



## Towards a more Comprehensive Classification of Ecosystem Services

Ecosystem services (ES), defined as the benefits that nature provides, have become a mainstream concept that connects ecosystems with society, ecology with economics, and conservation with development. Ecosystem services are often used as a starting point for economic valuation of nature, establishing a Total Economic Value of ecosystems in a certain place. This application of the ES concept is subject to fundamental criticisms – see BIOMOT’s policy brief # 1 for a summary. Some of these problems pertain also to the ES concept as such (e.g. the limage of nature as only bundle of services, and the image of human values as only hedonic consumer benefits), but in a less extreme manner. Therefore and with awareness of its limitations, the ES concept can be used for many purposes other than ‘total’ valuation, e.g. in policy design, environmental assessment, modeling and research programming, and as a justification for PES schemes (‘Payments for Ecosystem Services’).

For all these purposes, a good classification of ES is an essential basis. Attention to this issue is scant, however. In this policy brief we aim to overarch current classifications (including the Millenium Ecosystem Assessment) and repair some of their common shortcomings. Moreover we have tried to make the classification relatively detailed, because dropping services from a list is always better that having to invent new ones on the spot.

Current classifications lack attention to four particular aspects:

- 1. Sustainability aspects.** Most current classifications lack attention to the maintenance of resilience. Partially repairing this, we have included “maintenance service” to most service groups, with some examples added. This also partially re-installs biodiversity as an intrinsic aspect of ecosystem services.
- 2. Intrinsic values.** All ES classifications are purely human-centred. This can be seen as a logical consequence of the services concept but on the other hand, it carries the danger that the broader objectives of biodiversity conservation, focusing on nature’s non-utilitarian (‘intrinsic’) values are too grossly ignored. Partially repairing this, we added a “Habitat services” group, specifying the benefits from ecosystems to non-human carriers of intrinsic value. This is the forest for the bear, so to speak, the ocean for the dolphin.
- 3. Direct health services.** Obviously, nature is healthy for humans through many indirect pathways that are already included in many ES. Research has shown, however, that nature is also healthy in a direct manner: simply being in nature relieves stress and many ailments. We added that ‘direct health service’.
- 4. Non-biotic services.** Water and minerals flows, air purification etc. are often omitted; we include them.

In the classification on the next page, the sequence of ES groups roughly follows the Millennium Ecosystem Assessment. Group names are taken from there and several other sources such as Daly, De Groot and Costanza; service names are sometimes foprmal to indicate overall structure but may of course be adapted at will. “Managed provisioning services” are defined as those that co-produce and maintain material and immaterial human benefits after significant human inputs or management of the ecosystem. “Natural provisioning services” co-produce and maintain material benefits without human inputs. “Moderation services” are those through which ecosystems mitigate harmful natural or anthropogenic pheeneomena, to the direct benefit of humans. “Life-fullfilling services” co-generate and maintain non-material (‘spiritual’, ‘cultural’, ‘intangible’) benefits for humans or the human-to-nature relationship without requiring significant inputs. “Habitat services” are services provided by ecosystems to non-human carriers of intrinsic value. “Supporting services” are services that usually and mainly underlie the preceding services, in any causal layering.

We call the classification “ES 2013” as an invitation to other researchers to draft the even better ES 2014, ES 2015 and so on. The BIOMOT project acknowleges the valuable inputs R.S. de Groot in this classification.

# ES 2013: A more comprehensive classification of ecosystem services

## Managed provisioning services

1. *Agricultural services*: providing water, nutrients, solar energy etc. to agriculture (food, fiber, biofuels, flowers, ...)
2. *Forestry services*: providing water, nutrients, solar energy etc. to agroforestry and plantation forestry
3. *Livestock services*: providing water, nutrition etc. to livestock keeping
4. *Aqua-services*: providing nutrition, hatch etc. for aquaculture of fish, shellfish, ....
5. *Managed recreation services*: providing the beauty and naturalness for quality of life based on managed ecosystems (urban parks, golf courses, playgrounds ...)
6. *Maintenance services for managed provision*: providing the processes that help maintain managed system resilience and adaptability (wild genes, seed diversity, healthy soils, open space, ....).

## Natural provisioning services

7. *Plant extraction services*: providing fuelwood, fruits, timber, rubber, waxes, honey, rattan, thatch, ornamental plants, medicinal substances, .....
8. *Animal extraction services*: providing for capture fisheries, seafood, fur, pet animals, bushmeat, wildlife, test organisms, .....
9. *Water flow services* (for energy, transport, dry-season flows and storage for drinking water, ....)
10. *Air flow services* (wind for energy, transport, microclimate)
11. *Substance flow services* (natural sorting, accumulation and dispersal of sand, minerals, .....
12. *Maintenance services for natural provisioning*: providing the processes that help maintain natural system resilience and adaptability (e.g. species and functional diversity).

## Moderation services

13. *Water purification services*: (pre-)purification for domestic and industrial use
14. *Air purification services* (dust filtering, carbon-monoxide uptake, .....
15. *Soil purification services* (organic waste recycling, toxic substance degradation, ....)
16. *Water flow moderation services* (moderation of extreme water events e.g. floods, tsunamis, ...)
17. *Air flow moderation services* (wind breaks, coastal storm protection, ....)
18. *Minerals and substances flow moderation services* (protection against mudflows, blizzards, ...)
19. *Radiation flow moderation services* (local shade, night darkness, protection against UVb, ...)
20. *Control services*: control of human disease organisms.

## Life-fulfilling services

21. *Direct health services*: the direct health effects of green environments
22. *Science and education services*: provision of variety, beauty, surprise etc. for cognitive development.
23. *Artistic services* (examples and inspirations for painting, photography, music, theatre, design, .....
24. *Ecosystem diversity services*: providing the characteristic natures through which cultures develop and become attractive to each other (eco-tourism)
25. *Relationship services*: inviting and facilitating intense but balanced relationships between people and nature, e.g. in play, hiking, sports hunting and fishing, conservation volunteering
26. *Participation and contemplation services*: providing the species, places and occasions for experiencing the sublime, solitude and sacramental value.

## Habitat services

27. *Providing habitat* (food, shelter, competition, cyclicity, spatial variation, migration space etc.) *for non-human carriers of intrinsic value*
28. *Habitat maintenance services*: providing space, rhythms, patterns for the bioevolution to continue.

## Supporting services

29. *Biotic supporting services*: pollination, seed dispersal, pest control, ....
30. *Organic and toxic waste processing supporting services*, e.g. supporting freshwater fisheries, ....
31. *Productive supporting services*: pasture and fodder, organic fertilizer, manure and green manure, ...
32. *Soil and nutrient supporting services*: soil formation, nutrient cycling, nutrient dispersal, ....
33. *Disaster prevention supporting services*: prevention of floods, landslides etc.
34. *Climate mitigation supporting services*, e.g. carbon sequestration (geochemical and biotic); fire prevention
35. *Ecosystem resilience services*: substitution of lost species, recovery from devastation, .....