## **Appendix I: Classifications of ecosystem services**

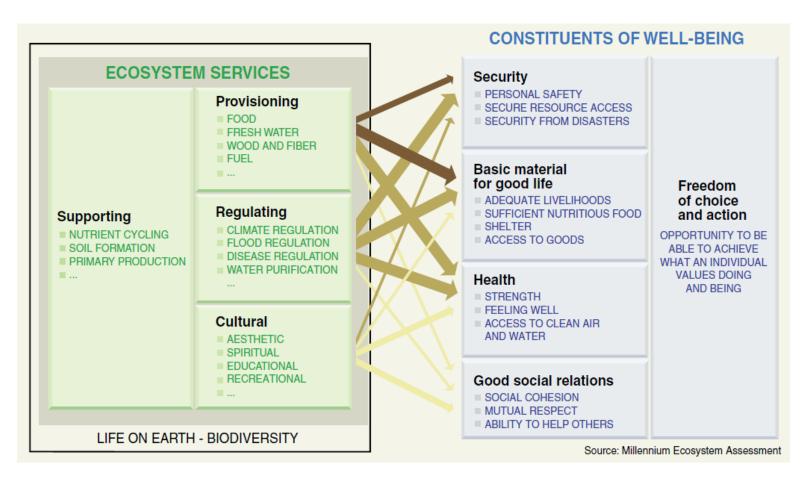


Figure A1. Summary of the Millenium Ecosystem Assessment classification of ecosystem services (according to (MA, 2005))

**Provisioning Services** are ecosystem services that describe the material outputs from ecosystems. They include food, water and other resources.



**Food:** Ecosystems provide the conditions for growing food – in wild habitats and in managed agro-ecosystems.



Raw materials: Ecosystems provide a great diversity of materials for construction and fuel. Fresh water: Ecosystems provide surface and groundwater.



**Medicinal resources:** Many plants are used as traditional medicines and as input for the pharmaceutical industry.

**Regulating Services** are the services that ecosystems provide by acting as regulators eg regulating the quality of air and soil or by providing flood and disease control.



**Local climate and air quality regulation:** Trees provide shade and remove pollutants from the atmosphere. Forests influence rainfall.



Carbon sequestration and storage: As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.



**Moderation of extreme events:** Ecosystems and living organisms create buffers against natural hazards such as floods, storms, and landslides.



**Waste-water treatment:** Micro-organisms in soil and in wetlands decompose human and animal waste, as well as many pollutants.



**Erosion prevention and maintenance of soil fertility:** Soil erosion is a key factor in the process of land degradation and desertification.



**Pollination:** Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee.



Biological control: Ecosystems are important for regulating pests and vector borne diseases.

**Habitat or Supporting Services** underpin almost all other services. Ecosystems provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals.



**Habitats for species:** Habitats provide everything that an individual plant or animal needs to survive. Migratory species need habitats along their migrating routes.



Maintenance of genetic diversity: Genetic diversity distinguishes different breeds or races, providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock.

**Cultural Services** include the non-material benefits people obtain from contact with ecosystems. They include aesthetic, spiritual and psychological benefits.



**Recreation and mental and physical health:** The role of natural landscapes and urban green space for maintaining mental and physical health is increasingly being recognized.



**Tourism:** Nature tourism provides considerable economic benefits and is a vital source of income for many countries.



Aesthetic appreciation and inspiration for culture, art and design: Language, knowledge and appreciation of the natural environment have been intimately related throughout human history.



**Spiritual experience and sense of place:** Nature is a common element of all major religions; natural landscapes also form local identity and sense of belonging.

Figure A2. Summary of the TEEB classification of ecosystem services (according to (TEEB, 2010)).

 $Table \ A1. \ The \ CICES \ classification \ of \ ecosystem \ services \ (according \ to \ ((EEA, 2015))).$ 

CICES for ecos	CICES for ecosystem service mapping and assessment							
Section	Division	Group	Class	Class type*	Examples**			
This column lists the three main categories of ecosystem services	This column divides section categories into main types of output or process.	The group level splits division categories by biological, physical or cultural type or process.	The class level provides a further sub-division of group categories into biological or material outputs and biophysical and cultural processes that can be linked back to concrete identifiable service sources.	Class types break the class categories into further individual entities and suggest ways of measuring the associated ecosystem service output.				
Provisioning	Nutrition	Biomass	Cultivated crops Reared animals and their outputs Wild plants, algae and their outputs Wild animals and their outputs Wild animals and their outputs  Plants and algae from in-situ aquaculture Animals from in-situ aquaculture	Crops by amount, type Animals, products by amount, type Plants, algae by amount, type Animals by amount, type  Plants, algae by amount, type Animals by amount, type	Cereals (e.g. wheat, rye, barely), vegetables, fruits etc.  Meat, dairy products (milk, cheese, yoghurt), honey etc.  Wild berries, fruits, mushrooms, water cress, salicornia (saltwort or samphire); seaweed (e.g. Palmaria palmata = dulse, dillisk) for food Game, freshwater fish (trout, eel etc.), marine fish (plaice, sea bass etc.) and shellfish (i.e. crustaceans, molluscs), as well as equinoderms or honey harvested from wild populations; Includes commercial and subsistence fishing and hunting for food In situ seaweed farming  In-situ farming of freshwater (e.g. trout) and marine fish (e.g. salmon, tuna) also in floating cages; shellfish aquaculture (e.g. oysters or crustaceans) in e.g. poles			

	Water	Surface water for drinking Ground water for drinking	By amount, type	Collected precipitation, abstracted surface water from rivers, lakes and other open water bodies for drinking  Freshwater abstracted from (non-fossil) groundwater layers or via ground water desalination for drinking
Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing	Material by amount, type, use, media (land, soil, freshwater, marine)	Fibres, wood, timber, flowers, skin, bones, sponges and other products, which are not further processed; material for production e.g. industrial products such as cellulose for paper, cotton for clothes, packaging material; chemicals extracted or synthesised from algae, plants and animals such as turpentine, rubber, flax, oil, wax, resin, soap (from bones), natural remedies and medicines (e.g. chondritin from sharks), dyes and colours, ambergris (from sperm whales used in perfumes); Includes consumptive ornamental uses.
		Materials from plants, algae and animals for agricultural use Genetic materials from		Plant, algae and animal material (e.g. grass) for fodder and fertilizer in agriculture and aquaculture;  Genetic material (DNA) from wild plants, algae and animals for
		all biota		biochemical industrial and pharmaceutical processes e.g. medicines, fermentation, detoxification; bio-prospecting activities e.g. wild species used in breeding programmes etc.
	Water	Surface water for non- drinking purposes	By amount, type and use	Collected precipitation, abstracted surface water from rivers, lakes and other open water bodies for domestic use (washing, cleaning and other non-drinking use), irrigation, livestock consumption, industrial use (consumption and cooling) etc.
		Ground water for non- drinking purposes		Freshwater abstracted from (non-fossil) groundwater layers or via ground water desalination for domestic use (washing, cleaning and other non-drinking use), irrigation, livestock consumption, industrial use (consumption and cooling) etc.
Energy	Biomass- based energy	Plant-based resources	By amount, type, source	Wood fuel, straw, energy plants, crops and algae for burning and energy production
	sources	Animal-based resources		Dung, fat, oils, cadavers from land, water and marine animals for burning and energy production
	Mechanical energy	Animal-based energy	By amount, type, source	Physical labour provided by animals (horses, elephants etc.)

Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro-organisms, algae, plants, and animals	By amount, type, use, media (land, soil, freshwater, marine)	Bio-chemical detoxification/decomposition/mineralisation in land/soil, freshwater and marine systems including sediments; decomposition/detoxification of waste and toxic materials e.g. waste water cleaning, degrading oil spills by marine bacteria, (phyto)degradation, (rhizo)degradation etc.
			Filtration/sequestration /storage/accumulation by micro-organisms, algae, plants, and animals	By amount, type, use, media (land, soil, freshwater, marine)	Biological filtration/sequestration/storage/accumulation of pollutants in land/soil, freshwater and marine biota, adsorption and binding of heavy metals and organic compounds in biota
		Mediation by ecosystems	Filtration/sequestration /storage/accumulation by ecosystems	By amount, type, use, media (land, soil, freshwater, marine)	Bio-physicochemical filtration/sequestration/storage/accumulation of pollutants in land/soil, freshwater and marine ecosystems, including sediments; adsorption and binding of heavy metals and organic compounds in ecosystems (combination of biotic and abiotic factors)
			Dilution by atmosphere, freshwater and marine ecosystems		Bio-physico-chemical dilution of gases, fluids and solid waste, wastewater in atmosphere, lakes, rivers, sea and sediments
			Mediation of smell/noise/visual impacts		Visual screening of transport corridors e.g. by trees; Green infrastructure to reduce noise and smells
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates	By reduction in risk, area protected	Erosion / landslide / gravity flow protection; vegetation cover protecting/stabilising terrestrial, coastal and marine ecosystems, coastal wetlands, dunes; vegetation on slopes also preventing avalanches (snow, rock), erosion protection of coasts and sediments by mangroves, sea grass, macroalgae, etc.
			Buffering and attenuation of mass flows		Transport and storage of sediment by rivers, lakes, sea
		Liquid flows	Hydrological cycle and water flow maintenance	By depth/volumes	Capacity of maintaining baseline flows for water supply and discharge; e.g. fostering groundwater; recharge by appropriate land coverage that captures effective rainfall; includes drought and water scarcity aspects.

		Flood protection	By reduction in risk, area protected	Flood protection by appropriate land coverage; coastal flood prevention by mangroves, sea grass, macroalgae, etc. (supplementary to coastal protection by wetlands, dunes)
	Gaseous / air flows	Storm protection	By reduction in risk, area protected	Natural or planted vegetation that serves as shelter belts
		Ventilation and transpiration	By change in temperature/humidity	Natural or planted vegetation that enables air ventilation
Maintenance of physical,	Lifecycle maintenance,	Pollination and seed dispersal	By amount and source	Pollination by bees and other insects; seed dispersal by insects, birds and other animals
chemical, biological conditions	habitat and gene pool protection	Maintaining nursery populations and habitats	By amount and source	Habitats for plant and animal nursery and reproduction e.g. seagrasses, microstructures of rivers etc.
	Pest and disease control	Pest control Disease control	By reduction in incidence, risk, area protected	Pest and disease control including invasive alien species In cultivated and natural ecosystems and human populations
	Soil formation and composition	Weathering processes	By amount/concentration and source	Maintenance of bio-geochemical conditions of soils including fertility, nutrient storage, or soil structure; includes biological, chemical, physical weathering and pedogenesis
		Decomposition and fixing processes		Maintenance of bio-geochemical conditions of soils by decomposition/mineralisation of dead organic material, nitrification, denitrification etc.), N-fixing and other bio-geochemical processes;
	Water conditions	Chemical condition of freshwaters	By amount/ concentration and source	Maintenance / buffering of chemical composition of freshwater column and sediment to ensure favourable living conditions for biota e.g. by denitrification, re-mobilisation/re-mineralisation of phosphorous, etc.
		Chemical condition of salt waters		Maintenance / buffering of chemical composition of seawater column and sediment to ensure favourable living conditions for biota e.g. by denitrification, re-mobilisation/re-mineralisation of phosphorous, etc.
	Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	By amount, concentration or climatic parameter	Global climate regulation by greenhouse gas/carbon sequestration by terrestrial ecosystems, water columns and sediments and their biota; transport of carbon into oceans (DOCs) etc.
		Micro and regional climate regulation		Modifying temperature, humidity, wind fields; maintenance of rural and urban climate and air quality and regional precipitation/temperature patterns

Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmenta	Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings  Physical use of land-/seascapes in different environmental settings	By visits/use data, plants, animals, ecosystem type	In-situ whale and bird watching, snorkelling, diving etc.  Walking, hiking, climbing, boating, leisure fishing (angling) and leisure hunting
	l settings]	Intellectual and representative interactions	Scientific Educational Heritage, cultural Entertainment Aesthetic	By use/citation, plants, animals, ecosystem type	Subject matter for research both on location and via other media Subject matter of education both on location and via other media Historic records, cultural heritage e.g. preserved in water bodies and soils Ex-situ viewing/experience of natural world through different media Sense of place, artistic representations of nature
	Spiritual, symbolic and other interactions with biota, ecosystems,	Spiritual and/or emblematic	Symbolic  Sacred and/or religious	By use, plants, animals, ecosystem type	Emblematic plants and animals e.g. national symbols such as American eagle, British rose, Welsh daffodil  Spiritual, ritual identity e.g. 'dream paths' of native Australians, holy places; sacred plants and animals and their parts
	and land-/seascapes [environmenta l settings]	Other cultural outputs	Existence Bequest	By plants, animals, feature/ecosystem type or component	Enjoyment provided by wild species, wilderness, ecosystems, land-/seascapes Willingness to preserve plants, animals, ecoystems, land-/seascapes for the experience and use of future generations; moral/ethical perspective or belief

<sup>\*</sup>Note: this section is open in that many class types can potentially be recognised and nested in the higher level classes, depending on the ecosystems being considered.

<sup>\*\*</sup>Note: this section is not complete and for illustrative purposes only. Key components could change by region or ecosystem.

Table A2. The CICES classification of ecosystem services and its parallels to the MA and TEEB classifications (according to (EEA, 2015)).

Section	Division	Group	Class	MA	TEEB
Provisioning	Nutrition	Biomass	Cultivated crops  Reared animals and their outputs  Wild plants, algae and their outputs  Wild animals and their outputs  Plants and algae from in-situ aquaculture  Animals from in-situ aquaculture		Food
		Water	Surface water for drinking Ground water for drinking	Water	Water
	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	Fibre, Timber, Ornamental, Biochemical	Raw materials, medicinal resources
		Water	Genetic materials from all biota Surface water for non-drinking purposes Ground water for non-drinking purposes	Genetic materials Water	Genetic materials Water
	Energy	Biomass-based energy sources Mechanical	Plant-based resources Animal-based resources Animal-based energy	Fibre	Fuels and fibres
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota  Mediation by	Bio-remediation by micro-organisms, algae, plants, and animals Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals Filtration/sequestration/storage/accumulation by	Water purification and water treatment, air quality regulation	Water purification and water treatment, air quality regulation
		ecosystems	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	Erosion regulation	Erosion prevention
		Liquid flows	Hydrological cycle and water flow maintenance Flood protection	Water regulation Natural hazard	Regulation of water flows, regulationof
		Gaseous / air	Storm protection	regulation	extreme events

		flows	Ventilation and transpiration
	Maintenance of	Lifecycle	Pollination and seed dispersal
	physical, chemical,	maintenance,	Maintaining nursery populations and habitats
	biological conditions	habitat and gene	
		pool protection	
		Pest and disease	Pest control
		control	Disease control
		Soil formation	Weathering processes
		and composition	Decomposition and fixing processes
		Water conditions	Chemical condition of freshwaters
			Chemical condition of salt waters
		Atmospheric	Global climate regulation by reduction of greenhouse
		composition and	gas concentrations
		climate regulation	Micro and regional climate regulation
Cultural	Physical and	Physical and	Experiential use of plants, animals and land-
	intellectual	experiential	/seascapes in different environmental settings
	interactions with	interactions	Physical use of land-/seascapes in different
	biota, ecosystems, and		environmental settings
	land-/seascapes	Intellectual and	Scientific
	[environmental	representative	Educational
	settings]	interactions	Heritage, cultural
			Entertainment
			Aesthetic
	Spiritual, symbolic	Spiritual and/or	Symbolic
	and other interactions	emblematic	Sacred and/or religious
	with biota,	Other cultural	Existence
	ecosystems, and land-	outputs	Bequest
	/seascapes		
	[environmental		
	settings]		

Pollination	Pollination
Pest regulation	Biological control
Disease regulation	
Soil formation	Maintenance of soil
[supporting services]	fertility
Water regulation	Water
Atmospheric regulation	Climate regulation
Air quality regulation	Air quality regulation
Recreation and ecotourism	Recreation and tourism
Knowledge systems and educational values, cultural diversity, aesthetic values	Inspiration for culture, are and design, aesthetic information
Spiritual and religious values	Information and congnitive development