

# Topical Applications of Mathematics

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## Happy Planet Index

## PUPIL TEXT

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In July 2007 the ‘New Economics Foundation’ (NEF), in association with Friends of the Earth, published the European Happy Planet Index.

The Index relates the carbon efficiency of nations to the happiness, health and wealth of their citizens. The following points came out of the NEF research.

- Having a large carbon footprint is no guarantee of happiness.
- Despite living in an age of readily available consumer goods, bigger cars, exotic food and cheaper foreign travel, people are little more contented than they were 40 years ago.
- For European countries, ranked in order of happiness, the UK was 21<sup>st</sup> of the 30 countries included.

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### Activity 1

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*How could you compare happiness between citizens of different countries?*

*How could you compare the happiness of people in different parts of the UK?*

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There are no simple answers; NEF used two factors,

**life expectancy** and **life satisfaction**

to calculate a measure of ‘**well-being**’.

They also asked the question,

“Which of these countries uses the earth’s resources most efficiently?”

This was measured by calculating the **carbon footprint** of each country.

We will look at each factor separately before combining them to give the European Happy Planet Index (HPI).

### Life expectancy

This is the average life expectancy at birth and is an estimate based on the current social, environmental and economic conditions in a country. It is calculated through the collection of data on mortality rates at different ages. This is a well-accepted comparative measure. *Data Sheet 1* gives the data for European countries.

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**Activity 2**

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*What do you notice about this data?*

*Can you explain the differences between countries?*

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**Life satisfaction**

This is much more difficult to measure. Surveys are used, with questions such as,

“If you consider your life overall, how satisfied would you say you are nowadays?

Give your response on a 0 – 10 scale, from ‘Not at all satisfied’ to ‘Extremely satisfied’.”

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**Activity 3**

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*Use the life satisfaction question and response scale to measure life satisfaction for a group of students or other people.*

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There have, in fact, been many recent surveys of this type in European countries, with consistency between the results. Some of these are summarised in *Data Sheet 2*.

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**Activity 4**

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*What do you notice about this data?*

*Can you explain the differences between countries?*

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**Well-being**

We can combine life expectancy and life satisfaction into one measure of ‘well-being’.

As life satisfaction is on a scale of 0 – 10 we can calculate a well-being index (WBI) as

$$\text{WBI} = \frac{\text{life satisfaction}}{10} \times \text{life expectancy}$$

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**Activity 5**

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*What does this formula give for the WBI when*

(a) life satisfaction = 10

(b) life satisfaction = 0 ?

*Does this make sense?*

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**Example 1**

Calculate the well-being index (WBI) for each of the following countries.

- (a) UK
- (b) Ireland
- (c) Switzerland
- (d) Latvia.

**Solution**

- (a) UK                       $\text{WBI} = \frac{7.2}{10} \times 78.4 \approx 56.4$  one d.p.
- (b) Ireland                 $\text{WBI} = \frac{7.7}{10} \times 78.2 \approx 60.2$
- (c) Switzerland          $\text{WBI} = \frac{8.2}{10} \times 80.5 \approx 66.0$
- (d) Latvia                  $\text{WBI} = \frac{5.1}{10} \times 70.7 \approx 36.1$

**Activity 6**

*Put the data for European countries in a spreadsheet and hence (or otherwise) calculate the WBI for all 30 countries, arranging them in rank order (highest first).*

**Carbon footprint**

If the output of human endeavour is a long and happy life, then the input is planetary resource consumption. Here we will represent this by the **carbon footprint**, the measure of the land area required to support the plant life needed to absorb CO<sub>2</sub> (carbon dioxide) emissions from fossil fuels used by a country, based on its levels of consumption.

The table in *Data Sheet 3* shows countries in Europe ranked by the size of their carbon footprint per person.

**Activity 7**

*What do you notice about this dataset?*

*Can you explain the differences between counties?*

**Happy Planet Index (HPI)**

We are now in a position to calculate the Happy Planet Index, which is a balance between well-being and carbon footprint.

The measure used by NEF is defined by

$$\text{HPI} = \frac{\text{WBI} \times 5}{\text{carbon footprint} + 3.3}$$

The '+ 3.3' and '× 5' in the formula are introduced to ensure that a country living within its means for its carbon footprint with a fair share of biocapacity to sustain current levels of consumption, has  $\text{HPI} = 100$ . Such a country would have a life satisfaction of 10, a life expectancy of 85 and a carbon footprint of 0.95 (which is required for an acceptable one-planet living).

### **Example 2**

Calculate the HPI for

- (a) UK                      (b) Ireland                      (c) Switzerland                      (d) Latvia.

### **Solution**

(a) UK                       $\text{HPI} = \frac{56.5 \times 5}{3.32 + 3.3} \approx 42.7$

(b) Ireland                       $\text{HPI} = \frac{60.2 \times 5}{3.12 + 3.3} \approx 46.9$

(c) Switzerland                       $\text{HPI} = \frac{66.0 \times 5}{3.04 + 3.3} \approx 52.1$

(d) Latvia                       $\text{HPI} = \frac{36.1 \times 5}{0.45 + 3.3} \approx 48.1$

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### **Activity 8**

- (a) *What difference does the carbon footprint make to the HPI compared with the WBI?*
- (b) *Calculate the HPI for all 30 European countries and comment on the countries at the top and bottom of the ranked list.*
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### **Activity 9**

*Using the full set of data, complete the graph on Data Sheet 4 for the European countries.*

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Countries in the top left-hand corners are those that have both high well-being and low carbon footprint. This is the position countries should aim to achieve.

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### **Activity 10**

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- (a) *The top three countries are Iceland, Sweden and Norway. Find out about these countries and determine the common factors that contribute to their high rankings.*
  - (b) *The bottom three countries are Belgium, Luxembourg and Estonia. Can you explain their low placings?*
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