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A common framework of natural capital assets for use in public and private sector decision making

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ABSTRACT

Natural capital assets are currently under pressure globally. This pressure may result in changes in the function of ecological systems and associated ecosystem services, resulting in changes in the benefits derived by people. The loss of natural capital also translates into economic and business risk. While advances have been made to understand and classify ecosystem services, the linkages between such services and the natural capital assets that combine to enable service provision are less well established. An agreed classification of natural capital assets is required to standardise their identification, description and measurement, and support action to reduce and mitigate the pressures they are under. Here, we evaluate the main systems classifying the environment into natural capital assets, against a number of requirements for decision making, showing that to date, we lack a unified classification encompassing all aspects of the natural environment. We have thus amended and consolidated existing classifications and propose a new hierarchical classification, which allows standardisation of use within public and private sector natural capital assessments. Promoting a common understanding is key in measuring and monitoring the value of assets and will enable more consistent and holistic decision making in relation to the management of natural capital.

1. Introduction

Natural capital is the "stock of renewable and non-renewable resources that combine to yield a flow of benefits to people" (Natural Capital Coalition, 2016). As such, it can be helpful in drawing connections between the natural world, sustainable development and human wellbeing and/or livelihoods (Guerry et al., 2015). Natural capital assets support the ecosystem services that underpin our economy and thus deliver inputs or indirect benefits to business (Guerry et al., 2015). As in economics, asset simply describes something that generates value (Bishop, 2004). For example, forests are natural capital assets which support ecosystem services including climate regulation and timber, and are an important component of the world's natural capital stocks (TEEB, 2010). Globally, more than 1.6 billion people depend on forests for their livelihoods (Chao, 2012) and it is estimated that forests are worth $4.7 trillion per year (Costanza et al., 1997). While some of the benefits that natural capital provides can be substituted by technology, such as synthetic foods, many essential ones, like nutrient cycling, cannot (Natural Capital Finance Alliance, 2015).

Numerous factors are leading to the depletion of natural capital assets, including unsustainable use of resources by humans, pollution, land use change, and habitat fragmentation. If these assets decline below a threshold, the natural function of ecological systems and the associated ecosystem service flows will change to a less favourable or non-functional state (Mace et al., 2015). Such changes may be severe, unpredictable or irreversible for some assets, and may lead to risk exposure for businesses and the broader economy. Risk exposure could be associated with, for example, loss of access to raw materials or increased costs associated with shifting supply chains to different locations (ACCA, Fauna & Flora International and KPMG, 2012; UN Environment Finance Initiative, 2008).

Currently the role of natural capital assets in supporting ecosystem service benefits is invisible to many key decision makers in business and governments. However, to enable the consistent monitoring and assessment needed for the management of natural capital, for example via the Natural Capital Protocol (Natural Capital Coalition, 2016), it is

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important to achieve a common understanding of what constitutes natural capital assets and how these relate to ecosystem services. Without such an understanding, the risk exists that ecosystem services are managed without maintaining the stock of natural capital assets. Managing the stock of natural capital assets is key to sustaining ecosystem service flows, for example, by managing stocks of wild pollinators, farmers are able to maintain pollination services more effectively (Garibaldi et al., 2013).

A common classification of natural capital assets is a first step in being better able to measure and monitor assets, and in better understanding their link to ecosystem services for consistent decision making. Understanding the link between natural capital assets and ecosystem services enables the loss and/or variation of ecosystem service provision to become more apparent to decision makers and can contribute to preventing the depletion of natural capital assets. The Natural Capital Protocol (Natural Capital Coalition, 2016) and Smith et al. (2017) provide a summary of known natural capital assets and how they support ecosystem services, but no formal classification or explanation of how combinations of natural capital assets support services (Costanza et al., 1997). Existing formal classifications group natural capital assets in varying ways (for example SEEA Central Framework (2014a–c); Natural Capital Committee (2014), Shepherd et al. (2016) and OECD Green Growth Indicators (2017)). However, their utility in public and private sector decision making is yet to be explicitly evaluated. A standardised classification of natural capital assets also needs to go beyond a breakdown into solely abiotic and biotic components (for example, classifications developed by the Department for the Economics, Assessment and Integration of Sustainable Development in France (2015) and European Environment Agency (2015)) to levels that are appropriate for decision makers within public and private sectors. For example, company risk assessments and siting decisions will be very different in wetlands compared to deserts so any classification of natural capital assets would need to breakdown habitats into this level of detail to ensure suitability for decision making.

2. Evaluation of existing natural capital asset classifications

In this section we evaluate the main existing systems for classifying natural capital against a number of requirements for public and private sector decision making, with the aim to understand (a) if they are currently able to standardise the identification and description of natural capital assets for decision making, (b) whether they require minor amendments or consolidation, or (c) whether an entirely new classification is needed to standardise assets. Requirements were identified based on available literature on ecosystem services classifications (for example La Notte et al. (2017)) – Table 1. Although developed with different objectives in mind, the systems evaluated here mostly aim to inform public sector decision making. To the best of our knowledge only the Natural Capital Protocol has attempted to list natural capital assets for private sector decision making – and in this case it is not a formal classification but a summary of known assets (Natural Capital Coalition, 2016).

2.1. The System of Environmental-Economic Accounting Central Framework

The System of Environmental-Economic Accounting (SEEA) Central Framework (2014) is a statistical framework for understanding interactions between the economy and the environment, and describes stocks of environmental assets. It was developed for use by public sector decision makers as it provides a readily accessible, common framework which can be adapted to countries' priorities and policy needs. Environmental assets are defined as the "naturally occurring living and non-living components of Earth which may provide benefits to humanity", and often provide resources for use in economic activity.

In the Central Framework, seven individual components of the environment are considered as assets: mineral and energy resources, land, soil resources, timber resources, aquatic resources, other biological resources and water resources. The land component denotes the provision of space and defines the locations in which economic activity and assets are situated. It also includes marine areas over which a country has a recognised claim, including its Exclusive Economic Zone (EEZ), and inland water bodies. Within this framework, forests, for example, are considered a type of land cover, whereas forestry is considered a land use. This example is useful for illustrating why integration of such data is important for natural capital assessments as forestry harvesting cycles will, temporally, strip areas of tree cover. This should be recorded as a reduction in the stock of forests and should not be indicative of a reduction in the extent of land employed for forestry activity. Some of the components in this framework are broken down into a further level of detail, for example water resources as surface water, ground water and soil water, but others are not, for example soil resources. Although simple and understandable, the categories are not comprehensive, for example the volume of water in the sea and the volume of air in the atmosphere was not included as these were considered too large to be meaningful for analytical purposes.

The Central Framework is extended by the Experimental Ecosystem Accounting framework (SEEA-EEA, 2014), which explicitly considers ecosystems as natural capital assets delivering service flows. However, the SEEA-EEA does not provide a typology for these ecosystem assets. There have since been attempts to classify ecosystems (such as Maes et al. (2014)), but they do not characterise all aspects of natural capital. The Central Framework, for example, considers natural capital assets that cut across multiple aspects of ecosystems (such as soils, freshwater etc.), as do the Natural Capital Committee (2014), but additional conceptualisation and consideration of the hierarchical organisation of

Table 1
Identified requirements for a natural capital asset classification to support public and private sector decision making. The requirements are based on previous research on the use of ecosystem service classifications in decision making.

Requirement	References
1. Few, understandable categories	La Notte et al. (2017), Maes et al. (2012) and Wallace (2007)
2. Readily accessible, i.e. users can access the classification when needed, not that it is only available on request or subject to subscription	La Notte et al. (2017)
3. Distinct boundaries to avoid double-counting	Haines-Young and Potschin (2009) and La Notte et al. (2017)
4. Comprehensive	Fisher et al. (2007), Haines-Young et al. (2012) and Mace et al. (2015),
5. Appropriate scale(s) for decision making	Fisher et al. (2007)

ecosystems (La Notte et al., 2017) are needed to understand ecosystems as assets. In particular the capacity to supply services (Hein et al., 2016) may often be related to particular features of ecosystems (for example, hedgerows for pollinators) or the interaction of ecosystems in multi-functional landscapes (such as the role of different ecosystems in mountainous and upland areas in water provision).

2.2. Natural Capital Committee – Towards a framework for defining and measuring changes in natural capital (and subsequently adapted by Shepherd et al. (2016))

The Natural Capital Committee is an independent advisory committee which provides advice to the UK government on the sustainable use of natural capital. A report by the Natural Capital Committee in 2014 sets out to clarify the meaning of natural capital for use in the Natural Capital Committee's work. In this framework natural capital assets are grouped into ten understandable and readily accessible categories in order to ensure the flow of benefits: species, ecological communities, soils, freshwater, land, atmosphere, minerals, sub-soil assets, coasts and oceans. However, it is noted that these categories are not mutually exclusive and there is overlap between some, for example soils include species, minerals, and water.

In this assessment of benefits derived from natural capital, Mace et al. (2015) use eight broad habitat types identified and mapped under the UK National Ecosystem Assessment as proxies for natural capital assets (UK NEA, 2011). This provides a classification of land uses with similar configurations to the natural capital assets described by the Natural Capital Committee, allowing the spatial distribution of areas with broadly consistent biophysical processes to be established. These are, in turn, expected to yield a flow of broadly commensurate benefits from each habitat type. However, these habitat types provide a poor representation of marine areas, overemphasise the differences between habitats and obscure the direct linkage between the broad range of natural capital assets, such as soils, species and ecological communities, the atmosphere, and the benefits they provide.

Mace et al. (2015) suggest there are a number of other possibilities for classifying natural capital assets, for example frameworks distinguishing ecocentric and anthropocentric types (De Groot et al., 2003), which may be more inclusive than classifications used in environmental economic accounting. The authors also suggest that more needs to be done to include all natural resources, renewables and non-renewables, within risk registers for public and private sector use, and within natural capital asset classifications.

The Natural Capital Committee classification was subsequently adapted in Shepherd et al. (2016). "Species" and "ecological communities" were combined to form biodiversity, "coasts" were included within oceans, and "carbon" was explicitly classified. However the classification proposed by Shepherd et al. (2016) also does not have distinct boundaries and is not comprehensive. Non-renewable resources, minerals and sub-soil assets, were excluded from Shepherd et al. (2016) because the study set out to assess progress towards Aichi Biodiversity Target 14, where non-renewables are not the focus. In addition, while the authors recognised that fertilisers and raw materials were sources of energy, this tends to be after extensive processing by human capital and in combination with other natural capital assets, which was another reason for their exclusion.

2.3. Organisation for Economic Cooperation and Development Green Growth Indicators

The OECD Green Growth Indicators (2017) were designed to help countries assess and compare their progress on green growth. These indicators consist of four data groups, one of which one group is "natural asset bases", defined as "data that characterize the availability, accessibility and quality of the natural assets (natural capital) that form the basis of economic activity". The other groups are "resource efficiency", "exposure to pollution and environmental risks" and "policies and economic opportunities".

The "natural asset bases" data group is comprised of renewable resources (endowments in freshwater resources, abstraction and intensity of use; endowments in forest resources; endowments in renewable energy resources and agricultural and fishery resources), non-renewable resources (endowments in subsoil assets (energy and mineral resources) and depletion/discovery rates), and biodiversity and ecosystems (land and soil resources, ecosystem services, priority areas for biodiversity conservation, and level of threat to species). Although the classification is readily accessible and has few, understandable categories, there is overlap between renewable resources and biodiversity and ecosystems, and the classification is not comprehensive. Marine habitats, atmosphere and carbon are not considered, even though the latter are important in, for example greenhouse gas accounting, and geomorphology is not included which can provide important information for corporate planning and siting decisions (for example, it is important to consider the extent of the sea shelf when deciding where to site an oil drilling platform).

In summary, while the existing classification systems have few, understandable categories and are readily accessible for decision makers, neither are comprehensive or available at multiple scales for decision making (Table 2). The ability to aggregate or disaggregate to varying levels of detail is important to ensure that natural capital assessments both capture the complexity of the natural environment and are communicable to non-expert decision makers. For example, a government using a natural capital asset classification to catalogue the stocks of natural capital assets within its country should be able to

Table 2
Evaluation of the main systems for classifying natural capital assets against identified requirements for public and private sector decision making. Tick marks (✓) indicate that the system meets the requirement, tildes (~) indicate that the system partially meets the requirement, and crosses (✗) indicate that the system does not meet the requirement. Justifications for these evaluations are provided in the text.

Existing natural capital asset classifications				
Identified requirements	SEEA Central Framework (2014)	Natural Capital Committee (2014)	Shepherd et al. (2016)	OECD Green Growth Indicators (2017)
Few, understandable categories	✓	✓	✓	✓
Readily accessible	✓	✓	✓	✓
Distinct boundaries to avoid double-counting	✓ (where possible)	✗	✗	✗
Comprehensive	✗	✗	✗	✗
Appropriate scale(s) for decision making	~ (available at a single scale)	~ (available at a single scale)	~ (available at a single scale)	~ (available at a single scale)

discriminate between habitats, like grasslands and forests, but would also need to aggregate as habitats or biodiversity for communications with senior government officials.

Classifications also need to be both collectively exhaustive and ideally mutually exclusive, meaning that no natural capital asset can occur more than once and that the classification encompasses the total possible assets of terrestrial, marine and freshwater ecosystems and the natural environment (lithosphere, biosphere, and atmosphere). Although the SEEA Central Framework classifies the majority of natural resources and ecosystems as natural capital assets, it does not consider the volume of water in the sea or air in the atmosphere, and only considers carbon within timber resources. In comparison, the Natural Capital Committee (2014) includes atmosphere, but does not explicitly include carbon or timber resources. Shepherd et al. (2016), likewise, do not include timber resources, but this framework does classify atmosphere and carbon. The OECD Green Growth Indicators, on the other hand, do not include atmosphere or carbon as natural capital assets. Due to essential relationships in the natural environment, there are, however, inevitably, inherent linkages in the system that are difficult to decouple, particularly with respect to species and habitats. This may mean that mutual exclusivity is not possible to achieve while being collectively exhaustive.

Our evaluation of existing classification systems suggests there is currently no single typology for classifying all aspects of natural resources and ecosystems as natural capital and existing systems are not able to aggregate or disaggregate natural capital to varying levels of detail. Yet minor amendments and the consolidation of existing systems could produce a classification which is able to standardise the identification and description of natural capital assets for use in public and private sector decision making.

3. A hierarchical natural capital asset classification

Based on the above appraisal, the existing classifications were amended and consolidated to produce a hierarchical natural capital asset classification that standardises the identification and description of all natural capital assets that combine to support ecosystem services (Table 3). A further hierarchical level was added, where necessary, to capture, for example, different types of aquatic or terrestrial habitats.

The resulting hierarchical classification has four levels to allow aggregation or disaggregation depending on the level of complexity required in decision making. It covers all aspects of natural capital, in marine, terrestrial and freshwater systems and all abiotic and biotic components. Where possible, the classification has distinct boundaries, noting that inherent linkages in natural systems may mean that some aspects are difficult to decouple, particularly with respect to species and habitats. For the purposes of this classification, we follow the Natural Capital Coalition's definition of natural capital: "the stock of renewable and non-renewable natural resources (for example, plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people" (Natural Capital Coalition, 2016). However, the classification can easily be adapted for use with other definitions of natural capital, which exclude non-renewables by omitting the "Non-renewable" assets in Level 2 (see Table 3).

The first level is broken down into abiotic and biotic natural capital assets as per a breakdown of natural capital proposed by the European Environment Agency (2015), the Department for the Economics, Assessment and Integration of Sustainable Development in France (2015) and Van der Meulen et al. (2016). The abiotic component is split into non-renewable (i.e. assets that can be depleted and not replaced – referred to in the OECD Green Growth Indicators), functional (i.e. assets that can be influenced, impacted and potentially degraded to a point at which they stop functioning), and physical natural capital assets (i.e. static assets referring to the land and ocean). Physical natural capital assets do not appear in the existing classifications but have been included here as land and ocean geomorphology to capture an important abiotic aspect of ecosystems. Consumptive use of non-renewable resources like minerals, soils and sediments which make up these physical assets is important in many industries, but the non-consumptive combination of these assets defining the shape and structure of terrestrial and marine environments also influences the provision of ecosystem services, such as erosion control. Land is classified into the four major landforms: mountains, plains, plateaus and valleys (Gutierrez and Gutierrez, 2016)), and ocean is classified into shelf, slope, abyssal and hadal as per the geomorphology of the ocean described in Harris et al. (2014).

Water and non-renewable assets are classified as per the SEEA Central Framework, with the inclusion of ocean water. Atmosphere is included as per the Natural Capital Committee (2014) and Shepherd et al. (2016) frameworks, but is here further broken down as atmospheric gases and atmospheric processes. Soil resources are included in all of the reviewed classifications, but here are further broken down as top-soil, sub-soil and ocean sediments. It should be noted that soil carbon is captured within top-soil and sub-soil in this classification (Level 4 - Table 3), and ocean carbon within ocean water (Level 4 - Table 3).

The biotic component in the classification is based on the biodiversity and ecosystems class within the OECD Green Growth Indicators. Biodiversity at Level 2 is broken down into habitats and species at Level 3 - Table 3. Marine and terrestrial habitats are based on the European Environment Agency's European Nature Information Service (EUNIS) habitat types and the UN SEEA Central Framework land cover classes (see Table 5.12 in the Central Framework), from the FAO Land Cover Classification System, version 3 (FAO, 2009). Genetic resources, and plant, animal, fungal, and algal species are further broken down as wild and domestic/commercial species to capture both commercial species assets, such as timber plantations, and wild species assets, such as wild tree species.

4. Discussion

Natural capital assets support the ecosystem services that underpin our economy and provide inputs or indirect benefits to business. Assets are likely to be depleted and degraded due to rates of regeneration and restoration being slower than the rate of consumption. Standardising the identification and description of natural capital assets will ultimately allow identification of the potential drivers of change in ecosystem service provision. But standardisation is also challenging as the way in which natural capital assets combine to support services and benefits is complex, and the data available for reporting on assets is often incomplete and may only provide a partial picture of overall status and trends.

The hierarchical nature of the proposed classification allows users to aggregate or disaggregate natural capital assets to varying levels of detail depending on the level of complexity required to discriminate between the natural capital assets. This is an important feature for non-expert decision makers within public and private sectors, and sets this classification apart from existing systems. Although public and private sector decision makers are likely to use the classification in a similar way, the motives for identifying and describing natural capital assets are likely to differ. Financial institutions, for example, may use the classification to assess the disruption risk to their potential investments (see Box 1), whereas governments may use it to catalogue the stocks of natural capital assets within countries.

The classification proposed here is an essential first step in creating a common understanding of the relationship between natural capital assets and ecosystem service flows to enable a consistent approach to natural capital assessments within public and private sectors. By including all aspects of natural systems the classification is able to be comprehensively exhaustive. This is important because service provision may be different for different combinations of assets, for example grassland plains versus grassland plateaus, and also because some plant

Table 3
Hierarchical classification of natural capital assets, including examples of the natural capital assets found within each level. The proposed natural capital asset classification includes four levels, initially split into abiotic and biotic components and then further broken down at each subsequent level to classify the natural capital assets in more detail.

	Level 1	Level 2	Level 3	Level 4	*Examples*
Natural Capital Assets	Abiotic	Functional	Atmosphere	Atmospheric gases	*Oxygen*
				Atmospheric processes	*Climate, weather and temperature regulation*
			Water	Surface	*Water resources provided by lakes*
				Ocean	*Water resources provided by oceans*
				Ground	*Water resources provided from aquifers*
				Fossil	*Water resources provided by glaciers*
				Soil	*Water resources provided by soil*
		Non-renewable	Energy	Oil resources	*Oil reserves*
				Gas resources	*Natural gas reserves*
				Coal and peat resources	*Coal reserves*
			Minerals	Metallic mineral resources	*Copper reserves*
				Non-metallic mineral resources	*Limestone or rock*
			Soils and sediments	Top-soil	*Top-soil composition*
				Sub-soil	*Sub-soil structure*
				Ocean sediments	*Ocean sediment composition*
		Physical	Land geomorphology	Mountains	*Height of peak*
				Plains	*Extent of plain*
				Plateaus	*Extent of plateau*
				Valleys	*Depth of valley*
			Ocean geomorphology	Shelf	*Extent of shelf*
				Slope	*Number of seamounts*
				Abyssal	*Number of canyons*
				Hadal	*Number of trenches*
	Biotic	Biodiversity	Habitats	Littoral	*Littoral sand*
				Sub-littoral	*Sub-littoral sediment*
				Deep-sea	*Deep sea mud*
				Coastal	*Coastal dunes*
				Inland surface waters	*Riparian habitat*
				Grasslands	*Alpine grassland*
				Heathland and scrub	*Arctic scrub*
				Woodland and forests	*Evergreen woodland*
				Unvegetated or sparsely vegetated	*Tundra*
				Agriculture and croplands	*Arable mixed crops*
				Urban and developed areas	*Opencast mines*
				Habitat complexes	*Wooded tundra*
			Genetic resources, and plant, animal, fungal, and algal species	Wild	*Number of threatened species*
				Domestic, commercial	*Livestock density*

species, such as canopy tree species for shade or shelter provision, which are found in multiple habitats, provide a service regardless of the habitat in which they are found. However, further research will be necessary to understand the mutual exclusivity of species and habitats in the classification and to identify how the classification links with existing ecosystem service classifications.

The role of natural capital assets in supporting ecosystem service benefits is often not understood or visible by decision makers. With a drive by both the public and private sector to assess natural capital, a consistent approach of what constitutes natural capital assets and how they relate to ecosystem services is vital. Without this there is a risk that different systems are developed which do not meet the requirements of decision makers and which lead to inconsistent monitoring and assessment of natural capital. Governments assessing and establishing policies to safeguard natural capital assets are likely to be more successful in engaging the private sector if they have adopted a similar classification by which to identify impacts and dependencies on natural capital. Failure of governments and the private sector to assess and manage natural capital against the same framework may therefore give rise to mismatches between policy requirements and corporate action to comply.

Box 1

Case study: Improving the consideration of risks from environmental degradation for financial institutions.

Banks and other financial institutions need to understand how environmental degradation can lead to disruption in the operations of the businesses that they lend to or invest in. To be able to do this, they first need to understand how these businesses depend on a range of ecosystem services for their operations. However, in order to assess the disruption risk to the businesses linked with these dependencies, they also need a robust approach to link services they depend on back to the natural capital assets that support them. A standardised classification of natural capital assets enables this link to be made, providing financial institutions with a tool to evaluate the status and trends of assets and to subsequently estimate the risk of disruption in the flow of ecosystem services. The classification proposed here thus constitutes a useful resource enabling banks and other financial institutions to reach a common understanding of their connection to nature and recognise the benefits they receive from well-functioning ecosystems.

For example, a bank investing in an infrastructure project in a low-lying region subject to coastal erosion, will be dependent on erosion control as an ecosystem service if their investment is to be viable. This service is delivered through a combination of vegetated habitats, well-structured soils and sediments, and stable land geomorphology. Standardising the identification and description of these natural capital assets enables a consistent approach to risk assessment both within and between financial institutions.

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References

ACCA, Fauna & Flora International and KPMG, 2012. Is Natural Capital a Material Issue?.
Bishop, M., 2004. Essential Economics. Bloomberg Press Economist Books.
Chao, S., 2012. Forest Peoples: Numbers Across the World. Forest Peoples Program, Moreton-in-Marsh, U.K. As cited in: World Bank, 2016. World Bank Group Forest Action Plan FY16–20. World Bank, Washington DC. Billions more, including people in cities, depend on forest resources.
Costanza, R., et al., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260.
De Groot, R., Van der Perk, J., Chiesura, A., van Vliet, A., 2003. Importance and threat as determining factors for criticality of natural capital. Ecol. Econ. 44, 187–204.
Department for the Economics, Assessment and Integration of Sustainable Development, 2015. Nature and the Wealth of Nations. France.
European Environment Agency, 2015. Natural Capital and Ecosystem Services. Briefing Note.
Fisher, B., Costanza, R., Turner, R.K., Morling, P., 2007. Defining and Classifying Ecosystem Services for Decision Making, CSERGE Working Paper EDM, No. 07-04. University of East Anglia, The Centre for Social and Economic Research on the Global Environment (CSERGE), Norwich.
Food and Agriculture Organization of the United Nations (FAO) Global Land Cover Network, 2009. Land Cover Classification System Version 3. FAO, Rome.
Garibaldi, L.A., et al., 2013. Wild pollinators enhance fruit set of crops regardless of honey bee abundance. Science 339, 1608–1611.
Guerry, A.D., et al., 2015. Natural capital and ecosystem services informing decisions: from promise to practice. Proc. Natl. Acad. Sci. U.S.A. 112, 7348–7355.
Gutierrez, F., Gutierrez, M., 2016. Landforms of the Earth: An Illustrated Guide. Springer International Publishing, Switzerland.
Haines-Young, E.K.N., Haines-Young, R., Potschin, M., Fish, R., 2012. Classifying Ecosystem Services. Ecosystems Knowledge Network Briefing Paper No. 1.
Haines-Young, R.H., Potschin, M.B., 2009. Project Code C08-0170-0062 In: Methodologies for Defining and Assessing Ecosystem Services. Final Report. JNCC, pp. 69.
Harris, P.T., Macmillan-Lawler, M., Rupp, J., Baker, E.K., 2014. Geomorphology of the oceans. Mar. Geol. 352, 4–24.
Hein, L., Bagstad, K., Edens, B., Obst, C., de Jong, R., Lesschen, J.P., 2016. Defining ecosystem assets for natural capital accounting. PLoS One 11, e0164460.
La Notte, A., et al., 2017. Ecosystem services classification: a systems ecology perspective of the cascade framework. Ecol. Indic. 74, 392–402.
Mace, G.M., Hails, R.S., Cryle, P., Harlow, J., Clarke, S.J., 2015. Towards a risk register for natural capital. J. Appl. Ecol. 52, 641–653.
Maes, J., et al., 2014. Assessment of Ecosystems and their Services. An Analytical Framework for Ecosystem Assessments Under Action 5 of the EU Biodiversity Strategy to 2020. Publications Office of the European Union, Luxembourg.
Maes, J., et al., 2012. Mapping ecosystem services for policy support and decision making in the European Union. Ecosyst. Serv. 1, 31–39.
Natural Capital Coalition, 2016. Natural Capital Protocol.
Natural Capital Committee, 2014. Towards a Framework for Defining and Measuring Changes in Natural Capital. Working Paper 1. Department for Environment, Food & Rural Affairs.
Natural Capital Finance Alliance, 2015. Towards Including Natural Resource Risks in Cost of Capital: State of Play and the Way Forward. Natural Capital Finance Alliance (A Collaboration between UN Environment Finance Initiative and Global Canopy).
OECD, 2017. Green Growth Indicators 2017. OECD Publishing, Paris.
Shepherd, E., Milner-Gulland, E.J., Knight, A.T., Ling, M.A., Darrah, S., van Soesbergen, A., Burgess, N.D., 2016. Status and trends in global ecosystem services and natural capital: assessing progress toward Aichi Biodiversity Target 14. Conserv. Lett. 9, 429–437.
Smith, A.C., et al., 2017. How natural capital delivers ecosystem services: a typology derived from a systematic review. Ecosyst. Serv. 26, 111–126.
System of Environmental-Economic Accounting 2012 Central Framework, 2014. United Nations, European Union, Food and Agriculture Organization of the United Nations, International Monetary Fund, Organisation for Economic Co-operation and Development, The World Bank.
TEEB, 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB.
The System of Environmental-Economic Accounting (SEEA) – Central Framework, 2014. United Nations, European Union, Food and Agriculture Organization of the United Nations, Organisation for Economic Co-operation and Development and World Bank Group.
The System of Environmental-Economic Accounting (SEEA) – Experimental Ecosystem Accounting, 2014. United Nations, European Union, Food and Agriculture

Organization of the United Nations, Organisation for Economic Co-operation and Development and World Bank Group.
UKNEA, 2011. The UK National Ecosystem Assessment: Technical Report. UK National Ecosystem Assessment. UNEP-WCMC, Cambridge, UK.
UN Environment Finance Initiative, 2008. Biodiversity and Ecosystem Services – Bloom or Bust? UN Environment Finance Initiative.
Van der Meulen, E.S., Braat, L.C., Brils, J.M., 2016. Abiotic flows should be inherent part of ecosystem services classification. Ecosyst. Serv. 19, 1–5.
Wallace, K.J., 2007. Classification of ecosystem services: problems and solutions. Biol. Conserv. 139, 235–246.