HAPPY
PLANET
INDEX

Happy Planet Index 2021

Methodology Paper

The **Happy Planet Index** (HPI) is a measure of sustainable wellbeing. It compares how efficiently residents of different countries are using natural resources to achieve long, high wellbeing lives. Equation 1 illustrates, approximately, how HPI scores are calculated.

Equation 1: Happy Planet Index (approximate)

$$\text{HAPPY PLANET INDEX} \approx \frac{\text{LIFE EXPECTANCY} \times \text{EXPERIENCED WELLBEING}}{\text{ECOLOGICAL FOOTPRINT}}$$

Note: The equation is approximate because it leaves out the statistical adjustments described fully in **Equation 2.**

In essence, to calculate Happy Planet Index (HPI) scores, we begin by multiplying the mean life expectancy of residents of a given country by the mean experienced wellbeing of residents in the same country, to calculate what we call 'Happy Life Years'.[1] We then divide this number by the country's Ecological Footprint per capita, to reveal the average number of 'Happy Life Years' produced per unit of demand on the natural environment from the country's residents.

[1] The combination of these two variables has been called 'happy life expectancy' (Veenhoven, R, 1996. Happy Life Expectancy: A comprehensive measure of quality-of-life in nations. Social Indicators Research 39:1-59). Chapter 8 of the World Happiness Report 2021 calls the same combination 'WELLBYs' (Layard, R. & Oparina, E., 2021. Living long and living well: The WELLBY approach. In J. Helliwell, R. Layard, J. Sachs, & J-E de Neve (eds) World Happiness Report: 2021. New York: Sustainable Development Solutions Network)

Box A:

Overview of components of the Happy Planet Index

The Happy Planet Index is calculated for a given country by combining:

Life expectancy: the average number of years an infant born in that country is expected to live if prevailing patterns of age-specific mortality rates at the time of birth in the country stay the same throughout the infant's life. Life expectancy is commonly used as an overall indicator of the standard of health in a country.

Experienced wellbeing: the average of all responses from within the population to the following question: "Please imagine a ladder with steps numbered from zero at the bottom to 10 at the top. Suppose we say that the top of the ladder represents the best possible life for you; and the bottom of the ladder represents the worst possible life for you. On which step of the ladder do you feel you personally stand at the present time, assuming that the higher the step the better you feel about your life, and the lower the step the worse you feel about it? Which step comes closest to the way you feel?" This measure of wellbeing, the 'Ladder of Life' is commonly used as an indicator of how people's lives are going overall.

Ecological Footprint: the average amount of land needed, per head of population, to sustain a country's typical consumption patterns. It includes the land required to provide the renewable resources people use (most importantly food and wood products), the area occupied by infrastructure, and the area required to absorb CO2 emissions. Crucially it is a measure of consumption, not production. This means that, for example, the CO2 associated with the manufacture of a mobile phone made in Korea but bought by someone living in Kuwait, will count towards Kuwait's Ecological Footprint, not Korea's. Ecological Footprint is expressed using a standardised unit: global hectares. A global hectare (gha) is a biologically productive hectare with world average productivity in a given year.

The precise formula used to calculate HPI scores requires some technical adjustments to be made, to ensure that no single component dominates overall HPI scores **(see 'Calculating the Happy Planet Index scores' below).**

In addition, obtaining the data we needed to calculate HPI scores for every country over the 15 year time period was challenging. Where it has been possible to impute missing data points robustly, we have done so. This has been particularly challenging with respect to 2020, given that little official data was available at the time of publication.

The rest of this paper describes how data for each component of the HPI was prepared, how imputing was carried out to fill data gaps, and how the components were brought together to calculate the final HPI scores for all 152 countries.

Components of the Happy Planet Index

This section describes in detail how each component of the HPI is calculated. The following section explains how these components are brought together into the overall HPI score for each country.

Data period

We have calculated the HPI for every year between 2006 and 2020. When data is referred to on the website without referencing a year, it pertains to 2019 as this is our focus year. For that year, we have data for 152 countries. Table 1 shows how many countries we have data for all years.

YEAR	NUMBER OF COUNTRIES
2006	86
2007	118
2008	121
2009	131
2010	132
2011	141
2012	141
2013	140
2014	141
2015	140
2016	140
2017	147
2018	146
2019	152
2020	88

Table 1: No. of countries for which we have calculated HPI for each year.

Life expectancy

The main rankings we report are from 2019, where real life expectancy data was available. We mostly use the data that was prepared for the 2020 UN Human Development Report.[2] For Taiwan, which is not included in the UN Human Development Report, we used data from the UN Population Division instead.[3]

2020 life expectancy

The exception is for 2020 itself, for which data had still not been gathered globally at the time of writing. This would not be a problem normally, because life expectancy tends to change rather slowly and follow a stable trend over time. However, of course, 2020 was the year the COVID-19 pandemic began and we anticipated that this would have a large and variable impact on life expectancy. We resolved this gap in two main ways.

For some countries, life expectancy for 2020 had been published on national websites. However, this data was not always exactly harmonised with UNDP data, so we did not use these figures directly. Instead, we calculated the change in life expectancy (in absolute terms) between 2019 and 2020, using the national level data and then applied this change to the UNDP data from 2019 to estimate the UNDP-harmonised life expectancy for 2020. This method, using actual life expectancy data, was possible for the following countries: Bangladesh, Chile, Colombia, Costa Rica,

[2] UNDP (2020) *Human Development Report 2020*. New York: United Nations. **http://hdr.undp.org/en/indicators/69206**. Accessed 18.05.2021

[3] United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev. 1. Accessed 19.05.2021. Because this data is based on five year bands, we assumed a curvilinear trend in life expectancy and interpolated all the years between 2006 and 2019.

Iceland, Japan, Norway, Russia, South Africa, Switzerland, UK, USA, and all EU member states except Ireland.[4]

However, for the majority of countries, we could not find actual life expectancy data, even at the national level. To resolve this, we made the assumption that the main deviation one could expect from normal trends in life expectancy in 2020 would be the actual death rate associated with COVID-19. Heuveline & Tzen (2021) have estimated for most countries the loss of life expectancy that can be associated with COVID-19 deaths based on COVID-19 mortality rates across age categories.[5] We combined this COVID-19 'shock' with the underlying trend in life expectancy within a country to estimate what the change in life expectancy should have been in 2020. For example, if Heuvelin & Tzen estimated a 1.2 year decrease in life expectancy due to COVID-19 in 2020, but life expectancy had increased by 0.1 between 2018 and 2019, then we assumed a decrease in life expectancy of 1.1 years (1.2 – 0.1).

Given that we had actual change in life expectancy for 36 countries, we were able to calibrate the estimated changes so that they better matched the actual ones. On average, Heuveline & Tzen's estimations of COVID-19 death rates, once combined with underlying trends, lead to an underestimation of the decline in life expectancy in 2020 by a factor of 1.3. For example, according to Heuveline & Tzen, COVID-19 led to a reduction in life expectancy in Hungary of 0.8 years. When combined with

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[4] Data for EU countries, Iceland, Norway and Switzerland came from Eurostat (**https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20210407-1**); data for Costa Rica and Colombia came from the OECD (**https://stats.oecd.org/Index.aspx?ThemeTreeId=9**). Full list of sources for other countries available upon request.

[5] Heuveline P & Tzen M (2021) 'Beyond deaths per capita: comparative COVID-19 mortality indicators' *BMH Open* 11. Up to date data provided by the authors.

the general trend of increasing life expectancy (at 0.2 years per year), this should have translated into a 0.6 year decrease in life expectancy. However, the actual decrease was 0.8 years. We applied the underestimation factor of 1.3 to estimations for all countries of the decline in life expectancy due to COVID-19.

It should be noted that, whilst Heuveline & Tzen's estimations lead to accurate estimates of changes in life expectancy for the European and Anglo Saxon countries that we had data for (R=0.7), they did not seem so reliable for other countries. For example, whilst Heuveline & Tzen predicted only a 0.3 year drop in life expectancy in Russia (even without adjusting for the underlying trend), the actual fall in life expectancy was 2.2 years. Meanwhile, Heuveline & Tzen predicted a 1.7 year fall in life expectancy in Colombia, but – according to national data sources – there was no fall in life expectancy in that country in 2020. Nevertheless, until up-to-date life expectancy data is available, this represents the best estimate of changes in life expectancy for 2020.

Wellbeing – Ladder of life

We used data on wellbeing drawn from responses to the so-called 'Ladder of Life' question collected as part of the Gallup World Poll, and gathered for the World Happiness Report.[6] The Poll asks samples of around 1,000 individuals per year[7] aged 15 or over in each of more than 150 countries the following question:

> Please imagine a ladder with steps numbered from zero at the bottom to 10 at the top. Suppose we say that the top of the ladder represents the best possible life for you; and the bottom of the ladder represents the worst possible life for you. On which step of the ladder do you feel you personally stand at the present time, assuming that the higher the step the better you feel about your life, and the lower the step the worse you feel about it? Which step comes closest to the way you feel?[8]

Gallup weights the responses to correct for unequal selection probability, non-responses, and to match the national demographics of each country.

Interpolating and extrapolating missing wellbeing data

The World Poll is not conducted in every country every year. Of the 2128 possible year-country data points between the years 2006 and 2019, 17%

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[6] Helliwell J., Layard R., Sachs J. & de Neve J-E (eds) *World Happiness Report: 2021*. New York: Sustainable Development Solutions Network). Data downloaded from: **https://happiness-report.s3.amazonaws.com/2021/DataPanelWHR2021C2.xls**. Accessed 18.05.2021

[7] Three small countries consistently had samples of around 500 a year: Haiti, Iceland, and Jamaica.

[8] Gallup (n.d.) *Understanding How Gallup Uses the Cantril Scale* [webpage]. Retrieved from **http://www.gallup.com/poll/122453/understanding-gallup-uses-cantril-scale.aspx**

were missing. We estimated some of these from other years using the following rules, particularly with the intention of having data for as many countries as possible for 2019:

- If data was available for the two adjacent years, the year in between was estimated as the average of them. When there is a two or three year gap, a mini-linear trend is estimated between them. Gaps of four years or more were not filled in in this way.
- For 2019, gap filling was sometimes not possible because there was no data available for 2020 either. In such cases, the value for 2018 was used for 2019 as well.
- If 2018 was also not available, the average of all years between 2013 and 2017 were used to estimate a value for 2019.[9]

Data availability for the World Gallup Poll was particularly poor for 2020, with only 94 countries out of the 152 in our data set available. However, given the atypical nature of the year, we did not estimate any data for wellbeing for 2020. We therefore did not calculate an HPI for 2020 for countries that were not in the Gallup World Poll that year.

It is worth noting that most of the wellbeing data for 2020 comes from well after the onset of the COVID-19 pandemic. According to the World Happiness Report, only 2% of the wellbeing data from the Gallup World Poll was collected before 15th March, 2020. Analysis provided by John Helliwell and Shun Wang shows that, for most countries, the median date of interview was between July and December 2020.[10]

[9] One exception to this rule was for Syria. The most recent data available was for 2015. Given the rapidly changing circumstances in the country, we did not use this to estimate a wellbeing score for 2019, and therefore Syria was not included in the HPI.

[10] A list of median dates country-by-country can be provided on request.

Wellbeing in Vanuatu

Lastly, we were keen to include Vanuatu in our dataset, because, based on an estimated life satisfaction score, Vanuatu came top of the first HPI produced in 2006[11], and the country's government has since given significant attention to the wellbeing of its population. Its remote location means that the Gallup World Poll has never been conducted in Vanuatu. However, two representative surveys have been conducted in Vanuatu including questions on subjective wellbeing: in 2013, as part of the Pacific Living Standards Survey, and in 2020, as part of the country's National Sustainable Development Plan Baseline Survey.[12] The latter survey reached 4,289 households and both were weighted to match national demographics, as in the Gallup World Poll.

However, compared to Gallup, the Vanuatu National Statistics Office used a different question to measure wellbeing (a question on life satisfaction which is recommended by the OECD and used in most official surveys which measure wellbeing, including within the EU and the UK).

The report produced by the Vanuatu National Statistics Office provides an equation to convert the mean score on the life satisfaction question to a score that is comparable to the Ladder of Life, based on an academic study by John Helliwell and colleagues.[13]

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[11] Marks, N., Abdallah, S., Simms, A. and Thompson, S. (2006) *The (un)Happy Planet Index.* London: New Economics Foundation.

[12] Vanuatu National Statistics Office (2021) *Well-being in Vanuatu: 2019-2020 NSDP Baseline Survey*

[13] Helliwell J, Shiplett H & Bonikowska A (2020). 'Migration as a test of the happiness set-point hypothesis: Evidence from immigration to Canada and the United Kingdom.' *Canadian Journal of Economics/Revue Canadienne d`Economique*.

However, researchers have found in previous analyses that national averages for the two questions diverge slightly in terms of how they correlate with economic conditions.[14] Specifically, the national averages for Ladder of Life correlate more strongly with GDP per capita than averages for life satisfaction.

The problem we face here is that, given that Vanuatu is a country with a low GDP per capita, it is likely that using life satisfaction to estimate its Ladder of Life score will lead to an overestimate for experienced wellbeing. Indeed, we note that if we were to use the formula included in the report by the Vanuatu National Statistics Office, then we would estimate Vanuatu to have a Ladder of Life score of 7.6, the fourth highest in the world, matching Switzerland and wealthy Scandinavian countries. This may not be inaccurate, but it would lead to unfair comparisons with other countries with similar economic conditions for which we have Ladder of Life data and not life satisfaction data. As such, we applied an adjustment based on a regression linking life satisfaction, Ladder of Life scores, and GDP per capita. Doing so led to a lower estimate of 7.0 for 2020. The years between 2013 and 2020 were interpolated for Vanuatu using a linear trend.

Ecological Footprint

We used the latest Ecological Footprint data, which was produced as part of the Global Footprint Network's National Footprint and Biocapacity

[14] E.g. Bjørnskov C (2010) 'How comparable are the Gallup World Poll Life Satisfaction Data' *Journal of Happiness Studies* 11:41-60; Helliwell J (2008) 'Life satisfaction and quality of development' NBER Working Paper Series #14507.

Accounts 2021, and which we extracted using their API (Application Programming Interface).[15]

2017 Ecological Footprint

The Accounts included data for most countries up until 2017. For that year, however, data for five countries needed to be estimated: Hong Kong, Iceland, Taiwan, Vanuatu, and Uruguay. The general principle for estimation was to generate predictive models using stepwise linear regressions of Ecological Footprint (for all countries where data were available) against a range of country-specific variables.

In the cases of Hong Kong, Iceland, and Uruguay, we used a model based on the following predictors: CO_2 emissions per capita, GDP Purchasing Power Parity (PPP) per capita (in current prices), exports and imports per capita, and population density (log). All data come from the World Bank Data Bank. [16] The model fit (R^2) was high: 0.89, meaning that these five variables explained 89% of the variation in Ecological Footprint.

For Vanuatu and Taiwan, no import or export data was available. A simplified regression model was used without these two variables (R^2 = 0.86). In the case of Taiwan, the predictor variables data was sourced from elsewhere – the IMF and the IEA.[17]

[15] York University Ecological Footprint Initiative & Global Footprint Network. National Footprint and Biocapacity Accounts, 2021 edition. Produced for the Footprint Data Foundation and distributed by Global Footprint Network. Available online at: **https://data.footprintnetwork.org**.

[16] World Bank (n.d). Data Bank. **https://databank.worldbank.org/home.aspx**. Accessed on 19.05.2021

[17] IMF World Economic Outlook Database: April 2021. **https://www.imf.org/en/Publications/WEO/weo-database/2021/April/** Accessed on 18.05.2021; IEA Data and statistics. **https://www.iea.org/data-and-statistics/data-browser**. Accessed on 18.05.2021.

2018 & 2019 Ecological Footprint

No Ecological Footprint data was available for 2018-2020. However, CO_2 emissions data of various kinds was available. Given that CO_2 emissions represent the main component of the Ecological Footprint, we used the changes in CO_2 emissions for each country over time to estimate the changes in Ecological Footprint.

For 2018 and 2019, territorial CO_2 emissions from the Global Carbon Atlas were used.[18] We used a general linear model to predict change in Ecological Footprint based on change in CO_2, with country fixed effects and a linear year effect that was allowed to vary by country.[19]

2020 Ecological Footprint

For 2020, there was still no Global Carbon Atlas data at the time of writing. Instead, several sources were used. The main source was the 2021 bp Statistical Review of World Energy.[20] This included CO_2 emissions for major countries and regions up until 2020. We were able to use this data to calculate the percentage change in emissions for all the countries required. When data for individual countries was not available, regional figures or neighbouring countries were used as a proxy. This was necessary for 34 countries.[21]

Rather than use the country-by-country declines in CO_2 emissions to directly estimate changes in total Ecological Footprint, we used it only

[18] Friedlingstein et al., 2020 : The Global Carbon Budget 2020, Earth System Science Data. Available at **https://doi.org/10.5194/essd-12-3269-2020**. Accessed on 18.05.2021.

[19] SPSS Syntax available on request.

[20] BP (2021) Statistical Review of World Energy 2021. **http://www.bp.com/statisticalreview** Accessed on 24.07.2021.

[21] Details available on request.

to estimate the changes in the carbon component of the Ecological Footprint. This decision was based on the Earth Overshoot Day 2020 report, which estimated substantively different changes for the different components of the footprint.[22] That report estimated a 14.5% decrease in carbon footprint in 2020, a 8.4% decrease in forest footprint, but no decrease in the footprint associated with food.

According to the Earth Overshoot Day 2020 report (page 4), changes in carbon emissions do not convert directly into changes in carbon footprint. That report derived a 14.5% fall in carbon footprint based on a 12.5% decrease in carbon emissions. We assumed that the same ratio could be applied to the country-by-country CO_2 emission data from BP.

As mentioned, the Earth Overshoot Day 2020 report, estimated an 8.4% decrease in forest footprint. Theoretically, we could have applied the same decrease to each country's forest footprint. However, because the later Earth Overshoot Day 2021 report[23] concluded that the 2020 report had overestimated the fall in carbon footprint by a factor of about two, we assumed that the same was true for forest footprint. We therefore assumed that the fall in forest footprint globally would be half of what was estimated in the 2020 report (4.2%), and applied that equally across countries. Lastly, like the Earth Overshoot Day 2020 report, we assumed no decline in the remaining components of the footprint, including food and built environment.

[22] Lin D, Wambersie L, Wackernagel M & Hanscom P (2020) Calculating Earth Overshoot Day 2020. **http://www.overshootday.org/2020-calculation/** Accessed on 28.07.2021.

[23] Lin D, Wambersie L & Wackernagel M (2021) *Estimating the date of the Earth Overshoot Day 2021*. **https://www.overshootday.org/2021-calculation/** Accessed on 28.07.2021

Applying these rules to the 2019 footprints country-by-country, we were able to create country estimates of 2020 footprints. However, when we calculated a population-weighted average of all these estimates, they suggested only a 5.4% decline in global Ecological Footprint. This was lower than the 6.5% global decline which the 2021 Earth Overshoot Day report estimated for 2020. We therefore linearly adjusted the country-level declines such that the overall global decline matched the 2021 report.

Calculating the Happy Planet Index scores

As noted earlier, when all the components are brought together to create final HPI scores, some technical adjustments are made to ensure that no single component dominates the overall score.

We begin by adjusting the wellbeing scores so that their coefficient of variance is equivalent to the coefficient of variance of the life expectancy scores. In effect, this involves adding a constant to the wellbeing score of each country (β in Equation 2 below). By doing so, we ensure that each of these two variables contribute the same amount of variance to the product term, which is 'Happy Life Years'. This can be understood as ensuring that the Happy Life Years measure is equally sensitive to changes in life expectancy and wellbeing.

Then, we adjust the Ecological Footprint scores so that their coefficient of variance is equivalent to that of the Happy Life Years measure. Again, this is done by adding a constant to the Ecological Footprint (ε in Equation 2). This can be understood as ensuring that the overall Happy

Planet Index score is equally sensitive to changes in the Happy Life Years measure and in the Ecological Footprint.

We also incorporate two scaling constants (α and γ in Equation 6), such that an HPI score of 100 would indicate excellent performance on all three indicators: namely an inequality adjusted life expectancy of 85 years, a maximum score for inequality adjusted wellbeing (10/10) and an Ecological Footprint that we define as environmentally sustainable for the year in question (see Box B below). Meanwhile an HPI score of zero would indicate an inequality adjusted life expectancy of 25 years, a minimum score for inequality adjusted experienced wellbeing (0/10) and an Ecological Footprint of 16 global hectares, which is higher than any single country in the world during the time period covered.

Equation 2: Happy Planet Index

$$\text{HAPPY PLANET INDEX} = \frac{\alpha \times \text{LIFE EXPECTANCY} \times (\text{LADDER} + \beta) - \gamma}{\text{EF} + \varepsilon}$$

where: $\alpha = 0.75$, $\beta = 2.92$, $\gamma = 54.92$, $\varepsilon = 6.39$

Colour-coding the results

We colour-coded world maps using a traffic light system – red, amber, and green – to give a visual representation of how each country scores on average life expectancy, average experienced wellbeing, Ecological Footprint, and for the overall HPI scores (see Table 2 for thresholds).

LIFE EXPECTANCY	LADDER OF LIFE (WELLBEING)	ECOLOGICAL FOOTPRINT
Less than 65 years	Less than 5/10	Below or at per capita biocapacity (1.56 gha for 2019)
65 – 75 years	5/10 – 6/10	Between per capita biocapacity and 2 times that value (1.56-3.12 gha for 2019)
75 years or more	6/10 or more	More than 2 times per capita biocapacity (3.12 gha or more for 2019)

Table 2: Colour-codes for components

Box B:

Global Hectares and environmental sustainability

A global hectare (gha) is a biologically productive hectare of land with world average productivity in terms of ability to provide the renewable resources people use (most importantly food and wood products), the area occupied by infrastructure, and the area required to absorb CO2 emissions.

According to the National Footprint and Biocapacity Accounts, the total biocapacity of the globe is around 12 billion gha. In 2006, that equated to 1.74 gha per capita. That means that, theoretically, if everyone in the world used 1.74 gha in that year, then the planet's resources would be able to renew themselves sustainably. We have used this global per capita biocapacity as a threshold for defining sustainability in the HPI. Of course, in reality, sustainability is far more complex than this single number.

As the global population increases, the biocapacity available to any one individual, and therefore the threshold for defining a country's consumption patterns as environmentally sustainable, falls. By 2017, it was 1.60 gha per capita. By 2019 it was 1.56 gha.