A new comprehensive index for a sustainable society:
SSI – Sustainable Society Index
(with results shown for 150 countries)

by

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Abstract

In search for an adequate set of indicators to measure the level of sustainability of a country, the main existing indexes have been examined. However, the conclusion must be that none of them completely fits our needs. The main shortcomings being a limited definition of sustainability, lack of transparency and no regular updates. Therefore a new index, the Sustainable Society Index, the SSI, has been developed. The SSI integrates the most important aspects of sustainability and quality of life of a national society in a simple and transparent way. The SSI, consisting of only 22 indicators, grouped into 5 categories, is built upon the definition of the Brundtland Commission, extended to the Brundtland+ definition by explicitly including the social aspects of human life.

The SSI, based on data from scientific institutes and international organizations, has been developed for The Netherlands and for 149 other countries for which the SSI could be calculated. The resulting SSI scores allow a quick comparison between countries and – as two-yearly updates become available – show developments over time. The underlying data allow in-depth analysis of the aspects that cause the differences between countries.

This article outlines the development of the SSI, the calculation methodology and gives the main results. It also summarizes the need for further research and development of the SSI.

1. Introduction

Sustainability is very much in the spotlight nowadays. The mission of Al Gore and his film An Inconvenient Truth have much attributed to the present, widespread sense of urgency. However, that sense is mainly confined to climate change. But sustainability is much more than climate change, however dramatically climate change might affect our future. Few people have the same sense of urgency with respect to sustainability in its wider sense.

The notion of what is meant by sustainability differs strongly among people. Even among scientists there are lots of definitions of sustainability. However, to be able to achieve a sustainable way of living on our planet, a clear definition of sustainability is required. Moreover one has to be able to measure the present level of sustainability and indicate how far away we are from complete sustainability. Therefore a new set of indicators has been developed, as described in this paper.

Section 2 deals with the development of a set of indicators. Existing sets of indicators are examined. The conclusion is that none of these fits completely to our needs, so a new set is required.
Section 3 describes the methodology of calculating the indicators and of aggregating the results into categories and finally into one index. A preliminary sensitivity analysis for the attached weights for the aggregations is given.
Section 4 gives the main results for all 150 countries, shown on world maps.
Section 5 outlines proposals for future use of the SSI.
Section 6 gives the main subjects for further research and development on the SSI.
A conclusion is given in section 7.

> *Achieving sustainability requires defining its components in measurable terms and clearly fixing the responsibility to assess progress comprehensively.*
> Hales and Prescott-Allen, 2002

2. Sustainability and its indicators

2.1 Definition of sustainability

> *It may only be a matter of time before the metaphor of Sustainability becomes so abused as to be meaningless, certainly as a device to straddle the ideological conflicts that pervade contemporary environmentalism.*
> O'Riordan, 1988

For many people the basic idea of sustainability focuses greatly on depletion of resources. Others include in sustainability (irreversible) pollution, conservation of nature and other environmental and ecological aspects. And again others include the aspects of quality of human life, the human well-being. From an anthropocentric point of view sustainability comprises all three elements:

1. depletion of resources → in order not to leave next generations empty-handed
2. environmental and ecological aspects → in order to enable present and next generations to live in a clean and healthy environment, in harmony with nature

3. quality of life → in order to ensure human well-being for present and next generations.

Sustainability without quality of life makes no sense and quality of life without sustainability has no perspective. All three elements are important for development towards a sustainable society. It is for this reason that IUCN, UNEP and WWF defined sustainable development as 'Improving the quality of life of humans while living within the carrying capacity of supporting ecosystems' (IUCN, 1991).

Another element, economy, is not included, though especially politicians often use the term 'sustainable economy'. However, the development of economy is certainly not a condition for sustainability nor a goal of sustainability. The economy of a country has to be developed within the limits set by sustainability.

> *The sustainable society is one that lives within the self-perpetuating limits of its environment. That society is not a 'no-growth' society. It is rather a society that recognizes the limits of growth and looks for alternative ways of growing.*
> Coomer, 1979

The well-known and worldwide respected definition of the Brundtland Commission (WCED, 1987) has been interpreted in two hundred or more different ways (Pezzey, 1989; Solow, 1993; Mebratu, 1998). To make explicitly clear that sustainability includes all three elements mentioned above, we have extended the definition of Brundtland by adding a sentence so that the qualitative aspects of human life are explicitly included. We have formulated the Brundtland+ definition as follows:

A sustainable society is a society

- *that meets the needs of the present generation,*
- *that does not compromise the ability of future generations to meet their own needs,*
- *and in which each human being has the opportunity to develop itself in freedom, within a well-balanced society and in harmony with its surroundings.*

The question now is whether there is a set of indicators available, resulting in an integrated Index, which enables us to show the extent to which every human being

- is able to develop himself healthy and to obtain a proper education,
- lives in a clean environment,
- lives in a well-balanced and safe society,
- uses non-renewable resources in a responsible manner so that future generations are not left empty handed and
- contributes to a sustainable world.

2.2 Relevant existing indicators

Many sets of indicators exist already. It seems that every year more are being developed. This suggests that either not one is completely satisfying or that every set serves a more or less different purpose. In Box 1 we have briefly examined the most relevant indexes and sets of indicators concerning sustainability on a national level. We have summarized their pros and cons, bearing in mind the Brundtland+ definition of sustainability given above.

Human Development Index (http://hdr.undp.org)

Developed by the UNDP, published every year. Comprises four sets of data: life expectation at birth, adult literacy rate, combined gross enrolment ratio for primary, secondary and tertiary schools and GDP per capita. HDI covers only a minor part of all aspects of sustainable development. Conclusion: HDI is very suitable to give a rough idea of the level of development, particularly in developing countries. For developed countries the HDI is less valuable due to the limited information it contains.

2. Environmental Sustainability Index, ESI-2005 (www.ciesin.columbia.edu-indicators-esi)

Developed by Columbia University and Yale University, USA. Previous editions in 2001 and 2002. ESI comprises no less than 76 variables, which are aggregated into 21 indicators, resulting in 5 categories. ESI covers the whole range of aspects of sustainable development in its broad context. However, the Gender Related Index is lacking in the ESI and Good Governance receives only minor attention. Conclusion: ESI supplies a lot of relevant and valuable information, but is not very transparent due to the great amount of data.

3. Environmental Performance Index, EPI-2006 (www.yale.edu/epi)

Developed by Columbia University and Yale University, USA. Published in 2006 for the first time in order to present a better insight in the 'environmental dimension' of the Millennium Development Goals. The EPI will be developed further. EPI comprises 6 categories (Environmental Health, Biodiversity and Habitat, Sustainable Energy, Water Resources, Air Quality, Productive Resource Management), derived from 16 indicators. Conclusion: the EPI – as the name already suggests – only partly covers sustainable development in its broader context.

4. Commitment to Development Index, CDI-2006 (www.cgdev.org/section/initiatives/_active/cdi)

Set up by Center for Global Development, an independent, not-for-profit think tank established in 2001 in the USA. Publishes the CDI every year since 2003. The CDI reviews for 21 rich countries the level of support given to poor countries to realize prosperity, good governance and security. It is composed of seven components: aid, trade, investment, migration, environment, security and technology. Conclusion: the CDI covers sustainable development only partly and offers information of no more than 21 countries.

5. Index for Sustainable Economic Welfare, ISEW (www.foe.co.uk/campaigns/sustainable_development/progress) Calculated for over 10 countries now, according to the design of Daly and Cobb (1989). The idea of the ISEW is to adjust the Gross Domestic Product of a country for costs that are currently not included in the GDP and/or are consciously shifted to the future (costs of environmental pollution, depletion of resources, costs of traffic accidents, but also matters like domestic and voluntary labor). Results are expressed in dollars. Conclusion: very valuable as a correction on the GDP. It shows clearly we mislead ourselves by taking GDP as a standard. It does not include the main aspects of quality of life and doesn't offer a clear insight in the level of sustainability of a country. ISEW is available for a limited number of countries only.

6. Genuine Progress Indicator, GPI (www.rprogress.org) GPI and ISEW are both variants of the 'green GDP'. GPI has been developed by Redefining Progress and was published for the first time in 1998. Its increasing importance is being recognized. The same remarks which have been made on the ISEW, apply to the GPI.

7. Ecological Footprint (www.footprintnetwork.org)

Developed by Wackernagel and Rees, published every two years by WWF in the Living Planet Report. Converts everything a person consumes (house, mobility, energy, food, recreation etc.) and what is needed to produce all these items, into the required area on earth, the number of hectares per capita. The Ecological Footprint only partly covers sustainability in its wider sense. There is still quite some discussion about the calculation methodology used, for instance how to convert energy consumption to required acreage. Conclusion: excellent index to offer people a quick and inspiring idea about the seriousness of present lack of sustainability. For instance, the level of consumption in The Netherlands requires almost three earths. Motivates to take action. However, the Footprint is not suited to give a good idea of sustainability in its broader sense.

8. Wellbeing of Nations Set up by Robert Prescott-Allen in 2001, in cooperation with international institutes. As yet published only once. Consists of the Human Wellbeing Index and the Ecosystem Wellbeing Index. Both comprise 5 categories, each built upon several indicators. Covers the whole field of sustainable development. Gives an enormous lot of information, which makes it rather complicated. The way of presentation hampers its accessibility and therefore its use.

Conclusion: excellent, though rather complicated index, published only once.

9. Millennium Development Indicators
(http://millenniumindicators.un.org/unsd/mdg/)

Set up by UN in order to monitor progress of reaching the Millennium Development Goals (1990 – 2015). Offers a lot of useful information. However, these indicators aim at a different goal than to measure the level of sustainability of a country. They do not cover the entire concept of a sustainable society.
Conclusion: valuable set of indicators, excellent to monitor the effectiveness of policy with respect to the MDGs. Limited usefulness for a good insight in the level of a country's sustainability.

10. Indicators for the EU Sustainable Development Strategy
(http://epp.eurostat.ec.europa.eu)

The set of indicators will be updated by the end of 2007. The present list of 155 indicators will be condensed. The EU aims at a set consisting of 3 levels, the first two being the most important for policy makers. These two levels will probably comprise some 50 indicators. With an eye on the Lisboa Strategy, among other things, the set comprises many macro-economic figures.

Conclusion: the set consists of a large number of indicators, including a number of indicators which are not much related to sustainability, like Gross Domestic Product and Official Development Assistance, while other issues only get minor attention or are missing, like Gender related development and Access to drinking water. The set is limited to the EU-member countries.

11. CSD indicators
(http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm)

This set, developed by UN Commission on Sustainable Development (CSD), has been reviewed for the third time in 2006. The set comprises 14 themes, 44 sub-themes, 50 core indicators and 46 other indicators. The set offers much information. However, many of the indicators are not (much) related to sustainability, like GDP, ODA and Tourism. Some indicators, like the important Gender Equality and Sufficient Food are missing, while others are only partly included (Good governance, International Cooperation, Waste recycling).

Conclusion: many indicators give a lot of information, but they do not cover sustainability in its broad sense.

Box 1. Relevant indexes and indicators on national level

The overall conclusion is that none of the existing indexes completely fits our needs. That is to say not one gives a complete and good insight into all relevant aspects of sustainability in a transparent, simple and easily understandable way, showing at a glance to what extent a society is (un)sustainable. So we have to develop a new index based on a set of indicators in accordance with the definition of Brundtland+.

2.3 Criteria for indicators

Indicators have to be chosen carefully, meeting the following criteria (Nagelhout, 2006; Bell and Morse, 2003; Meadows, 1998; Guy and Kibert, 1998):

- an indicator must be relevant for an issue according to the definition used;
- an indicator must be measurable;
- indicators have to be independent from each other and have no mutual overlap;
- data for the indicators must be available from public sources, scientific or institutional;
- data must be available for all countries, that is to say at least for all but the smallest countries;
- data must be reliable;
- data must be of recent date and regularly updated.

With respect to the resulting set of indicators also criteria can be formulated:

- the set of indicators has to be easily accessible, also for the public in general. This means the number of indicators should be limited;
- the set of indicators must cover the whole field of sustainability, in line with the definition used;
- the indicators have to be neatly arranged, in an easily understandable framework, in order to ensure the ease of use;
- the total set of indicators must give a good insight in the present situation with respect to sustainability and indicate the distance from the present situation to the situation of complete sustainability;
- the set must enable the comparison between countries.

One interesting criterion – people's involvement – is not included in our list. Not since this is not important. On the contrary. However, because the SSI is primarily meant to be used at national and international level and in view of all research which has been done on this subject already, we have chosen a top-down approach. Nevertheless, people, in the first place politicians and Government officials, play an important role by defining short-term and long-term goals. Moreover, every country will likely add one or more tailor-made indicators, covering country-specific circumstances or issues.

2.4 New set of indicators

Following the interpretation of Brundtland + and taking into account the criteria for the indicators as shown in paragraph 2.3, 22 indicators can be defined. These indicators can be grouped into 5 categories.

I Personal Development
- 1 Healthy Life
- 2 Sufficient Food
- 3 Sufficient to Drink
- 4 Safe Sanitation
- 5 Education Opportunities
- 6 Gender Equality

II Clean Environment
- 7 Air Quality
- 8 Surface Water Quality
- 9 Land Quality

III Well-balanced Society
- 10 Good Governance
- 11 Unemployment
- 12 Population Growth
- 13 Income Distribution
- 14 Public Debt

IV Sustainable Use of Resources
- 15 Waste Recycling
- 16 Use of Renewable Water Resources
- 17 Consumption of Renewable Energy

V Sustainable World
- 18 Forest Area
- 19 Preservation of Biodiversity
- 20 Emission of Greenhouse Gases
- 21 Ecological Footprint
- 22 International Cooperation

These 22 indicators and 5 categories constitute the new Sustainable Society Index, the SSI-2006. Box 2 gives the rationale for the selected indicators.

Indicator	**Rationale**
1 Healthy Life	Condition for development of each individual in a healthy way
2 Sufficient Food	Condition for the development of an individual
3 Sufficient to Drink	Condition for the development of an individual
4 Safe Sanitation	Condition for the prevention and spreading of diseases that would severely hamper a person's development
5 Education Opportunities	Condition for a full and balanced development of children
6 Gender Equality	Condition for a full and balanced development of individuals and society at large
7 Air Quality	Condition for human and ecological health
8 Surface Water Quality	Condition for human and ecological health
9 Land Quality	Condition for production of crops, livestock and timber

10 Good Governance	Condition for development of all people in freedom within the framework of (international) rules and laws
11 Unemployment	Access to labor-market is a condition for well-being for all people
12 Population Growth	Limitation of population pressure on earth is a condition for sustainability
13 Income Distribution	Fair spreading of prosperity is a condition for sustainability
14 Public Debt	Measure of a country's possibility to make independent decisions with respect to budget allocation
15 Waste Recycling	Measure of sustainable use of raw materials in order to prevent depletion of resources
16 Use of Renewable Water Resources	Measure of sustainable use of water resources in order to prevent depletion of resources
17 Consumption of Renewable Energy	Measure of sustainable use of energy resources in order to prevent depletion of resources
18 Forest Area	Preservation of forest area is a condition for sustainability
19 Preservation of Biodiversity	Condition for perpetuating the function of nature, in all its aspects
20 Emission of Greenhouse Gases	Measure of main contribution to climate change, causing unsustainable effects
21 Ecological Footprint	Measure of people's (un)sustainable usage of the earth's resources
22 International Cooperation	Measure of a country's willingness to take up its responsibility for the world at large with respect to sustainability

Box 2. Rationale for each indicator

The classifying of the indicators into 5 categories is directly derived from the definition Brundtland + (see paragraph 2.1).

2.5 Indicators which have been left out

2.5.1 GDP per capita

The most well-known indicator GDP per capita (Gross Domestic Product per capita) has been left out, for obvious reasons (Van den Bergh, 2007). Not surprisingly, since Economy is not included in the definition.

> The GDP does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It allows neither for the justice in our courts, nor the justness in our dealings with one another. The Gross Domestic Product measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion to country. It measures everything, in short, except that which makes life worthwhile.
>
> *Robert Kennedy*
> (quoted from Meadows, 1998)

Only few people still consider GDP per capita to be a useful indicator for development towards sustainability. In that respect other indicators, the ISEW (Daly and Cobb, 1989; Bleys, 2007) or the Dutch DNI (Duurzaam Nationaal Inkomen, Sustainable National Income) (Hueting, 1980), are far more indicative. Unfortunately they cannot be used for the SSI, since these two indicators are available for no more than a couple of countries.

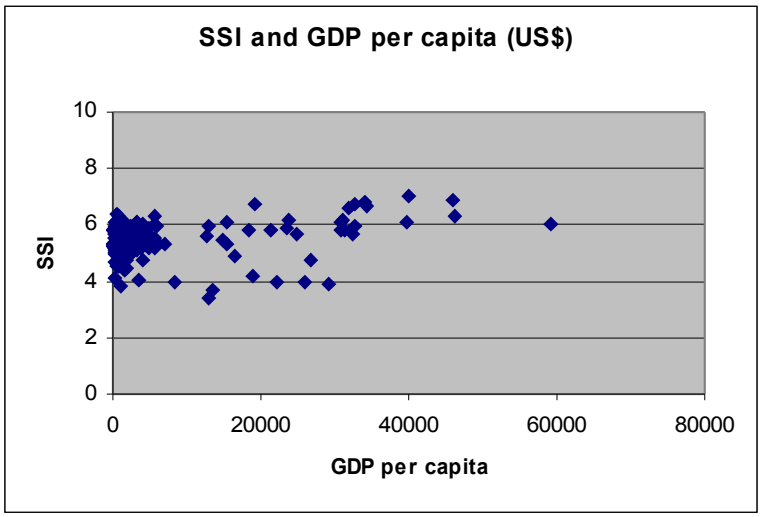


Figure 1. Relation between SSI and GDP per capita

Comparing the results of the SSI (see Annex 2) with the GDP per capita (Figure 1) gives no support to the conclusion that there is a statistically significant relationship between the two data.

2.5.2 Depletion of resources

Another item, depletion of resources, is not included in the SSI. Contrary to the GDP this item should be included. However, it is impossible to do so due to a lack of data. The amount of economically exploitable resources varies with the development of technology and market prices. Thus, no reliable and useful data is available to analyze the depletion of resources. An indication of the depletion could come from data about material consumption. However, this data is available for a limited number of countries only.

2.6 Comparing the indicators to the criteria

Comparing the selected indicators with the criteria outlined above in paragraph 2.3, shows that all indicators meet most of the criteria. However there are a few deviations.

Independency: There are two indicators that – no doubt – do not completely meet the criterion of independency. The value of Ecological Footprint consists for over 50% of energy use. Energy consumption is also a separate indicator. The same applies, to a lesser extent, for the indicators Forest Area and Preservation of Biodiversity.
Another overlap exists between Consumption of Renewable Energy and Emission of Greenhouse Gases. Both are comprised in the SSI from a different point of view as outlined in Box 2. However, the effects of this overlap need further research.
One might assume the two indicators Sufficient Food and Sufficient to Drink are greatly interrelated. A brief assessment of data does certainly not support this assumption.

Recent date*:* For only few indicators data of 2005 is available. There are even indicators of which the most recent data is from before 2000.

Reliability of data: this is a serious concern, which requires further examination. However, reliability will increase over time, due to the improvement of statistical offices around the world and the application of generally accepted rules.

2.7. Framework of the SSI

The framework of the SSI is new. It has no similarity with existing frameworks. It follows directly out of the interpretation of the Brundtland+ definition as given in paragraph 2.1.

The most well-known framework is PPP – People, Planet, Profit. This framework has the advantage to be well-known and easy to remember. However, it is not built upon a definition of sustainability. Apparently it assumes the notion of sustainability being the same for everyone.

Especially the item Profit is misleading. It suggests that profit and economic growth are necessary for a country. However, this is certainly not a condition for sustainability. It is important to define under what conditions welfare, a sound and sustainable economy – including possible economic growth – can be ensured.

Besides the three categories of PPP, one category is missing completely: the well-balanced society. Nevertheless this is a crucial category for a correct and complete set of conditions for a sustainable society. In order to meet this objection often a fourth category is suggested: Institution or Policy.

3 Calculation methodology

3.1 Selection of countries

The Sustainable Society Index has been developed for as many countries as possible. This offers the option for comparison between countries using various viewpoints: neighboring countries, more or less similar countries, regional comparisons, comparisons between rich countries like the OECD-members, comparison between North and South etc.
However, 43 of the existing 193 countries had to be left out, due to a lack of data. Criterion for the incorporation of a country in the SSI has been that data for at least 12 out of 22 indicators for a country had to be available. By doing so the set of indicators and the SSI could be calculated for nearly all big and medium sized countries. Exceptions for the bigger countries are Afghanistan, Djibouti, Eritrea, Somalia and Surinam. Beside these, most small island states had to be left out. In this manner the SSI could be calculated for 150 countries.

3.2 Calculation of indicators

3.2.1 Data

For the calculation of the indicators of the SSI only data from public sources has been used. If data was missing, no additional field work has been done. In that case the average of data of this indicator of comparable countries has been used. To define ‘comparable’ countries the classification in seven clusters as specified for the ESI has been used (ESI, 2005).

3.2.2 Sustainability value

The sustainability value of each of the 22 indicators is the value for the level at which full sustainability is achieved. The sustainability value is the final goal for an indicator. Full sustainability will be achieved when a country scores the sustainability value for each indicator. The difference between the current value of an indicator and the sustainability value gives the distance to sustainability. This is visualized in figure 2 for The Netherlands.

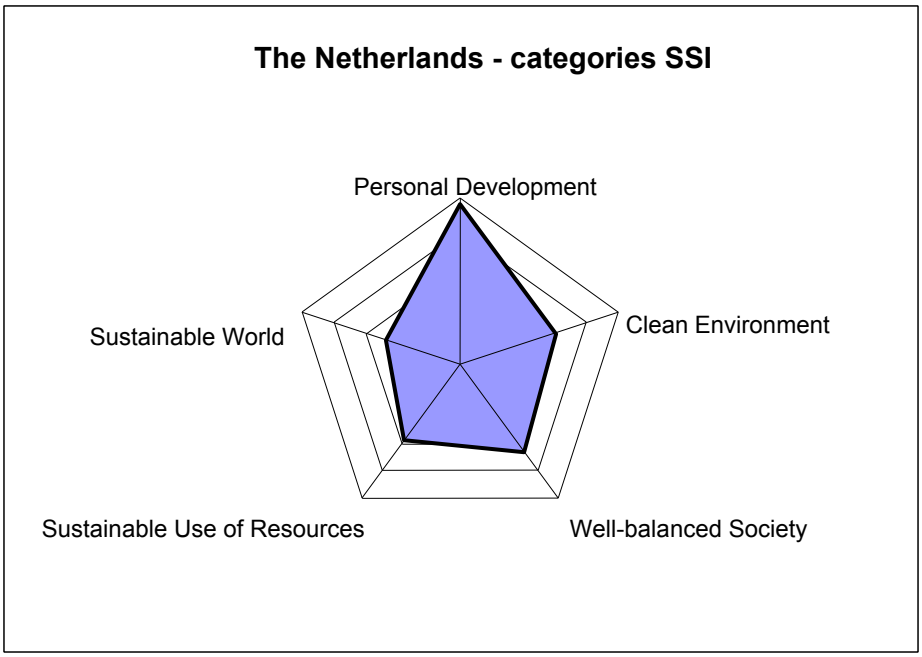


Figure 2. Distance to sustainability for The Netherlands for the five categories.

3.2.3 Calculating the indicators

*** Sustainability value is known**
If the sustainability value of an indicator is known, the value of the indicator is scored with a 10 in case of 100% sustainability. If there is no sustainability at all, the value for the indicator is 0. For some indicators this is clear enough: the number of undernourished people has to be 0 (indicator 2), or the percentage of people with access to safe drinking water has to be 100 (indicator 3). This reasoning applies for indicators 2, 3, 4, 5, 6, 15, 17 and 22. The basic data for these indicators is transformed to the scale of 0 to 10 (Ebert and Welsch, 2004).

*** Educated guess for the sustainability value**
For some indicators the sustainability value is less obvious. When is population growth sustainable? If the number of inhabitants stays constant? Or only when it declines? And at which percentage does it have to decline to be sustainable? Or when is income inequality sustainable? For some indicators, 18, 20 and 21, an educated guess of the sustainability value is possible, as outlined in Box 3.

18. Forest area: It seems obvious to determine as sustainability value the present situation. That would mean that a country with a constant forest area would score a 10 for this indicator. However it is very questionable whether the present situation reflects sustainability. To answer that question we have to know how much area should be allocated for nature. Moreover, the question is whether it is correct that the sustainability value of a country is rewarded with a 10. That would mean that countries which are 'more sustainable than sustainable' cannot be rewarded for this contribution allowing other countries to be less sustainable. Therefore a constant forest area in the period 1990 – 2000 is rewarded with a 7, an increase over 0.4‰ with a 10 and a decline over 0.65‰ with a 0.

20. Emission of Greenhouse Gases: At present, the generally accepted value of the sustainable level of emission of greenhouse gases is 2 ton CO_2 per capita per year. A score of 8 is awarded for this sustainability value. So countries which are 'more sustainable than sustainable' can be rewarded.

21. Ecological Footprint: Taking the middle scenario for room for nature as a starting point, the present sustainability value – at the present number of 6.5 billion world inhabitants – is 1.2 ha per capita. The score for this sustainability value is 8, similar to Emission of Greenhouse Gases.

Box 3. Educated guess for the sustainability value of some indicators

*** Sustainability value is unknown**
Wherever even an educated guess is not possible, we have chosen to give the highest score of the 150 assessed countries for that indicator a 10 and the lowest score a 0. Often the calculated maximum value is slightly lower than 10, depending on the chosen formula, so the calculation does not have to be adjusted every time new maximum basic data will come up. The same applies for the calculated minimum values.

The transformation from basic data to indicator values has been done by standardization, apart from indicators 11, 13, 14 and 18. For these indicators more complex formulas have been used, in line with the characteristics of the indicator.

The used formulas for all 22 indicators are given in Annex 1.

3.3 Aggregation

Opinions concerning aggregation vary enormously. For some it is an absolute 'don't', others simply do it (Ebert and Welsch, 2004). In view of the objectives of the SSI – among others to show at a glance the level of sustainability of a country – an aggregation has been made from indicators into categories and from categories into one single figure for the SSI.

One of the objections to aggregation is that it can be compared to the adding of apples and oranges. However, if one accepts the definition of Sustainability that has been used for the SSI, all 5 categories and 22 indicators are essential for assessing a country's sustainability; no matter whether they are apples or oranges. The objective of a country is (or should be) to achieve full sustainability. This requires achieving the sustainability value for each indicator. So there can be no trade-off between two (or more) indicators or categories (though very often a trade-off between economy and ecology can be seen, mostly at the cost of ecology).

In general, aggregating smoothes out possible extreme values, which then become less clear. The only answer to that justified remark is that it is important to look at the aggregated figures as well as at the underlying ones.

An essential question for aggregation is the attribution of weights. One may consider one indicator to be more important for achieving sustainability than another. However, due to a lack of a scientific basis for the attribution of different weights to the indicators every indicator has received the same weight for the aggregation into categories.

The same procedure, for the same reason, could be applied for the aggregation of the five categories into one figure for the index. However, examining the impact of each category on sustainability of the own country and of the world at large, it is obvious that quality of life has it main effects – though certainly not all – within the own country, whereas sustainability also has serious effects on other countries and on the world at large. Therefore the three categories with emphasis on quality of life received a weight 1; the two categories with emphasis on sustainability received a weight 2. As yet there is no sound scientific theory to do so. However, this has been done since it seems to better reflect the relative importance of the latter two categories.

Category	Weight
Personal Development	1
Clean Environment	1
Well-balanced Society	1
Sustainable Use of Resources	2
Sustainable World	2

Box 4. Weights for aggregation from category to index

The complete set of data is available on the website www.nederlandduurzaam.nl, presented in an Excel-spreadsheet (both in English and Dutch), which enables the interested reader to experiment with different weights.

3.4 Sensitivity

Since a solid scientific theory lacks for the aggregation into categories and into one single index, we have analyzed the sensitivity of the results (see Annex 2) for the choice of weights. The effect on the top and the bottom of the ranking list are given in Table 1.

	SSI	Rank	SSI calculated without weights	Rank	SSI calculated directly out of indicators	Rank
NORWAY	7.0	1	7.4	1	7.5	1
SWITZERLAND	6.9	2	7.2	3	7.3	2
SWEDEN	6.8	3	7.2	4	7.3	3
FINLAND	6.7	4	7.2	2	7.3	4
NEW ZEALAND	6.7	5	7.1	5	7.3	5
AUSTRIA	6.7	6	6.9	6	7.1	6
ICELAND	6.6	7	6.9	7	7.0	7
VIETNAM	6.4	8	6.1	35	6.3	37
GEORGIA	6.3	9	6.3	21	6.5	31
JAPAN	6.3	10	6.8	15	7.0	8
URUGUAY	6.3	11	6.4	19	6.6	22
NETHERLANDS	6.2	12	6.5	12	6.8	13
CANADA	6.1	13	6.7	9	6.8	11
BHUTAN	6.1	14	5.9	42	5.8	66
DENMARK	6.1	15	6.7	10	6.9	9
UZBEKISTAN	4.5	136	5.0	115	5.6	88
SYRIA	4.5	137	4.7	138	5.2	122
IRAN	4.5	138	4.7	139	5.2	118
EGYPT	4.5	139	4.8	130	5.4	99
JORDAN	4.4	140	4.8	135	5.4	101
MALTA	4.2	141	4.8	136	5.3	111
YEMEN	4.1	142	4.2	148	4.6	143
IRAQ	4.0	143	4.2	149	4.7	141
QATAR	4.0	144	4.9	122	5.4	102
LIBYA	4.0	145	4.5	143	5.1	127
KUWAIT	3.9	146	4.8	125	5.3	113
UNITED ARAB EMIRATES	3.9	147	4.8	126	5.3	110
TURKMENISTAN	3.8	148	4.4	146	4.8	137
OMAN	3.7	149	4.4	145	4.9	134
SAUDI ARABIA	3.4	150	4.0	150	4.5	147

Table 1. Sensitivity for the choice of weights

3.4.1 SSI calculated without weights

Calculating the SSI by giving all five categories the same weight – in other words, by using no weights – raises the average SSI score by 0.082 from 5.473 to 5.555. That is by 1.5%. However, it affects the ranking only slightly. At the top nothing changes very much, as can be seen in Table 1. At the sub-top countries like Vietnam and Bhutan end up in a lower position. Their relatively high scores for the category Sustainable World brought these to the top of the SSI ranking list, due to the fact that this category has been given the weight 2.

At the bottom of the list we see the same pattern. At the very bottom we mainly find the same countries. But Qatar, Kuwait and United Arab Emirates move to a higher position due to high scores for category Personal Development. This does not apply to the same extent for Libya, since Libya scores much lower than the three mentioned countries on categories Clean Environment and Well-balanced Society.

The biggest changes in SSI-score are for Qatar (+0.92) and Burundi (-0.68).

3.4.2 SSI directly calculated out of indicators
By calculating the SSI indirectly – as we have done: aggregating indicators into categories and then aggregating into the SSI – we have given more or less unnoticed weights. Since not every category comprises the same number of indicators, indicators making up a category with only three indicators receive a higher weight than indicators that are part of a category with six indicators. As might be expected there is a greater difference compared to the SSI than if we 'only' give the categories the same weight. The average score is raised by 0.318, from 5.473 to 5.791, that is by 4.3%.

At the very top no changes occur; countries in the sub-top show a stronger tendency to slip to a lower position. At the bottom of the list we find slightly bigger changes. The biggest changes in SSI-score are for United Arab Emirates (+1.41) and Democratic Republic Congo (-0.83).

A preliminary conclusion could be that the SSI is not very sensitive for the weighting of the categories for aggregating to one index. That is to say, for the weighting we gave the categories; other weightings are imaginable. Calculating the SSI directly from the indicators has slightly more influence.

4. Results of the SSI

4.1 The SSI for 150 countries

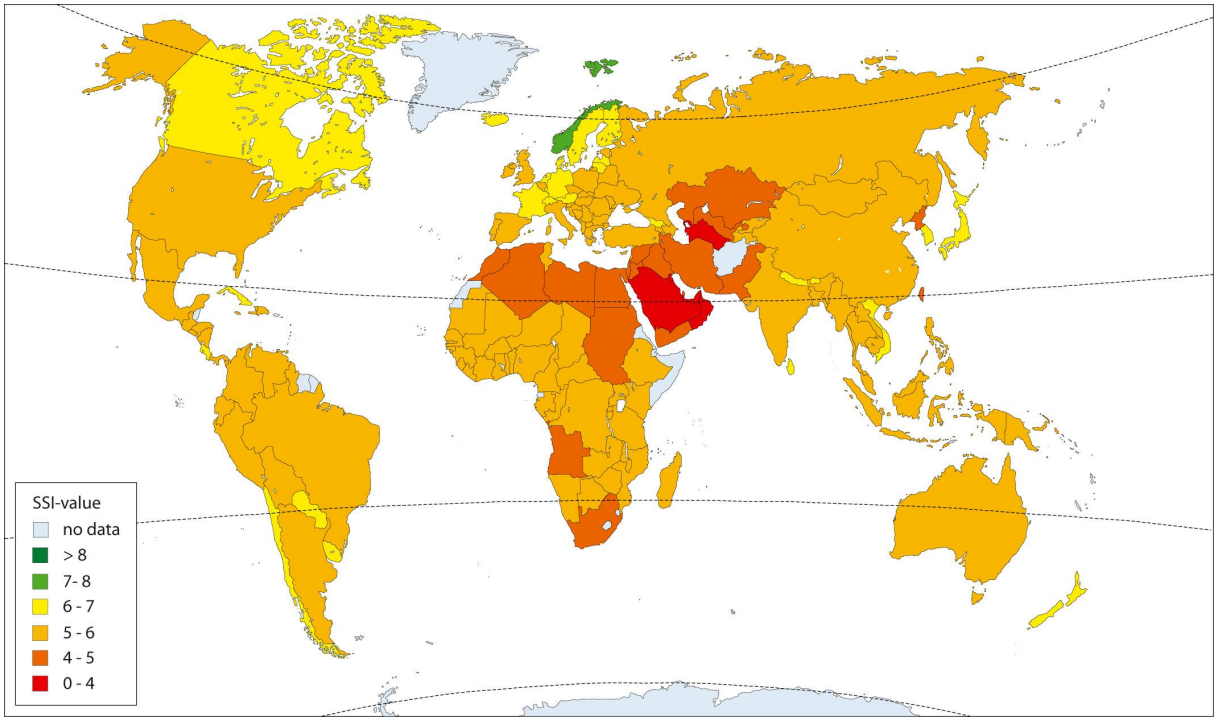


Figure 3. Overall SSI score

The world map shows at a glance the level of sustainability of 150 countries for which the SSI could be calculated. With a 7.0 Norway is number 1 on the SSI ranking list (see also Annex 2). The world at large scores lower than 6 on average. Western Europe and a couple of other countries, 27 in total, score 6.0 or above, relatively positive. However, even all these countries are way below the 10 of full sustainability. Many of the lower scores are for countries in Africa, the Middle East and Western Asia, the oil-rich countries bringing up the rear.

4.2 Results for each of the 5 categories

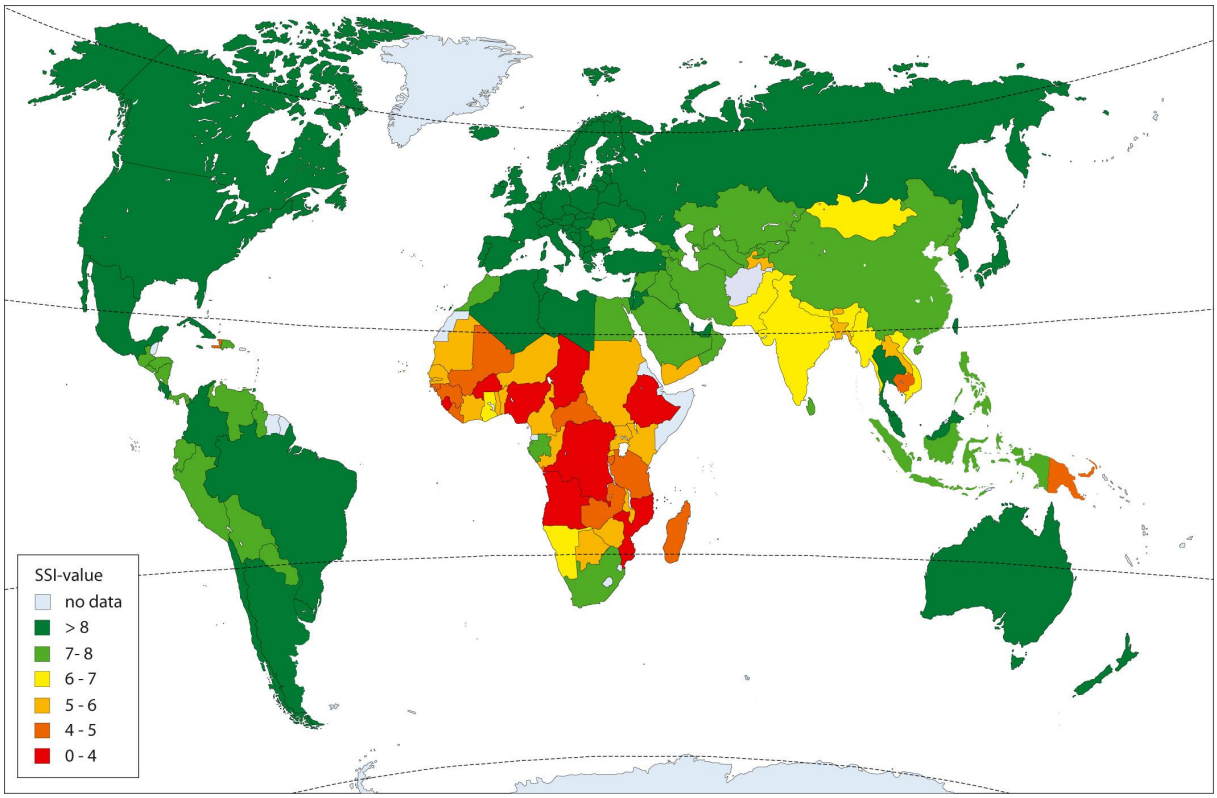


Figure 4. Scores for Personal Development

4.2.1 Personal Development

Worldwide large differences are found in Personal Development. 66 of the 150 assessed countries score an 8 (80% of the sustainability value) or above for this category. Out of 30 countries with the lowest scores no less than 25 are found in Africa.

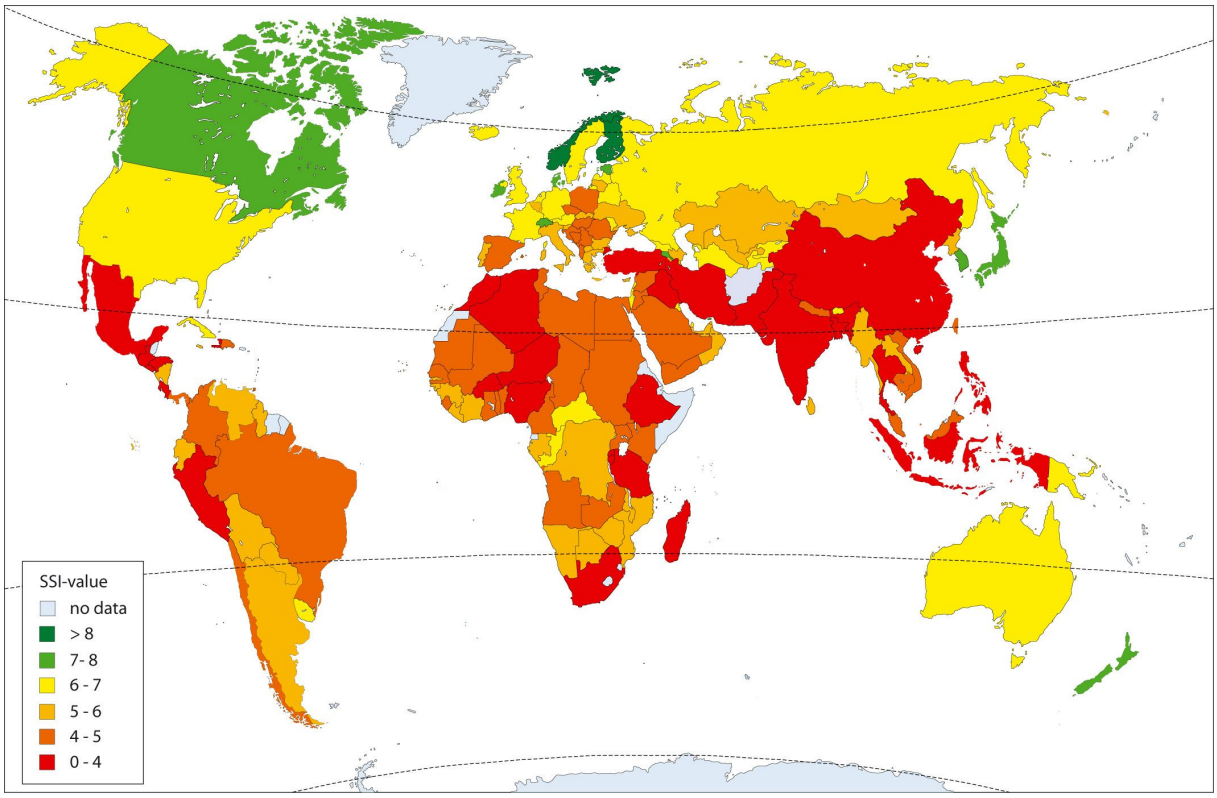


Figure 5. Scores for Clean Environment

4.2.2 Clean Environment

No more than 11 countries score a 7 or higher on Clean Environment, with Norway and Finland being the only ones scoring higher than 8.

In the top of the list we find many industrialized countries, but for example also two African countries: Congo and the Central African Republic. The 30 lowest scoring countries do – surprisingly? – not comprise a single high-industrialized country. China is third from the bottom, just above Pakistan and Haiti.

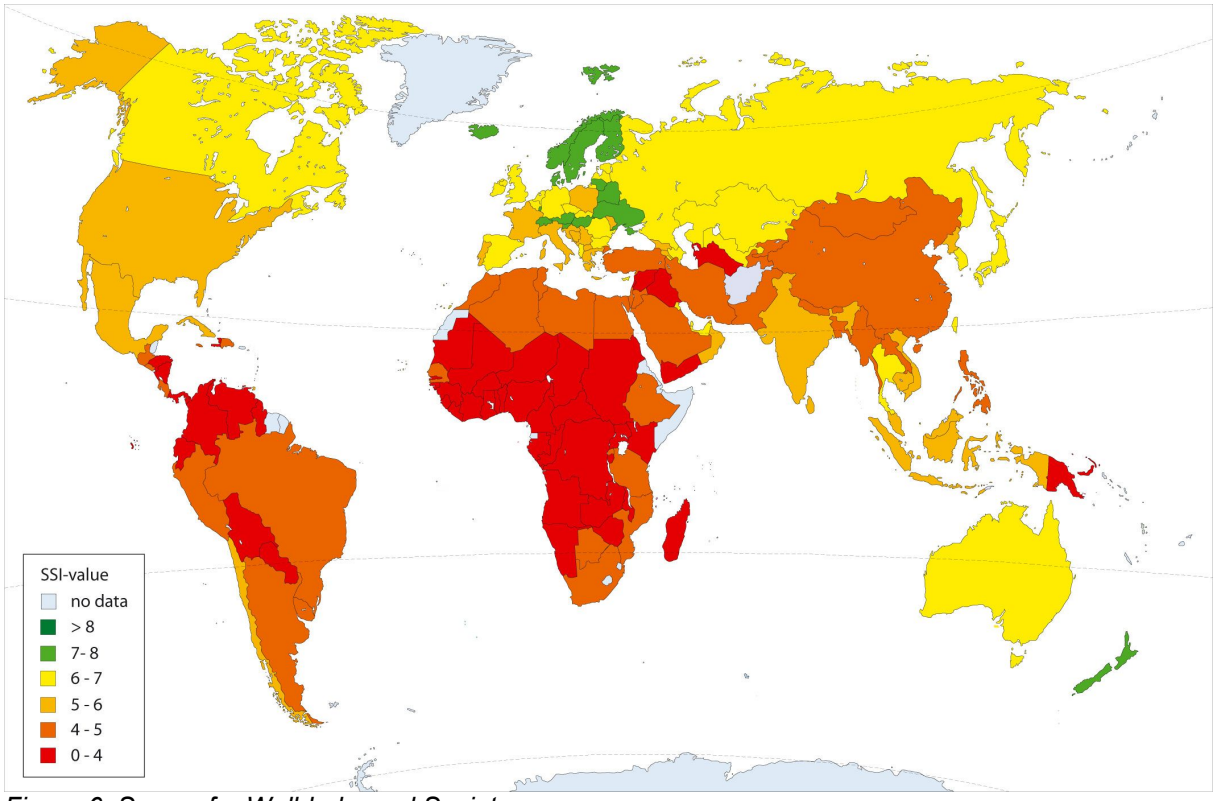


Figure 6. Scores for Well-balanced Society

4.2.3 Well-balanced Society

Norway tops the list for this category too. Among the top-thirty we also find Belarus. This last remaining European dictatorship takes 7th place, the dramatically low score for indicator 10 (Good Governance) notwithstanding. The high overall score is due to the good marks for the other 4 indicators, although they may possibly be overestimated.

The final 30 places are all occupied by non-western countries, among which the oil-rich countries Nigeria, Venezuela and Iraq. Bringing up the rear is Sierra Leone, partly due to very high unemployment and extremely unequal income distribution.

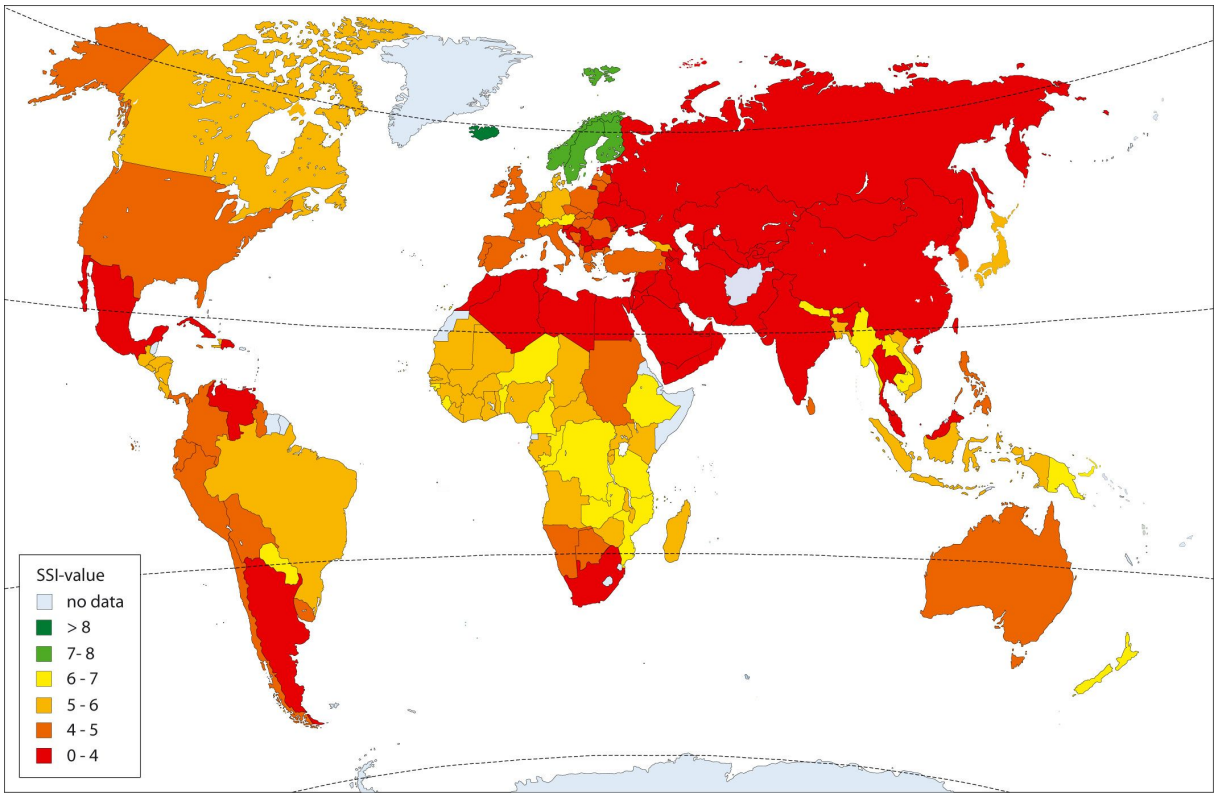


Figure 7. Scores for Sustainable Use of Resources

4.2.4 Sustainable Use of Resources

Iceland comes out best, thanks to a high score for both Use of Renewable Water Resources and Consumption of Renewable Energy (Iceland mostly uses hydropower and geothermal energy as energy sources). Kuwait takes last place with a score of a round zero. Worldwide, the use of resources is all but sustainable. The Middle East, the countries around the Caspian Sea and countries in North Africa receive the lowest scores, often due to very low scores for all three indicators.

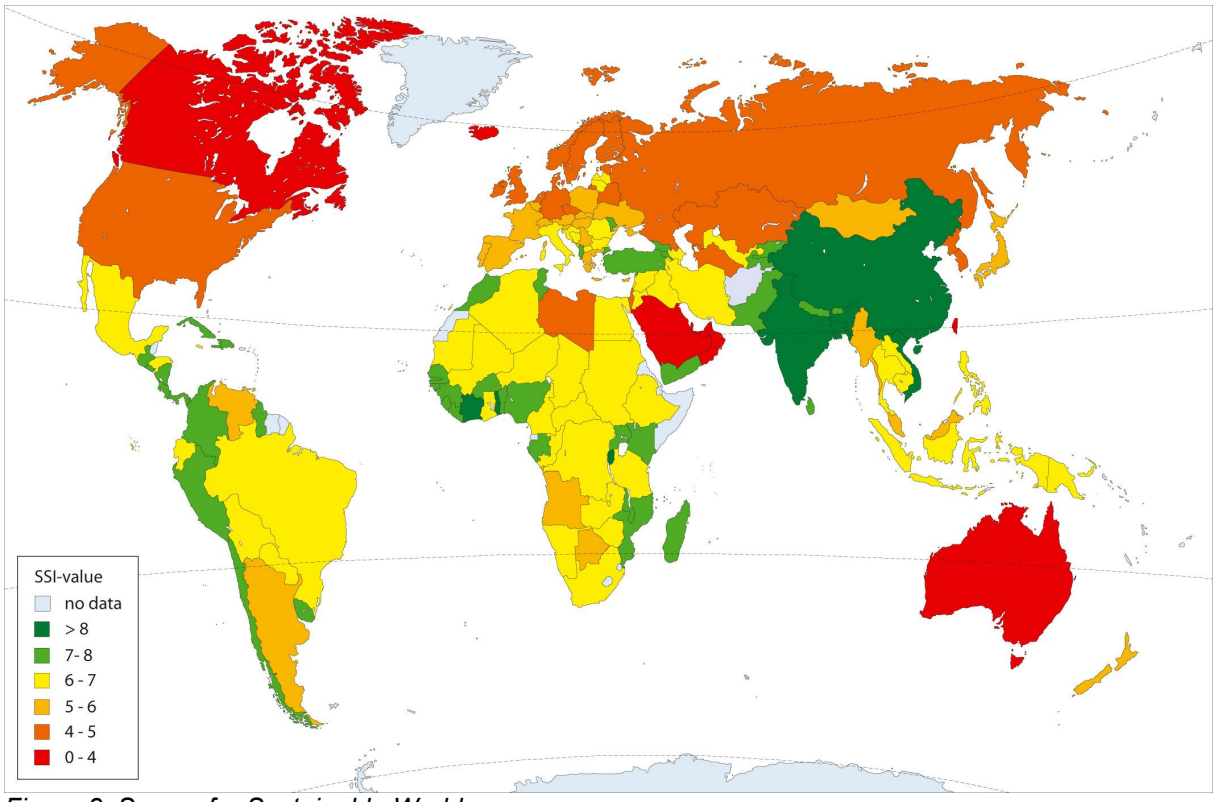


Figure 8. Scores for Sustainable World

4.2.5 Sustainable World

On the top of the list we find – quite surprisingly – India, followed by Vietnam and China. According to the available data all three countries have extended their forest area, emit little CO_2 per capita and have a small footprint. With their rapidly growing economies particularly India and China cannot be expected to be able to maintain their top position.

The rich OECD-countries score badly with respect to Sustainable World. The highest scoring OECD-country, Turkey, can be found on 32nd place, and the next on the list, Italy, only on place 83. At the bottom of the list we find three oil-rich countries, followed by Australia, its low position due to deforestation, high CO_2-emissions and a large footprint.

Countries with a large forestry industry like Brazil and Indonesia – despite a zero for the indicator Forest Area – still score over 6 for this category due to the high score for the remaining 4 indicators.

More details can be found on the website, www.nederlandduurzaam.nl (both in English and Dutch).

4.3 Regional differences

The results of the five categories for four regions are shown in spider webs (Figures 9 – 12). This illustrates the great differences in development towards sustainability between the four regions. All four regions are way below full sustainability. Europe scores relatively high on Personal Development, rather low on Well-balanced Society and Clean Environment and very low on Sustainable Use of Resources and Sustainable World. Africa scores lower than Europe on all categories, apart from Sustainable World. Compared to Africa, Latin & South-America scores much better on Personal Development and also on Well-balanced Society. The other three categories differ only slightly. Asia shows a very bad performance on Sustainable use of Resources.

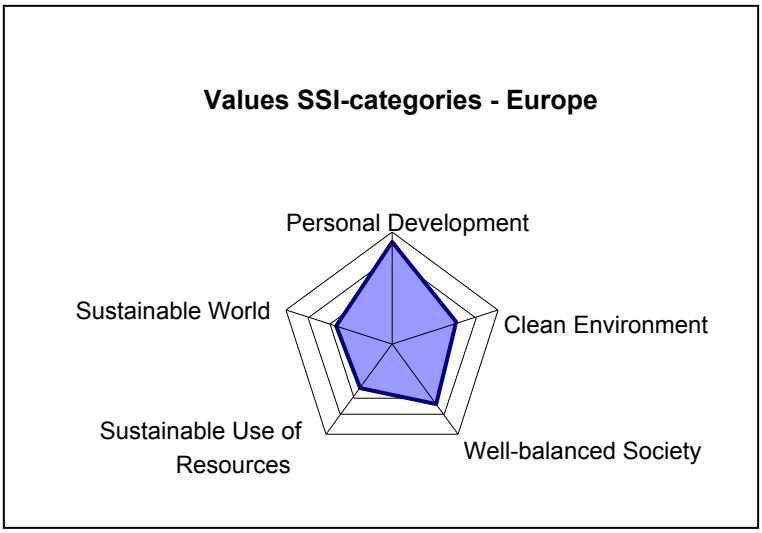


Figure 9. SSI-categories – Europe

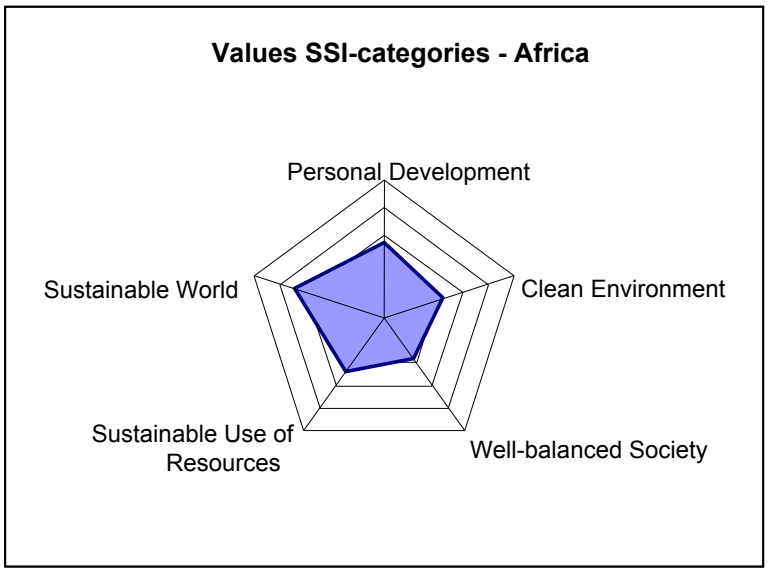


Figure 10. SSI-categories – Africa

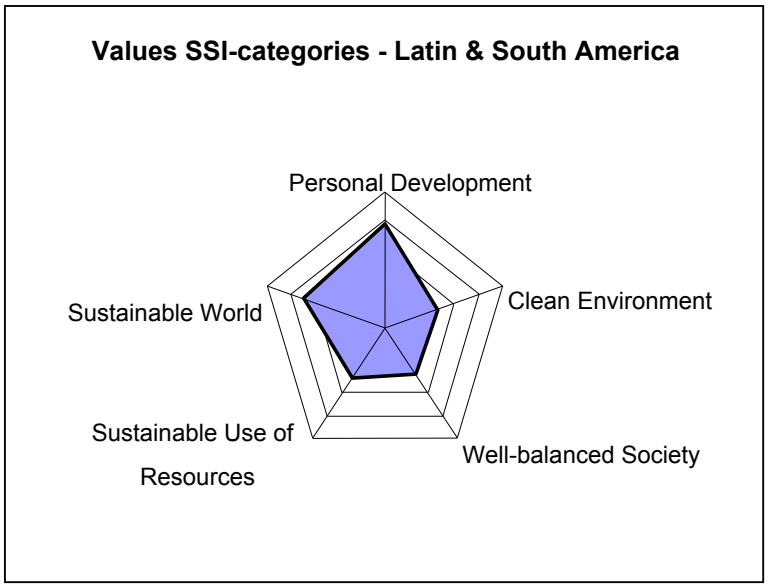


Figure 11. SSI-categories – Latin & South America

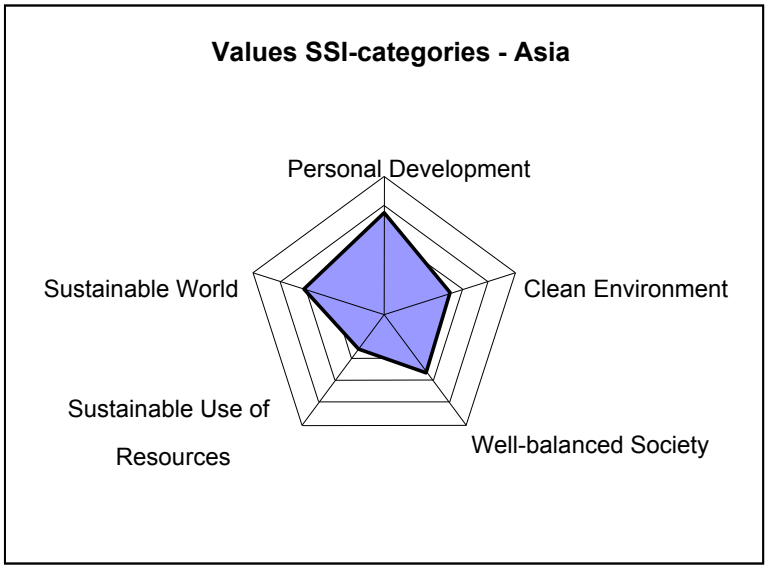
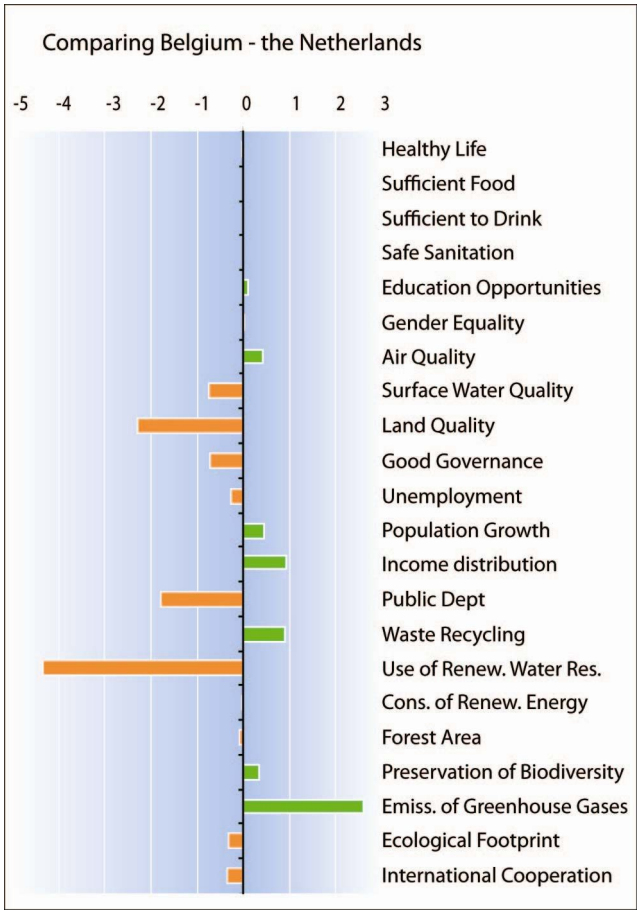


Figure 12, SSI-categories – Asia

5. Proposed use of the SSI

Having developed the SSI, several possible ways of using it come up:

1. To enlarge the awareness of people about the extent of (un)sustainability of their own country. This requires extensive press and media coverage.
2. To use it as a policy instrument for all government levels. For instance at national level, each indicator can be assigned to a specific ministry. This ministry will be responsible for the development towards sustainability with respect to this indicator. Frequent monitoring of progress will stimulate to reach the objectives set according to the scheme upon which the government has decided.
3. To use for NGOs to help them with their strategy towards Sustainability.
4. To use for easy communication between actor-networks at all levels of human society.
5. To compare the scores of countries in order to learn and to stimulate each other to make progress on the way to sustainability. In Box 5 a comparison has been made between two neighboring and rather comparable countries, Belgium and The Netherlands.
6. To use for educational purposes at all levels.



The graph shows the difference when deducting the value of an indicator of The Netherlands from the value of the corresponding one of Belgium. So a bar on the left side shows a better performance of The Netherlands, a bar on the right side indicates that Belgium is doing better.

The Netherlands and Belgium are in many ways comparable countries. For many indicators only slight differences between the two countries can be found. Nevertheless, considerable differences are found for some indicators. The main difference, on Use of Renewable Water Resources, is mainly due to geographical conditions. Belgium must do without the river Rhine, the main supply of water to The Netherlands (where rain is second best).

Other differences may reflect a difference in government policy in The Netherlands and in Belgium. It appears that Belgium is doing better on Air Quality, Population Growth, Income Distribution, Waste Recycling and especially Emission of Greenhouse Gases. The Netherlands score higher on Surface Water Quality, Land Quality, Good Governance and Public Debt.

Box 5. Comparison of the score for each indicator for Belgium and The Netherlands

6. Further research and development on the SSI

On several aspects of the SSI further research is required. Apart from the lessons that will be learned by using the SSI, research and development will be done on the following subjects:

1. To evaluate the relevance of each indicator.
2. To reconsider the three indicators, which are related to energy (17, 20 and 21).
3. To define the sustainability values for those indicators of which the sustainability values are as yet unknown and to refine the sustainability values for the other indicators.
4. To evaluate reliability of data.
5. To evaluate the calculation methods used, including the weights given to indicators and categories for calculating the SSI.
6. To analyze sensitivity of the assumptions used in the calculation of the SSI more extensively.
7. To develop the SSI for regional, sub-national levels.
8. To prepare the SSI for possible use for various branches (a test is now being executed for greenhouse culture).

> *We need to learn, but we need to waste no time with our learning.*
>
> Donella Meadows, 1998

7. Conclusion

It is demonstrated that the SSI is an easy instrument to assess a country's sustainability. The SSI shows at a glance the present level of sustainability of a country and the distance to full sustainability. Since the SSI only has a limited number of indicators, it is easy to understand, to use and to maintain. The SSI offers a country a practical tool to define goals on its way to sustainability and to monitor the progress over time. The underlying data offer the opportunity to analyze differences between countries and thus provide additional stimuli for improvements.

The very justified question why to develop a new index while so many exist already, has been answered in section 2 by reviewing the main existing indexes and sets of indicators – with respect to sustainability – on a national level. The preference of the SSI over existing indexes can be found in its transparency, its limited number of indicators and therefore its ease of use. Furthermore, the SSI covers sustainability in its broad sense, including social, environmental, ecological and institutional aspects, while most other indexes do so only partly. The complete data set and results of the SSI are available through the website (www.nederlandduurzaam.nl).

One of the main objections to the SSI is the aggregation of all indicators into one single figure for the Index. Should one only consider this figure in isolation, the results may be misleading and can easily be misused. That objection is inextricably bound up with aggregation into one final figure. It stresses the responsibility to present all the results of the SSI – values of all indicators and categories – in a transparent and easily understandable way.

As outlined briefly in section 6, further research is needed on several important items of the SSI. This will be done the next months and years. In every two-yearly update of the SSI the latest developments and results of research will be included. Comments and suggestions are very welcome.

References

Relevant literature

Anielski, Mark and Jonathan Rowe, 1999, *The Genuine Progress Indicator: Update 1998.*

Bell, S. and S. Morse, *Measuring Sustainability; learning from doing*, Sterling Earthscan Publications Ltd, London, 2003

Bergh, J.C.J.M.. van den, *Abolishing GDP*, 2007. .

Bergh, J.C.J.M. van den, *Ecological economics: themes, approaches, and differences with environmental economies*, Regional Environmental Change, Springer, Berlin, 2001, pp 13-23

Bergh, J.C.J.M. van den, and J. van der Straaten (eds.), *Towards Sustainable Development: Concepts, Methods and Policy,* Island Press, Washington D.C., 1994.

Coomer, J., *The Nature of the Quest for a Sustainable Society*. In: J. Coomer (Ed.), *Quest for a Sustainable Society*. Oxford: Pergamon Press, 1979.

Daly, H.E. and J. Cobb, *For the Common Good, Redirecting the Economy Toward Community, Environment and a Sustainable Future*. Beacon Press, Boston, MA, 1989.

Diamond, J., *Collapse: How Societies Choose to Fail or Succeed*, Penguin Group, 2005

Ebert, U. and H. Welsch, *Meaningful environmental indices: a social choice approach*, Journal of Environmental Economics and Management 47, 2004, pp 270 – 283.

Frazier J.G., *Sustainable Development: modern elixir or sack dress?*, Environmental Conservation, 1997, pp 182-193.

Guy, G.B. and C.J. Kibert, *Developing indicators of sustainability – US experience,* Building Research and Information, 1998

Hales, D. and R. Prescott-Allen, *Flying Blind: Assessing Progress Toward Sustainability*. In D.C. Esty and M.H. Ivanova (eds) Global environmental governance: options and opportunities. Yale Center for Environmental Law and Policy, 2002

Hecht, J.E., *Tracking Sustainability: A Review of Strategies*, USEPA Workshop on Sustainability, 2006

Hueting, R., *New scarcity and economic growth*, North-Holland, Amsterdam 1980.

IUCN/UNEP/WWF, *Caring for the Earth: A strategy for Sustainable Living*, IUCN/UNEP/WWF, Gland, Switzerland, 1991

Kerk, G.R. van de, *Lang leve de aarde en al haar bewoners*, De Vijver, The Netherlands, 2003

Kerk, G.R. van de, *Nederland duurzaam?*, De Vijver, The Netherlands, 2006

Liverman, D.M. and M.E. Hanson, B.J. Brown and R.W. Merideth Jr., *Global Sustainability: Toward measurement*, Environmental Management, 1988, pp 133-143

Meadows, D., *Indicators and Information Systems for Sustainable Development,* The Sustainability Institute, Hartland Four Corners, VT, 1998

Meadows, D.H. and D.L. Meadows, J. Randers, W.W. Behrens, *The limits to Growth*, Universe Books, New York, 1972

Mebratu, D., *Sustainability and sustainable development: Historical and conceptual review*, Environmental Impact Assessment Review 1998, pp 493 - 520

Nagelhout, D., *Indicatoren en duurzaamheidsindex*, Netherlands Environmental Assessment Agency, 2006

O'Riordan, T., *The politics of sustainability*, in Turner, R.K., ed. Sustainable Environmental Management: Principles and Practice. Belhaven Press, London, 1988

Pearce, A.R., *Defining sustainability: a content analysis comparison of definitions from the literature*, Georgia Tech Research Institute, Atlanta GA, USA

Pezzey, J., *Definitions of sustainability*, Working Paper No. 9, Institute of Behavioral Sciences, University of Colorado, 1989

Prescott-Allen, R., *The Wellbeing of Nations*, Island Press, 2001

Solow, R.M., *Sustainability: An economist's perspective*, in Economics of the environment, W.W. Norton & Cy, New York, 1993

Wackernagel, Mathis, and William Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, British Columbia, 1996

WCED, World Commission on Environment and Development, *Our Common Future*, Oxford University Press, 1987

Relevant reports

Education at a glance – OECD, 2006
EPI 2006 –Environmental Performance Index 2006, Yale University and Columbia University, USA
ESI 2005 –Environmental Sustainability Index 2005, Yale University and Columbia University, USA
FAO Global Forest Assessment 2005 – FAO, 2006
Global Biodiversity Outlook 2 – Convention on Biological Diversity, 2006
Global Monitoring Report 2005 – Millennium Development Goals, IBRD, 2005
Human Development Report 2005 –United Nations, 2005
Living Planet Report 2004 – Jonathan Loh and Mathis Wackernagel, WWF, 2004
Milieubalans 2005, 2006 – Netherlands Environmental Assessment Agency, 2005, 2006
Millennium Development Goals Report – United Nations, 2005
Nationale Milieuverkenning 6 2006-2040 – Netherlands Environmental Assessment Agency, 2006
Natuurbalans 2005, 2006 – Netherlands Environmental Assessment Agency, 2005, 2006
State of the World 2005 – Worldwatch Institute, 2005
The Wellbeing of Nations – Robert Prescott-Allen, 2001
UNHCR Annual Report 2004 – United Nations, 2004
Where is the Wealth of Nations? – World Bank, 2006
World Development Report 2004 – World Bank, 2004
World Population – United Nations, 2004

Relevant websites:

assets.panda.org/downloads/lpr2004.pdf – Living Planet Report 2004
biodiv.org – Convention on Biological Diversity
cbs.nl – Statistics Netherlands, The Netherlands
cdiac.ornl.gov – Carbon Dioxide Information Analysis Center
cgdev.org/section/initiatives/_active/cdi – Center for Global Development
ciesin.columbia.edu/indicators/esi – Environmental Sustainability Index 2005
earthtrends.wri.org/ – databank of World Resources Institute
ec.europa.eu/energy/index_nl.html - EU site on (renewable) energy
epp.eurostat.ec.europa.eu/portal – databank of Eurostat, Statistical Office of the EU
fairtrade.net/contactus/html – information about Fair Trade organizations
fao.org/ag/agl/aglw/aquastat/main – Aquastat – FAO databank with respect to water
fao.org/forestry/site/fra2005/en – Global Forest Assessment 2005
footprintnetwork.org – Ecological Footprint site
foreignpolicy.com – Failed States Index
hdr.undp.org – Human Development Reports van de UNDP
iisd.ca – International Institute for Sustainable Development
ipcc.ch – UN – International Panel on Climate Change
isric.org – World Soil Information, Wageningen, The Netherlands
iucn.org – The World Conservation Union
millenniumindicators.un.org/unsd/mi/mi_goals.asp * – UN Statistics Division – Millennium Indicators
mnp.nl – Netherlands Environmental Assessment Agency
oecd.org/statsportal – OECD databank
rprogress.org – The Genuine Progress Indicator
unep.org – United Nations Environmental Programme
unfccc.org – United Nations Framework Convention on Climate Change
un.org/esa/sustdev/natlinfo/indicators/isd.htm – UN Indicators of Sustainable Development
worldbank.org – World Bank
worldbank.org/wbi/governance/govdata – World Bank – Governance Indicators
worldwatch.org – Worldwatch Institute
wri.org – World Resources Institute
yale.edu/epi – Environmental Performance Index 2006

Annex 1: List of indicators

1. HEALTHY LIFE
Description: life expectation at birth in number of healthy life years − Hale
Source: WHO
Year: 2002
Formula: F(x) = (X-20)/60*10
Range of validity: 20 ≤ x ≤ 80

2. SUFFICIENT FOOD
Description: number of undernourished people as percentage of the total population
Source: FAO
Year: 2000 – 2002
Formula: F(x) = (100-X)/100*10.
Range of validity: 0 ≤ x ≤ 100

3. SUFFICIENT TO DRINK
Description: number of people with sustainable access to an improved water source as percentage of the total population
Source: WHO
Year: 2002
Formula: F(x) = X/100*10.
Range of validity: 0 ≤ x ≤ 100

4. SAFE SANITATION
Description: number of people with sustainable access to improved sanitation as percentage of the total population
Source: WHO
Year: 2002
Formula: F(x) = X/100*10.
Range of validity: 0 ≤ x ≤ 100

5. EDUCATION OPPORTUNITIES
Description: combined gross enrolment ratio for primary, secondary and tertiary schools
Source: Unesco
Year: 2002 / 2003
Formula: F(x) = X/100*10.
Range of validity: 0 ≤ x ≤ 100

6. GENDER EQUALITY
Description: Gender Related Development Index
Source: UNDP
Year: 2003
Formula: F(x) = X*10.
Range of validity: 0 ≤ x ≤ 1

7. AIR QUALITY
Description: air quality with respect to concentration of NO_2, SO_2, fine particulate matter and indoor air pollution from solid fuel use
Source: ESI
Year: 1993 – 2004
Formula: F(x) = (X+1.8)/4*10.
Range of validity: -1.8 ≤ x ≤ 2.2

8. SURFACE WATER QUALITY
Description: Surface Water Quality based on dissolved oxygen concentration, electrical conductivity, phosphorus concentration and concentration of suspended solids
Source: ESI
Year: 1993 – 2003

Formula: F(x) = (X+2)/4*10.
Range of validity: -2 ≤ x ≤ 2

9. LAND QUALITY
Description: degraded land as percentage of cultivated and modified land, the LQ-score
Source: HWI
Year: about 1997
Formula: F(x) = X/100*10.
Range of validity: 0 ≤ x ≤ 100

10. GOOD GOVERNANCE
Description: the average of the values of the 6 Governance Indicators of the World Bank
Source: World Bank
Year: 2004
Formula: F(x) = (X+15)/30*10.
Range of validity: -15 ≤ x ≤ 15

11. UNEMPLOYMENT
Description: employment as percentage of total labor force
Source: World Factbook 2006
Year: 2000-2004
Formula: F(x) = exp(-0.1*X)*10 for 0 ≤ x ≤ 60
F(x) = 0 for X > 60

12. POPULATION GROWTH
Description: average population growth in the period 2000 – 2005
Source: WRI
Year: 2002
Formula: F(x) = (1-(X+1.5)/6.5)*10.
Range of validity: -1.5 ≤ x ≤ 5

13. INCOME DISTRIBUTION
Description: income of the richest 10% to the poorest 10% of the people in a country
Source: HDR
Year: 1989 tot 2003
Formula: F(x) = exp(-0.1*(X-4.5))*10
Range of validity: 4.5 ≤ x ≤ 129

14. PUBLIC DEBT
Description: the level of public debt – and if this figure is lacking, the foreign debt – of a country as percentage of Gross Domestic Product
Source: IMF
Year: 2005
Formula: F(x) = exp(-0.009*X)*10.
Range of validity: 0 ≤ x ≤ 793

15. WASTE RECYCLING
Description: amount of recycled solid waste as percentage of the total amount of solid waste
Source: ESI
Year: 1996 – 2003
Formula: F(x) = X/100*10.
Range of validity: 0 ≤ x ≤ 100

16. USE OF RENEWABLE WATER RESOURCES
Description: water consumption per year as percentage of the total available renewable water resources
Source: WRI
Year: 2004
Formula: F(x) = (100-X)*10 for 0 ≤ x ≤ 100
F(x) = 0 for X > 100

17. CONSUMPTION OF RENEWABLE ENERGY
Description: consumption of renewable energy as percentage of total energy consumption
Source: WRI
Year: 2001
Formula: F(x) = X/100*10.
Range of validity: 0 ≤ x ≤ 100

18. FOREST AREA
Description: change in forest area of a country as pro mille content of world forest area in the period 1990 – 2000
Source: WRI
Year: 2000
Formula: F(x) = 0 for X < -0,7
F(x) = (10*X+7)^2*(-20*X+19)/11^3*10 for -0.7 ≤ x ≤ 0.4
F(x) = 10 for X > 0.4

19. PRESERVATION OF BIODIVERSITY
Description: National Biodiversity Index
Source: Global Biodiversity Outlook
Year: 2001
Formula: F(x) = X*10.
Range of validity: 0 ≤ x ≤ 1

20. EMISSION OF GREENHOUSE GASES
Description: CO_2 emission per capita
Source: CDIAC
Year: 2002
Formula: F(x) = 10-X for 0 ≤ x ≤ 10
F(x)=0 for X > 10

21. ECOLOGICAL FOOTPRINT
Description: the ecological footprint in hectares per capita
Source: WWF, Living Planet Report 2004
Year: 2001
Formula: F(x) = 10-3*X/1.8 for 0 ≤ x ≤ 6
F(x) = 0 for X > 6

22. INTERNATIONAL COOPERATION
Description: participation in 14 international treaties and agreements with respect to human rights, nature and environment
Source: HDR and ESI
Year: 2004, 2005
Formula: F(x) = X*10
Range of validity: 0 ≤ x ≤ 1

Annex 2: List of SSI-scores for 150 countries

Rank	Country	SSI
1	Norway	7.0
2	Switzerland	6.9
3	Sweden	6.8
4	Finland	6.7
5	New Zealand	6.7
6	Austria	6.7
7	Iceland	6.6
8	Vietnam	6.4
9	Georgia	6.3
10	Japan	6.3
11	Uruguay	6.3
12	Netherlands	6.2
13	Canada	6.1
14	Bhutan	6.1
15	Denmark	6.1
16	Latvia	6.1
17	France	6.1
18	Paraguay	6.1
19	Korea, South	6.1
20	Nepal	6.1
21	Lithuania	6.1
22	Cuba	6.0
23	Costa Rica	6.0
24	Chile	6.0
25	Luxembourg	6.0
26	Sri Lanka	6.0
27	Germany	6.0
28	Cote d'Ivoire	5.9
29	Colombia	5.9
30	Mozambique	5.9
31	Portugal	5.9
32	Hungary	5.9
33	Gabon	5.9
34	Gambia	5.9
35	Congo	5.9
36	Slovak Republic	5.9
37	United Kingdom	5.9
38	Rwanda	5.9
39	Kenya	5.8
40	Italy	5.8
41	Albania	5.8
42	Bangladesh	5.8
43	Nicaragua	5.8
44	Benin	5.8
45	Spain	5.8
46	Ireland	5.8
47	Myanmar	5.8
48	Belgium	5.8
49	Turkey	5.8
50	Guyana	5.8
51	Indonesia	5.7
52	Brazil	5.7
53	Laos	5.7
54	Cambodia	5.7
55	Guinea	5.7
56	Malawi	5.7
57	El Salvador	5.7
58	Armenia	5.7
59	Tanzania	5.7
60	Togo	5.7
61	United States	5.7
62	Australia	5.7
63	Ghana	5.7
64	India	5.7
65	Panama	5.7
66	Central African Republic	5.6
67	Cameroon	5.6
68	Peru	5.6
69	Poland	5.6
70	Jamaica	5.6
71	Slovenia	5.6
72	Papua New Guinea	5.6
73	Guatemala	5.6
74	Belarus	5.6
75	Ecuador	5.6
76	Moldova	5.6
77	Uganda	5.6
78	Guinea-Bissau	5.5
79	Croatia	5.5
80	Madagascar	5.5
81	Kyrgyz Republic	5.5
82	Romania	5.5
83	Senegal	5.5
84	Macedonia	5.5
85	Estonia	5.5
86	China	5.5
87	Greece	5.5
88	Russia	5.5
89	Ukraine	5.5
90	Bosnia-Herzegovina	5.4
91	Philippines	5.4
92	Liberia	5.4
93	Bulgaria	5.4
94	Dominican Republic	5.4
95	Bolivia	5.4
96	Czech Republic	5.4
97	Congo, Dem. Rep.	5.4
98	Haiti	5.4
99	Sierra Leone	5.3
100	Burkina Faso	5.3
101	Zambia	5.3
102	Argentina	5.3
103	Namibia	5.3

104	Cyprus	5.3
105	Ethiopia	5.3
106	Botswana	5.2
107	Zimbabwe	5.2
108	Mauritania	5.2
109	Trinidad and Tobago	5.2
110	Burundi	5.2
111	Mali	5.2
112	Nigeria	5.2
113	Azerbaijan	5.2
114	Lebanon	5.2
115	Serbia and Montenegro	5.2
116	Mexico	5.2
117	Malaysia	5.2
118	Chad	5.1
119	Thailand	5.1
120	Venezuela	5.1
121	Tunisia	5.1
122	Tajikistan	5.0
123	Honduras	5.0
124	Mongolia	5.0
125	Niger	5.0
126	Angola	4.9
127	Morocco	4.9
128	Israel	4.9
129	Kazakhstan	4.9
130	Taiwan	4.7
131	Algeria	4.7
132	Korea, North	4.7
133	South Africa	4.7
134	Sudan	4.7
135	Pakistan	4.6
136	Uzbekistan	4.5
137	Syria	4.5
138	Iran	4.5
139	Egypt	4.5
140	Jordan	4.4
141	Malta	4.2
142	Yemen	4.1
143	Iraq	4.0
144	Qatar	4.0
145	Libya	4.0
146	Kuwait	3.9
147	United Arab Emirates	3.9
148	Turkmenistan	3.8
149	Oman	3.7
150	Saudi Arabia	3.4