Natural Capital Finance Alliance Project 1: Advancing Environmental Risk Management

Accompanying guidance note for ecosystem service factsheets

Background:

The Natural Capital Finance Alliance (NCFA) is a collaboration with the finance sector to lead the integration of natural capital considerations into financial decision-making. It was launched as a set of Commitments, the Natural Capital Declaration, at the UN Conference on Sustainable Development (Rio+ 20 Earth Summit) in 2012. The Alliance is supported by over 75 signatories and supporters that include financial institutions and other stakeholders. The NCFA Secretariat is comprised of UN Environment Finance Initiative (UNEP FI) and the Global Canopy Programme, who work in partnership to manage the NCFA.

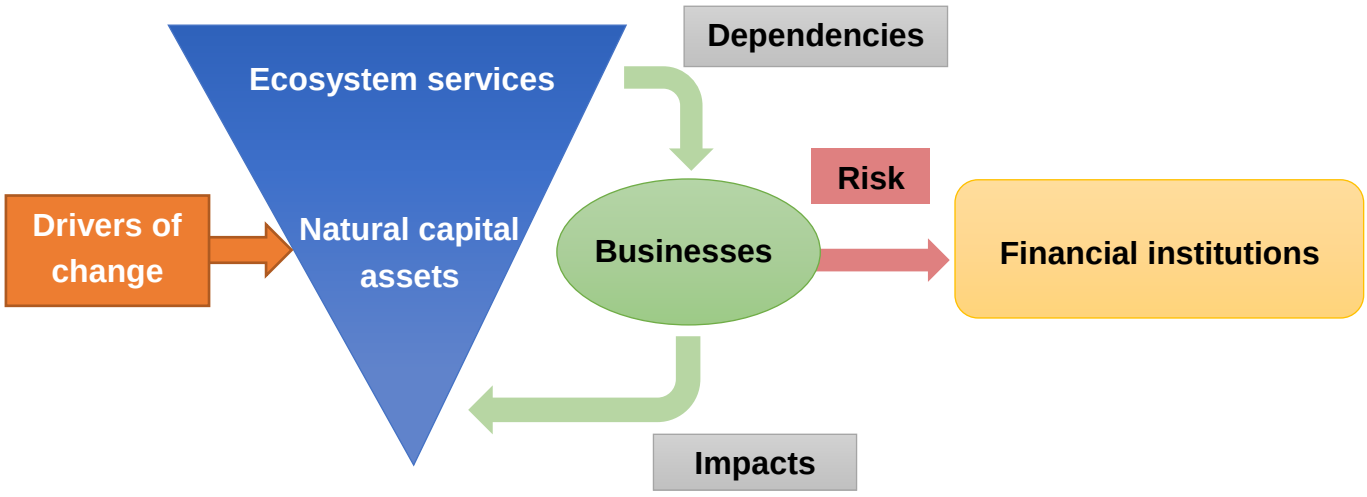
As part of the Advancing Environmental Risk Management project, UN Environment World Conservation Monitoring Centre (UNEP-WCMC) has been working with the Natural Capital Finance Alliance to enable financial institutions to better understand, assess, and integrate natural capital-related risk – the risk that businesses they lend to or invest in see their production disrupted because of an interruption in the flow of goods or services that they depend on nature to provide - into their existing risk management processes.

The first phase of this project, which ran from January to December 2017, produced a comprehensive knowledge base detailing how businesses depend on nature to enable their production processes, what the associated risks may be, and the data that can be used to qualify and quantify risk exposure at a global and national-level for four target countries: Peru, Colombia, South Africa and Indonesia. This stock-taking exercise also highlighted the current gaps in knowledge that require further research before more precise risk analysis can be undertaken.

This guidance note has been developed to accompany the factsheets. It outlines the methodology, limitations and prioritisation framework and assessments.

Approach:

Ecosystem services are provided through a number of underlying natural capital assets, with changes in these natural capital assets driven by a number of factors. Businesses both depend upon and impact natural capital assets and ecosystem services, and this in turn leads to risk for the financial institutions that provide finance or risk cover to them.



Factsheets were therefore developed for each ecosystem service, including: a description of the ecosystem service-natural capital asset system, identification of the main drivers influencing or impacting the system and the mechanism by which these impact the variability of service provision, a summary of data needs, and a description of the direct links to other ecosystem services. The factsheets were completed through literature reviews using Web of Science, Google and key document searches, for example TEEB for Business, with standardised search terms. They were compiled for all ecosystem services according to the Common International Classification on Ecosystem Services framework V4.3 (see Annex 1) with some categories broken down further, for example "Fibres and other materials from plants, algae and animals for direct use or processing" was broken down into separate factsheets for plants, algae and animals.

The factsheets firstly provide a narrative description of the natural capital asset-ecosystem service system, with a generic description of the way in which assets provide the ecosystem service, the underlying asset components, and the minimum conditions for maintaining the service flow. UNEP-WCMC developed a hierarchical natural capital asset classification to support the factsheets in identifying the natural capital assets which underpin ecosystem services (see Annex 2) as existing classifications were not fit-for-purpose. A hierarchical natural capital asset classification also enables alignment with the hierarchical industry and ecosystem services classifications used. A scientific paper to communicate the classification has been submitted to the journal *Ecosystem Services*.

The factsheets then describe the main drivers of change influencing or impacting natural capital assets, how the asset is likely to change in response, the mechanism by which the driver of change impacts the variability of the service provision, whether it results from a human action or natural variation, the timescale on which the change is likely to materialise (short-term refers to under 1 year, mid-term 3 years and long-term more than 3 years in relation to credit risk), and the spatial characteristics for which the change is likely to materialise. See Annex 3 for definitions of each of the drivers of change which are largely based on the International Union for the Consevation of Nature's threat classfication (more information here: http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme).

Data needed to assess the current, historical or future state of the natural capital assets and drivers of change is then identified. The information on data needs is used to inform the collection of data sources. Finally, the factsheets describe the direct links with other ecosystem services, including directionality and strength if possible, for a holistic view on ecosytem service provision and the numerous interlinkages.

Summary tables for each factsheet were included following feedback from financial institutions on the need to use the factsheets to quickly assess which natural capital assets are most important for ecosystem service provision and the most influential drivers of change on those natural capital assets. Importance here is defined as the sensitivity of the ecosystem service to a change in the state of the natural capital asset, and degree of dependence of the ecosystem service on the natural capital asset. Influence is defined as the degree to which the natural capital asset is susceptible to the driver of change, and the degree of variability and uncertainty in the response of the natural capital asset to the driver of change (see Annex 4). To enable the prioritisation of assets and drivers a framework was first developed with a number of Red-Amber-Green criteria, on for example, the sensitivity of the service to a change in the state of the natural capital asset. A number of contextual criteria were also developed to assess drivers of change individually, for example the likelihood of extreme variations in the driver. This framework was developed in collaboration with the Natural Capital Finance Alliance team and reviewed by key players in the natural capital and scientific community, such as Professor Georgina Mace (University College London).

The framework was applied to each ecosystem service, exploring the importance of natural capital assets for provision, then it was applied to each natural capital asset, exploring the influence of the main drivers of change on the state of the natural capital asset, and finally to each driver of change. Each prioritisation assessment against the criteria in the framework is accompanied by a justification for the Red-Amber-Green score, terms used to search the literature and references (see Annex 5). Each ecosystem service-natural capital asset and driver of change-natural capital asset combination is assigned an overall Red-Amber-Green score which is included in the summary table at the front of the factsheets.

Limitations:

- These factsheets were developed based on a context-less situation. Financial institutions and businesses are encouraged to integrate, apply and adapt the broad information gathered here for each individual project risk assessment. Shifting supply chains to a different country to manage impacts on natural capital assets is also not captured in this framework, but these mitigation efforts could be captured in individual risk assessments by financial institutions or businesses. In addition, the prioritisation framework described in Annex 4 should be used as a general guideline on the importance of natural capital assets for ecosystem service provision and influence of drivers of change on natural capital assets. It is possible that the importance or influence may change according to the specific context.
- The factsheets and prioritisation assessments include the main drivers of change influencing or impacting natural capital assets, but there also a number of other possible drivers of change. These are captured as grey boxes in the summary tables within each of the factsheets and within the prioritisation assessments in Annex 5.
- A new version of the Common International Classification on Ecosystem Services framework, V5.1, has recently been published. Although there are differences between this and the version used in the Advancing Environmental Risk Management project (V4.3), it does not alter the overall interpretation of ecosystem service provision through natural capital assets. A cross-walk table between V4.3 and V5.1 is available here: https://cices.eu/.

Annex 1: Common International Classification on Ecosystem Services framework V4.3

Section	Division	Group	Class
Provisioning	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing
			Materials from plants, algae and animals for agricultural use
			Genetic materials from all biota
		Water	Surface water for non-drinking purposes
			Ground water for non-drinking purposes
	Energy	Biomass-based energy sources	Plant-based resources
			Animal-based resources
		Mechanical energy	Animal-based energy
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro-organisms, algae, plants, and animals
			Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems
			Dilution by atmosphere, freshwater and marine ecosystems
			Mediation of smell/noise/visual impacts
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates
			Buffering and attenuation of mass flows
		Liquid flows	Hydrological cycle and water flow maintenance
			Flood protection
		Gaseous / air flows	Storm protection
			Ventilation and transpiration
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal
			Maintaining nursery populations and habitats
		Pest and disease control	Pest control
			Disease control
		Soil formation and composition	Weathering processes
			Decomposition and fixing processes
		Water conditions	Chemical condition of freshwaters
			Chemical condition of salt waters
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations
			Micro and regional climate regulation

Annex 2: Hierarchical natural capital asset classification

	Level 1	Level 2	Level 3	Level 4	*Examples*
Natural Capital	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*

Annex 3: Drivers of change and definitions

Driver of change		Definition
Anthropogenic	Industrial or domestic construction	Process of constructing a building or infrastructure for industrial or domestic purposes
Anthropogenic	Industrial or domestic activities	Human settlements or other non-agricultural land uses with a substantial footprint, production of non-biological resources and/or non-consumptive uses of biological resources
Anthropogenic	Human movement	Migration by people from one place to another with the intentions of settling, permanently or temporarily in a new location
Anthropogenic	Water abstraction	Changing water flow patterns from their natural range of variation due to human activities
Anthropogenic	Habitat modification	Major changes in habitat composition and location
Anthropogenic	Pollution	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources
Biological resource use	Intensive agriculture and aquaculture	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture and aquaculture (includes the impacts of any fencing around farmed areas)
Biological resource use	Overhunting	Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch
Biological resource use	Overfishing	Harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch
Biological resource use	Overharvesting	Harvesting plants, fungi, trees and other woody vegetation, and other non-timber/non-animal products, for commercial, recreation, subsistence, research or cultural purposes, or for control reasons
Biological interactions	Population changes	Changes in species populations over time and space
Biological interactions	Invasive species	Harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities
Biological interactions	Diseases	Harmful pathogens and microbes that are originally found within the ecosystem(s) in question, but have become “out-of-balance” or “released” directly or indirectly due to human activities
Biological interactions	Pests	Harmful plants or animals that are originally found within the ecosystem(s) in question, but have become “out-of-balance” or “released” directly or indirectly due to human activities
Biological interactions	Human modification of genetic material	Human altered or transported organisms or genes
Natural hazards/systems	Fire	Suppression or increase in fire frequency and/or intensity outside of its natural range of variation
Natural hazards/systems	Volcanoes	Volcanic events
Natural hazards/systems	Earthquakes	Earthquakes and associated events, such as tsunamis
Natural hazards/systems	Geological changes (e.g. landslides, erosion)	Avalanches or landslides
Natural hazards/systems	Droughts	Periods in which rainfall falls below the normal range of variation
Natural hazards/systems	Storms	Extreme precipitation and/or wind events
Natural hazards/systems	Flooding	Extreme precipitation events
Climate change impacts	Weather conditions	Weather conditions outside of the natural range of variation
Climate change impacts	Ocean acidification	Changes to the ocean chemistry which occurs when carbon dioxide is absorbed and reacts with seawater to produce acid
Climate change impacts	Sea level rise	Increase in global mean sea level as a result of an increase in the volume of water in the world’s oceans
Climate change impacts	Ocean current & circulation	Large scale movement of waters in the ocean basins
Climate change impacts	Sea surface temperature	Periods in which sea surface temperatures exceed or go below the normal range of variation

Annex 4: Prioritisation framework for ecosystem service factsheets

Criteria to assess the importance of natural capital assets to ecosystem service provision: Service = ∫ Assets

Criterion	Definition	RED	AMBER	GREEN	Example	Use case for risk management
Nature	Nature of the relationship between the natural capital asset and service provision	Non-linear	Linear		Linear relationship between surface water as a natural capital asset and surface water provision as a service.[1]	Functional form helps determine the risk management models to use for the quantification of natural capital risk exposure
Sensitivity	Sensitivity of the ecosystem service to a change in the state of the natural capital asset	High sensitivity	Medium sensitivity	Low sensitivity	El Salvador has lost 2.6% of service provision, notably pollination, through the process of replacing 12% of natural landscapes with agro-productive systems and urban areas.[2]	Essential to determine the form of the relationship between the ecosystem service and natural capital assets
Reversibility	Possibility for the impact of a change in a natural capital asset on ecosystem service provision to be reversed (subject to feasibility)	Not reversible in a human lifetime	Reversible impact with long-term (>1 year), active restoration	Natural, short-term (<1 year), reversible impact	Successful mangrove restoration for storm and flood protection is possible in less than 20 years.[3]	Allows for the identification of irreversible trends that would demand more analysis at the rapid appraisal stage
Substitutability	Degree of dependence of the ecosystem service on the natural capital asset	Only asset able to provide the service OR highly specific asset	One of only a small number of assets able to provide the service OR a supporting asset	One of a large number of assets able to provide the service	Various natural capital assets, including fungal, algal and bacterial species, can be used for the treatment of heavy metals from industrial wastewater.[4]	Indicates the existence of non-linearity in the provision of the ecosystem service in terms of a key natural capital asset being non-substitutable
Uncertainty	Degree of uncertainty in the relationship between the natural capital asset and service provision	High uncertainty	Medium uncertainty	Low uncertainty	The relationship between species, habitats and minerals and the provision of decomposition processes for healthy soils is often unclear.[5]	Cases with high sensitivity, low reversibility and substitutability, and high uncertainty should be prioritized to explore the relationship in more detail

[1] Brozovic et al. (2007) Estimating business and residential water supply interruption losses from catastrophic events. Water Resources Research, 43: W08423.
[2] Crespin & Simonetti (2016) Loss of ecosystem services and the decapitalisation of nature in El Salvador. Ecosystem Services, 17: 5-13.
[3] Mukherjee et al. (2014) Using expert knowledge and modelling to define mangrove composition, functioning, and threats and estimate time frame for recovery. Ecology and Evolution, 4: 2247-2262.
[4] Srivastava & Majumder (2008) Novel biofiltration methods for the treatment of heavy metals from industrial wastewater. Journal of Hazardous Materials, 151: 1-8.
[5] Dominati et al. (2010) A framework for classifying and quantifying the natural capital and ecosystem services of soils. Ecological Economics, 69: 1858-1868.

Criteria to assess the influence of drivers of change on natural capital assets: Asset = ∫ Drivers

Criterion	Definition	RED	AMBER	GREEN	Example	Use case for risk management
Nature	Nature of the relationship between the natural capital asset and the driver of change	Non-linear	Linear		Intensive agriculture has a direct, linear impact on habitats.[6]	Broadly captures the functional form describing the asset/driver relationship
Trend	Direction and timeframe of change in the asset alone	Situation expected to worsen in the short-term (<1 year)	Situation expected to worsen in the long-term (>1 year)	Situation expected to remain constant	Feedback loops can modify asset trends independently of drivers, for example, permafrost melting due to a warming climate can lead to the breakdown of organic carbon and release of greenhouse gases.[7]	Captures changes in the mean of the distribution and provides a baseline for the asset
Susceptibility	Degree to which the natural capital asset is susceptible to the driver of change	High susceptibility	Medium susceptibility	Low susceptibility	Pollinator species are highly susceptible to anthropogenic drivers, for example intensive agriculture leads to pollinator species loss and disruption of their daily activities.[8]	Useful for calculating the risk to natural capital assets i.e. the maximum loss that may be expected
Variability	Degree of variability in the response of the natural capital asset to the driver of change	High variability	Low variability	Stable (no variability)	Individual species vary greatly in their response to weather conditions and climate change.[9]	Captures the variance in responses, i.e. measures the spread of the responses
Uncertainty	Degree of uncertainty in the relationship between the natural capital asset and the driver of change	High uncertainty	Medium uncertainty	Low uncertainty	The relationship between volcanoes as a driver of change and habitats is uncertain, especially the proximity at which volcanoes can potentially impact certain habitats.[10]	Cases with high susceptibility, high variability, and high uncertainty should be prioritized to explore the relationship in more detail

[6] Tilman et al. (2002) Agricultural sustainability and intensive production practices. Nature, 418: 671-677.
[7] Schuur et al. (2015) Climate change and the permafrost carbon feedback. Nature, 520: 171-179.
[8] Potts et al. (2010) Global pollinator declines: trends, impacts and drivers. Trends in Ecology and Evolution, 25: 345-353.
[9] Chen et al. (2011) Rapid range shifts of species associated with high levels of climate warming. Science, 333: 1024-1026.
[10] Payne & Blackford (2008) Distal volcanic impacts on peatlands: palaeoecological evidence from Alaska. Quaternary Science Reviews, 27: 2012-2030.

Contextual criteria for the drivers of change in natural capital assets or ecosystem service provision: Drivers

Criterion	Definition	RED	AMBER	GREEN	Example	Use case for risk management
Trend	Direction and timeframe of change in the driver	Situation expected to worsen in the short-term (<1 year)	Situation expected to worsen in the long-term (>1 year)	Situation expected to remain constant	Habitat loss and fragmentation is already a widely distributed threat, and will continue to be a major threat into the future.[11]	Captures changes in the mean of the distribution
Variability	Degree of variability in the driver of change over time	High variability	Low variability	Stable (no variability)	Extent and duration of wildfires in tundra ecosystems varies greatly across space and time.[12]	Captures the variance in responses, i.e. measures the spread of the responses
Extreme events	Likelihood of extreme variations in the driver of change	High probability of a dramatic change	Low, but non-zero, probability of a dramatic change	Very low, almost impossible, probability of a dramatic change	Severe population changes have been recorded for African savannah ungulate species due to short-term droughts and long-term climate change impacts.[13]	Helps capture the notion of non-linearity and flags that an approach to deal with extreme deviations may be appropriate
Predictability	Existence of models/historical data to predict the future state of the driver of change	No		Yes	Sea level rise models can accurately project future sea level using the statistical relation between the physical response of water to heating and climate and past observations.[14]	Indicates forecasting power for the driver
	Credibility of models/data to predict the future state of the driver of change	Models are not calibrated independently	Models are calibrated by comparison with modelled datasets	Models are calibrated with independent empirical/observed datasets		
Uncertainty	Degree of uncertainty in the driver of change	High uncertainty	Medium uncertainty	Low uncertainty	Volcanic events are often associated with high uncertainty, especially the proximity at which this driver can potentially impact natural capital.[15]	Cases with high variability, uncertainty and probability of extreme events should be prioritized

[11] Newbold et al. (2015) Global effects of land use on local terrestrial biodiversity. Nature, 520: 45-50.
[12] Hu et al. (2015) Arctic tundra fires: natural variability and responses to climate change. Frontiers in Ecology and the Environment, 13: 369-377.
[13] Ogutu & Owen-Smith (2003) ENSO, rainfall and temperature influences on extreme population declines among African savanna ungulates. Ecology Letters, 6: 412-419.
[14] Mengel et al. (2016) Future sea level rise constrained by observations and long-term commitment. PNAS, 113: 2597-2602.
[15] Payne & Blackford (2008) Distal volcanic impacts on peatlands: palaeoecological evidence from Alaska. Quaternary Science Reviews, 27: 2012-2030.

Annex 5: Prioritisation assessments for ecosystem service factsheets

Assessments for each of the criteria above, including justifications and references, are documented in the attached spreadsheet.

- Part 1: Criteria to assess the importance of natural capital assets to ecosystem service provision
- Part 2: Criteria to assess the influence of drivers of change on natural capital assets
- Part 3: Contextual criteria for the drivers of change in natural capital assets or ecosystem service provision

Prioritisation assessments