Australian Government
Bureau of Meteorology

The Environmental Accounts Landscape

Contributing to the Australian Government National Plan for Environmental Information initiative

The Environmental Accounts Landscape
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1. Executive summary

As a core component of the Australian Government's National Plan for Environmental Information initiative, a framework is being developed to support and guide environmental accounting activity across Australia. In developing the framework, an understanding of existing environmental accounting approaches is required to ensure that work is not duplicated and to build on existing well-established environmental accounting approaches.

Currently, environmental accounts inform Australians about land use, water availability and its use, and trends in greenhouse gas emissions to name a few examples. Internationally, work is also underway to produce environmental accounts on a range of topics, and the United Nations Statistics Division is coordinating the rewriting of the System of Environmental–Economic Accounts.

Accounting concepts underpinning environmental accounts provide a systematic, robust method to present information and utilise standards, statistical units and cross-checking methods, such as accrual accounting, which are essential in developing a framework. Well-being and sustainability frameworks, ecosystem services approaches, and economic concepts of capital, in particular natural capital, provide models for understanding the account subject. This document provides an overview of these concepts, and in reviewing literature and existing frameworks and implementations, consideration is given to the perspective (such as economic or environmental perspectives), application, scale and units.

The revision of the System of Environmental–Economic Accounts is a key activity informing the development of a framework for Australian environmental accounting. The revision consists of three parts—the Central Framework, Experimental Ecosystem Accounts, and Extensions and Applications. The Central Framework has recently been adopted as an international standard by the United Nations Statistical Division and provides the framework for environmental asset accounts from an economic perspective. Of most relevance to the Bureau of Meteorology in developing a general framework for Australian environmental accounting is the Experimental Ecosystem Accounts. This is currently under development, and Australia is actively contributing to the revision through the Australian Bureau of Statistics. The Experimental Ecosystem Accounts aims to account for ecosystem capital and its capacity to provide ecosystem services.

The information presented in this document is a compendium of environmental accounting models and examples of their implementation. It is intended to provide a starting point for understanding environmental accounting, and should not be considered to be a comprehensive report of all current environmental accounts.

2. Introduction

This document provides an overview of the environmental accounting landscape both in Australia and internationally. It summarises work undertaken to date and describes various accounting frameworks and considerations for progressing the Environmental Accounts activity of the National Plan for Environmental Information initiative. Details of the initiative are available at www.bom.gov.au/environment/

Part A describes accounting concepts and existing environmental accounting frameworks and approaches that are currently being used to report on the natural environment. Part B provides examples of where these frameworks have been implemented. The frameworks and examples that are included in this document are those that are widely used, are currently being developed, or are considered to have relevance to developing a general framework for Australian environmental accounting.

2.1 Background

The Wentworth Group of Concerned Scientists developed a paper titled Accounting for Nature (2008) which outlines the need for Australia to have a national environmental account. This was subsequently revised, resulting in Accounting Metrics for Building Regionally Based National Environmental Accounts. Both papers make a case for:

- a framework that enables consistent, regular environmental accounting metrics
- measures that can be applied at national, regional and local scales
- accounts for stocks and flows of environmental assets
- reference condition metrics that can be interpreted for reporting on the health of ecosystems using a common currency.

The Australia 2020 Summit held in 2008 also raised the idea of national environmental accounts to inform government, business and community decision-making. It was proposed that accounts should 'track sustainability performance with something visible that will help people change their behaviour—environmental indicators should have the same status as economic indicators, showing trends in the ecological footprint' and 'undertake the valuation of environmental and social measures at the same level as economic measures, ensuring differentiation between "dollarization" and valuing' (Department of the Prime Minister and Cabinet 2009).

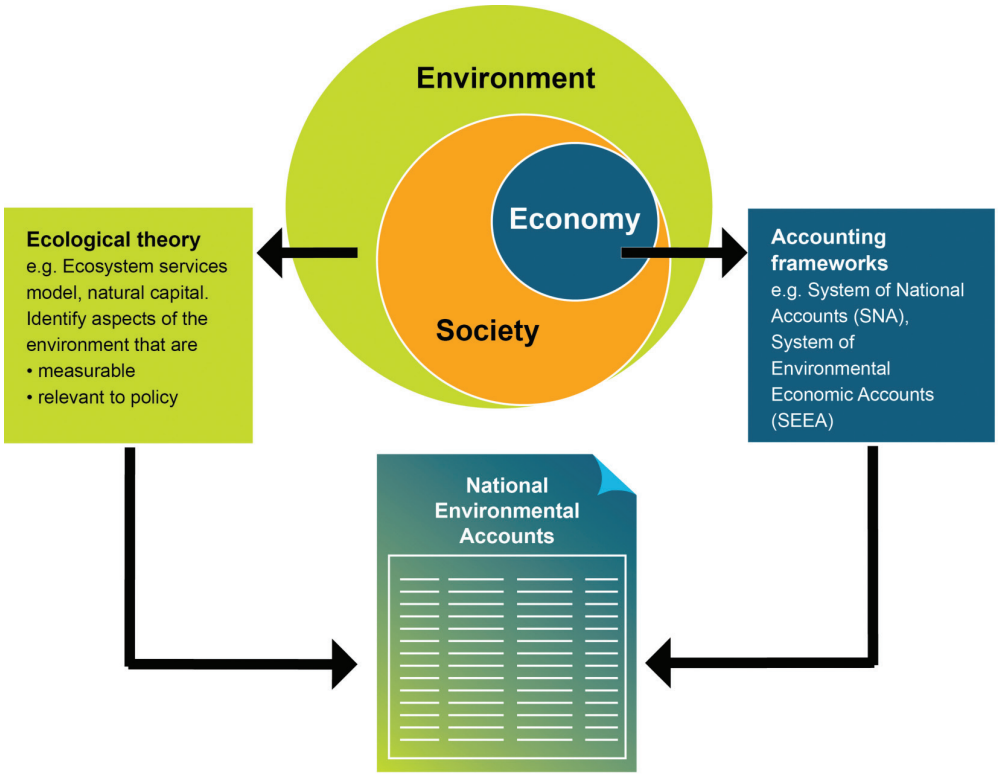
A proposal also emerged from the Australian Government driven by a range of needs, particularly the needs for improved access to environmental information by The Treasury for policy assessment purposes and by the Department of Sustainability, Environment, Water, Population and Communities in its role in national environmental decision-making. As well, the independent review of the *Environment Protection and Biodiversity Conservation Act 1999* by Dr Allan Hawke recommended that a system of environmental accounts be developed. In response to these ideas and drivers, the Australian Government announced in 2010 that one of the key elements to be delivered under the new National Plan for Environmental Information initiative would be a framework to support and guide environmental accounting activity across Australia.

2.2 Developing a framework for national environmental accounts

The development of a set of national environmental accounts that is legitimate, understandable, credible and relevant depends upon solid foundations. These accounts will take time to establish and refine. A parallel may be found in the development of economic accounts, which have evolved over many decades and are strongly linked to developments in economic theory and practise. It is proposed that the national environmental accounts would be underpinned by current ecological theory and, to the extent that they interact, theory and practice in the economic and social domains. There is a significant body of knowledge available from the accounting and auditing domains, including principles relating to legitimacy and credibility. A useful knowledge base is available through work done in the development and application of measures of environmental and ecological processes and functions.

The concept underpinning the development of environmental accounts is represented in Figure 1. Later sections describe ideas and concepts for consideration in building an environmental accounts framework.

Figure 1. Environmental accounting concept.



2.3 Criteria for understanding environmental accounting frameworks

Environmental accounts are being produced both in Australia and internationally. Accounts are differentiated based on their perspective, application, scale, unit (for example monetary or physical) and statistical unit (for example grid cell or business entity):

- Economic versus environmental perspective. Generally, accounting frameworks have an economic perspective, although new forms of accounting are emerging with a stronger environmental perspective (e.g. accounting for ecosystem services, reference condition accounting).
- Application. Different types of accounts can be used in the private or public sectors. The two basic types of accounting are financial and national (or economic) accounting.
- Regional scale accounting versus national scale accounting. Some frameworks are designed for use at specified scales, such as the System of National Accounts which describes a standard for reporting on a nation's economy. Conversely, accounts produced at a regional scale may not be able to be aggregated to a national level.
- Units. Units are often monetary but can also be physical measures (e.g. weight, volume, area and energy) or indices. New units are also emerging, such as carbon and water footprints.
- Statistical units. Statistical units are the entities about which statistics are compiled. In financial and economic accounting, the statistics used to develop accounts are gathered from households, governments and corporate entities such as businesses. In environmental accounting, a variety of statistical units is being explored. These are mostly land-based units such as land parcels or aggregations of these, for example, environmental assets or ecosystems.

3. Part A – Frameworks

This chapter describes key accounting and statistical concepts such as ecosystem services and approaches such as well-being frameworks that may underpin an environmental accounting framework.

3.1 Accounting frameworks

The rationale for developing environmental accounts is that accounting principles provide a structured and standardised approach for organising information so environmental change can be tracked through time. Key characteristics of an accounting framework are that information is systematic, consistent, and comparable over time and between entities, and that it uses standard definitions.

This section describes existing accounting practices and frameworks that are, or could be, applied to environmental accounts.

3.1.1 Financial accounts

Financial accounting provides information about a business to external users such as shareholders, customers, economists and government agencies. The objective of general purpose financial reporting is guided by the information needs of users and is defined as being able 'to provide information to users that is useful for making and evaluating decisions about the allocation of scarce resources' (Public Sector Accounting Standards Board of the Australian Accounting Research Foundation & Accounting Standards Review Board 1990). The presentation of financial reports is structured, and international standards such as the International Financial Reporting Standards (IFRS) are available. In Australia, this framework for presenting financial reports has been adopted and is defined in the Framework for the Preparation and Presentation of Financial Statements published by the Australian Accounting Standards Board (2009).

Financial reports use an accrual accounting approach. As described in the financial statements framework, 'under this basis, the effects of transactions and other events are recognised when they occur (and not when cash or its equivalent is received or paid)' (Australian Accounting Standards Board 2009).

Another key principle of a financial accounting framework is that 'users must be able to compare the financial reports of an entity through time in order to identify trends in its financial position and performance. Users must also be able to compare the financial reports of different entities in order to evaluate their relative financial position, financial performance and cash flows. Hence, the measurement and display of the financial effect of transactions and other events must be carried out in a consistent way throughout an entity and over time for that entity and in a consistent way for different entities' (Australian Accounting Standards Board 2009). It is these key accounting principles, allowing consistent, transparent and comparable reporting through time and between entities, that are being applied to environmental accounting.

The Bureau of Meteorology is applying general purpose financial accounting concepts to the National Water Account, an annual publication which fulfils a legislative responsibility of the Bureau under the Commonwealth Government *Water Act 2007*. The National Water Account is underpinned by the Water Accounting Conceptual Framework for the Preparation and Presentation of General Purpose Water Accounting Reports (Water Accounting Standards Board 2010) to facilitate account reports that are relevant, reliable and comparable.

3.1.2 System of National Accounts (SNA)

The internationally agreed System of National Accounts (SNA) standard defines the key economic processes of production, consumption and accumulation, and guides the measurement of the production of goods and services in monetary terms.

The SNA is a set of accounts comprising national income, capital, and financial accounts and balance sheets. Together, the accounts report on economic stocks and flows, where stocks are assets and liabilities, and flows are the creation, exchange, transfer or loss of economic value and 'involve changes in the volume, composition or value of assets and liabilities' (Australian Bureau of Statistics 2012). A key indicator of economic activity calculated from the national accounts is Gross Domestic Product (GDP).

The SNA uses accrual accounting principles so that flows are recorded when the event occurs rather than when the cash transaction occurs. For example, services are recorded when they are provided, output is recorded as production takes place and interest is recorded as it accumulates rather than on the payment due date.

The Australian Bureau of Statistics (ABS) notes that the accounts are 'fully integrated in that there is a balance between the value of assets and liabilities at the beginning of an accounting period, the transactions and other economic events that occur during the accounting period, and the closing values of assets and liabilities. Accounts for the economy as a whole are supported by accounts for the various sectors of the economy, such as those relating to the government, households and corporate entities' (Australian Bureau of Statistics 2012).

3.1.3 System of Environmental – Economic Accounts (SEEA)

One of the most mature environmental accounting frameworks is the United Nations Statistics Division's System of Environmental–Economic Accounts (SEEA) framework. The SEEA is an extension of the System of National Accounts and considers the interaction between the economy and the environment. The first SEEA handbook was released in 2003 and is currently under revision. The SEEA consists of three parts—the Central Framework, Experimental Ecosystem Accounts, and Extensions and Applications. The Central Framework was adopted by the UN Statistical Commission in March 2012 as the first international standard for environmental–economic accounting. The remaining two parts are being drafted. Australia has contributed to the revised framework, with the ABS taking a lead role.

The following sections set out some key aspects of the SEEA.

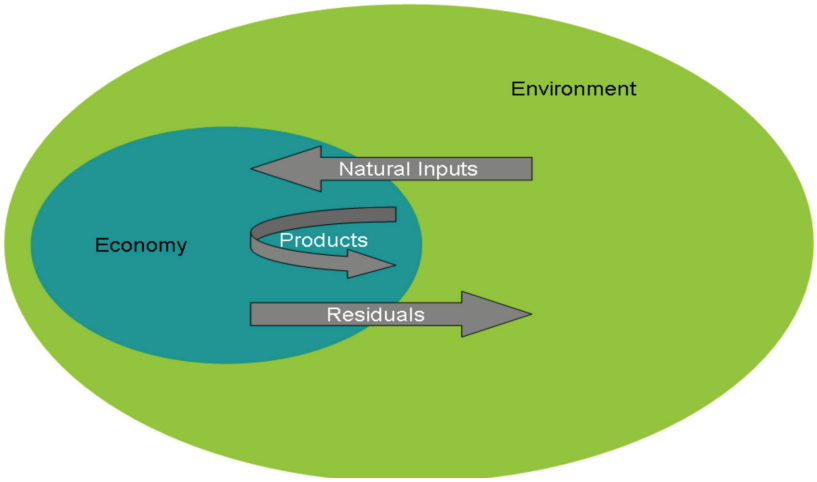
3.1.3.1 Conceptual framework

The broad conceptual approach taken in the SEEA Central Framework has a strong economic perspective that draws on current economic theory and characterises the environment as either a source of natural inputs or a sink for residuals (waste) as illustrated in Figure 2. Natural inputs are flows into the economy (such as minerals, energy, water and timber), products are flows within the economy and residuals are flows from the economy to the environment (for example, solid and liquid waste, air pollution).

3.1.3.2 Environmental assets

In the SEEA (2012), environmental assets are defined as 'the naturally occurring living and non-living components of the Earth, together comprising the biophysical environment, that may provide benefits

Figure 2. SEEA Central Framework conceptual model of the relationships between the economy and the environment.



to humanity'. The focus of the Central Framework is on the components of the environment that provide input to economic activities or that are affected by economic activities.

Environmental assets include land, natural biological resources such as timber and fish, mineral and energy resources, water resources and soil. In the System of National Accounts, only land that can provide economic benefits is included in the accounts. In SEEA, however, all land is recognised as an environmental asset as it defines 'the space in which economic activities and environmental processes take place and within which environmental assets and economic assets are located' (SEEA 2012). The area of land does not generally change, however the land use and land cover, as well as the capacity of the land to deliver benefits, can change.

The SEEA Central Framework provides a framework for accounting for individual assets, where the SEEA Experimental Ecosystems Accounts looks at ecosystem capital as a whole and its capacity to provide ecosystem goods and services.

3.1.3.3 Key components

There are three key components to the SEEA Central Framework:

1. Physical flow accounts
2. Stock (asset) accounts
3. Environmental activity accounts.

Physical flow accounts

The SEEA physical flow accounts describe the supply and use of natural assets in physical terms. They apply the accounting principle that total supply must equal total use. In the natural world, this translates to the conservation of matter and the principle that the inputs (supply) must equal the outputs (use) in the physical flow accounts. Flow accounts are presented in Physical Supply and Use Tables which report on the natural inputs, products and residuals in the economy supplied and used by institutional units including households, businesses and government.

The flows of any natural asset can be measured in physical terms. The unit of measurement is the appropriate unit for the phenomenon being measured, for example gigalitres or hectares.

Where it is appropriate to do so, the flows can also be presented in monetary terms. The SNA provides the framework for monetary accounts and the SEEA Central Framework allows for the integration of accounts measured in physical and monetary terms.

Stock accounts

The second component of SEEA is the stock or asset accounts that present the value or amount of an environmental asset at a given time. Land accounts are an example of this type of account. Asset accounts can be integrated with flow accounts to report on an asset at a given point in time (opening stock), the asset at a second point in time (closing stock) and the flows between the two time periods (changes in stock). Assets can be reported in physical or monetary terms.

Environmental activity account

The third component of SEEA is an environment activity account. Transactions already reported in the SNA of relevance to the environment such as spending on environment protection are collated. This is similar to a tourism account, where the tourism industry is itself not a statistical reporting unit, but all spending on goods and services relating to tourism such as travel are collated to present a purpose-based tourism industry account.

Adjustment for natural resource depletion

Another feature of the SEEA Central Framework is its consideration of the value of natural resources and adjustment of income for the cost of depletion of natural resources. In the SNA the depletion of natural resources is shown as a change in the volume of assets but it is not recognised as a cost. Aggregate measures such as GDP are adjusted in the SEEA Central Framework to calculate measures such as Depletion Adjusted Net Domestic Product. While this goes some way to account for the value of natural resources, it is limited to resources with an economic value.

3.1.3.4 Statistical units

'A statistical unit is an entity about which information is sought and for which statistics are ultimately compiled' (United Nations Statistics Division 2007). The SNA collects information on economic units such as a business or a household and uses standard industry and product classifications to report on the economy. As an extension of the SNA, the SEEA Central Framework uses these same statistical and reporting units. In Australia, the industry classes are defined in the Australian and New Zealand Standard Industrial Classification which is based on the International Standard Industrial Classification used by the SNA.

The United Nations Expert Group developing the SEEA Experimental Ecosystems Accounts is considering defining a statistical unit more suitable for environment and ecosystem accounts. It is suggested that a land-based unit such as a cadastral parcel or area of land based on a grid cell is used as the statistical unit for ecosystem accounts. This effectively changes the lens through which the stocks and flows are viewed, such that transactions are reported against a land-based statistical unit (e.g. a land parcel or grid cell) instead of an economic entity statistical unit (e.g. a business).

3.1.3.5 Application of SEEA

In Australia, the ABS is applying the SEEA framework to produce water, energy and land accounts, including the Water Account, Australia and the Land Account, Great Barrier Reef. The land accounting work is extending to other States and Territories. Work is currently underway to develop land accounts for Victoria, with the ultimate aim of producing land accounts for all jurisdictions. The European Environment Agency has also developed Land Accounts using the SEEA framework. These projects are described in more detail in section 4.1.

3.2 Environmental statistics

Environmental statistics are data on the environment. They can include any type of information such as temperature, rock type, water yields or species numbers. Environmental statistics provide data that can be organised into an accounting framework. There are a range of initiatives focused on the development of environmental statistics that could be used either directly or as inputs to accounts. These include the United Nations Statistics Division Framework for the Development of Environmental Statistics (FDES) and the National Statistical Services' Essential Statistical Assets for Australia framework.

3.2.1 Framework for the Development of Environmental Statistics

The United Nations Statistics Division developed A Framework for the Development of Environment Statistics (FDES 1984). The FDES is currently under revision. It is based on the concept that many environmental issues are a result of human activity and defines information categories that reflect this including social and economic activities, natural events, environmental impacts of the events and responses to environmental impacts. Within these categories, the FDES contains 'statistical topics' which are 'those aspects of environmental concerns that can be subjected to statistical description and analysis'. The framework is flexible and can be adjusted as required, and provides a method for organising environmental information.

3.2.2 Essential Statistical Assets for Australia framework

The ABS and the National Statistical Service are in the process of identifying a core set of statistics that are broad ranging and provide critical information for decision-making. The Essential Statistical Assets for Australia framework organises the statistics into three themes: societal progress, economic development and environmental sustainability. The environmental sustainability theme includes the subtopics of biodiversity, land, inland waters, oceans and estuaries, atmosphere, and waste. More information on the Essential Statistical Assets for Australia initiative is available at www.nss.gov.au/nss/home.NSF/Pages/Essential+Statistics+for+Australia

3.3 Economic theory and its application to the environment

Economic theory provides broad concepts of wealth, income, capital, production, accumulation, consumption, costs and benefits. These can provide a structured way to consider the benefits derived from ecosystems and the environment. While there are some benefits obtained by using consistent approaches, extending methods from one discipline into other fields can have limitations where some assumptions may not make sense when applied to another field. For example, in the economy, humans make economic decisions to maximise benefits, but this concept does not apply to plants and animals participating in an ecosystem.

3.3.1 Environmental economics

Environmental economics is the study of the influence of economics on the environment and vice versa. It usually involves a cost-benefit analysis of alternative options. As a key concept, it places a monetary value on environmental resources. Environmental economics is used to develop market-based instruments (for example environmental stewardship payments or carbon trading schemes), and for incorporating the cost of environmental resources in decision-making. Due to the difficulty of putting a market value on the environment, economic assessments can undervalue the benefits provided by nature by including only those aspects which can be assigned a monetary value. As well, because the value of non-market goods are not included, such assessments may result in decisions that do not provide the most efficient resource allocation.

3.3.2 Natural and ecosystem capital

Economic theory includes the concept of capital. Capital is a produced good (for example a machine) or a non-produced good (for example minerals) that can be used to produce goods and services. This is the definition applied to the System of National Accounts, however broader interpretations, such as that of Costanza et al. (1997), describe capital as the 'stock of materials or information that exists at a point in time' that have the capacity to produce goods and services. It is this broader definition that provides the notion of different forms of capital such as social, human and natural capital. While there are many types of capital referred to in literature, five commonly used types are: financial, natural, produced, human, and social.

Although there are varying interpretations for each kind of capital, the general definitions are:

- Financial capital is the money available to generate further wealth.
- Produced capital comprises the produced goods available for use in the production of further goods or services.
- Human capital is the knowledge and skills that enable growth.
- Social capital refers to the institutions and relationships that use human capital to create wealth.
- Natural capital can be defined in a number of ways; it is defined by the International Institute for Sustainable Development as 'the land, air, water, living organisms and all formations of the Earth's biosphere that provide us with ecosystem goods and services' and by The Economics of Ecosystems and Biodiversity as 'stocks of physical and biological resources found on earth'. It can be generally interpreted as the living and non-living components of the earth that provide goods and services, although there are differing interpretations as to how human systems and non-renewable natural resources are considered.

Ecosystem capital is an emerging concept, being considered by the editorial board of the SEEA Experimental Ecosystems Accounts. In order to assess ecosystem capital, both the quantity and quality of the stock are important. Both affect the capacity of the capital to produce a flow of ecosystem goods and services, now and into the future.

Natural capital accounting is a key aspect of assessing sustainability and well-being. In order to achieve sustainability, all kinds of capital (financial, produced, human, social, natural) must be maintained or increased. A number of projects have attempted to value natural capital and these are described in Part B – Implementations.

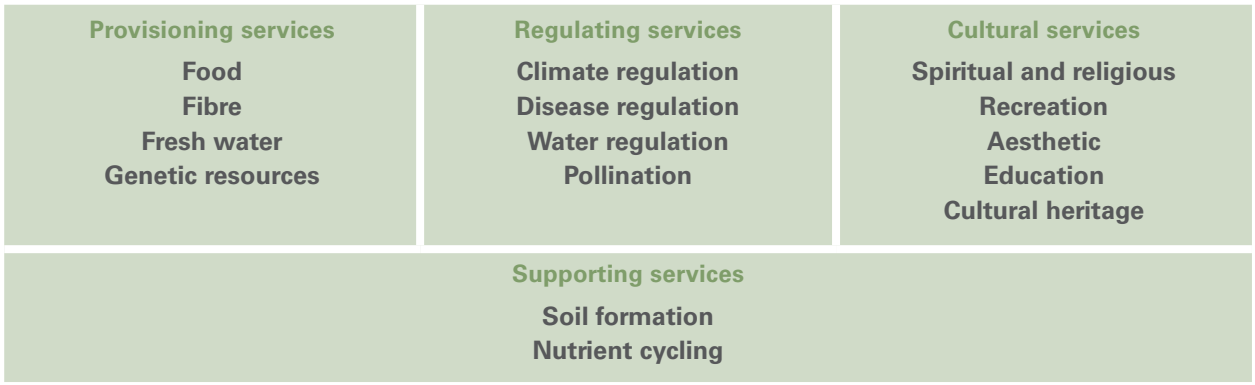
3.4 Ecosystem services

Humans depend on the environment for essential provisions such as food, fresh water and clean air. An ecosystem services approach provides a framework for considering the environment in reporting and decision-making.

A common and generally accepted definition of ecosystem services is provided by the Millennium Ecosystem Assessment as 'the benefits people obtain from ecosystems'. These are categorised as provisioning, regulating, cultural and supporting services:

- Provisioning—products obtained from ecosystems e.g. food, fresh water, wood, silk, genetic resources and pharmaceuticals.
- Regulating—regulating benefits obtained from ecosystem processes e.g. climate regulation through sequestration of greenhouse gases, water purification through filtering, storm protection through presence of mangroves.
- Cultural—non-material benefits obtained from ecosystems e.g. spiritual, religious and aesthetic values, recreation and inspiration.
- Supporting—services that are necessary for the production of all other ecosystem services, e.g. soil formation.

Figure 3. Ecosystem services. © Millennium Ecosystem Assessment 2003—used with permission. The Creative Commons licence does not apply to this material. If you wish to further use this material you must contact the copyright owner directly to obtain permission.



Some of these categories overlap and some services may occur in more than one category depending on the temporal scale. Supporting services underpin many other services, as depicted in Figure 3.

As described by Maynard et al. (2010) in The Development of an Ecosystem Services Framework for South East Queensland, 'Ecosystem services are produced through a complex interaction of processes (functions). The conservation of ecosystem structure and functioning in order to maintain ecosystem services is the prime objective of the "ecosystem approach"'.

An ecosystem services approach to environmental management identifies the linkages between people and the environment. It allows decision makers to address sustainability by considering the full range of benefits to human well-being provided by the environment and thus it promotes full consideration of the trade-offs between alternative management options. Examples of taking an ecosystem services approach to evaluating the benefits of ecosystems are described in section 4.2. An ecosystem services approach is being incorporated into environmental accounting methods. For example, the Expert Group developing the SEEA Experimental Ecosystems Accounts is considering this approach, and it is being applied in the World Bank's Wealth Accounting and Valuation of Ecosystem Services (WAVES) project described in section 4.1.8.

3.4.1 Final ecosystem services

Ecosystem services are a mix of goods, services, ecosystem processes and functions that directly or indirectly provide benefits to humans. Differentiating those services that directly benefit humans (such as clean water) from the underpinning ecosystem functions (such as biological and geochemical processes) is important in ensuring that ecosystem services are not double-counted in any assessment or reporting framework.

Services that provide a direct benefit to humans are referred to as final ecosystem services. These are the provisioning, regulating and cultural services described in the 2005 Millennium Ecosystem Assessment.

The supporting services described in the 2005 Millennium Ecosystem Assessment can be considered to be the ecosystem processes or functions essential for a functioning ecosystem. These may also be referred to as indirect or intermediate services.

One difficulty with the ecosystem services approach is that there are many different terms and definitions to describe the different types of ecosystems services. While the 2005 Millennium Ecosystem Assessment provides a widely accepted, broad definition of ecosystem services, there is less consistency in the terminology and definitions of intermediate and final ecosystem services. Some interpretations extend the distinction between intermediate and final services further to a third category, described as goods or benefits derived from final ecosystem services. These have value that can be attributed partly to the input ecosystem service and partly to value added by human input (for example by manufacturing). The concept of ecosystem services emerged in the late 1990's and it is likely that terms and definitions will converge as the thinking on ecosystem services matures.

There are various approaches to how final ecosystem services are dealt with in an assessment or account. A common practice is to identify discrete and mutually exclusive classes of goods and services that have direct benefits to an identified beneficiary or user. This method provides a sound basis for applying accounting frameworks as it removes the issue of double counting of ecosystem services that can undermine the validity of assessments. A classification scheme that defines unique classes of final ecosystem services is being developed by the European Environment Agency and is described in section 3.4.3.

3.4.2 Benefits and beneficiaries

Applying best practice economic principles to the assessment of ecosystem services introduces the concept of benefits and beneficiaries. This is an economic view of the value of a service that helps to identify final ecosystem services and ensure services are not double counted. For example, filtration is a supporting or intermediate ecosystem service that results in clean water (the final ecosystem service). The benefit to humans (the beneficiaries) is clean drinking water. In some cases, an ecosystem service is an intermediate service to one user but a final service to another user. In this instance, only the final ecosystem service is included in an assessment or account so it is not double counted. The value of the intermediate or supporting services is captured in the final ecosystem services that rely on them.

An important aspect of benefits is that they can be added together to evaluate ecosystem services. A single service can generate multiple benefits and it is valid to add the value of the benefits together. Identifying benefits and beneficiaries provides a way for the environmental benefits to be considered in a decision-making process that may traditionally be focused on an economic cost-benefit analysis.

3.4.3 Common International Classification for Ecosystem Services

The Common International Classification for Ecosystem Services (CICES) is a classification scheme for final ecosystem goods and services proposed by the European Environment Agency. Of key importance is that the classification is compatible with SEEA, allowing integration of environmental and economic accounts through linking the standard economic industry, products and consumption classification schemes to the CICES classes. It is likely that CICES will become a standard classification and the draft scheme is currently being considered by the United Nations Statistical Division as part of SEEA Experimental Ecosystem Accounts revision.

CICES is a hierarchical classification, allowing additional classes to be added. There are five levels in the hierarchy, with the first four applicable to accounting and the fifth (class types) required for mapping and assessment. The highest level describes the type of service (provisioning, regulating or cultural) with the next levels providing more detail. The draft classification of the first four levels is listed in Table 1.

Table 1. Common International Classification for Ecosystem Services (CICES) Draft version 4 (European Environment Agency 2012b).

CICES for ecosystem accounting				Examples and/or indicative benefits
Section	**Division**	**Group**	**Class**	
Provisioning	Nutrition	Terrestrial plants and animals for food	Crops	Cereals, vegetables
			Livestock and dairy products	Sheep, cattle for meat and dairy products
			Wild plants and animals and their products	Berries, fungi, honey, game
		Freshwater plants and animals for food	Fish (wild populations)	Plaice, sea bass
			Aquaculture products	Salmon, trout
			Fresh water plants	Water cress
		Marine algae and animals for food	Fish (wild populations including shellfish)	Includes crustaceans
			Aquaculture products	Includes crustaceans
			Algae	Macro and microalgae
	Water supply	Water for human consumption	Drinking water	Springs, managed supplies from rivers or reservoirs
			Domestic water use	Water for personal hygiene, water for toilet systems
		Water for agricultural use	Irrigation water (consumptive)	For crop production
			Water for livestock (consumptive)	Natural water sources, managed water supplies
		Water for industrial and energy use	Industrial water (consumptive)	For manufacturing in a wide range of industries
			Cooling water (non consumptive)	For power production, including marine waters for nuclear power plants
	Materials	Biotic materials	Non-food vegetal fibres	Timber, straw, flax
			Non-food animal fibres	Bone, corals, shells
			Ornamental resources	Bulbs, cut flowers, shells, pearls and feathers
			Genetic resources	Wild species used in breeding programmes
			Medicinal and cosmetic resources	Bio-prospecting activities
	Energy	Biomass based energy	Vegetal-based resources	Wood fuel, energy crops
			Animal-based resources	Dung, fat, oils

CICES for ecosystem accounting				Examples and/or indicative benefits
Section	**Division**	**Group**	**Class**	
Regulation and maintenance	Regulation of biophysical environment	Bioremediation	Remediation by plants or algae	Phytoaccumulation, phytodegradation
			Remediation by microorganisms	In situ (Bioremediation), ex situ (composting)
			Remediation by animals	Bioremediation e.g. filtration of particles using molluscs
		Dilution and sequestration	Dilution, decomposition, remineralisation and recycling	Dilution of municipal wastewater in rivers, marine denitrification
			Filtration	Filtration of particulates and aerosols
			Sequestration and absorption	Sequestration of nutrients and pollutants in organic sediments
	Flow regulation	Air flow regulation	Rural microclimatic regulation	Natural or planted vegetation that serves as shelter belts
			Urban microclimatic regulation	Ventilation
		Water flow regulation	Attenuation of runoff and discharge rates	Woodlands, wetlands and their impact on discharge rates
			Water storage for flow regulation	Flood plains and wetlands
			Coastal protection	Mangroves, sea grasses, dune systems
		Mass flow regulation	Erosion protection	Wetlands, mangroves
			Avalanche and gravity flow protection	Stabilisation of mudflows
	Regulation of physico-chemical environment	Atmospheric regulation	Global climate regulation (including C-sequestration)	Atmospheric composition, hydrological cycle
			Local and regional climate regulation	Modifying temperature, humidity etc., maintenance of urban climate and air quality, regional precipitation patterns
		Water quality regulation	Water purification and oxygenation	Natural or planted vegetation that serves nutrient retention
		Pedogenesis and soil quality regulation	Maintenance of soil fertility	Green mulches, N-fixing plants
			Maintenance of soil structure	Soil organism activity
	Regulation of biotic environment	Lifecycle maintenance, habitat and gene pool protection	Pollination	By biota
			Seed dispersal	By biota
			Maintaining nursery populations	Habitat refuges
		Pest and disease control (including invasive alien species)	Biological control mechanisms	By plants and animals, control of pathogens

CICES for ecosystem accounting				Examples and/or indicative benefits
Section	**Division**	**Group**	**Class**	
Cultural	Symbolic	Aesthetic, Heritage	Landscape character	Areas of outstanding natural beauty
			Cultural landscapes	Sense of place
		Spiritual	Wilderness, naturalness	Tranquillity, isolation
			Sacred places or species	Woodland cemeteries, sky burials
	Intellectual and experiential	Recreation and community activities	Charismatic or iconic wildlife or habitats	Bird or whale watching, conservation activities
			Prey for hunting, fishing or collecting	Angling, shooting, membership of environmental groups
			Landscape character for recreational opportunities	Bathing, scuba-diving, recreational leisure boating, hiking
		Information and knowledge	Scientific	Pollen record, tree ring record, genetic patterns
			Educational	Subject matter for wildlife programs and books

3.4.4 Biodiversity

The Convention of Biological Diversity defines biodiversity as '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 of ecosystems' (United Nations 1992).

Biodiversity can be considered to be a regulating ecosystem service in its own right, or can also be a supporting service or ecosystem function as it is fundamental to the functioning and resilience of ecosystems and therefore the provision of ecosystem services. While its importance is well understood, there is ongoing research and debate into the exact nature of biodiversity and its role in a resilient ecosystem. The degree to which an ecosystem can continue functioning with fewer species, lower species richness or different combinations of species are the subjects of scientific debate.

Whether biodiversity is considered to be a final or supporting ecosystem service in any type of assessment will depend on the underpinning conceptual framework.

3.5 Well-being and sustainability frameworks

Frameworks for assessing the environment include human well-being frameworks, which take into account broad aspects of society that contribute to human well-being. While there are a number of interpretations of the definition of well-being, the dimensions of well-being as defined by the Millennium Ecosystem Assessment are security (personal safety as well as secure access to resources), basic material for good life (including nutrition and shelter), health, good social relationships and freedom of choice and action. It is important to distinguish between current well-being and sustainability, which is about whether the aspects of well-being are available over time.

The challenge with gauging well-being and sustainability lies in determining suitable measures for the non-economic dimensions of well-being, including health, social connections and the environment. Some examples of well-being frameworks relevant to Australians are described below.

3.5.1 The Treasury well-being framework

The Treasury of the Australian Government has a mission to 'improve the well-being of the Australian people' (The Treasury 2011) and has developed a well-being framework to provide guidance for incorporating the elements of well-being into policy decisions. The Treasury describes well-being as 'a person's substantive freedom to lead a life they have reason to value'. The dimensions considered are the opportunities available to people, the distribution of those opportunities and the sustainability of those opportunities. In order to track Australia's well-being, the Treasury is seeking measures of the elements of well-being, including the environment, to supplement economic measures such as GDP.

3.5.2 Sustainability indicators

The Australian Government's Department of Sustainability, Environment, Water, Population and Communities is leading the development of a set of sustainability indicators. The framework is based on the concept that the quantity and quality of natural capital, social and human capital, and economic capital determine well-being (defined as economic prosperity, community liveability and environmental sustainability). Sustainability in this framework is dependent on maintaining or enhancing the total stock of capital for future generations. Indicators for stocks and flows are being identified, with data availability being a key criterion in determining which indicators are feasible.

3.5.3 Measures of Australia's Progress

Measures of Australia's Progress (MAP) is an ABS activity designed to answer the question 'Is life in Australia getting better?' It is a set of statistics on society, the economy and the environment. Six indicators are presented for the environment domain including: biodiversity, land, inland waters, oceans and estuaries, atmosphere, and waste. Further information is available at www.abs.gov.au/about/progress

3.5.4 GDP and the HALE Index

GDP is a measure of economic production but is frequently reported as a key measure of economic activity and well-being. The limitations of GDP as a measure of well-being have been described in the Report by the Commission on the Measurement of Economic Performance and Social Progress (2009), and while the issues are well recognised, it continues to be over emphasised as a measure of well-being. The Herald/Age – Lateral Economics (HALE) Index of Australia's Well-being was developed by Fairfax Media to produce a measure of progress that addressed the inadequacy of GDP. Among other limitations, GDP does not take the environment into consideration, so Fairfax Media commissioned Dr Nicholas Gruen, principal of Lateral Economics, to develop a more comprehensive index of well-being. The resulting HALE Index of Well-being encompasses nine economic and non-economic dimensions:

Economic well-being

- economic (recurrent plus physical capital)
- education (human capital)
- environment (natural capital)
- adjustment for the distribution of economic well-being.

Non-economic well-being

- environmental amenity
- health
- employment-related satisfaction
- political capital
- social capital.

Indicators for each of these dimensions are aggregated to calculate an index. Fairfax Media is currently reporting the HALE Index every quarter to coincide with the release of GDP and other economic figures.

3.5.5 Other measures of progress, well-being and sustainability

A number of other methods have been used to measure well-being and sustainability. The following is not a comprehensive list; however these are some of the measures used:

- Ecological Footprint is a measure of human impact on the environment. It includes an estimate of the natural resources (land and water) required to support current levels of consumption (see the Global Footprint Network at www.footprintnetwork.org).
- The Living Planet Index (a World Wildlife Fund project) measures global biodiversity using the ecological footprint tool (see the Living Planet Report at http://wwf.panda.org/about_our_earth/all_publications/living_planet_report).
- The Gross National Happiness Index of Bhutan is an index comprising nine domains, one of which is Ecological Diversity and Resilience (see www.grossnationalhappiness.com).

3.6 Sustainability reporting frameworks

Sustainability reporting is often undertaken by organisations to report on environmental and social aspects of their business or organisation in addition to more traditional financial reporting.

3.6.1 Triple Bottom Line

Triple Bottom Line reporting, sometimes referred to as TBL or the three P's (people, planet and profits), is an accounting framework that reports 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 TBL reporting however there are frameworks and guidelines that can be applied.

3.6.2 Integrated reporting

The International Integrated Reporting Committee (IIRC) is developing an Integrated Reporting framework that 'brings together the material information about an organisation's strategy, governance, performance and prospects in a way that reflects the commercial, social and environmental context in which it operates. It provides a clear and concise representation of how an organisation demonstrates stewardship and how it creates and sustains value' (IIRC 2011). Integrated reporting is being developed in response to a growing need for organisations to be more transparent in their corporate responsibilities, including environmental management. It provides a framework for reporting on financial, manufactured, human, intellectual, natural and social capital. An exposure draft is due to be released in late 2012.

3.6.3 Global Reporting Initiative

The Global Reporting Initiative (GRI) is a non-profit organisation which aims to make sustainability reporting standard practice for all organisations. The GRI has developed Sustainability Reporting Guidelines that provide a framework for reporting against economic, environmental and social indicators. The environmental indicators address inputs (including materials and energy), outputs (such as emissions and waste) and ways in which an organisation is operating to reduce energy use and environmental impacts. Further information is available at www.globalreporting.org

3.7 Environmental assessment frameworks

Environmental accounting provides a highly structured way of organising information to allow analysis of changes over time. While environmental accounting shares a number of characteristics with environmental monitoring and assessments, assessments are often undertaken by a number of different methods and for different purposes, and include analysis or interpretation of the information. For example, the Australian State of the Environment Report (Department of Sustainability, Environment, Water, Population and Communities (2011)) is an assessment that aims to describe the condition of Australia's environment, the pressures on the environment and management efforts towards protecting environmental assets. Environmental accounts may inform the State of the Environment Report, but the report is not in itself an account. It is worth noting that a plethora of environmental information is gathered at many different spatial and temporal scales as part of environmental assessments that may be used to produce environmental accounts.

Environmental assessment frameworks include:

- Pressure–State–Response (PSR) and Driver–Pressure–State–Impact–Response (DPSIR) models
- Monitoring, Evaluation and Reporting (MER) and Monitoring, Evaluation, Reporting and Improvement (MERI) frameworks
- Common Assessment and Reporting Framework (CARF)
- Criteria and indicators
- State and transition models
- State of the Environment (SOE) reports.

4. Part B – Implementation

In Australia and internationally, environmental accounts provide information on a range of topics including land, water availability and use, and greenhouse gas emissions. This chapter provides examples of the implementation of the accounting frameworks and approaches described in Part A. It is not a comprehensive list but aims to capture key activities that can inform the development and implementation of an environmental accounting framework for Australia.

4.1 Current implementation of environmental accounts

4.1.1 Water Account Australia (ABS)

Water Account Australia, produced by the ABS annually, reports on the water supply and use within the economy at the State and Territory and national level, and also for the Murray–Darling Basin. It is based on the SEEA framework, reporting physical and monetary supply and use tables.

The water resource that is accounted for is the volume of water extracted from the environment for consumption and production (for example extracted from inland water resources, rainfall that is collected for use, and sea water used for cooling purposes). The discharges include water returned to the environment or water discharged to sewerage treatments. The accounts describe who uses water, how much was used, and for what purpose. As per the SEEA Central Framework, the Water Account Australia applies the standard industry classes for the reporting unit.

4.1.2 National Water Account (Bureau of Meteorology)

The National Water Account produced by the Bureau aims to report on the total water resource. It complements the Water Account Australia by reporting on different aspects of Australia's water resources. Specifically, while the Water Account Australia reports on water use within the economy, the National Water Account provides information on the water available to be used. The 2011 Account contains a set of water accounting reports for eight nationally significant water management regions. The National Water Account uses an accrual accounting framework so transactions, such as water allocation announcements, are recorded at the time of the event. It reports on the volume of water assets and water liabilities, the changes to the water assets and water liabilities during the reporting period (for example water allocation announcements and rainfall), and the actual water flows (for example the delivery of water against a water allocation and rainfall).

The National Water Account can inform water management decisions and be used in conjunction with the Water Account Australia to understand water use and supply.

Due to uncertainties involved in measuring, for example, runoff, evaporation and groundwater seepage, the total volume of the water assets at the start of the reporting period, plus or minus the changes that occurred during the reporting period, may not equal the total volume at the end of the reporting period. The difference between these values is the unaccounted-for difference.

The National Water Account is guided by the Australian Water Accounting Standard 1 (AWAS 1) (Bureau of Meteorology 2012). AWAS 1 is underpinned by the Water Accounting Conceptual Framework for the Preparation and Presentation of General Purpose Water Accounting Reports which was approved by the Water Accounting Standards Board in 2009. The National Water Account was piloted in 2010, with the first National Water Account being released in 2011, and is produced annually. Further details are available at www.bom.gov.au/water/nwa/

4.1.3 Land Account (ABS)

The ABS has developed a pilot Land Account for the Great Barrier Reef based on the SEEA framework. The Great Barrier Reef ABS Land Account is an asset account providing land use and land cover area statements for Natural Resource Management regions adjacent to the Great Barrier Reef. The account has been developed by integrating data from a range of sources using a combination of grid-based statistical units and cadastral parcel units. This has allowed for the integration of cadastre-based data (such as industry sector and land values) with grid-based land cover data. A series of tables and maps are produced, showing the extent of different land uses and cover types within the region, cross referenced by area and value. As this is a pilot project, only one point in time has been reported to date and therefore no flows within the asset class have been included. An example of a map produced as part of the Land Account is shown in Figure 4.

4.1.4 National Greenhouse Gas Inventory and carbon accounting in Australia (Department of Climate Change and Energy Efficiency)

'Australia publishes comprehensive reports on greenhouse gas emissions in the National Greenhouse Accounts. This data is used to meet Australia's reporting commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and track progress against Australia's target under the Kyoto Protocol as well as inform policy makers and the public' (Department of Climate Change and Energy Efficiency 2012).

The National Greenhouse Accounts are produced by the Department of Climate Change and Energy Efficiency and comprise the National Greenhouse Gas Inventory and State and Territory inventories, reporting on the greenhouse gas emissions from land-based activities. The data in the National Greenhouse Gas Inventory is based on the Australian Greenhouse Emissions Information System (AGEIS) and the National Carbon Accounting System (NCAS), which source data from satellite imagery and land use data, as well as through institutional reporting arrangements such as the *National Greenhouse Energy and Reporting Act 2007.*

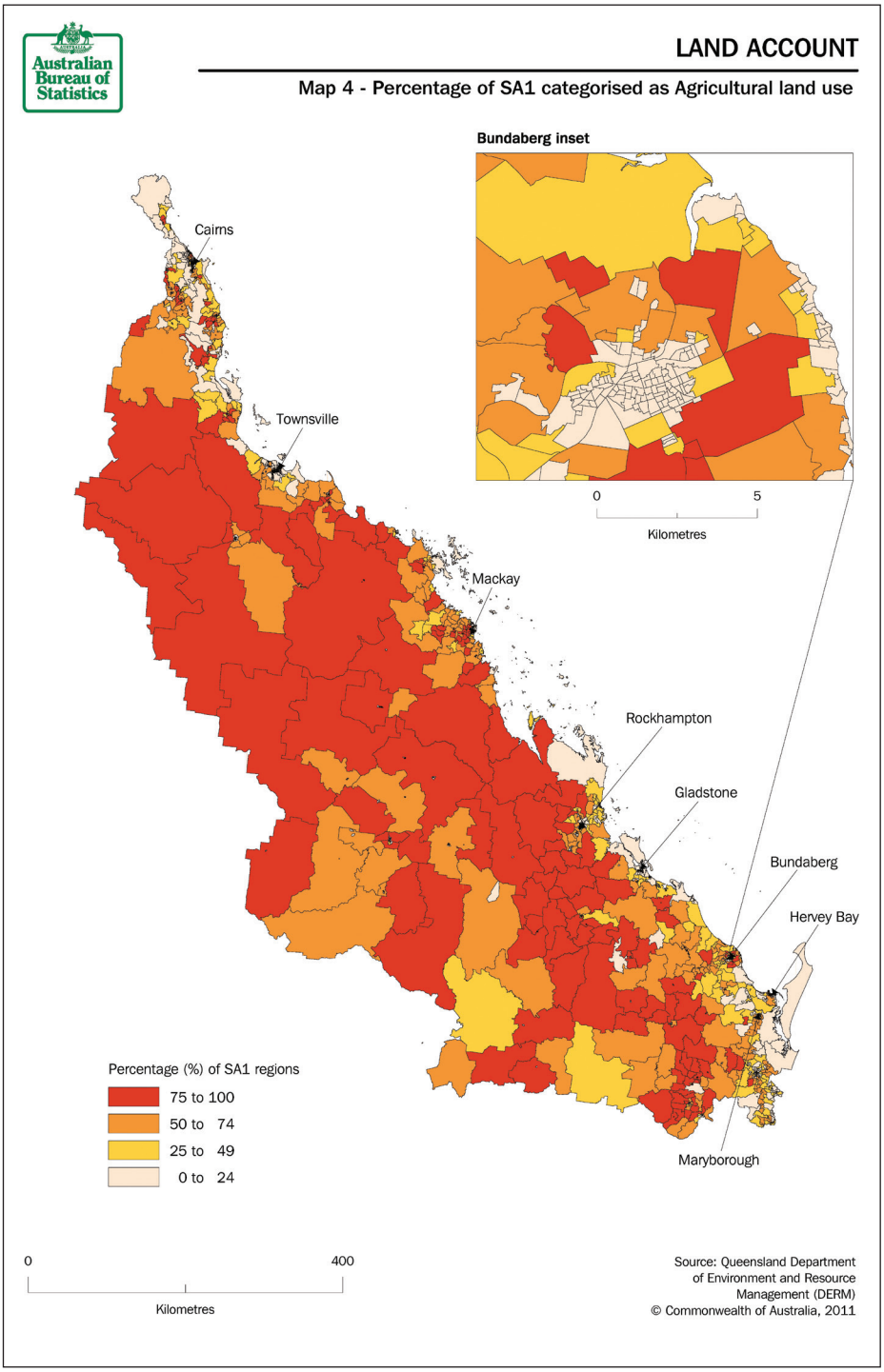
NCAS reports on human-induced greenhouse gas emissions from land-based activities such as agriculture, deforestation and forestry, and includes both emissions (sources) and removals (sinks). It reports against the UNFCCC land use, land use change and forestry (LULUCF) categories. AGEIS focuses on methane and nitrous oxide emissions from livestock and crop production. Together, NCAS and AGEIS provide information on emissions from land-based sectors.

These accounts report on flows, as their purpose is to report on emissions. It can be argued that a more complete carbon account should also include carbon stock accounts to report on the amount of carbon stored in reservoirs and help understand the impacts of changes such as afforestation and other land use changes (Ajani 2011).

4.1.5 Regional Environmental Accounts Trials (Wentworth Group)

The Wentworth Group of Concerned Scientists is trialling a model for environmental accounting that measures the condition of environmental assets and can be applied at any location and at any scale. The Accounting for Nature model (Wentworth Group 2008) compares the current condition of an environmental asset to a reference condition. It uses a common unit of measurement to enable comparisons between different types of environmental assets (for example a river and a rainforest) and between similar assets at different locations. It allows for accounting at regional scales at which management decisions are often made.

Figure 4. Land Account for the Great Barrier Reef - percentage of statistical areas categorised as agricultural land use (ABS 2011).



Environmental assets are defined in the Accounting for Nature model as 'any physical feature in nature that can be measured in time and space' (Wentworth Group 2008). An asset can be defined at any scale, for example, it could be a forest or a wetland. Assets are grouped into broad classes of land, water, atmosphere and marine. Biodiversity is not treated as an asset; rather, it is considered an intrinsic component of an asset.

The reference condition of an asset is defined as the natural condition of an ecosystem in the absence of significant human impact. The condition of the asset is assessed by a number of indicators that are scientifically credible measures of health. A reference condition score is then calculated based on comparing the current condition to the reference condition. The reference condition scores for the indicators are aggregated to a single unit of measure of environmental condition called the *Econd*. The *Econd* ranges from 0 to 100, where the reference condition has a value of 100.

A set of three linked tables are used to present the accounts. The first table summarises the *Econd* for each asset, grouped by class. For each asset, a second table describes the condition scores for each indicator, while the third table lists the raw data for each asset.

The Wentworth Group is undertaking regional trials of the model to test the approach. The trials are taking place in ten natural resource management regions across Australia using existing data, and are being overseen by a Scientific Standards and Accreditation Committee and a Technical Environmental Accounting Standards Committee. Two documents (Guidelines for Regional Environmental Accounts and Draft Standards and Accreditation Manual) are being developed to guide the production of the regional accounts. The Regional Environmental Accounts Trials are ongoing and aim to test concepts such as whether the accounts can be aggregated to a national scale and how the accounts can be integrated with SEEA-style accounts.

4.1.6 Victorian experimental ecosystem accounts

The Victorian Department of Sustainability and Environment (DSE) are developing ecosystem accounts based on the methods applied to their market-based environmental management programs such as ecoTender. The conceptual framework that underpins the accounts is that ecosystem assets are the 'structures, processes and functions formed by the complex interaction of biotic communities … and the physical environment' that can provide multiple ecosystem goods and services. These are 'intra' goods and services (used within the ecosystem, such as decomposition providing nutrients), 'inter' goods and services (transferred between ecosystems, for example water), and final ecosystem goods and services which are provided to the economy (for example, wood or a scenic picnic location). By consuming final goods, a trade-off is being made between economic and ecosystem utility and therefore the capacity to provide ecosystem goods and services. The experimental ecosystem accounts are linked to land accounts and aim to report on the ecosystem goods and services to enable management and investment decisions to be made. The accounts apply the SEEA Central Framework concepts with some adjustments for what is considered to be within the production boundary. The statistical unit of an ecosystem asset is a grid cell which has a spatial and temporal scale (for example 100 m by 100 m per annum), and these units can be aggregated to produce accounts, for example, by catchment or vegetation type.

4.1.7 European land accounts (EEA)

In 2006 the European Environment Agency released land accounts for Europe using the SEEA framework. Land accounts are similar to other asset accounts in that they report on how the stock changes over time. With some minor exceptions, such as coastal erosion, the area of land generally does not change, so land accounts account for land cover and land use.

In the conceptual model that underpins the European land accounts, land cover is an asset where the stock of a land cover type can be reduced (for example land clearing) or gained (for example tree planting). The changes in land cover are the flows between land cover types. Analysing the flows allows for an assessment of whether the gains in a land cover type compensate for the losses and 'whether the quality of the stock carried over from time one to time two has been maintained in terms of the benefits it provides to people or the support it offers to wider ecosystem functions' (European Environment Agency 2006). As such, an assessment of sustainability is allowed for.

The land asset stock and flow accounts developed for Europe were based primarily on the Commission of the European Communities' Coordination of information on the environment (CORINE) land cover data and derived from satellite imagery. The accounts describe 'the geographical patterns of land cover types across Europe, the way they are changing over time, and what types of processes bring about the various transformations' (European Environment Agency 2006).

4.1.8 Ecosystem capital accounting in Europe (EEA)

The European Environment Agency has trialled a Simplified Ecosystem Capital Accounting structure (SECA) as described in An Experimental Framework for Ecosystem Capital Accounting in Europe (European Environment Agency 2011b). The framework applies the definition that 'ecosystem services are the outcome of ecosystem functions which are accessible to people' and attempts to measure the capacity of ecosystems to provide services sustainably. This is done by measuring accessible biomass/carbon, where accessible means 'the share of the "total" or "available" resource that can be used without damaging ecosystem capital capacity' (European Environment Agency 2011b).

To trial SECA, landscape indicators such as land use, land cover, connectivity and environmental protection are combined with biomass and water balances to report the capacity of ecosystem units to deliver services. Key accounts are total ecosystem potential, net change in total ecosystem potential and ecosystem capital degradation. The accounts are consistent with the SEEA framework for ecosystem accounts and are able to be integrated with economic supply and use tables to provide further information to decision makers.

The ecosystem capital accounts can complement accounts produced for specific ecosystem services, although the different accounts would not be additive and care needs to be taken to ensure there is no double counting.

4.1.9 WAVES (World Bank)

Wealth Accounting and the Valuation of Ecosystem Services (WAVES) is a World Bank project that aims to promote sustainability by incorporating natural capital accounting in national accounts. The WAVES partnership is a collaboration between United Nations agencies, partner countries and non-government organisations and details are provided at www.wavespartnership.org/waves/ . The objective is to enable the value of natural resources and ecosystems to be considered by governments in policy decisions. A technical committee is overseeing the development of a method for implementing natural capital accounting based on SEEA. The WAVES project was launched in 2010 and the implementation phase began in June 2012, with the aim of completing the ecosystem accounts in five countries by 2015.

4.1.10 Comparison of existing environmental accounts

Table 2 provides a summary of the above examples of implementations of environmental accounts, comparing the account subject, scale and units applied.

Table 2. Comparison of environmental accounts, existing or under development.

Account	Agency	Account subject	Scale	Units	Statistical units	Accounting units
Water Account Australia	Australian Bureau of Statistics	Water use within the economy	National, State/Territory	Megalitres	Water utilities, economic entity	Industries
National Water Account	Bureau of Meteorology	Available water resource	National, Regional	Megalitres	Water entity	Water management regions
ABS Land Account	Australian Bureau of Statistics	Land use, land cover	State, Regional	Area (ha), dollars	Grid cells, cadastral parcels	Natural resource management regions, Statistical Areas (SAs)
National Greenhouse Accounts	Department of Climate Change and Energy Efficiency	Greenhouse gas emissions	National, State/Territory	Tonnes of carbon equivalents	Companies, facilities	Land-based industry sectors
Regional Environmental Accounts Trials	Wentworth Group	Environmental asset condition	Regional	Econd	Environmental asset	Environmental asset (aggregated)
Victorian Experimental Ecosystem Accounts	Victorian Department of Sustainability and Environment	Ecosystems, ecosystem goods and services	State, Regional	Combined spatial and temporal (e.g. ha/year)	Ecosystem asset (grid cell)	Aggregated as required (e.g. catchment, land tenure, land use)
European Land Accounts	European Environment Agency	Land use, land cover	Continent, National	Area (km^2)	Grid cells	Biogeographical regions, ecosystem types, landscape units
Simplified Ecosystem Capital Accounting in Europe	European Environment Agency	Capacity of ecosystems to provide services	Continent	Ecosystem Potential Unit Equivalent (EPUE), dollars	Ecosystem units, economic entity	Administrative regions, biogeographical regions, industries
Wealth Accounting and Valuation of Ecosystem Services	World Bank	Natural capital	National	Dollars and various units for physical flow and asset accounts (e.g. ha, ML)	Economic entity, various environmental statistical units (e.g. lake, forest)	Industries

4.2 Current implementations of ecosystem services assessment frameworks

4.2.1 Millennium Ecosystem Assessment framework

The Millennium Ecosystem Assessment has developed a conceptual framework for assessing ecosystem services at local, regional and global scales. This is described in Ecosystems and Human Well-Being: a Framework for Assessment (Millennium Ecosystem Assessment 2003).

Human well-being is a key concept of the Millennium Ecosystem Assessment framework. The framework applies an ecosystem services model that has at its core the benefits of ecosystems obtained by humans. Direct and indirect actions can impact ecosystems and therefore the benefits they provide, which in turn affect human well-being. These actions (direct drivers such as changes in land cover, application of fertiliser and introduction of species or indirect drivers including population growth, policy decisions and economic situations) can have impacts on ecosystem services at local, regional, national or global scales, and can have short or long-term impacts. The Millennium Ecosystem Assessment framework takes the interactions and relationships between the drivers and the impact on ecosystem services and human well-being into consideration as represented in Figure 5.

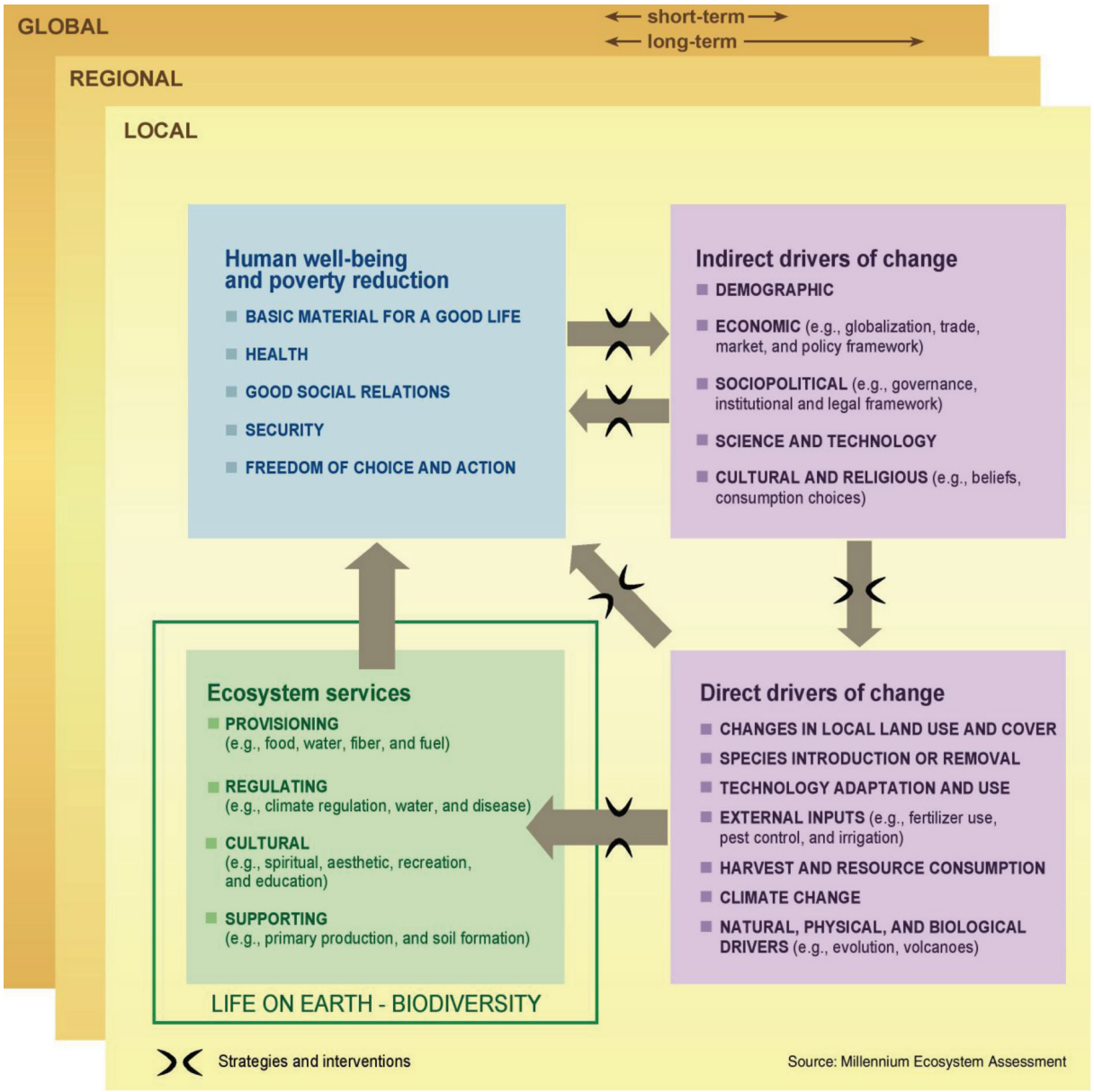
Case study: Millennium Ecosystem Assessment report on wetlands and water

The Ecosystems and Human Well-Being: Wetlands and Water Synthesis report produced in 2005 by the Millennium Ecosystem Assessment applied the framework to assess the current state of wetland ecosystems globally. The assessment identified the services provided by wetlands, such as food (for example, fish), water purification through the removal of excess nutrients and other pollutants, water flow regulation, opportunities for recreational activities and flood control. Drivers causing wetland degradation and loss were also identified, for example, land use change, invasive species and pollution. The assessment examines impacts of these drivers on different types of wetlands and how the impacts change under different management scenarios. The trade-offs between ecosystem services under different scenarios are examined, for example, the trade-off between agricultural production and water quality or the trade-off between current and future use. Spatial data and models have been used to assess the extent and distribution of wetlands and some possible responses to different management strategies.

4.2.2 The Economics of Ecosystems and Biodiversity (TEEB)

The Economics of Ecosystems and Biodiversity (TEEB) study is an international initiative proposed at the 2007 meeting of the G8 Environment Ministers in Potsdam, and is hosted by the United Nations Environment Programme (UNEP). As described on the TEEB website www.teebweb.org, the study aims to 'evaluate the costs of the loss of biodiversity and the associated decline in ecosystem services worldwide'. TEEB takes the approach that ecosystem services are underpinned by biodiversity and that the benefits provided by nature (through natural capital and ecosystem services) are consistently undervalued by decision makers. Although TEEB accepts that it is neither appropriate nor possible to put an economic value on all ecosystem services, it argues that at least attempting to value these services through the use of economic tools goes some way to more accurately assessing the value of nature to human well-being. TEEB does not distinguish between intermediate and final ecosystem services. Instead, it tries to account for the costs and benefits of conserving identified ecosystem services for a number of different case studies, such as the value that a wetland provides in water purification and storm damage control.

Figure 5. Millennium Ecosystem Assessment Conceptual Framework. The black cross bars represent where strategies and policies can be implemented to change the impact of drivers (either limit a negative impact or maintain a positive impact). © Millennium Ecosystem Assessment 2003—used with permission. The Creative Commons licence does not apply to this material. If you wish to further use this material you must contact the copyright owner directly to obtain permission.



The results are not asserted to be a complete economic valuation. TEEB acknowledges that results should be interpreted with care but they nonetheless provide a useful tool for more comprehensively valuing nature in decision-making processes. The aim is to aid a more sustainable use of the world's natural capital.

4.2.3 UK National Ecosystem Assessment (NEA)

The UK National Ecosystem Assessment (NEA 2011) is based on the Millennium Ecosystem Assessment framework but extends the conceptual framework to incorporate economic valuations and to define final ecosystem services in order to avoid double counting. The conceptual framework used by the NEA is shown in Figure 6.

At its core, the NEA analyses the role of the environment in human well-being. Three different types of valuations are undertaken to evaluate the environment and the ecosystem services it provides—economic valuation (of use and non-use goods), health benefits and shared values. The value of final ecosystem services is determined by identifying goods that are provided from the services and ensuring that the value of those goods is fairly attributed to ecosystems. For example, the full value of timber cannot be attributed to trees, as human capital has added value to convert the trees to timber.

The assessment is undertaken on a number of broad habitat or ecosystems classes, and the ecosystem services that each of these broad habitats provide are identified. The assessment evaluates the current capacity of the UK's ecosystems to provide services, as well as evaluating the drivers of change (such as conversion to farmland and overexploitation of natural resources). Possible outcomes for the future under six different scenarios are described. Scenarios include increased awareness of environmental issues, reduced dependency on imports, increasing global energy prices and market regulation. The scenarios provide a way to consider the impacts of different policy decisions.

Figure 6. UK National Ecosystem Assessment conceptual framework. © UK NEA 2011—used with permission. The Creative Commons licence does not apply to this material. If you wish to further use this material you must contact the copyright owner directly to obtain permission.

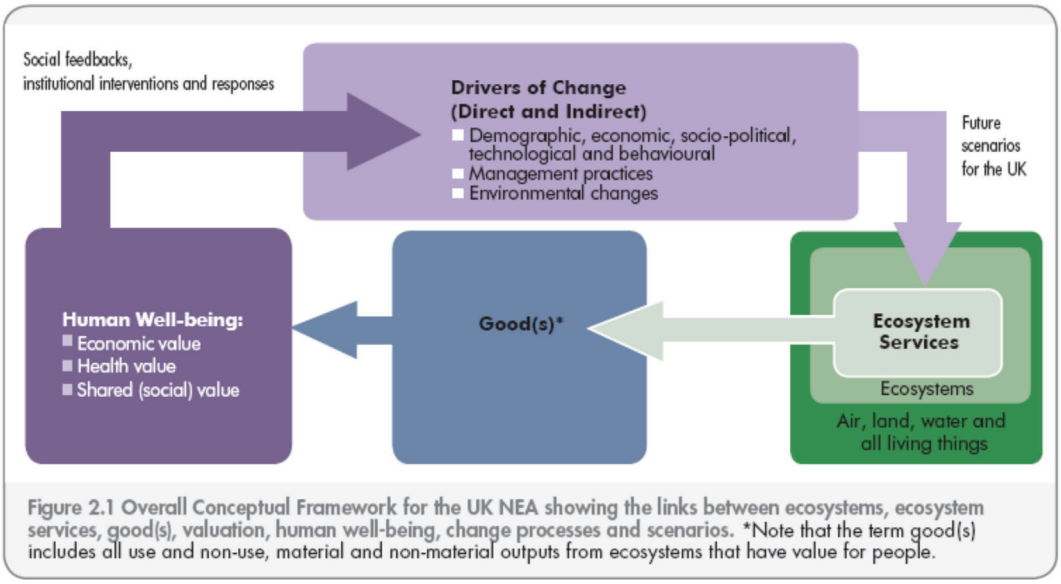


Figure 2.1 Overall Conceptual Framework for the UK NEA showing the links between ecosystems, ecosystem services, good(s), valuation, human well-being, change processes and scenarios. *Note that the term good(s) includes all use and non-use, material and non-material outputs from ecosystems that have value for people.

5. Conclusion

Environmental accounts provide a structured, systematic way to organise environmental information for a clear decision-making purpose. They are not a new concept, and there are existing frameworks and implementations currently in use both in Australia and internationally. Accounting principles, standards, and conceptual frameworks underpin environmental accounts to provide consistent, comparable data that allow for analysis of changes over time to assist decision-makers in improving management of the environment. The accounting concepts and frameworks described in this paper will help inform the development of a general framework for Australian environmental accounting being developed by the Bureau under the National Plan for Environmental Information. The framework will draw on SEEA and other established accounting models to deliver a framework that can support environmental accounting at a range of scales and for a range of perspectives, including economic, social and environmental perspectives.

6. Glossary

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.
Accrual accounting	System of accounting where economic events are recorded at the time at which the transaction/event occurs rather than when the payment is made or received.
Asset	A resource controlled by an entity as a result of past events and from which future economic benefits are expected to flow to the entity.
Beneficiary	Entity which receives money or other benefits.
Capital	A produced or non-produced good that can be used in the production of goods and services.
Ecosystem	Living organisms interacting with the non-living environment as a functional unit.
Ecosystem capital	Stock of natural ecosystems that yields a flow of valuable ecosystem goods or services.
Ecosystem Services	The benefits people obtain from ecosystems (Millennium Ecosystem Assessment)
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 management of water.
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 2012).
Flows	Changes in the volume, composition or value of stocks. In ecosystem accounts, flows are the services and benefits derived from ecosystems.
Liability	A present obligation of the entity arising from past events, the settlement of which is expected to result in an outflow from the entity.
Natural capital	The stock of living and non-living components of the earth that provide a flow of valuable ecosystem goods or services.
Non-use value	Value placed on knowing that a resource exists even if that resource is never used directly. Also known as existence value.

Option value	Preserving the option to use an (ecosystem) service in the future that may not be used at present.
Production boundary	Defined in the SNA as the goods and services produced in the economy.
Reference condition	The condition of an ecosystem at a point in time to which change can be compared, often interpreted in Australia as pre-European condition.
Reporting unit	Aggregation of statistical units used for accounting purposes. The SNA and SEEA apply a standard classification of industries for reporting.
Residual	Outflow from the economy to the environment (e.g. solid, liquid and gas waste) which uses the environment as a sink.
Statistical unit	Entity for which information is sought and for which statistics are ultimately compiled. For example, the SNA collects data about an economic entity, while the statistical unit for ecosystem accounts is likely to be a spatially defined area of land.
Stock	The amount of an asset (financial and non-financial) held at a particular time.
Strong sustainability	The existing stock of all forms of capital must be maintained or increased independently of each other.
Sustainability	World Commission on Environment and Development (1987) report 'Our Common Future' defined sustainable development as the ability to 'meet the needs of the present without compromising the ability of future generations to meet their own needs'. This notion has evolved and sustainability can be described as maintaining or enhancing the well-being of society now and into the future thorough the maintenance of economic, social and environmental capital.
Weak sustainability	Maintenance of total capital. Natural capital may be degraded or depleted as long as the depletion is offset by an increase in other forms of capital (for example, replace natural materials with manufactured goods).
Well-being	Multidimensional concept of having a good life; encompasses security, nutrition and shelter, health, good social relationships and freedom of choice and action.

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