

Threats to biodiversity

Using spatial data on threats for impact assessments

Key messages

Biodiversity is declining rapidly due to human-induced impacts on species and ecosystems. The major threats to biodiversity include habitat loss, overexploitation, invasive species, pollution and climate change.

Threats can be mapped in a number of ways: individually; in combination to produce cumulative threat maps; and by using species range data which includes information on species-specific threats.

There are an increasing number of spatial datasets on threats to biodiversity, and threat mapping has demonstrated its potential to be a useful tool for business decision-making (for example, see Figure 1), from screening to environmental impact assessments.

At present, the data do not exist to support comprehensive cumulative threat analysis globally, particularly for use at site level. Work to improve data availability is therefore key to the development of threat mapping as a means of supporting decision-making by the private sector.

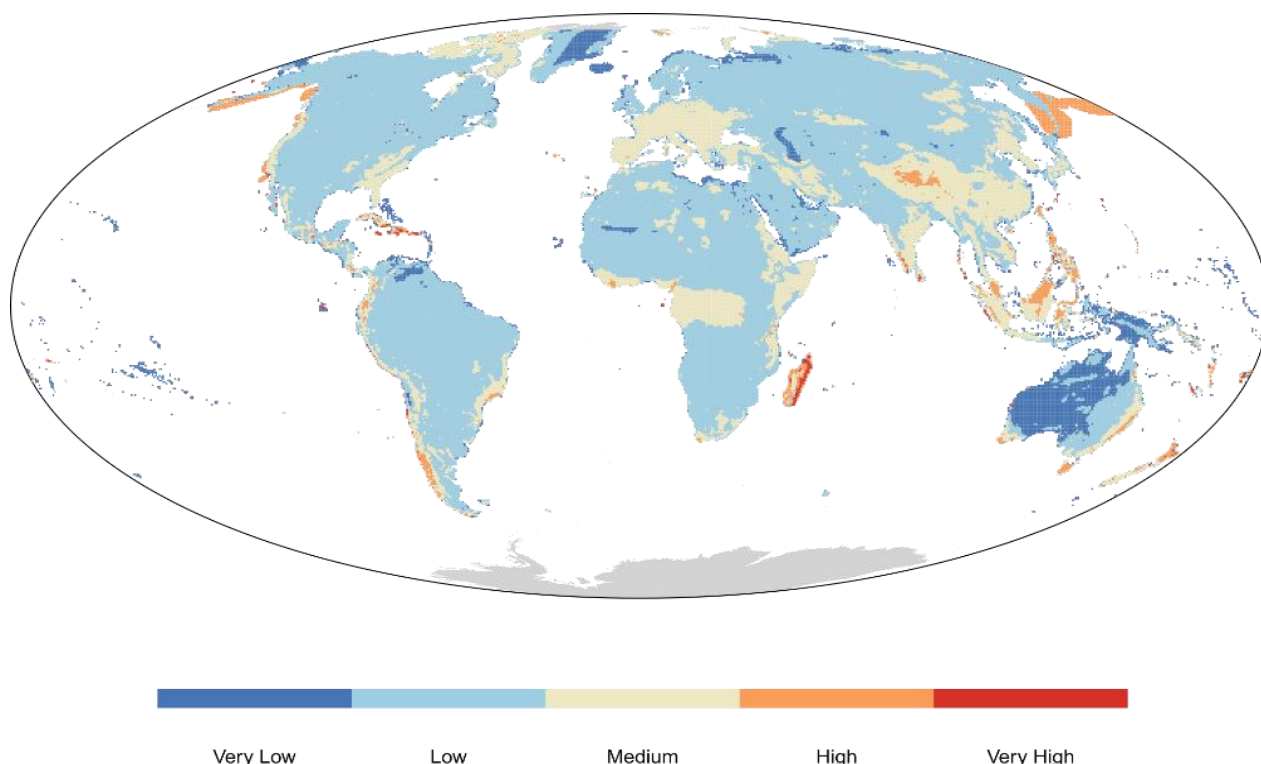


Figure 1: Spatial distribution of combined threats to species from habitat conversion, invasive species and hunting (based on International Union for Conservation of Nature (IUCN) Red List data for 11,727 species of mammals and amphibians). Source: UNEP-WCMC (2016).

Introduction

Biodiversity is declining rapidly as a result of human activities. These threats (see Box 1) are increasing [1,2,3], with species extinction rates estimated to be 1,000 times higher than they would be in the absence of human actions [4].

It is important to monitor the threats faced by biodiversity in order to understand when and where impacts may occur. There are a number of spatial datasets describing key threats to biodiversity, including human population density, roads and agriculture. These datasets show the intensity of particular threats per unit area but do not highlight the cumulative potential impact on biodiversity from all threats combined.

Cumulative threat maps combine different types of threats. Each threat is given a score relative to the other threats. The scores for each unit area are then summed, resulting in a combined threat score for each unit area. A species or ecosystem may be able to withstand a particular threat, for example logging, but the combined impacts from logging, road building and the introduction of invasive species, may lead to species extinction or ecosystem collapse.

Both individual and cumulative threat maps can be used to compare and contrast potential human impacts in areas of biodiversity importance, thereby allowing actions to be targeted where they are needed most. This

Box 1: Defining a threat

Threats and **pressures** are often used either interchangeably or in overlapping ways within the literature when describing an external force that unfavourably changes the state of biodiversity. This can often cause confusion when attempting to understand and map threats.

For the purpose of this briefing note the term **threat** will be used, and is defined as a process that may cause the destruction, degradation of biodiversity, and/or impairment of biodiversity targets.

Threats can take many forms including habitat loss, pollution and over-exploitation. The impact of a **threat** then relates to the effect that the **threat** has on the **state** of a biodiversity feature (for example, a species population size or area of habitat). The change in **state** can vary depending on the timing, scope and severity of the **threat**.

Threats are linked to **drivers of change**, which are social or economic factors that underpin the severity of threats. For example, population increase is a **driver of change** that is linked to increases in **threats** including habitat loss, pollution, and overexploitation.

Due to the difficulty in mapping some **threats** directly, mapping of **drivers of change** can be used as a proxy [5]. For example, mapping settlements can provide a proxy for the **threat** from overexploitation.

approach can be used by industry, for example when undertaking impact assessments, for site screening purposes or for mitigation design.

Although combining datasets on threats may add value to Environmental Impact Assessments (EIAs) and Strategic Environmental Assessments (SEAs), there are some limitations with this approach. These include challenges around combining different data types, and the differential, sometimes unquantifiable impact, that each threat has on biodiversity.

Recent studies have attempted to map cumulative threats across the planet, for example:

- The terrestrial human footprint maps [6] which describe the intensity of threats globally based on eight global threat datasets.
- The temporal human pressure index [7] which examines the change in terrestrial threats over time.
- The cumulative human impact to marine ecosystems [8] which looks at the spatial and temporal changes of threats in the ocean.
- Terrestrial [9] and marine [10] wilderness maps which use threat maps to identify areas of the globe which have had little impact from humans.

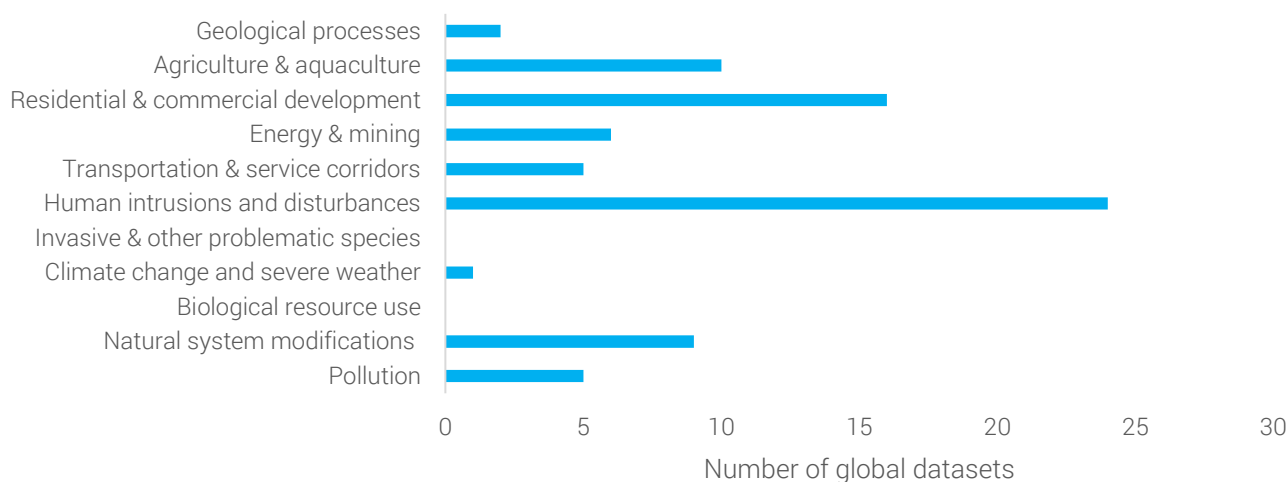


Figure 2: Threat datasets based on categories from Salafsky et al. [4]. Note that a dataset may be relevant to more than one category. Availability of datasets is detailed in Annex A.

A survey of Proteus Partners conducted by UNEP-WCMC regarding threat mapping has been used to understand the data needs of Partners for Environmental Impact Assessments. In this survey, biological resource use, natural system modifications and pollution were highlighted as important by all respondents, while data on geological processes were deemed less useful.

This briefing note provides an overview of the approaches and limitations of mapping threats and includes a list of 49 threat layers, as well as three cumulative threat maps, two wilderness maps and a land cover map (see Annex A). This list includes, for example, human population growth, agriculture, pollution and infrastructure. Figure 2 shows the IUCN threat categories that the datasets reviewed in this briefing note fall under. There is a significant disparity between the expressed needs and availability of

data, in particular with regards to biological resource use. Survey responses were regarding Environmental Impact Assessments and responses may differ when considering other potential uses, such as project screening.

The major threats to biodiversity

Threats to biodiversity come in a multitude of different forms (see Box 2), and the IPBES Global Assessment has documented a significant increase in these threats over the last 50 years [11]. A number of the most prevalent threats can be grouped under the following categories, but these are by no means exhaustive.

Habitat loss

The biggest current threat to terrestrial biodiversity is habitat loss/degradation. This is primarily related to agricultural activity, urban development and extraction

activities (for example mining and logging).

Overexploitation

Overexploitation – harvesting of biological resources at rates higher than they can reproduce or regrow – is another significant cause of biodiversity loss. This includes hunting species for bushmeat and traditional medicine, catching species for the pet trade, unsustainable logging, as well as overharvesting fish stocks in the ocean, lakes and rivers.

Climate Change

Climate change impacts species and habitats, and is likely to have wide ranging effects in the near future. While a threat in its own right, leading to flooding, droughts and extreme weather events that can negatively impact species, climate change also acts to magnify the impact of other threats in terms of their scope and severity [12]. Changing climates are, for example, leading to species range shifts, with restricted-range and isolated

species likely to be most vulnerable [13] (see [a previous Technical Briefing Note](#) for more details on species' responses to climate change). Continued rising sea-temperatures will also have substantial impacts, such as increased severity of coral bleaching events [14].

Pollution

The impacts of pollution on biodiversity are wide ranging, effecting species across trophic levels as well as ecosystems and the services they provide. This results from the multitude of forms pollution takes, from airborne particulates, to chemicals from agricultural and industrial sources, to plastics from domestic waste.

Invasive species

Invasive species have already caused many extinctions and have been particularly destructive on islands. One such example is the robust white-eye, a bird endemic to Lord Howe Island off Australia, which was common until the introduction of black rats. The robust white-eye plummeted to extinction after the introduction of this invasive species [15].

Cumulative impacts

Many species are directly impacted by more than one threat [5]. In addition, there are indirect and induced threats, such as introduction of invasive species through road building. The combined effects of direct and indirect threats and their interactions may have a greater

Box 2: Causal Chains

The first unified classification of direct threats was proposed by Salafsky *et al.* (2008) [4] to help systematically identify threats. It has been used, in addition to the complementary scheme of threat actions, to guide IUCN assessors in their assessment of threats to Red List species.

This approach addresses the threat and its sources as one, whereas decoupling the two can be particularly advantageous when one source has many mechanisms of threat. For example, agriculture can lead to both habitat destruction and pollution. Untangling these relationships can overcome the limitations in using the direct threat classification scheme.

Constructing the entire causal chain of threat as **driver-source-mechanism-state** however is favourable for targeted interventions and has been proposed as an alternative scheme to the direct threat classification [16]. An example of a causal chain is a reduction in population size (a **state**) of a frog which may be caused by habitat loss (a **mechanism**) due to logging (a **source**) as a result of the underlying **driver** of an increased demand for wood.

Threats to biodiversity are typically considered in two ways:

- (i) as direct threats to biodiversity (e.g. habitat loss)
- (ii) as a causal chain of threat consisting of four key elements:
 - 1) **State** – the condition of biodiversity (e.g. a reduction in the population size of a species).
 - 2) **Mechanism** – the cause for biodiversity being in an unfavourable state (e.g. habitat destruction, invasive species and pollution). *As such, mechanism broadly aligns with the definition of a threat used in this briefing note.*
 - 3) **Source** – the source of the mechanism (e.g. agriculture, energy production and mining)
 - 4) **Driver** – the underlying factors driving sources and in turn mechanisms (e.g. increased consumer demand, poverty and poor governance). *As such driver broadly aligns with the definition of a driver of change used in this briefing note.*

impact on biodiversity than any one threat alone [16].

Cumulative impacts are greatest in areas with highly sensitive biodiversity (i.e. with species or habitats that cannot adapt to changing environments), in terms of accelerating species extinctions and exacerbating habitat degradation. In already heavily degraded areas, cumulative impacts may prevent regeneration, restoration or species recovery.

The characteristics and state of biodiversity is important to consider when quantifying cumulative impact.

Approaches to mapping threats

Mapping threats to biodiversity allows visualisation of the spatial variation in threat intensity, both by individual threat, and by cumulative impact. Alternatively,

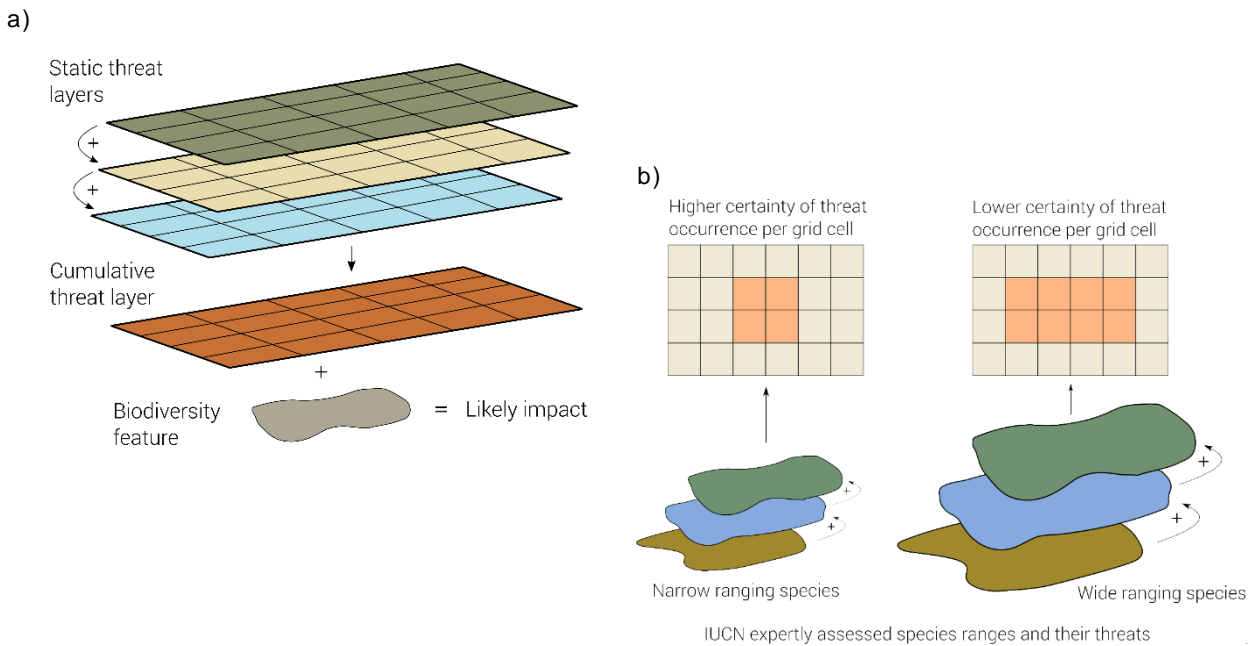


Figure 3: Different ways of mapping threats - a) summing several static threat data layers can produce a cumulative threat layer - overlaying this with biodiversity data (e.g. Key Biodiversity Areas or Protected Areas) reveals areas most likely to be impacted; b) using IUCN species range data, which has information on the threats impacting each species, areas where a specific threat is likely to be impacting species can be identified.

using species range maps, the potential spatial range of some threats' impacts can be mapped.

Static threats

A widely used approach to map threats is by the location and intensity of threats themselves, independently of the species

assessed. Some examples of static threat data include:

- Human population density
- Mining concessions
- Roads
- Agricultural areas

Many static threat datasets are available for commercial use (see

Annex A) and can be used to analyse change over time – an important indicator of the success of human response such as conservation projects, protected areas and industries' impact mitigation.

Towards a cumulative threat indicator

Cumulative threat maps combine a number of static threat maps to represent an overall intensity of threats (see Figure 3). There have been a number of attempts to map the cumulative human threats in both terrestrial and marine environments (e.g. Figure 4). These global maps provide an overview of cumulative human threats to biodiversity including: i) where the human footprint is largest; ii) where human impacts have increased; and iii) where the impact of potential new industry

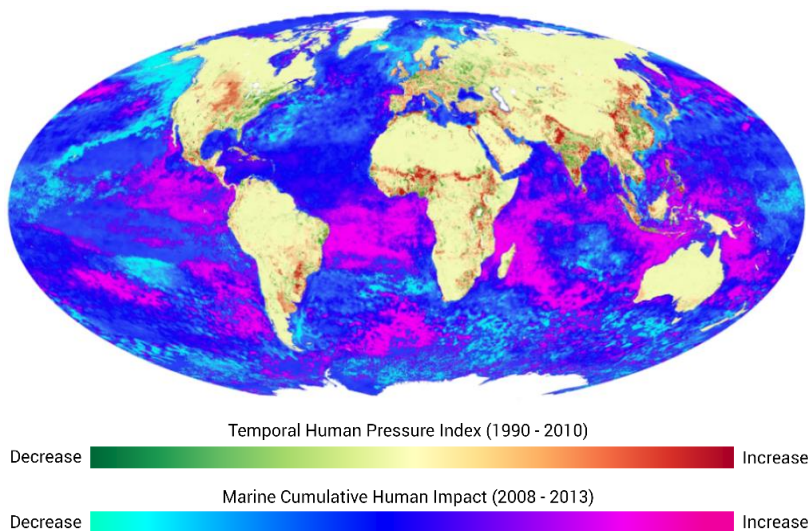


Figure 4: Temporal changes in human pressure on land and sea. Source: Data from Geldmann *et al.* (2014) and Halpern *et al.* (2015).

operations may be greatest. However, cumulative threat maps are limited to the threats that have been mapped, such as by satellite remote sensing or citizen science approaches. Whereas some threats are very difficult to monitor.

Species approach

The bottom-up approach for mapping threats to biodiversity uses two key pieces of information: i) where species are likely to be found and; ii) what threats those species face within their geographical range. By combining the geographic ranges of species in comprehensively assessed groups (i.e amphibians, mammals and birds), locations where there is a high probability of species being threatened by a given activity can be identified (an example of this approach is shown in Figure 1).

These data are recorded by IUCN species experts, however, the IUCN species range data does not indicate the location of threat within a species' range. Species with restricted ranges are more likely to be under threat across their entire range, whereas threats to wide ranging species, with a large geographical extent, may be more uncertain (see Figure 3). The probability that a species is threatened by a human activity in a particular location is therefore calculated based on whether the species is likely to be found there, whether the species is threatened by that activity and the size of the species' ranges [18].

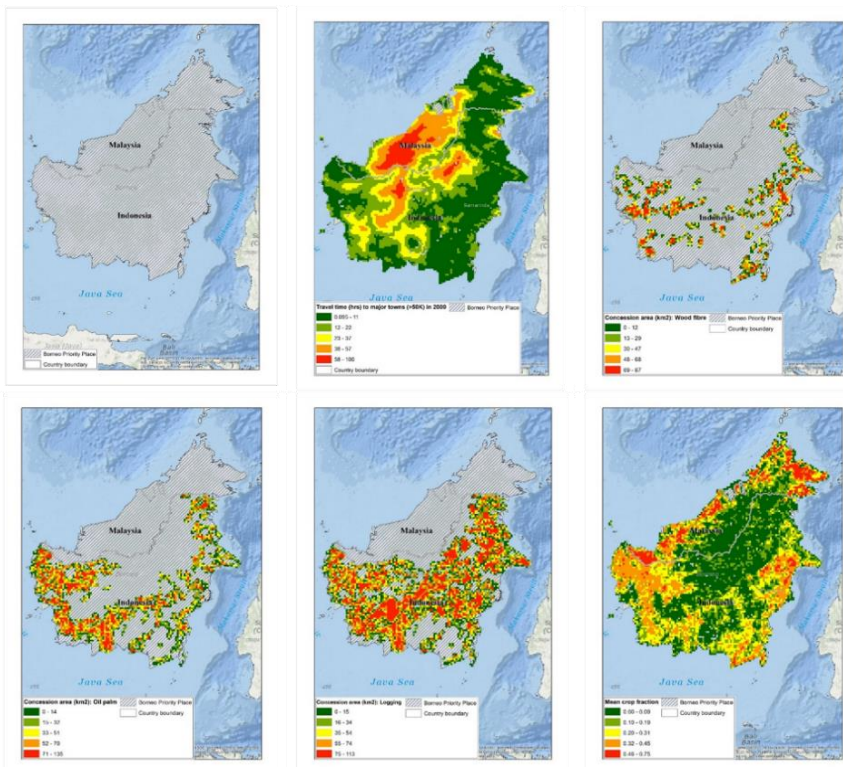


Figure 5: Static threat maps for Borneo, showing: a) extent of Borneo Priority Place (defined by [WWF](#)); b) travel time (hrs) to major towns; c) wood fibre concession areas; d) oil palm concession areas; e) logging concession areas; f) mean crop fraction (proportion of land covered by crops).

Wilderness maps

Threat data can also be used to map remaining wilderness areas. These are areas which have experienced very little or no human impacts. These maps have been produced for both land [9] and sea [10] and are effectively inverse threat maps.

Limitations of mapping threats

Static and cumulative threat maps

Mapping individual static threats provides accurate locations of where threats are (see Figure 5), and when summed into cumulative threat maps provides information on intensity. It does not, however, take into account threats at the species level, and

the impacts they may have. For example, the map may indicate a high number of threats in an area, but that area may have already lost all of its sensitive species.

In addition, the level of species resilience to a particular threat is not captured so the map does not represent impact. Due to their coarse resolution, current maps are also often not suitable to be used at the site level.

When comparable cumulative layers have been generated on multiple occasions, threats can be mapped temporally in order to show how they have changed over time. This can be useful to identify areas in which threats are increasing. However, care must be taken in the interpretation of such maps as there is no indication of intensity. For example, areas showing no change over time may be areas with high threats that

have remained high, low threats that have remained low, or somewhere in between.

Species approach

The species approach provides information on where species are most likely to be threatened by a particular human activity. It does not provide information on the impact of that threat on, for example, the population size of the species. In addition, because the method relies on the spatial

overlap of species ranges, unless those ranges are small, the method has relatively low accuracy in precisely locating threats arising from human activities, for example the impacts of a dam or a pollution source.

Limitations of combining threat data

Previous attempts to combine spatially explicit data on the distribution of threats into cumulative human pressure maps

have included many of the biggest threats biodiversity is facing, such as agriculture and human settlements. However, a lack of globally consistent and standardised data on threats such as biological resource use, invasive species, pollution and climate change, means these threats are underrepresented in global cumulative threat maps. Limitations to combining spatial threat data are described in Table 1.

Table 1: Limitations associated with combining threat data.

Limitation	Description
Combining threat data from different years	Available threat datasets span a range of years from pre-2000 to the present. Years often do not overlap between threat data layers.
Lack of temporal threat data	There is a general lack of consistent, temporal threat data which can be used to detect change in threat intensity over time.
Combining data types	Threat datasets encompass continuous, categorical and discrete data. This presents a number of methodological issues when attempting to standardise and combine for a cumulative threat score.
Assuming all threats are equal	When different threats are combined there is an assumption that they all have the same impact and that within one threat all features are equal, e.g. it assumes an aluminium mine has the same impact as a gold mine or a highway has the same impact as a dirt road. This is not the case and a conceptually-sound weighting system is needed, but this can be subjective and difficult to justify.
Combining related threats	The majority of threats are human-driven and are therefore closely related to human settlement, population and consumption. However, some threats are more related to these drivers than others, e.g. human access is directly linked to distance to roads. There is therefore the possibility for conflation of threats, inter-correlation and redundancy between datasets.
Lack of globally consistent spatial data on several important threats	Threats such as pollution, invasive species, diseases, biological resource use and climate change are difficult map in a standardised way on a global scale, therefore are underrepresented in cumulative threat maps.

Implications for private sector use of threat maps

Reducing biodiversity loss associated with business activities requires an understanding of the threats that biodiversity is facing. This includes what the threats are, how sensitive a species or habitat is, where the threat occurs and its intensity, as well as how threats are changing in type, intensity and over time[7, 19]. It is therefore important to consider the current threats to biodiversity that are occurring in areas of development.

Threat data could be used during impact assessments to examine the current threats to biodiversity and evaluate cumulative impacts, such as:

- Maps of individual threats to determine the locations of threats in relation to operations.
- Cumulative threat maps to assess threat intensity on a landscape scale.

- A species approach to threat mapping to assess which species may be impacted by certain activities.

Species approaches can provide an assessment of the number of species at a site likely to be impacted by a particular threat or group of threats. By examining maps of threats likely to be generated by a project, it is possible that species-based threat maps can be used as part of the screening process.

Static or cumulative maps show where threats already occur, without considering whether the species present will be impacted. As a result it is difficult to identify the impact a project may have as a part of a screening process. Instead these maps may be of use for more detailed assessments as part of Environmental Impact Assessments.

Existing guidelines

The use of several mapping techniques would help industry when following existing biodiversity guidelines.

Guidelines such as [CSBI's Good Practices for the Collection of Biodiversity Baseline Data](#) and [IPIECA's Biodiversity and Ecosystem Services Fundamentals](#) suggest that cumulative impacts be assessed before a project starts. This should be supplemented by site-specific habitat and species information.

User needs

A survey of Proteus Partners undertaken by UNEP-WCMC indicated that threat data from a

range of threat categories would be useful for impact assessments.

The datasets included in Annex A have been informed by this survey. Datasets that were noted as useful have been included and searches for similar data have been undertaken. Data for all threat categories that were indicated as relevant for Proteus Partner needs were included, where available.

There are a large number of threat datasets available but most do not meet required standards set out for assessing threats to biodiversity [19]. Datasets should be:

- Freely available.
- Have a spatial resolution that is comparable with global species range maps (i.e. ≤ 10 km²)
- Up to date (i.e. within the last decade)
- Repeated at least once in order to assess temporal changes
- Assessed for accuracy (i.e. have been independently reviewed)

In a recent study, only 14 of 290 datasets analysed met all five criteria [19]. In particular there is a lack of global threat data on invasive species and biological resource use (for example, bushmeat hunting, pest control and persecution).

In addition to gaps in the data, there are currently no available tools focussing on threat data. Developing a means to access threat data was noted to be of significant use to Proteus Partners in informing impact assessments,

especially if detailed location specific data as well as trends over time could be provided.

Conclusions and Implications

Threat maps have the potential to provide useful tools for business in screening projects and informing Environmental Impact Assessments.

A key barrier to applying threat maps to business decisions is the resolution and accuracy of spatial data. For example, species-based threat maps using IUCN threat categories are conducted on 50x50 km grid cells. This limits the application for site-level decision making. Further work to develop higher resolution maps could generate products that are of greater use for project screening.

Another barrier is the lack of datasets available for a number of threat categories, especially regarding threats from biological resource use and invasive species. These data gaps are likely to pose a significant challenge for the development of a comprehensive cumulative threat map, but ongoing work to develop cumulative threat maps will likely increase their utility for business decision making.

While current threat maps require further development they already provide useful tools for assessing threats to biodiversity at a global scale and show the potential for future improvements which could pave the way for greater integration into business decision making.

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Annex A – Available threat datasets

An overview of the datasets available to understand threats to biodiversity. The datasets have been grouped according to the causal chain method (Driver – Source – Mechanism), as well as ‘Other’ for datasets that did not fit this categorisation. Please note this list is non-exhaustive and access for commercial use varies.

Data Category		Dataset name and description	Temporal extent	Spatial resolution	Available for commercial use?	Link
Drivers	Rapid population growth	LandScan - global population distribution data. Developed using best available demographic (Census) and remote sensing imagery to disaggregate census counts within an administrative boundary.	2000 - 2017	1 km	No (can be licensed for commercial use)	https://landscan.ornl.gov/
		Global Human Settlements Population Grid – disaggregated GPWv4 data	1975, 1990, 2000 and 2015	250 m and 1 km	Yes	https://ghsl.jrc.ec.europa.eu/ghs_pop.php
		Gridded Population of the World (GPWv4) - estimates of population density.	2000 - 2020	1 km	Yes	http://beta.sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density
	Humanitarian relief	Refugee Camp locations in Iraq	2017	Point	Yes	https://data.humdata.org/dataset/fsm-t-sites-19-12-2016
		Syria Refugee Sites - verified data on the geographic location of refugee sites hosting Syrian refugees in Turkey, Jordan, and Iraq	2016	Point	Yes	https://data.humdata.org/dataset/syria-refugee-sites
		Refugee Camps in White Nile and East Sudan	2016	Point	Yes	https://data.humdata.org/dataset/refugee-camps-in-west-nile-and-east-sudan
		Malian Refugees: Camp locations in Mauritania, Niger and Burkina Faso	2014	Point	Yes	https://data.humdata.org/dataset/malian-refugees-camp-locations-in-mauritania-niger-and-burkina-faso
		Horn of Africa Refugee camps	2012	Point	Yes	https://data.humdata.org/dataset/hoa-refugee-database

Data Category		Dataset name and description	Temporal extent	Spatial resolution	Available for commercial use?	Link
		Refugee Camps in Nigeria	Unknown	Point	Not specified	https://data.humdata.org/dataset/nigeria-iom-dtm-datasets/resource/54d7e8af-2b0f-4af7-b8ac-28bf8b519488
	Poverty	Global Gridded Geographically Based Economic Data - global gridded Gross Domestic Product (GDP) data in both Market Exchange Rate (MER) and Purchasing Power Parity (PPP).	1990 - 2005	~111 km	Yes	http://sedac.ciesin.columbia.edu/data/set/spatialecon-gecon-v4
Source	Agriculture	Gridded Livestock of the World - global population densities of cattle, buffaloes, horses, sheep, goats, pigs, chickens and ducks.	2010	~10 km	Yes	https://dataverse.harvard.edu/dataverse.xhtml?alias=glw_3
		Cropland extent and watering method	2010 and 2015	30m and 1km	Not specified	https://web.croplands.org/download_PDAAC
		Global Cropland Extent - cropland probability and discrete cropland/not-cropland per grid cell	2000 - 2008	250m	No (contact: https://glad.umd.edu/projects/croplands/dataindex.html)	https://glad.umd.edu/projects/croplands/dataindex.html
		History Database of the Global Environment (HYDE) - Gridded cropland and pasture land use.	10 000 B.C. - 2005 A.D.	~10 km	Not specified	http://themasites.pbl.nl/tridion/en/themasites/hyde/download/index-2.html
		Cropland and Pasture Area	2000	~10 km	Yes	http://www.earthstat.org/cropland-pasture-area-2000/
	Forestry	Mining concessions in forests	1901 - 2015	Polygon	Yes	http://data.globalforestwatch.org/datasets/26a457ee3b584824bb930f2ec791b60d_0?geometry=-480.498%2C8.617%2C-145.987%2C57.251
	Global Power Plant Database	2018	Point	Yes	http://datasets.wri.org/dataset/globalpowerplantdatabase	

Data Category		Dataset name and description	Temporal extent	Spatial resolution	Available for commercial use?	Link
	Energy production & Mining	Mineral operations outside the United States	2006 - 2010	Point	Not specified	https://mrdata.usgs.gov/mineral-operations/
		Active mines and mineral plants in the US	2003	Point	Not specified	https://mrdata.usgs.gov/mineplant/
		World Copper Smelters	2002	Point	Not specified	https://mrdata.usgs.gov/copper/
		Global Reservoirs and Dams (GRanD)	2011	Point	Permission needed (ciesin.info@ciesin.columbia.edu)	http://sedac.ciesin.columbia.edu/data/set/grand-v1-reservoirs-rev01
	Habitat destruction	Global Forest Change	2000-2017	30m	Yes	https://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.5.html
		Global and Regional Risks of Tree Cover Loss	2014-2029	1km	Not specified	http://futureclimates.conservation.org/riskstreecoverloss.html
		Long Term Global Land Change	1982-2016	~5km	Not specified	https://glad.umd.edu/dataset/long-term-global-land-change
Climate change	Global Surface Temperature Anomaly	1951 - 2018	~222 km	Yes	https://data.giss.nasa.gov/gistemp/maps/	
Mechanism	Pollution	Nutrient Application for Major Crops - nitrogen and phosphorus application for different crop types	2000	~10 km	Yes	http://www.earthstat.org/nutrient-application-major-crops/
		Phosphorus Fertilizer Application - all crops combined	1994 - 2001	~56 km	Permission needed (ciesin.info@ciesin.columbia.edu)	http://sedac.ciesin.columbia.edu/data/set/ferman-v1-phosphorus-fertilizer-application
		Nitrogen Fertilizer Application - all crops combined	1994 - 2001	~56 km	Permission needed (ciesin.info@ciesin.columbia.edu)	http://sedac.ciesin.columbia.edu/data/set/ferman-v1-nitrogen-fertilizer-application
		Phosphorus in Manure Production - the amount of phosphorous in manure produced and present on the landscape.	1994 - 2001	~56 km	Permission needed (ciesin.info@ciesin.columbia.edu)	http://sedac.ciesin.columbia.edu/data/set/ferman-v1-phosphorus-in-manure-production
		Nitrogen in Manure Production - the amount of nitrogen manure produced and present on the landscape.	1994 - 2001	~56 km	Permission needed (ciesin.info@ciesin.columbia.edu)	http://sedac.ciesin.columbia.edu/data/set/ferman-v1-nitrogen-in-manure-production

Data Category	Dataset name and description	Temporal extent	Spatial resolution	Available for commercial use?	Link
Infrastructure	OpenStreetMap - roads, airports, train stations and much more. This data can also be downloaded within QGIS using plugins	2018	Point and polyline	Yes	http://download.geofabrik.de/
	Global Roads Open Access Data Set (gROADS)	1980 - 2010	Polyline	Use constraints that apply to a small number of countries	http://sedac.ciesin.columbia.edu/data/set/groads-global-roads-open-access-v1
	Airports, train stations and ferry terminals	2017	Point	Yes	https://openflights.org/data.html
	Global railways	2014	Polyline	Yes	https://data.humdata.org/dataset/global-railways
Urbanisation	NASA Black Marble Product - Moonlight-adjusted Nighttime Lights. This is a new product and more recent data are likely to be released by the end of 2018.	2012 - 2016	500 m	Yes	https://viirsland.gsfc.nasa.gov/Products/NASA/BlackMarble.html
	Global Human Settlements (GHS BUILT-UP GRID)	1975 - 2014	38m, 250m and 1Km	Yes	https://ghsl.jrc.ec.europa.eu/ghs_bu.php
	Nighttime Lights - cloud-free composites of lights at night. An indication of human presence.	1992 - 2013	~ 1 km	Yes	https://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html#AVSLCFC
	Global Urban Footprint - data show urban areas, land surface and water.	2011	~12 m	For commercial use contact Airbus DS Geo GmbH (see link 'Commercial Use').	https://www.dlr.de/eoc/en/desktopdefault.aspx/tabid-11725/20508_read-47944/
	The MODIS 500m map of global urban extent	2001 - 2002	500m	Yes	http://nelson.wisc.edu/sage/data-and-models/schneider.php
	Accessibility to cities - global travel time to cities, showing how accessible areas are.	2015	1 km	Yes	https://map.ox.ac.uk/research-project/accessibility_to_cities/

Data Category	Dataset name and description	Temporal extent	Spatial resolution	Available for commercial use?	Link
Tourism	Visitation rates to tourist sites from flickr photo posting rates	2005 -2012	No Specified	No (Author contact https://www.nature.com/articles/srep02976/email/correspondent/c1/new)	https://www.nature.com/articles/srep02976
Military activity	Armed Conflict Location and Event Data (Asia, Middle East and Africa)	2010 - 2018, 2016 - 2018, 1997 - 2018	Point	Permission needed (admin@acleddata.com)	https://www.acleddata.com/data/
Irrigation	Global Map of Irrigation Areas (GMIA) v5 - percentage and area of each cell that is irrigated	2005	~10 km	Permission needed (http://www.fao.org/contact-us/licence-request/en/)	http://www.fao.org/nr/water/aquastat/irrigationmap/index10.stm
	Historical Irrigation Dataset (HID)	1900-2005	10km	Yes	https://mygeohub.org/publications/8/about?v=2
Fire	MODIS Active Fire - fires in 1-km pixels that are burning at the time of satellite overpass	2000 - present	Point	Yes	Past 7 days - https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data Older than 7 days - https://firms.modaps.eosdis.nasa.gov/download/
	Modis Burned Area - burned areas are characterized by deposits of charcoal and ash, removal of vegetation, and alteration of the vegetation structure. Monthly aggregated data per MODIS grid square.	2000 - present	500m	Yes	https://search.earthdata.nasa.gov/search/granules?p=C1364190927-LPDAAC_ECS&m=0!0!2!1!0!0%2C2&tl=1526204731!4!!&q=MCD64A1%20V006&ok=MCD64A1%20V006
	Global Fire Atlas - global yearly aggregated data using Modis Burned Area.	2003 - 2016	500m and Polygon	Yes	http://www.globalfiredata.org/fireatlas.html

Data Category		Dataset name and description	Temporal extent	Spatial resolution	Available for commercial use?	Link
	Geological events	Global landslide susceptibility	2013	1km	Yes	https://pmm.nasa.gov/applications/global-landslide-model
		Global erosion risk	Not specified	~420m	Yes	http://data.globalforestwatch.org/datasets/erosion
Other	Global cumulative threat maps	Cumulative human impact to marine ecosystems	2008 - 2013	1km	Yes	https://knb.ecoinformatics.org/view/doi:10.5063/F19Z92TW
		Temporal human pressure index	1990 - 2010	10km	No	https://onlinelibrary.wiley.com/doi/full/10.1111/cobi.12332
		Terrestrial Human Footprint	1993 - 2009	1km	Yes	https://datadryad.org/resource/doi:10.5061/dryad.052q5
	Wilderness maps	Global marine wilderness	2013	1km	Yes	https://knb.ecoinformatics.org/view/doi:10.5063/F1RR1WFT
		Terrestrial wilderness	1993 - 2009	Polygon	Yes	https://datadryad.org/resource/doi:10.5061/dryad.124fp
Land cover maps	ESA Land Cover	1992 - 2015	300m	Permission needed (contact@esa-landcover-cci.org)	https://maps.elie.ucl.ac.be/CCI/viewer/	