Data included in the conservation decision support tool

The site data

The sites currently included in the conservation decision support tool are all registered sites under either one or more of the following criteria:

- a protected area from the global world database in protected areas [1] that is listed by the International Union for Conservation of Nature (IUCN) in either category I or II,
- a natural World Heritage Site (WHS),
- a Key Biodiversity Area (KBA).

The shapefiles for the IUCN protected areas as well as the World Heritage Sites were derived from protected planet[1]. The Shapefiles for the KBAs were derived from BirdLife International [2].

The conservation objectives data

The six different conservation objectives which are included in the decision support tool are biodiversity, ecosystem integrity, climatic stability, land-use stability, carbon storage and size. Each of these objectives consists of one or several underlying macro-ecological indicator variables. See below for a detailed description of the variables included within each of the six conservation objectives and how these variables are derived (*Shorter and simpler explanations can be found under the tab "**How to use**"*).

Biodiversity

The biodiversity objective includes three different variables, the total number of species, the degree of endemism and the evolutionary diversity of the species occurring in the region the site is located in.

<u>Species richness</u>

The species richness, for four taxa of vertebrates, is derived from range maps for virtually all species of the four terrestrial vertebrate taxa: from the BirdLife International for birds [3], the IUCN for mammals and amphibians [4], and from GARD for reptiles [5].

Sites with a higher species richness are allocated a higher suitability for long-term conservation than sites with a lower species richness.

<u>Endemism</u>

To capture biodiversity that is unique to a region, a measure for the prevalence of range restricted (endemic) species within the region is used. Species endemism is estimated by calculating weighted range size rarity, which is the sum of the inverted range extents of all species, divided by the number of species occurring in a site [6].

Sites with a higher rate of species endemism are allocated a higher suitability for long-term conservation than sites with a lower rate of species endemism.

<u>Evolutionary diversity</u>

Evolutionary diversity is included to have an estimate of how evolutionary unique the species within a region are. Measures of evolutionary diversity can give an idea of how much evolutionary history is stored within a set of species. A high amount of evolutionary history might imply a high feature diversity across the species within the region and could, arguably, make a community more resilient to disturbance. Evolutionary diversity is calculated using phylogenetic endemism (PE), which is a combined measure of evolutionary history and the uniqueness of a species community. PE identifies regions with high numbers of evolutionary isolated and geographically restricted species. In additiointo summing the shared evolutionary history of a species assemblage, PE also incorporates the spatial restriction of phylogenetic branches covered by the assemblage [7].

Sites with a higher evolutionary diversity are allocated a higher suitability for long-term conservation than sites with a lower evolutionary diversity.

Ecosystem Integrity

The ecosystem integrity objective includes three different variables, the biodiversity intactness index (BII), the human footprint in and around the site and the change from biome to anthrome in the past two decades.

<u>Biodiversity intactness index (BII)</u>

The BII presents the modeled average abundance of present species, relative to the abundance of these species in an intact ecosystem [8]. This means the index gives an indication of how much species abundances in a region have already changed due to anthropogenic impacts e.g. land-use change. For the BII we are using the global map of the Biodiversity Intactness Index calculated by Newbold et al (2016).

Sites with a higher estimated biodiversity intactness are allocated a higher suitability for long-term conservation than sites with a lower biodiversity intactness.

<u>Human footprint</u>

As a measure of how pristine the sites still are, a measure of the human footprint within the region is included. Estimates of the human footprint within sites are derived from the standardised human footprint layer by Venter et al (2016) [9], which includes data on the extent of built environments, crop land, pasture land, human population density, night-time lights, railways, roads and navigable waterways.

Sites with a lower human footprint are allocated a higher suitability for long-term conservation than sites with a higher human footprint.

Land-use change

To derive past changes in the land cover of a site we calculated the average percentage change across the site from biomes (natural vegetation cover) to anthromes (human-modified land cover such as rainfed cropland, irrigated cropland, mosaic cropland, mosaic natural vegetation and urban areas). The fraction of land cover classes time series, ranging from 1992 – 2018, was obtained from the GEOEssential project [10].

Sites with a lower percentage of land-use change are allocated a higher suitability for long-term conservation than sites with a higher percentage of land-use change.

Climatic stability

The climatic stability objective consists of two different variables: the projected stability of animal biodiversity and the projected tree cover change under future climate change.

Climatic stability of biodiversity

To estimate the climatic stability of a site we are looking at the potential impacts of climate change on the biodiversity within the site. Climate change is driving shifts in species distributions and it is well established that many taxa are shifting their ranges towards higher latitudes and elevations. But also, idiosyncratic species responses to climate change have been observed. These heterogeneous range shifts have the potential to reshuffle species assemblages, which can have highly unpredictable impacts on species interactions and ecosystem functions (e.g., changes in in prey predator relationships or competition). We assume that species assemblages that are not predicted to change a lot in future or experience large species losses are under less risk from climate change than species assemblages that experience a lot of reshuffling. Therefore, we include projected turnover in species under future climate change as an indicator for the climatic stability of biodiversity. Projections of species ranges are derived from species distribution models (see Hof et al 2018 [11] for a detailed description of the modelling). For each site all species that are projected to occur there currently and/or in future (2050) are extracted. The turnover is then calculated between the current and future species assemblage of a site, using the formula for Bray Curtis dissimilarity[12].

Sites with higher climatic stability (i.e., a lower projected turnover in species) are allocated a higher suitability for long-term conservation than sites with a lower climatic stability.

Forest cover change

We included the projected change in tree cover derived from the LPJ-GUESS process-based dynamic vegetation-terrestrial ecosystem model [13]. The climate input for the model was derived from the ISIMIP2b simulations, described above under climatic stability of biodiversity. The projected change of tree cover is calculated as the average percentage change projected to occur within the site.

Sites with a lower change in the projected tree cover are allocated a higher suitability for long-term conservation than sites with a higher change in projected tree cover.

Land-use stability

To assess the potential impacts of projected future land-use change we used predictions of the change in pastures, croplands and biofuel croplands in the buffer zone around the sites (50 km buffer), excluding the site itself.

<u>*Projected land-use change*</u>

Projected land–use change is derived from simulations of current and future land-use, based on global land-use change models, using the assumptions of population growth and economic development as provided by ISIMIP2b and described in Frieler et al. [14]. The land-use change models [15,16] account for climate impacts (e.g., on crop yields) and were driven with the same climate input as the species distribution models used to derive climatic stability of biodiversity (see above). The ISIMIP land-use scenarios provide percentage cover of six different land-use types (urban areas, rainfed crop, irrigated crop, pastures, as well as rainfed and irrigated bioenergy crops). We averaged annual land-use data for each of two different time periods (1995 and 2050), across the four GCMs (see above under Climatic stability), and calculated a combined value of average land-use change for the buffer zone around each site.

Sites with a lower projected increase in land-use in the buffer zone are allocated a higher suitability for long-term conservation than sites with a higher projected increase in land-use in the buffer zone.

Carbon storage

The carbon storage objective includes three different variables, using the three dimensions of ecosystem carbon stocks as defined by Goldstein et al. (2020) [17]. These include the amount of manageable carbon stocks that currently exist but could be influenced in principle by human actions, the amount of vulnerable carbon stocks that currently exist and will be released if land-use changes and the amount of irrecoverable carbon stocks in a site.

<u>*Manageable carbon*</u>

As an indicator for the climate protection capacity, we used the estimated amount of manageable carbon as provided by Noon et al (2021) [18]. This layer includes the amount of carbon stored in the above and below ground vegetation as well as soil organic carbon stocks up to 30 cm depth, or up to 100 cm within inundated soil, as these depths are most relevant to common disturbances [17]. We derived the average amount of carbon in t per ha for each site.

Sites with higher baseline carbon stocks are allocated a higher suitability for long-term conservation than sites with lower baseline carbon stocks.

Vulnerable carbon

Vulnerable carbon is defined by Goldstein et al (2020) [17] as the amount of the manageable carbon, described above, that is likely to be released through typical land conversion in an ecosystem. We derived the average amount of vulnerable carbon in t per ha for each site.

Sites with higher vulnerable carbon stocks are allocated a higher suitability for long-term conservation than sites with lower vulnerable carbon stocks.

Irrecoverable carbon

Irrecoverable carbon is defined as the amount of the vulnerable carbon, described above, that if it is lost through typical land conversion actions, cannot be recovered over the following 30 years [17]. We derived the average amount of irrecoverable carbon in t per ha for each site.

Sites with higher irrecoverable carbon stocks are allocated a higher suitability for long-term conservation than sites with lower irrecoverable carbon stocks.

Large size

For the extent of the area, we preselected sites that are larger than 2000 km^2, based on the precondition that Legacy Landscapes should have a minimum size to maintain a viable ecosystem.

Extent of the site

The area in km^2 is derived from the site polygons provided by protected planet [1] or the Key Biodiversity Area (KBA) database [2].

Larger sites are allocated a higher suitability for long-term conservation than smaller sites.

More details on how the individual data layers were derived can be found in the accompanying publication (to be released soon).

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