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Analysis of the Yale Environmental Performance Index (EPI)

Ecologic,
Institute for International and European Environmental Policy, Berlin

On behalf of the Federal Environment Agency

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Analysis of the Yale Environmental Performance Index (EPI)

- Final report -

February 2007

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Executive Summary

The Environmental Performance Index (EPI) is a research project aiming at establishing an international composite environment index. It is jointly implemented by two US-Universities (Yale/New Haven and Columbia/New York) and has been commissioned by the World Economic Forum/Davos. The research project attempts to facilitate quantitative cross-country comparison of the environmental performance of countries with the objective of enhancing conditions of success for environmental policies. It further strives to complement the environment indicator set of the United Nations Millennium Development Goals.

The EPI identifies scores/targets for several core environmental policy categories and measures how close countries come to meet them. In addition to publishing the composite index and individual country scores, a country ranking is released. The most recent publication of the Pilot-EPI (2006) has placed Germany in the 22nd position, which compares to a lower rank among Industrialised Countries. This study has traced the individual results for Germany, based on an analysis of data sources and data quality as well as an assessment of the underlying methodology of the composite index. As part of this assessment, the scientific validity of the ranking has been investigated.

At this point in time, it cannot be conceded that the claim to establish an analytically sound quantitative composite index has been achieved. The explanatory power of the cross-country comparison for Germany is low due to significant and obvious methodological deficiencies and problems of the composite index. However, the remarkable political and media attention, which has been generated by the Environmental Performance Index within a short period of time, has an important positive aspect. This public exposure is helpful to identify more entry points to initiative substantive debates on cross-country data sets in the environment field at the international level.

Regarding the relevance of the EPI for adequately assessing German environment politics and policies, a number of pivotal factors could be singled out. These include the selection, conceptualisation and weighting of individual indicators, the data quality and the policy scores. The selection and weighting of certain policy scores and indicators has been driven by the claim to complement the environment indicator set of the United Nations Millennium Development Goals. Accordingly, the selection reflects above all truly global environmental problems with widespread significance. However, such selection and weighting does not mirror sufficiently the specific dimensions of environmental problems typical for industrialised countries and therefore, reduces significantly the explanatory power of the EPI for Germany.

The low number of indicators as well as the partly low data quality does not permit to capture and assess the environmental performance of a country in its entirety. The selected indicators do not reflect the pivotal environmental problems in a number of policy areas, which are of high concern for a heavily industrialised country such as Germany. This includes in particular environmental problems with a strong quality dimension (for example, access to sanitation is less of a concern compared to the quality of sanitation and sewage treatment). Furthermore, the data sources for some indicators are unclear, the indicator methodology differs significantly from standard national conceptualisation (e.g. Regional Ozone) and in some cases, the results of some indicator conceptualisations are not scientifically sound (e.g. agricultural subsidies).

There are already a number of existing regional cross-country indicator sets of International Organisations (OECD, EU EEA), which offer methodologies that are more scientifically sound and have a higher explanatory power in assessing the environmental performance of Germany.

The relevance of the Environmental Performance Index is based on its explicit political dimension, which aims at stimulating a broad debate on scientifically sound cross-country methodologies and data sets. In this regard, the EPI has contributed significantly due to its combination of intelligent public relations, prominent author team and customer and despite grave data quality issues and obvious methodological deficiencies. It is highly recommendable to make use of this media and political attention to further the scientific debate on cross-country data and indicator development.

Content

I. Introduction

1.1 Environmental Performance Index (EPI)

The Environmental Performance Index (EPI) is a joint research project of two prominent US American Universities (Yale Centre for Environmental Policy and Law, New Haven and Centre for International Earth Science Information Network (CIESIN)/Columbia University, New York) and commissioned by the World Economic Forum/ Davos, with the objective to establish a scientifically sound international composite environment index, which would allow for a sound measurement of quantitative cross-country comparison of environmental performances. The research project further aims at enhancing the analysis with respect to conditions of success for environmental policies.

The EPI identifies scores for several core environmental policy categories and measures how close countries come to meet them. The index is constructed as a composite index, based on sixteen highly aggregated indicators which are weighted differently and which are assessed against absolute targets. In addition to publishing the composite index and individual country scores, a comparative country ranking is released.

The main objective of the Environmental Performance Index is to improve the empirical data basis for long-term environmental protection measures and to facilitate largely improved analytical assessments. The authors of the Environmental Performance Index have very consciously conceptualised the Index as a *political index*, which aims at stimulating an international debate about sound analytical methods and methodologies and how to gauge the environmental performance of states on a quantitative and cross-country basis. Moreover, the authors strive very much to draw attention to the hitherto deficient international data basis for numerous environmental substances and problems and to highlight the necessity for improvements of statistical data collection and indicators.

For the purpose of its initiator, the author team furthermore conceived the Environmental Performance Index as an analytically sound complement for the United Nations Millennium Development Goals.[1] The United Nations Millennium Development Goals, which were endorsed in the year 2000 by the international community, commit States to implement a number of highly critical development goals until the year 2015. The Millennium Development Goal Number Seven (MDG 7) requests states to foster environmental sustainability and to set quality standards for nature protection, natural resource management, human settlements and access to clean drinking water and adequate sanitation. All quality goals have been linked to selected indicators to set standards for measurable scores/targets.

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[1] *Pilot 2006 Environmental Performance Index, Executive Summary, p.1*

Experts unanimously agree in their critiques by pointing out that the given targets and indicator selection of MDG 7 are random, lack clear definitions and are not adequately measurable. The Environmental Performance Index has taken the initiative to improve the environmental dimension of MDG 7 by adding an analytically sound selection of environmental quality targets and an internationally comparable and measurable indicator set, as well as by further developing its methods.

The EPI-Team understands the Environmental Performance Index explicitly as “work-in-progress”. The project has been very consciously drawn up as a long-term research project, which foresees a continuous adjustment and improvement process of its methodological basis, the selection of indicators and data sources for the overall progression of the Index. The author team explicitly welcomes constructive critique and forward-looking proposals for improvements. Taking into account this explicit openness of the project, which is emphasised on almost every page of the study, each critic of the Index has to acknowledge that the authors at least do not claim to have delivered a scientifically sound, comprehensive piece of work.

The EPI author team furthermore empathetically points out that the value added of the Index is not based on the country rankings which have to be understood as a media instrument to stir attention among media and politicians. The real value added, however, lies in a thorough analysis of the data and indicators used in the study. The next publication of the Environmental Performance Index is planned for early January 2008.[2] The most recent publication of the Environmental Performance Index (2006) has placed Germany in the 22nd position, which compares to a lower rank among Industrialised Countries (compare table 2, p.33). The comparably poor placement is based in particular on negative indicator values within the policy categories *biodiversity* and *natural resources*. This study aims at tracing back the individual EPI results for Germany based on an analysis of data sources and data quality, as well as an assessment of the methodology of the Index and the analytical validity of the ranking.

The study features the results of the data source analysis for Germany and discusses the methodology and its related difficulties of the Environmental Performance Index. In addition, the study discusses the results and conclusions of a comparative assessment and comparison of the EPI with other relevant scientific and Germany-related environmental indices (OECD Indicators, EEA core indicators, UBA-core indicator set (DUX) regarding its political and scientific relevance for Germany. A concluding discussion highlights a number of possible and recommendable methodological improvements of the EPI.

[2] *Personal communication (Telephone interview) with Tanja Srebotnjak, Environmental Performance Measurement Project Director, Yale University, 13.11.2.2006*

EPI – Country results Germany

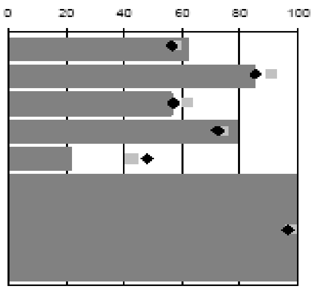
Germany

EUROPEAN UNION +
GDP/capita 2004 est. (PPP) $28,700

Income Decile 2 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	22
Score:	79.4
Income Group Avg.	80.2
Geographic Group Avg.	81.3

Policy Categories



	Country	◆ Income Group	■ Geographic Group
Air Quality	61.3	56.3	57.7
Water Resources	84.5	85.4	90.6
Prod. Nat. Resources	55.9	57.0	61.9
Sustainable Energy	78.3	72.3	74.1
Biodiv. and Habitat	21.1	48.2	42.6
Environmental Health	98.6	96.6	97.2

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
MORTALITY	Child Mortality (deaths/1000 population 1-4)	0.3	*0*	99.0
INDOOR	Indoor Air Pollution (%)	0	*0*	100.0
WATSUP	Drinking Water (%)	100.0	*100*	100.0
ACSAT	Adequate Sanitation (%)	100.0	*100*	100.0
PM10	Urban Particulates (µg/m³)	22.3	*10*	91.3
OZONE	Regional Ozone (ppb)	44.2	*15*	31.4
NLOAD	Nitrogen Loading (mg/L)	98.1	*1*	98.2
OVRSUB	Water Consumption (%)	15.9	*0*	70.9
PWI	Wilderness Protection (%)	0.9	*90*	1.0
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.00	*1*	2.2
HARVEST	Timber Harvest Rate (%)	1.9	*3*	100.0
AGSUB	Agricultural Subsidies (%)	6.0	*0*	34.2
OVRFSH	Overfishing (scale 1-7)	5	*1*	33.3
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	6,382	*1,650*	80.2
RENPC	Renewable Energy (%)	3.8	*100*	3.8
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	80	*0*	93.0

Source: Environmental Performance Index 2006 – Appendix C "Country Profiles", p. 46

1.2 Environmental Sustainability Index (ESI)

The Environental Sustainability Index (ESI), the first joint research product of the Yale and Columbia University team commissioned by the World Economic Forum Davos, had been conceived with the objective of constructing sustainability profiles of States, which would allow for a sound assessment of basic capabilities, to successfully deal with environmental problems over a longer period of time.

The EPI, the second joint research product of the Yale and Columbia University team, and main focus of this study, is not a derivative of the ESI, but instead an independent new Index construct with different objectives.

As a reaction, inter alia, to widely published critiques of methodical deficiencies of the ESI, the University team concentrates now on the further development of the EPI. The further development of the ESI is still under consideration, however, due to financial constraints, but the project has been discontinued for the time being.[3]

A brief discussion of the significance and explanatory power of the ESI for Germany can be found as part of the discussion on comparable indices (see Chapter 2.5.).[4] Here, similar to the EPI, Germany also scored comparably low among industrialised countries.

II. Stocktaking and methodical discussion

The EPI is designed as a so-called composite index based on sixteen highly aggregated indicators, which are weighted differently and assessed against absolute targets. This composite index encompasses three different quality levels of aggregation:

- calculation of values based on 2-5 indicators for six policy categories. These levels of aggregation allow countries to follow the relative environmental performance within its policy frame;
- calculation of values for two broad policy objectives: environmental health and ecosystem vitality; and
- calculation of a general EPI as average of both policy objectives.

The proper assessment of a composite index requires a thorough analysis of these different levels of index aggregation. This includes the selection and quality of data; the selection and conceptualisation of the indicators; the applied weighting of individual indicators; the targets which are used as the indicator measurement baseline; as well as different statistical standard forms, which are usually applied to aggregation and weighting.

The quality and validity of a composite index depends largely upon the quality of indicators, which in turn depend largely on the quality of the data in use. A sound index will always disclose its methodology, conceptualisation of indicators and data sources to allow for a transparent assessment and check. The observation of trend developments will always become problematic if data sources, methodological development and selection of indicators are continuously changing, thus new results are difficult to compare. An improved ranking over a period of time may reflect changes that cannot necessarily be linked to real environmental improvements but might have been caused by methodical causes.

2.1 Quality of data and indicators

Data source analysis and data quality

Data quality is a pivotal problem for most indicators. Experiences have shown that the high amount of time and costs needed for the development of comparable cross-country environmental indicators often

[3] *Personal communication (Telephone interview) with Tanja Srebotnjak, Environmental Performance Measurement Project Director, Yale University, 13.11.2.2006*

[4] *Originally, a more in depth review of the ESI and an assessment of its results for Germany was planned as well. Given that the ESI will currently not be further refined, the study concentrated instead more in depth on the EPI.*

seriously limits quality indicator conceptualisation. In addition, most often available data sources do not provide sufficient quality data. As a consequence, data is chosen that only allows for an assessment of some easily measurable aspects of an indicator or that stems from only 1-2 sources, which hardly permits to seriously trace the development for an indicator over time.

In the opinion of the authors, the lack of reliable, internationally comparable data sets have put serious constraints on the results of the EPI. It has only been possible to retrieve quality data for 133 countries. The authors point out that the EPI does not fully meet its challenges, in particular due to the lack of data for certain important environmental policy areas, which should be part of any scientifically sound composite index, including: waste (waste management, recycling and removal; chemicals (impacts of toxic chemicals, heavy metals); air pollution (SO_2-emissions and acid rain); soil protection (erosion, soil productivity); greenhouse gas emissions (beyond CO_2); and ecosystem problems (e.g. loss of wetlands and fragmented human settlements). According to an assessment by the EPI team, it is particularly difficult to identify comparable good data sets on pivotal pollution concentrations for water and air. Here, the international data set availability has been assessed as particularly deficient.

As far as data could be tracked back, the EPI team tried to make use of standardised data sets of the United Nations, as those data sets usually come directly from national statistical commissions and environmental agencies.[5]

Approximately 40% of EPI indicators (six out of sixteen indicators) are based on standardised data sources used by the United Nations (UNEP, FAO, WHO, UNICEF, Population and Statistics divisions of the UN Secretariat, World Bank, WTO). Further data stem from regional organisations (SOPAC, IEA, OECD, EU) as well as known international environmental organisations (IUCN, WWF, WCS) and prominent US American Universities and research facilities, respectively.

Data source analysis for Germany

For Germany, the original national data sources for only six indicators could be traced back (without remedies such as GIS information systems, and within the given time frame), which were all taken from UN databanks (for a more detailed explanation, see Annex 2).

The national data sources for the indicator calculation include:

- urban particulates (data delivered by Federal Environmental Agency through European Environmental Agency);
- drinking water (data delivered by National Statistical Agency through WHO and UN Secretariat);
- sanitation (data delivered by National Statistical Agency through WHO and UN Secretariat);
- child mortality (data delivered by National Statistical Agency through UNICEF and UN Secretariat);

- timber harvest rate (data delivered by Federal Ministry for Nutrition, Agriculture and Consumer Protection through UNECE/EUROSTAT and FAO);
- agricultural subsidies (data delivered by Federal Ministry for Nutrition, Agriculture and Consumer Protection *(Notification Aid reports)* through UNECE/EUROSTAT and EU Commission).

For another four indicators, only certain aspects of the data sources for each individual indicator could be traced back to its original data source:

- overfishing (data on fishing yields delivered by Federal Ministry for Nutrition, Agriculture and Consumer Protection / Federal research office for fisheries through FAO);
- ecosystem protection (data on protected areas delivered by Federal Agency for Nature Protection through UNEP WCMC /IUCN WCPA);
- wilderness protection (data on protected areas delivered by Federal Agency for Nature Protection through UNEP WCMC /IUCN WCPA);
- indoor air pollution (data on health risks delivered by Federal Ministry for Health/WHO Collaboration Centres);

The data sources for another three indicators (all to energy and CO_2-emissions) could only be approximately determined (unclear and vague data source citations). However, in these cases it has to be assumed that the original data sources were national agencies and that the data basis here may be of an acceptable origin (energy data from Federal Ministry for Environment, Federal Ministry for Commerce, Federal Environmental Agency through EU/OECD/IEA).

As for the indicators regional ozone, nitrogen loading and water consumption, the original national data sources could not be traced back due to the complexity of the underlying model calculation and amount of processed data.

The data calculation for nitrogen loading and water consumption, conducted by the WSAG/University of New Hampshire, were and published by the United Nations in its Second World Water Report. The data for regional ozone were generated by German and US American public research facilities (Hamburger Max-Planck-Institute for Meteorology, US-National Centre for Atmospheric Research, National Oceanic and Atmospheric Administration/ Geophysical Fluid Dynamics Laboratory) and processed by researchers at Princeton University/USA.

A final assessment of the data source analysis shows that the EPI-team has tried, wherever possible and available, to make use of standardised international data sources (United Nations, OECD, EU). If those were not available, prominent alternative data sources (public research facilities, universities) were identified and applied. The conducted data source analysis showed only in a few cases vague and

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[5] *UN data has largely been used reflecting the fact that there is internal quality control (such as methodological adjustments etc.). At international level, the UN offers the best and most professionally processed cross-country data. Personal communication (Telephone*

insufficient indications of data sources (compare data source analysis for the indicator over fishing) or a combination of data sources, which did not allow for a sound comparison of primary data (compare data source analysis for the indicator agricultural subsidies). In general, it can be concluded that the EPI team selected its data sources with scepticism and a sense of caution. The data source analysis for Germany revealed that approximately two thirds of the identified original data sources derive from public national agencies (Federal Environmental Agency, Federal Agency for Nature Protection, National Statistical Commission etc.). As for the other, not clearly identified data sources, it can be assumed that they also are derived from public national sources or were generated at least in a scientifically traceable manner.
The quality of the used data sources of the Environmental Performance Index can be assessed as sufficiently good. However, these assessments do not imply that there is no room for urgently needed improvements. The identification of the data sources is not the main criticism of the EPI.

Quality of indicators

The six defined policy categories of the EPI are defined through two to five selected indicators, which are quantitatively measurable. Altogether, nineteen indicators are used, whereby three indicators are used twice for different policy categories (urban particulates, timer harvest rate and water consumption).

The EPI study discusses and justifies the selection of indicators comprehensively. The indicators were chosen based on a broad review of scientifically relevant environmental literature, reference to the Millennium Development Goals and expert opinions. The selection of indicators was done according to a number of criteria, including relevance (relevant indicator under numerous conditions), performance-orientation (indication of on-the-ground results), transparency (with regard to data sources and calculation method) and data quality. For every indicator, one relevant long-term environmental quality target was identified, which, applied to every country, did not show variations and functioned as a benchmark.

Taking into account that international cross-country comparability of data represents the main claim of the Environmental Performance Index, indicators were chosen according to available internationally comparable data sets for environmental substances and critical categories. The existing international data basis is, therefore, the main lynchpin for quality issues and for criticism of the Environmental Performance Index and determines the political relevance of the indicator choice.

In the policy categories discussion (Appendix D), the EPI-team point out that the selection of indicators (and to a limited extent, the selection of policy categories) does not cover a number of crucial standard environmental substances (for example, sulfur dioxide and nitrogen for air pollution); therefore, the selection fails to sufficiently cover the individual policy categories accordingly. The EPI-team makes clear that the current coverage of policy categories through indicators is far from ideal. However, one has to take note that the EPI aims to cover global comparable environmental problems, and certain environmental problems of many regions and countries will therefore only see limited coverage.

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interview) with Tanja Srebotnjak, Environmental Performance Measurement Project Director, Yale University, 13.11.2.2006

Selection of indicators

The reduction of health problems caused as a consequence of environmental pollution (*policy category environmental health*) is one of the globally acknowledged MDG political priorities. The policy category environmental health is defined through five indicators, whereby three are taken directly from the MDG indicator set for environment and health goals (access to drinking water and sanitation, child mortality). In addition to the three MDG indicators, two additional ones were added to cover air pollution (urban particulates and indoor air pollution), based on new scientific results of United Nations studies. The selection of these two indicators is based on new studies conducted by UNEP and WHO, which study the direct relation of air pollution and world-wide deaths. These recent studies have drawn attention to the severe impact of indoor air pollution and urban particulates. The policy category *Ecosystem vitality & natural resources protection* is defined altogether through five policy categories, encompassing air pollution, water quality and consumption, protection of biodiversity, use of natural resources and energy.

- *Indicators for air pollution:* The causes of air pollution are widespread (i.e. through energy production, industry production, heating and cooking) and, accordingly, there are numerous indicators to chose from to gauge the negative impacts on human health (i.e. respiratory diseases) as well as on the vitality of ecosystems (i.e. the acidification of soil and water bodies, loss of natural resources). Classical standard indicators for air pollution encompass, in particular, sulfur dioxide, nitrogen, carbon dioxide, volatile organic compounds as well as benzol and urban particulates. The EPI-team points out that while they would have liked to undertake a comprehensive measurement of those standard indicators, there is no sufficiently acceptable comparable data available. The existing data basis, therefore, solely focuses on the indicators urban particulates and regional ozone. In particular, urban particulates had to substitute for a generally broader standard set of air pollution indicators.

- *Indicators for productive natural resources:* Agriculture, timber industry and fishery economy are dependent on healthy productive natural resources and represent the backbone of many national economies. However, in addition to a poor data basis, unclear definitions ("sustainable forestry") have also caused methodological problems particularly for this policy category. The EPI-team sees this policy category - due to its significance for the wellbeing of numerous national economies - both as the most important priority with respect to further methodological refinement and development of indicators and as the most difficult and complex one. One indicator was defined on an exemplary basis for each environment policy category (agriculture, timer industry and fishery economy), including the percentage of timber harvest rate measured against a whole timber yield for sustainable forest use, rates for over fishing and agricultural subsidies (only subsidies which foster environmentally negative practices).

- *Indicators for water resources:* The policy category water resources is defined through one exemplary indicator each for water quality (nitrogen load) and water quantity (water consumption). Here, the existing data basis has determined the selection of indicators, and the analysis of the data sources reveals, in particular, that there are very few standardized data sets available from international organizations. Therefore, scientific research models developed by universities were used. The selected research models and its data sources were used and published by the United Nations in its Second World Water Report (2006)

- *Indicators for biodiversity and habitat:* In the view of the EPI-team, these policy categories were also particularly difficult to measure, and the search for comparable data was especially challenging.
  Due to the particularly difficult data basis, existing data on protected areas was used to identify two indicators (protection of wilderness and eco-regions), which both calculate the degree of zoning of protected areas and wilderness. The EPI study points out that that the indicator “wilderness protection” will put highly industrialised and relatively overpopulated countries (such as Germany and the Netherlands) at a disadvantage, resulting in highly negative target values.

- *Indicators for Sustainable Energy:* The selection of indicators was guided by the assumption that a de-coupling of energy production and CO_2-Emissions from industrial growth reflects the most successful and good policies.

2.2 Plausibility of calculations

The methodical calculations and aggregations of the Environmental Performance Index reveal a number of problems and weaknesses, which also question the explanatory power of the country rankings. At the same time, this seriously limits the political relevance of the EPI with regard to a sound assessment of German environmental policies and its strengths and weaknesses. As mentioned in the introduction, there are various entry points for a methodical review of a composite index that have to be investigated.

At the international level, there are only very few methodically acceptable and standardized data sets for many environmental substances, which is a general reason for concern - the EPI can definitely not be charged with this. However, several choices of the EPI study have to be assessed critically, including, in particular, the selection of indicators, the calculation of indicators and the conceptualization of indicators, respectively, as well as the methodical approach applied for weighting of indicators and the selection of target values.

In the following, the problems and implications of the various methodical approaches will be discussed.

Selection of environmental goals:
The index is based on two fixed qualitative environmental goals:
(1) Reduction of environmental stress on human health; and
(2) Promotion of ecosystem vitality and sustainable natural resources management.

The selection and equal weighting of both goals (each time 50 percent of the overall assessment) reflect basically the political priorities of the international community, formulated through the objectives of the Millennium Development Goals and its environmental goal, as well as according to a thorough review of environmental expert literature. In particular, the strong weighting of environmental health corresponds to the significance of health aspects of the Millennium Development Goals, which comprises two individual health goals (MDG 3 and 4). Here, one has to take into account that human health aspects caused by environmental pollution do play a much more prominent role in qualitative as well as quantitative terms in developing countries compared to in industrial countries. The applied weighting in the EPI mirrors the global dimension of this problem. The scores for these five individual indicators in this policy category show positive results for Germany with scores between 91 and 100 (of 100). However, four out of these five indicators (child mortality, indoor air pollution based on burning of fossil fuels, access to safe drinking water and sanitation) are not of any particular relevance concerning the measurement of environmental improvements in Germany. Given that the EPI attempts to complement the MDG indicator set, this weighting of environmental goals is understandable and corresponds to the global priorities of assessing environmental problems. However, the weighting of these environmental goals and the respective selection of indicators, respectively, does not correspond sufficiently to the environmental protection policy in industrialised countries and limits, therefore, the usefulness of the EPI for a such as Germany.

Selection of policy categories:

Both environmental goals are defined through six so-called policy categories. While the environmental goal „environmental health“ represents at the same time its own policy category, the environmental goal ecosystem vitality is defined through five individual sub-policy categories.

(1) air quality;

(2) water resources;

(3) biodiversity and habitat;

(4) productive natural resources; and

(5) sustainable energy.

Policy categories cover classical standard categories of environmental policy – even if compared with other international indices. However, what is problematic is the *lack of certain policy categories* which are of significance at the global level, especially in industrialised countries such as Germany. This contributes to the fact that the current selection puts constraints on a *comprehensive assessment* of national environmental weaknesses and progresses. In this context, the lack of a policy category on soil/soil degradation and the impacts of chemicals have to be mentioned. As part of the policy category discussion, the EPI-team draws attention to this limitation and highlight that the selection of categories has been determined, above all, through the poor data basis.

Environmental targets and target sources:

The selection of the EPI targets is marked by a very ambitious understanding of environmental protection. The selection of the targets was conducted based on a review of environmental and health standards of international agreements, relevant environmental literature and expert opinions. The targets were chosen in such a way that their full implementation is relevant for all countries and at a truly global scale. For the policy category environmental health, four out of five indicators were already covered by international consensus goals, while internationally agreed goals could be found only for four out of twelve indicators for the policy category ecosystem vitality. Ambitious, partly idealistic targets were identified for almost all indicators, reflecting mainly a "political vision" of successful environmental protection policies. According to the EPI-teams' views, so-called absolute targets represent more useful reference points for measuring environmental performance than relative targets do. In addition, absolute targets would also allow for better information with respect to country-specific conditions.

Five targets were chosen according to the Millennium Development Goals: targets for drinking water, sanitation, child mortality, wilderness protection and energy efficiency. Another four targets were taken from internationally agreed contracts, conventions and action programmes: eco-region protection as target of the Convention of Biological Diversity, agricultural subsidies deriving form GATT/WTO specifications, 100% renewable energies following the Johannesburg Plan of Implementation and zero CO_2-emissionen as strict interpretation of UNFCCC-targets. The remaining seven targets were identified according to independent expert opinions: urban particulates, indoor air pollution, regional ozone, nitrogen loading, water consumption, timber harvest rate and over fishing.

These mixed sources provided guidance for the assessment of environmental targets and reflect the existence of already agreed and non-agreed environmental targets. This approach highlights the political necessity for negotiations of additional internationally agreed basic standards and targets. The recourse to expert opinions as means to identify targets in the light of lacking international agreement is a legitimate and typical approach. However, this approach also makes the EPI questionable, as there are usually several serious scientific expert opinions. The consulted experts for the study are scientists from renowned international organisations (i.e. World Bank for urban particulates and UNEP/GEMS Water Expert Group for water consumption) and prominent Universities (i.e. Princeton University for regional ozone and Yale University for timber harvest rate). A full and comprehensive discussion of the target quality could not be conducted as part of this study. However, it has to be mentioned that the EPI could have raised its transparency and credibility if the selection of targets, research models and expert opinions would have been better and comprehensively justified and made more traceable. Generally, it first has to questioned whether absolute targets do indeed provide better information regarding country-specific conditions and secondly, if recommendable but idealistic targets do not partly underestimate the overall environmental performance of countries.

While assessing the political relevance of an indicator result, it has to be taken into account that a potential bad score in meeting the desired environmental target does not automatically imply a generally poor or average performance (i.e. a 100% target for renewable energy as sole energy supply source).

Weighting

The selected EPI indicators are weighted quite differently within a given policy category with regard to significance and explanatory power. The weighting of individual indicators was conducted according to a combination of applied statistical principal component analysis and equal weighting. The weighting of indicators usually influences the overall index value and the country ranking with respect to sustainability. Most composite indices apply an equal weighting approach and calculate a simple average value. Unequal weighting is usually applied with the objective to highlight or minimise the significance of an indicator.

Weighting always implies a value judgement and subjective decisions, and an unequal weighting requires a thorough explanation and reasoning - as part of a good index. The EPI team applied a principal component analysis to achieve a more objective, statistical calculation for the weighting of individual indicators. The results of the analysis revealed a different weighting for the policy categories environmental health, biodiversity and habitat and sustainable energy as well as an equal weighting for the remaining indicators. There are generally no accepted statistical methods in order to weight individual indicators of a composite index (compare EU Commission, JRC, Weighting). The principal component analysis represents a commonly applied method for weighting. The selection of this method can therefore not be questioned, but its application in the study can.

The application and results of the principal component analysis, thus the calculations regarding the explanatory power of all indicators, are not sufficiently clear and explained neither in the study nor in the additional discussion of methods on weighting. For example, the indicator ‘energy efficiency’ is assessed four times more significant as the indicator ‘percentage of renewable energy’ within the policy category “Sustainable Energy” as a result of the principal component analysis – this section could be assessed quite differently from a energy politics point of view. Policy explanations are not offered in this case. Moreover, no satisfying explanations are offered why the study applies a mixed weighting approach, which leaves a lot of open questions. Altogether, the weighting of indicators is not truly traceable and there are no satisfying explanations, which raises questions regarding the methodical validity of the country ranking.

„Proximity-to-target method“

Indicators are expressed in different measurements and a statistical ‘normalisation’ is usually applied to make them comparable. The selection of an adequate method here is important to ensure that indicators stay comparable over time. The EPI 2006 chose the so-called „proximity-to-target method“ for the statistical normalisation – an approach which permits the comparability of indicators with different measurements following a simplified arithmetic transformation. This approach further aims at measuring the effectiveness of environmental policies and the implementation progress in relation to the set target, respectively.

Each of the sixteen indicators was transformed into a proximity-to-target score, based on a theoretical scale of 0 to 100, whereby 100 equals the set target and 0 equals the worst possible score. In a next step, the calculated score for each indicator was ranked along the 0-100 scale, which allowed for an assessment of how far the respective policy has approached the set target. This particular statistical method is a standard method for composite indices and aims at measuring performance over a long period of time. Despite being a standard method, it nevertheless represents an innovative approach in the study. Disadvantages of this method include that it does not reflect statistical variations very well, which in turn does not allow the tracing of gradual improvements and deterioration of a performance. Therefore, it has to be questioned in which ways the EPI is truly able to trace exact trend developments, for example as part of a peer review analysis.

Summary

The problematic lack of internationally comparable standardised and scientifically sound data sets for numerous environmental substances is not a “design failure” of the EPI. Moreover, the EPI attempts to shed light exactly on this problem. Considering the immanent difficulties facing the EPI-team here, one has to concede that an important first cornerstone has been set with respect to international data gathering and review. Nevertheless, the selection of indicators, the indicator calculation and conceptualisation as well as the applied weighting approach and selection of targets have to be viewed quite critically.

The weighting of indicators is always a value judgement and has a decisive impact on the index score and the country ranking. The reason for unequal weighting of indicators should be thoroughly discussed as part of a good index, and the EPI shows obvious flaws in its documentation. The results of the statistical calculations of the principal component analysis are not sufficiently explained and leave many open questions. Moreover, the principal component analysis was only partially applied, which led to an obvious inconsistent weighting of some individual indicators. The same applies to the choice of sources and expert opinions with respect to targets, which could benefit from a much more comprehensive and participatory debate to raise scientific transparency and credibility.

It has further to be questioned whether the claim of the EPI-team is true that absolute targets provide better information on country-specific conditions. It is also not clear whether this assumption delivers traceable results for peer-group-comparisons. The partially idealistic targets do not always allow to realistically measuring the environmental performance of countries.

2.3 Explanatory power of the EPI

Scientific literature on composite indices (compare Nardo et. al. 2006) states that composite indices *are as a matter of principle not very suitable* to comprehensibly reflect the complexity and policy developments of performances or to trace the qualitative relation among indicators. Furthermore, the complexity of most policy areas in the environment field (with dependent variables) makes the development of composite indices even more difficult. The more comprehensive a composite index is, the less it will be capable of reflecting appropriately country-specific performances with respect to environmental protection.

The degree of explanatory power of a global index for a specific country can be linked to many factors (and criticised). With regard to the relevance of the EPI concerning German environmental policies, selection, conceptualisation and weighting of individual indicators seems particularly pivotal.
Taking into account that the EPI claims to complement the indicator set of the Millennium Development Goals, the selection and weighting of individual environmental targets and indicators are understandable within this context. This applies, in particular, to the environmental target environmental health and to most of the indicators covering the policy category (child mortality, access to drinking water and sanitation, indoor air pollution due to burning of fossil fuels). The weighting of environmental policy targets and the selection of respective indicators does not correspond properly to environmental polices and politics in industrialised countries and limits substantially the explanatory power for Germany.

In addition, the general low number of indicators as well as the partly deficient data basis made it more difficult to truly capture and assess the environmental performance of a country *in its entirety*. The selected indicators do not reflect the pivotal environmental problems which are of particular concern for an industrialised country such as Germany; such as the *qualitative* dimensions of environmental problems (e.g. access to sanitation compared to qualitative sewage treatment or the qualitative management of protected areas). In addition, the data sources for some data and/or the method of calculation for some central indicators (i.e. regional ozone) were found to be vague, and the reliability of the indicator results had to be questioned (agricultural subsidies).

While environmental health should be - without question - a pivotal goal of any environmental and consumer policy, a more differentiated selection of indicators could have more appropriately the respective health problems in industrialised countries (i.e. indicators for indoor air pollution featuring the impact of chemical or biological environmental substances). This approach would also apply to the selection of most of the other indicators in other policy categories, particularly for the categories biodiversity and air quality. Some indicators do make sense at a global scale (e.g. wilderness protection) but distort, in combination with strong weighting over proportionally, the performance country ranking due its non-relevance for some countries (such as relatively overpopulated countries without any wilderness such as Germany).

2.4 Comparison with existing Indices

A comprehensive stocktaking and comparative analysis of existing indicator sets and indicator systems, focusing on cross-country reviews of national environmental performances with the Environmental Performance index, could not be conducted as part of this study.

In principle, a direct comparison of aggregated indices is a difficult methodological undertaking, given that every index is based on a specific method and pursues different qualitative and quantitative statements. Thus, a comparison will only be capable of identifying trends as well as assessing the coherence and heterogeneity of results. However, a brief comparative review of existing national and European indicator systems was conducted in order to better assess not only the EPI indicator selection but also the general data basis for potential indicators with specific reference to Germany.

There are a number of international indicator systems which have been conceptualised and developed to a large extent by multilateral and regional organisations. At the global level, these include the UN Sustainability Indicator Initiative (UN DESA); MDG indicator set (UN); the 'Environmental Vulnerability Index' (SOPAC) as well as more comprehensive concepts and studies with elaborated indicator sets, such as the '*ecological footprint'* (Redefining Progress) or the Millennium Ecosystem Assessment. As for the regional level, one has to mention in particular the OECD indicators and the core indicator system of the European Environmental Agency (EEA). At the national level, the German Federal Environmental Agency (UBA) has developed two indicator systems: a comprehensive core indicator system, which complements the national sustainability indicator system and the so-called "DUX", the German Environment Index, which is based on a few highly aggregated core indicators, reflecting the progress towards achieving environmental protection targets in Germany.

Global level

A brief examination of global indicator sets and indices shows the Environmental Performance Index is justified in its claim as a truly international comparative environment index. The "*Environmental Vulnerability Index*' (EVI), developed by the South Pacific Applied Geosciences Commission (SOPAC), aims at observing the development of environmental performances of a specific country group (Small Island States) under specific circumstances (vulnerability) despite its comprehensive cross-country coverage. Accordingly, the selection of indicators is tailored to the specific concept of vulnerability of island states. The EVI is based on 50 variables which capture at the same time the vulnerability and assess the environmental condition and performance of a country. The 'ecological footprint' is a comprehensive concept which clearly concentrates on reviewing specific environmental substances and material and commodity flows, and is not considered an index In comparison to the 'ecological footprint', the EPI is a classical environmental index without any specific perspective regarding certain environmental substances or concentration on specific regional county groups. Against this background, the Environmental Performance Index can be called by no means a pioneer effort.

Regional level

For Europe as well as the whole OECD region there are a several known comparative indicator sets and indices that feature much more elaborated indicator choices and draw on a qualitative better data basis.

The OECD is a pioneer organisation in the area of indicator development. The organisation has produced several indicator sets, which range from a 'key indicator set' with ten indicators to a 'core indicator set' with

50 indicators to comprehensive sector-specific indicator sets (OECD 2003, p.4). The OECD is the original creator of the so-called „Pressure-state-response (PSR) model, which features prominently in scientific discussions today. In its publications, the OECD clearly highlights which indicators are based and already applied on satisfactory and comparable data and methodical calculations and which indicators are still 'work-in-progress'. The organisation is of the view point that there can not be a internationally acceptable and scientifically sufficiently sound cross-country indicator set and therefore consciously pursues a different scientific approach. The known OECD '*Environmental Performance Reviews'* assess the qualitative environmental performance of OECD member states based on a complex and interactive peer-group-process. As part of this process, a selection of core indicators is complemented by national indicators. In addition, the OECD abstains from publishing country rankings. The most recent *Environmental Performance Review* for Germany identifies as most challenging national environmental problems nature protection, greenhouse emissions, sewage treatment and swage infrastructure, waste disposal and management, nitrogen loading of water bodies and the application of economic instruments (taxes etc.)

During the last few years, the European Environmental Agency has identified 37 core indicators as part of an extended participatory and consultative process with all European Member States. Those core indicators allow for a relatively coherent cross-country comparison of environmental performance. The selection of indicators follows the pivotal environmental policy goals agreed upon at EU level (EU Environment Programme) and is determined by data availability (extracted from available and standard data collection from EU Member States). The main objective of the EEA core indicator set is to improve the data quality of country data and to shed light on data quality issues. The EEA core set encompasses 37 aggregated indicators for eleven different environmental fields: Air quality (six indicators), ozone protection (one), climate change (four), biodiversity (four), soil (two), water (seven), waste (two), agriculture (two), energy (five), fishery (three) and transport (3). A review of the EEA core indicator set places Germany – similar to the EPI ranking – at a middle rank, with negative indicator scores in the areas of per-capita consumption (greenhouse gas emissions, water and energy consumption, and amount of waste).
A direct comparison with EEA indicators reveals the lack of pivotal indicators, whose absence in the EPI study do not permit for a proper assessment of specific environmental problems common in industrialised countries (compare table 2). This applies, in particular, for the environmental categories waste, chemicals, soil and transport.

National level
A brief review of existing national indicator systems reveals to what extent the current selection of indicators and conceptualisation of some individual indicators limit the relevance of the EPI for a proper assessment of German environmental policies.

The methodical conception and objective (PR) of the 'DUX', the German Environment Index, looks quite similar to those of the Environmental Performance Index. The Federal Environmental Agency conceptualised this specific value/parameter, which is supposed to reflect progress in achieving environmental protection goals in Germany as a single standalone number. The ‘DUX’ consists of nine aggregated individual indicators, which cover the most challenging environmental problems in Germany and are linked to political targets. The DUX indicators include climate, air quality, soil (consumption), water, energy productivity, commodity productivity, mobility, agriculture (nitrogen overload) and biodiversity of species. Similar to the EPI, the ‘DUX’ uses a ‘proximity-to-target- approach as part of its conceptualisation. Each single score can reach a maximum of 1000 points. All indicators are based on quantitative targets and the number of points represents the measure/gauge for the attainability of these targets against its reference year. According to the Federal Environment agency, the DUX and its indicator conceptualisation is still at an infancy stage, and it is planned to further develop this environment barometer. The quantitative targets of the ‘DUX’ are aligned with German as well as European political environmental targets and are more scientifically tailored to specific industrial country problems. Therefore, the DUX is more suited to reflect developments with regard to environmental performance more precisely and realistically.

The other indicator set developed by the Federal Environmental Agency, the so-called “Environment – core indicator system” (KIS) also aims to inform political decision-makers, the general public and the Media about relevant progress on environmental protection in Germany. The KIS indicators were selected according to environmental priorities in Germany and their comparability with other important international indicator sets. In addition, the KIS comprehensively complements the environment indicators of the national sustainability indicator set with suitable indicators, which allow for comprehensive measurements of impacts and effects of environmental stress. The KIS consist of sixteen environment themes, which are divided into causes and impacts to more precisely reflect the complexity of environmental problems and is defined through 50 indicators. If possible, environmental trends are assessed against quantifiable environmental targets. Environmental quality targets (describing the desired environment condition); environment action goals (helping to reach quality targets) and environment quality standards (defining the desired score of an environmental quality target) are part of a methodical toolbox used for proper assessments. The conceptualisation of KIS, with its combination of causes and effects of environmental stress, is more similar to the OECD-PSR-model than the EPI. A comparison of the quantity of indicators used in both indices reveals the confinement of the few EPI indicators.

Indices/aggregated indicator systems, which are not only quantitatively but also qualitatively tailored to a specific country, allow for much more concrete assessments of environmental performances (compare OECD approach). The Environmental Performance Index does not deliver, neither methodically nor scientifically, any new pivotal messages for Germany compared to existing regional specific indicator sets (OECD, EEA), which were developed based on long-term consultation processes.

2.5 Environmental Sustainability Index (ESI)

The Environmental Sustainability Index (ESI) - the first joint product of the Yale-Colombia team and commissioned by the World Economic Forum/ Davos – was developed as an index with the ambitious objective to conceptualise a sustainability profile of countries, to allow for the assessment of a country's basic capacities to deal with environmental problems on a long term basis. The overall ESI country ranking places Germany 31st out of 146 nations (13th place among OECD countries, thus a lower rank among industrialised countries). In more concrete terms, the ESI negatively assesses a high level of environmental stress (environmental system condition) for Germany as well as a low policy response, which is classified as unsustainable. On the positive side, the ESI also sees a high level of political and public awareness and a satisfying infrastructure and capacities to respond adequately in the long term (compare ESI, Executive Summary, p.4).

The ESI is based on an indicator conceptualisation, which merges 76 data sets into 21 sustainability indicators. The 21 indicators aim at comparing the sustainability profiles of countries according to five pivotal policy categories:

- environmental system condition,
- reduction of environmental stress,
- reduction of human vulnerability,
- societal and institutional capacities to respond to environmental challenges,
- global environmental responsibility.

The variables and the indicators are based on the established OECD Pressure-State-Response-model. Similar to the ESI, the selection of variables and indicators was conducted following a combination of expert opinions, literature reviews and an assessment of existing international data sets. A major methodical difference between ESI and EPI consists of different reference value for the assessment. The comparative cross-country assessment of the ESI does not apply a 'proximity-to-target'-approach, but for each category, the best placed country score serves as the absolute reference value. The EPI pursues a comparably more rigorous quality assessment by defining absolute environmental target scores at the outset.

Previous scientific reviews of the ESI have identified grave methodical deficiencies, which strongly question the overall explanatory power of the ESI (compare, inter alia, Wackernagel (2001) and Murthy, Bhanu & Jha, Raghbendra (2003). The following critique was mentioned:

- It is pointed out that the ESI is based on a vague and non-coherent definition of 'environmental sustainability', which overemphasises the selection of indicators featuring social issues.
- The coherence of the ESI indicator conceptualisation was strongly criticised insofar as statistical methods were only partially applied or not at all (i.e. lack of a sensitivity analysis). Further critique included criticism of unrealistic weighting of indicators based on only few expert opinions; an incoherent merging of environmental conditions, environmental flows and political intentions that are not comparable; and a general lack of sufficient data sets.

The ESI will currently not be further refined and developed. This is partly due to its serious methodical deficiencies, which are also acknowledged by its authors. The explanatory power of the ESI for Germany is, therefore, not of any particular relevance.

III. Conclusions

3.1 Political and scientific relevance of the EPI

As mentioned before, composite indices are as *a matter of principle rather not suited* to reflect the complexity of performances and policy developments in its entirety and to investigate the qualitative relation between indicators. The question has to be asked whether such an internationally comparative index makes sense from a scientific point of view? Is the EPI-team justified in claiming to have developed a scientifically sound, internationally comparative index following a thorough policy analysis?

At this point in time, it can not be conceded that the original claim to establish an analytically sound quantitative composite index has been achieved. The explanatory power of the cross-country comparison for Germany is low due not only to significant and obvious methodological deficiencies of the composite index, but also to a poor data basis. Compared to other regional-specific indicator sets (in particular OECD and EEA), the EPI does not offer any interesting new messages. However, the remarkable political and media attention, which has been generated by the Environmental Performance Index within a short period of time, has an important positive aspect. This public exposure is helpful to identify more entry points to initiate substantive debates on cross-country data sets in the international environment field.

However, despite all criticism and scientific limitations (data basis, methods, selection of indicators etc.), one has to concede that the EPI indeed enjoys some political and scientific relevance as an Environental Performance Index.
At the international level, there have been very few attempts to develop a comparative environment index (i.e. see Environmental Vulnerability Index), and against this background, the EPI appears as a pioneering effort, inter alia, because it does not follow any specific perspective (specific country group or environmental substance) and pursues a truly comprehensive international comparison. Undoubtedly, there are a number of qualitative, more elaborated and sound indicator sets at the regional level (OECD, EEA) with more scientific relevance for the assessment of German environmental policies. However, this applies only to country groups with similar good data basis. At the international level, the EPI could be called *the one-eyed king index among the blind.*

The significance of the Environmental Performance Index lies above all in its political outlook and character as a 'political index' with a message, aiming at stimulating a scientific debate about sound methods and data quality issues (as well as the identification of best practices among peer-groups). The EPI has been able to generate an impressive media echo so far. A combination of intelligent public relations, prominent authors, and a known originator and publishing platform (Davos world Economic Forum) has largely contributed to an enormous political and media attention with respect to indicators and quality of international data sets. This is unprecedented and helpful for the original cause. Scientific debates about indicators and quality of international data sets exist, but are hardly ever featured in prominent weekly and daily newspapers. Despite grave data problems, obvious methodical deficiencies, and questionable country rankings, the EPI has generated unusual media attention. It is highly recommendable to make use of this in scientific and political terms.

One interesting entry point for further refinement is the attempt to identify regional-specific peer-group comparisons, which could potentially allow making more precise statements regarding environmental performances in different fields.

It is the EPI team's understanding that the Environmental Performance Index has been conceptualised as a complement for the United Nations Millennium Development Goals environmental indicator set. The Environmental Performance Index aims at complementing the environmental dimension of the MDGs with a scientifically sound and selected number of environmental quality targets and internationally comparable and measurable indicator set. Another objective of the study is to draw attention on the current poor international data basis for many environmental substances and problems and to highlight the necessity for improved statistical data gathering and indicator development. Taking into account the high number of developing countries, which are in the process of formulating MDG reports and strategies, including environmental indicators and indices, the EPI offers some opportunities to enhance the development of methods and to lay some foundations for further scientific debates on indicators and data sets.

3.2 Potential methodical adjustments

Following the EPI team's self-assessment, the study does not cover the full spectrum of challenges and particularly lacks sound data for the following categories, which should be part of any good environmental composite index:

- Waste (waste disposal, recycling, and waste reduction),
- Chemicals (Impacts of toxic chemicals, heavy metals),
- Air pollution (SO_2-emissions and acid rain),
- Soil protection(erosion, soil productivity),
- Greenhouse gas emissions (beyond CO_2) and
- Ecosystem problems (e.g. loss of wetlands, and urban sprawl).

According to the EPI team, it turned out to be particularly difficult to identify comparable quality data sets for standard pollution concentrations in the classical fields of water and air. For those categories, the available international data set was assessed as particularly poor and deficient.

The following EPI areas would generally benefit from methodical improvements:

- It can not be assumed that the international data basis for many environmental substances will be improving in the near future. Against this background, it might be recommendable to undertake or facilitate at least a comprehensive international stocktaking and/or more thorough review of available scientific model calculations (and its data processing), which could help to identify new data sets and indicator conceptualisations. Improved co-operation and collaboration among international organisations, national environmental agencies and respective research facilities (universities etc.) could potentially contribute to ease access to data, to improve data processing and to increase overall transparency of data collection. At regional level, participatory processes have proved to be particularly useful to facilitate and improve the development, discussion and conceptualisation of indicators from a scientific and political perspective (see OECD and EEA approaches). These approaches could be a role model for the EPI and the international level in general.

- International environmental trends and reporting of international environmental organisations indicate that chemicals, soil degradation and climate change will be among the most pressing environmental problems in the years to come. Although it is generally very difficult and sensitive to rank environmental problems, it might be prudent to focus further indicator development in these areas.

As a matter of principle, most aggregated indicator conceptualisations and their underlying methods can be critically questioned. In the case of the Environmental Performance Index and its results for Germany, the following indicators should be critically assessed against alternative concepts:

- The indicator for agricultural subsidies is based on methodically not comparable data (EU/WTO data merging) and leads to distorted rankings and statements. Alternative indicator sets could include, for example, indicators, which calculate the percentage of area under cultivation with organic agriculture against the overall area under cultivation with agriculture (similar to the national KIS indicator) or calculate only the percentage of areas with organic agriculture which benefit from environmental subsidies (similar to the EEA indicator). These two examples could provide some guidance for the further development of this EPI indicator – given the availability of international data sets.

- The current indicators for biodiversity, particularly the indicators for eco-region protection and wilderness protection are solely quantitatively oriented. However, it is generally agreed that the qualitative aspects of managing and monitoring protected areas are as important as the original zoning. The review of quantitative zoning of protected areas often overestimates lip services. Moreover, one pivotal indicator measuring species biodiversity is completely lacking, but appears in all other international and regional indicator sets. It is generally recommendable to identify more qualitatively oriented indicators in the EPI study.

If the EPI team continues regularly to further refine and develop the Index, this would offer an interesting potential to truly establish an internationally comparable, scientifically sound qualitative oriented environmental index at the international level, and to initiate national debates on data quality and quantity in the long term.

IV. Acronyms:

AMIS	Air Management Information System
BfN	Bundesamt für Naturschutz (Federal Agency for Nature Protction)
CIESIN	Centre for International Earth Science Information Network
DESA	Department of Economic and Social Affairs
DUX	Deutscher Umweltindex (German Environment Index)
ECEH	Europäischen Zentrum für Umwelt und Gesundheit (European Centre for Environment and Health)
EEZ	Exclusive Economic Zones
EIA/DOE	International Energy Administration/US-Department of Energy
EPI	Environmental Performance Index
ESI	Environmental Sustainability Index
EVI	Environmental Vulnerability Index
EU	European Union
EUROSTAT	Council on European Statistics
FAO	United Nations Food and Agriculture Organization
GIS	Geographic Information System
IEA	International Energy Annual
IEA	International Energy Agency
IUCN	World Conservation Union
MDGs	Millennium Development Goals
OECD	Organization for Economic Cooperation and Development
PPP	Power Purchasing Parity
SOPAC	Pacific Islands Applied Geosciences Commission
ITTO	International Tropical Timber Organization
UBA	Umweltbundesamt (Federal Environmental Agency)
UNECE	UN Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
WCMC	World Conservation Monitoring Centre
WCS	Wildlife Conservation Society
WDPA	World Database on Protected Areas
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WSAG	Water Systems Analysis Group
WWAP	World Water Assessment Programme
WWDR	World Water Development Group
WWF	World Wildlife Foundation

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- World Bank 2003: *World Development Indicators 2003*: http://devdata.worldbank.org/dataonline/

- World Bank, *World Development Indicators 2004*, http://dev.data.worldbank.org/dataonline

- World Health Report 2001: Annex Table 3: *Burden of disease in disability-adjusted life years (DALYs) by cause, sex and mortality stratum in WHO Regions,* estimates for 2000, http://www.who.int/whr/2001/en/annex3_en.pdf

- World Water Development Report II Daten online: http://wwdrii.sr.unh.edu/download.html

- World Wildlife Fund & National Geographic WWF *Federation Map: Terrestrial Ecoregions of the World:* http://worldwildlife.org/wildworld

- Yale Centre for Environmental Policy and Law, New Haven and Centre for International Earth Science Information Network (CIESIN)/Columbia University, New York (2005), *Environmental Sustainability Index*, Main Report and Appendix A-H

- Yale Centre for Environmental Policy and Law, New Haven and Centre for International Earth Science Information Network (CIESIN)/Columbia University, New York (2006), *Pilot 2006 Environmental Performance Index*, Main Report and Appendix A-H

Table 1 : **EPI Indicators, targets and weighting**

Goals	*policy category*	*indicators*	*data sources*	*targets*	*target sources*	*weigthing/ category %*	
Environmental Health		Urban Particulates	World Bank, WHO	10 µg/m3	Expert judgment a	.13	.50
		Indoor Air Pollution	WHO	0% of house-holds using solid fuels	Expert judgment b	.22	
		Drinking Water	WHO-UNICEF Joint Monitoring Program	100% access	MDG 7, Target 10, Indicator 30	.22	
		Adequate Sanitation	WHO-UNICEF Joint Monitoring Program	100% access	MDG 7, Target 10, Indicator 31	.22	
		Child Mortality	UN Population Division	0 deaths per 1,000 pop aged 1-4	MDG 4, Target 5, Indicator 13	.21	
Ecosystem Vitality and Natural Resource Management	Air Quality	Urban Particulates	World Bank, WHO	10 µg/m3	Expert judgment a	.50	.10
		Regional Ozone	MOZART model	15 ppb	Expert judgment c	.50	
	Water Resources	Nitrogen Loading	UNH Water Systems Analysis Group	1 mg/liter	GEMS/Water expert group	.50	.10
		Water Consumption	UNH Water Systems Analysis Group	0% oversub-scription	By definition	.50	
	Biodiversity and Habitat	Wilderness Protection	CIESIN, Wildlife Conservation Society	90% of wild areas protected	Linked to MDG 7, Target 9	.39	.10
		Ecoregion Protection	CIESIN	10% for all biomes	Convention on Biological Diversity	.39	
		Timber Harvest Rate	FAO	3%	Expert judgment d	.15	
		Water Consumption	UNH Water Systems Analysis Group	0% oversub-scription	By definition	.07	
	Productive Natural Resources	Timber Harvest Rate	FAO	3%	Expert judgment d	.33	.10
		Overfishing	South Pacific Applied Geosciences Commission	No overfishing	By definition	.33	
		Agricultural Subsidies	WTO, USDA-ERS, EU	0%	GATT and WTO agreements	.33	
	Sustainable Energy	Energy Efficiency	Energy Information Administration	1,650 Terajoules per million $ GDP	Linked to MDG 7, Target 9, Indicator 27	.43	.10
		Renewable Energy	Energy Information Administration	100%	Johannesburg Plan of Implementation	.10	
		CO2per GDP	Carbon Dioxide Information Analysis Center	0 net emissions	Expert judgment e	.47	

Source: EPI 2006, Main report, p. 14.

** Note: Full indicator names, definitions, and data sources are provided in Appendix H.*

a *Determined in consultation with Kiran Pandey from the World Bank and other air pollution experts;*
b *Determined in consultation with Kirk Smith and Daniel Kammen at UC Berkeley and the indoor air pollution literature;*
c *Determined in consultation with Denise Mauzerall and her air pollution team at Princeton University;*
d *Determined in consultation with Lloyd Irland and Chad Oliver from the Yale School of Forestry and Environmental Studies;*
e *Strict interpretation of the goal of the 1992 UN Framework Convention on Climate Change.*

Explanations:

Red **=** *without remedies traceable data sources for a country (predominately UN data)* **-** *6 out of 16 data sources .*
Blue *= Data sources based on scientific model calculations (for example with application of UN data)*
Green *= Data taken from UN data banks (national delivery through EEA or national agencies)*

<u>Annex 1:</u> EPI – Country results Germany

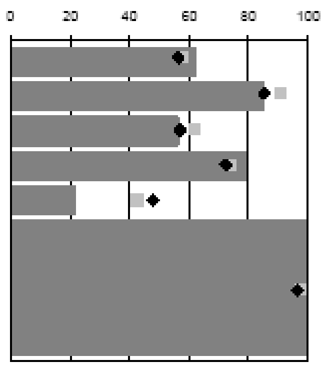
Germany

EUROPEAN UNION +
GDP/capita 2004 est. (PPP) $28,700

Income Decile 2 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	22
Score:	79.4
Income Group Avg.	80.2
Geographic Group Avg.	81.3

Policy Categories



	Country	◆ Income Group	■ Geographic Group
Air Quality	61.3	56.3	57.7
Water Resources	84.5	85.4	90.6
Prod. Nat. Resources	55.9	57.0	61.9
Sustainable Energy	78.3	72.3	74.1
Biodiv. and Habitat	21.1	48.2	42.6
Environmental Health	98.6	96.6	97.2

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
MORTALITY	Child Mortality (deaths/1000 population 1-4)	0.3	*0*	99.0
INDOOR	Indoor Air Pollution (%)	0	*0*	100.0
WATSUP	Drinking Water (%)	100.0	*100*	100.0
ACSAT	Adequate Sanitation (%)	100.0	*100*	100.0
PM10	Urban Particulates (µg/m³)	22.3	*10*	91.3
OZONE	Regional Ozone (ppb)	44.2	*15*	31.4
NLOAD	Nitrogen Loading (mg/L)	98.1	*1*	98.2
OVRSUB	Water Consumption (%)	15.9	*0*	70.9
PWI	Wilderness Protection (%)	0.9	*90*	1.0
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.00	*1*	2.2
HARVEST	Timber Harvest Rate (%)	1.9	*3*	100.0
AGSUB	Agricultural Subsidies (%)	6.0	*0*	34.2
OVRFSH	Overfishing (scale 1-7)	5	*1*	33.3
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	6,382	*1,650*	80.2
RENPC	Renewable Energy (%)	3.8	*100*	3.8
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	80	*0*	93.0

Source: Environmental Performance Index 2006 – Appendix C "Country Profiles", p. 46.

Table 2: ***EPI-Scores of selected industrialised countries and countries in transition***

EPI - Ranking	**Country**	**EPI-Score**
1	**New Zealand**	**88.0**
2	Sweden	87.8
3	Finland	87.0
5	United Kingdom	85.6
6	Austria	85.2
7	Denmark	84.2
8	Canada	84.0
10	Ireland	83.3
11	Portugal	82.9
12	France	82.5
13	Iceland	82.1
14	Japan	81.9
16	Switzerland	81.4
18	Norway	80.2
19	Greece	80.2
20	Australia	80.1
21	Italy	79.8
22	**Germany**	**79.4**
23	Spain	79.2
27	Netherlands	78.7
28	USA	78.5
32	Russian Federation	77.5
39	Belgium	75.9
94	China	56.2
118	India	47.7

Source: EPI 2006, Executive Summary, p. 3.

Annex 2: Data source analysis for Germany

Indicator urban particulates:

The ‚*Development Economics Research Group*' of the World Bank Institute has developed a model for the calculation of urban particulates (PM10) in larger urban residential areas, the so-called „*Global Model of Ambient Particulates*", (including macro economic, meteorological and demographic data). The model calculation uses largely topical data on worldwide air pollution from the WHO and presumably complemented by additional WHO data, or by data from national agencies for TSP and PM10. The used data derives predominantly from the WHO databank *„Air Management Information System (AMIS)"*, which contains summarized statistics on air pollution (annual average values, number of days, when WHO guidelines are crossed). AMIS was developed as part of the WHO programme „Healthy Cities" and served as information exchange among states; since 2000 AMIS was not further developed due to lack of financial resources. The data of the AMIS databank for Germany were delivered by the European Environmental Agency which in turn received data from the German Federal Environmental Agency. [6] The data could not be retrieved from AMIS as part of this study. However, it can be summarized that the original data used for the calculation of this indicator were provided and collected, respectively, from the respective national environmental agency. Additional data complements for European cities were extracted from the WHO-ECEH Project „Health Impact Assessment of Air Pollution" (HIAAP) (1999), WHO/European Centre for Environment and Health (ECEH), which made use of data from national and regional environmental agencies. For Germany, a footnote in the ECEH study takes note that 94 measurements/observations during the early 1990s could not be included due to missing appropriately defined variables (initial difficult data adjustments between West and East Germany).
For Germany, the World bank GMAPS-Model has calculated annual average values for PM10 concentrations for altogether 83 cities with more than <100.000 inhabitants. Based on this results, the model identified an annual average value of $\underline{22{,}3\ \mu g/m^3}$ for Germany.
The currently existing EU guideline1999/30/EG establishes a critical value of 40 $\mu g/m^3$ annual average value for PM10, which should not be exceeded since 2005. Momentarily, the critical value cannot be kept in at all locations throughout Germany. Measurements for PM10 exist as comprehensive data set for Germany only since 1999. Usually observed over a wide area, annual average values occur between 25 und 50 $\mu g/m^3$. The reduction potential for urban particulates is already widely exhausted; therefore, it has to be assumed that concentrations of urban particulates will decrease further, but at a substantially slower pace. [7]

Indicator indoor air pollution:

The indicator measures the percentage of households which are exposed to the burning of fossil fuels in indoor areas. The WHO is currently conducting a comprehensive research project on „*Assessing the environmental burden of disease at national and local level",* which encompasses numerous studies on various risk factors. A sub-theme deals with the problem of indoor air pollution, the respective WHO study was selected as a basis for the calculation of this indicator, including method, calculation model and data. *(WHO-Study: Indoor smoke from solid fuels: Assessing the environmental burden of disease, WHO Environmental burden of disease series No. 4, 2004).*The study aims at quantifying and linking environmental health problems from indoor air pollution and the burning of fossil fuels (so-called ‚exposure level').
Core data for this calculation include the percentage of the population which are exposed to the burning of fossil fuels in indoor areas as well as the health stress of the population (so-called 'disease burden'). Data for the exposure-level' were extracted from national health surveys, data for the 'disease burden' were taken from the World Health-Report 2001. The World Health-Report 2001 does not specify data or data

[6] ** Personal email- communication from WHO chef Michal Krzyzanowski, European WHO-centre for Environment and Health, office Bonn, 10.11.2006*

[7] *Compare information from the Federal Environmental Agency http://www.env-it.de/umweltdaten/public/theme.do?nodeIdent=2883*

sources for individual countries. Because of these vague data source indications, it was not possible to trace back all relevant health data for this indicator. According to the authors of the WHO study, data from national health surveys and respective national statistical agencies were used. The significance of the data sources for this indicator is low for Germany due to the relative irrelevance of this indicator for modern environmental problems in Germany.
Globally speaking, however, indoor air pollution caused by the burning of fossil fuels is a dramatic environmental health problem. The study (the indicator) only investigates one aspect of a whole spectrum of indoor air pollution causes, which does not have much relevance for industrialized countries. Generally, indoor air pollution is a prominent environmental problem also in European countries; however, this includes in particular biological and chemical pollution and effluvia.

Indicator drinking water:

This indicator measures the percentage of the population with access to safe drinking water for the years 1990 and 2002. This indicator is originally part of the MGD indicator set. The calculation was conducted by the MDG team in cooperation with several UN divisions. The country data, provided by several UN divisions, stem from national statistical commissions, national household surveys and respective national agencies. In the case of UNICEF and WHO, data is retrieved through surveys/questionnaires filled out by national UN representatives, which in turn obtain data from national public agencies. Due to the 100% positive result from Germany, it was abstained from following all individual data flows. However, it can be assumed that the data stems directly from respective national agencies (here: Federal German Statistical Commission), which publishes respective data (100% access to drinking water in Germany).

Indicator sanitation:

This indicator measures the percentage of the population with access to sanitation for the years 1990 and 2002. This indicator is originally part of the MGD indicator set. The calculation was conducted by the MDG team in cooperation with several UN divisions. The country data, provided by several UN divisions, stem from national statistical commissions, national household surveys and respective national agencies. In the case of UNICEF and WHO, data is retrieved through surveys/questionnaires filled out by national UN representatives, which in turn obtain data from national public agencies. Due to the 100% positive result from Germany, it was abstained from following all individual data flows. However, it can be assumed that the data stems directly from respective national agencies (here: Federal German Statistical Commission), which publishes respective data (100% access to sanitation in Germany).

Indicator child mortality:

This indicator measures the age-specific child mortality (1-4 years, death rates per 1000 inhabitants) for the period 2000-2005. This indicator is originally part of the MGD indicator set. The calculation was conducted by the MDG team in cooperation with several UN divisions. The data is part of a time line estimation and projection of population trends prepared by the UN Secretariat Population Division, which obtains its data directly from respective national statistical agencies.
Due to the 100% positive result for Germany, it was abstained from following all individual data flows. However, it can be assumed that the data stems directly from respective national agencies (here: Federal German Statistical Commission), which publishes respective data.

Indicator regional ozone:

This indicator measures ground level ozone values (up to a height of 70m), based on an annual average value of the 10 highest daily average values within a timeframe of 14 years (1990-2004). This indicator is a highly aggregated indicator, and was calculated as part of a complex scientific research model (‚global chemical tracer model: MOZART 2') for 218 countries. For this indicator conceptualization, no data from international organizations was used, but data was taken from an interdisciplinary US American-German research project (Model MOZART), which is jointly conducted by the German Institute Max-Planck-Institute for Meteorology/Hamburg, the US-National Centre for Atmospheric Research, NOAA/GFD and Princeton University/USA. The Columbia EPI team has calculated the statistical aggregations, scientists and researchers of Princeton University processed the ozone data using the MOZART-Model (Jungfeng Liu/ Denise Mauzerall). The MOZART-Model was used to calculate daily ozone concentrations for the period 1990-2004. The model is feed with multiple chemical, meteorological and other data from numerous sources, which could not be traced back individually for Germany. A request for more information, which was submitted to the EPI team at Colombia University, could not be answered sufficiently in time. The literature index of the MOZART model documentation provides an overview about used primary and secondary data sources.

The national German core indicator system (KIS), developed by the Federal German Environmental Agency, measures as relevant ozone indicator for Germany the *frequency of exceeding threshold limit values* (and not the 10 highest daily average values within a year). Since September 2003, the EU guideline 2002/3/EG of the European Parliament is in force and applies in Germany, which sets standards for ozone concentrations in the form of target values, long-term targets and threshold values for ground-level ozone: *annual average values* and *frequency of exceeding threshold limit values*. According to information provided by the German Federal Environmental Agency, *annual average values* of ozone concentration do not play a prominent role for the proper assessment of summer smog stress. Annual average values, however, play a more significant role when it comes to assessing long-term developments of ozone stress. The *frequency of exceeding threshold limit values* is a much discussed core measurement of ozone data collections, as the proper indication of absolute exceeding dependent on the number of gauging stations as well as the number of episodes of increased ozone concentration. An additional distorting factor consists of the type and location of the gauging station (big city, close to traffic, rural or mountain). In conclusion, ground-level ozone data are measured by the German Federal Environmental Agency in Germany, the national data basis is comprehensive and different calculation methods are applied and emphasized compared to the MOZART model.

Indicator nitrogen loading:

For this indictor, no data from international organizations was used, but data was taken from an interdisciplinary US American university research project. The indicator is a highly aggregated indicator, which was calculated for 172 countries using several scientific models. The indicator conceptualization - in a simplified manner - uses data on water flows of each individual existing water body and combines these data with multiple data on various types of nitrogen loading in a way that the average nitrogen concentration of water bodies can be determined. The calculations for the nitrogen loading of water bodies are based on several scientific model calculations, which were combined for this indicator conceptualization. The raw data was collected and processed by the Water Systems Analysis Group/University New Hampshire. The data sources of the various models could not be traced back to German sources due to their complexity (and for time reasons), but the website of the UN World Water Development Report 2 (2006) makes them partly accessible.

Indicator Water consumption:

For this indictor, no data from international organizations was used, but data was taken from an interdisciplinary US American university research project. The indicator is a highly aggregated indicator, and is based on the *„Relative Water Demand/Relative Water Stress Index,* which was developed by the Water Systems Analysis Group/ University New Hampshire. The *„Relative Water Demand/Relative Water*

Stress Index" is calculated - expressed in a simplified manner – by dividing the percentage of renewable water resources in a country though the national overall water consumption (household, industry, agriculture). The data used for the *Relative Water Demand/Relative Water Stress Index* include population data, national or regional per capita demand of households, industry and agriculture. The aggregated indicator is based on a number of sub-indicators, which feature three to six data sources, which could not be traced back for Germany due to the complexity of the individual model calculations and data simulations. The website of the UN World Water Development Report 2 (2006) makes them partly accessible.

Indicator overfishing:

This indicator measures the ratio of fisheries productivity (natural renewable rate of fish stock) and the ratio of fish catch over the last five years in order to determine the risk of unsustainable damage to fish stocks. This measure is drawn from the Environmental Vulnerability Index (Indicator 34) prepared by the South Pacific Applied Geosciences Commission (SOPAC) in partnership with other support. The FAO is the only worldwide source for comprehensive global fishery data and country data are provided by respective national agencies. Several fishery data and statistical year books could not be identified due to a change of website presentation of FAO fishery databases (in 2006) (compare FAO STAT). Thus, the data sources for productivity could not be sufficiently traced back for Germany while preparing this study. The data source indications of EPI and ESI name vaguely the University of British Columbia as main source for additional data, however, no more specific indication regarding the original sources of data (name of databank, research project etc.) could be identified. The University of Columbia maintains the renowned research centre "Fisheries Centre", which keeps several extensive databanks, in close collaboration with FAO. The exact databank source for 'fisheries productivity' could not be found, also given that the fisheries centre keeps a number of similar databanks on productivity data. For example, the ‚Sea around us' project, which applies the footprint-analysis to determine the productivity of EE zones, could be a potential data source of the EPI. The project offers time series data on *"Primary production required by the catches for Germany'*.)

Indicator agricultural subsidies:

For the calculation of this indicator, country data was used taken from different sources based on different data processing, which reveals obvious problems with respect to 'clean data' and scientific rigorousness of the validity of this indicator. Data was extracted from European Agencies for 15 EU member states (EU Commission for Agricultural Subsidies and EUROSTAT for data on national agricultural output value). For additional countries, data was taken from WTO databank (collected and provided by the US Department of Agriculture). As there are no internationally agreed standard calculation methods for agricultural subsidies, (and this is also part of an ongoing official dispute between the USA and the EU), this means that data was merged which was gathered and calculated based on different methods. In addition, as for the WTO data, so-called agricultural friendly subsidies were deducted (so-called Green Box values on ‚environmental payments'), however, this was not applied to the EU data (there are no Green Box values on ‚environmental payments' for EU country statistics). For this indicator, the used data from different data sources are not comparable due to different calculation methods. [8] The explanatory power of this indicator is questionable.

Indicator wilderness protection:

The indicator ‚wilderness' is a highly aggregated composite indicator, which is based on several secondary data sets from various organizations. This indicator was conceptualized by CIESIN/Columbia University in cooperation with the New York Wilderness Conservation Society, an international NGO. It measures the

[8] Discussion with and additional information and assessment provided by Dr. Rainer Muessner, Ecologic Nature Protection and Agricultural Expert. Compare also Andreas R. Kraemer's comment, EPI-Report (2006), Annex D Policy Category Discussion, on agricultural subsidies.

percentage of pre-defined wilderness area put under public protection. This indicator is based on ‘data maps’ which were created with the help of GIS software. The data on wilderness areas was extracted from the ‘Human Footprint”, another highly aggregated index, which was also jointly conceived by the Wildlife Conservation Society and CIESIN/Columbia University. The original data sources of the Human Footprint Index could not be retrieved (the existing online databank could not be used with standard PC software). The data on protected areas was taken from UNEP-WCMC and the IUCN - World Commission on Protected Areas/Consortium of world databanks on protected areas. The data source ‘Word Databank on Protected Areas (WDPA) is worldwide the most comprehensive data collection of this kind and is a generally renown data source on protected areas. All data is accessible online and the original data source (country, agency, commission etc.) is always indicated. As for Germany, 100% of all used data derives from respective national public agencies, i.e. the data on protected areas comes from the German Federal Agency for Nature Protection.

Indicator eco-region protection:

This indicator attempts to indicate the readiness and commitment of a Government to protect species biodiversity and nature zones. The indicator eco-region protection is a highly aggregated composite indicator, which is based on several secondary data sets from various organizations. The indicator was developed by CIESIN/Columbia University and measures, whether a State is protecting at least 10% of its biomes as nature protection zones (i.e. deserts, forests, water bodies, savannah, etc.). In this case, this indicator tries to implement a specific target of the Convention on Biological Diversity and the indicator was conceptualized accordingly. The underlying data for the indicator eco-region protection is all spacious and was created with the help of GIS. As for the original calculations, all spacious data on terrestrial biomes and protected areas were put together in a way that it generated a multi-layered polygon country boundary-biome-protection map. This multi-layered map was projected with the means of a statistical application (Molleweide) and each polygon area was calculated. The data on eco-regions stem from WWF and National Geographic while all data on protected areas were extracted from UNEP-WCMC and the IUCN - World Commission on Protected Areas/Consortium of world databanks on protected areas. The data source ‘Word Databank on Protected Areas (WDPA) is worldwide the most comprehensive data collection of this kind and is a generally renown data source on protected areas. All data is accessible online and the original data source (country, agency, commission etc.) is always indicated. As for Germany, 100% of all used data derives from respective national public agencies, i.e. the data on protected areas comes from the German Federal Agency for Nature Protection. The underlying data for the calculation of the WWF/National Geographic maps for the European region and Germany could only traced back insofar as it was possible to identify that the used ‚Federation Maps’ are based on the results of a larger research project called *„The Map of Natural Vegetation of Europe”* (1994), which was conducted by the EU and the German Federal Agency for Nature Protection during the mid 1990s. The potential vegetation map for Europe was put together by German Federal Agency for Nature Protection with the help of GIS; the used data could not be traced back but stems very likely from the German Federal Agency for Nature Protection itself.

Indicator timer harvest rate:

This indicator measures the percentage of timber harvest rate in standing forests. The data sources for this indicator are FAO data from various FAO databanks. Data on standing forests was extracted from a FAO standard report „State of the World’s Forest 2005”. The data on timber harvest rate were taken from the FAOSTAT Forestry-databank. The FAOSTAT Forestry-databank contains annually gathered data on production and trade on various timber products, including primary products. This data is collected based on annual survey conducted by FAO in cooperation with the ‘International Tropical Timber Organization’, the UN Economic Commission for Europe and EUROSTAT. The data collection of FAOSTAT derive from various data sources, for Europe in particular from both UN Economic Commission for Europe and EUROSTAT. The exact data sources from UNECE are not indicated, nor for EUROSTAT. The recent FAO website re-launch made it difficult to impossible to trace all missing data.

Indicator energy efficiency:

The calculation of this indicator looks at the ratio between national energy consumption in relation to the national GDP. The data were extracted from databanks of the US Department of Energy (DOE) (*International Energy Annual- EIA*), which conducts an annual comprehensive data gathering and processing of secondary global energy data on various energy categories, including energy production, energy consumption, energy trade, import and export and individual energy suppliers. Data sources are predominantly secure and renowned primary standard data sources, such as official national energy statistics, or also secondary energy data from databanks, such as International Energy Agency, OECD, APEC, IMF, UN, World bank, EU, OPEC etc. The so-called *International Energy Annual* is updated on an annual basis and offers data on trends of international energy developments concerning production, consumption, expert, import of primary energy commodities for over 2220 countries. In addition, it offers data on population, price developments for crude oil in selected countries. The data on renewable energy encompasses data on hydropower, biomass, waste residues, geothermal energy, solar and wind energy. Data sources for data from European countries include standard reports of European energy statistics, such as OECD data, EU data, and IEA data. As for this indicator, several European databanks and energy reports are indicated as data sources, thus the original sources for Germany could not be traced back in detail.

Indicator renewable energies:

This indicator calculates the percentage of renewable energy production of the overall national primary energy consumption for 181 countries for the period 1994-2003. Renewable energies include in this definition the following energy suppliers: hydropower, biomass, geothermal energy, solar and wind energy. The data were taken from databanks of the US Department of Energy, which conduct an annual comprehensive data gathering and processing of secondary energy data on various energy categories. Data sources for data from European countries include standard reports of European energy statistics, such as OECD data, EU data, and IEA data. As for this indicator, several European databanks and energy reports are indicated as data sources, thus the original sources for Germany could not be traced back in detail.

Indicator CO_2 per GDP:

This indicator measures the annual CO_2-emissions in (*t)* against the GDP (in millions) for 181 countries ((1995: US$). GDP data was extracted from the World Bank report on development indicators 2004. The *Carbon Dioxide Information Analysis Center* is part of the US Department of Energy and central data and analysis centre for global change. It publishes annually updated data and rankings on global CO_2-emissions. The CDIA figures contain overall CO_2-emissions, based on burning of fossil fuels, cement production and gas flaring, expressed in 1000 t carbon. The original data of these reports are gathered and processed by the *Oak Ridge National Laboratory,* a scientific and research laboratory of the US Department of Energy, which conducts applied research in the energy field. However, the original data for Germany could not be traced back in detail due to too vague data source indications. However, for this indicator, it can be stated that an assessment of the CO_2 per capita consumption would have been more useful to reflect trend developments of the original resource use in a country, which would allow more easily assessing as well if appropriate measures were taken at national level.

__Table 3__: ***Comparison of indicators of relevant indices***

Environment category	**EPI** **Environmental Performance Index**	**UBA KIS** **UBA-Core Indicator System (UBA= German Federal Environmental Agency)**	**DUX** **German Environment Index**	**EEA** **EEA Core Indicator Set**	**OECD** **Environmental Indicator Key Set**
Air	***Air quality*** **- Urban particulates** **- Indoor air pollution** **- Regional Ozone**	***Stress on environment mediums and areas through substances - Air*** - air pollution index of emissions - Transgression of critical loads for nitrogen (eutrophication) - Transgression of critical loads for acid (acidification) - Damage to forests of pollutant level 2 and more ***Environment, Health and quality of life – air quality in high density urban areas*** - Pollutant load in the air in high density urban areas (example benzol) **- Airborne particles load** - Transgression of critical levels for ozone in vegetation **- Ground level ozone – transgression frequency of threshold target values**	***Air*** - Development of emissions of air pollutants SO_2, NO_x, NH_3 and NMVOC (percentage)	***Air pollution and ozone depletion*** - Emissions of acid substances - Transgression of limit value targets for air quality in residential areas - Emissions of primary and secondary precursor particle emissions - Production and consumption of ozone depleting substances - Ecosystem load through acidification, eutrophication and ozone - Emissions of ozone precursor substances - Ecosystem load through acidification, eutrophication and ozone	***Air quality*** - SOx and NOx Emissions-intensity
Water resources -	***Water resources*** **- Water consumption**	***Stress on environment mediums and areas through substances - water bodies & Environment, Health and quality of life – incorporation of pollutants***	***Water***	***Water*** **- Water consumption**	***Water resources and Water quality*** - Intensity of water consumption

Environment category	**EPI** **Environmental Performance Index**	**UBA KIS** **UBA-Core Indicator System (UBA= German Federal Environmental Agency)**	**DUX** **German Environment Index**	**EEA** **EEA Core Indicator Set**	**OECD** **Environmental Indicator Key Set**
	- Nitrogen load	- Nutrient emissions in surface water bodies in Germany - Heavy metal emissions in surface water bodies in Germany - Water body quality level II for overall N and AOX **Groundwater quality** **Nitrate load** - Pollutant load in organism in North Sea - Bath water quality - Pathogen micro organism in coastal and inland water bodies	- Water body quality level II for overall N and AOX	- Nutrient in freshwater - Transitional nutrients, coastal and sea water - Chlorophyll in transitional, coastal and sea water - Oxygen using substances in rivers	
	- Drinking water *(access to clean drinking water)*	- Drinking water quality for end consumer (heavy metals)		- Bath water quality	
	- Access to basic sanitation			- Urban sewage treatment	- Connection rate to sewage treatment facilities
Biodiversity	***Biodiversity & Habitat*** **- Ecoregion protection** **- Wilderness protection**	***Biological Diversity, nature household and landscape, species and habitat and diversity of landscapes*** - Sustainable indicator for species biodiversity - Protected species and habitats - Percentage of foreign species and plants in Germany - Square footage and percentage of non-fragmented, low density transport areas - Status and implementation of	***Species biodiversity*** - Stock of representative bird species	***Biodiversity*** - Designated protection areas - Species biodiversity - Endangered and protected species	***Biodiversity*** - Endangered species

Environment category	**EPI** **Environmental Performance Index**	**UBA KIS** **UBA-Core Indicator System (UBA= German Federal Environmental Agency)**	**DUX** **German Environment Index**	**EEA** **EEA Core Indicator Set**	**OECD** **Environmental Indicator Key Set**
		landscape planning - Urban sprawl and fragmentation of landscapes ***Site and area protection*** - Natura 2000-areas **- Percentage of strongly protected areas (protected areas and national parks)**			
Productive natural resources	***Productive Natural Resources*** **- Timber harvest rate** **- Overfishing** **- Agricultural subsidies**	***Land use*** **- Percentage of areas with organic farming of overall agricultural area** **- Percentage of area FSC or ‚natural land’ certified forest area** - **Agricultural-environmental subsidies: subsidies and supported areas** - Use of genetically modified organisms ***Soil*** - Percentage of fertilizer and pesticides in agriculture - Nitrogen overload - Indicators for soil loading with substances	***Agriculture*** - Nitrogen overload in agriculture	***Agriculture*** **- Areas with organic farming** - Gross nutrient balance ***Fisheries*** - Aquaculture-production - Quantity of fishery fleet **- Status of ocean fish stock**	***Forest resources*** - Intensity of consumption of forest products ***Fishery resources*** - Intensity of consumption of fish stocks/resources
Sustainable energy	***Sustainable energy*** - **Energy efficiency**	***Climate protection in the energy sector*** - Energy productivity - Energy efficiency of electricity generation - Long distance heating and significance of power-heat - coupling (co-generation) of	***Energy*** **- Energy productivity – relative development of energy productivity against GDP and primary energy consumption**	***Energy*** - Final energy consumption (sectors) - Overall energy consumption (energy suppliers) **- Overall energy intensity**	***Energy resources*** - Intensity of energy consumption

Environment category	EPI Environmental Performance Index	UBA KIS UBA-Core Indicator System (UBA= German Federal Environmental Agency)	DUX German Environment Index	EEA EEA Core Indicator Set	OECD Environmental Indicator Key Set
	- Renewable energies **- CO_2-emissions per capita**	energy production - Share of renewable energies as part of electricity production - Primary energy consumption split into energy suppliers and share of renewable energies ***Climate change–Greenhouse effect*** - Emissions of the six Kyoto protocol greenhouse gases - CO2-emissions according to emitter group - Atmospheric CO2-concentrations - Annual average temperature in Germany since 1901 - Blossom time of certain plants		- Electricity through renewable energies **- Renewable energy consumption** ***Climate protection*** - Atmospheric greenhouse gas concentration - Global and European temperatures - Greenhouse gas emissions and reduction - Projections of greenhouse gas emissions and reduction	***Climate protection*** - CO_2-emission intensity *(Medium Term Indicators: Index of greenhouse gas emissions –* *CO2 emissions* *CH4 emissions* *N2O emissions* *CFC emissions)*
Environmental Health	***Environmental Health*** **- Child mortality** **- Access to sanitation** **- Access to clean drinking water**				

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Additional categories		***Climate protection in the transport sector*** - Modal Split of the freight and public transport performance - Transport intensity for freight and public transport - Specific emissions of road traffic ***Waste/ commodity productivity*** - Commodity productivity - Overall waste accumulation - Recycling quota of main waste flows - Disposal quota of main waste flows - Household waste ***Soil resources*** - Increase of settlements and traffic areas - Utilization-dependent erosion risk in Germany - Suspected relics areas in relation to percentage of rehabilitation ***Radiation protection*** - Radiation exposition through radon in buildings - Radiation exposition through radioactive substances ionizing radiation in medicine ***Noise*** - Noise load - Use of resources and waste economy ***Incorporation Heavy metals*** - Heavy metals in food	***Mobility*** - Transport intensity for freight and public transport ***Waste/ commodity productivity*** - Commodity productivity	***Transport*** - Freight transport demand - Public tranport demand - Consumption of clean and alternative energy suppliers ***Waste*** - Waste accumulation and recycling of packaging waste/waste - Waste accumulation (city) ***Soil*** - Soil consumption - Progress regarding management of contaminated soils	***Waste*** - Intensity of waste accumulation (city)

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		- Dioxin and additional persistent organic compounds in food - Lead in blood - Organic chlorine compounds in blood			

Red= Indicators which equal the respective EPI indicator