,438*	*4,628*
Inventories of plantation standing timber	10	10	12	10	10	10	9
Net financial assets with rest of the world	*–604*	*–677*	*–702*	*–727*	*–789*	*–797*	*–861*
Natural capital	*4,368*	*4,418*	*4,480*	*4,538*	*4,590*	*4,648*	*4,718*
Land	3,831	3,869	3,906	3,943	3,981	4,018	4,054
Subsoil assets	530	549	581	606	621	640	653
Native standing timber	2	2	2	2	2	2	2

Note: Reference year for chain volume measures is 2010–11.
Source: ABS 2012d.

and useful measure of how much land and water is used to support human demands and the capacity of ecosystems to provide materials (biocapacity); however, it does not cover many services provided by ecosystems such as carbon sequestration, water filtration, and soil functioning. Further, it does not include biodiversity measures, and has limited value for measuring actual impacts or assisting resource allocation decisions (UNEP and Global Footprint Network 2012). The closer the conceptual basis of the accounts can be to the real functioning of the world, the greater the long-term value of the accounts.

The opportunity for environmental accounting is to adopt a conceptual basis that is robust and consistent with reality, yet not overly complicated and impractical. If this is achieved, environmental accounting can contribute to a clearer understanding of Australia's natural capital.

Unintended or inadvertent on-ground outcomes

The requirement of accounting systems to have tightly defined classifications that simplify the real world can lead to unintended or inadvertent consequences. The relationships between carbon accounting, the emerging carbon market and biodiversity management provide a useful illustration. Environmental plantings to increase carbon sequestration have the potential to contribute strongly to biodiversity outcomes through the increased area of habitat, and increased connectivity, and by minimising edge-to-habitat ratios (Bradshaw et al. 2013); however, it is recognised that broad-scale planting can have large negative effects on catchment hydrology in agricultural areas through lowered watertables and loss of streamflow (see Vertessy et al. 2003 in Bradshaw et al. 2013). This in turn has negative consequences for existing natural ecosystems and biodiversity.

Due to the mismatch between strongly developed and standardised accounting schemes for carbon emissions and the much more variable status of biodiversity information and ecosystem services accounting, decisions related to carbon emissions management may have unintended outcomes because the consequences for biodiversity are harder to take into account. Economic investment is often focused more strongly on activities with lower risk and more certain returns. A more complete set of environmental accounts would assist decision makers to better consider the trade-offs of one option over another. In this particular example, it would allow for consideration of both carbon sequestration and biodiversity outcomes.

A further opportunity for environmental accounting is to design systems that integrate information, rather than generating unlinked, discrete silos of information. That way, disparate sources of information can be jointly viewed and compared. Ecosystem accounting is one such system.

Accounting limitations and misuse

Throughout the history of accounting there has been awareness of the limitations and misinterpretation of accounts and accounting methods, including in Australia (Carnegie 2009). As one example, the global financial crisis drew attention to the insufficient assessment of risks by corporations due to misuse of accounting and auditing methods. A range of responses have been developed to remedy the limitations and misuse of accounts, such as professional certification, standardisation of accounting frameworks, improved assurance and legislative solutions.

Similar issues can be expected to emerge around environmental accounting and similar responses will need to be established. For example, some corporations have been found in the past to be 'overly positive, biased and favourable to their corporate image, with absence of "bad news"

in reports' when conducting sustainability reporting, in part due to the focus on the corporation rather than the wider environment (Macquarie University 2011). This example is relevant to accounting practice as the choice of boundary for the reporting entity (e.g., the corporation boundary) can drive biases in the resulting reports or accounts (see Chesson 2013 for more on the boundary issue).

The challenge for environmental accounting is to ensure high standards of ethical and professional practice are embedded in the design of the accounting system, including a role for independent scientific accreditation and enabling of independent assurance. As an example, debate over controversial issues such as competing water uses can be gainfully informed by the availability of independently assured environmental accounts.

Accounting standards fragmentation or divergence

The ongoing development of accounting standards and use of different accounting or assurance and reporting frameworks can create problems if they are inconsistent and diverging. For example, there are a wide variety of environmental accounting and reporting methods emerging in the corporate sector. Approaches such as TEEB, the Global Reporting Initiative, and Corporate Ecosystem Valuation (WBCSD 2011) aim to minimise inconsistencies in reporting.

These difficulties are also illustrated when reporting is required under parallel but different systems. This can create a burden on account and report preparers and produces confusion for account users. For example, concerns were raised in 2002 about confusion and a lack of comparability in the application of the Australian Accounting Standard 31 (AAS 31) and the Government Finance Statistics for government accrual accounting and prompted a harmonisation project co-led by the ABS and the Australian Accounting Standards Board (2013) to seek solutions.

The use of accounting standards can allow different types of data to be integrated to provide insights that may not be gained from using the data sources in isolation. Consistency is improved through the use of standard accounting methods, classification schemes, and reporting units.

The challenge for environmental accounting is to ensure, as far as practical, consistency with existing frameworks and standards. Suitable governance structures need to be developed to oversee the creation and ratification of emerging standards.

Part B: Pathways to environmental accounting

Part B of the Guide sets out pathways for producing reliable and effective environmental accounts.

5. Conceptual basis of Australian environmental accounting

This chapter introduces and explains the conceptual basis of environmental accounting. First it describes a broad conceptual foundation or context for developing environmental accounts: the Joint Perspectives Model. The relevance of the model to the key operational environmental accounting conceptual model (the SEEA) is discussed. The chapter also looks at how the model helps account framers to choose one or more accounting perspectives to suit the purpose of an account and the implications of that choice for valuation.

Environmental accounting conceptual basis and framework

As for any human endeavour, the ideas underpinning the activity will shape the practice and results. For example, horticultural knowledge has shaped horticultural practice, and continues to do so as new knowledge is produced. This is also the case for environmental accounting. At the most fundamental level of system design, the conceptual foundation for environmental accounting needs to be consistent with the goal of living sustainably and enhancing human well-being. Our collective understanding of how this goal can be achieved continues to evolve, and this new knowledge continues to influence the development of environmental accounting.

This chapter presents a simple conceptual model of the relationships between the economy, society and environment. It is called the Joint Perspectives Model and it embeds the economy in society and then, in turn, society in the environment (Costanza et al. 2012). The model is consistent with key elements of current mainstream policy frameworks and opens new pathways for effective environmental accounting that bring multiple perspectives and worldviews together to enhance our ability to perceive and act effectively in the world.

While the Joint Perspectives Model provides a broad systems view, a more specific and operational level environmental accounting conceptual model is presented in the newly revised SEEA. The internationally agreed SEEA framework provides the technical concepts, classifications, and accounting rules needed to design and produce environmental accounts.[12] While such accounts are valuable for many purposes, the SEEA framework provides the added advantage of strong links into the economic system, which enables joint views of environmental and economic interactions.

The role of the Joint Perspectives Model is to provide a rich and detailed context for defining the entry point into the SEEA for a wide range of people and agencies considering how to go about environmental accounting. Further details of the SEEA are provided in Appendix 1 and Appendix 2, and the UNSD and ABS websites.

[12]. The SEEA-CF was adopted as an international standard in 2012.

The Joint Perspectives Model: a systems approach

The Joint Perspectives Model is formulated as a broad theoretical foundation for developing environmental accounts. The model takes a systems approach (see Box 3) and represents core relationships among the economy, society, and environment. It underpins an approach to environmental accounting that allows for:

- non-monetary valuation of environmental assets, costs and benefits, and the framing of accounts, in terms of physical, ecological, and social measures (e.g., carbon and water cycles, ecological condition indices, and measures of well-being);
- acknowledegment that environmental assets have local value at all scales, from the molecular to the global, and that imposes limits on treating them as interchangeable commodities;[13]
- recognition that not all environmental assets, benefits and costs, can be valued in monetary terms; and
- extension of monetary valuation methods to include environmental (and social) assets, costs and benefits where rigorous methods are available to price them realistically (e.g., in the case of near-market goods and services).

The Joint Perspectives Model for environmental accounts consists of four nested systems: the physical Earth system, the living system, the human cultural system, and the economic system. Each system has emerged from all the systems listed before it (see Figure 1).

[13]. For environmental assets, values are generated locally at each scale, the overall result being scale-dependent values which makes it difficult to apply a single value (e.g., monetary) developed at one scale to every other scale. In contrast, money is delocalised, which makes it a very useful medium for exchange and accounting.

Box 3. Systems thinking

A system is a group of interacting, interrelated or interdependent elements forming a complex whole. Systems:

- have inputs, outputs, and feedback mechanisms;
- maintain a characteristic internal steady-state (operating range);
- display properties exclusive to the whole (called 'emergent properties') that are not possessed by any of the individual elements; and
- have boundaries that are usually defined by the system observer.

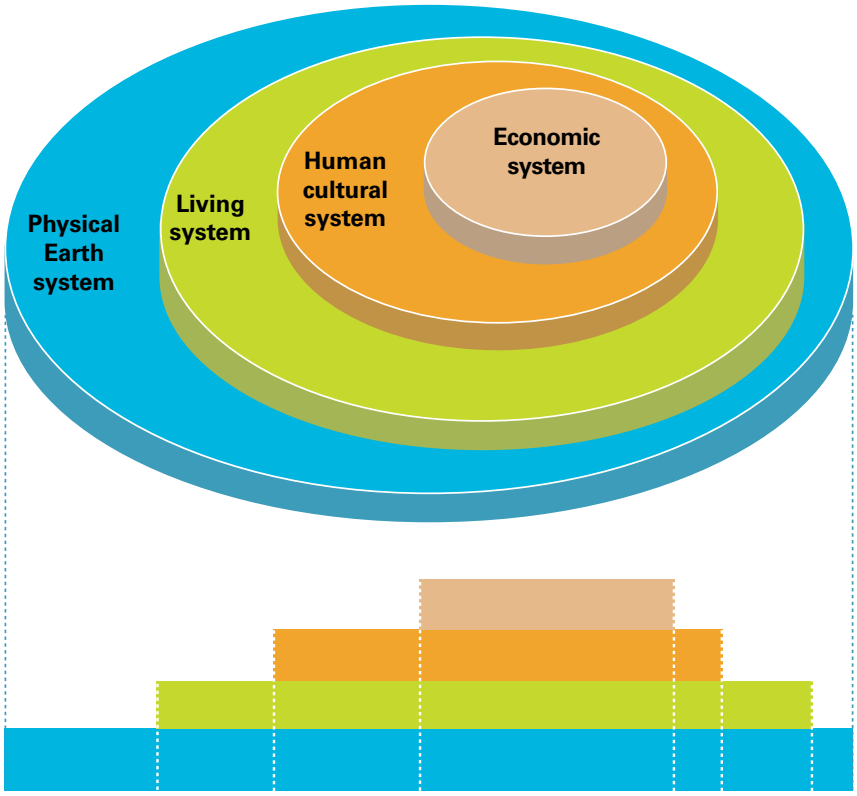


Figure 1. Joint Perspectives Model.

In this cross-section view, vertical dotted lines delineate systems, while the coloured horizontal slices represent the different perspectives from which systems can be viewed. Thus, while the economic system is generally viewed from the economic perspective, it can also be viewed from the physical Earth, living and human cultural system perspectives because it is, in turn, made of each of these systems. Similarly, the living system, which emerges from the physical Earth system, can also be understood from a physical perspective.

The living system emerged from the physical Earth system about 3.8 billion years ago when the first life forms appeared. In turn, the living system gave rise to the human cultural system, which gave rise to the economic system. A key concept in the Joint Perspectives Model is that emergent systems consist of all the systems from which they emerged and are not separate from them. In other words, the economic system is also made of the human cultural system, which is, in turn, made of the living system. The living system is made of the physical Earth system. These systems together can be thought of as the whole of the Earth including nature, all the people, and all their culture and activities.

Crucially, this means that any transaction in an emergent system can also be viewed from the perspective of the systems in which it is nested. For example, an economic transaction such as the sale of 30,000 tonnes of oranges can also be viewed from a human cultural perspective (social benefits of an orange-growing community), a living systems perspective (biological factors essential to growing oranges), and a physical Earth perspective (the

carbon and water cycles involved in the growth and harvesting of oranges). A feature of this approach is that measures useful in the base systems (e.g., fluxes of energy and matter in the physical Earth system) are also informative, though with limitations, in the emergent systems (e.g., quantity of carbon emissions in the economic system).

There are many other systems that can be recognised in the world around us, for example, legal systems, political systems, climate systems, and solar systems; however, for the purposes of the Joint Perspectives Model, the foundational systems are physical Earth, living, human cultural, and economic.

The following sections provide information about each system: what each system encompasses, what distinguishes it from the other systems, and the knowledge domains (disciplines) focusing on that system. Also discussed are important emergent properties of each system: those characteristics that make the whole system greater than the sum of its parts. Finally, potential subjects and statistical units for accounting are canvassed from the perspective of each system's emergent properties. The following sections are summarised in Table 5.

The physical Earth system

The physical Earth system (Figure 2) consists of all non-living components of our planet, including rocks, minerals, the atmosphere, and inputs and influences from the sun and moon including energy.

The basic material constituents and processes of chemistry and physics belong to the domain of the physical Earth system and, as such, the knowledge domains of these, as well as other physical sciences such as geology and meteorology, are relevant to this system.

Accounting within the physical Earth system involves being able to track the movements and changes of various forms of matter and energy between physically defined accounting units such as the atmosphere, rivers, ocean currents, and geographical locations on the surface of the land.

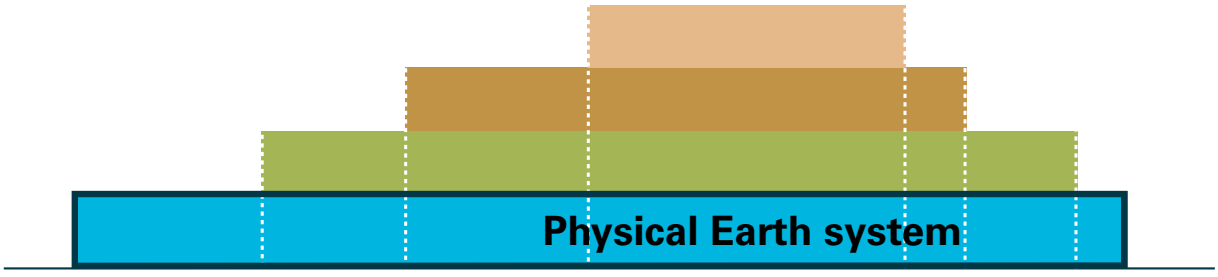


Figure 2. The physical Earth system.

The living system

The living system (Figure 3) emerged from the Earth system with the advent of organisms that could capture and concentrate energy.[14] The ability to concentrate energy is a vital emergent property of living organisms and serves to distinguish between the living system and the physical Earth system. In the process of living, the concentrated energy is ultimately converted to a less concentrated form, mostly heat.[15]

The constituents upon which the living system is based are the same matter and energy components that drive the physical Earth system. The laws of chemistry and physics that apply in the physical Earth system also apply to living things. The primary chemical reaction that drives the living system (photosynthesis) takes place in plants that use the sun's energy to convert carbon dioxide from the atmosphere into food and oxygen, thus supporting all other components of the living system including people.

As well as being driven by chemical and physical processes, the living system has emergent biological processes related to its ability to concentrate energy. These emergent processes include evolution, reproduction, and responsiveness to environmental stimuli.

As such, bodies of knowledge that apply to the living system include biology, genetics, and ecology.

Accounting within the living system involves being able to track the movements and changes of genes, organisms, and life processes, as well as matter and energy, between biologically defined accounting units such as species and ecosystems. This can be applied through accounting for ecosystems, ecosystem goods and services, biodiversity, or other aspects of living systems.

Relevant to accounting within the living system is the dynamic responsiveness of ecosystems to changes in the physical Earth system. The boundaries of ecosystems change over a range of time and spatial scales as the organisms that constitute them evolve, reproduce and respond to changing environmental conditions (e.g., climate changes, habitat loss, and competition).

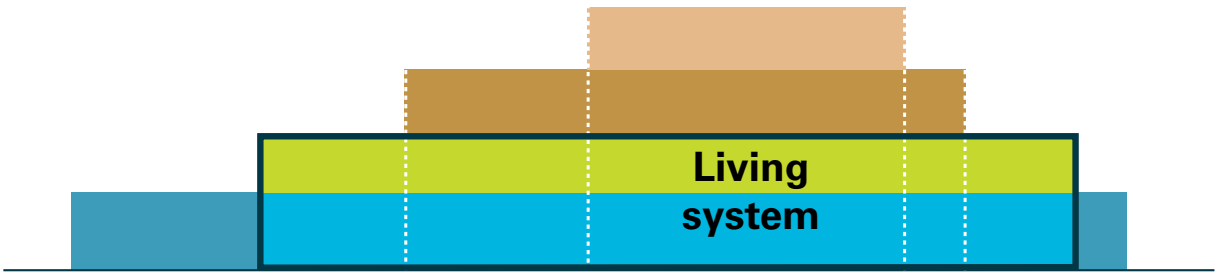


Figure 3. The living system.

The living system includes that part of the non-living physical Earth system that participates in the emergent properties of life.

[14]. Decrease entropy.

[15]. Increase entropy.

The human cultural system

The human cultural system (Figure 4) emerged from the living system with the development of the collaborative creation of knowledge and meaning, and the feeling of having a choice. These capacities are the basis for action, that is, reasoned or purposeful behaviour. The emergent properties of the human cultural system reveal themselves in activities such as science, religion, the arts, the legal system, and economics, and contribute to our adaptive advantage as a species and also our individual and collective well-being.

While socially-created knowledge and meaning and a sense of freewill are central to defining human culture, we are still part of the living system, dependent on its processes of production and reproduction and, at the same time, part of the physical Earth system that provides the basic constituents of life such as carbon, oxygen, water, and sunshine.

The distinction between the human cultural system and the living system is subtle and is linked to what we know about the world and how we act within it. Knowledge falls within the human cultural system and what we do not know (or cannot know) is outside it. Knowledge domains that apply to the human cultural system include sociology, anthropology, and psychology.

Accounting within the human cultural system involves being able to track movements and changes in components of the system that are relevant to human well-being, including non-material things such as knowledge and happiness, and spiritual and cultural benefits provided by ecosystems. Culturally defined accounting units are individuals or delineated human groups such as households, families, clans, tribes, associations, businesses, municipalities, communities, societies, and nations.

Environmental accounting is relevant to human cultural accounting to the extent that it tracks changes in characteristics of living and physical Earth systems linked to human well-being.

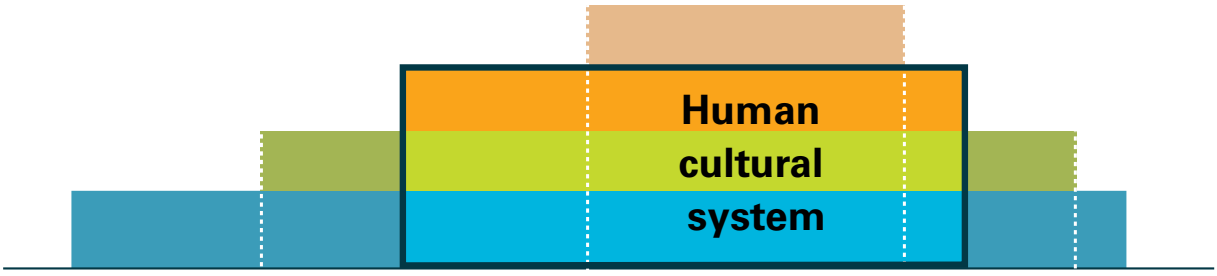


Figure 4. The human cultural system.
The human cultural system includes those parts of the living system and the physical Earth system that participate in the emergent properties of human culture.

Economic system

The economic system (Figure 5) has emerged from the human cultural system. Important emergent properties include markets, prices, and the existence of a common (delocalised) currency in the form of money. The economic system is delineated by the ability to value assets, goods, and services in monetary terms. Historically, the main mechanism for arriving at a monetary value has been the market. From an economic perspective, money is a measure of the value that people attach to something and all money is treated as more or less equal (in contrast to measures of value from other perspectives; see later sections).

From the national accounting perspective, the economic system includes human activity within the scope of the SNA (see Box 4). While the SNA includes non-market, public-sector production, such as health and education services, the costs of these to government, and hence to the public, are determined by markets. In this sense, they are near-market activities that are relatively feasible to value in monetary terms.

Outside the SNA are many activities and processes that contribute to human well-being, including unpaid domestic work, voluntary work more generally, and unmanaged natural processes such as the production of goods and services by ecosystems. These are termed externalities. The scope of the SNA can change; for example, water and carbon, previously treated as external to the economy, are starting to be priced and markets are emerging for these goods.

As an emergent system from the human cultural system, the economy is also made of that system and, in turn, made of the living and physical Earth systems.

In the economic system, the movements and changes of those components of the human cultural system subject to market-based valuation are tracked with economic accounting units (also called entities) of households, businesses, and countries using money as a common currency.

As the economic system is also made up of the systems from which it emerged, economic transactions can also be tracked by measuring changes in aspects of those systems. For example, accounts can report in physical terms on the basic constituents of life (carbon, water, nutrients, and energy) as well as in monetary measures.

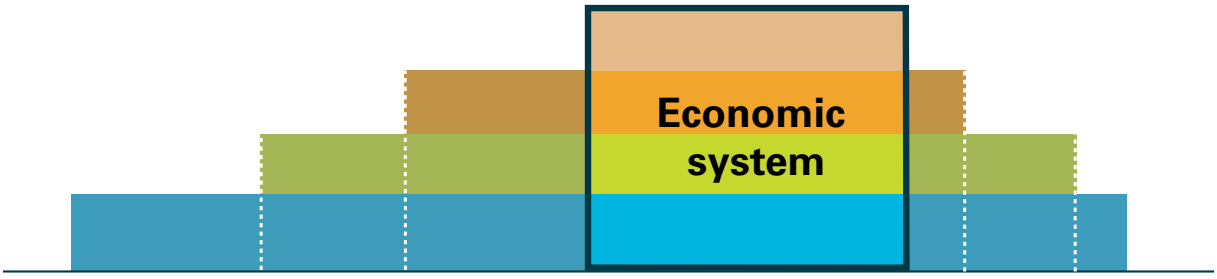


Figure 5. The economic system.
The economic system includes those parts of the human cultural system, the living system, and the physical Earth system that participate in the emergent properties of the economy, and is delineated by market-based monetary valuation.

Box 4. The scope of economics

It is important to distinguish between the economic system and the broader discipline of economics. The discipline of economics reflects our attempts to understand and quantify human economic behaviour, classically defined as the rational behaviour of individuals dealing with scarce means that have alternative uses (Robbins 1935). As such, it is broader in scope than activities characterised by market-based monetary valuation, hence the existence of the discipline of environmental economics, encompassing the economic and living systems; however, the economic system is defined here and elsewhere by market-based monetary valuation and the emergence of money, prices, and markets.

Table 5. Joint Perspectives Model summary table.

System	System description and delineation	Emergent properties	Knowledge domains	Candidate environmental account subjects	Candidate measures	Candidate account statistical units
Physical Earth system	The non-living Earth system: Non-living systems are slowly dissipating energy. The top of the atmosphere delineates the physical Earth system.	Emerged from coalescing star material during development of the solar system. Characteristic heat, light, and gravity fluxes.	• chemistry • physics • geology • geography • meteorology	minerals, solar inputs, wind, tides, geothermal, geology, temperature, water cycle, ground water, climate, rainfall	• mass balances of basic elements (matter) • energy fluxes	Primarily spatially defined using physical characteristics such as topography, climate or water.
Living system	The living system concentrates energy within its boundary and this characteristic distinguishes it from the physical Earth system. Information is stored in genes.	Use of energy (e.g., photosynthesis), evolution, metabolism, reproduction, growth, response to environmental stimuli.	• biology • evolutionary biology • genetics • ecology	natural capital, ecosystem assets and flows, ecosystem functions and processes, biodiversity, biocarbon cycle, water cycle	all above plus: • counts of genes and organisms • composite measures (e.g., resilience, vulnerability)	Primarily spatially defined using living system characteristics such as land cover, habitat, ecosystems, environmental assets.
Human cultural system	Human culture and society: Defined by socially-created knowledge and meaning. Boundary defined by knowledge and meaning (what is unknown or has no meaning to humans is outside the boundary).	Socially-created meaning. The sense of having a choice (free will). Cultural activities, language, music, art, social institutions (family, community), legal systems, political systems, science, religion, sense of well-being, knowledge systems.	• sociology • anthropology • psychology	ecosystem services: benefits flowing directly to human cultural systems and outside the economic system e.g., non-material benefits such as sense of place or an inspiration for design	all the above plus: • indices of human well-being, suffering, and happiness	Comprises individuals or delineated human groups such as families, clans, tribes, associations, municipalities, communities, societies, and nations.
Economic system	Human activity based on negotiated agreements about the value of goods and services. The system is largely delineated by market-based valuation.	Markets, prices, the delocalisation of currency, accumulation, wealth, economic production.	• economics • psychology	ecosystem services and waste (those with market-based values and captured in the SNA)	all the above, plus • money	individuals, households, businesses, enterprises, nations

Seeing with joint perspectives

As described previously and illustrated in Figure 1, the four nested systems of the Joint Perspectives Model represent the relationships between the different systems and show how they emerge from each other. Each system encompasses parts of the systems below it, while lower systems extend beyond the bounds of those above them.

To explain how the Joint Perspectives Model can be applied, consider the economic system of the model. Figure 6 shows the economic system which includes those parts of the human cultural, living, and physical Earth systems for which market-based monetary values are known (largely those captured by the SNA). For example, paid labour is part of the human cultural and economic systems, in that it falls within the production boundary of the SNA, whereas voluntary labour, while it may support the economy, is outside the scope of the SNA.

As the economic system also encompasses parts of the human cultural and living systems, most economic activities can also be viewed from the perspective of the other systems. Included within the economic system are elements such as paid labour, investment and overseas trade. These are also elements of the human cultural system, able to be viewed and interpreted from a cultural and social perspective. Similarly, from a physical perspective, economic activity can be measured in terms of matter (mass) and energy (work) transfers (e.g., carbon footprints).

One of the insights the Joint Perspectives Model offers is that measurements made in the more fundamental systems (e.g., carbon and water fluxes in the physical Earth and living systems) will also have some meaning in the emergent systems (as food and drink in human cultural and economic systems). The reverse case is, however, more limited; that is, properties of an emergent system will carry less information about the characteristics of the fundamental systems, particularly outside of their system boundary. For example, dollar values will not capture all the available information about biodiversity or the cultural benefits of nature, especially those aspects that fall outside the scope of market-based valuation. This is a useful insight in the search for measurements for accounting purposes that are meaningful across all the systems.

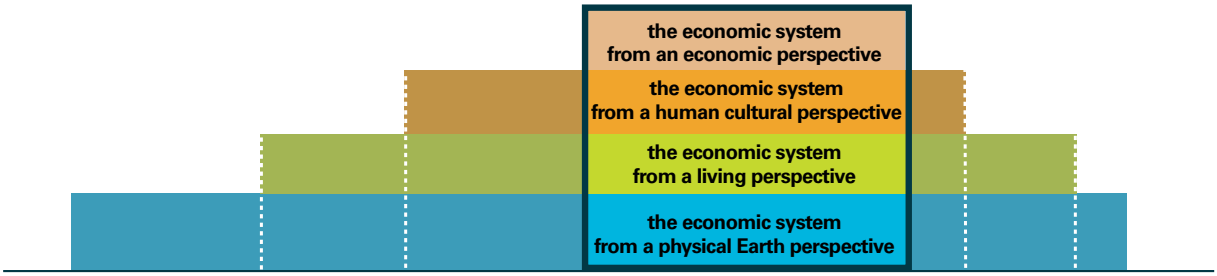


Figure 6. The economic system can be viewed from multiple perspectives.

The Joint Perspectives Model and measuring value

Accounting tracks the transfer of value between places, times, and entities. Each perspective of the Joint Perspectives Model offers measures and methods for accounting (see Figure 7) and each is associated with its own body of knowledge, including models of how the measurements link with what we value in the world. This is achieved by establishing a conceptual model (or best current understanding) and an evidence base (or best available scientific knowledge) of the account subject (see Chapter 7 for more information).

While there are well-tested conceptual models in place for monetary valuation from the economic perspective,[16] conceptual models of value from other perspectives are less well-tested for accounting purposes, although considerable knowledge is available to draw upon. The problems with non-monetary valuation are, in part, due to the subjectivity and knowledge limitations of the valuer and, in part, due to the complexity and dynamism of natural systems.

The difference between monetary value and other measures of value can be illustrated by the concept of local versus delocalised value. The term 'delocalised' refers to the concept that the location of money has little or no influence on its value, making it useful as a common currency. In contrast, all carbon, water and energy (or other potential currencies for ecosystem accounting) are not equal; to some extent, the value of these currencies is local as they depend on local conditions and context.

For example, when accounting for the quality of an ecosystem asset from a living system perspective, the value to the functioning of the ecosystem of water flowing into the ecosystem is strongly affected by the water's origin. Consider the difference in quality of wastewater from an industrial process compared with the natural rain-fed runoff from a wetland. Similarly, context and purpose is important to valuation. For example, when accounting for environmental benefit to people using a physical Earth system perspective, the value of a tonne of carbon in one form (wheat, timber, or coal) is not equal to a tonne of carbon in another (humans, coral reef, or rainforest).

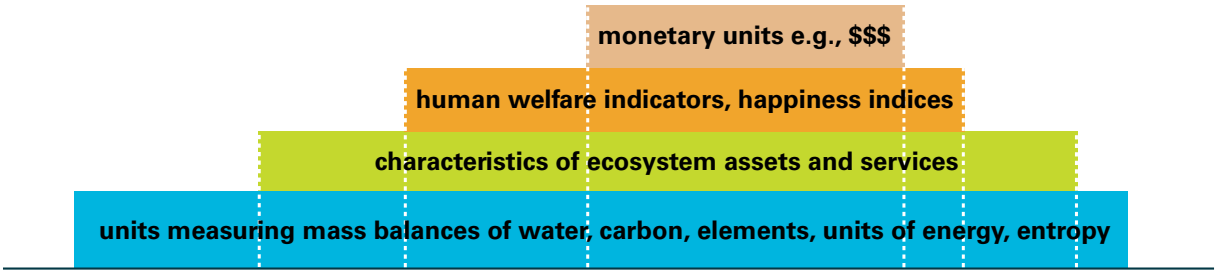


Figure 7. Examples of potential measurement units from different perspectives.

Measurements of the characteristics of fundamental systems are also relevant in their emergent systems, but measurements of properties of the emergent systems generally only apply within the emergent system's boundary (dashed white vertical lines).

[16]. Monetary valuation of near-market environmental assets, ecosystem services or public goods is an ongoing area of development; see SEEA-EEA Chapters 5 and 6 for a detailed discussion (European Commission et al. 2013).

The purpose of the Joint Perspectives Model is to assist the account framer to choose appropriate perspectives for accounting, and then use those perspectives to choose appropriate conceptual models and measurements of value (see Chapter 7 for more information on framing an environmental account).

Measuring environmental value from an economic perspective

A range of methods exist for estimating the monetary value of environmental assets, goods, and services. Most methods are based on discovering an individual's willingness to pay.

Considered most reliable are monetary values based on the prices of environmental assets, goods and services traded in markets. This method is termed 'revealed willingness to pay'. For example, water quality affects the costs of purifying drinking water and therefore the economic benefits of ecosystem services provided by wetlands that improve water quality can be measured by an actual decrease in the cost of providing clean drinking water.

If direct measurement using market prices is not possible, circumstantial evidence can be used to estimate imputed willingness to pay. In this case, values of environmental goods and services, or at least an estimate of the amount of degradation, are based either on the cost of avoiding damage due to lost environmental capacity, cost of replacing environmental capacity, or cost of providing goods and services to substitute for those provided by the environment. For example, the imputed value of the storm protection services of saltmarsh can be valued by measuring the cost of building coastal retaining walls to prevent erosion.

Further, if willingness to pay a certain amount for environmental assets, goods, and services cannot be revealed or imputed, surveys can determine people's expressed willingness to pay (also referred to as 'contingent valuation' or 'contingent choice methods'). These methods are used to estimate monetary values for all kinds of environmental assets, goods and services. They are the most widely used methods for estimating non-use values, such as bequest value, option value, and existence value.

Valuation and accounting for the environment in money terms has advantages, such as allowing easy integration of environmental accounts with other monetary accounts, including national accounts. It also has widely acknowledged disadvantages, both technical and theoretical, which will be explored in more detail in the next section.

Issues with monetary valuation

Economic value is the amount of money one is willing to trade for goods or services. In a market, prices emerge from the equilibrium between supply and demand. Individual producers and consumers decide whether to accept these prices, based on the economic value to them. Market prices do not reflect the true value of goods for which markets are imperfect or do not exist, for example, common goods or public goods, or goods that cannot be accurately priced for other reasons, such as lack of knowledge on the part of the consumer that a cost or benefit exists. Many ecosystem benefits and costs, including the benefits of global biodiversity, forest health, outdoor recreation, scenic beauty, and sense of place, do not, and in many cases cannot, have market prices.

Valid and credible monetary valuation of all the important non-market costs and benefits may not be achievable for three reasons:

- monetary valuation is not appropriate for some things;
- where monetary valuation is appropriate, current valuation methods are often inadequate or impracticable; and

- application of available methods to meet reasonable standards of quality is often too expensive to implement in current circumstances (Snyder et al. 2003).

New theories and methods to measure the transfer of value, applicable to environmental accounting, are being developed from human cultural, living system, and physical Earth perspectives. For example, see the work on shared social values in Chapter 24 of the United Kingdom National Ecosystem Assessment (Fish et al. 2011) (see a summary in Appendix 3). Chapters 5 and 6 in the SEEA-EEA contain detailed discussions of the methods, including the considerable drawbacks regarding the assumptions used in non-market valuation.

Measuring environmental value from the human cultural perspective

In environmental accounting, the human cultural perspective of the living and physical Earth systems considers the transfer of value that resides in goods, services, and assets such as a sense of place, pleasure gained from recreation, and inspiration. For these types of ecosystem goods and services, there is often no easily measured surrogate in the extent or state of the natural environment (Crossman et al. 2013), and the value cannot currently be captured in any credible or reliable way using methods of monetary valuation.

Of the four perspectives considered by the Joint Perspectives Model, the human cultural perspective offers the greatest challenge for developing methods to track the transfer of value through time and space and between entities, due to the subjectivity involved in measuring value of this kind. This is not to say that broadly acceptable indicators of value are not available but they may be highly localised. Methods and tools for tackling this challenge are under development including in the Common International Classification of Ecosystem Services (CICES) and in a practical application in South East Queensland by SEQ Catchments (Maynard et al. 2010).

An example of an environmental account addressing these types of values is the Bureau's National Water Account (the Bureau 2013c). Water values for Aboriginal and Torres Strait Islander people are recognised in the notes attached to the accounting tables and, although such value is yet to be measured for accounting purposes, it is a subject of interest for water accounting.

Measuring environmental value from the living system perspective

From the living system perspective, a range of methods is being trialled to measure the transfer of value embodied in environmental assets, goods and services. This includes measuring the capacity of ecosystems to provide ecosystem goods and services.

Ecologically or biologically-based measures under development will allow changes in the delivery of individual ecosystem services to be measured and accounted, such as the ability of ecosystems to provide food or regulate water quality (e.g., Logsdon and Chaubey 2013). Measures can be used for either the quantity or quality of environmental assets. Measures such as hectares of land cover type or marine habitats allow changes in the absolute quantities of valued environmental assets to be tracked.

Other quantification methods focus on measuring highly-valued characteristics of ecosystems such as structural connectivity (e.g., Worboys and Pulsford 2011) and biodiversity (SEEA-EEA, European Commission et al. 2013), indices of condition such as habitat hectares[17] (Parkes et al. 2003; Eigenraam et al. 2013), the condition score being trialled by the Wentworth Group of Concerned Scientists (Wentworth Group 2008), and European

[17]. Habitat hectares are based on explicit comparisons between existing vegetation features and those of benchmarks representing the average characteristics of mature stands of native vegetation of the same community type in a 'natural' or 'undisturbed' condition.

Environment Agency work in developing an Ecosystem Capability Unit (Weber 2011).

Measuring environmental value from the physical Earth perspective

The measurement of assets and transactions from a physical perspective predates the emergence of the economic system, relying only on the ability to count items and survey areas. However, drawing up physical accounts to track the movement of environmental assets, goods, and services is a relatively recent practice. The physical Earth perspective can be applied to non-living assets, such as volumes of water and minerals, or living assets such as carbon mass balances in ecosystems.[18] It can also be applied to assets within the human cultural system (e.g., physical changes in beach profiles due to sea-level rise) or economic system (e.g., carbon footprint measures).

From the physical Earth perspective, measurement units for environmental accounting can address the fundamental constituents of ecosystem functioning: the basic fluxes of matter and energy. Physical measurement of the characteristics of an ecosystem to assess environmental or ecosystem quality or condition[19] makes the assumption that the physical measures can realistically serve as a proxy. To be credible, these assumptions should be revealed and documented in a conceptual model (see Module 4 in Chapter 7) and open to revision.

Methods for measuring the relationship between water, carbon, and other key nutrients and their movement (cycling) through the environment may be useful for representing changes in the quality of an ecosystem and therefore the ability of the system to deliver valued ecosystem services.

An example of measuring value with joint perspectives

A key premise embedded in the Joint Perspectives Model is that measures useful in the base systems are also informative, although with limitations, in the emergent systems. A series of examples illustrate this, drawing on the living system characteristic of productivity (plant growth rates) and the human cultural system characteristic of stewardship (ethic of caring for the land for future generations).

Living system value from a physical Earth perspective

Satellite remote sensing gives us the ability to measure and map many physical characteristics of the land surface, such as colour, reflectance, and temperature, which, when interpreted through the lens of science, reveal a great deal about the living system. Mapping changes in the colour and other remotely sensed properties of the land surface, while not directly measuring emergent living system properties such as biological productivity and ecological resilience, can allow us to account for changes in living system characteristics. For example, colour as a remotely sensed physical property can serve as a proxy for the biological property of vegetation productivity.[20]

Human cultural system value from the living system and physical Earth perspectives

By extending the example, it can be seen that the physical and biological characteristics of a landscape detected by remote sensing offer information about the cultural values of the people who manage it.

For example, vegetation productivity is a highly valued living system attribute that is often the subject of human stewardship through the conservation of

[18]. Carbon mass balances measure the amount (mass) of carbon in living systems (ecosystem) at any one time.

[19]. The terms 'quality' and 'condition' are associated with subjective judgements about what constitutes good or poor condition. A forest in optimum condition for timber production may not be optimum for biodiversity conservation and vice versa. For an environmental account to have legitimacy, the point of view of the account framer and the intended purpose of the account need to be clearly stated.

[20]. Measures include the Normalised Difference Vegetation Index and Enhanced Vegetation Index.

threatened habitat or management for agricultural production. People seek to protect and enhance biological productivity through managing productive areas by applying fertilizer and water, selective vegetation management (weeding, fencing, pruning, and harvesting), or through the use of fire.

People could account for the quality of their stewardship (Coffey and Pearson 2007) by tracking changes in vegetation productivity via remote sensing, among other things. Higher measures of stewardship could be assumed if the productivity measured is commensurate with the capacity of the ecosystem and management objectives, and remains relatively stable over time. While measuring vegetation productivity through the living system and physical Earth system perspectives gives us no direct insight into the psychological dimensions and processes of stewardship, it can serve as a proxy to measure this valued cultural asset.

Economic system value from the human cultural, living and physical Earth system perspectives

In managed landscapes, the quality of stewardship of an area of land contributes to its economic value. This can potentially be estimated via its productivity (a living system variable) or the physical measures obtained by remote sensing (a physical Earth system variable).

One advantage of measuring productivity from these other perspectives is that it can help identify productivity in ecosystems outside the economic system. Using physical measures in this way allows accounting for the productivity, and hence (physical) value, of publicly-owned natural environments as well as that of land traded in markets by individuals.

In summary, physical measures can provide information about the emergent properties of the higher systems (Figure 8). The scope of these measures to account for the transfer of value (in this case, productivity through time) is more inclusive (i.e., extends across system boundaries) than that of higher system measures (e.g., monetary land value). Physical attributes are also generally easier to measure than stewardship or dollar value.

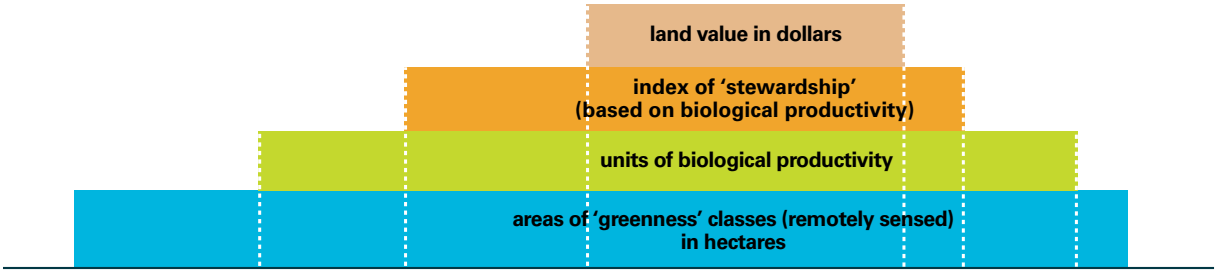


Figure 8. Measuring productivity from joint perspectives.

Examples of measurement types are given for each perspective. The figure also shows that the scope of physical, living and human cultural system measures for tracking the value of productivity extend beyond the economic system boundary.

Communicating environmental value

To increase understanding of environmental assets and goods and services, and thus inform human behaviour towards the environment, the measurement units chosen to track the transfer of value must function as a communication tool. Generally, most people understand the value of money. As an example, being told that the annual return of 2,800 gigalitres of water to the Murray–Darling rivers system will result in a $542 million loss in crop production while producing a $3–8 billion increase in environmental benefits to the community has an impact, despite the imprecision of the monetary estimate of environmental value (CSIRO 2012).

Still, it is not the case that monetary measures are the only effective way to convey environmental information. Indices based on the modelled behaviour of the natural environment can be effective communication tools. For example, people have learnt to quickly respond when threatened with a category 4 cyclone or when a catastrophic bushfire is coming their way. It is not necessary to convert the likely impacts of these events from indices into dollar values for people to take notice.

Nor is it necessary for the audience to fully understand the meaning of an index for it to be an effective communication tool. Reported trends in GDP influence a much wider audience than those who are aware of what this index of economic production does (and does not) include.

In part, the success of non-monetary accounting as a tool for policy, planning, or public education will depend on using units of measurement that resonate with intended audiences. The broader the audience influenced, the more likely it is that the methods of environmental accounting will gain traction and help improve our stewardship of the environment.

6. Principles of environmental accounting

This chapter presents the guiding values for environmental accounting and outlines a series of principles that are designed to support the production of useful environmental accounts and help overcome the pitfalls and barriers that may be encountered on the way.

Guiding values: relevance, credibility and legitimacy

To be effective, every environmental account needs to have the fundamental characteristics of relevance, credibility, and legitimacy. These crucial characteristics play different roles in the development and value of the account.

First, the account must have **relevance** to the users and an intended purpose. The selected account subject and associated characteristics, such as the spatial and temporal scale and the cost, must align with the users' needs.

The **credibility** of an account depends on whether it adequately represents the account subject. This relates to issues of measurement and analysis and questions such as, 'How accurately do the identified measures reflect the environmental subject of interest?', 'Are the right phenomena of interest being measured?', 'Do the measures provide us with the information we actually need to make decisions?' Answers to these questions are strongly influenced by the perspectives taken in the development of the account.

Legitimacy is a necessary dimension for the successful, effective implementation of environmental accounts. Legitimacy is the degree of acceptance of an account by the account users. Legitimacy reflects the perception that the production of information and technology has been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests (Cash et al. 2003). Even if they were available, well-founded, relevant, and credible measures of the environment are not enough for uptake and use; measures also need legitimacy.

These values guide and influence the environmental accounting principles and every aspect of the accounting process.

Principles of environmental accounting

Effective environmental accounting must provide relevant, credible and legitimate information about the environment and its relationship to human well-being. To do so, it must be based on the following principles:

1. Ecosystems are fundamental to human well being. Human cultural systems, including the economic system, are embedded in ecosystems and the living world.

2. For environmental accounts, all air, land, marine, and water environments are in scope as are all ecosystems, including human ecosystems (rural and urban areas).

3. Biodiversity is a fundamental characteristic of ecosystems, including within and between species diversity, as well as ecosystem diversity.

4. Each environmental account should clearly discern the account subject, noting that:

    a. Account subjects can be individual components of ecosystems and the environment or, for ecosystem accounting,[21] the subject is the integrated functioning of ecosystems (i.e., measures of ecosystem characteristics are used to gain an integrated view of ecosystem functioning).

[21]. Ecosystem accounting is a subset of environmental accounting described in the SEEA-EEA (European Commission et al. 2013).

b. Ecosystems are challenging to define and map precisely as they exist at overlapping spatial and temporal scales, so measures and indicators are used to infer their condition at specified scales.

c. Ecosystem services are not independent of each other; they are always combined and interconnected.

5. Environmental accounts should be based on the best available scientific knowledge and clearly defined descriptions (conceptual models) supported by an evidence base produced with best practice principles.

6. Environmental accounts should enable tracking of value (quantity and quality) through time, across space, and between entities, and this depends on the characteristics of environmental accounting, including that:

   a. The account subject and its valuation (meaning) depends on the worldview adopted by the valuer.

   b. The measures of value used for the account depends on the perspective taken (e.g., physical Earth, living, human cultural, or economic).

   c. Value can be defined with monetary or non-monetary methods. Non-monetary (biophysical) environmental accounting should draw on knowledge domains including biology, ecosystem science, physics, and chemistry. Independent scientific accreditation of the measures and methods applied is essential.

   d. Non-monetary valuation is often the only way to obtain information about the environment as many aspects of ecosystems and the broader environment are unable or impracticable to be valued with monetary methods.

   e. Continuous improvement is required in ways to present non-monetary and monetary information, separately and in combination, to ensure their relevance and assist in their use.

   f. For ecosystem accounting, relationships between ecosystems are fundamental to their quality and value, so where ecosystems are located is a fundamental organising principle.

   g. Temporal data are an essential requirement of environmental accounts.

   h. To support the legitimacy and credibility of the account, independent accreditation and assurance are essential contributors to any environmental accounting system.

7. Environmental accounts (including ecosystem accounts) and account-ready environmental data are useful in their own right and, where required, should also clearly link to environmental–economic accounts and through them to economic accounts.

7. Framing an environmental account

This chapter presents a general approach to framing an environmental account. It helps the user to decide whether an account is the best format for organising available environmental data to meet a stated purpose, and presents a generic method for framing an account. The method addresses a basic set of questions (why, who, what, and how?) that an account framer needs to answer to scope, and then specify, an account.[22]

The more general process of operationalising environmental accounts from an institutional perspective, including prioritising which accounts to produce, is discussed in Chapter 9.

The framing process

The pathway to designing or framing a specific environmental account must start with a basic understanding of the purpose of the account and whether an accounting format is needed. This chapter sets out a series of systematic questions to assist in preparing an account. It is important to understand the perspectives of the account users, as that will determine the subject and measurement methods of the account.

Once an account format is deemed to be relevant and useful, it is important, from the beginning, to incorporate elements into the design that will ensure credibility and legitimacy. This includes documentation of the account's conceptual model and evidence base and establishing independent scientific accreditation. Independent assurance should be further enabled through the use of data quality frameworks and standards (see Chapter 10).

This chapter presents a general approach for framing an environmental account that guides:

- the assessment of whether an environmental account is useful for organising environmental statistics and datasets to meet user requirements;[23] and
- if an account is required, how to frame the account; that is, how to identify the information needed to meet the principles, concepts, rules, and practices of environmental accounting. Fundamental framing questions include the purpose of the account, who will be involved in the account, what will be measured (account subject) and the measuring and statistical units.

Given the broad range and complexity of environmental account subjects, the approach here is general and provides guidance and principles to assist account framers rather than the technical detail or costing needed to produce any specific account.[24]

Any person or organisation considering the development of a specific account (the account framer) must ask a series of questions to determine the value of creating it. It is useful to organise these into a coherent modular structure by asking specific why, who, what, and how questions covering the basic principles of environmental accounting and that are consistent with the guiding values of relevance, credibility, and legitimacy.

In essence, an environmental account must be:

- purposeful and consequential for a party (the account-user) who depends on the reported information;
- able to measure change in a defined account subject (the phenomenon of interest) through time;

[22]. Please also refer to the *Environmental account framing workbook*—a complementary part of this Guide.

[23]. Alternatives include environmental assessments and monitoring programmes.

[24]. Technical requirements for each account depend on the account's purpose. Please refer to specific accounting frameworks, for example, the extensive SEEA documentation unstats.un.org/unsd/envaccounting/seea.asp

- organised to enable comparisons and crosschecks in an internally consistent manner; and
- comparable with other relevant accounts so it can provide the basis for more detailed or aggregated analyses.

The framing questions that flow from these core concepts are as follows:

1. Why have the account? What is its purpose?
2. Who are the parties to the account?
3. What is the account subject?
4. How will the account be structured and implemented in practice?

It is important to start by addressing the first three questions to establish the scope of the account, as these answers will drive the specification of any account and its implementation, that is, 'the how' (Figure 9). Together, the questions provide a robust framework for tackling complex environmental information challenges and producing an account. An expanded set of framing questions is presented in the *Environmental account framing workbook.*

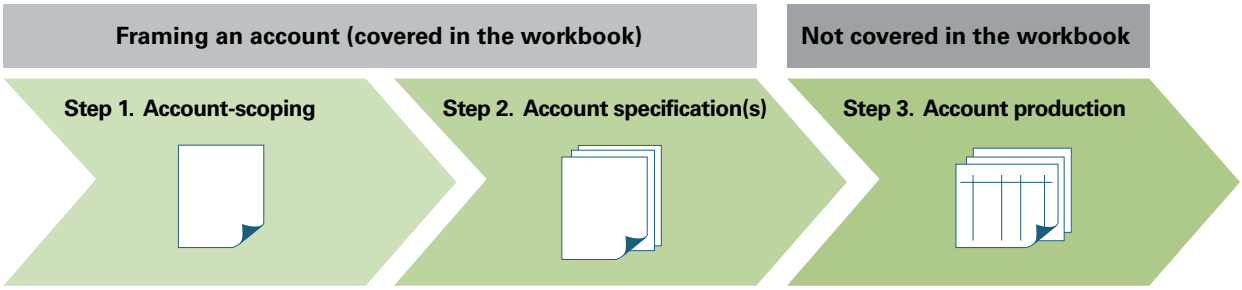


Figure 9. Three steps to producing an account.

A single scoping process can be used to specify and produce multiple, closely related accounts.

Framing an environmental account: Why, who, what, and how?

A method has been developed to address the why, who, what, and how questions of framing an environmental account via a series of eight modules, to be answered as part of the account-scoping process (see Figure 10). Once these questions have been answered, the results are entered into an account specification document that becomes a report, fulfilling a number of accounting functions. First, the account specification informs the production of the account. Second, it is published as a formal piece of metadata about the account, for anyone wanting to know how the account was produced. Finally, it can fulfil functions internal to the account-producing organisation, for example, it may be used as a sign-off document or as part of the process to seek support to produce the account.

The eight scoping modules are shown in Figure 10. The process of scoping the account is an iterative one. Modules can be completed in any order and can be partially completed, then revisited as information becomes available from working on other modules.

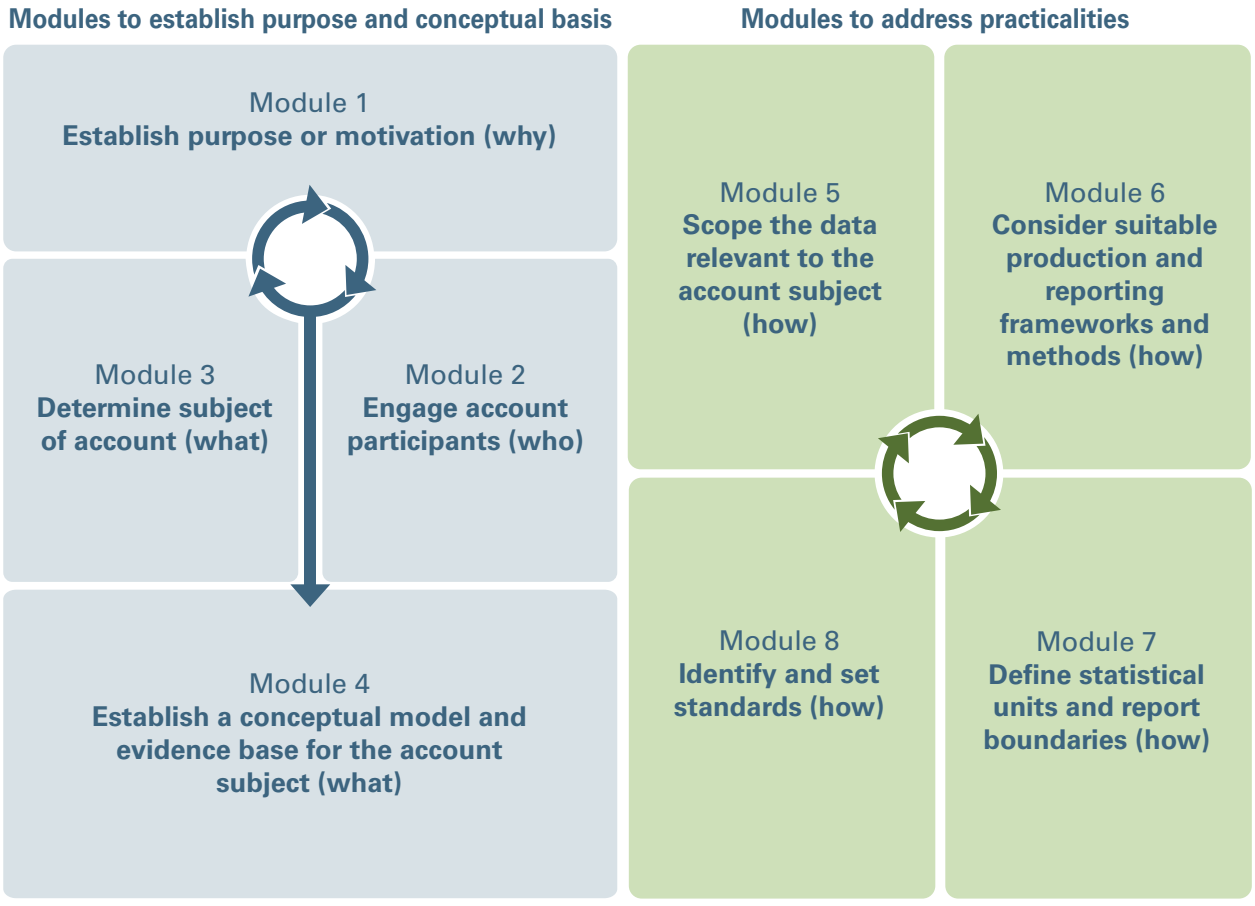


Figure 10. Eight modules for framing an environmental account.

Modules 1 to 4 answer why, who, and what questions and establish a conceptual model and evidence base for the account subject. The other four modules address the practicalities of how the account will be produced. The account scope, when completed, can be used to specify and produce one or more closely related accounts (see Figure 9).

The eight modules of account scoping and specification are described in this chapter and in more detail in the *Environmental account framing workbook*.

Module 1: Establish purpose or motivation (why)

There are a number of reasons for creating an environmental account. Primarily the purpose will be to obtain timely, credible information about changes in the account subject (e.g., gains or losses in environmental and ecosystem assets) that are relevant to decision-making. The purpose or motivation for an account is strongly influenced by the worldview of the account users on the subject of the account.

The worldview of the account framer and account users will inform their objectives, values, rights, and responsibilities (Table 6). For example, contrast the worldview of an organisation with objectives and values around conservation of ecosystems with a business concerned with mineral extraction. In turn, objectives, values, rights and responsibilities will shape the reason for the account, the interested parties, and the account subject.

Some examples of environmental account purposes and motivations are:

- meeting economic requirements (e.g., enabling market valuation to allow the buyer to judge value);
- meeting obligations to others (e.g., as part of a mandate, for taxation purposes, or legal requirements);
- meeting social norms and values (e.g., stewardship, reputation, positive regard and recognition as a competent manager, intergenerational equity); and
- meeting environmental management objectives (e.g., managing ecosystem and biophysical structure; conserving biodiversity; maintaining composition, function, and processes; reducing the impact of waste; or providing the feedback necessary for adaptive management and learning).

Role of the Joint Perspectives Model in establishing purpose and motivation

The purpose or motivation will determine the appropriate or practical perspective for accounting. If the purpose of the account is to measure the activities of a market, such as a carbon or water market, the use of an economic perspective and monetary units are clearly required. To obtain the

Table 6. Factors influencing the purpose and motivation for an environmental account.

Worldview	Multiple worldviews are always present; see the Joint Perspectives Model for more information
Responsibilities	Obligations, legislation, duty-of-care, commitments, future generations, neighbours
Rights	Ownership (private property), mandates, licences, entitlements
Values	Stewardship, existence value, dominion, utility extraction
Objectives	Business plan, management plan, conservation plan (including targets)

benefit of taking a joint perspective (e.g. to estimate trade-off costs) additional measures drawn from the living and physical systems will also be essential. On the other hand, if the aim is to account for a change in ecosystem capacity to provide a specific service, a physical Earth or living system perspective is likely to be more useful, using direct measures of change in the ecosystem capacity of interest.

Module 2: Engage account participants (who)

Consistent with public sector accountability principles,[25] the participants involved in an account should be identified and their roles and relationships defined and understood. This provides clarity, aligns the account with the participants' needs, and also underpins the legitimacy of the account. Interested parties to an account may be individuals, organisations (government and non-government), entities (economic statistical units such as households, businesses or enterprises), owners, controllers and/or the wider society. For example, when measuring sustainable development, Chesson (2013) recommends identifying the player to whom an asset belongs and, secondly, those assets impacted upon but not owned by the player. A second category of account participant is independent parties including assurers or those providing accreditation.

A further aspect of accountability involves determining a process and schedule for ensuring all the appropriate participants are involved in the account.

Role of the Joint Perspectives Model in engaging account participants

The perspectives of account participants may differ, depending on their interest in the account. In engaging account participants it is important to ensure that all participant perspectives are represented if the account is to be relevant, credible, and legitimate.

Module 3: Determine subject of account (what)

The subject of an environmental account will depend on the purpose of the account and the identity and objectives of the interested parties. For example, an account may have the purpose of providing an overview of changes in natural capital for all Australians to inform how well Australia is meeting its stewardship obligations. Such an account will focus its subject at a national scale and on measures related to natural capital.

The subject of the account also depends on the current ability to understand and measure the phenomena of interest. For example, ecosystems and their boundaries are challenging to define as they are complex entities operating at multiple and nested spatial and temporal scales. Advances in knowledge are defining new criteria for measuring these complex systems, such as condition, resilience, and safe operating ranges.

At this step, it is useful to consider the type of account or account framework. For example, many environmental accounts in Australia are based on the SEEA, although the National Water Account uses a financial accounting approach (the Bureau 2013c). More concrete and detailed decisions about the account framework will need to be made at Module 6.

Role of the Joint Perspectives Model in determining the subject of the account

The same account subject can be defined from any perspective of the Joint Perspectives Model. For example, water in the River Murray (an account subject) is simultaneously a physical phenomenon (with physical properties such as temperature, volume and flow rate), a living system component (essential for plant growth and as fish

[25]. See *Effective public sector accountability* by the Australasian Council of Auditors-General: www.acag.org.au/epsa.htm

habitat), culturally important (offering recreational opportunities and part of the identity of the community), and an economic resource (as managed water and valued as irrigation water).

Module 4: Establish a conceptual model and evidence base for the account subject (what)

For any account subject, although particularly when dealing with complex phenomena, it is necessary first to develop a conceptual model (description) using the best available current knowledge to provide the basis for measurement and subsequent policy and activity. This is a statutory requirement for some; for example, the Commonwealth *Water Act 2007* specifies that action under the Murray–Darling Basin Plan should be on the basis of the best available scientific knowledge.

The approach for this module is to identify the key structures, functions, and processes (e.g. habitats, carbon and water cycles, and biodiversity) in the account subject of interest from each relevant perspective and also the characteristics of human interactions with the subject (e.g., extraction, waste impacts, restoration, or management).

This approach is well recognised within environmental management practice, for example, the *Framework for the assessment of river and wetland health* uses conceptual models to underpin the selection of indices of aquatic ecosystem functioning (National Water Commission 2011). If the conceptual model is developed collaboratively with all account participants, it is more likely to capture the various perspectives of the account subject. For an example process, see the WetlandInfo approach to developing pictorial conceptual models (Queensland Department of Environment and Heritage Protection 2012; wetlandinfo.ehp.qld.gov.au/wetlands).

The conceptual model and evidence base should include information about the methods chosen to measure the transfer of value for accounting purposes, from one or more perspectives. For example, if monetary measures are being used to account from an economic perspective and the method to be applied is imputed willingness to pay,[26] the science behind the chosen method and evidence that the method is credible and appropriate should be included as part of this module.

Although there are many operational approaches to conceptual modelling, generic guidelines to conceptual modelling for environmental accounting are not currently available. Conceptual models are defined here to include a broad range of descriptions of system characteristics, from simple descriptions through to sophisticated diagrammatic science communication models and fully specified mathematical process models.

There are many benefits of developing and documenting a conceptual model of the best current understanding of the systems. For example, a conceptual model:

- provides a basis for identifying value and selecting measures;
- underpins credibility and adds legitimacy;
- communicates with account participants about the logic of the account;
- enables account assurance; and
- enhances the account presentation.

Building and evaluating an evidence base

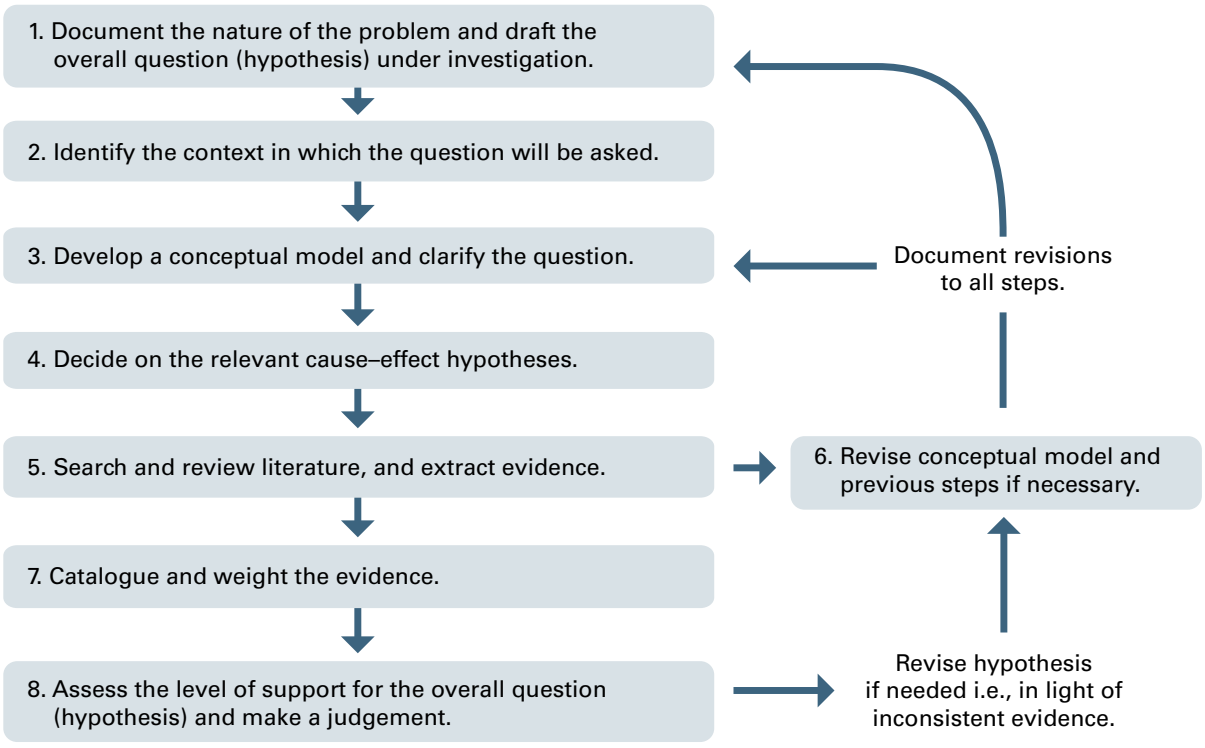
The conceptual model needs to be supported by the development of an evidence base for each account subject. The evidence base is

[26]. For more information, see 'The Joint Perspectives Model and measuring value' on page 41.

the body of scientific knowledge summarising assumptions upon which the account is based. For environmental accounting, the evidence base would typically be drawn from the disciplines relating to the physical Earth and living systems which might include ecology, hydrology, chemistry, and geomorphology (among many others). The evidence base will provide credibility and legitimacy that the account is measuring the value of the account subject, particularly when market values are absent.

Evidence-based design in the environmental field is in its early stages (Nichols et al. 2011). Recent examples of methods used to evaluate environmental evidence are described in the scientific literature (Webb et al. 2011; Norris et al. 2012) and an example is provided below.

The 'Eco Evidence' method involves examination of the published ecological literature to assess support (or otherwise) for specified hypotheses in environmental assessment. The method is an eight-step process and, as outlined in Figure 11, involves framing the problem, delineating the context and a conceptual model, and a systematic review of the evidence for one or more hypotheses against threshold criteria. The results of the review may warrant reframing of the initial hypotheses and reconsideration of the conceptual model. The results of the analysis provide a guide to the strength of evidence in light of the hypotheses. The thresholds, which can be altered given adequate justification, are used to reach a conclusion concerning the presence or absence of a causal relationship.



Source: Adapted from Nichols et al. (2011) and published in Norris et al. (2012).

Figure 11. Steps in the Eco Evidence framework.

When establishing a conceptual model and evidence base for environmental accounting, the account framer should ensure that the following criteria are applied:[27]

- An adequate amount of evidence is available from multiple independent sources (e.g., scientific literature, expert opinion, community knowledge/values) including attempts to refute the hypothesis.
- Multiple independent peer reviews of the evidence are available.
- A high maturity of understanding is needed for all model elements in the account.
- A high level of consistency is required between conclusions drawn from the multiple lines of evidence.
- At least one high-quality synthesis or review relevant to the account subject is available, including an assessment for unexpected risks or outcomes.
- No conflict of interest should exist (that is, none of the participants in developing the conceptual model and evidence base have a vested interest in the production of the account).

Role of the Joint Perspectives Model in establishing a conceptual model and evidence base

For all accounts, though especially in the absence of a market, it is essential to establish the conceptual basis for the account. The Joint Perspectives Model has multiple roles in relation to establishing a conceptual model and evidence base for the account subject.

First, collaborative establishment of the conceptual model using the Joint Perspectives Model as an explanatory tool will help clarify and reconcile differing perspectives among account participants.

Second, the conceptual model and evidence base will include information about how the transfer of value between places, times, and entities is measured from relevant perspectives. For example, if the economic perspective is chosen and measurement units are dollars, what is the science that links the monetary measurement with what it is intended to measure?

Finally, the scientific evidence base for an account will be drawn largely from its underpinning perspectives. For example, evidence for an ecosystem account would come from ecology, along with environmental chemistry and physics, if accounting is to be done in physical measurement units such as those used for measuring carbon, nutrient, and water cycles.

Module 5: Establish the measures and data relevant to the account subject (how)

A critical step towards specifying the account is matching the account subject required by managers and policy makers with the scientific capability and data to measure it. Measures are values recorded to represent the properties, characteristics, or attributes of a system and the account conceptual model is a critical reference point when identifying the relevant measures. The measures can be direct observations or estimates of characteristics based on surveys, models, or model–data fusion techniques.

Note that multiple measures or common measures may be required if there is a need to work with a number of perspectives. For example, if an account subject was the flow of water through an ecosystem, it could be measured from a physical Earth system perspective in megalitres and in monetary measures from an economic perspective. At the same time, it could be measured from a living system perspective

[27]. Acknowledgement: Carolyn Raine, Central West Catchment Management Authority, New South Wales.

by an estimate of the ecological value of the same gigalitres of water in terms of maintaining ecological processes and biodiversity. Alternatively, the ecosystem services of the ecological functions in regulating the flow of the water through the ecosystem could be estimated. These various measures can potentially be presented in combination (i.e., jointly) if the conceptual model indicates this is feasible and meaningful.

As environmental accounting requires tracking of value, attention must be given to the method of characterising value in the physical Earth and living systems. One aspect of the challenge is that the perceived value of all physical Earth and living system phenomena are highly dependent on their location and context and the worldview and perspective incorporated into the purpose of the valuation. As a simple example, from almost any perspective, a cubic metre of water at the top of a mountain range has a different value to a cubic metre of water in a desert or the ocean due to its different locational and physical characteristics (e.g., form, temperature, salinity, kinetic energy) and different roles and meaning in the surrounding ecosystem, including for people (e.g. habitat, food, crop irrigation). This reasoning—that location, context, and perspective are critical to value—has implications for the selection of the measures used for the account. Stepping through the framing process presented in this chapter of the Guide is one way to draw out the logic of the account.[28]

An important task is to investigate available datasets relevant to the measures chosen for the account subject. If suitable datasets are not available and fit for purpose, they will need to be collected or the account subject and purpose reconsidered in light of data availability.

Classifications

The compilation of accounts relies on the consistent application of classification schemes. In economic accounting, these classifications apply to economic activity, for example the Australian and New Zealand Standard Industrial Classification (ANZSIC). Classifications relevant to environmental accounting include classification schemes for land cover, land use and soil type. The CICES should be considered when identifying ecosystem services.

Scale matching

Matching the scale (or resolution) of the account subject with the scale of management is an important part of scoping measures and data. The scale of the account subject can be considered through time, across space, and by theme, as:

- temporal (duration or cycling of phenomena, transaction [event] definition);
- spatial (location and dimensions); and
- thematic (characteristics or classes of the subject, e.g., land cover classes or ecosystem services classes).

It is important to identify the definition and resolution of each of these dimensions to ensure they match the requirements of management and policy makers (e.g., Chesson 2013). Much of the environment-related management activity in Australia is at the regional and local scale so accounts populated with national-scale data and information will have limited applicability for this purpose. Conversely, information relevant to specific local-scale management may not aggregate well for national-level reporting.

Role of the Joint Perspectives Model in scoping the account subject data and measures

The account subject will be measured from one or more perspectives and these will influence the variables chosen to measure the subject. This will influence or be influenced by the availability of data at a suitable resolution to match the choice of variables.

[28]. Also see the discussion about value at the end of Chapter 5.

Module 6: Consider suitable accounting and analysis frameworks and methods (how)

Depending on the purpose and subject of the account, a number of accounting frameworks may be available. Questions such as whether the account needs to link to other accounts, or to international reporting frameworks, will help to determine the choice. As described previously, the SEEA provides a comprehensive framework for environmental accounting.

This module also addresses how the accounts are to be presented, for example, what analytical methods to use, and what tables, maps, and charts to produce. Please see Appendix 2 and the SEEA-AE for more detail.

In producing accounts, the availability of account production infrastructure such as data management and analytical and modelling capacity will need to be considered, and research or training may be needed to fill any gaps. Chapter 9 discusses these issues in more detail.

Role of the Joint Perspectives Model in scoping production and reporting frameworks and methods

The accounting perspective and account subject will influence the accounting frameworks, analytical methods, and the presentation of the results such as how measures are reported and which aspects of the account subject to depict in maps and charts.

Module 7: Define statistical units for accounting (how)

Accounting practice requires the definition of entities or statistical units as a structure for classifying and organising data into an account format. Examples of national accounting statistical units are households and businesses; these are the basic units to which measurements and estimates are assigned. The units then provide the basis of aggregation, analysis, and presentation for accounting purposes. Further, they provide the common denominator among various forms of accounts that allow links between those different accounts including through the use of classifications.

The central challenge for any environmental account is to define the subjects of interest (such as ecosystems or environmental assets) as precisely as possible and to clearly identify the classification schemes with which they will link.

Given the statistical units are the basis for organising measures, such as environmental statistics and spatial datasets, they should be as consistent as possible with the conceptual model for the account. As they must be a simplification of the real world they will necessarily contain reduced information. The key is to reduce the information content as little as possible and still meet the accounting principles. The relationship between the real world and units is depicted in Figure 12.

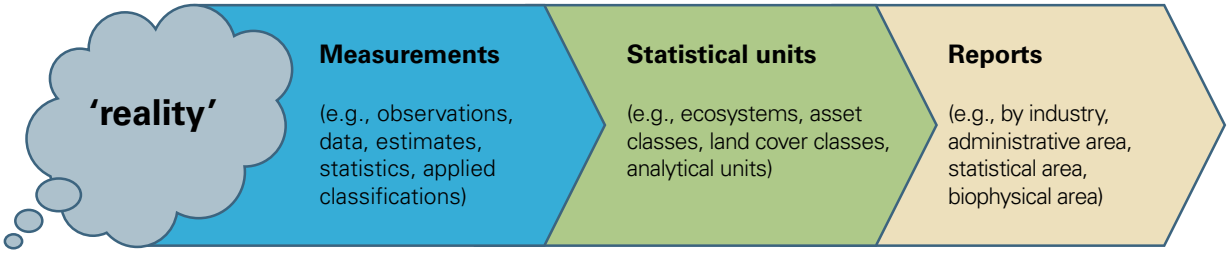


Figure 12. Representation of real world and statistical units.

Scope of statistical units

Statistical units for accounting must cover the full scope within the boundary of the territorial area of interest (e.g., Australia or a NRM region). They must be exhaustive and mutually exclusive. For environmental and ecosystem accounting, the SEEA-EEA defines a basic spatial unit (BSU) as the statistical unit to which information is attributed. A BSU must be able to adequately measure the account subject at specified accounting periods and scales. Ideally, these units are stable through time to support comparison and development of trends. In general, a BSU is delineated using spatial properties and not ecological properties. This will usually take the form of a tessellation such as a grid[29] (see Figure 13) or polygon, with dimensions that meet the scale-matching criteria (e.g., 1 ha, 1 km^2, 25 km^2, 100 km^2).

Reports

Reports are the basis for aggregating and presenting information, including indicators. If reporting on a spatial basis, reports may be formed by sets of BSUs with a common value and can be generated for many different purposes including reporting on specific ecosystem types (e.g., wetlands) or changes between ecosystem types (e.g., forested to urban). They can be ecological classes (e.g., ecosystem types), geographical (e.g., catchments), administrative (e.g., States and Territories) or any other aggregation, depending on the purpose and subject of the account.

Examples of report boundaries using physical characteristics are river basins and the Interim Biogeographic Regionalisation of Australia. Boundaries are also important for marine areas and can be determined by administrative areas, for example, the Exclusive Economic Zone or fisheries management areas, or physical characteristics (e.g., near-shore and off-shore).

The ABS Australian Statistical Geography Standard system provides a robust and tested spatial framework for many accounting purposes including reports containing presentations and analyses of accounts (ABS 2013c).

Role of the Joint Perspectives Model in choosing statistical units or reports

The characteristics to be recorded for the basic units depend on the account perspective. Reports will also be determined by the account perspective. For example, if an economic perspective is needed, SNA-based account statistical units such as households or nations might be used to allow for integration with economic accounts. For an account developed from a living system or physical Earth system perspective, BSUs could be ecosystems or land-based grid cells. If comparison across perspectives is required, some method of conversion or linking between statistical units will be needed, possibly based on aggregation, for example, of households into catchments. For these reasons, there is value in employing a common geography that supports the overlaying of units.

[29]. Ideally using the National Nested Grid (www.anzlic.org.au/node/56) or a similar standard.

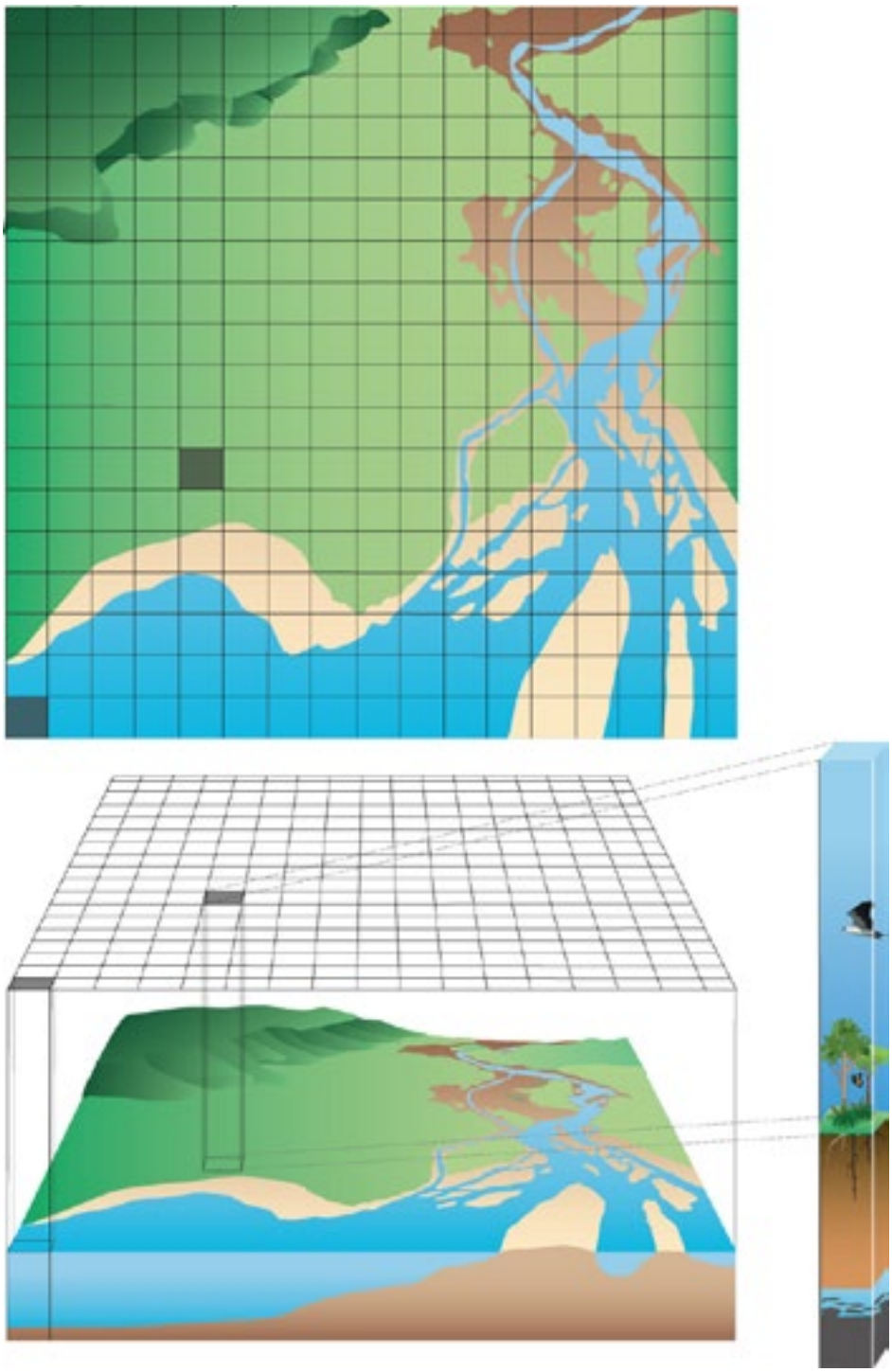


Figure 13. Schematic representation of a single grid-based basic spatial unit.

This figure illustrates how a single grid cell can be considered as a slice of reality and attributed with characteristics of the ecosystem at that location, including flora, fauna, elevation, soil type, groundwater, ecological connectivity, and position in the landscape.

Module 8: Identify and set standards (how)

Standards are a powerful adjunct to environmental accounts, underpinning their credibility and legitimacy and ensuring that a high quality, consistent, and repeatable process is used to produce an account. Standards could be applied at almost every step of the accounting pathway, including conceptual modelling, data collection, and management, and accreditation and assurance. Accounting frameworks can themselves be accredited standards; for example, the SEEA-CF has been adopted as an international standard for environmental accounting.

In the absence of formally accredited standards, recognised best-practice processes and protocols (as they apply to each module of the account-framing process) should be used as de facto standards. Alternatively, it may be determined that a standard needs to be developed.

Chapter 10 and Appendix 5 describe in more detail the standards that are relevant to environmental accounting and the process for developing a standard.

Role of the Joint Perspectives Model and setting standards

The standards relevant to each account will depend on the accounting perspectives. For example, as classifications must align with the purpose of the account, different classification schemes will be chosen based on which perspective is taken. For example, a living system perspective may require a habitat type classification, whereas a physical Earth system perspective may need a geomorphological classification.

8. Sample account outputs

This chapter briefly presents some basic sample account tables and outputs. For further detail on account types, refer to Appendix 2.

Basic outputs from environmental accounts

Drawing on the SEEA, these account tables are presented to assist the reader in understanding the basic concepts.

Land account

Land accounts are a powerful way of integrating data that measure characteristics of land and how these characteristics change over time. Land accounts help inform land use and land management decisions and policies (such as population settlement) and the sustainable production of goods and services (ABS 2011a). They can also help us understand the productive capacity of land across different industries, and the impact of different land management decisions on the carbon cycle and water availability.

The following are some examples from a land cover account for an area of interest, in this case, the Flinders–Norman rivers catchment in Queensland. The examples are a form of land account using physical measures and the SEEA-CF framework. Three types of output reports are presented: a basic stock table, a change (flow) matrix, and a change (flow) map.

A basic spatial unit of a 250 m x 250 m grid cell has been used and attributed with the dominant land cover type of that unit. The land cover classification that has been applied is the international standard Land Cover Classification System (LCCS) developed by the United Nations Food and Agriculture Organization. In this example, broad classes are used:

- primarily non-vegetated;
- primarily vegetated—cultivated and managed lands;
- primarily vegetated—natural and semi-natural terrestrial vegetation—herbaceous;
- primarily vegetated—natural and semi-natural terrestrial vegetation—woody—shrubs;
- primarily vegetated—natural and semi-natural terrestrial vegetation—woody—trees; and
- primarily vegetated—aquatic or regularly flooded.

An example of a basic stock account is shown in Table 7, in this case a physical account for land cover. A net land cover change matrix is shown in Table 8. For these examples, Geoscience Australia's 2012 Dynamic Land Cover Dataset version 2–beta has been used to produce experimental accounts.

Table 7. Example physical account for land cover ('000 ha).

	Primarily non-vegetated	Cultivated and managed lands	Vegetated—herbaceous	Vegetated—woody—shrubs	Vegetated—woody—trees	Primarily vegetated—aquatic or regularly flooded
Opening stock (2006–2007)	**25**	**1**	**10,939**	**635**	**11,425**	**109**
Additions to stock						
Managed expansion						
Natural expansion						
Upwards reappraisals						
Total additions to stock	4	0	561	187	2,163	64
Reductions in stock						
Managed regression						
Natural regression						
Downwards reappraisals						
Total reductions in stock	3	0	2,099	414	415	46
Closing stock (2010–2011)	**26**	**1**	**9,401**	**408**	**13,172**	**126**

Note: In this example only the total additions and reductions are shown. Data are not available for the sub-categories of additions and reductions in stock (e.g., 'Managed expansion' and 'Managed regression').

Table 8. Example of a net land cover change matrix.

	Opening stock (2006–2007)	Net increases (positive numbers) and decreases (negative numbers) from other land covers, 2006–2007 to 2010–2011 ('000 ha)							
		Primarily non-vegetated	Cultivated and managed lands	Vegetated—herbaceous	Vegetated—woody—shrubs	Vegetated—woody—trees	Primarily vegetated—aquatic or regularly flooded	Net change (increase—decrease)	Closing stock (2010–2011)
Primarily non-vegetated	**25**	—	0	0	0	1	0	**1**	**26**
Cultivated and managed lands	**1**	0	—	0	0	0	0	**0**	**1**
Vegetated—herbaceous	**10,939**	0	0	—	8	–1,523	–24	**–1,539**	**9,401**
Vegetated—woody—shrubs	**635**	0	0	–8	—	–219	0	**–228**	**408**
Vegetated—woody—trees	**11,425**	–1	0	1,523	219	—	7	**1,747**	**13,172**
Primarily vegetated—aquatic or regularly flooded	**109**	0	0	24	0	–7	—	**18**	**126**

Additions and reductions can also be represented spatially. Figure 14 depicts changes (additions) to the natural and semi-natural and aquatic vegetated land cover classes.

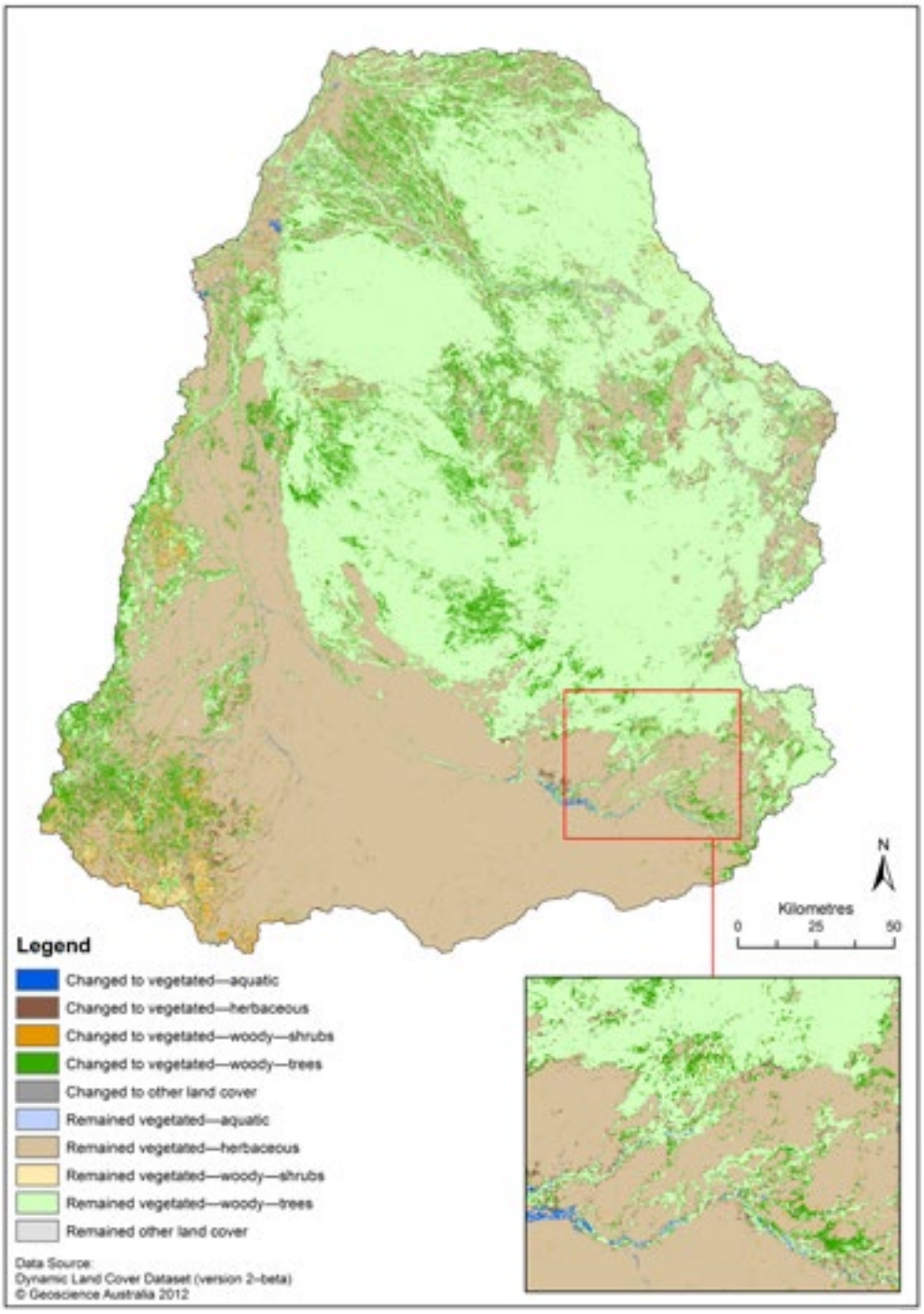
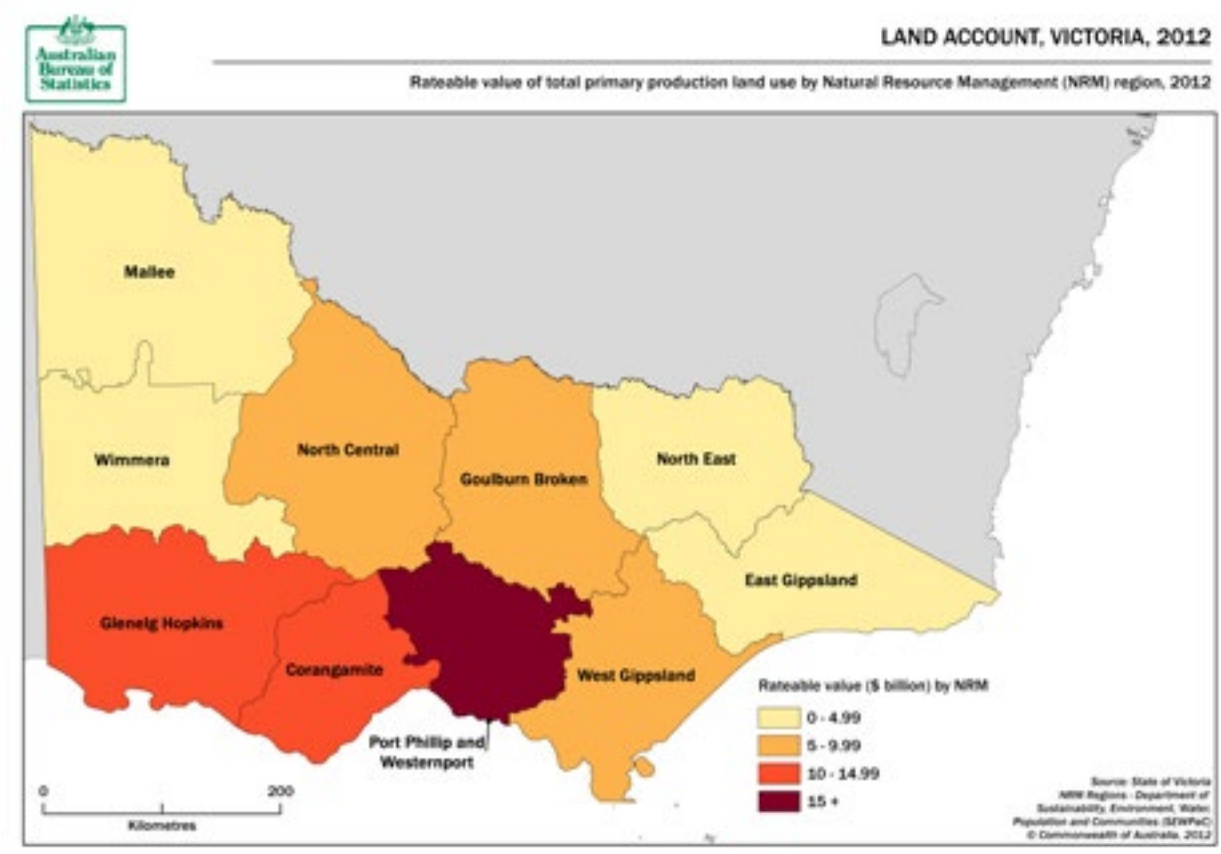


Figure 14. An example map showing additions to land cover groups from 2006–2007 to 2010–2011 in Flinders–Norman rivers.

Land accounts enable the integration of economic data and biophysical data using a spatial statistical unit. In Figure 15, an example for the State of Victoria, cadastral land parcels are the basic statistical unit to which characteristics such as land use, land value, and land cover are assigned. By integrating this information, accounts can present analyses such as the land value of a particular land use type.

Waste Account

The following examples are drawn from the *Waste Account, Australia: Experimental estimates 2013* (ABS 2013e) which provides integrated monetary and physical waste accounts based on the SEEA-CF. In this example, the statistical unit is an industry unit, or entity, classified into the ANZSIC scheme. The examples below include a physical supply table (Table 9) and a graphical representation of the data showing the rate of Australian waste generation compared to an economic measure (Gross Value Added or GVA, which is a measure of the value of output minus the value of intermediate consumption) and population growth (Figure 16).



Source: ABS 2012c.

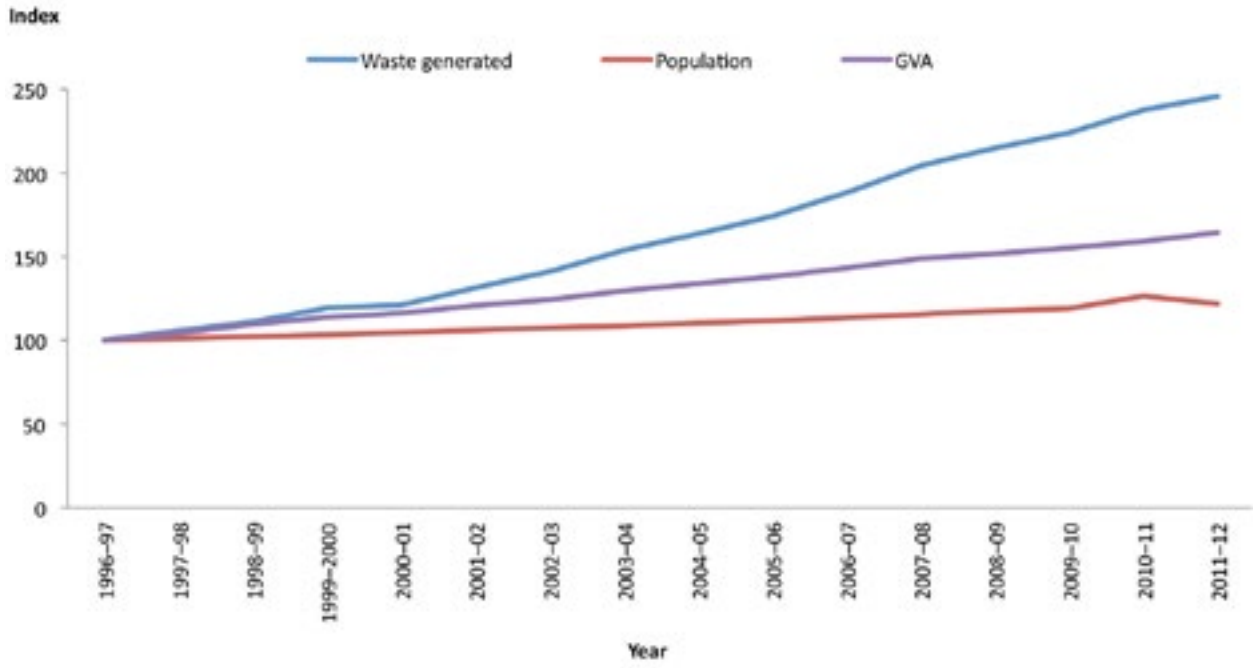
Figure 15. Rateable value of total primary production land use by natural resource management regions, 2012.

Table 9. Waste generated by industry, government, and households by type of waste material, 2009–10, physical supply ('000 tonnes).

	Australian and New Zealand Standard Industrial Classification 2006								Other			
	Agriculture and forestry[1]	Mining[2]	Manufacturing	Electricity, gas, and water services	Waste management services[3]	Construction	Services[4]	Total	General government	Households	Imports	Total
Paper and cardboard	1	2	1,507	34	2	230	1,586	**3,362**	186	2,868	3	**6,419**
Glass	0	0	570	1	0	57	204	**832**	5	585	0	**1,422**
Plastics	2	1	335	8	0	201	246	**793**	8	648	6	**1,454**
Metals	5	44	2,522	49	0	1,124	453	**4,197**	11	439	503	**5,149**
Organics[5]	1,749	1	1,719	4	2	11	3,380	**6,866**	20	5,897	10	**12,794**
Masonry	18	74	298	471	0	14,087	3,695	**18,643**	590	556	0	**19,789**
Electrical and electronic	2	3	35	5	0	26	92	**163**	2	68	0	**233**
Solid hazardous waste	107	91	1,059	69	7	497	1,362	**3,192**	13	278	6	**3,488**
Leather and textiles	3	2	111	2	1	15	137	**271**	4	293	0	**568**
Tyres and other rubber	0	1	60	5	1	30	185	**282**	36	0	3	**321**
Timber and wood products	2	1	56	1	0	157	44	**261**	2	190	10	**464**
Inseparable/unknown	32	46	194	31	1	107	567	**978**	33	601	13	**1,626**
Total	**1,920**	**267**	**8,465**	**680**	**14**	**16,541**	**11,951**	**39,838**	**909**	**12,425**	**554**	**53,726**

[1] Excludes fishing.
[2] Excludes mineral waste.
[3] Includes waste collection, treatment and disposal services (ANZSIC Division D, subdivision 29).
[4] Includes ANZSIC Divisions F-S, excluding subdivision 75.
[5] Excludes timber.

Source: ABS 2013.



GVA = Gross value added
Note: Index calculated as change since 1996–97.
Source: ABS 2013e.

Figure 16. Waste generation, population and gross value added, 1997–2012.

9. Enabling operational environmental accounting

This chapter discusses the requirements and issues to address when designing, implementing and using an environmental accounting production system. It addresses the institutional and organisational issues associated with account production. The chapter includes a section on prioritising environmental accounts for production.

Creating an enabling environment

To further expand environmental accounting activities, a variety of strategic and practical factors need to be considered. There has been increasing awareness about the factors contributing to the successful implementation and use of environmental accounts over two decades in Australia and overseas. There is an accompanying increase in the availability of documents, tools, and procedures that capture these lessons; a prominent example is the suite of materials developed to support the SEEA. This Guide draws on, and points to, the wide range of available resources to support policy makers, scientists, and account practitioners in implementing environmental accounts (see Appendix 1).

Addressing strategic issues

While these resources provide a solid bank of information for account producers to draw upon, the development of accounting programmes must also deal with a range of strategic issues. These issues relate to:

- optimising the institutional setting;
- prioritising accounts for production;
- assessing data quality and access issues;
- ensuring adequate resourcing;
- building technical capacity;
- building expertise for producing and using accounts; and
- ensuring continuous improvement.

Perhaps the most important of these factors in the development and maintenance of environment accounts is the institutional setting. As environmental accounts draw on a wide range of data and disciplines, expertise from a number of different organisations and professions is required to produce and sustain them. This requires high levels of formal cooperation as well as goodwill and understanding between operational staff. It also requires coordination of the overall institutional accounting capacity, such as ensuring an adequate supply of technical skills and suitable accounting infrastructure.

Another key strategic issue is determining which accounts can or should be produced. This issue is especially important as the resources available for accounting are often constrained and knowledge about how accounts can be used by decision makers is not yet widely understood. As such, the identification of information needs, evaluation of data sources, and strategic priority setting are of critical importance.

Similarly, the process used to develop specific accounts and ensure that the information contained in them is relevant and credible requires attention (see Chapter 7 for more on framing a specific account[30]). Important considerations are how to engage account participants and how to ensure data quality.

Finally, there is a need for continuous improvement in environmental accounting skill and methods. A national research agenda needs to be established to produce the advances necessary in this rapidly evolving field. Each of these strategic issues is dissected further and solutions canvassed in the following section.

[30]. Also see the companion to this Guide, the *Environmental account framing workbook*.

Institutional arrangements and coordination

The development of environmental accounting occurs within the context of institutional arrangements and the historical roles and responsibilities of different organisations. It is essential to understand the legal and administrative responsibilities of the organisations producing environmental accounts, and environmental information more broadly. It is common for all levels of government to have responsibilities for environment policy, environmental management, and the production of environmental information.

Coordination mechanisms are needed for the collection of environmental data and production of environmental accounts. Existing mechanisms in Australia are limited at present but do exist, for example, the Council of Australian Governments (COAG). The NPEI initiative is an Australian Government initiative aimed at improving accessibility of environmental information for decision-making. The NPEI will produce more consistent and comprehensive environmental information through the development of common units, definitions and frameworks, as well as the implementation of information access and distribution systems. This will be significant for the future development of environmental accounts.

As part of this initiative, the Australian Government Environmental Information Advisory Group (AG EIAG) published the *Statement of Australian Government requirements for environmental information* (2012). The Statement identifies the Australian Government's enduring and critical requirements for environmental information and provides a framework to enable more detailed priority setting and targeted institutional collaboration. This environmental information framework will support the development of environmental accounting.

Broad strategic issues to be considered include what data should be produced, when it should be produced, and which organisations should be responsible for the collection, integration, and dissemination of environmental information. Practical considerations include issues such as which methods are used to collect and process the data and in what format the data are to be disseminated.

General processes to prioritise accounts

A general process for the production of accounts involves determining needs, reviewing existing accounts and data, prioritising accounts for production, planning for production and, finally, specifying and producing the accounts. The process for framing a specific account outlined in Chapter 7 is complementary to the priority-setting process described here. The *Environmental account framing workbook* can be used to document candidate accounts and add depth to the prioritising process.

Once candidate accounts are identified, a range of criteria are used to assess which environmental accounts should be given priority. Criteria may be based on one or more of the following considerations: environmental domains, issues, mandates, sectors (or industries), policy options or instruments, spatial areas, or ease of production. Ranking the criteria and factors within each stage is necessary for prioritisation. A suggested process and criteria for prioritising accounts is presented in Appendix 4, while other aspects of planning and production of accounts are described in this chapter. Also see Table 3.5 in the SEEA-EEA (European Commission et al. 2013).

Account participants

The participants typically involved in the production and use of environmental accounts are many and varied. The users of particular accounts may be largely unknown. In Australia, the main stakeholders using or potentially using accounts include Australian government agencies, State and

Territory government agencies, local government, research institutions, NRM organisations, some corporations, business associations, non-government organisations, and philanthropic organisations.

Data-sharing

As environmental accounts draw on a large number of data sources, data-sharing and the institutional arrangements for data-sharing are of critical importance. The benefits of data-sharing go beyond enabling the construction of accounts. For data collectors, cost may be eliminated or reduced through the removal of duplicate data collections. It also reduces respondent burden (i.e., data are collected only once and used by multiple agencies). For account users, it reduces the risk of conflicting data being produced.

Sharing of data between organisations can occur in a number of ways, but because of sensitivities about data confidentiality such arrangements may need to be formalised, usually by data-sharing agreements. In some cases, environmental information systems, including publication of data via web services, may be established. Some of the practicalities and legal aspects of accessing and sharing data will be discovered during the identification and review of information sources. A common problem is that some organisations are unwilling or unable to share data, for legal, institutional, or other reasons.

To maintain the trust and confidence of those providing data via surveys or by other means (i.e., the respondents), all producers of environmental accounts need to have procedures in place to prevent the disclosure of private or damaging information (e.g., threatened species' locations or commercially sensitive information).

Resource availability

Understanding the resources available for bringing accounts to an operational status, including across institutions, is critical for planning the production of accounts. Resources needed include staff, information technology, and data. In addition to securing the staff to compile accounts, staff may need new skills or knowledge and so resources for their development are necessary.

Access to appropriate information technology, both hardware and software, is an important aspect of account production. As large datasets are often involved in the compilation of accounts, considerable computing power is required. Statistical software is needed for data manipulation and estimation, while geographic information systems are needed for spatial analysis and presentations.

As it is unlikely that all data required for a particular account or suite of accounts are readily available, provision may need to be made for acquisition of data. This might involve direct purchase or negotiating access to free data.

Data quality assessment for environmental accounts

Ensuring data quality is a primary consideration for any organisation, and the development and use of environment accounts is no different in this regard. A range of tools and procedures has emerged to support high-quality information production and foremost among them has been the development of data quality assessment frameworks and procedures for describing metadata.

Assessing data quality is essential because it provides account users with general confidence in the process used to produce the accounts as well as specific information necessary to judge the suitability of the account for particular purposes. Data quality is usually described using a suite of

dimensions (outlined below and described further in Chapter 10). Metadata are the information about a set of data in terms of the concepts, sources, as well as the methods used to collect, compile, and disseminate statistics. Metadata are also applied to spatial data to describe aspects such as accuracy, lineage, and scale to enable users to determine its fitness-for-purpose.

Metadata are of benefit to data users as well as account producers. Knowledge gained from generating metadata may lead to enhancements in both account production (e.g., lower costs and improved data quality) and account dissemination (e.g., comprehensive, timely, accessible, and reliable data). Metadata also enables comparison between the account-compiling practices of different agencies and jurisdictions. This may encourage consistent standards, and for the best practices of account compilation to be identified, adopted, and implemented.

Building technical capacity for environmental account production

A range of skills, knowledge, and information technology infrastructure are needed to produce accounts. These cover a diverse range of specialists in various disciplines (including scientists, accountants, statisticians, and economists) and broad domains of knowledge (e.g., land, inland water, marine, atmosphere, biodiversity, human settlements).

A range of material is available to build knowledge of accounts and statistical processes. A useful starting point for understanding the underlying processes is the General Statistics Business Processing Model used by the ABS and internationally by other statistical agencies (UNECE Secretariat 2009). It describes in detail the stages and steps of producing an account.

For environmental accounts, a range of materials has been developed internationally to assist with the implementation and use of environmental accounting by agencies such as the UNSD, Eurostat and OECD (see Appendix 1 in the Guide).

In Australia, the ABS (2012b) publication *Australian System of National Accounts: concepts, sources and methods* covers aspects of environmental accounting (for the natural resources on the balance sheet as well as energy and water). In addition to the reference material, training courses or seminars are regularly run by Eurostat and irregularly by the United Nations. As part of the World Bank's WAVES programme and the United Nations SEEA implementation plan, a range of additional materials and courses are planned.

Technical models for account production

Models are frequently used for estimating some of the parameters in environmental accounting. These models can be in the form of a simple statistical estimation of a total from a sample, through to complex models estimating hydrological parameters, flows from ecosystems, or the condition of assets. EnSym, a model developed by the Victorian Department of Environment and Primary Industries, is one example, while internationally there is the Integrated Valuation of Environmental Services and Tradeoffs (InVEST) (Kareiva et al. 2011) and Artificial Intelligence for Ecosystem Services (ARIES) (Villa et al. 2009). Developing the capacity to review and apply existing models and develop new models is an area for capacity development. It is vital that the technical models selected for the account are consistent with the conceptual model and evidence base developed while framing the account (see Module 4 in Chapter 7).

Increasing use and understanding of environmental accounts

If environmental accounts are to be incorporated into decision making, then a greater level of understanding of the accounts is needed, both within and outside of Australian Government. Accounts have been used as the basis of government reporting against the UNFCCC and the ABS has produced two publications *Completing the picture: environmental accounting in practice* (ABS 2012a) and *Towards the Australian environmental-economic accounts* (ABS 2013b) which point to potential policy uses of environmental accounting.

Building technical capacity in the users of environmental accounting is less well developed than the production side of accounting; however, a range of materials is available, including the newly completed SEEA-AE, the OECD's *Green growth indicators* (which includes the use of accounts) and the World Bank's *Beyond GDP*, as well as ABS publications.

Some academic research into how the accounts have been or could be used is in evidence (Vardon et al. 2007; Godfrey and Charmers 2012; Lenzen et al. 2012; Ajani et al. 2013; Edens and Heins 2013); however, this will need to be extended if the accounts are to gain acceptance as a decision-making tool.

Central to increasing the use and understanding of environmental accounts is developing ways to better communicate information contained within them. Developing summary presentations and indicators, for example, is an area for further research and development.

Research for continuous improvement of environmental accounts

A large part of environmental accounting has been standardised in terms of concepts and there is a body of material describing best practice for estimating parameters for producing accounts. Yet continuing research into the concepts, data sources, and methods is needed to improve the accounts and demonstrate their use in decision-making. Within this, ways to improve the quality of the accounts and efficiency of their production are sought.

It is useful to separate the research needed to support the wider implementation of the standardised accounts of the SEEA-CF from the development and standardisation of SEEA-EEA, and how the accounts can be applied to decision-making, particularly in Government.

Internationally, research agendas have been developed for both the SEEA-CF and SEEA-EEA. The research agendas overlap with the plan for global implementation of the SEEA, which aims to develop materials, including methodologies, to assist with the compilation of accounts. The application of accounts to decision-making in an international context is a separate line of investigation and work by the World Bank's WAVES initiative.

Research into accounts has been undertaken within the Australian Government through the ABS, the Bureau and former Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education. The Victorian Government and SEQ Catchments have also been involved in research, as have academics from the Australian National University, University of Queensland and the Wentworth Group of Concerned Scientists. Much of the research and experience from Australia has fed the development of the SEEA.

There are four general areas of research for the production of accounts nationally in Australia:

1. Development of methodologies to fit existing data to accounting concepts, including linking physical environmental data to economic data, the valuation of physical stocks and flows, the development of models for the estimation of data, and the refinement of the units model.

2. Further articulation and testing of the concepts for ecosystem accounting, including ecosystem flows, inter- and intra-ecosystem flows, ecosystem services, ecosystem assets, ecosystem condition, and the relationships between ecosystem flows, services, and asset condition.

3. Identifying the gaps and deficiencies in current data sources and determining the most cost-effective ways to correct this. This would include finding suitable proxies for important characteristics that at present are not directly measurable, and the possible development of indices to measure, for example, the condition of particular areas or assets.

4. Developing and testing different ways to present the accounts, including the development of combined and summary presentations and indicators.

These areas of research may initially be directed towards specific themes such as carbon or biodiversity accounts, as these are the least developed of the specific accounts proposed in the SEEA-EEA. Further to producing accounts, research may be undertaken into how the accounts can be applied to policy analysis and government decision-making.

10. Standards and assurance

This chapter explains the role and value of standards in environmental accounting and presents a typology of standards. Links are made to data quality frameworks and the assurance of accounts. The chapter sets out procedures for identifying existing standards and developing new accounting standards.

Standards to support environmental accounting

Using standards allows for consistent and comparable environmental accounts. They also provide assurance that the accounts are produced using best practice for the collection and reporting of data.

Standards can be applied to all steps of an environmental account, from raw data capture through to the compiling of data into an environmental accounting framework and publishing the information with a data quality assurance statement. Standards can range from legislated requirements to best practice guidelines. There are a vast number of standards and guidelines that can be applied to the production of environmental accounts to ensure credible, reliable and consistent outputs.

What are standards?

According to Standards Australia (2013a), standards are 'published documents setting out specifications and procedures designed to ensure products, services, and systems are safe, reliable, and consistently perform the way they were intended to. They establish a common language which defines quality and safety criteria'. For environmental accounting, standards provide rigour and consistency to the process, resulting in more credible accounts that are able to be compared through time and across different locations. Standards may or may not be legislated requirements, but to be effective they must be well-documented, recognised as industry or community best-practice, and be integrated with normal business practice.

Types of standards

Standards can exist in various formats, such as a published international or Australian standard, guidelines, or community best-practice. Standards can be formalised through endorsement and accreditation processes such as the Bureau's Water Information Standards endorsement process. Other informal (or de facto) standards exist where they are widely used by domain expertise but not necessarily published as a standard.

Typology of standards to support environmental accounting

To make sense of the hundreds of standards available, a typology of standards that support the production of an environmental account has been developed and is represented in Figure 17. Following that is a brief description of each type, or theme, of standard.

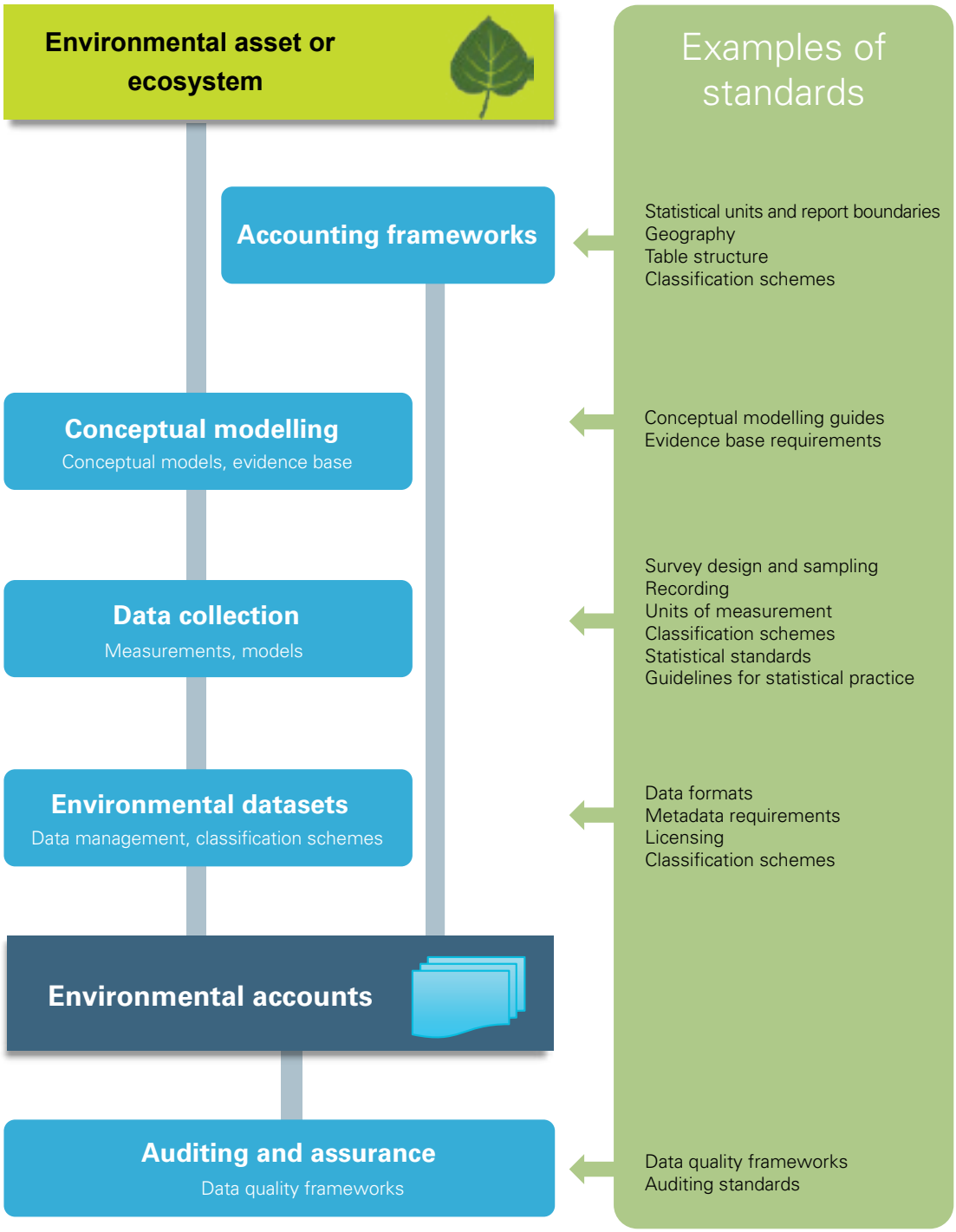


Figure 17. Typology of standards to support the production of environmental accounts.

Accounting frameworks

The accounting frameworks theme covers selection and documentation of an accounting framework for the account. The SEEA-CF has been endorsed as an international standard, including by the Australian Government, and is the pre-eminent standard for environmental accounting purposes in Australia. The Bureau has released the Australian Water Accounting Standard 1 for voluntary adoption. There are also environmental accounting approaches and concepts that can be applied which are not yet published standards, in particular the SEEA-EEA.

Account statistical units and reports

A key component of the accounting framework is the identification of account statistical units about which information is collected. The appropriate unit depends on the topic being observed and the spatial and temporal scales at which it is required. The available accounting framework standards, such as the SNA and the SEEA, provide guidance on the choice of units. For ecosystem accounting, the SEEA-EEA provides a sound basis for unit selection. For spatially-based units, the ABS Australian Statistical Geography Standard and the ANZLIC National Nested Grid are relevant.

Account reports are generated based on information that is aggregated and analysed. Standard definitions of reports will help ensure consistency and comparability over time. Classes that are useful for reports may be spatial, such as administrative (e.g., jurisdictions or NRM regions) or landscape-based (e.g., catchments) or some other type of region relevant to the account subject. They also may be aspatial, such as economic statistical units (businesses, households) or industry sectors.

Classification schemes

Classification schemes allow thematic data to be attributed in a consistent way. Similar to data collection standards, there are many classification schemes available but the extent to which they are developed depends on the topic of interest. Some classification schemes are recognised international standards, such as the United Nations Food and Agriculture Organization Land Cover Classification Scheme. Many other national classification schemes are agreed to by a committee of domain experts such as the Australian National Aquatic Ecosystem Classification, which was developed by the Aquatic Ecosystems Task Group and endorsed by the Standing Council on Environment and Water, and the National Vegetation Information System, developed by the Executive Standing Committee for Australian Vegetation Information. Of relevance to environmental accounting is the development of the Common International Classification of Ecosystem Services (CICES), which is being led by the European Environment Agency and the UNSD.

Classification schemes are important in accounting as they affect the way that data are aggregated and reported, and can allow for data to be integrated with other information. For accounting purposes, classes should be designed to be mutually exclusive and collectively exhaustive so that items are not double-counted or omitted. Standard classification schemes may need to be developed for environmental accounting purposes depending on the topic.

Conceptual models and evidence base

The conceptual models and evidence base theme refers to the analysis and documentation of the current understanding of the account subject (i.e., topic or phenomenon of interest). Standards and guidelines for conceptual modelling are developing and peer-reviewed scientific literature is also relevant. The evidence base supports the current understanding of the account subject and provides assurance that the account is well founded.

Independent certification or endorsement of the conceptual model and evidence base will strengthen the credibility and legitimacy of the account. See Module 4 in Chapter 7 for more detail. This is particularly important for environmental accounting, as standard weights and measures of ecosystem functioning, among others, are still emerging.

Data collection

The data collection theme covers field observations, measurement standards, model results, and survey/sampling design. Depending on the topic of interest, there are numerous standards relating to data collection, in particular instruments, observations, and measurements (e.g., water quality, meteorological observations, and air quality). Some topics are likely to have many standards (e.g., there are 12 standards registered with Standards Australia relating to water quality) while others (such as vegetation condition) do not have recognised standards, although there is much work by domain experts that is relevant.

Environmental data

Standards relating to environmental data include data management and licensing.

Data management covers standards for managing, storing, and disseminating data. There are a number of standards both internationally and nationally for data management, particularly for spatial data management. In Australia, the ANZLIC—Spatial Information Council (2007) Metadata Profile provides guidance on creating metadata for geographic information that conforms to the international metadata standard ISO 19115. International groups such as the Open Geospatial Consortium deliver standards to allow data to be managed and made accessible to a wide range of users. This theme is well-covered in terms of standards, and it is widely recognised that to maximise benefits, aspatial and spatial data should be managed in a way that allows users to find, use, and understand whether data are fit-for-purpose.

Access to data is fundamental to enabling the production of environmental accounts. Open-access licensing such as Creative Commons provides standard terms and conditions for the use of data.

Auditing and assurance

The auditing and assurance theme covers the standards that relate to the auditing or assurance of the accounts and the accounting process, including by independent parties. While there is limited information on standards for auditing and assurance specifically for environmental accounting, there is a major body of standards that relates to auditing and assurance more generally that is readily applied to environmental accounting. The Australian Assurance and Auditing Standards Board and, internationally, the International Organization of Supreme Audit Institutions produce guidelines and standards related to independent assurance assessments. Of particular relevance are standards for compliance and performance assurance assessments. Compliance auditing is conducted when there is a specific standard to test against, and performance auditing is for the purpose of determining effective or efficient performance of an activity, particularly when there are no standards against which to test. Environmental accounts should be designed to enable auditing to be conducted by identifying, documenting, and implementing the other themes in this chapter including conceptual models, standards, evidence bases, certification of processes, and quality assurance frameworks.

In addition to auditing by an independent party, governance and accountability for public sector organisations is described by the Australian Council of Auditors General. The Council has published principles and guidelines for effective public sector accountability that is relevant to environmental accounting. They cover elements of good governance, identifying the participants and their roles and responsibilities. Care needs to be exercised in navigating privacy and disclosure obligations with data providers (e.g., survey respondents).

Quality assurance frameworks

Quality assurance frameworks relate to the quality of the overall processes for producing data, statistics, and accounts. There are many frameworks and approaches for quality assurance of statistics that could be adapted for environmental accounting. They include the ABS Data Quality Framework (ABS 2011b), Quality Framework and Guidelines for OECD Statistical Activities (OECD 2011), and Statistics Canada (2002) Data Quality Assurance Framework, among others. The frameworks cover similar aspects of data quality:

- institutional environment (legitimacy);
- relevance;
- accuracy;
- timeliness;
- accessibility;
- interpretability; and
- coherence.

The institutional environment aspect refers to the organisation or institution producing the statistics and tests whether they produces information that is objective, transparent, and impartial. It covers issues such as the mandate for collecting data, and adequate resourcing to produce a quality output, and allows for an assessment of the credibility of the information.

Relevance is the degree to which the information meets user needs. Factors to consider include the scope and coverage of the information, the scale (e.g., national or regional), reference period, and the extent to which classifications capture the topic of interest.

Accuracy is the degree to which the data replicate the actual values and is often assessed in terms of error, such as sampling, coverage, or processing errors.

Timeliness refers to the length of time between the release of the information and the event that is being described (the reference period).

Accessibility is a measure of how easily the data can be obtained and includes considerations such as the format of the data, how it can be located, price, availability of metadata, and licence conditions.

Interpretability is the degree to which users can understand and interpret the data. Supporting documentation describing concepts and methodology and the use of clear terms can ensure the data can be interpreted and analysed.

Coherence refers to the consistency of data within and across datasets and over time. The use of standard classification schemes, methodologies, and concepts supports coherence as it allows data to be compared and combined with other data sources, as well as providing internal consistency. It also allows for data to be compared over time. Coherence means that data are reconcilable and if the data are not consistent, the differences can be explained.

Developing new standards

In some circumstances, it is appropriate to develop a new standard. This process depends on the type and requirements of the standard, its stakeholders, and the subject matter involved. These factors will influence the time and resources required to take a standard from an identified need through to adoption and implementation.

As an example, the process (and funds) needed for developing a new legislative reporting requirement across States and Territories will be very different to those needed for developing a standardised classification scheme within a community-of-practice. Appendix 5 explores broad phases and considerations for developing a standard that may apply in some, but not all, cases.

Conclusion

Environmental accounting provides a powerful way to factor Australia's unique natural estate, and its immense contribution to well-being, into policy and decision-making. The *Guide to environmental accounting in Australia* describes the environmental accounting process and sets out directions for implementation.

To be effective, environmental accounts need to have the fundamental characteristics of relevance, credibility, and legitimacy and must provide information about the environment and its relationship to human well-being. They should be based on best available scientific knowledge and enable tracking of value through time, across space, and between entities. Importantly, value can be measured using monetary or non-monetary methods.

The conceptual basis for environmental accounting set out in this Guide takes a systems approach that nests the economic system within the human cultural system, which is in turn nested within the living and physical Earth systems. This basis provides a model for viewing a transaction from a number of perspectives, which can then be considered when framing an account.

The SEEA is a powerful and flexible accounting framework that meets the needs of Australia's environmental policy makers and managers. It provides a framework for integrated environmental and ecosystem accounting.

These principles, conceptual basis, and accounting framework underpin the environmental accounting process described in the Guide. Modules are presented that address aspects of account production such as user needs, data requirements, scope, and relevant standards. The process will aid the production of environmental accounts that are relevant and credible. Given the wide range of expertise needed for environmental account production, it needs to be supported by cooperative institutional arrangements. These include technical capability, access to data, skills training, and resources.

In producing this Guide, the Bureau is aiming to improve decision-making about Australia's natural capital through the delivery of environmental accounts that allow for tracking ecosystem change and understanding the reasons for change. Existing work provides a foundation which can be systematically built upon to achieve this aim, and the Bureau is working with key partners including Australian Government agencies, including the Department of the Environment, ABS, and the Murray–Darling Basin Authority, regional NRM organisations, and the research sector, to develop environmental accounts that meet policy and decision-making needs.

Part C: Environmental accounting technical reference (Appendices)

Part C of the Guide provides technical reference material to support the purpose, concepts, and fundamentals of environmental accounting described in parts A and B. It covers:

- Environmental accounting frameworks (Appendix 1)
- Structure (typology) of SEEA environmental accounts (Appendix 2)
- Shared social values (Appendix 3)
- A general process to prioritise accounts (Appendix 4)
- Developing a standard (Appendix 5).

Appendix 1. Environmental accounting frameworks

Established accounting frameworks

Table 10. Summary of selected accounting frameworks.

Framework and custodian	Summary
Integrated Environmental and Economic Accounting for Fisheries (United Nations Food and Agriculture Organization)	This handbook provides a common framework for organising economic and environmental information related to fisheries, permitting the monitoring of the economic importance of fisheries, improvement of management and estimation of the full costs and benefits. unstats.un.org/unsd/envaccounting/Fish_final_whitecover.pdf
Australia's National Greenhouse Accounts (Department of the Environment)	Australia's National Greenhouse Accounts provide an accounting and forecasting system for human-induced sources and sinks of greenhouse gas emissions from Australian land-based activities. www.climatechange.gov.au/climate-change/greenhouse-gas-measurement-and-reporting/tracking-australias-greenhouse-gas-emissions
Water Accounting Conceptual Framework (Bureau of Meteorology)	The Water Accounting Conceptual Framework provides guidance on the development of Australian Water Accounting Standards to ensure they remain cohesive and integrated. It has been written in consultation with water industry experts, financial accountants, and financial accounting standard setters. www.bom.gov.au/water/standards/wasb/wacf.shtml
System of Environmental-Economic Accounting (UNSD)	The SEEA framework provides standard concepts, definitions, classifications, accounting rules and tables for producing and organising statistics on the environment and economy. It follows a similar accounting structure to the SNA. unstats.un.org/unsd/envaccounting/seea.asp (general) unstats.un.org/unsd/envaccounting/SEEA-Brochure-SC-2013.pdf (briefing note)
System of Environmental-Economic Accounting for Energy (UNSD)	SEEA-Energy is a SEEA sub-system that is under development to provide agreed concepts, definitions, classifications, tables, and accounts for energy and energy-related air emission accounts. unstats.un.org/unsd/envaccounting/seeae/

Framework and custodian	Summary
System of Environmental-Economic Accounting for Water (UNSD)	SEEA-Water is a SEEA sub-system that provides agreed concepts, definitions, classifications, tables, and accounts for water and water-related emission accounts. unstats.un.org/unsd/envaccounting/seeaw (general) unstats.un.org/unsd/envaccounting/WWAP_UNSD_WaterMF.pdf (briefing note)
System of Environmental-Economic Accounting—Applications and Extensions (UNSD)	The SEEA-AE is a companion compendium of analyses and presentations for the SEEA-CF and SEEA-EEA volumes. unstats.un.org/unsd/envaccounting/SEEA-Brochure-SC-2013.pdf
System of Environmental-Economic Accounting—Central Framework (UNSD)	The SEEA-CF is a multi-purpose conceptual framework for understanding interactions between the economy and environment, and for describing stocks and changes in stocks of environmental assets. It was adopted in 2012 as the first international standard for environmental–economic accounting. unstats.un.org/unsd/envaccounting/White_cover.pdf
System of Environmental-Economic Accounting—Experimental Ecosystem Accounting (UNSD)	The SEEA-EEA is an integrated statistical framework for organising biophysical data, measuring ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity. It provides a complementary perspective to the SEEA-CF but does not have the status of an international statistical standard. unstats.un.org/unsd/envaccounting/eea_white_cover.pdf (general) unstats.un.org/unsd/envaccounting/workshops/int_seminar/note.pdf (briefing note)
System of National Accounts (UNSD)	The SNA is an internationally agreed standard that defines the key economic processes of production, consumption, and accumulation, and guides the measurement of the production of goods and services in monetary terms. unstats.un.org/unsd/nationalaccount/sna.asp

Other frameworks and activities

Table 11. Summary of other related frameworks and activities.

Framework, activity and custodian	Summary
Common International Classification of Ecosystem Services (CICES)	The idea of a common international classification is important, because if ecosystem accounting methods are to be developed and comparisons made, then some standardisation in the way we describe ecosystem services is needed. Standardisation is especially important where the link to economic accounting is to be made. cices.eu
Ecological Footprint (Global Footprint Network)	The Ecological Footprint tracks how much land and water area a human population uses to provide all it takes from nature. It documents how much biologically productive area is available to provide these services. www.footprintnetwork.org
Economy-wide material flow accounts (European Commission)	Economy-wide material flow accounts provide a framework for compiling statistics linking flows of materials from natural resources to a national economy. epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/publications/economy_wide_material_flow_accounts
Environmental expenditure statistics: general government and specialised producers data collection handbook (European Commission)	This data collection handbook was developed to further the harmonisation of environmental expenditures for the public sector and for specialised producers. epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/KS-RA-07-012-EN.pdf
Environmental goods and services sector: data collection handbook (European Commission)	The *Environmental goods and services sector data collection handbook* is a reference tool for developing a data collection system on the environmental goods and services sector at national level. It aims to facilitate the development and production of harmonised and comparable data. epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-09-012

Framework, activity and custodian	Summary
Environmental taxes: statistical guide (European Commission)	This publication presents guidelines for compiling statistics on environmental taxes, including definitions and concepts, data sources and estimation methods. The guidelines are based on a harmonised statistical framework developed in 1997 by Eurostat, the European Commission, OECD, and International Energy Agency. epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/2.pdf
Fairfax Lateral Economics Wellbeing Index (Fairfax Media)	The Fairfax Lateral Economics Wellbeing Index was developed to produce a measure of progress that addressed the inadequacy of GDP. It encompasses nine economic and non-economic dimensions, with results reported quarterly. www.theage.com.au/national/wellbeing
Framework for the Development of Environment Statistics (UNSD)	The FDES 2013 is a multi-purpose conceptual and statistical framework that is comprehensive and integrative in nature and marks out the scope of environment statistics. It provides an organising structure to guide the collection and compilation of environment statistics at the national level. unstats.un.org/unsd/environment/fdes.htm
Global Reporting Initiative	The Global Reporting Initiative is a non-profit organisation which aims to make sustainability reporting standard practice for all organisations. The initiative has developed the Sustainability Reporting Framework to assist organisations to report on their economic, environmental and social sustainability. www.globalreporting.org
Guide to corporate ecosystem valuation (World Business Council for Sustainable Development)	The *Guide to corporate ecosystem valuation* provides a framework for improving corporate decision-making through valuing ecosystem services, and resources to navigate through related jargon and techniques. www.wbcsd.org/work-program/ecosystems/cev.aspx
International Recommendations for Energy Statistics (UNSD)	The International Recommendations for Energy Statistics provide standards and guidance on concepts, definitions, classifications, data sources, and methods related to energy statistics. unstats.un.org/unsd/statcom/doc11/BG-IRES.pdf

Framework, activity and custodian	Summary
International Recommendations for Water Statistics (UNSD)	The International Recommendations for Water Statistics provide coherent principles, concepts and definitions for the collection and compilation of water statistics on a comparable basis. unstats.un.org/unsd/envaccounting/irws/irwswebversion.pdf
Manual for air emissions accounts (European Commission)	This manual describes the methodologies and procedures for compiling air emissions accounts in the European Statistical System. epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-09-004
Measures of Australia's Progress (ABS)	Measures of Australia's Progress is designed to help address the question, 'Is life in Australia getting better?' Statistical measures to answer this question and demonstrate change are grouped under three broad headings: society, economy, and environment. www.abs.gov.au/ausstats/abs@.nsf/mf/1370.0.55.001
Measuring Sustainability Program (Department of the Environment)	The Australian Government has developed a set of sustainability indicators that provide information about Australia's social and human, natural, and economic capital. www.environment.gov.au/sustainability/measuring/indicators/index.html
OECD Better Life Index (OECD)	The OECD Better Life Index is an interactive tool that shows how OECD countries perform on 11 topics (e.g., housing, income, health, education, and environment) that contribute to a better life. www.oecd.org/statistics/betterlifeinitiativemeasuringwell-beingandprogress.htm
The Economics of Ecosystems and Biodiversity (TEEB)	TEEB is a global initiative that draws attention to the economic benefits and values of ecosystems and biodiversity. www.teebweb.org
Triple bottom line reporting	Triple bottom line refers to reporting on the economic, environmental, and social aspects of a business or organisation with the aim of assessing and communicating progress towards sustainability. There are no agreed standards for triple bottom line reporting; however, there are frameworks and guidelines that can be applied.

Framework, activity and custodian	Summary
Wealth Accounting and the Valuation of Ecosystem Services (WAVES)	WAVES is a global partnership to promote sustainable development by ensuring that the national accounts used to measure and plan for economic growth include the value of natural resources. www.wavespartnership.org/waves
Wellbeing framework (Australian Treasury)	A well-being framework is part of Treasury's Strategic Framework document and provides guidance on incorporating the elements of well-being into policy decisions. www.treasury.gov.au/About-Treasury/OurDepartment/Treasury-Strategic-Framework

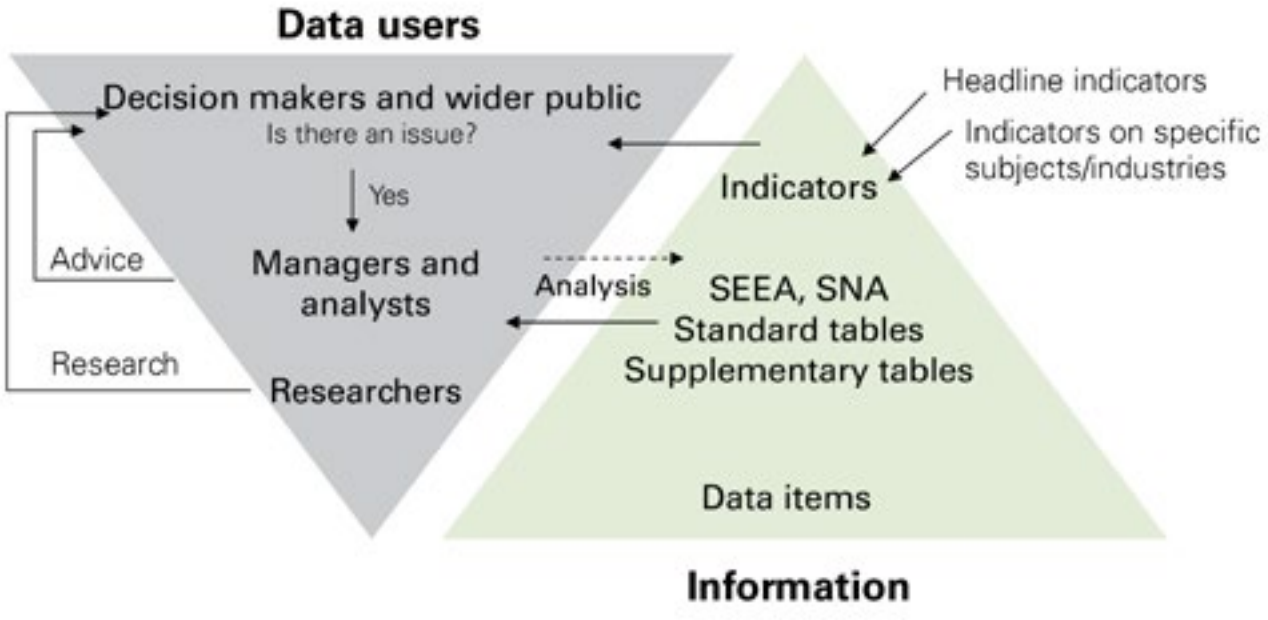
Appendix 2. Structure (typology) of SEEA environmental accounts

SEEA account structures are closely aligned with those of the SNA and this supports the ready linking of accounts. Figure 18 illustrates the basic elements of the information pyramid (in green) in relation to the inverted data users pyramid (in grey) as conceived by the ABS. In essence, there are many more users of the highly developed indicators and more specialised users of the underlying body of raw, supporting data.

The following listing presents the basic components of SEEA accounts and can be considered as a basic typology of accounts and account outputs (presentations and analyses).

Structuring of accounts

1. Data containing relevant information are organised into accounts in the form of accounting tables (standard and supplementary).
2. The units for the measures and estimates can be monetary and non-monetary (physical).
3. All accounts are based on the core concepts of stocks and flows.
    a. Stocks are the holdings of assets and liabilities at a point in time. In environmental accounts, stock is the amount of an environmental or ecosystem asset that at a particular time has the capacity to produce environmental or ecosystem goods or services.
    b. Flows are changes in the volume, composition, or value of stocks. In ecosystem accounts, flows are the intra- and inter-ecosystem flows and the goods, services, and benefits derived from the environment and the flow of residuals (waste) to the environment.



(Acknowledgement: ABS)

Figure 18. Basic structures and language associated with SEEA and SNA accounts.

4. Account variants include SNA and SEEA, and trade (export/import accounts).

5. The boundaries for the SNA are:

    a. territorial boundary (i.e. for Australia);

    b. production boundary;

    c. consumption boundary; and

    d. asset boundary.

6. Assumptions are made regarding substitutability between asset types.

7. Monetary valuation must distinguish between social (e.g., willingness to pay, welfare) and non-social (market price) valuation methods.

Application of accounts: analysis and output typology[31]

Application of accounts

Once in account format, the tables can be applied:

1. through analysis (including via matrix mathematical manipulation);

2. to produce analytical outputs or identities (such as supply and use tables and input–output tables);

3. from which indicators can be extracted, aggregated and weighted (e.g., energy intensity observed for various industries); and

4. for presentation at national, industry, and institutional (including government) sector levels or by environmental activity or by product or asset type or spatially (regional, jurisdictional).

Types of analysis

1. sustainable resource use and environmental efficiency;

2. production, employment, and expenditure relating to environmental activities;

3. environmental taxes and environmental subsidies and similar transfers; and

4. environmental assets, net wealth, income, and depletion of resources:

    a. environmental assets in physical terms (non-monetary)

    b. environmental assets in terms of wealth and incomes (monetary).

Types of analytical outputs

1. supply and use tables:

    a. monetary supply and use table

    b. physical supply and use table; and

2. input–output tables:

    a. environmentally extended input–output table

    b. hybrid input–output table

    c. single and multi-region input–output table.

[31]. Drawn from the SEEA-AE (European Commission et al. 2013b).

Types of indicators (based on analyses and purpose)

Example 1: Resource use and efficiency indicators:

1. Indicators can be expressions of intensity, productivity, decoupling ratios, decoupling factors, volume (adjusted for inflation).
2. Indicator types: Environmental efficiency indicators and resource use efficiency indicators; production or consumption-based. For example:
    a. environmental efficiency indicators:
        i. greenhouse gas production
        ii. air pollutant emission intensities
        iii. water pollution intensity
        iv. nutrient surplus intensity
        v. waste generation intensity
        vi. energy intensity;
    b. resource use efficiency indicators:
        i. material productivity or intensity
        ii. energy productivity or intensity
        iii. water use or intensity; and
    c. production or consumption-based indicators:
        i. production indicators:
            - track environmental flows related to the production process.
        ii. consumption indicators:
            - induced by final demand
            - track environmental flows with the rest of world (imports and exports) (via multi-regional input–output tables or bilateral trade agreements)
            - examples: consumption-based carbon and greenhouse gas indicators (similar to carbon and water footprints)
            - expected resource life.

Example 2: Environmental assets, net wealth, income and depletion of resources indicators:

1. GDP adjusted for depletion of environmental assets.

Types of presentations:

1. tabular;
2. charts;
3. maps (e.g. spatial representation of land accounts through maps);
4. time-series; and
5. combined (physical and monetary).

Appendix 3. Shared social values

The following is an extract from the United Kingdom's *National Ecosystem Assessment technical report* (Chapter 24) (Fish et al. 2011). It presents a rationale for identifying the shared value of ecosystem services:

> Ecosystem assessment requires a consideration of shared values. Valuing the contribution that ecosystem services make to human well-being cannot be reduced to individual preferences and motivations alone. Ecosystem services have collective meaning and significance. Whether individuals choose to regard themselves as isolated beings driven to satisfy their own needs and desires before taking account of others' needs, or whether they see themselves as wanting to moderate their rights to maximise their own satisfaction because they have shared responsibility for collective well-being, is a matter of context and philosophical perspective.
>
> Shared values concern the values people hold for ecosystem services as 'citizens'; that is as 'social beings' capable of expressing preferences for ecosystem services not simply in terms of individual costs and benefits, but in terms of social rights and wrongs. An important dimension of shared values is, therefore, consideration of the ethical arrangements which guide society's concern for nature, place, and landscape, and includes issues of altruism and existence value, as well as aesthetic considerations.
>
> The reliability and legitimacy of decision-making processes that flow from ecosystem assessment depends on the explicit recognition of shared values. This is particularly the case when trade-offs have to be made between utilitarian, ethical, and aesthetic dimensions of change. In order to ensure public trust and confidence when reaching difficult decisions, decision makers need to be able to demonstrate knowledge and understanding of the shared values individuals and social groups attribute to their interactions with the natural world.
>
> Consideration of shared values within ecosystem assessment and decision-making requires a more interpretative approach to valuation. The primary focus is on qualitative expressions of value for ecosystem services. Evidence for these values may be explored textually, such as through the interpretation of documents and media, but also via group discussion, learning, and deliberation. As such, there is a natural overlap between these techniques and non-monetary forms of valuation. However, the use of deliberation within decision-making can also be used to link social values to quantitative and monetary valuation techniques. The key techniques are 'deliberative monetary valuation' and 'participatory multi-criteria analysis'.
>
> There is an overall need for theoretical and methodological plurality in how we assess the value of ecosystem services for human well-being. Just as there are quite different grounds on which judgments of value can be communicated and inferred for ecosystem services, so too are there many different ways in which values can be formally recorded and assigned significance. Both individual and collective values have validity in their own right to ecosystem assessment and corresponding processes of decision-making. Hybrid valuation techniques, such as deliberative monetary valuation and participatory multi-criteria analysis, hold much promise for systematic and integrated treatment of utilitarian, ethical and aesthetic considerations, although they remain at an experimental stage.

Appendix 4. A general process to prioritise accounts

Introduction

Inevitably, the number of accounts that may be produced will be limited by resources. The modular nature of the account format lends itself to gradual implementation and hence growth over time in the range of accounts produced. Deciding which accounts to produce first can be a daunting task given the large number of possible accounts and the variety of criteria that could be used for prioritisation. While recognising resource constraints and the need for prioritisation of accounts, the long-term aim should be to provide a comprehensive set of accounts to meet the changing needs of decision makers and to enable tracking of change over time.

A general process for the production of accounts, including prioritisation between accounts, involves five stages. The stages are listed below and illustrated in more detail in Figure 19. The general stages of the process are:

1. determine needs;
2. review existing accounts and data;
3. prioritise accounts for production;
4. plan for production; and
5. specify and produce accounts.

The first two stages can begin to be addressed using the account scoping step outlined in Chapter 7 and described in detail in the associated *Environmental account framing workbook*. The initial account scoping should contain some suggestions or options about the accounts to be produced. This will necessarily require an assessment of the likely resources available for implementation and the results of the first two stages directly feed into Stage 3.

Stage 3 is to prioritise accounts for production and is the main focus of this appendix. The prioritisation process is explained in detail in the following sections; also see Table 3.5 in the SEEA-EEA (European Commission et al. 2013).

Based on the prioritisation undertaken in Stage 3, the final two stages can be completed. Assistance for these stages can be found in the account specification process described in Chapter 7 (and in the associated *Environmental account framing workbook*). Strategic aspects of planning and producing operational accounts are outlined in Chapter 9.

Prioritisation criteria

Identifying priorities for account production requires an assessment of multiple factors or criteria. A wide range of criteria can be used to prioritise the accounts to be produced and a selection of these is summarised in Table 12. The criteria are not exclusive and indeed one of the objectives is to see which accounts can meet multiple criteria. For example, carbon dioxide emissions accounts could be selected with several criteria including: by domain (atmosphere); by issue (climate change); by mandate (reporting to the International Panel on Climate Change; by industry (energy producers); and by policy options (e.g., cap and trade, taxes).

Table 12. Criteria for prioritising accounts.

Criteria for prioritisation	Examples	Example of links to accounts
Domain	land, inland waters, marine, atmosphere, human settlements, biodiversity	possible accounts (e.g., water, energy, land, environment protection expenditure)
Issues	green growth, climate change, sustainable development, biodiversity conservation	for climate change energy, carbon dioxide emissions, carbon and taxes and subsidies
Mandates	international reporting obligations, national obligations, e.g., see *Statement of Australian Government requirements for environmental information* (AG EIAG 2012)	carbon dioxide emissions reporting under the UNFCCC
Sector or industry	households, industry, environmental goods and services sector	water and waste accounts by sector
Policy options or instruments	polluter pays, beneficiary pays, cap and trade	taxes and subsidies, payments for ecosystem services, environmental protection expenditure
Spatial areas	particular environmental or ecosystem assets	Murray–Darling Basin, Great Barrier Reef, forests, urban areas
Ease of production	data availability and technical capacity	for land accounts, availability of data on vegetation cover and the human and technical resources needed to process this into accounts

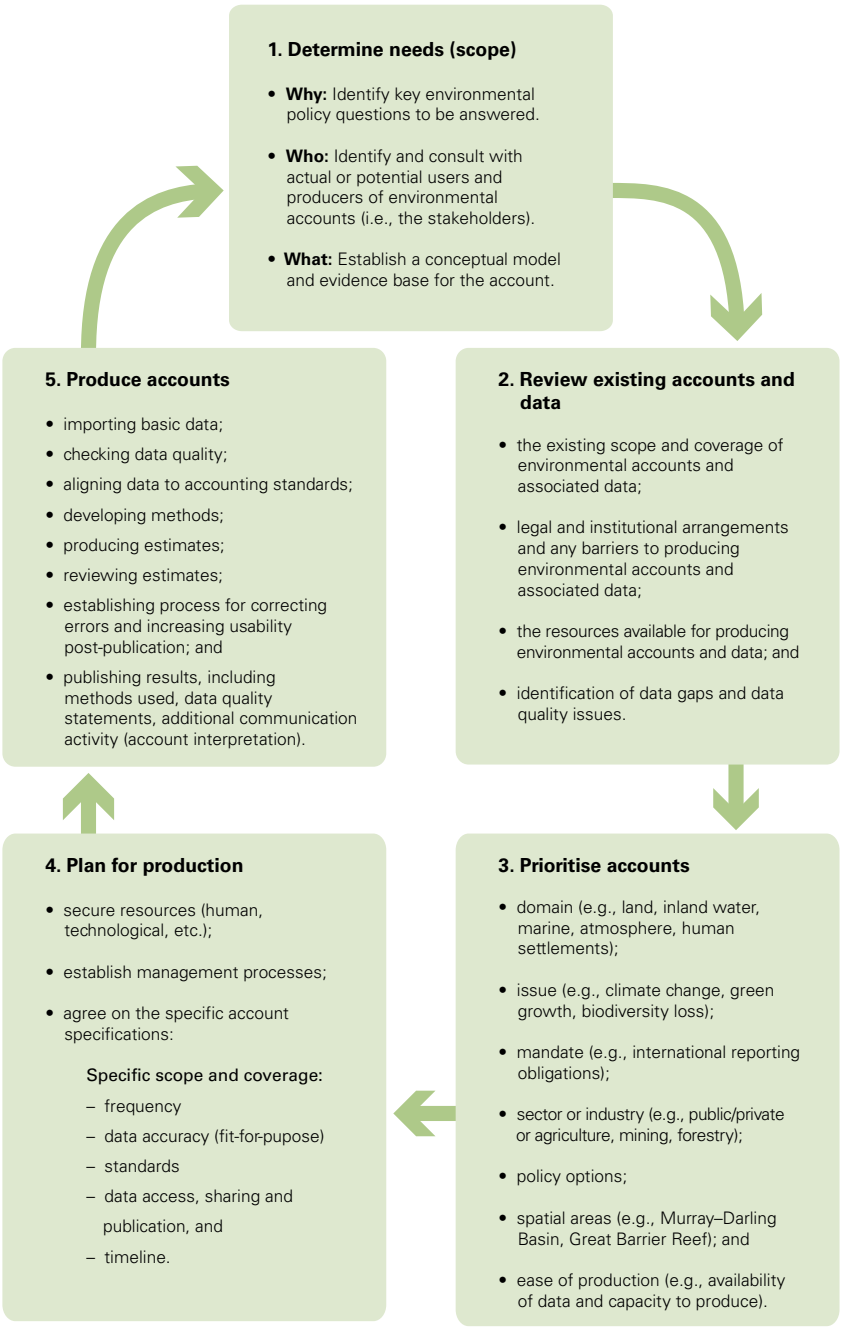


Figure 19. Five stages in the production of environment accounts.

This process is useful for selecting between multiple accounts, for example, at the national scale and as a process for scoping and specifying a specific account. The Environmental account framing workbook will assist when scoping and specifying a specific account.

Prioritising using domains

There could be a number of ways in which domains are classified, and as an example, the domains used in State of the Environment reporting include atmosphere, land, inland water, marine environment, biodiversity, coasts and the built environment. Different domains are typically managed by different organisations and the data needed for management may be aligned by domain, especially for physical environmental data.

For each domain, it is possible to list a number of accounts that might be able to assist decision makers.

Prioritising using issues

The range of issues that are the focus of government attention shifts over time with community values and with changing environmental and economic conditions; however, while there are shifts in focus, the broad areas of interest tend to be similar. For example, biodiversity conservation and sustainable development have been an area of interest for several decades. Nonetheless, some issues emerge with new information or understanding. For example, climate change as an area of policy focus has emerged in the past 10–15 years, while coal seam gas, and green growth and the green economy, are more recent environmental issues.

For each issue, it is possible to list a number of accounts that might assist decision makers (Table 13).

Prioritising using mandates

National or international reporting obligations are commitments enshrined in law. A key international obligation is reporting greenhouse gas emissions according to the UNFCCC and the Kyoto protocol. As a signatory to the UNFCCC, Australia reports annually on these emissions in the form of accounts and there is national legislation to support this obligation.

Australia is a signatory to a variety of other international treaties, for example, the Ramsar Convention and the Convention on Biological Diversity (UN 1992), but accounts are not mandated by these nor the supporting legislation. These treaties do, however, point to particular aspects or parts of the environment of potential interest to account producers or users.

Another mandated account in Australia is the National Water Account produced by the Bureau (2013c) in accordance with the Commonwealth *Water Act 2007* (Section 122).

Table 13. Example accounts of relevance to different environmental issues.

Issue	Examples of accounts linked to issue
Climate change	greenhouse emissions, carbon, energy, land cover, taxes and subsidies
Biodiversity conservation	land cover and land use, threatened species, environmental protection expenditure
Sustainable development	natural resources, water, land cover and land use, environmental protection expenditure, natural capital
Green growth	ecosystem good and services

Prioritising using geographic regions

Particular places or types of places can be prioritised for accounting production. Places could include areas defined by river basins (e.g., the Murray–Darling Basin) or NRMs (e.g., those of catchment management authorities) or significant natural features (e.g., the Great Barrier Reef). Types of places include ecosystems such as wetlands, forests, or alpine areas.

While national or state-level environmental accounts are useful for many purposes, accounts are typically more useful when they are developed for particular areas or regions of importance. These regions may be identified on the environmental, economic, social-demographic, or combinations of these characteristics.

With respect to environmental characteristics, and using water as an example, those regions that have low or highly variable levels of rainfall and competing demands for water are likely to have a higher priority for data when compared with regions with relatively abundant amounts of water. The Murray–Darling Basin is one such area in Australia.

Prioritising using policies, policy options, or instruments

Policies are usually related to particular issues. Prioritising using different policy options or instruments is a variation of this approach. Policy options and instruments include:

- cap and trade schemes;
- taxes and subsidies;
- payments for environmental stewardship or provision of ecosystem services; and
- education.

Prioritising using sector or industries

Sectors and industries are defined in the SEEA (and the SNA). Industry relates to the nature of the productive activities (e.g., agricultural, mining, manufacturing, education or health), while sectors relate to the nature of organisation and these can be involved in both economic production and consumption. The five sectors defined are:

- government;
- households;
- not-for-profit institutions;
- non-financial corporations; and
- financial corporations.

Within Australia and New Zealand, industries are defined using the Australian and New Zealand Standard Industrial Classification (ANZSIC [ABS 2013d]). The classification is hierarchical and the highest level of aggregation defines nine industries:

- agriculture;
- mining;
- electricity supply;
- manufacturing;
- water supply;
- communications;
- education;
- health; and
- restaurants and accommodation.

Some types of industries, such as tourism, are not defined in ANZSIC. In the case of tourism, the organisations involved in tourism activities can be separately identified and grouped (e.g., in tourism accounts). Environmental expenditure can also be accounted for in this way.

Industries prioritised in accounting are those which have the greatest direct impact on the environment through either use of natural resources (agriculture, forestry, fishing, mining, or water supply) as well as those generating pollution (agriculture, mining, energy, or manufacturing).

Prioritising using ease of production

Access to data and the ability to process this into accounts is often used to prioritise account production.

Starting with accounts that are easy to produce has three particular benefits:

1. accounts can be produced relatively quickly;

2. the production of accounts helps to build the capacity (institutional arrangements, human understanding and knowledge, technical infrastructure) needed to produce additional accounts; and

3. the production of accounts helps to plan for the production of future accounts and in particular identify gaps and deficiencies in knowledge or institutional arrangements not previously recognised.

Appendix 5. Developing a standard

There may be a requirement to develop a standard and the broad phases and considerations are described below.

Scoping

The process of developing a new standard begins when a need is identified. This may be a technical issue or gap based on industrial, scientific, or user experiences (e.g., lack of consistency in collecting data, classifying and reporting on ecosystems). A new standard may be instigated by the organisation which will sponsor and develop it, or come from stakeholders external to that organisation. As one example, the International Organization for Standardization (ISO) does not decide when to develop new standards; instead it responds to requests from industry, consumer groups, and other stakeholders.

The need for a new standard must be justified. For example, Australian Standards® created by the independent, not-for-profit organisation Standards Australia must demonstrate a positive net benefit to the community. The standard's positive impacts should always exceed its costs. This could involve exploring how the community would benefit from, or be enabled by, adopting the standard in social, environmental and economic terms.

Justifying the need for a new standard may involve a formal cost-benefit analysis or, where this is not possible, an effects analysis or less formal study of potential impacts. Prior to the introduction of the Australian Water Accounting Standard 1, the Water Accounting Standards Board (WASB) instigated an effects analysis of the benefits and costs of its adoption for data preparers and users (WASB 2012). Due to difficulties in quantifying these benefits and costs, the evaluation took a largely qualitative approach, and drew upon reports, desktop reviews, and industry research from Deloitte Access Economics, Ernst and Young, Access MQ, and the Bureau.

Potential stakeholders, users and others impacted by the new standard should be identified as part of the scoping phase. Achieving early stakeholder buy-in will support the standard throughout its development and increase the likelihood of acceptance and uptake later on.

Drafting

New standards should draw upon existing guidelines and align with international standards and frameworks where they are available and applicable. Existing standards should be reviewed to ensure a new standard does not duplicate or contradict what already exists. Further, a conceptual framework should underpin standards where possible. For example, the WASB developed the Water Accounting Conceptual Framework to ensure that all water standards are aligned and share similar concepts and definitions.

The drafted standard should include detailed specifications that are relevant to the subject matter and needs identified in the scoping stage. It should specify whether the standard is voluntary or mandatory, to whom and what it applies, how quality will be assured and how compliance will be monitored (if at all). Standards should not set impossible goals and should be based on sound experience and expertise.

Standards Australia (2013b) notes that documents should be:

- as complete as necessary within the limits specified by its scope;
- consistent, clear, and accurate;
- take full account of the state of the art;
- provide a framework for future technological

development; and

- comprehensible to qualified persons who have not participated in its preparation.

The format of the drafted document will vary depending on the type of standard and its audience. It can include formal legislation, standard documentation aligning with international protocols, or less formal best practice guidelines. It may be accompanied by implementation guidance to explain the standard and how it is achievable, and worked examples of how the standard might be met.

Consultation

Consulting with stakeholders is essential and should be undertaken throughout to achieve broad community ownership, acceptance and compliance. This may involve a community-of-practice or representatives from within and/or across jurisdictions where the standard will be applied. Technical, business, academic, government, interest group and community experts may be asked to review and provide comments on the proposed standard. The consultation period should be long and targeted enough to gather sufficient feedback from relevant stakeholders.

As an example, the Water Information Standards Business Forum brings together key water industry representatives and the Bureau to coordinate the development of water information standards. The consultation time in the water information standards endorsement process (shown in Figure 20) is no less than ten weeks. During this time, there can be an online review by the forum and targeted comments and review from experts and practitioners in the field. The standard's sponsor and the forum's secretariat collate review comments and undertake revision of the standard.

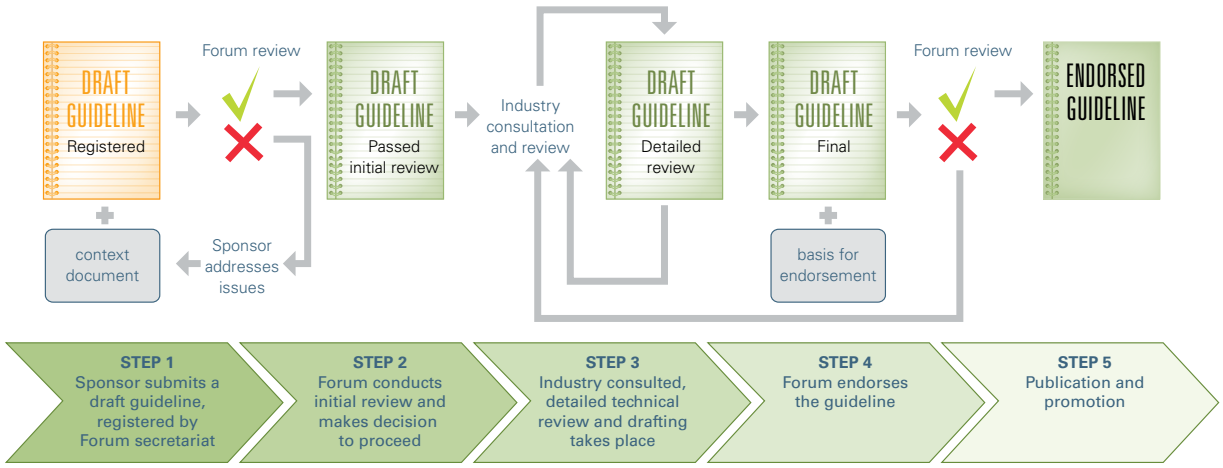
Adoption and monitoring

A broad consensus should be achieved before any standard is adopted and published in its final form. In some circumstances, formal endorsement may occur by a government organisation (such as the Bureau in the case of water information standards), a regulatory or standards body (such as Standards Australia for Australian Standards®) or a forum or committee of domain experts (such as the Spatial Data Management Group for ANZLIC—Spatial Information Council standards on spatial metadata quality).

As many of the effects of adopting a standard are unlikely to be known until after it has been applied, the standard should be further evaluated for any positive and negative impacts on the community. For example, a further effects–analysis is planned for the Australian Water Accounting Standard 1 as the benefits and costs of applying this standard become more quantifiable.

Compliance or uptake should also be monitored after the standard has been published. This may be the responsibility of a relevant government organisation or nationally certified regulatory body.

In some circumstances, changes may be made to a standard after it is adopted. Standards should be reviewed to keep pace with environmental and technological changes and stakeholder needs. Based on these changes, previously endorsed standards may need to be revised, superseded, or withdrawn. Voluntary standards may become mandatory if there is a clear need and a wide base of support.



Source: The Bureau 2013d.

Figure 20. The water information standards endorsement process.

Dissemination

Following the development and publication of standards, further work should be undertaken to disseminate these standards and encourage their use. This may involve organisations that promote the use of standards in Australia and internationally.

In Australia, the National Statistical Service led by the ABS supports the use of classifications, concepts, and data dictionaries and provides links to these resources. As one case study, the Australian Institute of Health and Welfare operates METeOR, an online repository for sharing national data standards related to health, community services, and housing assistance.

Similarly, the Water Information Standards Business Forum is developing a central repository of water information standards in Australia. The Water Information Standards Database could assist with the development of new standards by increasing access to existing standards and may facilitate comparisons across jurisdictions and organisations.

Resources for developing standards

The resources (time, money, and staff) required to develop a standard vary widely between different types of standards. The following factors may influence what resources are required, and in particular, the costs involved.

- requirements for a board, forum or committee of experts;
- number of jurisdictions involved;
- use of consultants (e.g., for a cost-benefit analysis);
- development of a website for information-sharing;
- requirements for travel;
- number of meetings (and associated expenses);
- production of outputs (e.g., printed handbooks and reports); and
- number of consultation and drafting phases.

Contributions of resources may come from governments, industry, academia, environmental groups, and other stakeholders. Strong stakeholder buy-in may lead to greater contributions.

Glossary

Term	Explanation
Account	1. An organised set of records of transactions usually produced with double-entry bookkeeping methods. 2. To recount a situation, provide a description of the situation from a particular perspective, '…to provide an account'. 3. To be held accountable, '…to be called to account'.
Accounting framework	Provides the standard concepts, definitions, classifications, accounting rules, and tables for producing and organising statistics and data.
Accounting period	Time period for which accounts are prepared and balanced. Usually annual (especially for economic accounts), but may be any set length of time.
Accumulation	In economics, accumulation is the acquisition of tangible assets during a period of account minus the incurred liabilities. In ecosystems, accumulation is variously called 'biomass' or a 'reservoir' and the process of accumulation is known as 'growth' or 'sequestration'.
Asset	In economics, an asset is 'a store of value representing a benefit or a series of benefits accruing to the owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another'. (European Commission et al. 2009). An ecosystem asset is a store of value representing a series of benefits and opportunities accruing to all ecosystem participants by maintaining the processes of primary productivity, respiration, growth, reproduction, accumulation, release[32] and evolution (adaptation) over a period of time (adapted from the economic definition).
Biodiversity	'The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and ecosystems.' (Convention on Biological Diversity—UN 1992). In the SEEA-EEA, biodiversity is an ecosystem characteristic (European Commission et al. 2013).
Capital	In economics, capital is a form of wealth, often an asset, owned or controlled by an individual or organisation and able to be used to produce goods and services.

[32]. The release of resources through decay, disturbance and/or disruption.

Term	Explanation
Consumption	In economics, consumption is the use of goods and services for the satisfaction of individual or collective human needs or wants. In ecosystems, consumption is the use of ecosystem flows (water, energy, nutrients) by ecosystem participants, functions and processes for maintaining living systems (adapted from the economic definition).
Ecosystem	An ecosystem is 'a dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit'. (UN 1992; European Commission et al. 2013). In the Guide, ecosystems include those that are human-influenced such as rural and urban ecosystems.
Ecosystem accounting	An 'integrated statistical framework for organising biophysical data, measuring ecosystem services, tracking changes in ecosystem assets and linking this information to economic and other human activity.' (European Commission et al. 2013).
Ecosystem asset	An ecosystem asset is an ecosystem that may provide benefits to humanity. They are spatial areas containing a combination of biotic and abiotic components and other characteristics that function together (European Commission et al. 2013). A subset of environmental assets with an emphasis on the living systems. They are environmental assets seen from a systems perspective according to the SEEA-EEA.
Ecosystem capacity	The capacity to supply ecosystem goods and services to humans, whether or not humans are currently consuming the goods and services. Estimating ecosystem capacity depends on knowing the objectives for the ecosystem including sustainability objectives. For example, the capacity of an ecosystem (measured by extent and condition) is different depending on whether it is being managed for sustainable forestry, sustainable conservation, or sustainable agriculture.

Term	Explanation
Ecosystem characteristic	'Ecosystem characteristics relate to the ongoing operation of the ecosystem and its location. Key characteristics of the operation of an ecosystem are (i) its structure (e.g., the food web within the ecosystem); (ii) its composition, including living (e.g., flora, and micro-organisms), and non-living (e.g., mineral soil, air, sunshine and water) components; (iii) its processes (e.g., photosynthesis, decomposition); and (iv) its functions (e.g., recycling of nutrients in an ecosystem, primary productivity). Key characteristics of its location are (i) its extent; (ii) its configuration (i.e., the way in which the various components are arranged and organised within the ecosystem); (iii) the landscape forms (e.g., mountain regions, coastal areas) within which the ecosystem is located; and (iv) the climate and associated seasonal patterns. Ecosystems also relate strongly to biodiversity at a number of levels. For this reason ecosystem characteristics include within and between species diversity, and the diversity of ecosystem types.' (European Commission et al. 2013: Paragraph 2.4).
Ecosystem service	Ecosystem services 'are the contributions of ecosystems to benefits used in economic and other human activity' (European Commission et al. 2013).[33]
Entity	In accounting terms, a clearly defined unit, such as an individual or an organisation, that engages in economic activities. Can be applied to other frameworks; for example in the National Water Account, an entity is defined as holding or transferring water, or engaging in the management of water, and can include a physical reservoir.
Environment	There are many potential meanings for the word environment but for this Guide, it is 'the naturally occurring living and non-living components of the Earth, together comprising the bio-physical environment...' (derived from European Commission et al. 2012).
Environmental asset	Environmental assets 'are the naturally occurring living and non-living components of the Earth, together comprising the bio-physical environment, that may provide benefits to humanity' (European Commission et al. 2012).
Flow	In economic accounts, flow refers to changes in the volume, composition or value of stocks. In ecosystem accounts, flows are the intra- and inter-ecosystem flows and the goods and services contributed by the environment to human benefit (ecosystem services) and the flow of residuals (waste) to the environment.

[33]. In this context, use includes both the transformation of materials (e.g., use of timber to build houses or for energy) and the passive receipt of non-material ecosystem services (e.g., amenity from viewing landscapes).

Term	Explanation
Inter-ecosystem flows	'Inter-ecosystem flows are flows between ecosystem assets that reflect ongoing ecosystem processes. An example is the flows of water between ecosystem assets via rivers.' (European Commission et al. 2013)
Intra-ecosystem flows	'Intra-ecosystem flows are flows within ecosystem assets that reflect ongoing ecosystem processes. An example is nutrient cycling.' (European Commission et al. 2013)
Joint Perspectives Model	A conceptual model of the relationships between the economy, society, and the environment. It is a systems-based approach that embeds the economy in society and then, in turn, society in the environment. Each horizontal slice represents a perspective unique to each system based on its emergent properties or characteristics (e.g., money in the economic system; genes in the living system).
Measurement unit	The unit used to measure the subject of the account and the 'currency' in which the account is set. This can be a monetary unit such as dollars or yen or a physical unit such as megalitres (of water) or tonnes (of carbon dioxide equivalents).
Natural capital	Natural capital is a relatively broad term that refers to the stock of environmental assets, ecosystem assets and natural resources in the environment that yields a flow of valuable ecosystem goods or services into the future. It includes land, air, water, ecosystems and living organisms.
Natural resources	Natural resources are a subset of environmental assets that are inputs to the economic system and that include all natural biological resources (including timber and aquatic resources), mineral and energy resources, soil resources and water resources.
Production	In economics, production is an activity that uses inputs of labour, capital, and goods and services to produce outputs of goods or services (OECD 2013). Commonly, primary production refers to the outputs of farming. In ecosystems, production is an activity that uses inputs of ecosystem assets and flows to reproduce ecosystem assets and flows (adapted from the economic definition). In ecosystem science, primary production is the creation of plant biomass via the function of photosynthesis, that is, the base of the food chain.
Residual (waste)	Outflow from the economy to the environment (e.g., solid, liquid, and gas waste).

Term	Explanation
Resilience	'The capacity of a system to absorb disturbance and reorganise so as to retain essentially the same function, structure and feedbacks' (Walker and Salt 2006; 2012).
Statistical unit	Statistical units are the entities about which information is sought and about which statistics are ultimately compiled. It is the statistical unit that provides the basis for compilation of statistical aggregates and to which tabulated data refer. In economic statistics, the statistical units are the various establishments, enterprises, government and household entities about which economic data are collected. The statistical units of ecosystem accounting are spatial areas about which information is collected and statistics are compiled (European Commission et al. 2013).
Stock	In economic accounts, stock is the amount of an asset (financial and non-financial) held at a particular time that has the capacity to produce goods or services. In environmental accounts, stock is the amount of an environmental or ecosystem asset that at a particular time has the capacity to produce environmental or ecosystem goods or services.
Worldview	The philosophy and set of values and objectives that an individual or organisation brings to conceptualising its interactions with the environment and society.

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Notes