Perry World House Global Climate Security Atlas - Summary of datasets

Description: The Atlas visualizes global and transboundary climate risk and impact through digitization of IPCC (2021, 2022) related research complemented with global social and political datasets that indicate vulnerability and exposure to climate change. Within this document, we outline the information for the datasets used, following the same structure as presented in the Atlas.

Interactive Atlas web: https://global.upenn.edu/perryworldhouse/global-climate-security-atlas

Index

- **Biodiversity** Maps showing the current state of biodiversity and the impacts of climate change on biodiversity loss.
- **Natural disasters** Maps showing current frequency and intensity of floods, droughts, extreme temperature events, earthquakes, hurricanes, pollution…
- **Social and political indices** Compilation of social and political indices that show human vulnerability to climate change.
- **Environmental risk indices** Compilation of indices that combine social vulnerability with environmental impact to display the risk associated with climate change, natural disasters, or biodiversity loss.
- **Geography, population, and infrastructure** Maps showing elevation, population projections and urban growth, energy infrastructure, and other infrastructure variables.
- **External datasets** Links to external maps, multi sectoral indices, and visualization efforts at the intersection of climate, biodiversity, society and politics

IPCC WG1 - Hazards

Source: IPCC Interactive Atlas by Predictia

Data was provided by authors, and can be downloaded in the IPCC Interactive Atlas
More information
https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Atlas.pdf

Format: netCDF

Description
Data shown in the Atlas:
Historical average over the period 1981-2010 (WMO2 period)
Change predicted at different warming levels (with respect to the historical period average).
Original projections from the Coupled Model Intercomparison Project Phase 6.

How are the predictions at different warming levels calculated? (processed maps)
Noting the approach taken in the recent IPCC Special Report on Global Warming of 1.5°C (SR1.5) above 1850–1900 levels (IPCC, 2018b), the Atlas also presents global and regional

climate change information at different Global Warming Levels (GWLs). In particular, to provide policy relevant climate information and represent the range of outcomes from the emissions scenario and time periods considered, GWLs of 1.5°C, 2°C, 3°C and 4°C are considered. The information is computed from the 4 standard scenarios (SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5).
A model future climate simulation reaches the defined GWL of 1.5°C, 2°C, 3°C or 4°C when its global near-surface air temperature change averaged over successive 20-year periods first attains that level of warming relative to its simulation of the 1851-1900 climate. (1851–1900 defines the pre-industrial baseline period for calculating the required global surface temperature baseline). Note that this process is different from the one used in the SR1.5 report which used 30-year future periods. If a projection stabilizes before reaching the required threshold it is unable to simulate climate at that GWL and is thus discarded (e.g. SSP1-2.6 scenario only provides information for GWL 1.5°C and 2°C).
Each warming level is then the average of the different available scenarios.

IPCC WG2 - Impacts, Adaptation, Vulnerability

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=bfb0a1b8bcba4e50a11d50e270e2c4f3

Source: The WGII Global to Regional Atlas (Annex I) (The numbering below refers to the figure number in the Annex I Atlas)

Data AR6 Data center distribution (data available for few maps)

5. Evidence and attribution of climate change impacts

Source: Machine-learning-based evidence and attribution mapping of 100,000 climate impact studies, Callaghan et al. 2021

Data: https://github.com/mcallaghan/interactive-impacts-map
da_data.json is a collection of features, where each item is a grid cell, and
- af_temp is the temperature trend predicted in climate models with anthropogenic forcing
- obs_temp is the observed temperature rise
- da_cat_temp is the category (+-2/3 signal detectable trend attributable to anthropogenic influence on the climate)
In ws_data, each item is a gridcell-impact type-driver type combination, and weight is the number of weighted studies.
Interactive site https://mcallaghan.github.io/interactive-impacts-map

Format: .json

Description: "Increasing evidence suggests that climate change impacts are already observed around the world. Global environmental assessments face challenges to appraise the growing literature. Here we use the language model BERT to identify and classify studies on observed climate impacts, producing a comprehensive machine-learning-assisted evidence map. We estimate that 102,160 publications document a broad range of observed impacts. By combining our spatially resolved database with grid-cell-level human-attributable changes in temperature and precipitation, we infer that attributable anthropogenic impacts may be occurring across 80% of the world's land area, where 85% of the population reside. Our results reveal a substantial 'attribution gap' as robust levels of evidence for potentially attributable impacts are twice as prevalent in high-income than in low-income countries. While gaps remain on confidently attributing climate impacts at the regional and sectoral level, this database illustrates the potential current impact of anthropogenic climate change across the globe.
The majority of land grid cells show attributable warming trends, with exceptions where trends cannot be robustly distinguished from internal variability or where there is insufficient data to establish trends. For precipitation, attributable wetting and drying trends are found with greater geographical variation. There are also more grid cells where a trend in precipitation cannot be established, or where the observed trend is opposite in sign to that simulated by climate model historical simulations."

6. Marine richness projections

Source: Climate velocity and the future global redistribution of marine biodiversity, García Molinos et al. 2016 (Fig. 1 in paper)

Data: via author Jorge Garcia Molinos

Difference between historical (year 2006) and projected (year 2100) marine cell species richness for climate change scenario RCP4.5 (+2.7C) - https://repository.upenn.edu/handle/20.500.14332/59762

Difference between historical (year 2006) and projected (year 2100) marine cell species richness for climate change scenario RCP8.5 (+4.5C) - https://repository.upenn.edu/handle/20.500.14332/59763

Format: .asc

Description: "Here, we use climate velocity trajectories, together with information on thermal tolerances and habitat preferences, to project changes in global patterns of marine species richness and community composition under IPCC Representative Concentration Pathways (RCPs) 4.5 and 8.5. Our simple, intuitive approach emphasizes climate connectivity, and enables us to model over 12 times as many species as previous studies. We find that range expansions prevail over contractions for both RCPs up to 2100, producing a net local increase in richness globally, and temporal changes in composition, driven by the redistribution rather than the loss of diversity. Conversely, widespread invasions homogenize present-day communities across multiple regions. High extirpation rates are expected regionally (for example, Indo-Pacific), particularly under RCP8.5, leading to strong decreases in richness and the anticipated formation of no-analogue communities where invasions are common."

9. Biodiversity hotspots

Source: GLOBAL 200 ECOREGIONS - Olson, D. M., Dinerstein, E. 2002. The Global 200: Priority ecoregions for global conservation. Annals of the Missouri Botanical Garden 89(2):199-224

Data: https://www.worldwildlife.org/publications/global-200
https://databasin.org/datasets/a5b34649cc69417ba52ac8e2dce34c3b/

Format: Shape files

Description: "WWF's Global 200 project analyzed global patterns of biodiversity to identify a set of the Earth's terrestrial, freshwater, and marine ecoregions that harbor exceptional biodiversity and are representative of its ecosystems. We placed each of the Earth's ecoregions within a system of 30 biomes and biogeographic realms to facilitate a representation analysis. Biodiversity features were compared among ecoregions to assess their irreplaceability or distinctiveness. These features included species richness, endemic species, unusual higher taxa, unusual ecological or evolutionary phenomena, and the global rarity of habitats.This process yielded 238 ecoregions--the Global 200--comprised of 142 terrestrial, 53 freshwater, and 43 marine priority ecoregions. Effective conservation in these ecoregions would help conserve the most outstanding and representative habitats for biodiversity on this planet."

10. Climate change and habitat loss in terrestrial biodiversity hotspots

Source and data: Cross-Chapter Paper 1: Biodiversity Hotspots Supplementary Material - IPCC WG2 - Table CCP1.1

Format: List (excel)

Description: "The projected vulnerability of the terrestrial hotspots to climate warming and loss of habitat derived from the current and future projected distributions of ~130,000 fungi, plants, invertebrates, and vertebrates (Warren et al., 2018). Numbered hotspots are mapped in Figure CCP1.1 (Cross-chapter 1 in IPCC WG2 Report)"
Bibliography:
The projected effect on insects, vertebrates, and plants of limiting global warming to 1.5°C rather than 2°C , Warren et al. 2018 ___ "In the Paris Agreement on Climate Change, the United Nations is pursuing efforts to limit global warming to 1.5°C, whereas earlier aspirations focused on a 2°C limit. With current pledges, corresponding to ~3.2°C warming, climatically determined geographic range losses of >50% are projected in ~49% of insects, 44% of plants, and 26% of vertebrates. At 2°C, this falls to 18% of insects, 16% of plants, and 8% of vertebrates and at 1.5°C, to 6% of insects, 8% of plants, and 4% of vertebrates. When warming is limited to 1.5°C as compared with 2°C, numbers of species projected to lose >50% of their range are reduced by ~66% in insects and by ~50% in plants and vertebrates".

11. Climate projections for marine animals - fish

Source: Next-generation ensemble projections reveal higher climate risks for marine ecosystems, Tittensor et al. 2021

Data: Data from authors Camilla Novaglio and Derek Tittensor

Original data: https://zenodo.org/records/7703393

Similar previous data: Cheung, William, 2022, AR6 SROCC Data for Figure SPM.3(b): Total animal biomass as a result of climate change, MetadataWorks, https://doi.org/10.48490/ys63-9451

Format: .Rdata

Description: "Here we apply an enhanced suite of global marine ecosystem models from the Fisheries and Marine Ecosystem Model Intercomparison Project (Fish-MIP), forced by new-generation Earth system model outputs from Phase 6 of the Coupled Model Intercomparison Project (CMIP6), to provide insights into how projected climate change will affect future ocean ecosystems. Compared with the previous generation CMIP5-forced Fish-MIP ensemble, the new ensemble ecosystem simulations show a greater decline in mean global ocean animal biomass under both strong-mitigation and high-emissions scenarios due to elevated warming, despite greater uncertainty in net primary production in the high-emissions scenario. Regional shifts in the direction of biomass changes highlight the continued and urgent need to reduce uncertainty in the projected responses of marine ecosystems to climate change to help support adaptation planning."

15. Ecological disruption

Source: The projected timing of abrupt ecological disruption from climate change, Trisos et al. 2020

Data: Code and data that were used to make Figs. 2–4 is available at Figshare (https://doi.org/10.6084/m9.figshare.11814633).
Interactive map https://climatehorizons.users.earthengine.app/view/biodiversity-risk
Also, in IPCC Data Center: AR6 WGII Data for Figure TS.5(b): Global distribution of biodiversity exposed

Format: original .r files (processed to shape files)

Description: "Under RCP 8.5, 81% of terrestrial and 37% of marine assemblages are projected to have at least one species exposed to unprecedented mean annual temperatures (that is, beyond historical niche limits) before 2100. Despite the lower magnitude of warming, the magnitude of exposure is greatest in the tropics, where narrow historical climate variability and shallow thermal gradients mean that many species occur close to their upper realized thermal limits throughout their geographic range. In total, 68% of terrestrial and 39% of tropical marine assemblages are projected to have more than 20% of their constituent species exposed to unprecedented temperatures by 2100, compared with 7% of terrestrial and 1% of marine assemblages outside the tropics. The Amazon, Indian subcontinent and Indo-Pacific regions are most at risk, with more than 90% of species in any assemblage exposed to unprecedented temperatures by 2100.
The most notable feature of horizon profiles for local assemblages is their abruptness. Under RCP 8.5, on average 71% (median) of local species exposure times for any given assemblage are projected to occur within a single decade, with the abruptness of exposure higher among marine assemblages than on land. This pattern of highly synchronized species exposure within assemblages is robust to the choice of climate model. This pervasive pattern of abrupt exposure arises primarily because co-occurring species often share similar realized thermal limits, rather than abruptness being dependent on higher rates of warming.
In some locations—such as the Caribbean and the Coral Triangle—exposure is predicted to be underway already, with these hotspots of exposure expanding in spatial extent over time. By 2050, exposure spreads beyond ocean ecosystems to iconic terrestrial ecosystems, such as the Amazon, Indonesian and Congolese rainforests."

17. Food production shocks (Cottrell et al. 2019) - crops, livestock, fisheries, aquaculture

Source: Food production shocks across land and sea, Cottrell et al. 2019

Data: Data from author Richard Cottrell

Format: .csv

Description: "From 741 available food production time-series (crops = 187; livestock = 190; fisheries = 202; aquaculture = 162), we detected 226 shocks across 134 nations. When pooled, we found agricultural sectors (crop and livestock) to be slightly more shock prone than aquatic sectors (fisheries and aquaculture) over the 53-year period (0.31 versus 0.29 shocks per country, respectively). Shock frequencies were regionally distinct within sectors, with some areas experiencing shocks far more frequently than others. Shock frequencies were highest in South Asia for crops, the Caribbean for livestock, Eastern Europe for fisheries and South America for aquaculture. Importantly, some regions experienced a high frequency in more than one sector. For example, South Asia experienced one of the highest shock frequencies to livestock as well as crops, and the Caribbean experienced a high frequency of fisheries shocks alongside livestock systems. Therefore, while there is varying exposure to production shocks within sectors, in several regions, patterns of high shock frequency overlap and create areas of high cumulative exposure to production shocks across multiple fronts."
They have also found that the frequency of shocks has increased across all sectors at a global scale (Fig. 1e–h). Fig. 2 shows the drivers of food production shocks.

18-21 Yield Constraint Score (Sharps et al. 2020) - wheat, maize, rice, soybean

Source: Sharps et al. 2020 data on crops stress is derived from the paper Mills et al. 2018

Data: Yield Constraint Score (YCS) for the effect of five crop stresses on global production of four staple food crops
https://data.gov.uk/dataset/ebc67ea7-3f63-4b72-b56a-50ad01c6533c/yield-constraint-score-ycs-for-the-effect-of-five-crop-stresses-on-global-production-of-four-staple-food-crops

Format: shape files

Description: “Increasing both crop productivity and the tolerance of crops to abiotic and biotic stresses is a major challenge for global food security in our rapidly changing climate. Our modelling shows that the highest ozone-induced production losses for soybean are in North and South America whilst for wheat they are in India and China, for rice in parts of India, Bangladesh, China and Indonesia, and for maize in China and the United States. Crucially, we also show that the same areas are often also at risk of high losses from pests and diseases, heat stress and to a lesser extent aridity and nutrient stress."

22-23 Climate change impacts on crop yield - wheat, maize, rice, soybean

Source: Climate impacts on global agriculture emerge earlier in new generation of climate and crop models, Jägermeyr et al. 2021

Data: Data from author Jonas Jaegermeyr.
https://repository.upenn.edu/handle/20.500.14332/59769
Find related data in – Jaegermeyr, Jonas; Müller, Christoph; Ruane, Alex C.; Elliott, Joshua; Balkovic, Juraj; Castillo, Oscar; Faye, Babacar; Foster, Ian; Folberth, Christian; Franke, James A.; Fuchs, Kathrin; Guarin, Jose; Heinke, Jens; Hoogenboom, Gerrit; Iizumi, Toshichika; Jain, Atul K.; Kelly, David; Khabarov, Nikolay; Lange, Stefan; Lin, Tzu-Shun; Liu, Wenfeng; Mialyk, Oleksandr; Minoli, Sara; Moyer, Elisabeth J.; Okada, Masashi; Phillips, Meridel; Porter, Cheryl; Rabin, Sam; Scheer, Clemens; Schneider, Julia M.; Schyns, Joep F.; Skalsky, Rastislav; Smerald, Andrew; Stella, Tommaso; Stephens, Haynes; Webber, Heidi; Zabel, Florian; Rosenzweig, Cynthia, 2023,

- Projected changes in global wheat production under ssp585, MetadataWorks, https://doi.org/10.48490/b7qz-6532
- AR6 SYR Data for Figure SPM.3(c1): Projected changes in global maize production, MetadataWorks, https://doi.org/10.48490/qxxy-rn67
- Projected changes in global maize production under ssp585, MetadataWorks, https://doi.org/10.48490/3nza-ab60

Format: .nc4 (netCDF)

Description: "Potential climate-related impacts on future crop yield are a major societal concern. Previous projections of the Agricultural Model Intercomparison and Improvement Project's Global Gridded Crop Model Intercomparison based on the Coupled Model Intercomparison Project Phase 5 identified substantial climate impacts on all major crops, but associated uncertainties were substantial. Here we report new twenty-first-century projections using ensembles of latest-generation crop and climate models. Results suggest markedly more pessimistic yield responses for maize, soybean and rice compared to the original ensemble. Mean end-of-century maize productivity is shifted from +5% to −6% (SSP126) and from +1% to −24% (SSP585)—explained by warmer climate projections and improved crop model sensitivities. In contrast, wheat shows stronger gains (+9% shifted to +18%, SSP585), linked to higher CO2 concentrations and expanded high-latitude gains. The ‘emergence’ of climate impacts consistently occurs earlier in the new projections—before 2040 for several main producing regions. While future yield estimates remain uncertain, these results suggest that major breadbasket regions will face distinct anthropogenic climatic risks sooner than previously anticipated.”

24 - Drought risk on rainfed and irrigated agricultural systems

Source: Global-scale drought risk assessment for agricultural systems, Meza et al. 2020

Data:
https://grow-globedrought.net/data/global-scale-drought-risk-assessment-for-agricultural-systems/

Format: Shape files

Description: “Droughts continue to affect ecosystems, communities and entire economies. Agriculture bears much of the impact, and in many countries it is the most heavily affected sector. Over the past decades, efforts have been made to assess drought risk at different spatial scales. Here, we present for the first time an integrated assessment of drought risk for both irrigated and rainfed agricultural systems at the global scale. Composite hazard indicators were calculated for irrigated and rainfed systems separately using different drought indices based on historical climate conditions (1980–2016). Exposure was analyzed for irrigated and non-irrigated crops. Vulnerability was assessed through a socioecological-system (SES) perspective, using socioecological susceptibility and lack of coping-capacity indicators that were weighted by drought experts from around the world. The analysis shows that drought risk of rainfed and irrigated agricultural systems displays a heterogeneous pattern at the global level, with higher risk for southeastern Europe as well as northern and southern Africa. By providing information on the drivers and spatial patterns of drought risk in all dimensions of hazard, exposure and vulnerability, the presented analysis can support the identification of tailored measures to reduce drought risk and increase the resilience of agricultural systems.”

25. Heat stress in domesticated livestock species

Source: Increases in extreme heat stress in domesticated livestock species during the twenty-first century, Thornton et al. 2021

Data: From author Philip Thornton
Cat = cattle, goa = goats, she = sheep, pig = pigs and chi = chickens. Change in the number of days per year above “extreme stress” values from 2000 to the 2090s for SSP5-8.5, estimated

using the temperature humidity index (THI). Data mapped for each species' current global distribution (Gilbert et al., 2018). For livestock presence / absence, the author used a threshold of 5000 animals per 30-minute grid box for all species other than chickens, 15000 animals.

Format: ASCII ArcRaster files (can be transformed to shape files with software ArcMap)

Description: "Anthropogenic climate change is expected to have major impacts on domesticated livestock, including increased heat stress in animals in both intensive and extensive livestock systems. We estimate the changes in the number of extreme heat stress days per year for animals raised outdoors that can be expected in the major domesticated animal species (cattle, sheep, goats, poultry, and pigs) across the globe during this century. We used the temperature humidity index as a proxy for heat stress, calculated using temperature and relative humidity data collated from an ensemble of CMIP6 climate model output for mid and end century. We estimate changes in the proportions of different livestock species that may be at increased risk of extreme heat stress under two contrasting greenhouse gas emission scenarios. Results are discussed in relation to changes in the suitability of different climate conditions for domesticated livestock during the current century. We find that by end century, extreme heat stress risk is projected to increase for all livestock species in many parts of the tropics and some of the temperate zones, and to become climatically more widespread, compared to 2000. Although adaptation options exist for both intensive and extensive livestock production systems, the increasing pervasiveness of extreme heat stress risk in the future will seriously challenge the viability of outdoor livestock keeping, particularly in the lower latitudes in lower and middle-income countries where the costs of adaptation may be challenging to address."

27. Mortality costs (from Climate Impact Lab)

Source: Climate impact Lab

Data: Downloaded from web page (country resolution)
Projected monetized risks of future climate change, as a percent of projected future GDP (measured in percent). Negative damages indicate economic benefit.

Format: .xlsx

Description: "The methodology for estimating the mortality costs of future climate change is described in full in Carleton et al. (2020). This study uses comprehensive historical mortality records to quantify how death rates across the globe have been affected by observed climate changes. Carleton et al. (2020) compile the largest sub-national vital statistics database in the world, detailing 399 million deaths across 41 countries accounting for 55 percent of the global population. By combining these records with decades of detailed daily and local temperature observations, the authors discover that extreme cold and extreme heat have important effects on death rates. These relationships are modified by the climate and income levels of the affected population. Carleton et al. (2020) use these results to model how adaptation affects the sensitivity of a population to extreme temperatures. Estimates of the mortality-temperature relationship are used to generate projections of the future impacts of climate change on mortality rates for areas across the globe, dividing the world into 24,378 distinct regions (each containing roughly 300,000 people, about the size of a U.S. county). Using a revealed preference technique to measure the total cost of adaptive behaviors and technologies, these projections capture the full mortality risk of climate change, accounting for both adaptation benefits and costs, in addition to direct mortality impacts."

28 - Future of the human climate niche

Source: Future of the human climate niche, Xu et al. 2020

Data: https://datadryad.org/stash/dataset/doi:10.5061/dryad.fj6q573q7

Format: .tif

Description: "We show that for thousands of years, humans have concentrated in a surprisingly narrow subset of Earth's available climates, characterized by mean annual temperatures around ~ 13 °C. This distribution likely reflects a human temperature niche related to fundamental constraints. We demonstrate that depending on scenarios of population growth and warming, over the coming 50 y, 1 to 3 billion people are projected to be left outside the climate conditions that have served humanity well over the past 6,000 y. Absent climate mitigation or migration, a substantial part of humanity will be exposed to mean annual temperatures warmer than nearly anywhere today. In the absence of migration, one third of the global population is projected to experience a MAT > 29 °C currently found in only 0.8% of the Earth's land surface, mostly concentrated in the Sahara."

30 - UNHCR - Refugees, internally displaced people

Source: Operational Data Portal UNHCR (United Nations High Commissioner for Refugees)

Data: https://data.unhcr.org/en/geoservices/

External Maps:
https://unhcr.maps.arcgis.com/apps/webappviewer/index.html?id=2028db44801d43fe8eb49321eea19285

Format: GIS

Description:
“The GDS presence layer (UNHCR Presence) is a geographic representation of the UNHCR operational presence in the countries where UNHCR is operating. It shows the diverse types of presence including temporary presence such as Field Units. Each office is either Active or Inactive depending on the operational status reported by the field. The status of the GIS layer represents the current operational presence in the world.
The UNHCR People of Concern layer represents all the people of concern's known locations in the world (Refugees, Internally displaced, Stateless persons and other of concern). The data is displayed by population type and location type.”

31- Human dependence on marine ecosystems

Source: Mapping global human dependence on marine ecosystems, Selig et al. 2018

Data: Supporting information latest table.

Format: List, excel

Description: “Many human populations are dependent on marine ecosystems for a range of benefits, but we understand little about where and to what degree people rely on these ecosystem services. We created a new conceptual model to map the degree of human dependence on marine ecosystems based on the magnitude of the benefit, susceptibility of people to a loss of that benefit, and the availability of alternatives. We focused on mapping nutritional, economic, and coastal protection dependence, but our model is repeatable, scalable, applicable to other ecosystems, and designed to incorporate additional services and data. Here we show that dependence was highest for Pacific and Indian Ocean island nations and several West African countries. More than 775 million people live in areas with relatively high dependence scores. By identifying where and how people are dependent on marine ecosystems, our framework can be used to design more effective large-scale management and policy interventions.”

32 - Vulnerability to climate and fisheries

Source: Climate change and marine fisheries: Least developed countries top global index of vulnerability, Blasiak et al. 2017

Data: Supporting information.

Format: List

Description: “Future impacts of climate change on marine fisheries have the potential to negatively influence a wide range of socio-economic factors, including food security, livelihoods and public health, and even to reshape development trajectories and spark transboundary conflict. We calculate a vulnerability index by drawing on the most recent data related to the impacts of climate change on marine fisheries. Building on the Intergovernmental Panel on Climate Change framework for vulnerability, we first construct aggregate indices for exposure, sensitivity and adaptive capacity using 12 primary variables. Seven out of the ten most vulnerable countries on the resulting index are Small Island Developing States, and the top quartile of the index includes countries located in Africa (17), Asia (7), North America and the Caribbean (4) and Oceania (8). More than 87% of least developed countries are found within the top half of the vulnerability index, while the bottom half includes all but one of the Organization for Economic Co-operation and Development member states. This is primarily due to the tremendous variation in countries’”

33 - Prevalence of inadequate micronutrient intake

Source: Global trends in dietary micronutrient supplies and estimated prevalence of inadequate intakes, Beal et al. 2017

Data: Supplementary data in paper.

Format: List

Description: "Understanding dietary patterns is vital to reducing the number of people experiencing hunger (about 795 million), micronutrient deficiencies (2 billion), and overweight or obesity (2.1 billion). We characterize global trends in dietary quality by estimating micronutrient density of the food supply, prevalence of inadequate intake of 14 micronutrients, and average prevalence of inadequate intake of these micronutrients for all countries between 1961 and 2011. Over this 50-year period, the estimated prevalence of inadequate intakes of micronutrients has declined in all regions due to increased total production of food and/or micronutrient density. This decline has been particularly strong in East and Southeast Asia and weaker in South Asia and sub-Saharan Africa. Sub-Saharan Africa is the only region where dietary micronutrient density has declined over this 50-year period. At the global level, micronutrients with the lowest levels of adequate estimated intake are calcium, iron, vitamin A, and zinc, but there are strong differences between countries and regions. Fortification has reduced the estimated prevalence of inadequate micronutrient intakes in all low-income regions, except South Asia. The food supply in many countries is still far below energy requirements, which suggests a need to increase the availability and accessibility of nutritious foods. Countries where the food energy supply is adequate show a very large variation in dietary quality, and in many of these countries people would benefit from more diverse diets with a greater proportion of micronutrient-dense foods. Dietary quality can be improved through fortification, biofortification, and agricultural diversification, as well as efforts to improve access to and use of micronutrient-dense foods and nutritional knowledge. Fortification means that commonly eaten staple foods are enriched with micronutrients."

34 - Climate change risk to freshwater and marine fisheries in Africa

Source: Climate Change 2022: Impacts, Adaptation and Vulnerability, Chapter 9 - Africa (Figures 9.25 and 9.26)

Data: from author Beth Nyboer

Format: .xlsx and shape files

Description from IPCC Figures:

MARINE FISHERIES Climate change risk to nutrition and catch potential from Marine Fisheries: Panels comparing countries current percent dependence on marine foods for nutrition compared with projected change in maximum catch potential (MCP) from marine fisheries. (a) The percentage of animal sources foods consumed that originate from a marine environment. Countries with higher dependence are indicated by darker shades of blue (Golden et al., 2016). (b–c) Projected percent change in maximum catch potential (MCP) of marine fisheries under 1.6C and 4C global warming from recent past (1986–2005) to end of 21st century (2081-2100) in countries' Exclusive Economic Zones (EEZs)(Cheung William et al., 2016). Darker red indicates greater percent reduction [negative values].

FRESHWATER FISHERIES Climate change risk to Freshwater Fisheries: Panels comparing countries current dependence on inland fisheries compared with climate change vulnerability of important fishery species. (a) Countries' reliance on inland fisheries was estimated by catch (total, tonnes) (FAO, 2018b; Fluet-Chouinard et al., 2018), per capita catch (kg/person/year) (FAO, 2018b), percent reliance on fish for micronutrients, and percent consumption per household (Golden et al., 2016). Z-scores of each metric were averaged for each country to create a composite index describing current dependence on freshwater fish for each country with darker blue colours indicating higher dependence. (b–c) Projected concentrations (numbers) of vulnerable freshwater fishery species averaged within freshwater ecoregions under 2.4C and >4C global warming estimated from recent past (1961–1992) to the end of the 21st century (2071 to 2100) (Nyboer et al., 2019). Numbers of vulnerable fish species translate to an average of 55– 68% vulnerable at >2.4C and 77–97% vulnerable at <4C global warming. Darker reds indicate higher concentrations of vulnerable fish species.

CITATIONS and some original data:

- Projected change in fish catch potential under climate change: Cheung, W. W. L. et al., 2016: Structural uncertainty in projecting global fisheries catches under climate change. 24 Ecological Modelling, 325, 57-66, doi:10.1016/j.ecolmodel.2015.12.018 . Find data here: https://repository.upenn.edu/handle/20.500.14332/59768

- Percent reliance on marine foods for essential micronutrients: Golden, C. (2016). Fall in fish catch threatens human health. Nature 534, 317–320. https://www.nature.com/articles/534317a (Data in supplementary file)

- Projections of concentrations of vulnerable fishery species by ecoregion: Nyboer, E.A., Liang, C. & Chapman, L.J. 2019. Assessing the vulnerability of Africa's freshwater fishes to climate change: a continent-wide trait-based analysis. Biological Conservation. 236: 505 - 520. https://www.sciencedirect.com/science/article/abs/pii/S0006320718313016 Data: https://datadryad.org/stash/dataset/doi:10.5061/dryad.8fp561k

- Reliance on freshwater fish for food. Average of standardized scores including:
    - Percent reliance on freshwater fishes for micronutrients: Golden, C. (2016). Fall in fish catch threatens human health. Nature 534, 317–320.

    - Estimates of inland fishery capture (tonnes) and percentage fish consumption based on houshold surveys: Fluet-Chouinard, E., Funge-Smith, S. and Mcintyre, P. B. (2018). Global hidden harvest of freshwater fish revealed by household surveys. Proc. Natl. Acad. Sci. 115, 7623–7628. https://doi.org/10.1073/pnas.1721097115 (Data in supplementary file)

    - Estimates of inland fishery capture (tonnes) and per capita inland fishery production based on FAO statistics. Data from FAO FishStatJ: FAO 2022. Global Production. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/collection/global_production?lang=en

36 - Drought risk, vulnerability, exposure, hazard (Carrao 2016)

Source: Mapping global patterns of drought risk: An empirical framework based on sub-national estimates of hazard, exposure and vulnerability, Carrao, Naumann, Barbosa, 2016

Data: from author Hugo Carrao

Drought risk global map for the period 2000–2014 - https://repository.upenn.edu/handle/20.500.14332/59766

Drought exposure global map for the period 2000–2014 - https://repository.upenn.edu/handle/20.500.14332/59767

Drought hazard global map for the period 2000–2014 - https://repository.upenn.edu/handle/20.500.14332/59765

Drought vulnerability global map for the period 2000–2014 - https://repository.upenn.edu/handle/20.500.14332/59764

Format: .tif

Description: “Drought risk is assessed for the period 2000–2014 and is based on the product of three independent determinants: hazard, exposure and vulnerability. Drought hazard is derived from a non-parametric analysis of historical precipitation deficits at the 0.5°; drought exposure is based on a non-parametric aggregation of gridded indicators of population and livestock densities, crop cover and water stress; and drought vulnerability is computed as the arithmetic composite of high level factors of social, economic and infrastructural indicators, collected at both the national and sub-national levels. The performance evaluation of the proposed models underlines their statistical robustness and emphasizes an empirical resemblance between the geographic patterns of potential drought impacts and previous results presented in the literature. Our findings support the idea that drought risk is driven by an exponential growth of regional exposure, while hazard and vulnerability exhibit a weaker relationship with the geographic distribution of risk values. Drought risk is lower for remote regions, such as tundras and tropical forests, and higher for populated areas and regions extensively exploited for crop production and livestock farming, such as South-Central Asia, Southeast of South America, Central Europe and Southeast of the United States. As climate change projections foresee an increase of drought frequency and intensity for these regions, then there is an aggravated risk for global food security and potential for civil conflict in the medium- to long-term. Since most agricultural regions show high infrastructural vulnerability to drought, then regional adaptation to climate change may begin through implementing and fostering the widespread use of irrigation and rainwater harvesting systems. In this context, reduction in drought risk may also benefit from diversifying regional economies on different sectors of activity and reducing the dependence of their GDP on agriculture.”

Citations related: As a reference/acknowledgement to their work, Global Drought Observatory GDO (https://edo.jrc.ec.europa.eu/gdo/php/index.php?id=2000) and the paper http://www.sciencedirect.com/science/article/pii/S0959378016300565.

37 - Lowland dependence on mountain water resources

Source: Increasing dependence of lowland populations on mountain water resources, Viviroli et al. 2020

Data: https://datadryad.org/stash/dataset/doi:10.5061/dryad.ns1rn8pnt

Format: .tif

Description: "We show that lowland water resources have become increasingly dependent on mountain areas in the past decades and are likely to become even more so in the future. Water scarcity is projected to be more severe, and ongoing groundwater depletion may pose a serious water security risk in intense agricultural regions. This might cause higher vulnerability under an uncertain climate, as highlighted by our finding that well over half of lowland areas equipped for irrigation might depend on both mountain water surpluses and unsustainable lowland water resources by the mid-twenty-first century under a 'middle of the road' scenario. At the same time, population and land use pressure are expected to increase further, leading to considerable challenges to environmental sustainability. In addition, large-scale human interventions such as land-use and land-cover changes, the construction of dams and reservoirs, and withdrawals from surface water and groundwater negatively affect the downstream parts of river catchments and may lead to additional imbalances between mountain and lowland areas. All of this underscores the special protection and attention that mountain areas deserve in efforts towards sustainable development, and suggests that highland–lowland interactions should not be a one-way process in favour of the lowlands, but that compensation mechanisms in the reverse direction should be considered to support sustainable development in both mountain and lowland areas. In summary, our work emphasizes that hydrosolidarity between mountain and lowland populations sharing a common river basin is essential, with the goal of an ethically sound orchestration of land-, water- and ecosystem-related activities."

39 - Extreme sea level events

Source: Extreme sea levels at different global warming levels, Tebaldi et al. 2021

Data: from author Claudia Tebaldi

Extreme sea levels at different global warming levels - https://repository.upenn.edu/handle/20.500.14332/59788

Related data (not exactly the same): Lambert, Erwin; van de Wal, Roderik, 2022, AR6 SROCC Data for Figure SPM.4: Extreme sea level events, MetadataWorks, https://doi.org/10.48490/fetp-8694

Format: .csv (list)

Description: "Projections of hazards and risk are increasingly framed in terms of global warming levels rather than emission scenarios. Here, we use a multimethod approach to describe changes in extreme sea levels driven by changes in mean sea level associated with a wide range of global warming levels, from 1.5 to 5 °C, and for a large number of locations, providing uniform coverage over most of the world's coastlines. We estimate that by 2100 ~50% of the 7,000+ locations considered will experience the present-day 100-yr extreme-sea-level event at least once a year, even under 1.5 °C of warming, and often well before the end of the century. The tropics appear more sensitive than the Northern high latitudes, where some locations do not see this frequency change even for the highest global warming levels."

40 - Projected shoreline changes - Sandy coastlines under threat of erosion

Source: Sandy coastlines under threat of erosion, Vousdoukas et al. 2020

Data: https://data.jrc.ec.europa.eu/dataset/18eb5f19-b916-454f-b2f5-88881931587e

Format: .csv (list)

Description: "Sandy beaches occupy more than one-third of the global coastline and have high socioeconomic value related to recreation, tourism and ecosystem services. Beaches are the interface between land and ocean, providing coastal protection from marine storms and cyclones. However the presence of sandy beaches cannot be taken for granted, as they are under constant change, driven by meteorological, geological and anthropogenic factors. A substantial proportion of the world's sandy coastline is already eroding, a situation that could be exacerbated by climate change. Here, we show that ambient trends in shoreline dynamics, combined with coastal recession driven by sea level rise, could result in the near extinction of almost half of the world's sandy beaches by the end of the century. Moderate GHG emission mitigation could prevent 40% of shoreline retreat. Projected shoreline dynamics are dominated by sea level rise for the majority of sandy beaches, but in certain regions the erosive trend is counteracted by accretive ambient shoreline changes; for example, in the Amazon, East and Southeast Asia and the north tropical Pacific. A substantial proportion of the threatened sandy shorelines are in densely populated areas, underlining the need for the design and implementation of effective adaptive measures."

41- Population vulnerable to coastal inundation

Source: New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding, Kulp and Strauss 2019

Data: Supplementary data

Format: List

Description: "Most estimates of global mean sea-level rise this century fall below 2 m. This quantity is comparable to the positive vertical bias of the principle digital elevation model (DEM) used to assess global and national population exposures to extreme coastal water levels, NASA's SRTM. CoastalDEM is a new DEM utilizing neural networks to reduce SRTM error. Here we show – employing CoastalDEM—that 190 M people (150–250 M, 90% CI) currently occupy global land below projected high tide lines for 2100 under low carbon emissions, up from 110 M today, for a median increase of 80 M. These figures triple SRTM-based values. Under high emissions, CoastalDEM indicates up to 630 M people live on land below projected annual flood levels for 2100, and up to 340 M for mid-century, versus roughly 250 M at present. We estimate one billion people now occupy land less than 10 m above current high tide lines, including 230 M below 1 m."

42- Timing of coastal flood risk

Source coastal risk: Long-term sea-level rise necessitates a commitment to adaptation: A first order assessment, Haasnoot et al. 2021 (based on Fig. 4 in paper, but adapted to IPCC regions)

Data: via authors Marjolijn Haasnoot and Gundula Winter
Data is available on: BlueEarth Data services (under Coastal Flood Risk).

Format: .csv, list

Description: "Fig. 4. The colour of the circles indicates when an impact threshold is exceeded for the median value of RCP4.5 (a) and RCP8.5 (b) according to IPCC SROCC (Oppenheimer et al., 2019) projections (now updated to AR6 WG1 SLR scenarios). Impact thresholds considered are 0.01, 0.1, 1, 5 and 10 million people per country that will become at risk of a 100-year flood event, in addition to the people currently at risk of a 100-year flood event, assuming present population and protection. The size of the circles indicates the additional number of people that become at risk compared to the current population at risk. Where circles have similar colours, risk increases rapidly. Countries with dark colours have an early increase of risk. Countries with

small circles have lower risk until 2150. This information is provided for countries, in which the minimum threshold of 100,000 people additionally at risk will be exceeded by 2150."
Definition of the IPCC regions

Source IPCC regions: An update of IPCC climate reference regions for subcontinental analysis of climate model data: definition and aggregated datasets. Iturbide et al. 2020

Data:
https://github.com/SantanderMetGroup/ATLAS/blob/main/reference-regions/IPCC-WGI-reference-regions-v4_shapefile.zip

Format: Shape files

Description: "We present an updated version of the reference regions for the analysis of new observed and simulated datasets (including CMIP6) which offer an opportunity for refinement due to the higher atmospheric model resolution. As a result, the number of land and ocean regions is increased to 46 and 15, respectively, better representing consistent regional climate features. The paper describes the rationale for the definition of the new regions and analyses their homogeneity."

43 - Vulnerability to sea level rise - Sea level rise and built-up area

Sea level rise:

Source: Global LiDAR land elevation data reveal greatest sea-level rise vulnerability in the tropics. Hooijer & Vernimmen, 2021

Data: https://data.mendeley.com/datasets/v5x4vpnzds/1
Other data and visualization on sea level rise: CoastalDEM 90 m from Climate Central, https://coastal.climatecentral.org/

Format: .tif

Description: "Coastal flood risk assessments require accurate land elevation data. Those to date existed only for limited parts of the world, which has resulted in high uncertainty in projections of land area at risk of sea-level rise (SLR). Here we have applied the first global elevation model derived from satellite LiDAR data."

Built-up area:

Source: GHSL- Global Human Settlement Layer

Data: The layers Urban center boundaries and Dense Urban Cluster boundaries were downloaded from https://ghsl.jrc.ec.europa.eu/download.php?ds=smod GHS-SMOD 2020, 1km, Mollweide

Format: shape files

Description: “The Global Human Settlement Layer (GHSL) project produces global spatial information, evidence-based analytics, and knowledge describing the human presence on the planet. The GHSL relies on the design and implementation of spatial data processing technologies that allow automatic data analytics and information extraction from large amounts of heterogeneous geospatial data including global, fine-scale satellite image data streams, census data, and crowd sourced or volunteered geographic information sources.”
Visualisation: https://ghsl.jrc.ec.europa.eu/visualisation.php (LANDSAT)
More information
https://ghsl.jrc.ec.europa.eu/documents/GHSL_Data_Package_2023.pdf?t=1683540422

44 - Flood protection standards (FLOPROS)

Source: FLOPROS: an evolving global database of flood protection standards, Scussolini et al. 2016

Data: from Supplementary data. FLOOD PROTECTION STANDARDS - only using the merged layer for river floods - "MerL_Riv": value of river flood protection standard in the Merged layer.

Format: Shape files - excel file

Description: “FLOPROS is a database of flood protection standards, based on a wide range of sources, and on a modelling approach. The database is structured into three layers of information, namely a. the design layer, containing information about protection defined by engineers in the design and realisation of currently existing river and coastal flood protection infrastructure; b. the policy layer, specifying the legislative and normative (or required) standards of protection from river and coastal floods; c. the model layer for river flood protection, which is based on a flood-modelling approach and on the observed relationship between per capita wealth and protection.
We deem the design layer to be the most reliable to represent existing protection standards because it contains direct information concerning the standards used when designing the protection infrastructure. The two other layers, policy and model, contain information that is a

proxy for actual protection. We consider the policy layer to have intermediate reliability because although it provides indication about the intended or required standard of protection, it does not indicate whether such protection is yet realised or enforced. Lastly, the model layer is third in order of reliability because even though partially validated against observations, it involves a method to indirectly attribute protection information.
We propose a method for this integration of the three layers into a merged layer (the one shown here). In this method, for places where information is not available in the most reliable layers, information from the subsequent lower layers is employed. In practice, if information is available in the design layer for a given sub-country unit, then this information is included in the merged layer. If no information is contained in the design layer, then the policy layer information is included in the merged layer. Finally, if information is not available even at the policy layer, then the model layer information is included in the merged layer."

45 - River flooding projections - Hirabayashi 2021

Source: Global exposure to flooding from the new CMIP6 climate model projections, Hirabayashi et al. 2021

Data: Data from author Yukiko Hirabayashi for scenario ssp585

Return period (years) in future (2071–2100) for discharge corresponding to a 100-year flood in the past (1971–2000), for CMIP6 under the ssp585 scenario - https://repository.upenn.edu/handle/20.500.14332/59783

Return period (years) in future (2071–2100) for discharge corresponding to a 30-year flood in the past (1971–2000), for CMIP6 under the ssp585 scenario - https://repository.upenn.edu/handle/20.500.14332/59787

Return period (years) in future (2071–2100) for discharge corresponding to a 10-year flood in the past (1971–2000), for CMIP6 under the ssp585 scenario - https://repository.upenn.edu/handle/20.500.14332/59786

Format: .tif

Description: "The overall patterns of increase and decrease in flood frequency (corresponding to decreases and increases in the return period, respectively) are remarkably similar with CMIP5 and CMIP6, with increases in many regions in South Asia, Southeast Asia, Northeast Eurasia, eastern and low-latitude Africa, and South America and decreases in northern and eastern Europe, Anatolia, Central Asia, central North America, and southern South America. The results of three other RCP scenarios showed similar spatial distributions. The result indicates that the large-scale features of flood projection are robust to the resolution and assumptions of the models, despite the substantial development of climate models since CMIP5. Differences in the direction of change in Texas (USA), the Amazon, Italy, and South Africa were not caused by differences among the models used. Our comparison of return period change data obtained by six models from institutions that participated in both CMIP5 and CMIP6 showed very similar differences in the spatial patterns of flood frequency changes. Model consistency was low for Texas, Italy, and South Africa in CMIP5, and in the Amazon in CMIP6, which was the main reason for differences in the direction of changes between CMIP5 and CMIP6."

Climate projections - WorldClim

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=23c3356c4e77422bb418d581430d83de

Source and Data**:** WorldClim

Format: netCDF

Description: WorldClim provides historical climate data (version 2.1 climate data for 1970-2000, released in January 2020), and projected changes for the multi-model mean of 9 CMIP6 models and 4 scenarios.
Here we show projections to 2050 under the scenario RCP7.0 which results in an approx. 2.1C warming, and projections to 2070 under the scenario RCP8.5 which results in an approx. 3.4C warming (with respect to the preindustrial period 1850-1900).

"Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. These are often used in species distribution modeling and related ecological modeling techniques. The bioclimatic variables represent annual trends (e.g., mean annual temperature, annual precipitation) seasonality (e.g., annual range in temperature and precipitation) and extreme or limiting environmental factors (e.g., temperature of the coldest and warmest month, and precipitation of the wet and dry quarters)."

TEMPERATURE
BIO 1 - Mean temperature
BIO 2 - Diurnal Range - Average of monthly (max temp - min temp). Expected higher diurnal change in desert, arid areas.
BIO 5 - Maximum temperature of warmest month. It informs about extreme heat.
BIO 8 - Mean temperature of wettest quarter (indicates hot and wet - risk to health and expansion of diseases)
BIO 9 - Mean temperature of driest quarter (indicates hot and dry hotspots - risk of wild fires)

PRECIPITATION
BIO 12 - Mean precipitation
BIO 13 - Precipitation of the wettest month
BIO 14 - Precipitation of the driest month
BIO 15 - % seasonality in precipitation (coefficient variation) The Coefficient Variation is simply the standard deviation divided by the average annual rainfall. 67% of the time, at a given point, rainfall will vary +/- x % from its long term average. More yellow means more occasional but strong rain, more erratic, or all the rain happening in one season.

Climate impacts - heat, drought, flood, health

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=25e74fdfe9714448abc104ef252d5bb6

African heritage sites threatened as sea-level rise accelerates

Source: African heritage sites threatened as sea-level rise accelerates, Vousdoukas et al 2022

Data: In paper

Format: Shape files

Description: “The African coast contains heritage sites of ‘Outstanding Universal Value’ that face increasing risk from anthropogenic climate change. Here, we generated a database of 213 natural and 71 cultural African heritage sites to assess exposure to coastal flooding and erosion under moderate (RCP 4.5) and high (RCP 8.5) greenhouse gas emission scenarios. Currently, 56 sites (20%) are at risk from a 1-in-100-year coastal extreme event, including the iconic ruins of Tipasa (Algeria) and the North Sinai Archaeological Sites Zone (Egypt). By 2050, the number of exposed sites is projected to more than triple, reaching almost 200 sites under high emissions. Emissions mitigation from RCP 8.5 to RCP 4.5 reduces the number of very highly exposed sites by 25%. These findings highlight the urgent need for increased climate change adaptation for heritage sites in Africa, including governance and management approaches, site-specific vulnerability assessments, exposure monitoring, and protection strategies.”

Additional information:
https://www.carbonbrief.org/loss-and-damage-how-can-culture-and-heritage-loss-be-measured-and-addressed/

Climate variability - Niño correlations with historical temperature and precipitation

Source and data: http://climexp.knmi.nl/selectindex.cgi?id=someone@somewhere

Data processing:
Select a monthly time series
Select Nino3.4
Correlate with only observations
Select 1901-2019: CRU TS 4.04 (land) 0.5°
Average over 3 months (seasonally)

Format: .tif

Description: Niño fluctuations intensify or weaken droughts, floods, etc. This is really important in tropical areas, although it can also impact higher latitudes. A Niño fluctuation on top of climate change can really worsen a drought, etc. We plot the correlation between historical temperature and precipitation and the El Niño index.

Human temperature niche - See IPCC WG2 Impacts

Confluence of extreme climate events CMIP6 (Vogel et al. 2020)

Source: Projected changes in hot, dry and wet extreme events' clusters in CMIP6 multi-model ensemble, Vogel et al. 2020

Data: from author Mathias Hauser

Format**:** netCDF with dimension lon,lat, and depth (k). k=4 layers, for a global warming of 1,1.5, 2, 3 degrees above historical climate.

Description: "Concurrent extreme events, i.e. multi-variate extremes, can be associated with strong impacts. In this article, we analyse the projected occurrence of hot, dry, and wet extreme events' clusters in the multi-model ensemble of the 6th phase of the Coupled Model Intercomparison Project (CMIP6). Changes in 'extreme extremes', i.e. events with only 1‰ probability of occurrence in the current climate are analysed, first as univariate extremes, and then when co-occurring with other types of extremes (i.e. events clusters) within the same week, month or year. The projections are analysed for present-day climate (+1 °C) and different levels of additional global warming (+1.5 °C, +2 °C, +3 °C). The results reveal substantial risk of occurrence of extreme events' clusters of different types across the globe at higher global warming levels." Here we only show the projections at +2°C global warming.

Heat stress indicators in CMIP6 (Schwingshackl et al. 2021)

Source: Heat stress indicators in CMIP6: Estimating Future trends and exceedances of impact-relevant thresholds, Schwingshackl et al., 2021

Data: https://archive.norstore.no/pages/public/datasetDetail.jsf?id=10.11582/2021.00011 (for 24 CMIP6 models). The data contain netCDF files for yearly maximum values for all heat stress indicators (HSIs) included in the study, for the yearly number of threshold exceedance days, and time series of global mean temperature. Data are provided for all CMIP6 models that are included in the analysis. These are the available heat indices: Daily Maximum Near-surface Air Temperature (TX), Apparent Temperature (AT), NOAA Heat Index (HI), Humidex (Hu), Wet-Bulb Temperature (TWB), Wet-Bulb Globe Temperature (TWBG),Simplified Wet-bulb Globe Temperature (TWBGs), Universal Thermal Climate Index (UTCI).

Format: netCDF

Description: "Global warming is leading to increased heat stress in many regions around the world. An extensive number of heat stress indicators (HSIs) has been developed to measure the associated impacts on human health. Here we calculate eight HSIs for global climate models participating in the Coupled Model Intercomparison Project Phase 6 (CMIP6)."

Global heat stress on health and wildfires

Source: Global heat stress on health, wildfires, and agricultural crops under different levels of climate warming, Sun et al. 2019

Data: from author Chiyuan Miao

Format: Matlab files

Description: "Using global climate and impact models from the Inter-Sectoral Impact Model Intercomparison Project, our analysis shows that the frequency and intensity of heat events increase, especially in tropical regions (geographic perspective) and developing countries (national perspective), even with global warming held to the 1.5 °C target. An additional 0.5 °C increase to the 2 °C warming target leads to >15% of global land area becoming exposed to levels of heat stress that affect human health. Globally, about 38%, 50%, 46%, 36%, and 48% of the increases in exposure to health threats, wildfire, crop heat stress for soybeans, wheat, and maize could be avoided by constraining global warming to 1.5 °C rather than 2 °C. With high emissions, these impacts will continue to intensify over time, extending to almost all countries by the end of the 21st century: >95% of countries will face exposure to health-related heat stress, with India and Brazil ranked highest for integrated heat-stress exposure. The magnitude of the changes in fire season length and wildfire frequency are projected to increase substantially over 74% global land, with particularly strong effects in the United States, Canada, Brazil, China, Australia, and Russia. "

We used the health heat index (HHI) as a measure of apparent temperature (AT). This index is calculated from daily temperature and relative humidity (RH) values obtained from the five climate models in the ISI-MIP datasets. Computation of HHI involves a refinement of the multiple regression analysis carried out by Rothfusz (1990)
Health heat index (HHI)
Number of days with HHI > 40.6°C
Fire season length
We used the McArthur Forest Fire Danger Index (FFDI) (Noble et al., 1980) to measure the degree of wildfire danger. The FFDI was calculated from the mean temperature, maximum temperature, precipitation, relative humidity, and wind data.
The number of days when the normalized daily fire danger index was above a threshold value of 50.

Increasing probability of record-shattering climate extremes

Source: Increasing probability of record-shattering climate extremes, Fischer, Sippel, and Nutti, 2021

Data: https://data.iac.ethz.ch/Fischer_et_al_2021_RecordExtremes/figures/figure3/

Format: netCDF

Description: “Recent climate extremes have broken long-standing records by large margins. Such extremes unprecedented in the observational period often have substantial impacts due to a tendency to adapt to the highest intensities, and no higher, experienced during a lifetime. Here, we show models project not only more intense extremes but also events that break previous records by much larger margins. These record-shattering extremes, nearly impossible in the absence of warming, are likely to occur in the coming decades. We demonstrate that their probability of occurrence depends on warming rate, rather than global warming level, and is thus pathway-dependent. In high-emission scenarios, week-long heat extremes that break records by three or more standard deviations are two to seven times more probable in 2021–2050 and three to 21 times more probable in 2051–2080, compared to the last three decades. In 2051–2080, such events are estimated to occur about every 6–37 years somewhere in the northern midlatitudes.”

Observed historical multivariate climate departures 1958 to 2017

Source: Multivariate climate departures have outpaced univariate changes across global lands, Abatzoglou, Dobrowski, Parks, 2020

Data: from author John Abatzoglou

Historical multivariate climate departures (1958 to 2017) - https://repository.upenn.edu/handle/20.500.14332/59780

Format: netCDF

Description: "We calculate annual multivariate climate departures during 1958–2017 relative to a baseline 1958–1987 period that account for covariance among four variables important to Earth's biota and associated systems: annual climatic water deficit, annual evapotranspiration, average minimum temperature of the coldest month, and average maximum temperature of the warmest month. Results show positive trends in multivariate climate departures that were nearly three times that of univariate climate departures across global lands. Annual multivariate climate departures exceeded two standard deviations over the past decade for approximately 30% of global lands. Positive trends in climate departures over the last six decades were found to be primarily the result of changes in mean climate conditions consistent with the modeled effects of anthropogenic climate change rather than changes in variability. These results highlight the increasing novelty of annual climatic conditions viewed through a multivariate lens and suggest that changes in multivariate climate departures have generally outpaced univariate departures in recent decades. The largest positive σd trends occurred in regions of historically low variance (e.g., equatorial regions), in regions such as southern Europe that have seen large changes in climate trends in the variables considered, and in boreal regions that saw joint increases in AET (annual evapotranspiration) and D (annual climatic water deficit) that are orthogonal to the historical covariance of these variables."

River flooding projections - Hirabayashi 2021 - See IPCC WG2 Impacts

Global projections of river flood risk in a warmer world - Alfieri 2016

Source: Global projections of river flood risk in a warmer world, Alfieri et al. 2016

Data: Available in supplementary table

Format: List

Description: “In this work, we present a framework to estimate the economic damage and population affected by river floods at global scale. It is based on a modeling cascade involving hydrological, hydraulic and socioeconomic impact simulations, and makes use of state-of-the-art global layers of hazard, exposure and vulnerability at 1-km grid resolution. An ensemble of seven high-resolution global climate projections based on Representative Concentration Pathways 8.5 is used to derive streamflow simulations in the present and in the future climate. Those were analyzed to assess the frequency and magnitude of river floods and their impacts under scenarios corresponding to 1.5°C, 2°C, and 4°C global warming. Results indicate a clear positive correlation between atmospheric warming and future flood risk at global scale. At 4°C global warming, countries representing more than 70% of the global population and global gross domestic product will face increases in flood risk in excess of 500%. Changes in flood risk are unevenly distributed, with the largest increases in Asia, U.S., and Europe. In contrast, changes are statistically not significant in most countries in Africa and Oceania for all considered warming levels.”

Drought risk, vulnerability, exposure, hazard - Carrao 2016 - see IPCC WG2 Impacts

Drought risk on rainfed and irrigated agricultural systems - Meza 2020 - See IPCC WG2 Impacts

Trend in moderate-to-severe drought days per year - Pokhrel 2021

Source: Global terrestrial water storage and drought severity under climate change, Pokhrel et al. 2021

Data: https://figshare.com/articles/journal_contribution/Climate_Change_Terrestrial_Water_Storage_and_Drought/13218710

Format: netCDF and excel

Description: “We show the trend in moderate-to-severe drought days per year, 2006 - 2099 RCP6.0 (1 day extra of drought per year is equivalent to 10 days extra of drought per decade) "These results show that climate change could reduce TWS (terrestrial water storage) in many regions, especially in the Southern Hemisphere, the United States and southwestern Europe; exceptions are regions with high increases in precipitation, including east Africa and northern Asia. By the late twenty-first century and under RCP6.0, two-thirds of the global land could experience a reduction in TWS. We find strong agreement among ensemble model projections, especially in the direction of change, suggesting that the results are robust. Globally, land area and projected population in extreme-to-exceptional TWS drought under RCP6.0 are projected to more than double, each increasing from 3% to 7% and 8%, respectively, by the late twenty-first century."

Glacier elevation change in meters (from 2000 to 2019) at the beginning of 21st century

Source: Accelerated global glacier mass loss in the early twenty-first century, Hugonnet et al. 2021

Data: https://doi.org/10.6096/13 (Inside Time series Regional time series with fixed glacier areas)

Format: .csv

Description: Glaciers worldwide are undergoing retreat, leading to rising sea levels and shifts in water availability. Significant losses are observed in North West America, while the Himalayas experience comparatively minor losses. These changes over the past two decades are primarily driven by global warming but are influenced by factors such as the North Atlantic Oscillation and other climatic patterns.

Accelerated mass loss of Himalayan glaciers since the Little Ice Age

Source: Accelerated mass loss of Himalayan glaciers since the Little Ice Age, Lee et al. 2021

Data: https://archive.researchdata.leeds.ac.uk/787/

Format: shape files

Description: “We reconstruct the extent and surfaces of 14,798 Himalayan glaciers during the Little Ice Age (LIA), 400 to 700 years ago. We show that they have lost at least 40 % of their LIA area and between 390 and 586 km3 of ice; 0.92 to 1.38 mm Sea Level Equivalent. The long-term rate of ice mass loss since the LIA has been between − 0.011 and − 0.020 m w.e./year, which is an order of magnitude lower than contemporary rates reported in the literature. Rates of mass loss depend on monsoon influence and orographic effects, with the fastest losses measured in East Nepal and in Bhutan north of the main divide. Locally, rates of loss were enhanced with the presence of surface debris cover (by 2 times vs clean-ice) and/or a proglacial lake-terminating (by 2.5 times vs land-terminating). The ten-fold acceleration in ice loss we have observed across the Himalaya far exceeds any centennial-scale rates of change that have been recorded elsewhere in the world.”

Himalaya snow max accumulation (mm, projections to 2100)

Source: Climate change decisive for Asia’s snow meltwater supply, Kraaijenbrink et al. 2021

Data: https://zenodo.org/record/4715786#.YOVw1pMzaL4

Format: netCDF

Description: Snow water equivalent and snowmelt projections for the end of century (2071-2100) with respect to present day (2000–2019) based on CMIP6 SSP-RCP ensemble mean forcing. Data includes projections of climatological change of peak snow water equivalent, mean snow water equivalent, and mean snowmelt discharge. Included CMIP6 experiments are ssp119, ssp126, ssp245, ssp370, ssp434, ssp460, and ssp585.
"Over the period 1979–2019, we estimate significant negative changes in the maximum annual amount of water stored as snow (that is, peak SWE) for large regions in HMA. Most affected are the northern plains of Syr Darya, Helmand and Indus as well as large parts of central and eastern HMA. Although absolute changes in peak SWE are small for the eastern parts of the arid interior region, such as the Tibetan Plateau and upstream parts of the Brahmaputra, relative changes in peak SWE are largest there, with annual reductions of over 6.0 ± 1.8% for the period 1979–2019. "

Transmission suitability of zika and dengue (months)

Source: Global expansion and redistribution of Aedes-borne virus transmission risk with climate change, Ryan et al. 2019

Data: https://dataverse.harvard.edu/dataverse/Aedesmaps

Format: .tif

Description: "Forecasting the impacts of climate change on Aedes-borne viruses-especially dengue, chikungunya, and Zika-is a key component of public health preparedness. We apply an empirically parameterized model of viral transmission by the vectors Aedes aegypti and Ae. albopictus, as a function of temperature, to predict cumulative monthly global transmission risk in current climates, and compare them with projected risk in 2050 and 2080 based on general circulation models (GCMs). Our results show that if mosquito range shifts track optimal temperature ranges for transmission (21.3-34.0°C for Ae. aegypti; 19.9-29.4°C for Ae. albopictus), we can expect poleward shifts in Aedes-borne virus distributions. However, the differing thermal niches of the two vectors produce different patterns of shifts under climate change. More severe climate change scenarios produce larger population exposures to transmission by Ae. aegypti, but not by Ae. albopictus in the most extreme cases. Climate-driven risk of transmission from both mosquitoes will increase substantially, even in the short term, for most of Europe. In contrast, significant reductions in climate suitability are expected for Ae. albopictus, most noticeably in southeast Asia and west Africa. Within the next century, nearly a billion people are threatened with new exposure to virus transmission by both Aedes spp. in the worst-case scenario."

Transmission suitability of Malaria and dengue (months)

Source: Projecting the risk of mosquito-borne diseases in a warmer and more populated world: a multi-model, multi-scenario intercomparison modelling study - The Lancet Planetary Health, Colon-Gonzalez et al. 2021

Data: https://osf.io/hpaey/ There are outputs for malaria and dengue. Each infection has results for three modeling schemes. We use the average over the three models. For each model, data for LTS and PAR and for lots of scenarios. LTS as the number of suitable transmission months per year. PAR is the total population in a grid cell having at least one suitable month in the same year (change only available for 2080).

Scenarios: **Rcp26_ssp1,** Rcp26_ssp2, Rcp45_ssp2, Rcp60_ssp2, Rcp85_ssp2, **Rcp85_ssp5**

And years:
Historical 1970_1999, 2010_2039, **2040-2069,** 2070-2099

Format: netCDF

Description: "Our findings offer strong support for a northward shift of the malaria-epidemic belt in North America, central northern Europe, and northern Asia. Our findings are in line with the emergence of autochthonous cases in Europe, and the increasing presence of Ae albopictus and Ae aegypti in the region. We predict that malaria suitability will gradually increase as a consequence of a warming climate in tropical areas in most tropical regions, especially highland areas in the African region, the Eastern Mediterranean region, and the Americas, as previously estimated. At altitudes below 1000 m, climatic and socioeconomic conditions could decrease malaria transmission in Africa even when maintaining current malaria interventions.
Dengue suitability is predicted to increase mostly in lowland areas in the Western Pacific region and the Eastern Mediterranean region, and in highland areas in the Americas, as previously

proposed. Climate change could promote a shift from malaria to dengue transmission in sub-Saharan Africa in the future. Warmer-adapted anopheline species (eg, An stephensi) could also invade and replace An gambiae populations and continue malaria transmission in sub-Saharan Africa.

Dengue is the fastest-growing mosquito-borne viral disease in the world, and has substantially expanded its spatial range in the past 60 years. The disease is endemic in more than 120 countries, and is considered a global health priority. Most cases occur in the WHO region of the Americas, the South-East Asia region, and the Western Pacific region. Dengue is transmitted between humans by female Aedes mosquitoes. The two main dengue vectors are Aedes aegypti and Aedes albopictus. Both species are highly anthropophilic and often compete for the same habitats.1Aedes mosquitoes are typically found in urban and peri-urban regions, although Ae albopictus are also found in rural environments.Ae albopictus has a cooler thermal optimum (26·4°C) than Ae aegypti (29·1°C), and has the ability to diapause over winters. Consequently, Ae albopictus is frequently found in temperate zones."

Mortality costs (from Climate Impact Lab) - See IPCC WG2 Impacts

Sea level risk to airports

Source: Global analysis of sea level rise risk to airports, Yesudian and Dawson, 2021

Data: Supplementary Data. Risk for airports in the Low Elevation Coastal Zone - found location by matching IATA codes with ArcGIS online layer Airports of the World.

Format: List

Description: "Major airports are already at risk of coastal flooding. Sea level rise associated with a global mean temperature rise of 2 °C would place 100 airports below mean sea level, whilst 1238 airports are in the Low Elevation Coastal Zone. A global analysis has assessed the risk to airports in terms of expected annual disruption to routes. The method integrates globally available data of airport location, flight routes, extreme water levels, standards of flood protection and scenarios of sea level rise. Globally, the risk of disruption could increase by a factor of 17–69 by 2100, depending on the rate of sea level rise. A large number of airports are at risk in Europe, Norther American and Oceania, but risks are highest in Southeast and East Asia. These coastal airports are disproportionately important to the global airline network, by 2100 between 10 and 20% of all routes are at risk of disruption. Sea level rise therefore poses a systemic risk to global passenger and freight movements. Airports already benefit from substantial flood protection that reduces present risk by a factor of 23. To maintain risk in 2100 at current levels could cost up to $57BN. Although the cost of protecting larger airports is higher, busier airports are typically well protected and more likely to have better access to adaptation finance. However, 995 coastal airports operate 5 commercial routes or fewer. More detailed consideration of these airports shows that regions, especially low lying islands, will experience disproportionate impacts because airports can provide important economic, social, and medical lifelines. Route disruption was used as the risk metric due to its global coverage and relationship with direct economic impacts. Further work should collate a wider range of impact metrics that reflect the criticality of an airport in terms of the isolation and socio-economic context of the location it serves."

Local warming and humidity patterns per degree of global warming

Source: [Increased labor losses and decreased adaptation potential in a warmer world, Parsons et al. 2021]

Data: https://zenodo.org/record/5594470#.YfD0Q1jMKL4

For Fig. 2
Files
'swbgt_patterns_CMIP6_1pctCO2_MMMedian_Annual_JJA_DJF_75p_95p_99p_1x1_grid.nc', 'huss_patterns_CMIP6_1pctCO2_MMMedian_Annual_JJA_DJF_75p_95p_99p_1x1_grid.nc', and 'tas_patterns_CMIP6_1pctCO2_MMMedian_Annual_JJA_DJF_75p_95p_99p_1x1_grid.nc' contain the CMIP6 multi-model median warming patterns for swbgt, huss, and tas annual mean, JJA, DJF, the 75th percentile of daily temperatures, the 95th percentile, and the 99th percentile regridded to a common 1x1 degree horizontal resolution.
We show the 75th percentile as in Fig. 2

For Sup. Fig 8 (labor hours lost to heat and costs lost to heat) .
File
'heavylaborlost_global_populationweighted_annual_hours_lost_mean_present_warming_1_2_3_4_C_grid_05x05.nc' contains climatological (20-year) mean labor losses multiplied by GPWv4 working age population in agriculture + construction industries (units: lost hours/year). Provided on a 0.5x0.5 degree horizontal grid structure. File 'heavylaborlost_global_populationweighted_annual_productivity2017PPP_lost_mean_present_warming_1_2_3_4_C_grid_05x05.nc' contains climatological (20-year) mean productivity (2017PPP$) losses in agriculture + construction/industry sectors (units: 2017PPP$/year).

Format: netCDF

Description: "Working in hot and potentially humid conditions creates health and well-being risks that will increase as the planet warms. It has been proposed that workers could adapt to increasing temperatures by moving labor from midday to cooler hours. Here, we use reanalysis data to show that in the current climate approximately 30% of global heavy labor losses in the workday could be recovered by moving labor from the hottest hours of the day. However, we show that this particular workshift adaptation potential is lost at a rate of about 2% per degree of global warming as early morning heat exposure rises to unsafe levels for continuous work, with worker productivity losses accelerating under higher warming levels. These findings emphasize the importance of finding alternative adaptation mechanisms to keep workers safe, as well as the importance of limiting global warming".

Food security

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=81dc97074b4c428db1b971bad41580c3

Livelihood Zones

Source: Famine Early Warning Systems Network

Data: https://fews.net/data/livelihood-zones

Format: shape files

Description: "Livelihood zone maps define geographic areas of a country where people generally share similar options for obtaining food and income and similar access to markets. An understanding of geographic livelihood systems is a key component of FEWS NET's food security analysis. The maps are produced through multi-day workshops during which food security stakeholders and country experts identify zones. Factors considered include agro-climatology, elevation, land-cover, market accessibility, sources of food, and major economic activities. A livelihood zone map is typically accompanied by a livelihood description which outlines the key characteristics of each zone. In some cases, maps may also be accompanied by livelihood profiles, which are in-depth descriptions of the characteristics of wealth groups within each zone."

Crop allocation to food, feed and fuel

Source: Earthstat

Data: Crop allocation

FoodProdAreaFrac.tif: Fraction of total harvested area used to produce food directly for feed (the remainder represent area used for feed and nonfood uses).
DeliveredkcalFraction.tif: Fraction of produced calories that are ultimately delivered as food calories after accounting for the type of crop and its allocation as food, feed, or nonfood.
GlbFoodkcal.tif: Total kilocalories produced for usage as food.
GlbFeedkcal.tif: Total kilocalories produced for usage as feed.
GlbNonFoodkcal.tif: Total kilocalories produced for usage as non-food products.
Glbkcal.tif: Total kilocalories produced for all types of allocations (sum of Food/Feed/NonFood).

Format: .tif

Description: “EarthStat serves geographic data sets that help solve the grand challenge of feeding a growing global population while reducing agriculture’s impact on the environment. EarthStat is a collaboration between the Global Landscapes Initiative at the University of Minnesota’s Institute on the Environment and the Land Use and Global Environment lab at the University of British Columbia.”

Land subsidence

Source: Mapping the global threat of land subsidence, Herrera-Garcia et al. 2021

Data: https://info.igme.es/visor/?Configuracion=globalsubsidence&idioma=en
https://www.landsubsidence-unesco.org/maps/

Format: .tif

Description: "Subsidence, the lowering of Earth's land surface, is a potentially destructive hazard that can be caused by a wide range of natural or anthropogenic triggers but mainly results from solid or fluid mobilization underground. Subsidence due to groundwater depletion is a slow and gradual process that develops on large time scales (months to years), producing progressive loss of land elevation (centimeters to decimeters per year) typically over very large areas (tens to thousands of square kilometers) and variably affects urban and agricultural areas worldwide. Subsidence permanently reduces aquifer-system storage capacity, causes earth fissures, damages buildings and civil infrastructure, and increases flood susceptibility and risk. During the next decades, global population and economic growth will continue to increase groundwater demand and accompanying groundwater depletion and, when exacerbated by droughts, will probably increase land subsidence occurrence and related damages or impacts. Potential subsidence areas are concentrated in and near densely urban and irrigated areas with high water stress and high groundwater demand, overlying some of the largest and most depleted aquifer systems in Asia (e.g., North China Plain) and North America (e.g., Gulf of

Mexico coastal plain); coastal and river delta areas worldwide (e.g., Vietnam, Egypt, or the Netherlands); and inland sedimentary basins of México, Iran, and the Mediterranean countries. Potential subsidence is lower in Africa, Australia, and South America, owing to the lower groundwater depletion."

Yield Constraint Score (Sharps et al. 2020) - See IPCC WG2 Impacts

Prevalence of inadequate micronutrient intake - See IPCC WG2 Impacts

Food production shocks - Cottrell - See IPCC WG2 Impacts

Climate change impacts on crop yield - wheat, maize, rice, soybean - See IPCC WG2 Impacts

Soil health

Source: UNEP-WCMC https://www.unep-wcmc.org/en

Data, format, and description: See Above and below ground biomass carbon and soil organic carbon to 1m depth (tonnes/ha) ESRI layer

Other external ESRI layers (access only with organizational account)
GLDAS soil moisture 2000 - present - ESRI layer
Global Land cover 1992-2019 ESRI layer
World Soils Harmonized World Soil Database - Chemistry ESRI layer
Soil Health Assessments ESRI layer
Wheat mega environments ESRI layer

Livestock - external layer

Source, data, format: ESRI layer

Description:
“This layer contains the number of livestock (pigs, sheep, goats, horses, buffalo, cattle, chickens, and ducks) in each country. The default symbology highlights most common livestock in each country, but with a few changes to the symbology, the map can also show the distribution of each livestock individually.   The inspiration for this layer came from the FAO

(Food and Agriculture Organization of the United Nations) site which is home to eight maps highlighting livestock distribution around the world. The source data, last updated in August 2018, contain the global distribution of each livestock in 2010 expressed in total number of livestock per pixel (5 min of arc) according to the Gridded Livestock of the World database (GLW 3). Click here to download the data from Harvard's Dataverse. This layer is derived from the tif file of the dasymetric product of the absolute number of animals per pixel (4,230 by 2,160 pixels of 0.083333 decimal degrees resolution)."

Heat stress in domesticated livestock species - See IPCC WG2 Impacts

Water security

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=81dc97074b4c428db1b971bad41580c3

Rivers, glaciers, aquifers

Rivers and groundwater basins WHYMAP BGR

Source and Description:
https://www.whymap.org/whymap/EN/Maps_Data/Rgwb/rgwb_node_en.html

Data: Original data from link under River and Groundwater Basins of the World as a shapefile in the BGR Geoportal

Format: shape (and line) files

Major river basins of the world

Source:
The GRDC - the world-wide repository of river discharge data and associated metadata

Data: Original file from Major river basins of the world https://mrb.grdc.bafg.de/

Format: shape files

Description: "GRDC Major River Basins of the World (MRB) is an ongoing GIS project of the Global Runoff Data Centre (GRDC). It is provided for public use under the condition of full citation and reference to incorporated data from the HydroSHEDS database (Lehner 2013). This is the 2nd, revised edition 2020 and replaces the basin polygons and river lines of the edition 2007 (GRDC 2007). Citation:GRDC (2020): GRDC Major River Basins. Global Runoff Data Centre. 2nd, rev. ed. Koblenz: Federal Institute of Hydrology (BfG)."

Global Map of Irrigation Areas - version 5.0

Source:
http://www.fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/latest-version

Data:
https://firebasestorage.googleapis.com/v0/b/fao-aquastat.appspot.com/o/PDF%2FMAPS%2Fgmia_v5_lowres.pdf?alt=media&token=d098a48f-ab49-4eae-a16e-82a5779f924e

Format: Shape files.

Description: "The map shows the amount of area equipped for irrigation around the year 2005 in percentage of the total area on a raster with a resolution of 5 minutes. Additional map layers show the percentage of the area equipped for irrigation that was actually used for irrigation and the percentages of the area equipped for irrigation that was irrigated with groundwater, surface water or non-conventional sources of water. An explanation of the different terminology to indicate areas under irrigation is given in this glossary. Please note that information for the additional layers on area actually irrigated or on the water source for irrigation was derived from statistical survey data (e.g. census reports). Therefore all grid cells belonging to the same statistical unit will have the same value. Consequently, the accuracy at pixel level will be very limited, depending on the size of the statistical unit.Users are requested to refer to the map as follows: "Stefan Siebert, Verena Henrich, Karen Frenken and Jacob Burke (2013). Global Map of Irrigation Areas version 5. Rheinische Friedrich-Wilhelms-University, Bonn, Germany / Food and Agriculture Organization of the United Nations, Rome, Italy".

Irrigated Cropland 300m from ESA 2018 - external layer

Source and data: ArcGIS layer

Format: Imagery layer in ArcGIS online

Description: "The ESA 2018 ICDR Irrigated Cropland layer contains only class 20 (Irrigated Cropland). This dataset does not include rainfed cropland areas (classes 10-12) or "Mosaic

Cropand/Vegetation” classes 30-40, and is intended to be used as a mask product to isolate remotely-sensed irrigated croplands worldwide.”

Water depletion

Source: Earth Stat

Data: http://www.earthstat.org/

Format: .tif

Description: “Water depletion is a measure of the fraction of available renewable water consumptively used by human activities within a watershed. Our characterization of water depletion uses calculations from the WaterGAP3 global hydrology model to assess long-term average annual consumed fraction of renewably available water, then integrates seasonal depletion and dry-year depletion, also based on WaterGAP3 calculations, with average annual depletion into a unified scale.”

Global Dam Databases

Source: Global Dam Watch curates and hosts three leading global dam databases.

Data: Grand dams database http://globaldamwatch.org/home
Downloaded these shape files
https://ln.sync.com/dl/bd47eb6b0/anhxaikr-62pmrgtq-k44xf84f-pyz4atkm/view/default/447819520013

Format: shape files

Description: "Each of the three core datasets has been developed over many years with a particular focus and methodology. The Global Geo-referenced Database of Dams (GOODD) maps all dams visible on Google Earth satellite imagery globally; it catalogues the geospatial coordinates of 38,660 dams. The Global Reservoir and Dam Database (GRanD) maps the location and attribute data of 7,320 dams greater than 15m in height or with a reservoir of more than 0.1km³. Future Hydropower Reservoirs and Dams (FHReD) maps 3,700 dams that are under construction or in advanced planning stages. Together, these three datasets represent the most detailed, freely available global database of dams and georeferenced information about global dams.
Currently, some overlaps exist between the datasets. For example, large dams mapped by GRanD may also exist in GOODD, though the GOODD dam points are location-only and do not

carry the attribute data found in GRanD. Dams that were under construction before 2015 may have been captured by FHReD; those that have been completed since may also be reflected as completed and operational in GRanD or GOODD, though again without attribute data. Our future efforts are focused on harmonizing these three datasets so that researchers can either use them independently or in combination with all overlaps attributed for and easily filtered out."
This is the paper explaining DOR
https://esajournals.onlinelibrary.wiley.com/doi/full/10.1890/100125

Aquifers vulnerability - WHYMAP

Source: WHYMAP webpage

Data can be downloaded in shape files
https://www.whymap.org/whymap/EN/Maps_Data/maps_data_node_en.html;jsessionid=5B6832AEF6F6D896D69F43DB71BECF68.2_cid292
Map viewer
https://www.whymap.org/whymap/EN/Map_Applications/map_applications_node_en.html

Format: shape files

Description:
"Groundwater is the largest accessible and often still untapped freshwater reservoir on earth. Its world-wide resources are assessed at 10.5 million km^3. The increasing number of regional water shortages and water crises can only be met with a rational and sustainable use of this resource. Such sustainable use requires understanding and knowledge as well as careful planning and management. Yet, information on this hidden resource is still weak in many places. In order to provide data and information about the major groundwater resources of the world and thus make a contribution to their reasonable management and protection the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP) was launched in 2000. The programme compiles data on groundwater from national, regional and global sources, and visualises them in maps, web map applications and services. The generated products provide information on quantity, quality and vulnerability of the groundwater resources on earth and help communicating groundwater related issues to water experts as well as decision makers and the general public."
"The World Karst Aquifer Map focuses on groundwater resources in karst aquifers, which are developed primarily in carbonate rocks. Evaporites also constitute important karst aquifer systems, but high sulfate concentrations often hamper their direct utilisation as drinking water. Rocks that contain at least 75 % of soluble minerals are typically karstifiable. The actual degree of karstification can vary greatly as a function of various geological, hydrological and climatological factors; however, it is safe to assume that exposed carbonate rocks are karstified

at least to some degree, unless proven otherwise. It is important to note that even a slight degree of underground chemical rock dissolution can result in a typical karst aquifer with rapid groundwater flow and contaminant transport, even when no accessible caves and geomorphological karst features are present."

Flood prone areas

Source: River Flood Hazard Maps at European and Global Scale GloFAS
https://data.jrc.ec.europa.eu/collection/id-0054

Data:
Flood hazard map of the World - 10-year return period
Flood hazard map of the World - 100-year return period

Format: .tif

Description: “The map depicts flood prone areas at global scale for flood events with 10-year return period and 100-year period. Resolution is 30 arcseconds (approx. 1km). Cell values indicate water depth (in m). The map can be used to assess flood exposure and risk of population and assets. NOTE: this dataset is based on JRC elaborations and is not an official flood hazard map (for details and limitations please refer to related publications).”

Citations:
Dottori, Francesco; Alfieri, Lorenzo; Salamon, Peter; Bianchi, Alessandra; Feyen, Luc; Hirpa, Feyera (2016), European Commission, Joint Research Centre (JRC)
Dottori F, Salamon P, Bianchi A, Alfieri L, Hirpa F, Feyen L. Development and evaluation of a framework for global flood hazard mapping. ADVANCES IN WATER RESOURCES 94; 2015. p. 87-102. JRC93811

Flood protection standards - see IPCC WG2 Impacts

Hydro-political risk (Farinosi et al. 2018)

Source: An innovative approach to the assessment of hydro-political risk: A spatially explicit, data driven indicator of hydro-political issues, Farinosi et al. 2018.

Data: via author Fabio Farinosi

Hydro-political risk - https://repository.upenn.edu/handle/20.500.14332/59782

Format: .adf

Description: "Competition over limited water resources is one of the main concerns for the coming decades. Although water issues alone have not been the sole trigger for warfare in the past, tensions over freshwater management and use represent one of the main concerns in political relations between riparian states and may exacerbate existing tensions, increase regional instability and social unrest. In this study, we analyze what are the pre-conditions favoring the insurgence of water management issues in shared water bodies, rather than focusing on the way water issues are then managed among actors. We do so by proposing an innovative analysis of past episodes of conflict and cooperation over transboundary water resources (jointly defined as "hydro-political interactions"). On the one hand, we aim at highlighting the factors that are more relevant in determining water interactions across political boundaries. On the other hand, our objective is to map and monitor the evolution of the likelihood of experiencing hydro-political interactions over space and time, under changing socioeconomic and biophysical scenarios, through a spatially explicit data driven index. Historical cross-border water interactions were used as indicators of the magnitude of corresponding water joint-management issues. These were correlated with information about river basin freshwater availability, climate stress, human pressure on water resources, socioeconomic conditions (including institutional development and power imbalances), and topographic characteristics. This analysis allows for identification of the main factors that determine water interactions, such as water availability, population density, power imbalances, and climatic stressors. The proposed model was used to map at high spatial resolution the probability of experiencing hydro-political interactions worldwide. This baseline outline is then compared to four distinct climate and population density projections aimed to estimate trends for hydro-political interactions under future conditions (2050 and 2100), while considering two greenhouse gases emission scenarios (moderate and extreme climate change). The combination of climate and population growth dynamics is expected to impact negatively on the overall hydro-political risk by increasing the likelihood of water interactions in the transboundary river basins, with an average increase ranging between 74.9% (2050 – population and moderate climate change) to 95% (2100 - population and extreme climate change). Future demographic and climatic conditions are expected to exert particular pressure on already water stressed basins such as the Nile, the Ganges/Brahmaputra, the Indus, the Tigris/Euphrates, and the Colorado."

TWAP Transboundary Waters Assessment Programme - river basins and aquifers

River basins

Source: Hydropolitical Tension for Basin County Unit, http://twap-rivers.org/

Data: http://twap-rivers.org/indicators/. Easy to download shape files next to the name of the variable.

Format: Shape files

Description: “The TWAP River Basins (TWAP RB) component is a global assessment of 286 transboundary river basins, aimed at enabling the prioritisation of funds for basins at risk from a variety of issues, covering water quantity, water quality, ecosystems, governance and socio-economics. The TWAP RB assessment also covers risks to deltas from threats of a transboundary nature, and considers the relative influence of lakes on these river basins. TWAP RB is an indicator–based assessment, allowing for an analysis of basins, based on risks to both societies and ecosystems. It also includes provisional outlook projections to 2030 and 2050 for a limited number of indicators.”

Transboundary aquifers

Source: http://geftwap.org/data-portal

Data: https://ggis.un-igrac.org/view/twap/ (easy to download into shape files)

Rivers at risk

Source (2010):
Rivers in crisis
Nature article
Nature supplementary

Data: https://www.riverthreat.net//data.html

Format: netCDF

Description: “Rivers maintain unique biotic resources and provide critical water supplies to people. The Earth's limited supplies of fresh water and irreplaceable biodiversity are vulnerable to human mismanagement of watersheds and waterways. Multiple environmental stressors, such as agricultural runoff, pollution and invasive species, threaten rivers that serve 80 percent of the world’s population. These same stressors endanger the biodiversity of 65 percent of the world’s river habitats putting thousands of aquatic wildlife species at risk. Efforts to abate fresh water degradation through highly engineered solutions are effective at reducing the impact of

threats but at a cost that can be an economic burden and often out of reach for developing nations.
Areas in the world where farming is threatened by high salinity include the Indus Basin in Pakistan where they also face the problem of a rising water table. The Imperial Valley in California, formerly productive agricultural lands in South America, China, India, Iraq, and many other regions throughout the world are all facing the threat of losing fertile land because of salinization. After the building of the Aswan Dam in Egypt, the Nile River and the surrounding fields that had been irrigated successfully for over 5,000 years became threatened by high salinity in the water."

Deltas at risk

Source:
Global deltas at risk
Science article

Data: https://www.globaldeltarisk.net/data.html

Format: shape files

Description: Wetland disconnectivity is an estimate of wetland area that has been drained or otherwise converted for human use
Unsustainable groundwater depletion over delta areas. Groundwater extraction from delta sediments reduces pore pressure and accelerates land subsidence.

Lowland dependence on mountain water resources - Viviroli - See IPCC WG2 Impacts

Coastal risks

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=3bab51cdb16340b39b19ee5129781a96

Coastal ecosystems UN WCMC

Source: Ocean Data Viewer UN WCMC https://data.unep-wcmc.org/

Data: The web ('view dataset detail') has the info on the ArcGIS online layers that can be linked to the Atlas

Format: ArcGIS online layers

Description (references):

Global distribution of mangroves: Giri C, Ochieng E, Tieszen LL, Zhu Z, Singh A, Loveland T, Masek J, Duke N (2011). Status and distribution of mangrove forests of the world using earth observation satellite data (version 1.4, updated by UNEP-WCMC). Global Ecology and Biogeography 20: 154-159. Paper DOI: 10.1111/j.1466-8238.2010.00584.x . Data DOI: https://doi.org/10.34892/1411-w728

World Atlas of Mangroves: Spalding M, Kainuma M, Collins L (2010). World Atlas of Mangroves (version 3.1). A collaborative project of ITTO, ISME, FAO, UNEP-WCMC, UNESCO-MAB, UNU-INWEH and TNC. London (UK): Earthscan, London. 319 pp. Data DOI: https://doi.org/10.34892/w2ew-m835

Global mangrove watch: Bunting, P.; Rosenqvist, A.; Hilarides, L.; Lucas, R.M.; Thomas, T.; Tadono, T.; Worthington, T.A.; Spalding, M.; Murray, N.J.; Rebelo, L-M. Global Mangrove Extent Change 1996 – 2020: Global Mangrove Watch Version 3.0. Remote Sensing. 2022

Global Distribution of Coral Reefs: UNEP-WCMC, WorldFish Centre, WRI, TNC (2021). Global distribution of warm-water coral reefs, compiled from multiple sources including the Millennium Coral Reef Mapping Project. Version 4.1. Includes contributions from IMaRS-USF and IRD (2005), IMaRS-USF (2005) and Spalding et al. (2001). Cambridge (UK): UN Environment World Conservation Monitoring Centre. Data DOI: https://doi.org/10.34892/t2wk-5t34

Global Distribution of Cold-water Corals: Freiwald A, Rogers A, Hall-Spencer J, Guinotte JM, Davies AJ, Yesson C, Martin CS, Weatherdon LV (2021). Global distribution of cold-water corals (version 5.1). Fifth update to the dataset in Freiwald et al. (2004) by UNEP-WCMC, in collaboration with Andre Freiwald and John Guinotte. Cambridge (UK): UN Environment Programme World Conservation Monitoring Centre. Data DOI: https://doi.org/10.34892/72×9-rt61

Global Distribution of Seagrasses: UNEP-WCMC, Short FT (2021). Global distribution of seagrasses (version 7.1). Seventh update to the data layer used in Green and Short (2003). Cambridge (UK): UN Environment World Conservation Monitoring Centre. Data DOI: https://doi.org/10.34892/x6r3-d211

Global distribution of saltmarshes: UNEP-WCMC, Short FT (2021). Global distribution of seagrasses (version 7.1). Seventh update to the data layer used in Green and Short (2003). Cambridge (UK): UN Environment World Conservation Monitoring Centre. Data DOI: https://doi.org/10.34892/x6r3-d211

Coastal ecosystems - Blue carbon wealth

Source and data: Blue carbon wealth of nations, Bertram et al. 2021

Format: .xlsx

Description: "We calculate the areas covered by three coastal ecosystem types, mangroves, salt marshes and seagrass meadows, in each country's exclusive economic zone (EEZ) based on global spatial data sets and combine these data with average annual carbon sequestration rates for mangroves, salt marshes and seagrass meadows, respectively, to obtain estimates for each country's blue carbon sequestration potential. Summing over all countries results in mean ± s.e.m. cumulative sequestration potentials of 24.0 ± 3.2 MtC yr−1 for mangroves, 13.4 ± 1.4 MtC yr−1 for salt marshes and 43.9 ± 12.1 MtC yr−1 for seagrass meadows, totalling 81.2 ± 12.6 MtC yr−1 across all BCEs. This is in line with earlier global estimates for mangroves and salt marshes but is lower, and hence more conservative, for seagrass meadows. Australia, the United States and Indonesia are the three countries with the largest annual carbon sequestration potentials aggregated over all three BCE types (10.6 ± 1.6, 7.5 ± 0.8 and 7.2 ± 0.9 MtC yr−1, respectively, Fig. 1). Among countries that host any BCEs, the smallest absolute annual carbon sequestration potentials exist in Mauritania (2.4 ± 0.3 tC yr−1), Bulgaria (77.3 ± 8.2 tC yr−1) and Saint Vincent and the Grenadines (81.3 ± 10.7 tC yr−1).

CARBON UPTAKE RATES
Saltmarsh 245tC m-2 yr-1
Mangroves 174 tC m-2 yr-1
Seagrass 138tC km-2 yr-1

Global protected areas UNEP-WCMC and IUCN (2022)

Source and data: Protected Planet: The World Database on Protected Areas (WDPA) and World Database on Other Effective Area-based Conservation Measures (WD-OECM) at: http://www.protectedplanet.net, https://mpatlas.org/zones/
We are using the layer already in ArcGIS online Living Atlas

See https://mpatlas.org/ for a good visualization on marine protected areas

Format: shape files

Description: The World Database on Protected Areas (WDPA) is the most comprehensive global database of marine and terrestrial protected areas, updated on a monthly basis, and is one of the key global biodiversity data sets being widely used by scientists, businesses, governments, International secretariats and others to inform planning, policy decisions and management. The WDPA is a joint project between UN Environment and the International Union for Conservation of Nature (IUCN). The compilation and management of the WDPA is carried out by UN Environment World Conservation Monitoring Centre (UNEP-WCMC), in collaboration with governments, non-governmental organisations, academia and industry. There are monthly updates of the data which are made available online through the Protected Planet website where the data is both viewable and downloadable.
Citation: UNEP-WCMC and IUCN (2024), Protected Planet: The World Database on Protected Areas (WDPA) [Online], January 2024, Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

Biodiversity priority conservation ocean - Sala et al 2021

Source: Protecting the global ocean for biodiversity, food and climate, Sala et al. 2021

Data: https://datadryad.org/stash/dataset/doi:10.25349/D9N89M

Format: .tif

Description: "At present only 2.7% of the ocean is highly protected. This low level of ocean protection is due largely to conflicts with fisheries and other extractive uses. To address this issue, here we developed a conservation planning framework to prioritize highly protected MPAs in places that would result in multiple benefits today and in the future. We find that a substantial increase in ocean protection could have triple benefits, by protecting biodiversity, boosting the yield of fisheries and securing marine carbon stocks that are at risk from human activities. Our results show that most coastal nations contain priority areas that can contribute substantially to achieving these three objectives of biodiversity protection, food provision and carbon storage. A globally coordinated effort could be nearly twice as efficient as uncoordinated, national-level conservation planning."

Marine sediment carbon stocks - Atwood et al. 2020

Source: Global Patterns in Marine Sediment Carbon Stocks, Atwood et al. 2020

Data: https://datadryad.org/stash/dataset/doi:10.25349/D9N89M).
The exact figures can be subtracted from R code described here
https://github.com/emlab-ucsb/ocean-conservation-priorities

Format: .tif

Description: “Here we quantify global marine sedimentary C stocks at a 1-km resolution, and find that marine sediments store 2322 Pg C in the top 1 m (nearly twice that of terrestrial soils). Sediments in abyss/basin zones account for 79% of the global marine sediment C stock, and 49% of that stock is within the 200-mile Exclusive Economic Zones of countries. Currently, only ~2% of sediment C stocks are located in highly to fully protected areas that prevent the disturbance of the seafloor. Our results show that marine sediments represent a large and globally important C sink. However, the lack of protection for marine C stocks makes them highly vulnerable to human disturbances that can lead to their remineralization to CO_2, further aggravating climate change impacts.”

Global 200 ecoregions

Source: GLOBAL 200 ECOREGIONS - Olson, D. M., Dinerstein, E. 2002. The Global 200: Priority ecoregions for global conservation. Annals of the Missouri Botanical Garden 89(2):199-224

Data: https://www.worldwildlife.org/publications/global-200
https://databasin.org/datasets/a5b34649cc69417ba52ac8e2dce34c3b/

Format: Shape files

Description: “WWF’s Global 200 project analyzed global patterns of biodiversity to identify a set of the Earth's terrestrial, freshwater, and marine ecoregions that harbor exceptional biodiversity and are representative of its ecosystems. We placed each of the Earth's ecoregions within a system of 30 biomes and biogeographic realms to facilitate a representation analysis. Biodiversity features were compared among ecoregions to assess their irreplaceability or distinctiveness. These features included species richness, endemic species, unusual higher taxa, unusual ecological or evolutionary phenomena, and the global rarity of habitats.This process yielded 238 ecoregions--the Global 200--comprised of 142 terrestrial, 53 freshwater, and 43 marine priority ecoregions. Effective conservation in these ecoregions would help conserve the most outstanding and representative habitats for biodiversity on this planet.”

Myers regions

Source: [Biodiversity hotspots for conservation priorities, Myers et al. 2000]

Data: https://zenodo.org/records/3261807#.X8_iaNhKg2y
(https://www.cepf.net/our-work/biodiversity-hotspots/hotspots-defined)

Format: shape files

Description: In 1988, British ecologist Norman Myers published a seminal paper identifying 10 tropical forest “hotspots.” These regions were characterized both by exceptional levels of plant endemism and serious levels of habitat loss.

Marine biodiversity hotspots - Zhao et al.

Source: [Where Marine Protected Areas would best represent 30% of ocean biodiversity, Zhao et al. 2020]

Data: https://data.mendeley.com/datasets/wk6s7kh48m/1

Format: .tif

Description: "The IUCN (the International Union for Conservation of Nature) World Conservation Congress called for the full protection of 30% of each marine habitat globally and at least 30% of all the ocean. Thus, we quantitatively prioritized the top 30% areas for Marine Protected Areas (MPAs) globally using global scale measures of biodiversity from the species to ecosystem level. The analysis used (a) Ecosystems mapped based on 20 environmental variables, (b) four Biomes (seagrass, kelp, mangrove, and shallow water coral reefs) plus seabed rugosity as a proxy for habitat, and (c) species richness within each biogeographic Realm (indicating areas of species endemicity), so as to maximise representivity of biodiversity overall. We found that the 30% prioritized areas were mainly on continental coasts, island arcs, oceanic islands, the southwest Indian Ridge, the northern Mid-Atlantic Ridge, the Coral Triangle, Caribbean Sea, and Arctic Archipelago. They generally covered 30% of the Ecosystems and over 80% of the Biomes. Although 58% of the areas were within countries Exclusive Economic Zones (EEZ), only 10% were in MPAs, and <1% in no-take MPAs (IUCN category Ia). These prioritized areas indicate where it would be optimal to locate MPAs for recovery of marine biodiversity within and outside the country's EEZ. Our results thus provide a map that will aid both national and international planning of where to protect marine biodiversity as a whole."

Restoration projects of coastal marina habitats

Source: [Rebuilding marine life, Duarte et al. 2020]

Data source: Data set on restoration projects of coastal marine habitats reported worldwide, Duarte et al. 2020

Format: .csv

Description: Data set on restoration projects of coastal marina habitats reported worldwide. The data set includes projects on mangroves, seagrass, saltmarshes, oyster reefs and tropical coral reefs, and include details on the location of the restoration project, the year the restoration project was established or reported, and the source of the information.

Global status of marine spatial plans development in 2019

Source: Integrating climate change in ocean planning, Santos et al. 2020

Data: Supp. data
https://static-content.springer.com/esm/art%3A10.1038%2Fs41893-020-0513-x/MediaObjects/41893_2020_513_MOESM1_ESM.pdf

Format: List

Description: "The acceleration of global warming and increased vulnerability of marine social-ecological systems affect the benefits provided by the ocean. Spatial planning of marine areas is vital to balance multiple human demands and ensure a healthy ocean, while supporting global ocean goals. To thrive in a changing ocean though, marine spatial planning (MSP) must effectively integrate climate change. By reviewing existing literature on MSP and climate change, we explore the links between them and with ocean sustainability, highlight management challenges, and identify potential pathways to guide action towards the effective integration of climate impacts in MSP."

Fisheries - Sea Around Us

Source: Sea Around Us - a research initiative at the University of British Columbia and the University of Western Australia

Data: via author Valentina Ruiz Leotaud

Format: List

Description: "The Sea Around Us assesses the impact of fisheries on the marine ecosystems of the world, and offers mitigating solutions to a range of stakeholders. They emphasize catch time series starting in 1950, and related series (e.g., landed value and catch by flag state, fishing sector and catch type), and fisheries-related information on every maritime country (e.g., government subsidies, marine biodiversity)."
Citations: Pauly D., Zeller D., Palomares M.L.D. (Editors), 2020. Sea Around Us Concepts, Design and Data

Mapping the spatial distribution of global mariculture production

Source: Mapping the spatial distribution of global mariculture production, Clawson et al. 2022

Data: Supplementary data

Format: list

Description: "We categorised mariculture production into six broad categories (salmonidae fish, unfed or algae fed bivalve molluscs, shrimps and prawns, bluefin tuna, general marine fish, and non-shrimp crustaceans), based on functional and taxonomic groupings consistent with existing literature (e.g., MacLeod et al., 2020; Tacon and Metian, 2008; Tacon and Metian, 2015) and comprising 96% of global fish and invertebrate mariculture production for 2017. Our map does not include seaweed mariculture due to a lack of information on farming locations that would be needed to inform our modeling. We included all countries (73) that reported more than 500 t production of any single mariculture species in 2017 to the FAO (FAO, 2019b). We excluded countries reporting those species with lower production levels because they tended to report highly variable production levels and produced a tiny fraction of global mariculture production in 2017 (<0.1% combined), implying established production systems for those species do not yet exist in these places.
We used six "data types" in our workflow (Fig. 1, Figs. S1–6): A) The total number of farms in a country was reported and all farm locations were provided; B) The total number of farms in a country was reported, but no location details were provided for those farms; C) The total number of farms in a country was reported, but location details were only provided for a subset of those farms; D) The total number of farms in a country was not reported, rather a subset of farms within the country were reported and had locations provided; E) The total number of farms was not reported, rather a subset of the farms were reported, but no location information was provided. F) No information on the number of farms or their locations were reported."

Global LiDAR land elevation data - Sea level rise vulnerability

Source: Global LiDAR land elevation data reveal greatest sea-level rise vulnerability in the tropics. Hooijer & Vernimmen, 2021

Data: https://data.mendeley.com/datasets/v5x4vpnzds/1
Other data and visualization on sea level rise: CoastalDEM 90 m from Climate Central, https://coastal.climatecentral.org/

Format: .tif

Description: “Coastal flood risk assessments require accurate land elevation data. Those to date existed only for limited parts of the world, which has resulted in high uncertainty in projections of land area at risk of sea-level rise (SLR). Here we have applied the first global elevation model derived from satellite LiDAR data.”

Extreme sea level events - Vousdoukas

Source: Global probabilistic projections of extreme sea levels show intensification of coastal flood hazard, Vousdokas et al. 2018

Data: https://data.jrc.ec.europa.eu/dataset/jrc-liscoast-10012

Format: List

Description: Extreme sea level rise (ESL) is defined as a function of mean sea level rise and water levels driven by tides, waves, and storm surges. Scenarios shown are RCP4.5 and RCP8.5.

> 100-year Extreme sea level (meters of sea level extreme events that occur once every 100 years)
>
> Frequency of the present-day once-every-100-year extreme events by 2050 and 2100.

"By 2100, the regions with the highest projected ESLs are South America, South East Asia, and South Pacific. Other areas that under RCP8.5 show a rise in ESL100 above the global average are Australia and the west coast of the US and Canada. Locally, areas like the North Sea German coast, as well as parts of East Japan, China, North Vietnam and many of the South Pacific Small Island Developing States. Translating the projected rise in ESLs into the frequency domain shows that under both RCPs already by 2050 the present day 100-year event will occur annually in most of the tropics, rendering many coastal areas exposed to intermittent flood hazard (from cyclones and storms)."

Extreme sea level events - Kirezci

Source: [Projections of global-scale extreme sea levels and resulting episodic coastal flooding over the 21st Century, Kirezci et al. 2020]

Data: Supporting data for Tebaldi et al. 2021 - Nature Climate Change
https://zenodo.org/records/5095675

Format: .csv files

Description: "Global models of tide, storm surge, and wave setup are used to obtain projections of episodic coastal flooding over the coming century. The models are extensively validated against tide gauge data and the impact of uncertainties and assumptions on projections estimated in detail. Global "hotspots" where there is projected to be a significant change in episodic flooding by the end of the century are identified and found to be mostly concentrated in north western Europe and Asia. Results show that for the case of, no coastal protection or adaptation, and a mean RCP8.5 scenario, there will be an increase of 48% of the world's land area, 52% of the global population and 46% of global assets at risk of flooding by 2100. A total of 68% of the global coastal area flooded will be caused by tide and storm events with 32% due to projected regional sea level rise."

Extreme sea level events at different global warming levels - Tebaldi - See IPCC WG2 Impacts

Extreme wind-wave events - Meucci

Source: [Projected 21st century changes in extreme wind-wave events, Meucci et al. 2020]

Data: via author Alberto Meucci

Format: .csv

Description: "We describe an innovative approach to estimate global changes in extreme wave conditions by 2100, as a result of projected climate change. We generate a synthetic dataset from an ensemble of wave models forced by independent climate simulation winds, enhancing statistical confidence associated with projected changes in extreme wave conditions. Under two IPCC representative greenhouse gas emission scenarios (RCP4.5 and RCP8.5), we find that the magnitude of a 1 in 100-year significant wave height (Hs) event increases by 5 to 15% over the Southern Ocean by the end of the 21st century, compared to the 1979–2005 period. The North Atlantic shows a decrease at low to mid latitudes (≈5 to 15%) and an increase at high latitudes (≈10%). The extreme significant wave height in the North Pacific increases at high latitudes by 5 to 10%. The ensemble approach used here allows statistical confidence in projected changes of extremes."

Projected shoreline changes - See IPCC WG2 Impacts

Rivers and deltas at risk - See Water Security

Climate change projections in the sea - See IPCC WG1 Hazards

Climate projections for marine animals - fish - See IPCC WG2 Impacts

Ecological disruption - Trisos - See IPCC WG2 Impacts

Marine richness projections - Molinos - See IPCC WG2 Impacts

Projections in fisheries catches (Free et al. 2020)

Source: Realistic fisheries management reforms could mitigate the impacts of climate change in most countries, Free et al. 2020

Data: via author Chris Free

Maximum sustainable fish yield now and projected in the future with climate change - https://repository.upenn.edu/handle/20.500.14332/59784

Percent difference in mean fisheries catch and profits in 2091–2100 relative to 2012–2021 - https://repository.upenn.edu/handle/20.500.14332/59779

Marine regions v8 (used in paper) downloaded from here.

Format: .csv

Description: "Maximum sustainable yield (MSY) of the evaluated stocks is forecast to decrease by 2.0%, 5.0%, and 18.5% from 2012–2021 to 2091–2100 under RCPs 4.5, 6.0, and 8.5, respectively. Across emissions scenarios, MSY is generally projected to decrease for equatorial countries and increase for poleward countries. Particularly dramatic reductions in MSY are predicted for the equatorial West African countries. Even under the least severe emissions scenario, nineteen countries, fifteen of which are in West Africa, are projected to experience reductions in MSY of 50–100%. The number of countries projected to experience dramatic losses in MSY, and the intensity of these losses, expands under the more severe emissions scenarios. In the most severe scenario, 51 countries are expected to experience reductions in MSY of 50–100%. All eighteen West African countries south of Senegal and north of Angola (including these two countries) are forecast to experience reductions in MSY greater than 85%. The equatorial Indo-Pacific and South America are also projected to experience considerable losses in MSY under the three emissions scenarios, with especially pronounced losses under RCP 8.5. Twenty-two countries are projected to experience increases in MSY under all three emissions scenarios with seven of these countries showing a 15% average increase in MSY across scenarios. The five most consistent and pronounced climate change "winners" are: Finland, Antarctica, Norway (4 EEZs: Norway plus Bouvet Island, Jan Mayen, and Svalbard), Portugal (3 EEZs: Portugal plus Azores and Madeira), and Fiji."

Similar data: Cheung, William, 2023, AR6 SYR Data for Figure SPM.3(c2): Projected changes in maximum catch potential (fisheries yield), MetadataWorks, https://doi.org/10.48490/0f3x-k646

Coral reef area and Risks

Coral reef area by marine ecoregion

Source: The Nature Conservancy

Data: hosted in Data Basin, provided by Nature Conservancy.

Format: shape file, GIS ArcGIS online layer

Description: Area of coral reefs (square kilometers), by marine ecoregion. Citation: Hoekstra, J. M., J. L. Molnar, M. Jennings, C. Revenga, M. D. Spalding, T. M. Boucher, J. C. Robertson, T. J. Heibel, with K. Ellison. 2010. The Atlas of Global Conservation: Changes, Challenges, and Opportunities to Make a Difference. Ed. J. L. Molnar. Berkeley: University of California Press. Percent of reefs at risk by marine ecoregion

Reefs at risk

Source: These data were derived by The Nature Conservancy, and were displayed in a map published in The Atlas of Global Conservation (Hoekstra et al., University of California Press, 2010). More information at http://nature.org/atlas

Data and description: ArcGIS external layer.

Format: GIS layer

Description: Data derived from: Bryant, D., L. Burke, J. McManus, and M. Spalding. 1998. Reefs at Risk: A Map-Based Indicator of Threats to the World's Coral Reefs. Washington, DC: World Resources Institute, International Center for Living Aquatic Resources Management, UNEP World Conservation Monitoring Centre and United Nations Environment Programme. Citation: Hoekstra, J. M., J. L. Molnar, M. Jennings, C. Revenga, M. D. Spalding, T. M. Boucher, J. C. Robertson, T. J. Heibel, with K. Ellison. 2010. The Atlas of Global Conservation: Changes, Challenges, and Opportunities to Make a Difference. Ed. J. L. Molnar. Berkeley: University of California Press. This dataset was used in a scientifically peer-reviewed publication.

Coral bleaching

Source: A new, high-resolution global mass coral bleaching database, Donner et al. 2017

Data: https://figshare.com/projects/Coral_Bleaching_Database_V1/19753

Format: .xlsx

Description: "Episodes of mass coral bleaching have been reported in recent decades and have raised concerns about the future of coral reefs on a warming planet. Despite the efforts to enhance and coordinate coral reef monitoring within and across countries, our knowledge of the geographic extent of mass coral bleaching over the past few decades is incomplete. Existing databases, like ReefBase, are limited by the voluntary nature of contributions, geographical biases in data collection, and the variations in the spatial scale of bleaching reports. In this study, we have developed the first-ever gridded, global-scale historical coral bleaching database. First, we conducted a targeted search for bleaching reports not included in ReefBase by personally contacting scientists and divers conducting monitoring in under-reported locations and by extracting data from the literature. This search increased the number of observed bleaching reports by 79%, from 4146 to 7429. Second, we employed spatial interpolation techniques to develop annual 0.04° × 0.04° latitude-longitude global maps of the probability that bleaching occurred for 1985 through 2010."

Percentage of fisheries economic impact to country GDP

Source: Projected change in global fisheries revenues under climate change, Lam et al. 2016 (Supplementary data)

Data: supplementary data in paper

Format: List

Description: “The GDP of each country in 2010 was obtained from the International Monetary Fund (IMF) (https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx). The total revenue is the current actual landed values obtained from Sea Around Us and Fisheries Economics Research. Then, the percentage of the economic impact by the fisheries sector to the total GDP of a country was computed to represent the dependency of a country’s national economy on fisheries (Table S7).”

Oceans Health Index

GLOBAL OCEAN HEALTH INDEX - external layer
Data can be found here

Food production shocks (Cottrell et al. 2019) - crops, livestock, fisheries, aquaculture - See IPCC WG2 Impacts

Human dependence on marine ecosystems - Selig et al 2018 - See IPCC WG2 Impacts

Vulnerability to climate and fisheries - Blasiak et al 2017 - See IPCC WG2 Impacts

Fisheries benefits at 1.5C (compared to 3.5C)

Source: Large benefits to marine fisheries of meeting the 1.5°C global warming target, Cheung et al. 2016

Data: Fig. 4 data from https://datadryad.org/stash/dataset/doi%253A10.5061%252Fdryad.pq6p2

ΔMCP (maximum catch potential)
FIG4_MAP_benefit_fisheries_at_1_5_shape_SppTurn
ΔSppTurn (sum of local extinction and invasion)
FIG4_MAP_benefit_fisheries_at_1_5_shape
ΔMCP (maximum catch potential)
ΔSppTurn (sum of local extinction and invasion)

Format: list

Description: “Translating the Paris Agreement to limit global warming to 1.5°C above preindustrial level into impact-related targets facilitates communication of the benefits of mitigating climate change to policy-makers and stakeholders. Developing ecologically relevant impact-related targets for marine ecosystem services, such as fisheries, is an important step. Here, we use maximum catch potential (ΔMCP) and species turnover (ΔSppTurn, as the sum of local extinction and invasion) as climate-risk indicators for fisheries. We project that potential catches will decrease by more than 3 million metric tons per degree Celsius of warming. Species turnover is more than halved when warming is lowered from 3.5° to 1.5°C above the preindustrial level. Regionally, changes in maximum catch potential and species turnover vary across ecosystems, with the biggest risk reduction in the Indo-Pacific and Arctic regions when the Paris Agreement target is achieved.
Climate-risk reduction for fisheries is projected to be the largest in tropical oceans under 1.5°C warming, partly because of the avoided local extinction. Countries such as Ecuador, Costa Rica, Ghana, Thailand, the Philippines, and Indonesia, with their exclusive economic zones and fisheries in these large marine ecosystems, will benefit substantially from meeting the Paris Agreement. In contrast, the Arctic Ocean would see an increase in productivity (and catch) under 3.5°C warming as the area becomes ice-free.”

One Shared Ocean

Source and data: http://onesharedocean.org/data

Format: list combined with shape files

Description: Deprecated project. It is not online anymore. It was part of TWAP.

Eutrophication & Hypoxia Map Data Set

Source: World Resources Institute. Diaz, R., M. Selman. and C. Chique. 2011. 'Global Eutrophic and Hypoxic Coastal Systems.' Washington, DC: World Resources Institute. Eutrophication and Hypoxia: Nutrient Pollution in Coastal Waters.

Data: https://www.wri.org/data/eutrophication-hypoxia-map-data-set
Few rows more from Sup. Table 3 here https://www.pnas.org/content/114/14/3660#T3

Format: .xlsx

Description: “The Interactive Map of Eutrophication & Hypoxia represents 762 coastal areas impacted by eutrophication and/or hypoxia. There are 479 sites identified as experiencing hypoxia, 55 sites that once experienced hypoxia but are now improving, and 228 sites that experience other symptoms of eutrophication, including algal blooms, species loss, and impacts to coral reef assemblages. These data were compiled using a literature search conducted by Dr. Robert Diaz of VIMS and WRI staff.”

Plastic waste into the ocean

Source: Plastic waste inputs from land into the ocean, Jambeck et al. 2015

Data: Supplementary data

Format: .xlsx

Description: "Plastic debris in the marine environment is widely documented, but the quantity of plastic entering the ocean from waste generated on land is unknown. By linking worldwide data on solid waste, population density, and economic status, we estimated the mass of land-based plastic waste entering the ocean. We calculate that 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean. Population size and the quality of waste management systems largely determine which countries contribute the greatest mass of uncaptured waste available to become plastic marine debris. Without waste management infrastructure improvements, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025. "

Biodiversity

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=5c0d25358e8b4aaeb24287efcc9ed5d6

Biodiversity priority conservation - Jung et al 2021

Source: Areas of global importance for conserving terrestrial biodiversity, carbon, and water, Jung et al. 2021

Data: All maps available through https://unbiodiversitylab.org/ and on a data repository (https://doi.org/10.5281/zenodo.5006332).

Format: .tif

Description: “Here we present results from a joint optimization that minimizes the number of threatened species, maximizes carbon retention and water quality regulation, and ranks terrestrial conservation priorities globally. We found that selecting the top-ranked 30% and 50% of terrestrial land area would conserve respectively 60.7% and 85.3% of the estimated total carbon stock and 66% and 89.8% of all clean water, in addition to meeting conservation targets for 57.9% and 79% of all species considered.”

Last chance ecosystems

Source: Nature Conservancy - Last chance ecosystems

Data: Last chance ecosystems, Ecosystems Crisis
External visualization:
https://tnc.maps.arcgis.com/apps/View/index.html?appid=6412e531e2ac40b3b29710fa3d8752f8

Format: shape files already in ArcGIS online

Description: “Last Chance Ecosystems bring together multiple, state-of-the-art global assessments developed by TNC and collaborators. The tool can identify the places which, if conserved, will reduce extinction rates and protect the best representations of the least-protected global habitat types, ensuring we move the needle on our goal to conserve the diversity of life on Earth.”

Other biodiversity priority conservation datasets - See Coastal risks

Biomes and ecoregions 2017

Source: An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm, Dinerstein et al. 2017

Data and complementary visualization: Biomes and ecoregions 2017 (under About)

Format: shape files

Description: "This new map offers a depiction of the 846 ecoregions that represent our living planet. Ecoregions are ecosystems of regional extent. These are color coded on this map to highlight their distribution and the biological diversity they represent. This new map is based on recent advances in biogeography - the science concerning the distribution of plants and animals. The original ecoregions map has been widely used since its introduction in 2001, underpinning the most recent analyses of the effects of global climate change on nature by ecologists to the distribution of the world's beetles to modern conservation planning. In the same vein, our updated ecoregions can now be used to chart progress towards achieving the visionary goal of Nature Needs Half, to protect half of all the land on Earth to save a living terrestrial biosphere."

World Terrestrial ecosystems

Source and Data: World terrestrial ecosystems

Format: shape file already in ArcGIS Living Atlas

Description: This map displays the 431 classes of the World Terrestrial Ecosystem dataset developed by USGS, The Nature Conservancy, and Esri

Carbon storage in vegetation - Earthstat

Source: Earthstat

Data: http://www.earthstat.org/carbon-stocks-potential-natural-vegetation/

Format: .tif

Description: Land used for agricultural production presents a tradeoff to society. On one hand, agricultural lands provide essential food, feed, fiber, and increasingly, biofuels. On the other hand, in their natural state, these lands could provide additional important ecosystem services. Many social, political, and economic factors drive land use decisions and the choice to manage for some services at the expense of others. Understanding the tradeoffs among ecosystem services is critical to manage ecosystems for multiple goals. Some tradeoffs connect local actions with global issues. Agricultural practices affect carbon storage, with consequences for greenhouse gasses and climate change. How do we balance the need to expand agricultural production with the need to maintain or even expand ecosystem carbon stocks?
Citation: West, P.C., H.K. Gibbs, C. Monfreda, J. Wagner, C.C. Barford, S.R. Carpenter, and J.A. Foley (2010). Trading carbon for food: Global comparison of carbon stocks vs. crop yields on

agricultural land. Proceedings of the National Academy of Sciences (PNAS) 107(46), 19645–19648. Doi: 10.1073/pnas.101107810

Intact Forest Landscapes

Source: World Wide Fund for Nature

Data: ArcGIS online Image Layer
https://www.arcgis.com/home/item.html?id=c712ad7c068040508fe2b60b20092469

Format: Image Tile

Description: “The Intact Forest Landscapes dataset (IFL) identifies unbroken expanses of natural ecosystems within the zone of forest extent that show no signs of significant human activity and are large enough that all native biodiversity, including viable populations of wide-ranging species, could be maintained.”

Global Forest Fire Analysis - 2000-2020

Source: World Wide Fund for Nature

Data: ArcGIS online Image Layer
https://www.arcgis.com/home/item.html?id=5d9c283c8e5344f194c34254e6f9c07a

Format: Image Tile

Description: “global forest fires.
annual burned area from MODIS fire data
emerging hotspots analysis on FIRMS fire data
Methods: we used Google use and MODIS Fire data to assess forest fire trends over time. ”

Global forest analysis - Forest cover loss

Source: World Wide Fund for Nature

Data: ArcGIS online Image Layer
https://www.arcgis.com/home/item.html?id=ef56ea768f354941ae20e74a4458e37d

Format: Image Tile

Description: To advance our understanding of forest cover changes, given the discrepancies, this work provides an original analysis by assessing five available remote sensing datasets (ALOS PALSAR forest and non-forest data, ESA CCI Land Cover, MODIS IGBP, Hansen/GFW on global tree cover loss, and Terra-I) to estimate the likely extent of current forests (circa 2018) and forest cover loss from 2001-2018, for which data was available.

Deforestation fronts - WWF

Source: World Wide Fund for Nature

Data: ArcGIS online Image Layer
https://www.arcgis.com/home/item.html?id=28ccef7736f0400ba348b831e86052ac

Format: Image Tile

Description: WWF Global Deforestation Fronts based on remote sensing data series from Terra-i for Latin America, Africa, Asia and Oceania for the period from 2004 to 2017.
WWF developed a global analysis of the world's most important deforestation areas or deforestation fronts in 2015. This assessment was revised in 2020 as part of the WWF Deforestation Fronts Report.
See complete description here.

Future effects of climate and land-use change on terrestrial vertebrate community diversity

Source: Future effects of climate and land-use change on terrestrial vertebrate community diversity under different scenarios, Newbold 2018

Data: from author Tim Newbold available here https://doi.org/10.6084/m9.figshare.21408435.v1: "There are separate projections for land-use and climate impacts, under each of the four RCP scenarios. Values represent projected proportional changes, where positive values indicate projected increases in local species richness, and negative values projected decreases. The climate projections are just from the GLM distribution modelling algorithm (as shown in Figure 4 in my paper)."

Format: .tif

Description: "Land-use and climate change are among the greatest threats facing biodiversity, but understanding their combined effects has been hampered by modelling and data limitations, resulting in part from the very different scales at which land-use and climate processes operate. I combine two different modelling paradigms to predict the separate and combined (additive) effects of climate and land-use change on terrestrial vertebrate communities under four different scenarios. I predict that climate-change effects are likely to become a major pressure on biodiversity in the coming decades, probably matching or exceeding the effects of land-use change by 2070. The combined effects of both pressures are predicted to lead to an average cumulative loss of 37.9% of species from vertebrate communities under 'business as usual' (uncertainty ranging from 15.7% to 54.2%). Areas that are predicted to experience the effects of both pressures are concentrated in tropical grasslands and savannahs. The results have important implications for the conservation of biodiversity in future, and for the ability of biodiversity to support important ecosystem functions, upon which humans rely."

Climate change risk in biodiversity hotspots

Source: Endemism increases species' climate change risk in areas of global biodiversity importance, Manes et al. 2021

Data and format:
Here are the database sources where we downloaded the shapefiles from:
Biodiversity hotspots: https://www.cepf.net/our-work/biodiversity-hotspots/hotspots-defined
WWF Global 200: https://databasin.org/datasets/a5b34649cc69417ba52ac8e2dce34c3b/

The values to connect to the shapefiles can be found in the paper's supplementary tables

Description: "Climate change affects life at global scales and across systems but is of special concern in areas that are disproportionately rich in biological diversity and uniqueness. Using a meta-analytical approach, we analysed >8000 risk projections of the projected impact of climate change on 273 areas of exceptional biodiversity, including terrestrial and marine environments. We found that climate change is projected to negatively impact all assessed areas, but endemic species are consistently more adversely impacted. Terrestrial endemics are projected to be 2.7 and 10 times more impacted than non-endemic natives and introduced species respectively, the latter being overall unaffected by climate change. We defined a high risk of extinction as a loss of >80% due to climate change alone. Of endemic species, 34% and 46% in terrestrial and marine ecosystems, and 100% and 84% of island and mountain species were projected to face high extinction risk respectively. A doubling of warming is projected to disproportionately increase extinction risks for endemic and non-endemic native species. Thus, reducing extinction risks requires both adaptation responses in biodiversity rich-spots and enhanced climate change mitigation."

Extinction-risk footprint

Source: Quantifying and categorising national extinction-risk footprints, Irwin et al. 2022

Data from links in paper

Format: excel

Description: “Biodiversity, essential to delivering the ecosystem services that support humanity, is under threat. Projections show that loss of biodiversity, specifically increases in species extinction, is likely to continue without significant intervention. Human activity is the principal driver of this loss, generating direct threats such as habitat loss and indirect threats such as climate change. Often, these threats are induced by consumption of products and services in locations far-removed from the affected species, creating a geographical displacement between cause and effect. Here we quantify and categorise extinction-risk footprints for 188 countries. Seventy-six countries are net importers of extinction-risk footprint, 16 countries are net exporters of extinction-risk footprint, and in 96 countries domestic consumption is the largest contributor to the extinction-risk footprint. These profiles provide insight into the underlying sources of consumption which contribute to species extinction risk, a valuable input to the formulation of interventions aimed at transforming humanity’s interactions with biodiversity.
We adopt the extinction risk of species as a quantifiable representation of biodiversity loss and present the non-normalised Species Threat Abatement and Restoration (nSTAR) metric. Calculated using detailed information from the IUCN Red List of Threatened Species for all threatened and Near Threatened terrestrial birds, mammals, and amphibians, this unit-less metric provides an additive measure of extinction risk which can be aggregated and disaggregated across the three relevant dimensions of species, country, and economic sector. When linked with the 2013 Eora multi-region input–output (MRIO) global supply chain database this metric forms the basis of the consumption extinction-risk footprint, which is further refined to derive imported, exported, and domestic extinction-risk footprints at a country level.
These footprints are identified by considering the role each country serves as both a steward of the biodiversity within its borders, represented in its territorial extinction-risk footprint, and as a consumer of products whose supply chains extend beyond its borders, represented in its consumption extinction-risk footprint. The interplay between these generates a domestic footprint (the impact of a country’s consumption on extinction risk within the country), an exported footprint (the impact of other countries’ consumption on extinction risk within the country), and an imported footprint (the impact of a country’s consumption on extinction risk outside of the country) for each country (Supplementary Note S2). At a global level, or at a total

species level, the territorial extinction-risk footprint and the consumption extinction-risk footprint will be equal."

Irrecoverable carbon

Source: Mapping the irrecoverable carbon in Earth's ecosystems, Noon et al. 2021

Data: https://zenodo.org/record/4091029
Here their representation of data https://irrecoverable.resilienceatlas.org/map
Main page https://www.resilienceatlas.org/

Format: .tif

Description: "Avoiding catastrophic climate change requires rapid decarbonization and improved ecosystem stewardship at a planetary scale. The carbon released through the burning of fossil fuels would take millennia to regenerate on Earth. Though the timeframe of carbon recovery for ecosystems such as peatlands, mangroves and old-growth forests is shorter (centuries), this timeframe still exceeds the time we have remaining to avoid the worst impacts of global warming. There are some natural places that we cannot afford to lose due to their irreplaceable carbon reserves. Here we map 'irrecoverable carbon' globally to identify ecosystem carbon that remains within human purview to manage and, if lost, could not be recovered by mid-century, by when we need to reach net-zero emissions to avoid the worst climate impacts. Since 2010, agriculture, logging and wildfire have caused emissions of at least 4.0 Gt of irrecoverable carbon. The world's remaining 139.1 ± 443.6 Gt of irrecoverable carbon faces risks from land-use conversion and climate change. These risks can be reduced through proactive protection and adaptive management. Currently, 23.0% of irrecoverable carbon is within protected areas and 33.6% is managed by Indigenous peoples and local communities. Half of Earth's irrecoverable carbon is concentrated on just 3.3% of its land, highlighting opportunities for targeted efforts to increase global climate security."
News piece:
https://www.theguardian.com/environment/2021/nov/18/revealed-the-places-humanity-must-not-destroy-to-avoid-climate-chaos?CMP=Share_iOSApp_Other

Natural disasters

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=ed3d0ad500aa4bfd87decd0c264e3ef6

Natural disasters record - GDIS and EM-DAT

Source: GDIS, a global dataset of geocoded disaster locations, Rosvold and Buhaug, 2021

Data: https://sedac.ciesin.columbia.edu/data/set/pend-gdis-1960-2018/data-download (with longitude and latitude)

Format: .csv

Description: “GDIS presents a new open source extension to the Emergency Events Database (EM-DAT) that allows researchers, for the first time, to explore and make use of subnational, geocoded data on major disasters triggered by natural hazards since 1960 until 2018. EM-DAT, maintained by the Centre for Research on the Epidemiology of Disasters (CRED) at the Catholic University of Louvain in Belgium, constitutes a comprehensive and widely used multi-disaster catalogue. A search for the term “EM-DAT” in Google Scholar returns more than 17,000 hits, testimony to its widespread application in academic work. The EM-DAT database records disaster events by country and “location” (i.e., a string variable providing the names of affected provinces, districts, towns, etc.), but the database contains no geographical information that allows easy integration into a geospatial analysis framework.“

Earthquakes record

Sources:
USGS Pager Alerts https://earthquake.usgs.gov/data/pager/
Global Earthquake Model Foundation https://www.globalquakemodel.org/

Data:
Recent earthquakes
Global active earthquake faults

Format: ArcGIS online layers

Description: External authoritative ArcGIS layers that present recent earthquake information from the USGS Prompt Assessment of Global Earthquakes for Response (PAGER) program and from the Global Earthquake Model Foundation.

Air quality recent conditions

Source: Air quality data https://openaq.org/

Data: Recent Conditions in Air Quality (PM2.5) - ESRI layer

Format: ArcGIS online authoritative layer

Description: “Every day activities such as driving, burning coal for electricity, wildfires, running factories, even cooking and cleaning, release particles into the air. Besides being an irritant, small particles of 2.5 micrometers or less (PM2.5) are a health hazard since they can get deep into the respiratory system and damage the delicate tissues. The exposure of populations to high levels of PM2.5 increases the risk of respiratory and cardiovascular illnesses.
The World Health Organization (WHO) guidelines provide long-term and short-term exposure limits to PM2.5: Long-term: 10 µg/m³ annual mean Short-term: 36 µg/m³ 24-hour mean Exposure to PM2.5 above these limits may significantly impact human health.
The source information is the OpenAQ community which reports measured concentrations of PM2.5 (µg/m³) on a global scale by aggregating station data from national networks of air quality. The Recent Conditions in Air Quality (PM2.5) layer is updated every hour using the Aggregated Live Feed (ALF) methodology. It shows the latest PM2.5 value of the stations in the OpenAQ data set with at least one value reported in the past 30 days. Additionally, a Learn ArcGIS lesson is available for implementing one version of the ALF methodology.”

Recent and historical Hurricanes tracks and extra information

Recent hurricanes, cyclones, and typhoons

Source and description: “This layer features tropical storm (hurricanes, typhoons, cyclones) tracks, positions, and observed wind swaths from the past hurricane season for the Atlantic, Pacific, and Indian Basins. These are products from the National Hurricane Center (NHC) and Joint Typhoon Warning Center (JTWC). They are part of an archive of tropical storm data maintained in the International Best Track Archive for Climate Stewardship (IBTrACS) database by the NOAA National Centers for Environmental Information.”

Data: https://www.arcgis.com/home/item.html?id=adfe292a67f8471a9d8230ef93294414

Format: ArcGIS external authoritative layer

Active hurricanes, cyclones, and typhoons

Source and description: “This layer describes the observed path, forecast track, and intensity of tropical cyclone activity (hurricanes, typhoons, cyclones) and is provided by NOAA National Hurricane Center (NHC) for the Central+East Pacific and Atlantic, and the Joint Typhoon

Warning Center for the West+Central Pacific and Indian basins. For more disaster-related live feeds visit the Disaster Web Maps & Feeds ArcGIS Online Group."

Data: https://www.arcgis.com/home/item.html?id=248e7b5827a34b248647afb012c58787

Format: ArcGIS external authoritative layer

Trends in the occurrence of tropical cyclones (Murakami et al. 2020)

Source: Observed trend in the number of tropical cyclones per year from 1980 to 2020, Murakami et al., 2020.

Data: from author Hiroyuki Murakami

Historical trend in the frequency of occurrence of most intense tropical cyclones - https://repository.upenn.edu/handle/20.500.14332/59785
Historical trend in the frequency of occurrence of tropical cyclones - https://repository.upenn.edu/handle/20.500.14332/59781

Format: netCDF

Description: "Owing to the limited length of observed tropical cyclone data and the effects of multidecadal internal variability, it has been a challenge to detect trends in tropical cyclone activity on a global scale. However, there is a distinct spatial pattern of the trends in tropical cyclone frequency of occurrence on a global scale since 1980, with substantial decreases in the southern Indian Ocean and western North Pacific and increases in the North Atlantic and central Pacific. Here, using a suite of high-resolution dynamical model experiments, we show that the observed spatial pattern of trends is very unlikely to be explained entirely by underlying multidecadal internal variability; rather, external forcing such as greenhouse gases, aerosols, and volcanic eruptions likely played an important role. This study demonstrates that a climatic change in terms of the global spatial distribution of tropical cyclones has already emerged in observations and may in part be attributable to the increase in greenhouse gas emissions. Insights: The frequency of tropical cyclone has increased in the Caribbean, and the intensity has increased everywhere - Intense storms (hurricanes) have increased in frequency (Here intense storms are defined as the same as major hurricanes (>=96 kt or >=111 mph in maximum wind speed). In the future, the models show that the intensity and severity of tropical storms is projected to increase but the frequency is projected to decrease". Further information in Carbon Brief

Satellite fire activity

Source: NASA's Earth Science Data

Data: ESRI layer

Format: ArcGIS external authoritative layer

Description: This layer presents detectable thermal activity from VIIRS satellites for the last 7 days. VIIRS Thermal Hotspots and Fire Activity is a product of NASA's Land, Atmosphere Near real-time Capability for EOS (LANCE) Earth Observation Data, part of NASA's Earth Science Data.
Source: NASA LANCE - VNP14IMG_NRT active fire detection - World Scale/Resolution: 375-meter
Update Frequency: Hourly using the aggregated live feed methodology

Standardized Precipitation Index (SPI) Recent Conditions

Source: Climate Hazards Center InfraRed Precipitation with Station data (CHIRPS)

Data: ESRI layer

Format: ArcGIS external authoritative layer

Description: Droughts are natural occurring events in which dry conditions persist over time. Droughts are complex to characterize because they depend on water and energy balances at different temporal and spatial scales. The Standardized Precipitation Index (SPI) is used to analyze meteorological droughts. SPI estimates the deviation of precipitation from the long-term probability function at different temporal periods (e.g. 1, 3, 6, 9, or 12 months). SPI only uses monthly precipitation as an input, which can be helpful for characterizing meteorological droughts. Other variables should be included (e.g. temperature or evapotranspiration) in the characterization of other types of droughts (e.g. agricultural droughts).
This layer shows the SPI index at different temporal periods calculated using the SPEI library in R and precipitation data from CHIRPS data set.

Additional datasets

Global Risk data Platform
MAP: https://preview.grid.unep.ch/index.php?preview=map&lang=eng

Socioeconomic data and applications center (NASA) (hazard mortality risk)

Additional sources: https://ourworldindata.org/natural-disasters

Social and political indices

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=39bfdc937b1e46fb99490bf6a7c36358

Format: In all the cases, the data is given in a text list format (.csv, .xlsx, …)

Conflict

Number of violent deaths per 1 million population

Source and data: Small Arms Survey

Description: The Small Arms Survey tracks statistics on violent deaths and compiles them in its Global Violent Deaths (GVD) database.

Military size by country 2021

Source, data and description: World Population Review

Piracy attacks

Source: Crime at Sea: A Global Database of Maritime Pirate Attacks (1993–2020), Benden et al. 2021

Data: https://zenodo.org/records/4583802

Description: "This dataset contains information from more than 7,500 maritime pirate attacks that took place between January 1993 and December 2020, as well as country indicator data for the same time period. The pirate attack data was collected from the International Maritime Bureau (IMB), tidied, and augmented with geospatial data."

Major episodes political Violence / High casuality terrorist bombings (1989-2021) - Institute for Systemic Peace

Source and data: Institute for Systemic Peace

Description: Major Episodes of Political Violence, 1946-2018 (War List), Annual Set lists annual, cross-national, time-series data on interstate, societal, and communal warfare magnitude scores (independence, interstate, ethnic, and civil; violence and warfare) for all countries

How climate disasters contribute to climate risk (Ide et al. 2020)

Source and data: Multi-method evidence for when and how climate-related disasters contribute to armed conflict risk, Ide et al, 2020

Description: "We show that climate-related disasters increase the risk of armed conflict onset. This link is highly context-dependent and we find that countries with large populations, political exclusion of ethnic groups, and a low level of human development are particularly vulnerable. For such countries, almost one third of all conflict onsets over the 1980- 2016 period have been preceded by a disaster within 7 days. Improved opportunity structures for armed groups to escalate violence in ongoing conflicts is the main mechanism behind this link."
"Furthermore, most research still focuses on whether rather than how disasters increase conflict risks two broad categories of mechanisms are of particular relevance for the disaster-conflict nexus. They can be distinguished as grievance- and opportunity based. Grievances are predominantly linked to the perceptions of socioeconomic and/or political injustices as causes of armed conflict. Several mechanisms can be involved in the creation or intensification of grievances after climate-related disasters. Prominent among them are perceptions of unequal distribution of disaster-related vulnerability, deprivation, relief or reconstruction support. Disaster impacts often reflect if not intensify pre-existing inequalities and make them more acute and/or visible due to the disaster's magnitude. Disaster can also trigger (often temporary) migration flows that can accelerate competition for resources and jobs as well as ethnic animosities in the receiving regions. Opportunities refer to factors that enhance the ability of actors to engage in collective violence. Disasters can, for example, weaken local government structures, both in the affected areas The resulting power vacuum can be exploited by challengers of the government to prepare and start the next offensive one should notice that for a 7 day period, a statistically significant number of about 10% of armed conflict onsets globally have been preceded by hydrological disasters such as floods or storm surges."

Global Terrorism Index

Source: Vision of Humanity

Data: https://www.visionofhumanity.org/public-release-data/

Description: “The Global Terrorism Index provides a comprehensive summary of the key global trends and patterns in terrorism over the last 50 years, placing a special emphasis on trends over the past decade. This period corresponds with the rise and fall of the Islamic State of Iraq and the Levant (ISIL).The GTI report is produced by the Institute for Economics & Peace (IEP) using data from the Global Terrorism Database (GTD) and other sources. Data for the GTD is collected and collated by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland. The GTD contains over 170,000 terrorist incidents for the period 1970 to 2019.”

Major episodes political Violence - Institute for Systemic Peace

Source and data: Institute for Systemic Peace

Description: Major Episodes of Political Violence, 1946-2018 (War List), Annual Set lists annual, cross-national, time-series data on interstate, societal, and communal warfare magnitude scores (independence, interstate, ethnic, and civil; violence and warfare) for all countries

Indices of governability, democracy

Fragile State Index 2020

Source and data: Fragile States Index Database

Description: The Fragile States Index is based on a conflict assessment framework – known as “CAST” – that was developed by FFP nearly a quarter-century ago for assessing the vulnerability of states to collapse. The CAST framework was originally designed to measure this vulnerability and assess how it might affect projects in the field, and continues to be used widely by policy makers, field practitioners, and local community networks. The methodology uses both qualitative and quantitative indicators, relies on public source data, and produces quantifiable results. Twelve conflict risk indicators are used to measure the condition of a state at any given moment. The indicators provide a snapshot in time that can be measured against other snapshots in a time series to determine whether conditions are improving or worsening. Below is the list of indicators used both in the CAST framework and also in the Fragile States Index.

More information: Detailed description of all the indicators

Global Peace Index

Source and data: Vision of Humanity

Description: The Global Peace Index (GPI) ranks 163 independent states and territories according to their level of peacefulness. Produced by the Institute for Economics and Peace (IEP), the GPI is the world's leading measure of global peacefulness.
The GPI covers 99.7% of the world's population, using 23 qualitative and quantitative indicators from highly respected sources, and measures the state of peace across three domains:
– the level of Societal Safety and Security,
– the extent of Ongoing Domestic and International Conflict,
– and the degree of Militarisation.
This year's results (2021) show that the average level of global peacefulness deteriorated by 0.07%.
This is the ninth deterioration in peacefulness in the last thirteen years, with 87 countries improving, and 73 recording deteriorations; however, the change in score is the second smallest in the history of the index.
The 2021 GPI reveals a world in which the conflicts and crises that emerged in the past decade have begun to abate, only to be replaced with a new wave of tension and uncertainty as a result of the COVID-19 pandemic and rising tensions between many of the major powers.

Positive Peace Index

Source and data: Vision of Humanity

Description: This report details the latest findings from IEP's research into Positive Peace, including country rankings and their changes over time.
The report also analyses the relationship between development and Positive Peace, finding that Positive Peace acts as a catalyst for better development outcomes.

Transformation towards democracy index - BTI

Source: Transformation towards democracy index web page

Data: https://bti-project.org/en/index/political-transformation

Maps: Atlas

Description: The Bertelsmann Stiftung's Transformation Index (BTI) analyzes transformation processes toward democracy and a market economy in international comparison and identifies successful strategies for peaceful change.
Results BTI 2020 - More inequality and repression
The quality of democracy, market economy and governance in developing and transformation countries has fallen to its lowest level in 14 years. The Transformation Index shows that

democratic regression, rampant corruption and deepening polarization are interlinked and mutually reinforcing each other in many of the 137 states surveyed.
The BTI 2020 findings record a growing number of countries that are subject to distorted political and economic competition. Government leaders and their associated economic elites are leveraging their positions and privileges to consolidate their power and line their pockets. And while we've always observed this form of patronage-based rule in autocracies, it is increasingly also a feature of democratically elected governments. As a result, we see growing numbers of people being excluded from the political process as the rule of law is hollowed out and opportunities for political participation are curtailed. We also see more people being excluded from economic participation and being subjected to unfair competition and growing social inequality. At the same time, consensus-building and other aspects of governance designed to balance interests are losing ground. Ethnic, religious or regional divisions are often instrumentalized and deepened, which has generated more societal polarization worldwide over the last decade.

Global Freedom - Freedom House

Source:
Freedom House reports
Freedom House Maps

Data: https://freedomhouse.org/reports/publication-archives

Maps on website (with trends):
https://freedomhouse.org/explore-the-map?type=fotn&year=2021

Description:
"Freedom House rates people's access to political rights and civil liberties in 210 countries and territories through its annual Freedom in the World report. Individual freedoms—ranging from the right to vote to freedom of expression and equality before the law—can be affected by state or nonstate actors. Click on a country name below to access the full country narrative report.
Freedom House assesses the level of internet freedom in 70 countries around the world through its annual Freedom on the Net report. Click on a country name below to access the full country narrative report.
Freedom House measures the level of democratic governance in 29 countries from Central Europe to Central Asia through its annual Nations in Transit report. The democracy score incorporates separate ratings on national and local governance, electoral process, independent media, civil society, judicial framework and independence, and corruption. Click on a country name below to access the full country narrative report."

World Press Freedom

Source and data: World Press Freedom Web page

Description: See more here

Polity index

Source and data: Center for Systemic Peace

Description: See the polity indices description here.

Social vulnerability

Ethnic fractionalization

Source and data: GeoEPR 2021 - Geo-referencing Ethnic Power Relations 2021

Data: shape files
Other external layers
2014 GeoEPR from online ArCGIS

Description: The GeoEPR 2021 dataset geo-codes all politically relevant ethnic groups from the EPR-Core 2021 dataset. GeoEPR assignes every politically relevant group one of six settlement patterns and, if possible, provides polygons describing their location on a digital map.

Citations:
Vogt, Manuel, Nils-Christian Bormann, Seraina Rüegger, Lars-Erik Cederman, Philipp Hunziker, and Luc Girardin. 2015. "Integrating Data on Ethnicity, Geography, and Conflict: The Ethnic Power Relations Data Set Family." Journal of Conflict Resolution 59(7): 1327–42.
Wucherpfennig, Julian, Nils B. Weidmann, Luc Girardin, Lars-Erik Cederman, and Andreas Wimmer. 2011. "Politically Relevant Ethnic Groups across Space and Time: Introducing the GeoEPR Dataset." Conflict Management and Peace Science 28(5): 423–37.

Degree of ethnic fractionalization

Source: Drazanova, L., 2020. Introducing the Historical Index of Ethnic Fractionalization (HIEF) Dataset: Accounting for Longitudinal Changes in Ethnic Diversity. Journal of Open Humanities Data

Data:
https://dataverse.harvard.edu/file.xhtml?persistentId=doi:10.7910/DVN/4JQRCL/GZLWGZ&version=2.0

Description: "This paper introduces a new dataset containing an annual ethnic fractionalization index for 162 countries across all continents in the period of 1945–2013. The Historical Index of Ethnic Fractionalization (HIEF) dataset is a natural extension of previous ethnic fractionalization indices. It offers the opportunity to study the effects of ethnic fractionalization across countries and over time. The article concludes by offering some preliminary descriptive analysis of patterns of change in ethnic fractionalization over time."

World Religion Data 2010

Source and data: World Religion Data

Description:
"The World Religion Project (WRP) aims to provide detailed information about religious adherence worldwide from 1945 to 2010. Here we show the data from 2010. It contains data about the number of adherents by religion in each of the states in the international system. The data record percentages of the state's population that practice a given religion. Some of the religions (as detailed in the Codebook) are divided into religious families. To the extent data are available, the breakdown of adherents within a given religion into religious families is also specified in the Codebook."
Citation:
Zeev Maoz and Errol A. Henderson. 2013. "The World Religion Dataset, 1945-2010: Logic, Estimates, and Trends." International Interactions, 39: 265-291.

Global social progress index

Source and data: ArcGIS Online
from Social Progress web page

Description
"The Global Social Progress Imperative defines "social progress" as the capacity of a society to meet the basic human needs of its citizens, establish the building blocks that allow citizens and communities to enhance and sustain the quality of their lives, and create the conditions for all individuals to reach their full potential. Inclusive growth requires achieving both economic and social progress. The Social Progress Index measures social progress strictly using outcomes of success, not how much effort a country or community makes. For example, how much a country spends on healthcare is much less important than the health and wellness actually achieved by that country, which is what outcomes measure. The image below shows the component-level

structure of the 2017 Social Progress Index, which has 12 components (shown) and 50 indicators (not shown). This layer has been time-enabled and contains data for 2014 - 2017. View the European Union Regional Social Progress Index here.To learn more about the Social Progress Index, visit the website and view the FAQs. This service is not endorsed by the Social Progress Imperative."

Social vulnerability - Social Unrest - Poverty - Miscellaneous

Main Sources**:**
World Bank https://data.worldbank.org/indicator
Our World in Data https://ourworldindata.org/ (poverty and human rights)

Information for each layer:

Share of labor force dependent on agriculture (Our World in Data)

Population living in areas where elevation is below 5 meters (% of total population) (World Bank)

Share of population extreme poverty (Our World in Data) - poverty headcount ratio at $1.90 day

Agricultural land (% of land area) (World Bank)

Agricultural irrigated land (% of total agricultural land) (World Bank)

Human development index by UN (WorldBank)
The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. Measured by: Life expectancy at birth, Mean years of schooling & Expected years of schooling, GNI per capita (in PPP adjusted international-$)

Share multipoverty (Our World in Data) - Multidimensional poverty index is defined as being deprived in a range of health, education and living standards indicators. The MPI is a measure that reflects both the prevalence and the intensity of multidimensional poverty.

Human rights violations 2014 (Our World in Data, older version)

Access to electricity (% of population) (World Bank)

Share expenditure in food (Our World in Data)

GINI index 2019 (measures inequality) (ArcGIS external layer) (original from World Bank)

Population vulnerability (subnational level)

Source: Spatial Data Repository, The Demographic and Health Surveys Program.

Description: "The Spatial Data Repository provides geographically-linked health and demographic data from The DHS Program and the U.S. Census Bureau for mapping in a geographic information system (GIS)." Information for most global south countries, but not all of them.

Migration - Internally displaced people due to conflict/disaster

Source: Internal displacement organisation

Data: UNHCR Refugee Statistics Internally displaced people 2020
https://www.internal-displacement.org/database/displacement-data (internal displacement due to conflict or disaster)

Description: see the report
We have plotted separately the internal displacements due to natural disasters (mostly water-related) and the ones due to conflict. The new displacements in 2020 are mostly due to disasters across the world, although conflict dominates displacements in most regions in Africa. When we look at the total number of internal displacements, conflict still dominates as a main cause for displacements, but this trend is changing.

Migration - Migration stocks and trends

Source: Migration data portal

Data and description: Downloaded data from here to show:
Table 3 International migrant stock as a percentage of the total population, both sexes combined
Table 5: Annual rate of change of the migrant stock by sex and by region, country or area of destination, 1990-2020 (percentage)
Table 6: Estimated refugee stock (including asylum seekers) at mid-year by region, country or area of destination, 1990-2020

Migration - UNHCR - Refugees, internally displaced people

Source: Operational Data Portal UNHCR

Maps: https://unhcr.maps.arcgis.com/apps/webappviewer/index.html?id=2028db44801d43fe8eb49321eea19285

Economic vulnerability

World Economic Outlook Database - WEO

Source: World Economic Outlook Database

Data: WEO 2020 Database 2007-2020
Tip: It is better to download it by queries (by countries, select all)…
Here one can find the full database

Description: "The World Economic Outlook (WEO) database contains selected macroeconomic data series from the statistical appendix of the World Economic Outlook report, which presents the IMF staff's analysis and projections of economic developments at the global level, in major country groups and in many individual countries. The WEO is released in April and September/October each year."

World Inequality Database

Source: World Inequality Database

Description: "The World Inequality Database aims to provide open and convenient access to the most extensive available database on the historical evolution of the world distribution of income and wealth, both within countries and between countries."

Global Health Security Index

Source: 2021 GHS Index

Data: https://www.ghsindex.org/report-model/

Description: "The 2021 GHS Index measures the capacities of 195 countries to prepare for epidemics and pandemics. All countries remain dangerously unprepared for future epidemic and pandemic threats, including threats potentially more devastating than COVID-19. Read the report's findings and recommendations, explore the data, view the country rankings, and learn more about the GHS Index."

Food insecurity - Global report on food crises 2021

Source and data:
Fight food crises http://www.fightfoodcrises.net/
Food security information platform
Other visuals:
Data Viz
Hunger Map

Description: The Global Network Against Food Crises (GNAFC) is an alliance of humanitarian and development actors united by the commitment to tackle the root causes of food crises and promote sustainable solutions through shared analysis and knowledge, strengthened coordination in evidence-based responses and collective efforts across the Humanitarian, Development and Peace (HDP) nexus. We publish reports such as the Global Report on Food Crises, Hunger Hotspots and others available in our Resources section. We also organize events addressing food insecurity, and its root causes in climate, conflict and economic factors.

Additionally: World Food Program Offices (external ArcGIS layer)

Environmental risk indices

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=3984b30324904cf8b80264b8d2ca5a5c

ND-GAIN Country Index

Source and data: ND-Gain web page

Description: “The ND-GAIN Country Index is a measurement tool that helps governments, businesses and communities examine risks exacerbated by climate change, such as over-crowding, food insecurity, inadequate infrastructure, and civil conflicts by Notre Dame. The ND-GAIN Country Index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. It aims to help governments, businesses and communities better prioritize investments for a more efficient response to the immediate global challenges ahead.”

Description index: ND-GAIN measures both of these dimensions: vulnerability and readiness. ND-GAIN's framework breaks the measure of vulnerability into exposure, sensitivity and adaptive capacity, and the measure of readiness into economic, governance and social components.

Vulnerability: Propensity or predisposition of human societies to be negatively impacted by climate hazards. ND-GAIN assesses the vulnerability of a country by considering six life-supporting sectors: food, water, health, ecosystem services, human habitat and infrastructure. Each sector is in turn represented by six indicators that represent three cross-cutting components: the exposure of the sector to climate-related or climate-exacerbated hazards; the sensitivity of that sector to the impacts of the hazard and the adaptive fcapacity of the sector to cope or adapt to these impacts.

Readiness: Readiness to make effective use of investments for adaptation actions thanks to a safe and efficient business environment. ND-GAIN measures readiness by considering a country's ability to leverage investments to adaptation actions. ND-GAIN measures overall readiness by considering three components: economic readiness, governance readiness and social readiness.
More info in their paper here.

INFORM Risk and Severity Index 2022

Source and data: Inform Index
Maps online

Description: "The INFORM Risk Index is a global, open-source risk assessment for humanitarian crises and disasters. It can support decisions about prevention, preparedness and response. The INFORM Risk Index simplifies a lot of information about risk. It uses 80 different indicators to measure hazards and peoples' exposure to them, vulnerability, and the resources available to help people cope.
The INFORM Severity Index is a composite indicator designed to measure the severity of humanitarian crises globally, against a common scale. It aggregates data from various sources to categorise all crises into five levels of severity. We show here the aggregate over countries. If a country has more than one crisis, the index shows an average of all the crisis."

World Risk Index 2020

Source and data: Welt Risiko Bericht

Description: “Every year millions of people worldwide suffer from disasters in the aftermath of extreme natural events. But whether it be earthquakes, storms or floods, the risk of a natural event turning into a disaster only partly depends on the force of the natural event itself. The framework conditions of a society and the structures in place to respond quickly and to provide assistance in the event of emergency are just as significant. The more fragile the infrastructure network, the greater the extent of extreme poverty and inequality and the worse the access to the public health system, the more susceptible a society is to natural events. Extreme natural events cannot be prevented directly, but countries can reduce disaster risk by fighting poverty and hunger, strengthening education and health, and taking preparedness measures. Those who build earthquake-proof buildings, install and use early warning systems and invest in climate and environmental protection, are better prepared against extreme natural events.
The annual editions focus on a main topic and include the WorldRiskIndex. Since 2018 the report is published in cooperation with the Institute for International Law of Peace and Armed Conflict (IFHV) of the Ruhr-University Bochum. The WorldRiskReport should contribute to look at the links between natural events, climate change, development and preparedness at a global level and to draw future-oriented conclusions regarding relief measures, policies and reporting.”

Ecological Threat Index (Score)

Source and data: Vision of Humanity Ecological Threat Index

Description: “The report assesses threats relating to food risk, water risk, rapid population growth, temperature anomalies and natural disasters. These assessments are then combined with national measures of socio- economic resilience to determine which countries have the most severe threats and lowest coping capabilities.”

Ecological footprint

Source: Footprint network

Data: https://www.footprintnetwork.org/licenses/public-data-package-free/
See some of the data also here https://data.footprintnetwork.org/#/

Description: “The Ecological Footprint is derived by tracking how much biologically productive area it takes to provide for all the competing demands of people. These demands include space for food growing, fiber production, timber regeneration, absorption of carbon dioxide emissions from fossil fuel burning, and accommodating built infrastructure. A country’s consumption is calculated by adding imports to and subtracting exports from its national production. All commodities carry with them an embedded amount of bioproductive land and sea area necessary to produce them and sequester the associated waste. International trade flows can

thus be seen as flows of embedded Ecological Footprint. The Ecological Footprint uses yields of primary products (from cropland, forest, grazing land and fisheries) to calculate the area necessary to support a given activity. Biocapacity is measured by calculating the amount of biologically productive land and sea area available to provide the resources a population consumes and to absorb its wastes, given current technology and management practices. To make biocapacity comparable across space and time, areas are adjusted proportionally to their biological productivity. These adjusted areas are expressed in “global hectares”. Countries differ in the productivity of their ecosystems, and this is reflected in the Accounts.
A country has an ecological reserve if its Footprint is smaller than its biocapacity; otherwise it is operating with an ecological deficit.”

Material Footprint

Source data: https://wesr.unep.org/indicator/index/12_2_1

Description: “Material Footprint (MF) is the attribution of global material extraction to domestic final demand of a country. The total MF is the sum of the material footprint for biomass, fossil fuels, metal ores and non-metal ores. This indicator is calculated as raw material equivalent of imports (RMEIM) plus domestic extraction (DE) minus raw material equivalents of exports (RMEEX). Multi-regional input-output (MRIO) framework is employed for the attribution of the primary material needs of final global demand.”
The material footprint index is used as part of the Sustainable Development Goal (SDG) 12 - Ensure sustainable consumption and production patterns
It is the indicator SDG 12.2.1

Further information:
Assessing Global Resource Use Report
https://unstats.un.org/sdgs/report/2020/goal-12/
The material footprint of nations, Wiedman et al. 2015

A good life for all within planetary boundaries

Source: A good life for all within planetary boundaries, O'Neill et al. 2018

Data: https://goodlife.leeds.ac.uk/

Description: “Humanity faces the challenge of how to achieve a high quality of life for over 7 billion people without destabilizing critical planetary processes. Using indicators designed to measure a ‘safe and just’ development space, we quantify the resource use associated with meeting basic human needs, and compare this to downscaled planetary boundaries for over

150 nations. We find that no country meets basic needs for its citizens at a globally sustainable level of resource use. Physical needs such as nutrition, sanitation, access to electricity and the elimination of extreme poverty could likely be met for all people without transgressing planetary boundaries. However, the universal achievement of more qualitative goals (for example, high life satisfaction) would require a level of resource use that is 2–6 times the sustainable level, based on current relationships. Strategies to improve physical and social provisioning systems, with a focus on sufficiency and equity, have the potential to move nations towards sustainability, but the challenge remains substantial."

Trends in social shortfall and ecological overshoot

Source: The social shortfall and ecological overshoot of nations, Fanning et al. 2022

Data: https://goodlife.leeds.ac.uk/

Description: "Using the doughnut-shaped 'safe and just space' framework, we analyse the historical dynamics of 11 social indicators and 6 biophysical indicators across more than 140 countries from 1992 to 2015. We find that countries tend to transgress biophysical boundaries faster than they achieve social thresholds. The number of countries overshooting biophysical boundaries increased over the period from 32–55% to 50–66%, depending on the indicator. At the same time, the number of countries achieving social thresholds increased for five social indicators (in particular life expectancy and educational enrolment), decreased for two indicators (social support and equality) and showed little change for the remaining four indicators. We also calculate 'business-as-usual' projections to 2050, which suggest deep transformations are needed to safeguard human and planetary health. Current trends will only deepen the ecological crisis while failing to eliminate social shortfalls."

Global Atlas of Environmental Justice

Source: Environmental Justice Atlas

Data: ArcGIS external layer
https://www.arcgis.com/home/item.html?id=2bfd5b9f206d496cbcce2a862f5a2887

Description: "The Global Environmental Justice Atlas (EJAtlas) documents and catalogues social conflicts around environmental issues. It is an online interactive platform coordinated and managed by a team of researchers and activists. The content and data are the result of the work of hundreds of collaborators across the world who tell their own stories of resistance or write about what they witness."

Citations:
Temper, L., Del Bene, D., & Martinez-Alier, J. (2015). Mapping the frontiers and front lines of global environmental justice: the EJAtlas. Journal of Political Ecology, 22(1), 255-278. https://doi.org/10.2458/v22i1.21108
Scheidel, A., et al. "Environmental conflicts and defenders: a global overview." Global Environmental Change 63 (2020): 102104; https://doi.org/10.1016/j.gloenvcha.2020.102104

Geography, population, and infrastructure

ArcGIS online list of layers (Web Map)
https://www.arcgis.com/home/item.html?id=1a38c1f489ee4d839ceba04f6640c87b

Infrastructure

Quality infrastructure - Global Competitiveness Index (World Economic Forum) This indicator is calculated by the World Economic Forum by aggregating eight indicators that measure roads, railroads, air transport and water transport infrastructure. For more information, write to gcp@weforum.org.

World Ports Index - Data from Maritime Safety Information (version January 2024)

Global shipping routes ArcGIS layer Cumulative commercial shipping activity in the twelve months beginning October 2004. Data taken from the NCEAS report A Global Map of Human Impacts to Marine Ecosystems.

Global roads ArcGIS layer The data set combines the best available roads data by country into a global roads coverage, using the UN Spatial Data Infrastructure Transport (UNSDI-T) version 2 as a common data model.

Global Power Lines from OpenStreetMap Powerlines extracted from OpenStreetMaps in September 2021 by Pablo Izquierdo, WWF-Norway.

Global Railways from OpenStreetMap Railways extracted from OpenStreetMaps in September 2021 by Pablo Izquierdo, WWF-Norway.

Global Optical Fiber Network Cables shown on include international submarine cables with a maximum upgradeable capacity of at least 5 Gbps, by World Wide Fund for Nature - Norway

Global Airline Routes

A visualization of global airline routes, based on data from openflights.org

Internet users ArcGIS layer. Data Sources: International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates via World Bank DataBank; Natural Earth 50M scale data.

Earth at night 2016 This layer presents a nighttime view of the Earth that provides an informational and educational view of our planet at night. For more information, please visit the NASA website, and view a list of available imagery products.

Megacities

Source, data: 30 Megacities from UN Data (Urban Agglomerations - Population Dynamics UN, File 11b)

Description: File 11b: Time Series of the Population of the 30 Largest Urban Agglomerations in 2018 Ranked by Population Size, 1950-2035

Built-up area

See here

City growth projections

Source: Population predictions for the world's largest cities in the 21st century, Hoornweg and Pope, 2016

Data: The supplementary text has tables with data. Note that it always refers to the 100 most populous cities, and this list might change depending on the year of the projection.

Description: "We project populations to 2100 for the world's larger cities. Three socioeconomic scenarios with various levels of sustainability and global cooperation are evaluated, and individual "best fit" projections made for each city using global urbanization forecasts. In 2010, 757 million people resided in the 101 largest cities – 11 per cent of the world's population. By the end of the century, world population is projected to range from 6.9 billion to 13.1 billion, with 15 per cent to 23 per cent of people residing in the 101 largest cities (1.6 billion to 2.3 billion). The disparate effects of socioeconomic pathways on regional distribution of the world's 101 largest cities in the 21st century are examined by changes in population rank for 2010, 2025, 2050, 2075 and 2100. Socioeconomic pathways are assessed based on their influence on the world's largest cities. Two aspects of the projections raise concerns about reliability: the unlikely degree of growth of cities suggested for Africa and the growth of cities in coastal settings (and likely global immigration). Trends and the effect of sustainable development on regional distribution of large cities throughout the 21st century are discussed."

Energy

Electricity reliability index from Global Competitiveness Index - World Economic Forum
How reliable is the electricity supply (lack of interruptions and lack of voltage fluctuations

Oil consumption, production, subsidies from Our World in Data

- Annual change in oil consumption - Our World in Data
- Oil production by country - Our World in Data
- Fossil fuel subsidies - Our World in Data
- Oil consumption per capita - Our World in Data

Global power plants ArcGIS layer - This layer contains over 28,000 power plant locations in 164 countries around the globe. This layer was created by the World Resources Institute and was last updated June 2018. The dataset is updated by the World Resources Institute every 4 to 6 months. For more information, please contact Aaron Kressig at aaron.kressig@wri.org

Global nuclear plants ArcGIS layer - Map provides information about nuclear power plants in the world. The layer has been created by utilizing data available on Wikipedia page List of nuclear power stations. Not currently in the Atlas as it is only for ArcGIS online subscribers.

Undiscovered oil and gas resources ArcGIS layer WEP_AU represents boundaries for the Assessment Units drawn by the U.S.G.S. World Petroleum Resources Assessment Project, 2009-2011, by WWF

Global oil and gas features ArcGIS layer - This data was downloaded as a File Geodatabse from EDX at https://edx.netl.doe.gov/dataset/global-oil-gas-features-database. This data was developed using a combination of big data computing, custom search and data integration algorithms, and expert driven search to collect open oil and gas data resources worldwide. This approach identified over 380 data sets and integrated more than 4.8 million features into the GOGI database.

Global distribution of mines USGS ArcGIS layer - The data (https://doi.org/10.5066/F7GH9GQR) represent the global distribution of selected critical mineral resources in mines, deposits, districts, and regions as of 2017. These data complement the report by Schulz and others (2017) which provides national and global information on 23 critical minerals

Global active mineral mines (non-US) - Mineral facilities and operations outside the United States compiled by the National Minerals Information Center of the USGS.

World heritage sites - UNESCO

Source and data: https://whc.unesco.org/en/interactive-map/

Description: World Heritage Sites are cultural and/or natural sites considered to be of 'Outstanding Universal Value', which have been inscribed on the World Heritage List by the World Heritage Committee.

Population

Population projections UCAR

Source and data: Spatial Population Scenarios Downloads

Format: .tif or .netcdf

Description: “The projected size and spatial distribution of future population are important drivers of global change and key determinants of exposure and vulnerability to hazards. Researchers from NCAR’s IAM group and the City University of New York Institute for Demographic Research developed a new set of global, spatially explicit population scenarios that are consistent with the new Shared Socioeconomic Pathways (SSPs). The SSPs describe alternative future pathways of societal change that were developed to facilitate global change research. The spatial population scenarios cover the period 2010-2100 in ten-year time steps. The projections were initially made at a spatial resolution of 1/8-degree, and were later downscaled to 1-km resolution. Read more about the scenarios in the Environmental Research Letters paper “Spatially explicit global population scenarios consistent with the Shared Socioeconomic Pathways” (http://dx.doi.org/10.1088/1748-9326/11/8/084003).

Country-based:

Population structure - median age - Our World in Data - The median age provides an important single indicator of the age distribution of a population. It provides the age 'midpoint' of a population; there are the same number of people who are older than the median age as there are younger than it.

Projected population to 2100, millions population 2020: Projected population from Gap Minder excel file (used the sheet 'organized by columns') which is compilation of UN data (2020 to 2100)

Natural population growth 2020 -Our World in Data - Natural population growth is the population increase determined by births and deaths. Migration flows are not taken into account. Future projections are based on the UNmedium-fertility scenario.

Format: list

Elevation

Elevation (NOAA) ArcGIS layer - An image service providing access to bathymetric/topographic digital elevation models stewarded at NOAA's National Centers for Environmental Information.

Lidar elevation- sea level vulnerability

Source: Global LiDAR land elevation data reveal greatest sea-level rise vulnerability in the tropics. Hooijer & Vernimmen, 2021

Data: https://data.mendeley.com/datasets/v5x4vpnzds/1
Other data and visualization on sea level rise: CoastalDEM 90 m from Climate Central, https://coastal.climatecentral.org/

Format: .tif

Description: “Coastal flood risk assessments require accurate land elevation data. Those to date existed only for limited parts of the world, which has resulted in high uncertainty in projections of land area at risk of sea-level rise (SLR). Here we have applied the first global elevation model derived from satellite LiDAR data.”

Administrative Areas

Source: GADM

Data: https://gadm.org/download_country.html

Note: It is best to download country by country. The full shape file is too big for ArcGIS online to handle. Until now, we have Pakistan, India, Afghanistan, and Iran.

Format: shape files

Description: “GADM wants to map the administrative areas of all countries, at all levels of sub-division. We provide data at high spatial resolutions that includes an extensive set of attributes.”

Multilateral agreements and disputes maps Lega Carta:

Source: https://legacarta.intracen.org/

Data: https://legacarta.intracen.org/countries/ (Indicator is average rate of ratification of multilateral trade instruments in a given country)
Here all the treaties https://legacarta.intracen.org/instruments/ (go under Instruments Tab)

Description: “LegaCarta is a multilingual Web-based tool that provides information on over 300 multilateral trade treaties and instruments most relevant to trade. Designed to assist primarily policy makers and trade promotion organisations in optimising their country´s legal framework on international trade by integrating trade into development strategies, it is a comprehensive tool that can also be used by researchers, analysts and international law and trade students.
LegaCarta helps decision-makers (public/private) understand how key multilateral trade conventions and model laws impact on the national legal environment and assists them in making informed decisions in terms of ratification/adhesion. It operates within ITC’s strategic objective of supporting policymakers in integrating the business sector into the global economy.
LegaCarta covers key trade multilateral conventions in a broad range of issues such as contracts, customs, dispute resolution, environment, finance, illicit trade, intellectual property, investment, transport and telecommunications. It includes over 300 legal maps, full text of 244 multilateral trade instruments, explanatory notes for each instrument, updated tables of ratifications and with subscription, country analysis profiles and technical assistance.
The International Trade Centre (ITC), is a joint agency of the United Nations and the World Trade Organization (WTO) for operational, enterprise-oriented aspects of trade. ITC supports developing and transition economies, and particularly their business sector, in their efforts to realise their full potential for developing exports and improving import operations. To this end, it cooperates with other relevant agencies inside and outside the UN system, building upon each other’s comparative advantages and “best practices”.
Providing access to a core group of some 250 multilateral trade instruments with references to approximately 450 amendments and protocols, in addition to legal maps, ratification tables, accession statistics and country analysis and technical assistance tools, LegaCarta offers

national authorities, trade promotion organisations, private sector organisations and educational institutions a truly global picture of the multilateral rules that impact trade."

External datasets - visualizations

https://experience.arcgis.com/experience/8bacbb10ee82480a9dfb3198f5a1d160/page/Links-to-External-maps/

(* if the database is included in this Atlas)

Risk and vulnerability to climate change and environmental degradation

*IPCC 6th Assessment Report (WG1 Physical Science Basis) and Interactive Atlas 2022 - Climate projections for temperature and precipitation
*IPCC 6th Assessment Report (WG2 Impacts, Adaptation, and Vulnerability to Climate Change) 2022 - Climate impacts on societies, economies, countries, and sectors such as health, food, water, and biodiversity
World Environment Situation Room (UN) - Climate, biodiversity, pollution, risk
World Research Institute Data Platforms - Climate, security, water, energy, indigenous lands, resources, forests
Resilience & Preparedness - Risk, vulnerability, and exposure to climate change and biodiversity loss
Resource Watch (World Resources Institute) - Food and agriculture, energy, forests, water, cities, climate, society + Data and Visualizations
Resilience Atlas (Conservation International) - Key stressors and shocks affecting rural livelihoods, production systems, and ecosystems in the Sahel, Horn of Africa and South and Southeast Asia
Our World in Data - Country data on poverty, disease, hunger, climate change, war, existential risks, and inequality
SDG Tracker and SDGs Today- Measuring progress towards de Sustainable Development Goals
NASA Earth Observatory - Global Maps of chlorophyll, radiation, clouds, vegetation, fires, ...
SEDAC (Socio-economic Data and Applications Center) Map Viewer

Climate impacts

World Environment Situation Room - Climate Change (UN)

Probable futures - Heat, precipitation, drought, humidity, and wet-bulb temperature climate change projections (CORDEX HD models)
Aqueduct (World Resources Institute) - Observed and projected risk of drought, flood, and food security
*Climate Impact Map - Climate Mortality and Energy costs
Attributing extreme weather to climate change (Carbon Brief) - How climate change affects extreme weather around the world
World Atlas of Desertification (European Commission) - Convergence of global change issues on land degradation
Global drought observatory (European Commission and Copernicus) - Risk of drought impact for agriculture
Climate change impacts in Europe (European Environment Agency)
Climate Watch - Information on countries' climate progress.
Climate TRACE - Greenhouse gas emissions by sector

Food security

Hunger Map (World Food Program) - Current prevalence of undernutrition, hazards, conflict
Famine Early Warning Systems Network (USAIDS) - Acute food insecurity alerts in the short- and mid-term
GADAS Global Agricultural and Disaster Assessment System - Vegetation index, crop condition, agricultural lands, land cover, weather, disasters, infrastructure, population
Crop Explorer (US Dept of Agriculture) - Distribution of grains, oilseeds, and cotton
Hand-in-Hand (FAO) - Food security, crops and vegetation, livestock, trade and production, land, water, climate, fishery, forestry. More info here.
The RaPP Map (http://map.geo-rapp.org/) (Group on Earth Observations Global Agricultural Monitoring)- Time series data on vegetation and environmental conditions (relevant to rangeland and pasture productivity)
SoilGrids - Soil physical and chemical properties, soil classification
GloSIS Global Soil Information System (FAO) - Soil Maps
HIstoric Land Dynamics Assessment + (HILDA +) (http://hilda.plus/hildaplus_map.html) - Data-driven reconstruction of global land use/cover change (forestry and crops) from 1960 to 2019 (more info)
The FABIO Sankey Tool - Visualization of the global supply chains of a wide range of agricultural products from the producing to the consuming country
OneSoil - AI-detected fields and crops (not fully available to the public now)

Water security

Water Peace and Security - Current and predicted water conflicts
MERIT Hydro Visualisation - River width, river channel, and terrain (elevation and hand, height above the nearest drainage) to determine flood risk
Deltares Aqua Monitor - Surface water changes (1985-2016) - Locations where water turned into land (accretion, land reclamation, droughts) and land turned into water (erosion, reservoir construction)
*Global Dam Watch - Information related to dams
Free-flowing river status (WWF) - State of world's rivers
Aqueduct (WRI) - Risk of drought, flood, and food security now and projected into the future
Blue Earth Data (Deltares) - Flooding, Coastal Management and Offshore themes relevant to oceans and freshwater
Water balance (Living Atlas, ESRI) - Water balance change over time
*World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP) - Compilation of groundwater data from national, regional and global sources
Water Conflict Chronology - Location of historical water conflicts
World Environment Situation Room - Water - Maps on freshwater
*EarthStat - Agriculture, Irrigation Data
*Transboundary Waters Assessment Programme (TWAP) (http://geftwap.org/data-portal) - River Basins, Lakes, Groundwater, Open Ocean
*Rivers in Crisis - Threats to Human Water Security and River Biodiversity - agricultural runoff, pollution, invasive species
*Deltas at Risk - Deltas at risk due to sea-level rise and anthropogenic drivers of land subsidence
Delft-FEWS: flood forecasting in the future (Deltares) - A Flood forecasting and Early Warning System Tool

Health

Lancet countdown - Tracking progress on health and climate change
*Global Health Security (GHS) Index - Preparedness for epidemics and pandemics
Institute for Health Metrics and Evaluation - Multiple health data (Anemia, stunting, ...)
State of Global Air - Air pollution and health in Cities
IQAir - Air Quality
World Air Quality Index Project
Quantifying the human cost of global warming, Lenton et al. 2023 (Nature)

Biodiversity

UN Biodiversity Lab
Nature Map Explorer - Maps on biodiversity, conservation areas, ecosystems services, including carbon uptake, and human impacts
Ecological tapestry (Living Atlas, ESRI) - Definition of terrestrial ecosystems, bioclimate, landform, geology, and land cover
Ecoregions - depiction of the 846 ecoregions that represent our living planet
Esri Landsat Satellite Map - Planet's geology, vegetation, agriculture, and cities
Global Forest Watch - Tree cover loss, deforestation
EarthEnv - Global, remote-sensing supported environmental layers for assessing status and trends in biodiversity, ecosystems, and climate
Last chance ecosystems (The Nature Conservancy) - Maps showing ecosystems crisis and last opportunities to protect the diversity of global ecosystems and the last-chance places to reduce the extinction risk for mammal species
Forest restoration potential (Crowther Lab) - Forest restoration potential
World Environment Situation Room - Mountains
*Irrecoverable carbon (Noon et al. 2021) - Areas of high irrecoverable carbon and biodiversity
*The projected timing of abrupt ecological disruption from climate change (Trisos, Merow, Pigot 2020) - Percent of native species at each location projected to be exposed to potentially dangerous climate conditions this century
The Open Timber Portal (WRI) - Tool to incentivize the production and trade of legal timber

Coastal risks

Global fishing effort - Vessel-based human activity at sea, Apparent fishing effort (hours per km2)
Coastal futures (IHE Delft) - Sea level change, extreme sea level rise, coastal flooding, shoreline change, extreme waves
Long-term shoreline changes (TU Delft) - Erosion/accretion along coasts
Sea level risk (Climate Central) - Maps to assess sea level rise risk
*Sea Around Us - Fisheries-related data
Mapping Ocean Wealth Explorer (Nature Conservancy) - Compilation of maps relevant to ocean protection (ecosystems, coastal protection, carbon sequestration, tourism...)
World Environment Situation Room - Ocean, Seas, and Coasts - Biogeochemistry of the oceans
Blue Earth Data (Deltares) - Flooding, Coastal Management and Offshore themes relevant to oceans and freshwater
Global Wastewater (http://www.globalwastewatermodel.com/webmap.html) (Halpern Lab) - Nitrogen sources (grams/year)

AquaMaps (FishBase and SeaLife Base) - Standardized distribution maps for over 33,500 species of fishes, marine mammals and invertebrates
Bio-ORACLE - Geophysical, biotic and environmental data for surface and benthic marine realms

Natural hazards

World Environment Situation Room - Risks - Fires, volcanoes, tsunamis, floods, landslides, earthquakes, tropical cyclones, multi-hazards
earth.nullschool.net - A visualization of global weather conditions forecast by supercomputers updated every three hours

Risk & vulnerability to climate change and other planetary boundaries

*ND-GAIN Country Index (Notre Dame) - Risks exacerbated by climate change, such as over-crowding, food insecurity, inadequate infrastructure, and civil conflicts
*INFORM Risk Index - Risk assessment for humanitarian crises and disasters
*World Risk Report - Disaster risk from extreme natural events and negative climate change impacts
*A good life for all within planetary boundaries - Countries level of basic needs and transgression of environmental limits
*Ecological Footprint (Global footprint Network) - A measure of how much area of biologically productive land and water a country requires to produce all the resources it consumes and to absorb the waste it generates
*Ecological Threat Register (Vision of Humanity) - A composite index measuring the impact of ecological threats based on food security, natural disasters, population growth, and water risk
*EJAtlas- The environmental justice atlas documents and catalogues social conflict around environmental issues
The land matrix - The Land Matrix was established to address the lack of transparency and information of large-scale land acquisitions (LSLAs)
LandMark - Global Platform of Indigenous and Community Lands

Socio-economic and political vulnerability

v-Dem (Democracy Index) - Policy-relevant indices to measure democracy
*Fragile States Index (Fund for Peace) - Countries fragility to conflict risk

*Global Peace Index, Global Terrorism Index (Vision of Humanity) - The Global Peace index measures the level of Societal Safety and Security, the extent of Ongoing Domestic and International Conflict, and the degree of Militarisation. The Global Terrorism Index (GTI) is a comprehensive study analysing the impact of terrorism.
*BTI Transformation Index - Analysis of transformation processes toward democracy and a market economy + Atlas
*The Armed Conflict Location & Event Data Project - Collection of real-time data on the locations, dates, actors, fatalities, and types of all reported political violence and protest events around the world.
*Small Arms Survey
Global Barometer Surveys - Global Barometer Surveys (GBS) is a collaborative research project consisting of five regional barometers. It is the first comprehensive effort to measure, at a mass level, the current social, political, and economic climate around the world
*Social Progress Index & Just Transition Score (Social Progress Imperative) - Progress in social rights (basic human needs, wellbeing, opportunity, nutrition, basic health care, water, shelter, safety, ...)
*Global Freedom Status (Freedom House) - Tracking democracy and freedom around the world
*World Inequality Database - Income, wealth, carbon, and gender income inequality
Edelman Trust Barometer - Annual global survey that covers societal indicators of trust among business, media, government and NGOs
Europe Migratory Map (FRONTEX) - This map presents the current migratory situation in Europe
The Refugee Project - Refugees routes
Aid Atlas - Development finance around the world
Atlas of Economic Complexity - Main imports and exports for each country on Earth
CrisisWatch - Global conflict tracker

Infrastructure - exposure - population

World Heritage Sites (UNESCO)
Mining locations (FINEPRINT Geovisualisations)
Map of active metal and energy minerals mining sites (World Atlas of Desertification)
GLOBIO 4 - Dam and Reservoir Inventory Project
Infrastructure maps (World Bank) - Geography, digital, energy, transport
Global Atlas for Renewal Energy
Global Human Settlement Layer (European Commission) - Degree of urbanization
World Population Review
Global Population Explorer (Earth Engine)

Waste

[World Environment Situation Room - Pollution]
[World Environment Situation Room - Air]
[World Environment Situation Room - Chemicals and Waste]