Layer Explanations

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Rationale for choice of data layers

In order to detect nature-related risks and opportunities for companies, it is necessary to refer to a set of indicators, rather than single aggregated metrics, that precisely capture the current status of ecosystems and nature with regard to multiple drivers of nature change (IPBES/3/INF/4). For example, recent explanations of habitat loss such as deforestation and freshwater conditions are ones of considerable importance. Spatial distribution map, on a global scale, of such metrics corresponding to business risks and opportunities is essential as background information to identify priority locations in relation to business sectors, thereby improving the effectiveness of corporate financial disclosure and/or decision making.
Here, GBNAT offers a set of ecosystem condition metrics: Deforestation for a recent reduction of forest area, Human footprint increase for recent increase in human pressure to nature, Flood probability for current flood risk, and Water shortage for drought risk. Note that those metrics are in line with the recommended core global metrics by Taskforce on Nature-related Financial Disclosures (TNFD 2023). Other metrics referred in the recommendation, such as GHG and other pollutant emissions, as well as marine ecosystem condition layers, are to be included in later versions of GBNAT.

Recommendations of the Taskforce on Nature-related Financial Disclosures

Explanation of data layers

Biodiversity Importance (Terrestrial Integrated)

An indicator of the importance of site's biodiversity in terms of extinction risk reduction, calculated using the species composition of +120,000 vertebrate and tree species, ranging from 0 to 1, with higher values indicating greater importance.
Global distribution of broadleaf trees (88,406 species), mammals (3,780 species), birds (10,775

species), reptiles (5,557 species), amphibians (5,624 species), and freshwater fishes (5,964 species) were used, totaled 120,106 species.

Lehtomäki, J., & Moilanen, A. (2013). Methods and workflow for spatial conservation prioritization using Zonation. Environmental Modelling & Software, 47, 128-137.

Terrestrial Biodiversity Intactness

An index that quantifies the degree of modification of ecosystems due to land use. Higher values indicate a higher degree of ecosystem integrity.
The rate of species loss (i.e., MSA value) along the intensity of human land alteration were adopted from Cambridge Institute for Sustainability Leadership (2020). MSA values are given for three levels of land alteration intensity (minimal, light, and intense) for natural forests, secondary forests, croplands, and pastures, respectively. We combined this value with the spatial data layer of habitat map (Jung et al. 2020) to produce spatial representation of biodiversity intactness index. Since sourced habitat data layers were in 300-meter resolutions, we aggregated the value into 10 arcminute using mean values.

Jung, M., Dahal, P. R., Butchart, S. H., Donald, P. F., De Lamo, X., Lesiv, M., ... & Visconti, P. (2020). A global map of terrestrial habitat types. Scientific data, 7(1), 256.
University of Cambridge Institute for Sustainability Leadership (CISL). (2020, April). Measuring business impacts on nature: A framework to support better stewardship of biodiversity in global supply chains. Cambridge, UK: University of Cambridge Institute for Sustainability Leadership.

Deforestation (2000-2020)

The amount of change over the past 20 years in the percentage of each grid (approximately 15 km in circumference) occupied by forests. Areas with significant declines may be at high risk of deforestation. On the other hand, grassland areas may be forested (and thus a risk factor for grazing, etc.) due to climate change.
Forest distribution data was obtained from global forest cover datasets (Potapov et al. 2022), which predicted canopy height at 1 arc-second (about 30 meters at the equator) from 2000

to 2020 using manually collected training datasets and Landsat imageries. We defined forest at 5 meter in canopy height and calculated the reduction in forest cover between 2000 and 2020 at 10 arcminute. Areas where deforestation is in progress are valued positively, while areas where forest cover is expanded are denoted as a value of zero. The values were scaled as the percentage of reduced forest cover relative to the whole land area within the target 10 arcminute grid cell.

Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

Potapov, P., Turubanova, S., Hansen, M. C., Tyukavina, A., Zalles, V., Khan, A., ... & Cortez, J. (2022). Global maps of cropland extent and change show accelerated cropland expansion in the twenty-first century. Nature Food, 3(1), 19-28.

Water Pollution

The value of BOD, a comprehensive indicator of overall water quality; a value below 2 indicates high quality water, such as a mountain stream.

We used Biochemical oxygen demand (BOD) as a comprehensive measure of water quality. Gridded BOD data was obtained from the World Bank dataset (see Damania et al. 2019) from 1992-2010. BOD values are represented in 0.5-degree (30 arcminute) resolution. Values are averaged through 1992-2010 and then downscaled to 10 arcminute using bilinear interpolation. Further, we modelled a relationship between BOD values and environmental variables including topography, land cover, climate, soil (extracted water-related environmental variables used for SDMs), and pollutant emission data (Crippa et al. 2018) using Random Forest algorithm, then projected to data-deficient grid cells.

Richard Damania, Sébastien Desbureaux, Aude-Sophie Rodella, Jason Russ, and Esha Zaveri QUALITY UNKNOWN THE INVISIBLE WATER CRISIS 2019 International Bank for Reconstruction and Development / The World Bank https://openknowledge.worldbank.org/bitstreams/9f19c149-c22c-503c-b260-87c15e58e452/download| Desbureaux, S., Mortier, F., Zaveri, E., van Vliet, M. T., Russ, J., *Rodella, A. S., & Damania, R. (2022). Mapping global hotspots and trends of water quality (1992–2010): a data driven approach. Environmental Research Letters, 17(11), 114048.*

Human Footprint Increase (2000-2018)

An index that integrates human pressure on the environment and scores it on a scale from 0 to 50. The increase in this value from 2000 to 2019.
The human footprint metrics was first developed by Venter et al. (2016), which aggregates human pressure to the ecosystem by land development, agriculture and navigable waterways. In GBNAT, data layers calculated by Mu et al. (2022) for 2000 and 2019 in 1 km resolution were used to obtain a data layer for the increase in human footprint. The source data layers, giving human footprint score for each grid cell in 0 - 50 scale, were aggregated by 10 arcminute resolution using mean values and increase in human footprint was calculated as an absolute change in footprint score values.

Venter, O., Sanderson, E. W., Magrach, A., Allan, J. R., Beher, J., Jones, K. R., ... & Watson, J. E. (2016). Global terrestrial Human Footprint maps for 1993 and 2009. Scientific data, 3(1), 1-10.
Mu, H., Li, X., Wen, Y., Huang, J., Du, P., Su, W., ... & Geng, M. (2022). A global record of annual terrestrial Human Footprint dataset from 2000 to 2018. Scientific Data, 9(1), 176. Dataset, https://doi.org/10.5061/dryad.052q5

Future Flood Risk

Risk value of flood frequency under the climate for the next 20 years predicted from the frequency of past flood events. A gridded flood risk layer (CHRR and CIESIN 2005), originally at 2.5 arcminute level, was obtained then upscaled to 10 arcminute. In the sourced dataset, the flood frequencies are given in 10 decile class bins. Next, we modelled the risk values by land cover, climate variables, and human footprint before the year of 2000 using Random Forest algorithm. We then projected the value using predictor variables in 2020. This projected value can be interpreted as the flood risk value in 2020, scaled by the flood risk decile value in 2000. We note that the resulting map of flood risk was generally comparable to results derived from climate model projections (Hirabayashi et al. 2021).

Global Flood Hazard Frequency and Distribution. 2005. Center for Hazards and Risks Research (CHRR), Columbia University; Center for International Earth Science Information Network (CIESIN), Columbia University; International Research Institute for Climate and Society (IRI), Columbia University. Palisades, NY: CHRR, Columbia University. Available: http://www.ldeo.columbia.edu/chrr/research/hotspots/coredata.html
Hirabayashi, Y., Tanoue, M., Sasaki, O., Zhou, X., & Yamazaki, D. (2021). Global exposure to flooding from the new CMIP6 climate model projections. Scientific Reports, 11(1), 3740.

Water Shortage

How little water is available; a value of 1 indicates that there is as much available water as the global average, while a value of 10 indicates that there is only 1/10th of the global average.
The AWARE factor represents how much surplus water is available after ecological and human demands are met, relative to the global average, with larger values indicating a greater likelihood of water shortage (1: global average, 10: 10 times less available water remaining to the global average). The commonly used water stress (the ratio of demand to supply of water) can be high for large populations, even in areas with a high abundance of water in absolute quantity. The AWARE index is an indicator that considers the absolute amount of water that is redundant and thus better represents the risk of water scarcity. AWARE factor (Boulay et al. 2018) version 1.2c was obtained at watershed levels from the WULCA website. As was done for water quality data, we used downscaling and modelling-projection to create a 10 arcminute degree data layer.

Boulay, Anne-Marie, et al. "The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE)." The International Journal of Life Cycle Assessment 23 (2018): 368-378.

Biodiversity Importance (Marine Integrated)

An index of the importance of biodiversity at each site, calculated in terms of the species composition of marine organisms (multiclass taxa).
Targeted taxonomic groups were marine fishes (12,800 species), marine mammals (100

species), marine reptiles (65 species), marine algae and seagrass (822 species), seabirds (230 species), marine crustaceans (8,514 species), Scleractinia corals (636 species), and marine shells (7,659 species), totalled 30,826 species.

Marine Biodiversity Intactness

An index that represents the intactness of marine ecosystem by quantifying degrees of modification of ecosystems due to use of human (fishery, shipping, construction, climate change etc.) as a proxy for biodiversity loss. Higher values indicate a higher degree of ecosystem integrity (1: intact ~ 0: heavily degraded)
An established framework on direct indicators to quantify the intactness of ocean ecosystem is still lacking. In our framework, among existing approaches, we used the intensity of human development and resource use in the ocean, calculated by Halpern et al. (2019), as an indicator of the degree of intactness. This indicator is the cumulative value of 14 indicators for human pressure to the ocean ecosystem, including climate change, fisheries, light pollution, organic pollution, and shipping. The most recent data currently available (2013) was aggregated into a 10 arcminute grid using mean values.

Halpern, B. S., Frazier, M., Afflerbach, J., Lowndes, J. S., Micheli, F., O'Hara, C., ... & Selkoe, K. A. (2019). Recent pace of change in human impact on the world's ocean. Scientific reports, 9(1), 11609.