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Draft material on accounting for carbon and biodiversity

(for discussion)

REVISION OF THE SYSTEM OF ENVIRONMENTAL - ECONOMIC ACCOUNTING (SEEA)

SEEA Experimental Ecosystem Accounts

Draft material prepared for the 7th Meeting of the Committee of Experts on Environmental-Economic Accounting (UNCEEA)

Meeting in Rio di Janeiro, Brazil 11-13 June, 2012

PRELIMINARY DRAFT

Draft material on accounting for carbon and biodiversity

The following text has been drafted for discussion among UNCEEA members as part of the process of developing the SEEA Experimental Ecosystem Accounts. The material should not be considered definitive and should not be quoted.

Note by the SEEA Editor

The following text on accounting for carbon (Section 4.6) and accounting for biodiversity (Section 4.7) has been drafted by members of the expert group based on papers and discussions on these topics within the expert group. They have not been broadly distributed for peer review at this stage and hence should be regarded as preliminary drafts. Nonetheless they do provide a strong indication of the direction that is intended for text in these areas and are aligned with the agreed outcomes for text in these areas at the recent expert group meeting on ecosystem accounts in Melbourne in May, 2012.

Preliminary Draft: Accounting for carbon

4.6 Accounting for carbon

4.6.1 Motivation and purpose of carbon accounts

Carbon underpins practically all life on Earth with its capacity to bond to other elements particularly oxygen, hydrogen and nitrogen. Carbon is abundant in both the geosphere (in fossil fuels, rocks and deep ocean sediments) and biosphere (in living and dead plant and animal material in ecosystems and soils). Carbon, like water and land, is fundamental to the provision of ecosystems services and in particular the provisioning and regulating services. It is also the common thread between human energy production systems based on fossil fuels formed from ancient vegetation and the biomass fuels of today. The level of carbon in the atmosphere in the form of various gases, and in particular carbon dioxide, plays a critical role in the regulation of climate.

Climate change is caused by increases in the stock of greenhouse gases in the atmosphere and is the subject of the United Nations Framework Convention on Climate Change (UNFCCC). The ultimate objective of the UNFCCC is to achieve '… *stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*' (United Nations 1992, Article 2).

In 2009, the six greenhouse gases included in the Kyoto Protocol reached 439 parts per million (ppm) CO_2 equivalent[1], an increase of 160 ppm compared to pre-industrial levels (European Environment Agency 2012). Carbon dioxide is the most important anthropogenic greenhouse gas (IPCC 2007) and reached a level of 386 ppm CO_2 equivalent by 2009, increasing to 389 ppm in 2010 (Global Carbon Project). The Intergovernmental Panel on Climate Change (IPCC) considers that avoiding dangerous climate change requires limiting greenhouse gas concentrations in the atmosphere to between 445 and 650 ppm CO_2 equivalent.

The initial focus of the UNFCCC was to reduce emissions from fossil fuels, this being the biggest single source of human-induced greenhouse gas emissions. Under the guidance of the IPCC, a flows based inventory system was established. Reporting flows is appropriate for fossil fuel use because it generates what is effectively a one-way emission to the atmosphere. The emissions associated with

[1] Greenhouse gases cause different amounts of global warming. A greenhouse gas equivalent measure (CO_2 equivalent) is used to enable aggregation. It expresses the combined effect of the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation in terms of the amount of CO_2 that would cause the same amount of warming over a given time, usually 100 years.

land cover and land use change were incorporated into the flows-based greenhouse gas inventories on a ‘net emissions’ basis.

Accounting for carbon due to changes in land cover and land use brought new challenges particularly because of fundamental differences in the characteristics of different ecosystems and also the difficulty of distinguishing anthropogenic from non-anthropogenic flows of CO_2 for both emissions to the atmosphere and removals from the atmosphere. Extending the current flows-based UNFCCC accounting to cover both stocks and flows of carbon, and in particular to move from a net emissions from land to a more comprehensive coverage of carbon flows to and from stocks in the landscape, as well as aligning the data on carbon with the economic and environment information contained in the SNA and the SEEA, permits a more complete understanding and analysis of the issues for decision-making and policy analysis. It also creates the scope to structure the accounts to capture fundamentally important quality differences in carbon reservoirs (where stocks of carbon are stored) and also directly link carbon accounts to the UNFCCC objective that is expressed in stock terms.

The information presented in a carbon stock account (described below) has a multitude of uses for policy makers and researchers. In addition to policies aimed at reducing emissions by maintaining stocks of fossil fuels in the geosphere, carbon stock accounts could provide consistent and comparable information for policies aimed at, for example, protecting and restoring natural ecosystems, i.e. maintaining carbon stocks in the biosphere. Combined with measures of carbon carrying capacity[2] and land use history, biosphere carbon stock accounts can be used to:

- investigate the depletion of carbon stocks due to converting natural ecosystems to other land uses;
- prioritise land for restoration of biological carbon stocks through reforestation, afforestation, revegetation, restoration or improved land management with their differing trade-offs against food, fibre and wood production, and;
- identify land uses that result in temporary carbon removal and storage.

Applying the SNA’s principles of completeness and consistency and the SEEA Central Framework’s approach to accounting for waste, carbon stock accounts would record the stock changes from human activities at any point along the chain: from their origin in the geosphere and biosphere to changes in the various anthropogenic stocks (e.g. inventories of oil in storage; concrete in fixed assets; wood and plastic in consumer durables; waste – i.e. residuals that remain in the economy in controlled land fill sites; imports and exports) and as residuals to the environment, including emissions to the atmosphere. Carbon stock accounts can assist in informing us of the implications of policy interventions at any point along the chain.

4.6.2 The carbon cycle

Carbon flows between the reservoirs of carbon in the geosphere, biosphere, atmosphere and hydrosphere. This is commonly called the carbon cycle and the main elements of this are shown in fig. x.

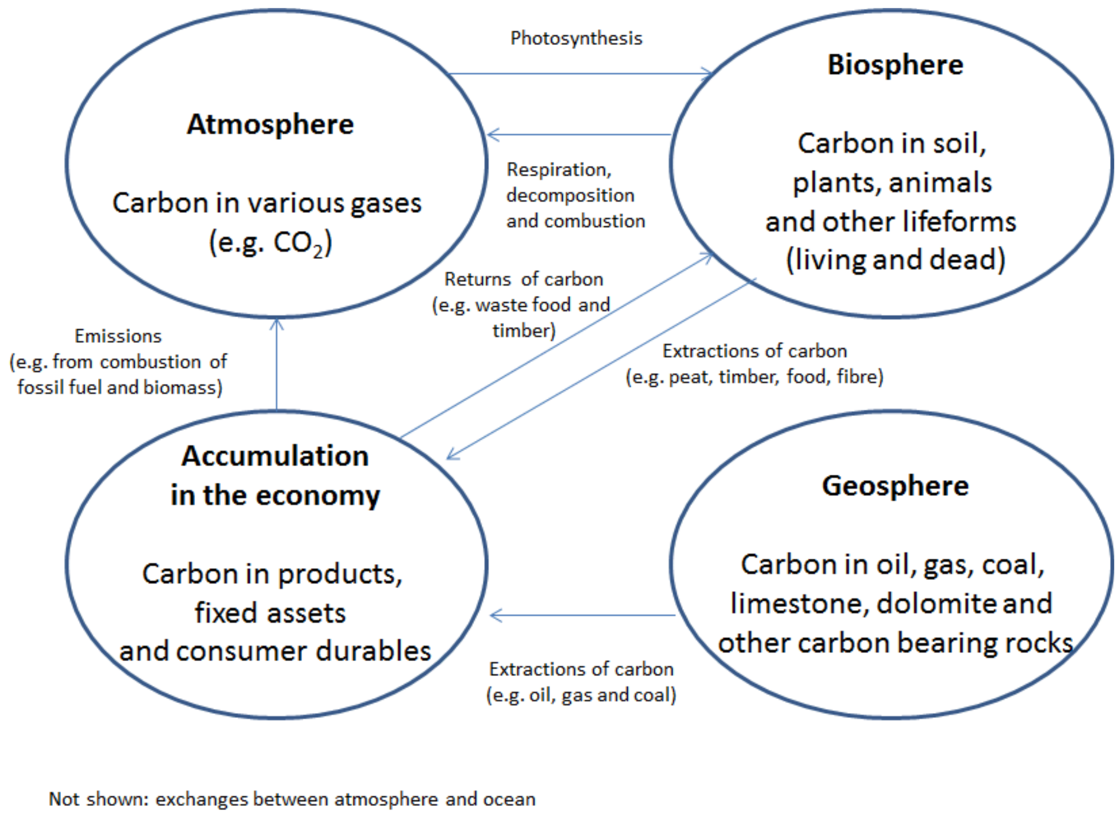
The different reservoirs of carbon in the geosphere and biosphere differ in important ways, namely in the amount and stability of their carbon stocks, their capacity to be restored and the time required to do so. Different reservoirs therefore have different degrees of effect on atmospheric CO_2 levels

[2] The mass of biocarbon able to be stored in the ecosystem under prevailing environmental conditions and disturbance regimes, but excluding human disturbance (Gupta and Rao 1994).

(Prentice et al. 2007). Carbon stocks in the geosphere are generally stable in the absence of human activity; however stock declines as a result of anthropogenic fossil fuel emissions are effectively irreversible. The stability of the carbon stocks in the biosphere depends significantly on ecosystem characteristics. In natural ecosystems, biodiversity underpins the stability of carbon stocks by bestowing resilience and the capacity to adapt and self-regenerate (Secretariat of the Convention on Biological Diversity 2009). Stability confers longevity and hence the capacity for natural ecosystems to accumulate large amounts of carbon over centuries to millennia, for example in the woody stems of old trees and soil. Semi-modified and highly modified ecosystems are generally less resilient and less stable (Thompson et al. 2009). These ecosystems therefore accumulate smaller carbon stocks, particularly if the land is used for agriculture where the plants are harvested regularly.

Structuring the carbon stock accounts to capture these quality differences between reservoirs is important because reservoirs with different qualities play different roles in the global carbon cycle. For given rates of fossil fuel emissions, it is the total amount of carbon and the time it is stored in the biosphere that influences the stock of carbon in the atmosphere.

Figure x. The main elements of the carbon cycle



4.6.3 Carbon stock account

The carbon stock account is presented in Table X. It is constructed in accord with the SEEA Central Framework. It provides a complete and ecologically grounded articulation of carbon accounting based on the carbon cycle and in particular the differences in the nature of particular carbon reservoirs. Opening and closing stocks of carbon are recorded with the various changes between the beginning and end of the accounting period recorded as either additions to the stock or reductions in the stock.

Table x Carbon Stock account

Gigagrams carbon (GgC)	Geocarbon				Biocarbon				Atmosphere	Water in Oceans	Accumulation in economy				TOTAL
	Rocks	Oil resources	Gas resources	Coal resources	Natural ecosystems	Semi-natural ecosystems	Agricultural ecosystems	Other ecosystems			Inventories*	Fixed assets	Consumer durables	Waste	
Opening stock															
Additions to stock															
Natural expansion															
Managed expansion															
Discoveries															
Upwards reappraisals															
Reclassifications															
Total additions to stock															
Reductions in stock															
Natural contraction															
Managed contraction															
Downwards reappraisals															
Reclassifications															
Total reductions in stock															
Imports and exports															
Imports															
Exports															
Closing stock															

*excludes inventories included in biocarbon (e.g. plantation forests, orchards, livestock, etc)

Carbon stocks are disaggregated to geocarbon (carbon stored in the geosphere) and biocarbon (carbon stored in the biosphere, in living and dead biomass and soils). Geocarbon is further disaggregated into Rocks (e.g. carbonate rocks used in cement production), oil, gas, coal and peat resources. Biocarbon is classified by type of ecosystem. In this case the classification is based on degree of human modification of the ecosystem and the categories are:

> **Natural ecosystems**: are largely the product of natural and ongoing evolutionary, ecological and biological processes. The key mechanism of 'management' in natural ecosystems is natural selection operating on populations of species which has the effect over time of optimizing system level properties and the traits of component species. System-level properties which are naturally optimized with respect to, among other things, environmental conditions include canopy density, energy use, nutrient cycling, resilience, and adaptive capacity. Natural processes dominate natural ecosystems within which human cultural and traditional uses also occur. Natural ecosystems include terrestrial and marine ecosystems.
>
> **Semi natural ecosystems**: are human modified natural ecosystems. Natural processes, including regenerative processes, are still in operation to varying degrees. However, the system is often prevented from reaching ecological maturity or is maintained in a degraded state due to human disturbance and land use. Thus, the vegetation structure may not reflect natural optima, and the taxonomic composition may be depauperate.
>
> **Agricultural ecosystems**: are human designed, engineered and maintained systems on agricultural lands that grow animals and crops mainly for food, wood and fibre and as feedstocks for biofuels and other materials. Plantations of trees for timber or fruit production (e.g. orchards) are included in the agricultural ecosystem. Note that these stocks in the SEEA Central framework and SNA would be included as inventories of the economy and hence must be removed from this category.
>
> **Ecosystems other**: include settlements and land with infrastructure.

The **atmosphere** and **ocean** are the receiving environments for carbon released from primary reservoirs and accumulations in the economy. In this, the atmosphere and oceans may be viewed in a way similar to the way the rest of the world is treated in physical supply and use tables in the SEEA Central Framework, since they are not under the control of a particular owner. Ocean water can be split into shallow and deep ocean reservoirs.

Accumulations in economy are the stocks of carbon in anthropogenic products and are further disaggregated into the SNA components: Fixed assets (e.g. concrete in buildings, bitumen in roads); Consumer durables (e.g. wood and plastic products); Inventories (e.g. petroleum products in storage, but excluding those include in agricultural ecosystems); and Waste. Accounting for waste follows the SEEA Central Framework where waste products (e.g. disposed plastic and wood and paper products) stored in a controlled land fill sites are treated as part of the economy. Carbon stored through geosequestration (i.e. injecting gaseous CO2 into the surface of the Earth) is similarly treated. Any release of carbon to the environment is treated as a residual with carbon stock changes in Accumulations in economy matched by corresponding carbon stock changes in the atmosphere.

Although not shown in the table, these ecosystem types could be disaggregated further into marine and terrestrial ecosystems. Marine ecosystems include mangroves, saltmashes and seagrass beds. Peat stocks and flows align with the biocarbon sector with peatland vegetation associated with a variety of ecosystems, including forests, grasslands, mossbeds, mangroves, saltmashes and paddies. There is potential to disaggregate Geocarbon and Biocarbon further.

The row entries in the account follow the basic form of the asset account in the SEEA Central Framework: opening stock, additions, reductions and closing stock. Additions to and Reductions in stock have been split between managed and natural expansion. Additional rows for imports and exports have been included, thus making the table a stock account, as distinct from an asset account.

There are six types of additions in the carbon stock account.

Natural expansion: These additions reflect increases in the stock of carbon over an accounting period due to natural growth. This will be effectively only for biocarbon and may arise from climatic variation, ecological factors such as reduction in grazing pressure, and indirect human impacts such as the CO_2 fertilisation effect (where higher atmospheric CO_2 concentrations cause faster plant growth).

Managed expansion: These additions reflect increases in the stock of carbon over an accounting period due to human-managed growth. This will be for biocarbon in ecosystems and Accumulations in economy, in inventories, consumer durables, fixed assets and waste stored in controlled land fill sites including the injection of greenhouse gases into the earth.

Discoveries of new stock: These additions concern the arrival of new resources to a stock and commonly arise through exploration and evaluation. This applies mainly, perhaps exclusively, to geocarbon.

Upwards reappraisals: These additions reflect changes due to the use of updated information that permits a reassessment of the physical size of the stock. The use of updated information may require the revision of estimates for previous periods to ensure a continuity of time series.

Reclassifications: Reclassifications of carbon assets will generally occur in situations in which another environmental asset is used for a different purpose, for example increases in carbon in Semi-natural ecosystems by the establishment of a national park on an area used for agriculture would be equalized by an equivalent decrease in Agricultural ecosystems. Here, it is only the land use that has changed; that is, reclassifications may have no impact on the total physical quantity of carbon.

Imports: A line for imports is shown to enable accounting for imports of produced goods (e.g. petroleum products). Imports are show separately from the other additions so that they are presented with exports.

There are five types of reductions in the carbon stock account.

Natural contraction: These reductions reflect natural, including episodic, losses of stock during the course of an accounting period. They may be due to changing distribution of ecosystems (e.g. a contraction of Natural ecosystems) or biocarbon losses that might reasonably be expected to occur based on past experience. Natural contraction includes losses from episodic events including drought, some fires and floods, and pest and disease attacks. Natural contraction also includes losses due to volcanic eruptions, tidal waves and hurricanes.

Managed contraction: These are reductions in stock due to human activities and include the removal or harvest of carbon through a process of production. This includes mining of fossil fuels and felling of timber. Extraction from ecosystems includes both those quantities that continue to flow through the economy as products (including waste products) and those quantities of stock that are immediately returned to the environment after extraction because they are unwanted, for example, discarded timber residues. Managed contraction also includes losses as a result of a war, riots and other political events; and technological accidents such as major toxic releases.

Downwards reappraisals: These reductions reflect changes due to the use of updated information that permits a reassessment of the physical size of the stock. The reassessments may also relate to changes in the assessed quality or grade of the natural resource. The use of updated information may require the revision of estimates for previous periods to ensure a continuity of time series.

Reclassifications: Reclassifications of carbon assets will generally occur in situations in which another environmental asset is used for a different purpose, for example decreases in carbon in Ecosystems agriculture by the establishment of a national park on an area used for agriculture would be equalized by an equivalent increase in Semi-natural ecosystems. Here it is only the land use that has changed; that is, reclassifications have no impact on the total physical quantity of carbon.

Exports: A line for exports is shown to enable accounting for exports of produced goods (e.g. petroleum products). Exports are show separately from the other reductions so that they are presented with imports.

Catastrophic losses, as defined in the SNA, are not shown but split between Managed contraction and Natural contraction. Managed contraction would include fires deliberately lit to reduce the risk of uncontrolled wild fires. Also for the purposes of accounting, human accidents, such as rupture of oil wells, would also be included under managed contraction. Catastrophic losses could, however, be separately identified in the table or a related table.

4.6.4 Links to other accounts

Carbon accounts are linked to the physical flow, environmental activity and asset accounts of the SEEA Central Framework as well as to the flows of ecosystem services presented in chapter 3. Carbon stock accounts may also be used as one of the components in the assessment of the condition and capacity of ecosystem capital.

The simplest linkage is to the energy asset accounts in the SEEA Central framework. Here the geocarbon stocks recorded in table x, align closely with the information recorded in table 5.5.3 of the SEEA Central Framework for oil, natural gas, coal and resources. Table x adds the additional carbon reservoir of the rocks (e.g. limestone, dolomite). Peat resources are recorded in the biocarbon stocks.

The second link is to the land accounts, and in particular to the land cover account, table 5.6.3 in the Central Framework. This is because different land covers can be associated with different levels of carbon stocks, and estimates of carbon stocks can be made by applying coefficients to the area of different land covers. In this, the broad categories used in the land cover account may be aligned with the classification of ecosystems according to their state of naturalness shown in the carbon stock account (table x). In some cases this is a simple task, for example, artificial surfaces would be allocated to other ecosystems and crops to agricultural ecosystems. Some categories in the land cover account, like grassland and tree covered areas would need to be re-assessed and allocated to natural, semi-natural or agricultural ecosystems, based on the level of human management. In this, tree covered areas which are plantations would be included in agricultural ecosystems, while harvested native forest would be semi-natural or natural ecosystems, depending on the degree of human modification and management.

An important aspect of linking to the land account is that the carbon stocks may be analysed on the basis of ownership or management by sector (e.g. households, government and enterprises) or industry (agricultural, forestry, mining, etc). Once the link to the land account is made then secondary links can be made to the environmental activity accounts, and in particular the environmental protection expenditure accounts and environmental payments to and from government (or environmental taxes and subsidies), which may separately identify expenditures and payments specifically to increase carbon stocks or reduce emissions to the atmosphere.

The linking of the carbon stock account to the flow of ecosystem services, and in particular to the service of carbon sequestration, is also of particular importance. In this, the total additions of stock in the biosphere shown in the stock account, would equate to the level of the flow of the carbon sequestration service. Particular attention might be given to natural and managed expansion of carbon stocks in the biosphere.

Carbon in the biosphere is one of the fundamental components of living organisms and therefore ecosystem capital. As such it has to be considered in any determination of ecosystem capacity and condition. This may be done by reference to time (e.g. the time considered to be unaffected by industrial activity), some notion of maximum capacity (e.g. the greatest theoretical amount of carbon that can be stored in 'perpetuity' in a particular area or ecosystem) or other ecosystems (e.g. bare earth contains relatively little carbon compared to a natural forest).

4.6.5 Indicators from carbon stock accounting

Various indicators can be derived directly from carbon stock accounts or in combination with other information, such as land cover, land use, population, and industry value added. The suite of indicators can provide a rich information source for policy makers, researchers and the public. For example, comparing the actual carbon stock of different ecosystems with their carbon carrying capacities can inform land use decision making where there are significant competing uses of land for food and fibre.

A key indicator that would emerge from the carbon stock account is what is commonly termed the 'net carbon balance' which is the stock of carbon remaining in all reservoirs, or a particular reservoir, at the end of an accounting period.

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4.7 Accounting for biodiversity

4.7.1 Motivation and purpose

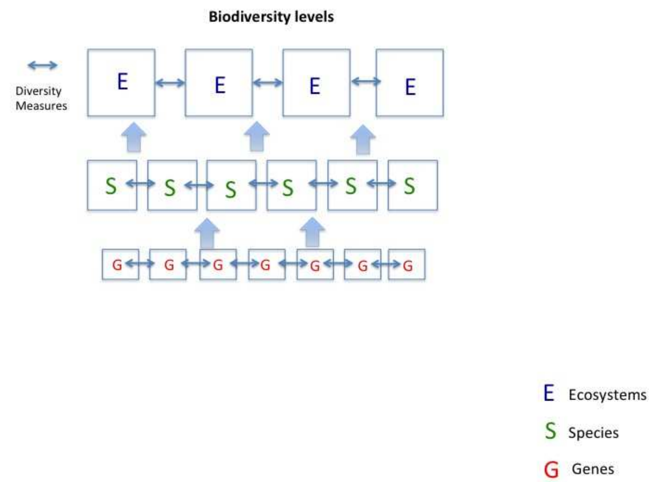
Biodiversity is a fundamental component of ecosystems and underpins many ecosystem services. Human activity can drive changes in biodiversity, both directly through direct extraction of species via harvest (e.g. fish and timber) and indirectly (e.g. pollution which may be toxic to some species), and hence the level or quality of the ecosystems services able to be delivered. Understanding the relationships between biodiversity and ecosystems, the ecosystem services they provide, and the impact of human activity is the primary motivation for accounting for biodiversity. In addition, there are several international agreements concerning biodiversity and conservation of biodiversity. Perhaps the most important is the Convention on Biological Diversity (Secretariat of the Convention on Biological Diversity 2003).

Biodiversity accounts can be used to track progress against policy targets such as those concerning the protection of threatened species or ecosystems (or habitats), the maintenance and improvement of ecosystem condition and capacity, and the sustainable use of harvested species. Such assessments of progress can be enhanced by links to the land cover and environmental activity accounts of the SEEA Central Framework, and in particular the environmental protection expenditure accounts. For example, the cost-effectiveness of expenditure on habitat and species conservation may be analysed.

4.7.2 Definition and description of biodiversity

Biodiversity is defined as ‘the variability among living things and the ecosystems they inhabit’ by the Secretariat of the Convention on Biological Diversity (2003). The scientific community has conceptualised biodiversity as a hierarchy of genes, species and ecosystems (Norse 1986; Office of Technology Assessment 1987). This is shown in Figure x.

Fig x. The three levels of biodiversity – ecosystems, species and genes.



In this section, only species are considered further but it should be noted that ecosystems may be approximated by land cover which is covered in the SEEA Central Framework and the link between the number of species and the area and type of habitat is well established in the ecological literature (Brooks et al. 2002). For example, forests, deserts and larger areas of a particular habitat support more species than smaller areas of the same habitat type. Furthermore, accounting for ecosystems as a whole is the subject of this entire chapter (i.e. Chapter 4).

The accounts described below use species as the fundamental units measured in these account. Linnaeus (1758) classified life into Kingdoms, Classes, Orders, Families, Genera, and Species, and created the foundation for biological nomenclature and simplified binomial naming system (Genus and Species). The classification has been evolving since its inception in the 18th Century.

4.7.2 Structuring information on species

Species may be described in a number of ways. For example, they may be described in terms of their physiology (including morphology, DNA), population dynamics (habitat use and reproductive biology), distribution (or range), abundance and likelihood of extinction. In this, while the basic physiology of species will remain constant, the abundance of species may change across its distribution. This is particularly important for species with large distributions within countries and for species which span countries. For example, a particular species might be common in one area but rare in other.

Abundance may be measured in absolute terms as the total number of individuals of a species or a density per hectare. It can also be measure in broad classes related to absolute measures, for example very abundant, abundant, common, rare, and very rare. Abundance may also be measured in relative terms, and in particular current abundance relative to the past. If a species is less abundant now than in the past then it may be at risk of extinction.

The risk of extinction is a function of the population dynamics, distribution and abundance of species. In this, the more widely distributed and abundant and the higher the reproductive rate of a species is, the less likely it is to become extinct. Some species are naturally rare, have limited distributions or low reproductive rates and hence are more susceptible to extinction. The IUCN Red List Categories (IUCN-Species Survival Commission 2001) take into account these factors and others into account to determine the overall status of species.

Accounts may be structured to show absolute abundance or risk of extinction of species. If abundance is to be used then classes of abundance need to be defined. If risk of extinction is used then status of species in the IUCN Red List categories and criteria may be used. These categories are defined as:

> **Extinct** is when there is no reasonable doubt that the last individual of a species has died;
>
> **Extinct in the wild** is when a taxon is known to only survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range;
>
> **Critically endangered** is when a taxon is considered to be facing an extremely high risk of extinction in the wild;
>
> **Endangered** is when a taxon is considered to be facing a very high risk of extinction in the wild;
>
> **Vulnerable** is when a taxon is considered to be facing a high risk of extinction in the wild;
>
> **Near Threatened** is when a taxon is close to qualifying for or is likely to qualify for a threatened category in the near future;
>
> **Least concern** is when a taxon is widespread and abundant;
>
> **Data deficient** or **Not evaluated**. <u>Data deficient</u> is when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status (data deficient is therefore not a category of threat). <u>Not evaluated</u> is when a taxon has not yet been evaluated against the IUCN threat criteria.

Species may be grouped in a number of ways. The first is according to taxonomic rank (Kingdom, Phylum, Class, Order, Family, Genus, Species). The accounts described below take this approach. Alternatively, species may be grouped according to their broad habitat (e.g. terrestrial, marine, aquatic), origin (e.g. native or exotic to particular areas), their usefulness or otherwise to people (e.g. classed as pests or weeds because they are not useful), or animals may be grouped according to their diet under headings such as herbivores, omnivores and predators.

Species accounts may be prepared for countries as a whole or for particular areas or ecosystems within countries. In subnational accounts is important to note that the status assessments from the IUCN Red List relates to an assessment of the species in the entire world, not to the area in question. As such it might be that a species is of “least concern” in the world as a whole, but it might be much less abundant in particular areas with a risk of local extinction. This issue is addressed in the description of the accounts below. The use of absolute abundance of species in accounts negates this issue, but collecting data on the abundance of all species is resource intensive and hence for practical reasons species status is preferred at the present time.

4.7.3 Species status and abundance accounts

Table 4.7.1 presents the general form of a species asset account for a particular time. It shows the number of species by Kingdom and their status of these species according to the IUCN Red List categories, (noting that categories of absolute abundance could be used in place of the species status categories). It is important to note that all Kingdoms are included in the account but in practice there is greater data availability for animals and plants than for other Kingdoms. This also highlights the fact that for different Kingdoms and groups with Kingdoms, there is a different degree or completeness of knowledge of species. Generally, the best known groups are the vertebrate animals (mammals, birds, reptiles, etc), and these may be a proxy for all species (or of biodiversity).

Table 4.7.1. Status of species

	IUCN Red List categories									
	Extinct	Extinct in the wild	Critically endangered	Endangered	Vulnerable	Lower risk	Near threatened	Data deficient or not evaluated	Least concern	**TOTAL**
Animals										
Mammals										
Birds										
Reptiles										
Amphibians										
Insects										
Subtotal										
Fungi										
Protista										
Plants										
TOTAL										

*An abundance of species would simply replace the IUCN Red Categories with categories of absolute abundance (e.g. very abundant, abundant, common, rare, very rare)

Table 4.7.2 shows the species asset account. The account follows the general form of assets accounts in the SEEA Central Framework, with opening stock, additions, reductions and closing stock.
The rows of the account are:

Opening stock is the status of species at the stated point in time

Additions from lower threat categories, which indicates an increased risk of extinction for species;

Additions from higher threat categories, which indicates a reduced risk of extinction for species;

Additions from discoveries of species, includes the detection of species that were previously unknown to country (or the particular sub-national area that is the subject of the account) as well as the detection of species that were previously unknown to science;

Additions from reclassifications, where one existing species is now recognised as two or more distinct species;

Additions from updated assessments, where a species remains in the same IUCN category but shows up as a new addition in the IUCN year list because it has been removed from previous list years;

Additions from new additions to the IUCN list, where a species has been assessed for the first time;

Reductions to lower threat categories, which indicates a reduced risk of extinction for species;

Reductions to higher threat categories, which indicates an increased risk of extinction for species;

Reductions from local extinction is where a species previous found in the country (or the particular sub-national area that is the subject of the account) but is no longer found;

Reductions from reclassifications, where two or more existing species are now recognised as one species;

Reductions from updated assessments, where a species has previously been unlisted by the IUCN in the opening stock year;

Net change is the additions less reductions

Closing stock is the status of species at the end of the accounting period

The account can be presented for all species or for different groups of species. That is, species asset accounts can be prepared for particular taxonomic groups (e.g. mammals, birds, reptiles, etc.) or according to other groupings (e.g. native and exotic species).

Table 4.7.2. Species asset account*

	IUCN Red List categories									
	Extinct	Extinct in the wild	Critically endangered	Endangered	Vulnerable	Lower risk	Near threatened	Data deficient	Least concern	**TOTAL**
Opening stock 2010										
Additions										
- from lower threat categories										
- from higher categories										
- discoveries of new species										
- rediscoveries of extinct species										
- reclassifications										
- updated assessments										
- new additions to list										
Total additions										
Reductions										
- to lower threat categories										
- to higher categories										
- reclassifications										
- local extinction										
- updated assessments										
Total reductions										
Net change										
Closing stock 2011										

*An abundance of species account would replace the IUCN Red Categories with categories of absolute abundance (e.g. very abundant, abundant, common, rare, very rare). Some renaming and defining of the rows would also be necessary but would not be a significant task.

4.7.4 Links to other accounts

Accounting for biodiversity via the species status and abundance accounts and the land cover account of the SEEA Central Framework becomes more useful when linked to other accounts of the SEEA Central Framework and to the ecosystem services described in Chapter 3. For the accounts in the

SEEA Central Framework, links can be made to the land use account and to the environmental activity accounts.

For terrestrial species the land use and land cover accounts together provide an indication of the amount of particular ecosystems in public and private ownership as well as the amount set aside for nature conservation (which may be in public or private ownership). The environmental activity accounts can link the expenditure on species protection to the status of species and hence be used to analyse the cost-effectiveness of species and ecosystem conservation measures.

For ecosystem services, the species harvested directly for food, fibre or timber provide provisioning services. Changes in the abundance species due to human extraction would be reflected in the species abundance and status. In particular, harvesting in excess of a species capacity to regenerate (i.e. unsustainable harvesting) would result in higher risks of extinction and be reflected in moving to higher risk categories in the species status account. Species that provide regulating services, such mangroves species (flood protection) and bees (pollination) can also be linked to the species and land cover accounts. For mangroves the amount of service would be function of the location extent and condition of mangroves, which could be derived from a land cover account. For bees the level of pollination service would be function of the abundance of bees, which could be drawn from the species abundance account.

4.7.5 Biodiversity indicators

A range of indicators can be drawn directly from the species status or abundance accounts, while additional indicators can be made drawing on accounts combined with other information, from the SEEA, SNA or other sources. A large number of indicators have been used by international organisations and countries to assess biodiversity and it would be difficult to summarise all of this work here. Instead the indicators used or proposed by the CBD are briefly outlined, along with the account that the indicator would be linked to.

The CBD’s scientific body, Subsidiary Body on Scientific, Technical and Technological Advice (SBSSTA), is establishing biodiversity indicators that can be implemented worldwide, on national or regional scale (Subsidiary Body on Scientific Technical and Technological Advice 2011). A large number of global and regional indicators have been proposed, and the CBD has been requested to propose a few generic indicators of biodiversity for global use to be discussed at the 2012 Conference of the Parties.

The indicators to be discussed build on previous indicators[3], and several of these can be drawn from the SEEA Central Framework as well as the ecosystem accounts, and the species status account described above. In particular is the status and trends of the components of biodiversity, which are:

- Trend in extent of selected ecosystems (land cover account)
- Trend in abundance and distribution of selected species (species abundance account)
- Trend in status of threatened species (species status account)
- Extent of protected areas (land use account)
- Products derived from sustainable sources (land cover account, various material flow account)

References

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[3] Provisional indicators for Assessing progress towards the 2010 Biodiversity target. http://www.cbd.int/2010-target/framework/indicators.shtml