Documentation for the
Natural Resource Protection and Child Health Indicators, 2020 Release

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Center for International Earth Science Information Network (CIESIN), Columbia
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Abstract

This document outlines the basic methodology and data sets used to construct the Natural
Resource Protection and Child Health Indicators, 2020 Release (2010−2020), along with
use cases, limitations, and use constraints.

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We appreciate feedback regarding this data set, such as suggestions, discovery of errors, difficulties in
using the data, and format preferences. Please contact:

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Contents

I.   Introduction

The Natural Resource Protection and Child Health Indicators, 2020 Release, is produced in support of the U.S. Millennium Challenge Corporation (MCC) as selection criteria for funding eligibility. The Natural Resource Protection Indicator (NRPI) and Child Health Indicator (CHI) are based on proximity-to-target scores ranging from 0 to 100 (at target). The NRPI covers 250 countries and is calculated based on the weighted average percentage of biomes under protected status. The CHI is a composite index for 194 countries derived from the average of three proximity-to-target scores for access to at least basic water and sanitation, along with child mortality. The 2020 release includes a consistent time series of NRPI scores for 2010 to 2020 and CHI scores for 2010 to 2019.

Note that two versions of the NRPI – one with and one without Man and Biosphere (MAB) reserves included, are appended for reasons described in the methods.

II.   Data and Methodology

Input data

Data on the Natural Resource Protection Indicator (NRPI) were calculated by CIESIN with data from the United Nations Environment Programme-World Conservation Monitoring Centre and International Union for Conservation of Nature, Protected Planet (UNEP-WCMC and IUCN, 2020). Kosovo is not yet a UN member state, so data for Kosovo protected areas boundaries were obtained from the European Environment Agency (EEA, 2018).

The 2020 Child Heath Indicator (CHI) scores are based on data from three underlying indicators: Access to At Least Basic Sanitation, Access to At Least Basic Water, and Child Mortality.

The Child Health Indicator (CHI) is comprised of three underlying indicators:

1) Access to At Least Basic Sanitation: Prior to 2017, this indicator was Access to Improved Sanitation. Produced by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), access to at least basic sanitation includes the population using improved sanitation methods that are not shared. Improved sanitation methods comprise flush or pour-flush to piped sewer system, septic tank, or pit latrine; ventilated improved pit (VIP) latrine; pit latrine with slab; or composting toilet.

2) Access to At Least Basic Water. Prior to 2017, this indicator was Access to Improved Water. Produced by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), access to at least basic water includes the population using improved drinking water sources which require less than 30 minutes for collection. Improved drinking water sources comprise piped water into dwelling, yard or plot; public tap or standpipe; tubewell or borehole; protected spring; protected dug well; or rainwater collection.

3) Child Mortality (Ages 1-4 – i.e., between age 1 and 5). Produced by the United Nations Inter-Agency Group for Child Mortality Estimation (UN IGME), this indicator represents the probability of dying between age 1 and 5, expressed per 1,000 children in that age group (4q1). Because the causes of child mortality among 1-4 year olds are strongly influenced by environmental causes, this indicator is considered to be a useful proxy for underlying environmental conditions.

Data on Access to Least Basic Sanitation and Access to At Least Basic Water were obtained from:

- Joint Monitoring Program (JMP) for Water Supply, Sanitation and Hygiene. Estimates on the use of water, sanitation and hygiene by country (2000-2017), updated July 2019. World Health Organization (WHO) and United Nations Children's Fund (UNICEF). https://washdata.org/data. Accessed 17 September 2019.

Data on Child Mortality (the probability of dying between age 1 and 5 (4q1)) for 2010-2019 were obtained from:

- United Nations Inter-agency Group for Child Mortality Estimation (UN IGME), last updated 9 September 2020, downloaded from http://www.childmortality.org. Accessed 19 September 2020.

For complete definitions of the child mortality variables, see the *Child Mortality Estimation Explanatory Notes*. September 2020. https://childmortality.org/wp-content/uploads/2019/09/UNIGME_explanatory_notes_EN_2020.pdf.

There were gaps in the sanitation and water time series. To fill gaps in the time series for water and/or sanitation data, the following procedures were used for the countries below:

<u>Water</u>
All countries were missing data for 2018 and 2019, so data from 2017 were carried forward (copy and pasted) to 2018 and 2019.
- Missing 2017: Copied 2016 to 2017, 2018, and 2019
  - Eritrea, Cayman Islands, Aruba, Central African Republic
- Missing 2016 and 2017: Copied 2015 to 2016, 2017, 2018, and 2019
  - Argentina, Dominica, Montserrat
- Missing 2014, 2015, 2016, and 2017: Copied 2013 to 2014, 2015, 2016, 2017, 2018, and 2019
  - Saint Kitts and Nevis

<u>Sanitation</u>
All countries were missing data for 2018 and 2019, so data from 2017 were carried forward (copy and pasted) to 2018 and 2019
- Missing 2017: Copied 2016 to 2017, 2018, and 2019
  - Eritrea, Cayman Islands, Aruba,
- Missing 2016 and 2017: Copied 2015 to 2016, 2017, 2018, and 2019
  - Argentina, Dominica, Brunei
- Missing 2014, 2015, 2016, and 2017: Copied 2013 to 2014, 2015, 2016, 2017, 2018, and 2019
  - Saint Kitts and Nevis

Methods

General Methods
All indicators are computed as a standardized proximity-to-target ranging from 0 (worst performance) to 100 (at target or best performance).

Natural Resource Protection Indicator
The method for developing the proximity-to-target scores for the NRPI is derived from processing spatial data on protected areas, biomes, and country boundaries. Additional details on the spatial data processing are included at the bottom of this page.

For the Natural Resource Protection Indicator (NRPI), all scores by biome are capped at 17%, which is the target established at the 10th Conference of the Parties of the Convention on Biological Diversity (Nagoya, Japan). The scores are capped so that protection levels greater than 17% in a given biome do not offset less than 17% protection in another biome. Since the range of protection levels across all countries is from 0-17%, the proximity-to-target scores are calculated as the ratio of the weighted biome protection percentage to 17%, multiplied by 100. Thus, a country with 5% weighted biome protection would be calculated as follows:

$$\frac{5}{17} = 0.29411$$

$$0.29411 * 100 = 29.41$$

By way of illustration, details on the NRPI methodology for Romania are presented in the table below. Romania has three biomes: temperate broadleaf & mixed forests, temperate coniferous forest, and temperate grasslands, savannas and shrub lands. First, the biome protected area (Column E) is divided by the total biome area (Column D) and the result is a percentage area protected (Column F). As stated, where there is greater than 17% protection (e.g. for Biome 5 and Biome 8), this is capped at 17% (Column G). Next, the proportion of Romania's land area in each biome class is calculated to weight the three scores (Column H). The final column represents the result of the score weighting for the three biomes (Column I). These are then summed, and the total is divided by 17 (bottom left) to produce an overall score of 95.1.

Note: In consultation with the World Conservation Monitoring Center (WCMC), CIESIN made the determination to remove UNESCO Man and Biosphere (MAB) reserves from the calculation of the NRPI (for reasons described below). Owing to an error, the version sent by CIESIN to the MCC, and therefore used in the FY21 MCC Scorecards, included MAB reserves. The version without MAB reserves, which was posted as the only version of the NRPI in the preliminary release, is included as an additional tab in the downloadable spreadsheet.

A	B	C	D	E	F	G	H	I
Country	Biome	Biome Description	Biome Area (sq km)	Biome Protected Area	Percentage area Protected = (Biome Protected Area/Biome Area) x 100	Indicator Percent Protected Capped at 17%	Biome Weighted = (Biome Area/ Country Biome Area)	Protected Ecoregion Indicator = (Biome Weighted x Indicator % Capped)
Romania	Biome 4	Temperate Broadleaf & Mixed Forests	159,254.58	25,098.91	(25,098.91/159,254.58) x 100 = 15.76	15.76	25,098.91/ 237,389.09 = 0.67	15.76 x 0.67 = 10.57
Romania	Biome 5	Temperate Coniferous Forests	53,542.95	22,129.37	(22,129.37/53,542.56) x 100 = 41.33	17.00	22,129.37/ 237,389.09 = 0.23	17 x 0.23 = 3.83
Romania	Biome 8	Temperate Grasslands, Savannas & Shrublands	24,591.95	10,428.33	(10,428.33/24,591.95) x 100 = 42.41	17.00	10,428.33/ 237,389.09 = 0.10	17 x 0.10 = 1.76
		Country Biome Area	159,254.58 + 53,542.56 + 24,591.95 = 237,389.09				Country Ecoregion Indicator	10.57 + 3.83 + 1.76 = 16.17

Country	ISO3	Prox to 17% = (Country Ecoregion Indicator/17) x 100
Romania	ROU	(16.17/17) x 100 = 95.1

Additional details on the geospatial methods used to calculate the NRPI are found below.

Child Health Indicator

The Child Health Indicator (CHI) is a simple average of the three proximity-to-target scores for Access to At Least Basic Sanitation, Access to At Least Basic Water, and Child Mortality. For Access to At Least Basic Sanitation and Access to At Least Basic Water, the proximity-to-target measure is equal to the reported percentage. For example, if a country has 84% of its population with access to adequate sanitation, it is considered to have a proximity-to-target score of 84. For Child Mortality, the ratio of the measured probability of dying in a given country to the highest observed probability of dying in each year is computed. To calculate the child mortality proximity-to-target score, it is necessary to have a benchmark for the highest reported child mortality as a worst performance lower bound. In the time series data reported by the United Nations Inter-agency Group for Child Mortality Estimation (UN IGME) between 2010 and 2018, Haiti had the highest reported mortality rate between ages 1 and 4 (4q1), at 134.6 per 1,000, owing to the exceptionally high mortality during the 2010 Earthquake. Because this was an exceptional event that killed an estimated 100,000 to 300,000 people (see https://en.wikipedia.org/wiki/ 2010_Haiti_earthquake), it did not seem appropriate to use that as the highest reported mortality rate. Chad was then chosen as the next highest reported rate in 2010, since Chad's rate of 70.03 per 1,000 in 2010, was consistent with the time series of child mortality data reported for the country. The formula for calculation is as follows:

$$100 - \left(\left(\frac{country\ value}{highest\ probability}\right) * 100\right)$$

For example, a country whose children between ages 1 and 5 have a probability of dying of 43.3 per 1000, therefore it would have a proximity-to-target score of 38.2 or

$$100 - \left(\left(\frac{43.3}{70.03}\right) * 100\right)$$

Additional Details on the NRPI

What it measures

This indicator measures the degree to which a country achieves the target of protecting at least 17% of each terrestrial biome within its borders. A target of 17% of each biome protected was adopted based on the updated target established at the Convention on Biological Diversity (CBD) Conference of Parties 10 in Nagoya, Japan. A protected status is treated as a necessary but not sufficient condition for an ecological region to be "effectively conserved." How well protected areas are managed, the strength of the legal protections extended to them, and the actual outcomes on the ground, are all vital elements of a comprehensive assessment of effective conservation. Such measures are not available on a widespread basis (Chape et al., 2005, 452), though there are efforts underway to fill critical gaps, e.g. through the Global Database of Protected Area Management Effectiveness (https://pame.protectedplanet.net/).

The target as expressed by the CBD and the conservation community, more generally refers to "ecological regions." To make this metric concrete, a specific data set accepted in both scientific and policy-making circles was chosen. The delineation of "biomes" was used for this purpose (Olson et al.,

2001). Biomes are broad terrestrial ecological regions. Nested within the biomes are what the authors call "ecoregions," which are finer-scale areas sensitive to more specific ecological patterns. These ecoregions are probably more appropriate as policy targets, because they identify areas based on factors that affect biodiversity on the ground more precisely than biomes. However, given the scale of the present analysis (global 1 km grids) and the processing time requirements, it was determined that using ecoregions as the unit of analysis would not be possible (see Caveats section below).

Data Set Preparation
The February 2020 World Database on Protected Areas (WDPA) is maintained by the United Nations Environment Programme-World Conservation Monitoring Centre and International Union for Conservation of Nature (UNEP-WCMC and IUCN, 2020), and downloaded from Protected Planet. As with prior versions of the WDPA, the 2020 release includes both points and polygon layers. The protected areas represented by polygons, which provide the actual boundaries, are a subset of the protected areas represented by points.

Based on advice from UNEP-WCMC (Edward Lewis, personal communication 22 Oct 2019), protected areas in the WDPA were excluded based on three criteria:

1. Sites with a STATUS of 'Proposed' and 'Not Reported'. These sites cannot be treated definitely as protected areas.
2. Sites without boundaries (points) without a REP_AREA value. These sites are often removed automatically depending on how you treat them.
3. Sites with a DESIG value of 'UNESCO Man and Biosphere Reserve'. These sites have an uncertain boundary due to the three-tiered nesting of the MAB sites, only the innermost tier of which is widely regarded as a protected area, but in the WDPA it is unclear what tier the boundaries represent. These sites also do not typically have an IUCN management category.[1]

In addition, protected area polygons with less than 25% of their area on land were considered marine and did not count toward the NRPI score, assuming that their primary purpose is marine and not terrestrial biodiversity protection.

For protected areas that had point and area information but not an explicit polygon identified, a circular buffer was created around the point with a total area equivalent to the area listed in the database. However, where protected areas are near a country's border, the buffered point is arbitrarily clipped to the border (so as not to spill over into neighboring countries), thereby losing a certain percentage of the total area. (Countries are encouraged to provide protected area boundary data to the UNEP-WCMC WDPA team.) Marine protected areas whose points were located offshore were excluded from this step. To avoid over-counting overlapping protected areas, the "dissolve" command in ArcGIS was used to create a consolidated set of polygons that distinguished areas that were under protected status from those that were not.

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[1] For more on IUCN management categories, see https://www.iucn.org/theme/protected-areas/about/protected-area-categories. As mentioned earlier in the documentation, CIESIN inadvertently sent MCC a version of the NRPI that included the MAB sites which was included in the MCC scorecards. Subsequently, the NRPI preliminary release excluded MAB sites. In this year's release, both the NRPI scores with and without MAB sites are included.

Previously, a spatially accurate coastline data set that was distributed as part of the CIESIN Gridded Population of the World, Version 4 (GPWv4) data collection (CIESIN, 2018) was used. For the 2020 release, the ungeneralized input country boundaries for a more precise coastline were used.

The biome data were obtained from The World Wildlife Fund (WWF) Terrestrial Ecoregions of the World (Olson et al., 2001). Rather than utilize the 867 ecoregions, many of which are quite small, 14 terrestrial biomes identified in the data set were utilized. Biome 98 (water) was excluded because the extent of terrestrial protected areas is being measured. The WWF Terrestrial Biome was regenerated to match the new GPWv4 ungeneralized input country boundary to ensure that all areas particularly along the coast or small islands are assigned a biome type.

Methods
In order to compute what proportion of each biome in a country is protected, a composite layer was created consisting of country boundaries, WWF's terrestrial biomes layer, and the consolidated country protected area polygon layer for each year. The area for each unique polygon in the composite layer was computed in square kilometers. The tabular data set quantifies, for each country, the total area of each biome and the total area of each biome that is protected. The percentage of each biome that is protected was calculated. The percentage was capped at 17%, so that additional "credit" does not accrue where protection exceeds 17%. The country's overall score is a weighted average of the protection score for each biome. The weights were derived by calculating the biome area as a fraction of a country's overall area. Greater weights were applied to larger biomes.

Caveats
Spatial errors are always a possibility when combining multiple global, 1:1m scale data sets for analytical purposes. Uncertainty about the exact location of boundaries of some protected areas, especially those represented by creating circles around points, and the potential spatial mismatch between the protected areas layer and the biome-country layer represent potential sources of error. Also worth mentioning is that the WDPA database has been a work in progress since 2006. Over the years, as relatively accurate boundary data has become available, point protected areas are replaced with boundary delineations that often result in changes to the total area under protection.

To streamline the processing steps, geospatial processing was performed such as buffering point protected areas and country-biome protected areas separately for each country before importing areas into the ecoregion protection indicator calculator. A major benefit of this change is eliminating over-estimation of protected areas as a result of point buffers in adjacent countries from spilling over into neighboring countries thereby inflating the overall ecoregion protection score.

Using a newly generated biome layer revealed an issue with the biome boundaries that were used in processing 2015-2017 releases and that was corrected in 2018. While discussing the new criteria for excluding protected areas, it was discovered that the 2019 release did not filter out international sites. These changes may account for differences between the NRPI releases, but the time series in this release is entirely consistent.

Documentation last revised September 20, 2021.

Note that in 2020, in consultation with the World Conservation Monitoring Center (WCMC), CIESIN made the determination to remove UNESCO Man and Biosphere (MAB) reserves from the calculation of the NRPI. Owing to an error, the version sent by CIESIN to the MCC, and therefore used in the 2020 MCC Scorecards, included MAB reserves. The version without MAB reserves, which was posted as the only version of the NRPI in the preliminary release, is included here as an additional tab in the spreadsheet. For most countries, there are no differences in the scores.

III. Data Set Description(s)

Data set description:
The NRPI and CHI data consist of country-level estimates in a Microsoft Excel spreadsheet. This spreadsheet includes the NRPI scores for 2010-2020 ("NRPI_2020_scorecard_version" and "NRPI_2020_without_MAB_sites") and CHI scores for 2010-2019.

Data set web page:
SEDAC URL:
https://sedac.ciesin.columbia.edu/data/set/nrmi-natural-resource-protection-child-health-indicators-2020
Permanent URL: https://doi.org/10.7927/7ppx-6m60

Data set format:
The data are available in Microsoft Excel (XLSX) format as a downloadable zip file. The downloadable is a compressed zip file, containing: 1) Workbook with country-level values for the NRPI and CHI, and 2) PDF documentation.

Data set download:
nrpi-chi-2020-xlsx.zip

IV. How to Use the Data

The tabular data can be used directly for statistical analysis.

V. Potential Use Cases

The NRPI and CHI scores are used as a component of the MCC scorecards and more recently the CHI has been adopted as part of United States Agency for International Development (USAID) Self Reliance Roadmaps (see https://selfreliance.usaid.gov/). The data can be used in statistical analyses where country-level indicators are needed.

VI. Limitations

All data inputs have uncertainties, but no effort to quantify the uncertainties were made. See additional text in the NRPI calculation section that addresses caveats related to the calculation of that index.

VII. Acknowledgments

CIESIN calculated the NRPI and CHI with data provided by other sources, and CIESIN acknowledges the data providers. Funding for development and dissemination of this data set was provided under the U.S. National Aeronautics and Space Administration (NASA) contract 80GSFC18C0111 for the continued operation of the Socioeconomic Data and Applications Center (SEDAC), which is operated by the Center for International Earth Science Information Network (CIESIN) of Columbia University.

VIII. Disclaimer

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X. Recommended Citation(s)

Data set(s):

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XI.   Source Code

No source code is provided.

XII.   References

Chape, S., J. Harrison, M. Spalding and I. Lysenko, 2005. Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets, *Philosophical Transactions of the Royal Society, B* 360: 443-455. https://doi.org/10.1098/rstb.2004/1592.

Center for International Earth Science Information Network (CIESIN), Columbia University. 2018. Gridded Population of the World, Version 4 (GPWv4): National Identifier Grid, Revision 11. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4TD9VDP.

European Environment Agency (EEA). 2018. Nationally Designated Areas (Common Database on Designated Areas [CDDA]) for Kosovo under UNSC Resolution 1244/99 at https://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-12#tab-gis-data. Accessed 10 October 2018.

Harris, E. (World Conservation Monitoring Centre), personal communication on 22 October 2019.

Joint Monitoring Program (JMP) for Water Supply, Sanitation and Hygiene. Estimates on the use of water, sanitation and hygiene by country (2000-2017), updated July 2019. World Health Organization (WHO) and United Nations Children's Fund (UNICEF). https://washdata.org/data. Accessed 17 September 2019.

Olson, D. M., E. Dinerstein, E. D. Wikramanayake, et al., 2001. Terrestrial ecoregions of the world: A new map of life on earth. *Bioscience* 51(11): 933-938. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2.

United Nations Environment Programme-World Conservation Monitoring Centre and International Union for Conservation of Nature (UNEP-WCMC and IUCN). 2020, Protected Planet: World Database on Protected Areas (WDPA). [Online], February 2020, Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

United Nations Inter-agency Group for Child Mortality Estimation (UN IGME), last updated 9 September 2020, downloaded from http://www.childmortality.org. Accessed 19 September 2020.

XIII. Documentation Copyright and License

Appendix 1. Data Revision History

No revisions have been made to this data set.

Appendix 2. Contributing Authors & Documentation Revision History

Revision Date	ORCID	Contributors	Revisions
September 20, 2021	0000-0002-8875-4864	A. de Sherbinin T. Chai-Onn	This document is the 1st instance of documentation.