

Release Notes: National Ecological Footprint and Biocapacity Accounts, 2023 Edition

The 2023 Edition of the National Ecological Footprint and Biocapacity Accounts details Ecological Footprint and Biocapacity, by total and by component, at a national level and on a world-total basis, from 1961 to 2022. Ecological Footprint is measured for production, imports, exports, and consumption, where consumption equals production plus imports minus exports.

Accounts were generated for 244 territories including the world, current and former/split/unified nations. Of these, 190 countries, plus the world, have a reliable timeline of data and are provided on an open-access basis.

Versions and updates

- Version 1.0. Public release on April 20, 2023.

Recommended citation:

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Credits:

This edition was produced by Eric Miller, Sila Basturk, Peri Dworatzek, and Athaven Nithianantha, with the support and direction of the Footprint Data Foundation and its Science Advisory Committee, and with funding from York University and its Faculty of Environmental and Urban Change. This edition benefited from an accumulation of prior-year coding and research from analysts in the Ecological Footprint Initiative and from Global Footprint Network.

This edition integrated data from global statistics that detail consumption, production, population, and economic parameters by year, and by country or the world. Key sources include the International Energy Agency (IEA), the Food and Agriculture Organization (FAO) of the United Nations and its PopStat, ProdStat, TradeStat, ResourceStat, and FishStat databases, Sea Around Us, UN COMTRADE, CORINE Land Cover, Global Agro-Ecological Zones (GAEZ), Global Land Cover (GLC), Global Carbon Budget, World Bank, International Monetary Fund, and Penn World Tables. This edition also used parameters from peer-reviewed science journals and thematic collections, with a full list of citations available upon request.

Definitions and concepts

Ecological Footprint is the area of land and water used to grow food and to harvest renewable materials, plus the area occupied by settlements and infrastructure, plus the area of forests needed to sequester human-generated carbon emissions. Biocapacity is a measure of the potential of an area to support an Ecological Footprint.

Ecological Footprint is measured in global hectares as the sum of the following components: fishing grounds, built-up land, cropland, grazing land, forest products, and forest carbon uptake. Biocapacity is also measured in global hectares as the sum of the following components: fishing grounds, built-up land, cropland, grazing land, and forest biocapacity (which provides the capacity to supply forest products or to absorb carbon).

Fishing grounds	Area of marine and inland waters used to produce the fish, invertebrates, and aquatic plants that were captured or cultured by humans
Built-up land	Area of land occupied by human-built infrastructure, including housing and other buildings, roads and paved areas, and urban greenspace
Cropland	Area of cropland used to grow food and fibre crops consumed by humans, and for crops that humans fed to animals and cultured fish
Grazing land	Area of grassland needed to feed livestock beyond the feed supplied by crops
Forest products	Area of forests harvested for timber products and pulpwood
Forest carbon uptake (Forest C-uptake)	Area of forests needed to sequester anthropogenic carbon emissions from the combustion of fuels including for electricity generation and for the production and transportation of globally traded goods, minus the proportion of anthropogenic emissions sequestered in the same year by the world's oceans

A global hectare is a hectare of land that provides a world-average amount of biological regeneration each year. Global hectares are derived from hectares by applying several conversion factors, including: a yield factor that relates national yield of a specific land type relative to world-average yield, an equivalence factor that relates components to one another based upon their level of biological productivity, and an intertemporal yield factor that relates changes in biological productivity over time. Expressing Ecological Footprint and Biocapacity in standardized units of global hectares allows for comparisons across the world and over time.

Further details about the concepts and calculations are provided in:

Lin, D., Hanscom, L., Murthy, A., Galli, A., Evans, M., Neill, E., Mancini, M.S., Martindill, J., Medouar, F.Z., Huang, S. and Wackernagel, M., 2018. Ecological footprint accounting for countries: updates and results of the national footprint accounts, 2012–2018. *Resources*, 7(3), p.58. doi:10.3390/resources7030058

Borucke, M., Moore, D., Cranston, G., Gracey, K., Iha, K., Larson, J., Lazarus, E., Morales, J.C., Wackernagel, M. and Galli, A., 2013. Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework. *Ecological indicators*, 24, pp.518-533. doi:10.1016/j.ecolind.2012.08.005

How Edition 2023 compares to the prior Edition 2022:

This 2023 edition adds the years 2019-2022 to the timeline of Ecological Footprint and Biocapacity and re-calculates the entire timeline since 1961 from data that was newly downloaded in 2022 and early 2023 and which was processed using the latest methodology. This edition reflects several significant methodological changes that were directed by the Footprint Data Foundation and its Science Advisory Committee.

- Results up to 2022 incorporated estimates beyond (inter)nationally reported data.

Edition 2023 presents results up to and including 2022. That final year has the greatest proportion of estimated data, with only some nations having reported 2022 trade data through UN Comtrade, which we integrated into Edition 2023. Where national or international data was not available, Edition 2023 estimated the data on a per-source-dataset basis, with methodologies reflecting the usual dynamics of each dataset. Emissions were estimated using recent economic statistics that have correlated well with historic emissions from transportation, manufacturing, and electricity demand, together with trends in national emission intensities. Ocean uptake of carbon in 2022 was replicated from 2021. Crops, livestock, forest products, and fish (catch and culture and trade) were estimated using the same methods from prior editions to fill in missing or lagging datapoints. Trade data from Comtrade were cleaned and filled using the same methodology applied to past years in Edition 2022. National area data was replicated from latest source year to 2022.

- Fishing grounds footprint was enhanced with unreported catch and aquaculture data.

Edition 2023 incorporates unreported marine catches, including major discards, from Sea Around Us using its reconstructed estimates of marine capture on a national basis. Edition 2022, and prior editions, applied one parameter to the entire timeline of marine catch. That single parameter reflected more recent world averages but understated historic discards and historic under-reports. This change in Edition 2023 affected the fishing grounds component of footprint for all countries and the world, across the full timeline, with the net effect of a relatively greater footprint earlier in the timeline.

- National crop intensity was improved to better reflect multi-cropping.

Edition 2023 revised its indicator of crop intensity to be the amount of harvested cropped area relative to the amount of cropland. Farming practices, and climate, combine to generate national differences in the extent to which multiple harvests can be derived from the same portion of cropland, and the extent to which some cropland is fallow. Edition 2023 distinguishes between the (annual) yield of all cropland versus the weighted average yield of all crops that were harvested. Edition 2023 applies cropland yield to the built-up land component rather than the weighted average yield of all crops that were harvested (which was done for Edition 2022 and prior editions). Edition 2023 applies the crop intensity statistic to the footprint of cropland rather than the footprint of each specific crop,

since we had no data to confirm whether specific crops were more or less likely to be intensively cropped as compared to others. Crop exports in Edition 2023 reflected national and world yields in proportion to the amount of the primary product that was harvested in the country or imported; previously in Edition 2022, and prior editions, crop exports assumed a world-average yield. Altogether, these changes affected the footprint of cropland, especially the footprint of cropland embodied within exports; these changes also affected the footprint of built-up land, while also affecting the biocapacity of cropland and built-up land to reflect cropland yield. These netted to an increasing or decreasing of biocapacity and decreasing or increasing of footprint by an amount that varied depending on the difference between national cropland yield and world-average cropland yield.

- Ocean carbon sequestration data was fully sourced from the Global Carbon Budget.

Edition 2023 sources the Global Carbon Budget as its sole source of data for the uptake of carbon emissions from the world's oceans. Edition 2022, and prior editions, relied on additional datasets that were not updated with the same frequency by which the Global Carbon Budget has been renewed in the last several years. Differences between this edition and prior editions affected all countries and the world equally since ocean uptake is applied uniformly to all national anthropogenic emissions regardless of whether the nation bordered an ocean. Differences were greater earlier in the timeline.

- Nationally reported land use and cover is used consistently for all European countries.

Edition 2023 prioritizes UN-sourced data of national reporting on land use and cover for all countries, whereas Edition 2022 and prior editions prioritized the use of land cover data sourced from CORINE which was limited to European countries. This change affected the hectares of cropland, grazing land, forests, and inland fishing grounds of all European countries, which also affected the derived statistic of cropland intensity.

This edition also integrated revisions to FAOStat production data which combines production crops, production livestock, and livestock primary in one file instead of 3 separate files in the previous edition. Edition 2023 also integrated two sets of FAOStat food balance sheets which differ in their timeline and methodology, which affected traded crops and animals and therefore the crop and grazing components of footprint and biocapacity. For the 2010-13 period, Edition 2023 transitioned from using the old balance sheet methodology to the new, whereas Edition 2022 and prior editions extended the old timeline into the future. The net effect of these changes affected the cropland and grazing land footprint of some countries more than others, from the period of 2010-present. Countries affected with changes of greater than a few percentage are: Algeria, Benin, China, Denmark, Croatia, Japan, Libyan Arab Jamahiriya, Nigeria, Suriname, Serbia, South Sudan.

Edition 2023 produced accounts for Bonaire Sint Eustatius and Saba, and Saint-Barthélemy, whose (relatively low) production and consumption were previously allocated to Netherlands

and France, respectively. Edition 2023 updated the duration in years of the timeline for the Pacific Islands Trust, Palau, and Saint-Martin (French Part).

Edition 2023 omits 2022 data for Ukraine because we were not confident in being able to estimate the significant changes in that year to biocapacity and production and trade.

Data availability:

Ecological Footprint and Biocapacity, by total and by component, of production and of consumption, at a national level and on a world-total basis, are available within a spreadsheet that can be download from <https://footprint.info.yorku.ca/data/>

The same data of national and global measures of Ecological Footprint (of consumption) and Biocapacity, and their components, are also available at <https://data.footprintnetwork.org/> which presents the data in a more user-friendly way and with integrations of other data.

Data for all countries are categorized with a “data quality score” that informs whether all or some or none of the data for a particular nation in a particular year is available.

Additional details may be requested for one nation in one year in the form of an MS Excel Workbook that contains all the refined input data used to produce the results.

Questions and comments:

Please direct data-related questions or comments to footprint@yorku.ca or by mail to:

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York University’s Ecological Footprint Initiative has the website: <https://footprint.info.yorku.ca>

The Footprint Data Foundation has the website: <https://fodafo.org>

The Global Footprint Network has the website: <https://www.footprintnetwork.org>