INTERIM REPORT

SELF ASSESSMENT STUDY ON THE ENVIRONMENTAL PERFORMANCE INDEX (EPI) FOR MALAYSIA

Ministry of Natural Resources and the Environment (NRE)

In collaboration with

Universiti Teknologi Malaysia (UTM)

Prepared by the UTM EPI Study Team
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1.0 STUDY BACKGROUND

Environmental Performance Index (EPI), created by the collaboration of Yale University and Columbia University is a data driven approach that ranks environmental sustainability performance of countries around the globe based on 25 performance indicators tracked across ten policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at national government scale of how close countries are to established environmental policy goals. EPI employs proximity-to-target methodology that facilitates cross-country comparisons as well as analysis of how the global community is doing collectively on each particular policy issue. Malaysia was ranked 54 among 163 countries accounted in the 2010 EPI. Among the benefits of implementing EPI at national level include the following:

a) Identifying current environment and sustainability issues and problems;
b) Tracking the trends of the environmental pollution control and natural resources management;
c) Highlight successful policies that produce positive results;
d) Track policies and programs that are not productive and reallocate resources to more effective actions and initiatives;
e) Provide the basis for cross sectoral comparisons;
f) Facilitates benchmarking and identification the leaders in the environmental issues; and
g) Identifying the best practices and successful policy models.

Considering the importance of EPI to the country, Ministry of Natural Resources and Environment (NRE) will work closely with Universiti Teknologi Malaysia (UTM) to conduct a study on Malaysia's EPI and put forward a self assessment report and recommendations to the government.

1.1 OVERVIEW

The Environmental Performance Index (EPI) is a method of quantifying and benchmarking the environmental performance of a country's policies. The EPI, published every two years since 2006, was developed by the Yale Centre for Environmental Law and Policy, Yale University and the Centre for International Earth Science Information Network (CIESIN), Columbia University, in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission. Previously, Yale University and Columbia University published the Environmental Sustainability Index (ESI) between 1999 and 2005. The ESI was developed to evaluate the country’s environmental sustainability relative to the paths of other countries. The EPI, on the other hand, uses outcome-oriented indicators based on the proximity-to-target approach in which the current environmental status is measured relative to a policy target. It is considered as a benchmarking index that can be more easily used by policy makers, environmental scientists, advocates and the general public. The EPI emphasizes on the need to track on-the-ground environmental results and offers a tool for enhanced environmental policymaking.

Following the 2000 Millennium Declaration and the Millennium Development Goals (MDGs), there have been major global efforts in education improvement, healthcare expansion, and poverty reduction. However, the MDGs achievement in environmental sustainability goals has been lagging behind, partially due to the lack of clearly-defined environmental goals which would help to illuminate the problems, quantify the burdens imposed by environmental degradation, measure policy progress, and assure private and public funders of the return on their investments. The EPI was developed and published, in part, as a respond to this call.

EPI can be considered as an instrument for the environmental management, that

- highlights current environmental problems and high priority issues;
- tracks pollution control and natural resource management trends at regional, national, and international levels;
- identifies policies currently producing good results;
- identifies where ineffective efforts can be halted and funding redeployed;
- provides a baseline for cross-country and cross sectoral performance comparisons;
- facilitates benchmarking and offers decision-making guidance;
- spotlights best practices and successful policy models.
- elucidates linkages between environmental policy and other issue areas such as public health, revealing new, and effective leverage points for change.

As of January 2010, three EPI reports have been released - the Pilot 2006 EPI, the 2008 EPI, and the 2010 EPI. In the 2006 Pilot EPI, 133 countries were ranked in which New Zealand, Sweden, and Finland were the top three performers with their EPI Scores 88.0, 87.8, 87.0, respectively, while Malaysia was ranked 9 with EPI score of 83.3. In the 2008 EPI, 149 countries were ranked, and the top three performers were Switzerland, Sweden and Norway with their EPI scores of 95.5, 93.1, and 93.1, respectively. Malaysia was ranked 26 with the EPI score of 84.0 in the 2008 EPI. Released in January 2010, during the World Economic Forum in Davos, Switzerland, the 2010 EPI ranks 163 countries on their performance across 25 indicators aggregated into ten policy categories. The policy categories are: Environmental Burden of Disease; Water Resources for Human Health; Air Quality for Human Health; Air Quality for Ecosystems; Water Resources for Ecosystems; Biodiversity and Habitat; Forestry; Fisheries; Agriculture; Climate Change. Malaysia was ranked 54 with the EPI score of 65.0, a significant drawback compared to our performance in the previous EPIs. The top three performers of 2010 EPI are Iceland, Switzerland, and Costa Rica with their EPI scores of 93.5, 89.1, and 86.4, respectively. Iceland’s top-notch performance in the 2010 EPI derives from their success in addressing pollution control and natural resource management challenges resulting in the high scores on environmental public health, controlling greenhouse gas emissions, and reforestation. Other top performers including Switzerland, Costa Rica, Sweden, and Norway – all of which have made substantial investments in environmental infrastructure, pollution control, and policies designed to move toward long-term sustainability. On the contrary, the lowest performers in EPI generally come from impoverished countries that lack basic environmental amenities and policy capacity including Togo, Angola, Mauritania, the Central African Republic, and Sierra Leone.

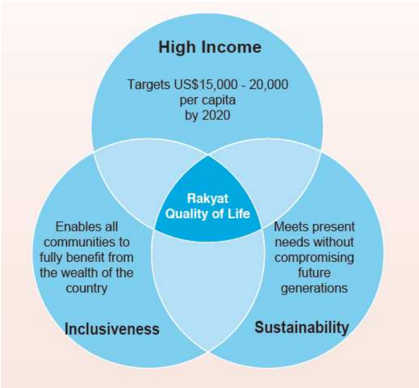
The EPI itself is considered as work in progress due to data constraints and limitations in methodology. Therefore it is expected that changes and adjustments were made in some policy categories and indicators of the EPI frame work and methodology. For example, the 2008 EPI calculated a simple average of the untransformed Environmental Health and Ecosystem Vitality objective scores, while in the 2010 EPI, the raw data of twelve indicators were logarithmally transformed and the Ecosystem Vitality objective scores were rescaled to match those of the Environmental Health objective. These have the effects of redistribution of the countries ranks as well as allowing inclusion of more countries previously not included in the EPI computation. For example, Singapore was included in the 2010 EPI for the first time and ranked 28 with the EPI score of 69.6. **Appendix 1.1** shows comparison of Malaysia's performance in each indicator of the 2008 EPI and the 2010 EPI.

Malaysia's performance has been continuously declining from 2006 Pilot EPI to 2010 EPI. Malaysia maintained relatively good performance in the Environmental Health Objective but lagged behind in several indicators of the Ecosystem Vitality Objective. Indicators where serious attention need to be given include those aggregated into the Air pollution Effects on Ecosystem policy category, Marine Protection, Trawling Intensity, and those indicators aggregated into the Climate Change policy category.

1.2 Objectives of the Study

Issues related to the environment and sustainability have recently entered a new level of concern by the government and the public. In the years to come, the environmental and sustainability issues will become among the major factors for driving policy considerations and competitive advantages. Hence, the New Economic Model (NEM) that is designed for transforming Malaysia from a middle income to an advanced nation by 2020 puts strong emphasis on sustainability as one of the three dimensions of the model. In the past, Malaysia's economic growth has come at considerable environmental cost. The GDP measurement of economic growth did not take into account the costs to the society arising from the environmental degradation. There is a need for a check-and-balance between the economic growth and the environmental sustainability.

The New Economic Model



The NEM gives equal emphasis on both protection of the environment and economic growth. In this context, EPI has a role to be a useful tool for the government to benchmark our environment and sustainability performance and progress towards certain targets for sustainability. The ability to provide quantitative measures on the environmental health and ecosystem vitality enables EPI to complement the triple dimensions of NEM. It is therefore imperative that Malaysia maintain high performance in both the Environmental Health and Ecosystem Vitality while striving towards high income advanced economy. In relation to the abovementioned scenario, the objectives of the present work on the EPI of Malaysia are as follows:

a) to carry out self-assessment of the Malaysia's EPI based on the data gathered from various agencies that are related to the EPI indicators.
b) to recommend to the government on the measures that need to be taken for improvements of Malaysia's environmental performance.

1.3 Study Approach

The study started with identification of various stake holders consisting of the government agencies and departments responsible in collecting and managing all the data related to the indicators of the EPI. Some of the agencies identified are shown in **Table 1.1**. Universiti Teknologi Malaysia (UTM) and the Ministry of Natural Resources and the Environment (NRE) agreed to appoint a team of academic staff (**Appendix 1.2**) to conduct the study. If necessary a working committee is formed in order to facilitate the study and the data collection. For example, the Environmental Burden of Disease Working Committee is formed in collaboration of the Ministry of Health Malaysia for the study of the Environmental Burden of Disease indicator (**Appendix 1.3**).

The study team with the cooperation of the stake holders identify the available data relevant to each of the 2010 EPI indicators. Data are collected and collated, and differences in data formats are identified. Among issues anticipated in the data collection are data incomplete or unavailable, in certain cases, different data formats may render direct application of the data difficult.

The 2010 EPI website (http://epi.yale.edu/) provides the database of the indicators as well as a complete aggregation methodology from the indicators up to the index value of the EPI for each country. The study team examines the proximity-to-target computation methodology for each indicator and apply them to the available data whenever possible. As the main objective of the current study is to carry out a self assessment to the Malaysia's performance in the 2010 EPI, the study team members will highlight issues in the data availability and management that contribute to the performance.

Table 1.1 Stake holders identified for the 2010 EPI study

NO.	INDICATOR	OBJECTIVE	POLICY CATEGORY	STAKE HOLDER
1	Environmental Burden of Disease	Environmental Health	Health	Kementerian Kesihatan /Kementerian Tenaga, Teknologi Hijau dan Air
2	Access to sanitation	Environmental Health	Water (effects on humans)	Kementerian Kesihatan /Kementerian Tenaga, Teknologi Hijau dan Air
3	Access to water	Environmental Health	Water (effects on humans)	Kementerian Kesihatan /Kementerian Tenaga, Teknologi Hijau dan Air
4	Indoor air pollution	Environmental Health	Air pollution (effects on humans)	Kementerian Kesihatan /Kementerian Sumber Manusia
5	Outdoor air pollution	Environmental Health	Air pollution (effects on humans)	NRE
6	Sulfur dioxide emissions per populated land area	Ecosystem Vitality	Air pollution (effects on ecosystem)	NRE
7	Nitrogen oxides emissions per populated land area	Ecosystem Vitality	Air pollution (effects on ecosystem)	NRE

NO.	INDICATOR	OBJECTIVE	POLICY CATEGORY	STAKE HOLDER
8	Non-methane volatile organic compound emissions per populated land area	Ecosystem Vitality	Air pollution (effects on ecosystem)	NRE
9	Ecosystem ozone	Ecosystem Vitality	Air pollution (effects on ecosystem)	NRE
10	Water quality index	Ecosystem Vitality	Water (effects on ecosystems)	NRE
11	Water stress index	Ecosystem Vitality	Water (effects on ecosystems)	NRE
12	Water scarcity index	Ecosystem Vitality	Water (effects on ecosystems)	NRE
13	Protected areas cover	Ecosystem Vitality	Biodiversity and Habitat	NRE
14	Percentage of EEZ Covered by Marine Protected Areas (MPAEEZ)	Ecosystem Vitality	Biodiversity and Habitat	NRE / Kementerian Pertanian dan Industri Asas Tani
15	Critical habitat protection	Ecosystem Vitality	Biodiversity and Habitat	NRE
16	Annual change in forest cover	Ecosystem Vitality	Forestry	NRE
17	Growing stock rate	Ecosystem Vitality	Forestry	NRE
18	Marine Trophic Index slope	Ecosystem Vitality	Marine and Fisheries	Kementerian Pertanian dan Industri Asas Tani
19	Trawling and dredging intensity	Ecosystem Vitality	Marine and Fisheries	Kementerian Pertanian dan Industri Asas Tani
20	Agricultural water intensity	Ecosystem Vitality	Agriculture	Kementerian Pertanian dan Industri Asas Tani
21	Pesticide regulation	Ecosystem Vitality	Agriculture	Kementerian Pertanian dan Industri Asas Tani / NRE
22	Agriculture subsidies	Ecosystem Vitality	Agriculture	Kementerian Pertanian dan Industri Asas Tani
23	Greenhouse gas emissions per capita (including land use emissions)	Ecosystem Vitality	Climate Change	Kementerian Tenaga, Teknologi Hijau dan Air / NRE / Kementerian Perusahaan Perladangan dan Komoditi / Kementerian Perumahan dan Kerajaan Tempatan / Kementerian Pengangkutan

NO.	INDICATOR	OBJECTIVE	POLICY CATEGORY	STAKE HOLDER
24	Industrial greenhouse gas emissions intensity	Ecosystem Vitality	Climate Change	Kementerian Tenaga, Teknologi Hijau dan Air / NRE
25	CO_2 emissions per electricity generation	Ecosystem Vitality	Climate Change	Kementerian Tenaga, Teknologi Hijau dan Air

2.0 EPI METHODOLOGY

EPI can be considered as an environmental management tool that is based on empirical data and utilises the proximity-to target approach to gauge the performance of countries policy implementation. EPI measures the effectiveness of national environmental protection efforts in each country. It represents a composite value of two **core objectives** of environmental policy:

1. Environmental Health, which measures environmental stresses to human health; and
2. Ecosystem Vitality, which measures ecosystem health and natural resource management.

Each of the above core objectives is a result of scores aggregation of several **policy categories** that, in turn, are resulted from the computation PTT scores of several **indicators**.

Computation of the EPI is carried out according to the following steps:

a) Computation of indicators proximity-to-target values:

- A number of indicators that capture the best environmental data available on a country scale are developed, and for each indicator, a policy target is identified based on a certain criteria. 2010 EPI was established on 25 indicators (**Figure 2.1**).
- Each of the indicator data is converted to a proximity-to-target value with a range of 0 to 100. The proximity-to-target value measures the country-scale performance on an environmental policy goal for which the government is held accountable.

b) Based on the proximity-to-target values of the indicators, scores are calculated at three levels of aggregation as follows:

1. Scores are calculated for each of the ten core **policy categories** based on two to eight underlying indicators. Each indicator is given a weight. Figure 2.1 Table 2.1 shows the weights as percent of total EPI score, sources of data and target for each indicator. The 2010 EPI was established on ten policy categories as follows:

   i. Environmental Burden of Disease;
   ii. Water Resources for Human Health;
   iii. Air Quality for Human Health;
   iv. Air Quality for Ecosystems;
   v. Water Resources for Ecosystems;

vi. Biodiversity and Habitat;
vii. Forestry;
viii. Fisheries;
ix. Agriculture;
x. Climate Change.

2. Scores are next calculated for the objectives of Environmental Health and Ecosystem Vitality with weights allocated as shown in **Figure 2.1**. The weights (as % of total EPI score), sources, and targets of EPI Objectives, Categories, Subcategories, and Indicators are given in **Appendix 2.1.**

3. The overall Environmental Performance Index is then calculated, based on the mean of the two core objective scores. The Global EPI rankings are based on this index score for each country.

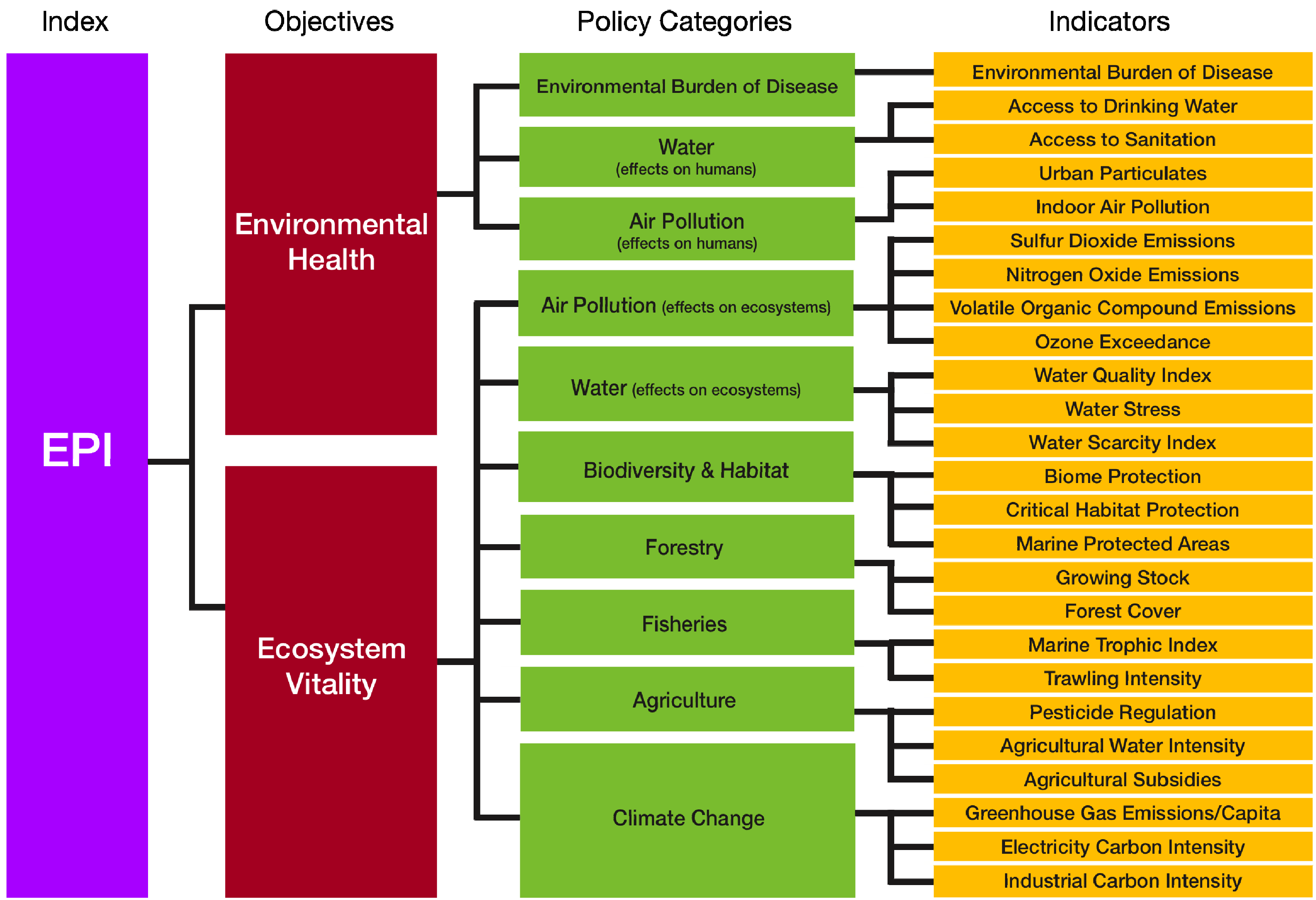
2.1 Indicator Selection

The EPI indicators are developed to cover the full spectrum of the underlying issues of the policy categories. The following criteria are used to determine the most appropriate metric:

- *Relevance*: The indicator tracks the environmental issue in a manner that is applicable to countries under a wide range of circumstances.
- *Performance orientation*: The indicator provides empirical data on ambient conditions or on-the-ground results for the issue of concern, or is a "best available data" proxy for such outcome measures.
- *Transparency*: The indicator is based on peer reviewed scientific data or data from the United Nations or other institutions charged with data collection.
- *Data quality*: The data represent the best measures available. All potential data sets were reviewed for quality and verifiability. Those that did not meet baseline quality standards were discarded.

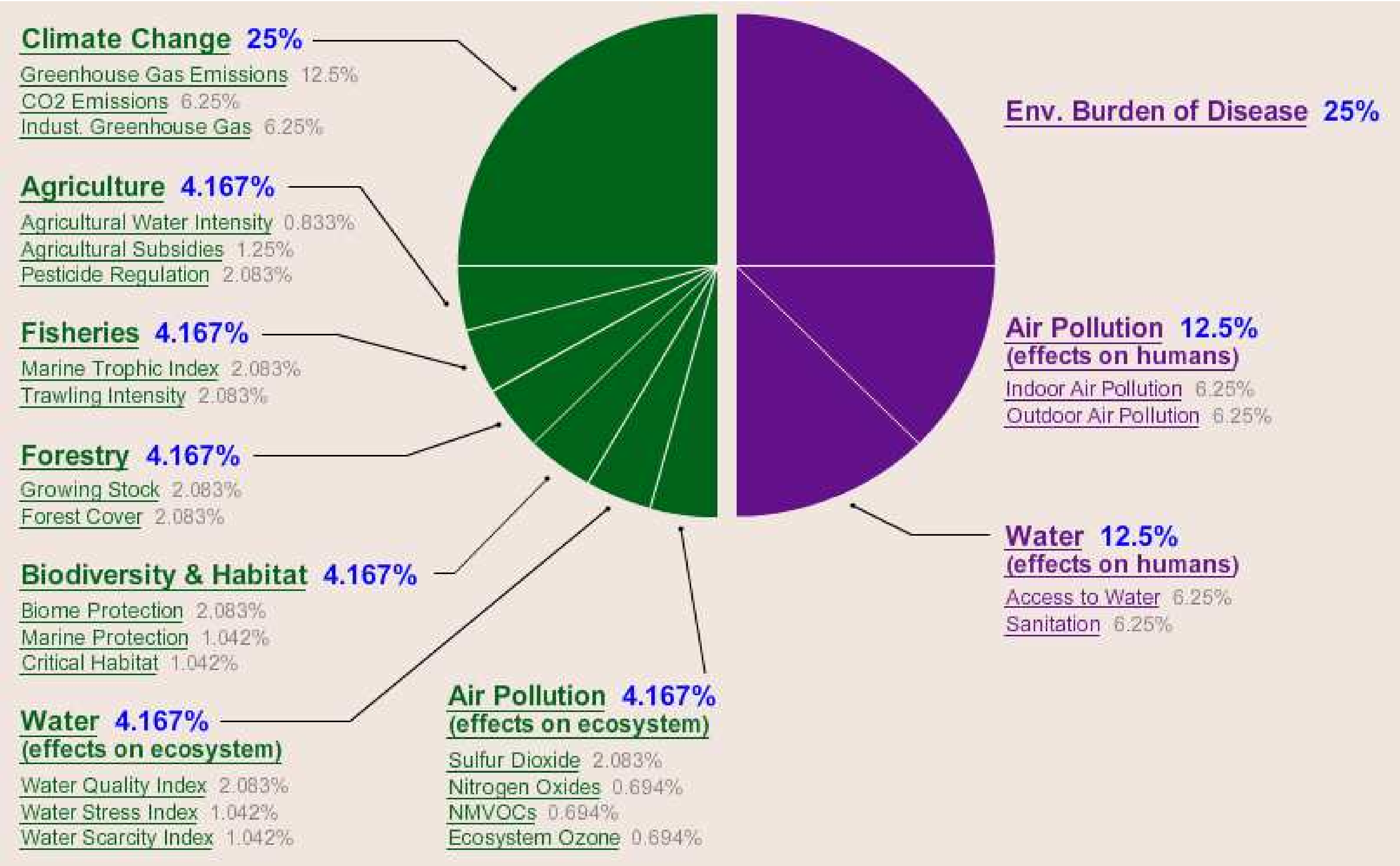
Performance indicators ideally track a given country's state of environment compared to targets. This would be the "states" category of the widely-used DSPIR (driving forces, pressures, states, impacts, responses) environmental assessment framework (Figure 2.2.). However, due to data gaps in the 2010 EPI, nonperformance indicators were used in some cases. Examples include S02, NOx, and NMVOC emissions per populated land area, which are "pressure" indicators, and Pesticide Regulation and Biome Protection, which are "response" indicators.

Figure 2.1 The 2010 EPI Frame Work



Self Assessment Study of EPI for Malaysia 2010

Figure 2.2 The 2010 EPI Frame Work With Weight (as % of Total EPI Score)



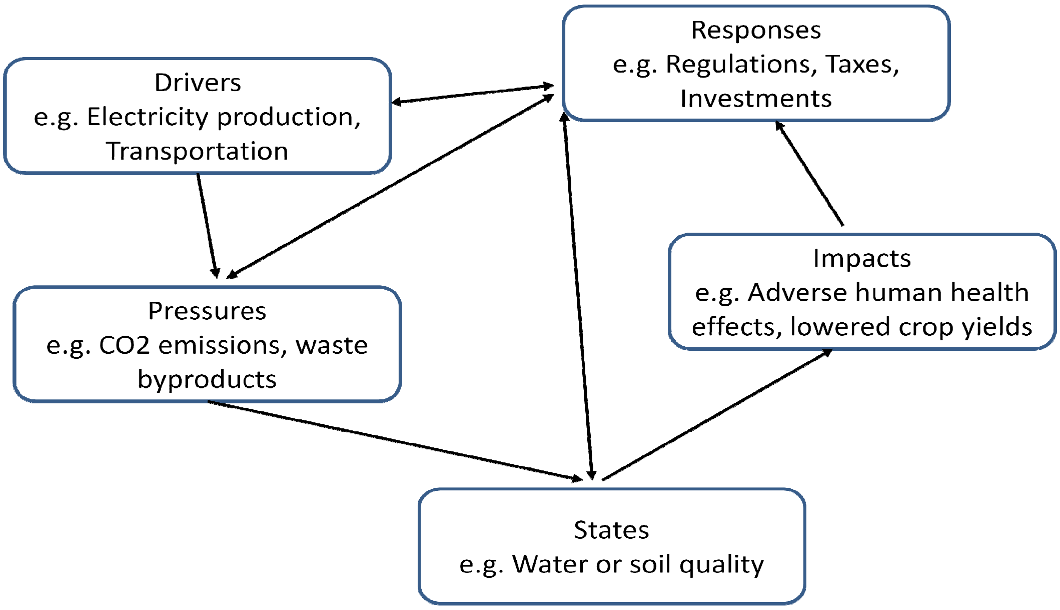


Figure 2.2: DSPIR Framework for environmental assessment

2.2 Indicator Target

The environmental performance indicators of a country are measured in terms of their proximity to carefully chosen policy targets. Targets are selected based on the following criteria:

a) Whenever possible, targets are based on international treaties and agreements.
b) For issues with no international agreements, targets are derived from environmental and public health standards developed by international organizations and national governments, the scientific literature, and expert opinion.
c) Where targets could not be established based on any scientific criteria, relative targets were set based on measures such as estimation of best performance among peer countries or that were sufficiently ambitious that all countries had some room to improve.
d) Some targets, such as the Convention on Biological Diversity's recommended 10% of national territory under protected areas, represent political compromises.

It was recognized that such targets do not necessarily reflect environmental performance required for full sustainability. In fact, only a few of the indicators have explicit targets established by consensus at a global scale. This suggests that there is a need for the international and national policy communities to be clearer about the long-term goals of environmental policies set at all levels.

2.3 Indicator Data Sources and Types

The indicators of the EPI are chosen based on a wide range of data sets from international organizations, NGOs, government agencies, and academia. The data include:

- official statistics that are measured and formally reported by governments to international organizations (but which are not independently verified);
- modeled data; and
- observations from monitoring stations.

2.4 Calculation of EPI

Step-by-step EPI calculation:

a. Input raw data: "indicator name_raw"

Input the untransformed data

b. Transformation: "indicator name_tr"

Transform (logharitm base e) the raw data for the following 12 indicators:

1. Environmental burden of disease
2. Outdoor air pollution
3. Sulfur dioxide emissions per populated land area
4. Nitrogen oxides emissions per populated land area
5. Non-methane volatile organic compound emissions per populated land area
6. Ecosystem ozone
7. Water stress index
8. Marine protection
9. Agricultural water intensity
10. Greenhouse gas emissions per capita (including land use emissions)
11. Industrial greenhouse gas emissions intensity
12. CO2 emissions per electricity generation

(The use of the log transformation has the effect of “spreading out” the leading countries, allowing the EPI to reflect important differences not only between the leaders and laggards, but among best performing leaders as well. When using raw data, caused the EPI to ignore small differences among top-performing countries and only acknowledge the more substantial differences between leaders and laggards. Logarithmic transformation also improves the interpretation of differences between countries at opposite ends of the scale. Compared to the use of the raw measurement scale, the log scale somewhat downplays the differences between the leaders and laggards, while more accurately reflecting the nature of differences at all ranges of performance.)

c. Winsorization: "indicator name_w"

- Winsorized for all indicators
- From winsorization, we get minimum and maximum winsorized value that will be used in the calculation of proximity-to-target

(Winsorising or Winsorization is the transformation of statistics by transforming extreme values in the statistical data. The distribution of many statistics can be heavily influenced by outliers. A typical strategy is to set all outliers to a specified percentile of the data; for example, a 90% Winsorisation would see all data below the 5th percentile set to the 5th percentile, and data above the 95^{th} percentile set to the 95^{th} percentile.)

d. Set targets: "indicator name_t"

- Targets are based on international treaties and agreements for each indicators

e. Transform targets: "indicator name_ttr"

- Transform (logharitm base e) the target for the 12 transformed indicators

f. Calculation of proximity-to-target: "indicator name_pt"

➢ Where high values equate to good performance:

[(target value-minimum winsorized value)-(target value-winsorized value)]x100/
(target value-minimum winsorized value)

➢ Where high values equate to bad performance:

[(maximum winsorized value-target value)-(winsorized value -target value)]x100/
(maximum winsorized value-target value)

Calculation of the Proximity-to-Target values are given in **Appendix 2.2.**

g. Aggregation to policy category

- differential weights
- scores are calculated for each of the ten core policy categories based on two to eight underlying indicators. Each indicator is given a weight (**Figure 2.2 and Appendix 2.1**).

Policy Categories	Calculation
Environmental Burden of Disease	- indicator is mandatory
Water Resources for Human Health	- average around the two indicators
Air Quality for Human Health	- average around the two indicators
Air Quality for Ecosystems	- SO2 is mandatory - The remaining 3 indicators are averaged around, transferring the weights within the group if any is missing

	(if all missing, SO2 gets the total score)
Water Resources for Ecosystems	- WQI average around countries with no surface water - any one of the water quantity indicators (WSI or WATSTR) are mandatory (average around the two indicators)
Biodiversity and Habitat	- PACOV is mandatory - if other indicator are missing, PACOV gets the total score - average around MPAEEZ (transfer weight to PACOV) - average around AZE (transfer weight to PACOV)
Forestry	- average around the two indicators
Fisheries	- both indicators are mandatory
Agriculture	- AGSUB and AGPEST are mandatory - average around AGWAT indicator, transferring weights equally to the remaining indicators
Climate Change	- all indicators are mandatory

h. Aggregation to objective

- based on differential weights of the policy categories

Objectives	Calculation
Environmental Health	- all policy categories are mandatory to have an EPI score
Ecosystem vitality	- average around for landlocked countries - rescale Ecosystem vitality scores on Environmental Health scale

i. Aggregation to EPI index

- The overall Environmental Performance Index is then calculated, based on the mean of the two core objective scores with equal weights. The Global EPI rankings are based on this index score for each country.

3.0 2010 EPI RESULTS

The top five out of 163 countries ranked in the global 2010 EPI are Iceland with a score of 93.5, followed by Switzerland (89.1), Costa Rica (86.4), Sweden (86.1), and Norway (81.1) (**Table 3.1**). Malaysia was ranked 54 with a score of 65.0. Top performing countries generally have the following characteristics:

- they are mostly developed countries,
- these are countries with strong financial resources,

Table 3.1 Global 2010 EPI Scores and Ranking

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
1	Iceland	93.5	56	Syria	64.6	111	Tajikistan	51.3
2	Switzerland	89.1	57	Estonia	63.8	112	Mozambique	51.2
3	Costa Rica	86.4	58	Sri Lanka	63.7	113	Kuwait	51.1
4	Sweden	86.0	59	Georgia	63.6	114	Solomon Islands	51.1
5	Norway	81.1	60	Paraguay	63.5	115	South Africa	50.8
6	Mauritius	80.6	61	United States	63.5	116	Gambia	50.3
7	France	78.2	62	Brazil	63.4	117	Libya	50.1
8	Austria	78.1	63	Poland	63.1	118	Honduras	49.9
9	Cuba	78.1	64	Venezuela	62.9	119	Uganda	49.8
10	Colombia	76.8	65	Bulgaria	62.5	120	Madagascar	49.2
11	Malta	76.3	66	Israel	62.4	121	China	49.0
12	Finland	74.7	67	Thailand	62.2	122	Qatar	48.9
13	Slovakia	74.5	68	Egypt	62.0	123	India	48.3
14	United Kingdom	74.2	69	Russia	61.2	124	Yemen	48.3
15	New Zealand	73.4	70	Argentina	61.0	125	Pakistan	48.0
16	Chile	73.3	71	Greece	60.9	126	Tanzania	47.9
17	Germany	73.2	72	Brunei	60.8	127	Zimbabwe	47.8
18	Italy	73.1	73	Macedonia	60.6	128	Burkina Faso	47.3
19	Portugal	73.0	74	Tunisia	60.6	129	Sudan	47.1
20	Japan	72.5	75	Djibouti	60.5	130	Zambia	47.0
21	Latvia	72.5	76	Armenia	60.4	131	Oman	45.9
22	Czech Republic	71.6	77	Turkey	60.4	132	Guinea-Bissau	44.7
23	Albania	71.4	78	Iran	60.0	133	Cameroon	44.6
24	Panama	71.4	79	Kyrgyzstan	59.7	134	Indonesia	44.6
25	Spain	70.6	80	Laos	59.6	135	Rwanda	44.6
26	Belize	69.9	81	Namibia	59.3	136	Guinea	44.4
27	Antigua & Barbuda	69.8	82	Guyana	59.2	137	Bolivia	44.3
28	Singapore	69.6	83	Uruguay	59.1	138	Papua New Guinea	44.3
29	Serbia & Montenegro	69.4	84	Azerbaijan	59.1	139	Bangladesh	44.0
30	Ecuador	69.3	85	Viet Nam	59.0	140	Burundi	43.9
31	Peru	69.3	86	Moldova	58.8	141	Ethiopia	43.1
32	Denmark	69.2	87	Ukraine	58.2	142	Mongolia	42.8
33	Hungary	69.1	88	Belgium	58.1	143	Senegal	42.3
34	El Salvador	69.1	89	Jamaica	58.0	144	Uzbekistan	42.3
35	Croatia	68.7	90	Lebanon	57.9	145	Bahrain	42.0
36	Dominican Republic	68.4	91	Sao Tome & Principe	57.3	146	Equatorial Guinea	41.9
37	Lithuania	68.3	92	Kazakhstan	57.3	147	North Korea	41.8
38	Nepal	68.2	93	Nicaragua	57.1	148	Cambodia	41.7
39	Suriname	68.2	94	South Korea	57.0	149	Botswana	41.3
40	Bhutan	68.0	95	Gabon	56.4	150	Iraq	41.0
41	Luxembourg	67.8	96	Cyprus	56.3	151	Chad	40.8
42	Algeria	67.4	97	Jordan	56.1	152	United Arab Emirates	40.7
43	Mexico	67.3	98	Bosnia & Herzegovina	55.9	153	Nigeria	40.2
44	Ireland	67.1	99	Saudi Arabia	55.3	154	Benin	39.6
45	Romania	67.0	100	Eritrea	54.6	155	Haiti	39.5
46	Canada	66.4	101	Swaziland	54.4	156	Mali	39.4
47	Netherlands	66.4	102	Côte d'Ivoire	54.3	157	Turkmenistan	38.4
48	Maldives	65.9	103	Trinidad and Tobago	54.2	158	Niger	37.6
49	Fiji	65.9	104	Guatemala	54.0	159	Togo	36.4
50	Philippines	65.7	105	Congo	54.0	160	Angola	36.3
51	Australia	65.7	106	Dem. Rep. Congo	51.6	161	Mauritania	33.7
52	Morocco	65.6	107	Malawi	51.4	162	Central African Rep.	33.3
53	Belarus	65.4	108	Kenya	51.4	163	Sierra Leone	32.1
54	Malaysia	65.0	109	Ghana	51.3			
55	Slovenia	65.0	110	Myanmar	51.3			

- the governments of these countries are committed to environmental management, and
- sophisticated environmental policy systems are implemented in these countries.

It is not surprising, therefore, that advanced European countries constitute more than half of the countries ranked top 30. Nevertheless, Costa Rica and Cuba, which are middle-income countries were able to outperform many higher income countries because they have strong Environmental Health scores, implement effective environmental policy systems and generally have low levels of industrial pollution.

On the other hand, most countries with the worst EPI performance are among the poorest in the world, lack of resources for health care or basic environmental investment and have weak policy capacity. Among these countries are Togo (with rank, score: 159, 36.4), Angola (160, 36.4), Mauritania (161, 33.7), the Central African Republic (162, 33.3), and Sierra Leone (163, 32.1).

3.1 The EPI Drivers

2010 EPI identified a selection of potential drivers for good environmental performance as follows:

- Per capita income
- Government effectiveness
- Population density
- Urbanization
- Ecological footprint
- Corruption
- Institutional and regulatory system variables
- Trade openness
- Climate change policies

The three EPI drivers that stand out for their clear correlation with good environmental performance are:

- Per capita income
- Corruption (the accountability, transparency, and corruption of the public sector)
- Government effectiveness.

3.2 Peer Group Analysis

The 2010 EPI provides peer group ranking of all countries based on their EPI scores which generated eighteen groups as follows:

1. Americas
2. Asia and Pacific countries
3. Eastern Europe and Central Asia
4. Europe
5. Middle East and North Africa
6. Sub-Saharan Africa

7. Organization for Economic Cooperation and Development countries
8. The Least Developed Countries
9. European Union Member Countries
10. ASEAN and China, Japan and South Korea
11. Asia Pacific Economic Cooperation member countries
12. OPEC member countries
13. FTAA member countries
14. African Union Member Countries
15. Alliance of Small Island States
16. Russia and the Newly Independent States
17. The Desert Countries
18. High Population Density Countries

While the global overall ranking on the EPI is of interest, it is also important to understand how Malaysia fares within relevant regional, economic and political peer groups. Peer group analysis allows our policymakers to contextualize our policy choices in light of the performance of other countries with similar socioeconomic or geographic situations. The policies and programs of peer group leaders provide insight into best practices and illuminate the most efficient approaches to improving Environmental Health and Ecosystem Vitality among countries facing similar challenges and opportunities.

Geographically, Malaysia is located among the Asia and the Pacific countries and ranked 10 behind New Zealand (EPI score 73.4), Japan (72.5), Singapore (69.6), Nepal (68.2), Bhutan (68.0), Maldives (65.9), Fiji (65.9), the Philippines (65.7), and Australia (65.7) (**Table 3.2**). Among the ASEAN countries, Japan, china and South Korea, Malaysia was ranked 4, behind Japan, Singapore and the Philippines (**Table 3.3**). Within the Asia Pacific Cooperation member countries, Malaysia was ranked 10 out of the 19 member countries (**Table 3.4**).

Table 3.2 Malaysia's ranking among the Asia & Pacific countries

Rank	Country	Score	Rank	Country	Score	Rank	Country
1	New Zealand	73.4	10	Malaysia	65.0	19	China
2	Japan	72.5	11	Sri Lanka	63.7	20	India
3	Singapore	69.6	12	Thailand	62.2	21	Pakistan
4	Nepal	68.2	13	Brunei	60.8	22	Indonesia
5	Bhutan	68.0	14	Laos	59.6	23	Papua N. G.
6	Maldives	65.9	15	Viet Nam	59.0	24	Bangladesh
7	Fiji	65.9	16	South Korea	57.0	25	Mongolia
8	Philippines	65.7	17	Myanmar	51.3	26	North Korea
9	Australia	65.7	18	Solomon Islands	51.1	27	Cambodia

Table 3.3 Malaysia's ranking among the ASEAN countries, Japan, China and South Korea

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
1	Japan	72.5	6	Brunei	60.8	11	China	49.0
2	Singapore	69.6	7	Laos	59.6	12	Indonesia	44.6
3	Philippines	65.7	8	Viet Nam	59.0	13	Cambodia	41.7
4	Malaysia	65.0	9	South Korea	57.0			
5	Thailand	62.2	10	Myanmar	51.3			

Table 3.4 Malaysia's ranking among the Asia Pacific Cooperation member countries

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
1	New Zealand	73.4	8	Philippines	65.7	15	Viet Nam	59.0
2	Chile	73.3	9	Australia	65.7	16	South Korea	57.0
3	Japan	72.5	10	Malaysia	65.0	17	China	49.0
4	Singapore	69.6	11	United States	63.5	18	Indonesia	44.6
5	Peru	69.3	12	Thailand	62.2	19	Papua N.G.	44.3
6	Mexico	67.3	13	Russia	61.2			
7	Canada	66.4	14	Brunei	60.8			

3.3 Cluster Analysis

A clustering method was used the EPI analysis to assign a set of observations into subsets (called *clusters*) so that observations in the same cluster are similar in some sense. Considering for consistency and easy interpretation from an environmental performance and socio-economic development perspective, the clustering process has resulted in the generation of seven country clusters based on the overall similarity across the 25 indicators. Hence, several interesting patterns become apparent as a result of the cluster analysis:

a) First, the weights given to Environmental Burden of Disease, Indoor Air Pollution, Outdoor Air Pollution, Access to Drinking Water, Access to Sanitation, Greenhouse Gas Emissions per Capita, CO2 Emissions Per Electricity Generation, and Industrial GHG Emissions Intensity result in their being the primary drivers of the clustering. Other indicators (receiving less weight in the EPI) contribute in smaller ways to differences between the clusters.

b) Secondly, there are some differences between the 2010 and 2008 cluster analysis; specifically, the use of logarithmic transformation for some of the indicators in 2010 increases the ability to differentiate between countries performing close to the target (and with a less severe penalty on the lagging countries). In 2008, some of the clusters were driven by indicators where there was little or no variability among the leading countries on the untransformed scale of the data; now, this is less of an issue (except for a few indicators like FORGRO and FORCOV where many of the countries achieve the target).

According to the 2010 EPI Cluster Analysis, Malaysia is included in the Cluster Seven. Countries of this cluster are mostly developed, wealthy nations that perform the best in the environmental health categories. While generally trending toward the top of the pack on most indicators, they have the lowest score for agricultural subsidies and the second-lowest performance on greenhouse gas emissions per capita. Included in this cluster are Australia, Austria, Belgium, Brazil, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Malaysia, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, United Kingdom, and the United States.

3.3 Malaysian Profile in 2010 EPI

Figure 3.1 shows the Environmental Health and Ecosystem Vitality scores for Malaysia in 2010 EPI. Malaysia performs better in Environmental Health than the Ecosystem vitality. The two overarching objectives of the EPI cover the ten Policy Categories and Malaysia's performance (**Figure 3.2**) shows that Air Pollution impact on ecosystem, Fisheries and Climate Change are the Policy Categories where more attentions are needed. The country's performance is more precisely described based on the Proximity-to-Target (PTT) values for each indicator of the EPI. **Table 3.5** shows the value, target and the Proximity-to-Target score for each indicator of the Malaysia's performance in 2010 EPI. Malaysia's performance as seen by the global ranking and Proximity-to-Target score for each indicator is given in **Table 3.6** where the proximity-to-Target scores are listed in the order from worst best performance. Based on the PTT score, the overall performance indicators may be divided into five categories as follows:

a) Those indicators with PTT scores less than 10
b) Indicators with PTT scores greater than 10 but less than 50
c) Indicators with PTT score between 50 and 80
d) Indicators with PTT scores greater than 80 but below 100
e) Indicator with PTT score of 100

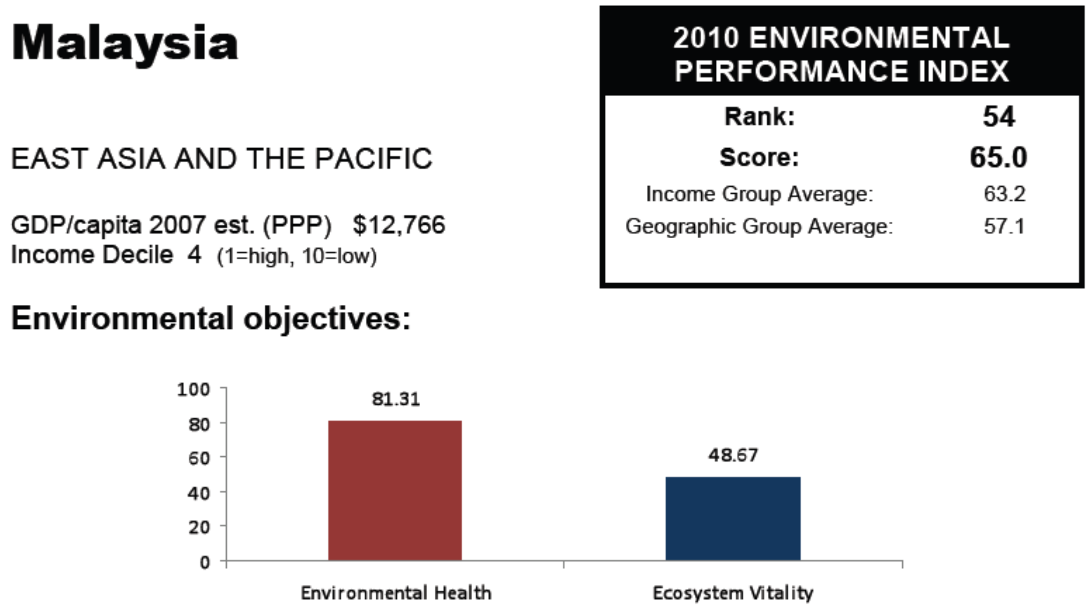


Figure 3.1 The Environmental Health and Ecosystem Vitality score for Malaysia in 2010 EPI

The percentage of the indicators according to their respective performance is given in **Table 3.7**. Seven indicators or 28% of the indicators (or 23.9% of the total EPI weight) performed less than 50% of their respective targets. In fact, these include two indicators (Trawling intensity *(EEZTD)* and CO_2 emissions per electricity generation *(CO2KWH)*) that performed below 10% of their respective targets. Six indicators (or 38.6% of total EPI weight) performed between 50 – 80% of their respective targets, while seven indicators (or 29.4% of the total EPI weight) performed better than 80% of their respective targets and only 5 indicators with only 8.1% of the total EPI weight met 100% of the their respective targets.

It is obvious that Malaysia needs to take steps to improve the performances of those indicators, in particular those with low performances. Initiative towards such improvements is being carried out by identifying availability of the relevant data as well as related methodological issues.

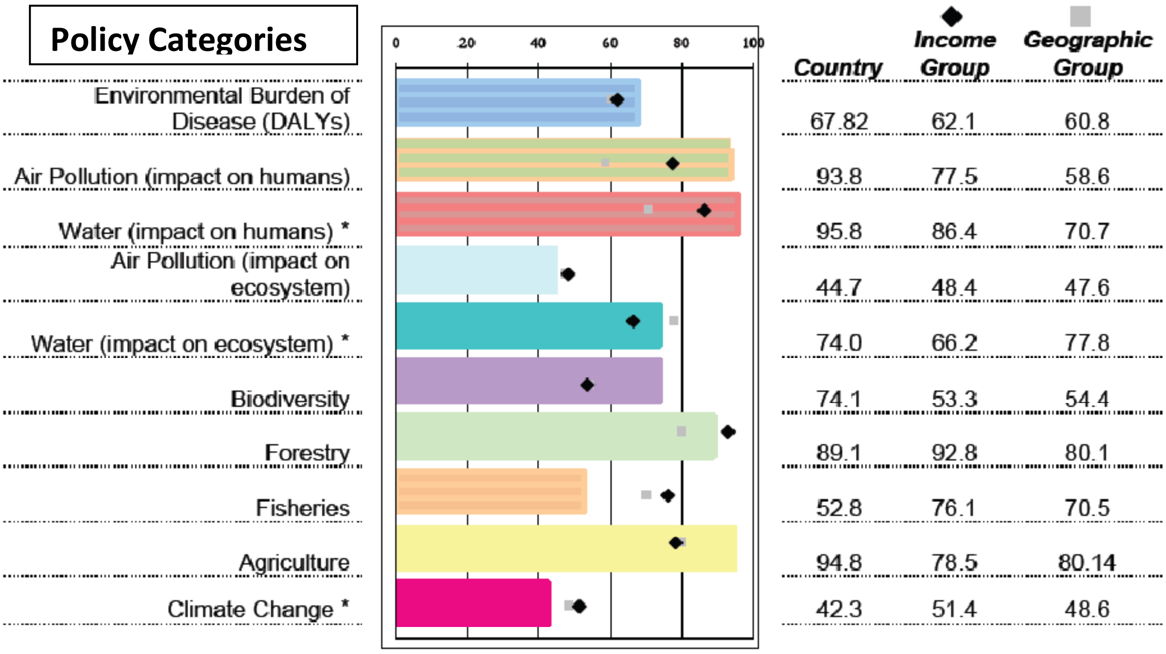


Figure 3.2 Malaysia' Policy Categories performance in 2010 EPI

Table 3.5 The Indicator Value, Target and Proximity-to-Target for Malaysia in 2010 EI

Indicators	Value	Target	Proximity to Target (100=target met)
DALY: Environmental Burden of Disease (DALY)	27.0	10	67.8
INDOOR: Indoor air pollution (%)	5.0	0	94.7
OUTDOOR: Outdoor air pollution (µg/m3)	22.9	20	92.9
ACSAT: Access to sanitation (%)*	94.0	100	93.3

WATSUP: Access to water (%)	99.0	100	98.3
SO2: Sulfur dioxide emissions (Gg/1000 sq km)	1.0	<=0.01	51.8
NOX: Nitrogen oxides emissions (Gg/1000 sq km)	1.9	<=0.01	45.0
NMVOC: Non-methane volatile organic compound emissions (Gg/1000 sq km)	4.5	<=0.01	32.6
OZONE: Ecosystem ozone (ppb)	380622.0	0	35.2
WQI: Water quality index *	54.6	100	54.6
WSI: Water scarcity index	0.0	0	100.0
WATSTR: Water stress index	0.7	0	86.8
PACOV: Biome protection (%)	10.0	>=10	100.0
MPAEEZ: Marine protection (%)	1.0	>=10	29.6
AZE: Critical habitat protection (%)	66.7	100	66.7
FORGRO: Growing stock change (ratio)	1.0	>=1	100.0
FORCOV: Forest cover change (%)	-0.7	>=0	78.2
MTI: Marine trophic index (slope)	0.0	>=0	100.0
EEZTD: Trawling and dredging intensity (%)	94.3	0	5.7
AGWAT: Agricultural water intensity (%)	1.0	<=10	100.0
AGSUB: Agricultural subsidies (NRA)	0.0	0	97.7
AGPEST: Pesticide regulation	20.0	22	90.9
GHGCAP: Greenhouse gas emissions per capita including land use emissions (Mt CO2 eq) *	14.5	2.5	41.9
GHGIND: Industrial greenhouse gas emissions intensity(t CO2 per mill US$)	59.4	36.3	76.6
CO2KWH: CO2 emissions per electricity generation (CO2 per kWh) *	619.1	10	8.9

Table 3.6 2010 EPI Indicator and their Proximity-to-Target (PTT) score and rank for Malaysia

Indicators	PTT Score	Rank/163 countries
Trawling intensity *(EEZTD)*	5.7	112
CO_2 emissions per electricity generation *(CO2KWH)***	8.9	127
Marine protection *(MPAEEZ)***	29.6	35
Non-methane volatile organic compound emissions per populated land area *(NMVOC)***	32.6	131
Ecosystem ozone *(OZONE)***	35.2	84

Indicators	PTT Score	Rank/163 countries
Greenhouse gas emissions per capita (including land use emissions) *(GHGCAP)***	41.9	127
Nitrogen oxides emissions per populated land area *(NOX)***	45.0	104
Sulfur dioxide emissions per populated land area (*SO2*)**	51.8	93
Water quality index *(WQI)*	54.6	79
Critical habitat protection *(AZE)*	66.7	21
Environmental burden of disease (DALY)**	67.8	57
Industrial greenhouse gas emissions intensity *(GHGIND)***	76.6	81
Forest cover change *(FORCOV)*	78.2	115
Water stress index *(WATSTR)***	86.8	51
Pesticide regulation *(AGPEST)*	90.9	57
Outdoor air pollution (PM10)**	92.9	46
Access to sanitation (ACSAT)	93.3	54
Indoor air pollution (INDOOR)	94.7	34
Agricultural subsidies *(AGSUB)*	97.7	107
Access to water (WATSUP)	98.3	46
Water scarcity index *(WSI)*	100	49
Biome protection *(PACOV)*	100	25
Growing stock change *(FORGRO)*	100	39
Marine trophic index *(MTI)*	100	26
Agricultural water intensity *(AGWAT)***	100	39

Table 3.7 Percentage distribution of the 2010 EPI indicator according to PTT scores

Proximity-to-Target Score	Number of Indicators	Number Percentage	Weight Percentage*
Less than 10	2	8	8.3
Greater than 10 but less than 50	5	20	15.6
Greater than 50 but less than 80	6	24	38.6
Greater than 80 but less than 100	7	28	29.4
PTT score of 100	5	20	8.1
TOTAL	25	100	100

*The percentage of the indicators under each category with and without weight is given in **Figure 2.2**.

4.0 SELF ASSESSMENT OF MALAYSIAN EPI INDICATORS

4.1 Environmental Burden of Disease

Environmental Burden of Disease (EBD) (code *DALY*) is the largest indicator which constitutes 25% of the total 2010 EPI. It is the only component of Environmental Burden of Disease Policy Category in the Environmental Health Objective. The target for this indicator is 10 DALYs per 1000 population. The raw value of DALYs for Malaysia is 27 DALYs/1000 capita (**Table 4.1.1**) which is derived from the WHO Public Health and the Environment publication for Malaysia (2009): http://www.who.int/quantifying_ehimpacts/national/countryprofile/malaysia.pdf. (**Appendix 4.1.1**.). Malaysia's performance based on the proximity-to-target (PTT) of this value resulted in the score of 67.8 and the global ranking of 57 for Malaysia (**Appendix 4.1.2**).

Table 4.1.1. 2010 EPI database for Malaysia's DALY – value 27 DALYs/1000 capita

1	Note: Values in cells with cross-hatching a							
2	code	ISO3V10	Country	CO2KWH_pt	DALY_raw	ACSAT_raw	WATSUP_raw	INDOOR_raw
51	858	URY	Uruguay	48.18963865	25	100	100	5
52	388	JAM	Jamaica	3.561761922	25	83	93	45
53	400	JOR	Jordan	10.02761993	25	85	98	5
54	434	LBY	Libyan Arab Jamahiriya	1.983470377	25	97	71	5
55	..	SCG	Serbia and Montenegro	8.018462068	26	92	99	..
56	268	GEO	Georgia	38.45317612	26	93	99	42.75
57	807	MKD	Macedonia	4.937509668	26	89	100	36.54
58	70	BIH	Bosnia and Herzegovina	0	26	95	99	49.19
59	458	MYS	Malaysia	8.874013204	27	94	99	5
60	862	VEN	Venezuela	32.88934948	27	86	90	5
61	788	TUN	Tunisia	11.2220457	27	85	94	5
62	780	TTO	Trinidad and Tobago	4.946339341	27	92	94	5
63	348	HUN	Hungary	21.79888391	28	100	100	5
64	8	ALB	Albania	68.0097645	29	97	97	50

4.1.1 Indicator Description

Environmental Burden of Disease (EBD) measured in Disability Adjusted Life Years (DALYs) is a health gap measure that extends the concept of potential Years of Life Lost (YLL) due to premature death to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability (YLD). The EBD integrates DALYs from poor water, sanitation and hygiene; indoor air pollution; urban air pollution; and climate change. The burden of disease due to modifiable environmental factors represents approximately one-quarter of the global disease burden, and more than one-third of the burden among children. Major disease burdens affected by environmental factors include diarrhoea, lower respiratory infections, various forms of unintentional injuries, and malaria. This 'environmentally-mediated' disease burden is much higher in the developing world than in developed countries - although in the case of certain non-communicable diseases, such as cardiovascular diseases and cancers, the per capita disease burden is larger in developed countries. The environmental burden of disease integrates many environmental health risks, and as such serves as an important metric of country-level performance.

4.1.2 Indicator Methodology

There are two aspects of the environmental burden of disease estimates shown in Figure 1:

a) The EBD estimates for a specific risk factors, such as water and sanitation or air pollution;

b) The EBD estimates that represent the risk factor of the environment as a whole, and more specifically the modifiable environment, such as water bodies, air pollution, etc.

For the purpose of global comparison and benchmarking, the EPI uses the EBD values (DALYs/1000 capita) that represent the component of disease attributable to the modifiable environment. These data are derived from the combination of the **Population Attributable Fraction** (PAF) and the **national statistics of Death and DALYs data** of a member country.

4.1.3 The National Health Statistics

In 2004, the Ministry of Health Malaysia published the Malaysian Burden of Disease and Injury Study for the first time. The study was undertaken by the Burden of disease Division, Institute for Public Health (IKU) in collaboration with researcher from the Institute for Medical Research (IMR). The objective of the study was to comprehensively quantify the burden of illness and injuries in the country in terms of Disability Adjusted Life Years (DALYs), which combines both the mortality and morbidity components of a disease or injury. The Malaysian Burden of disease and Injury Study was based on the baseline population and mortality data in year 2000 because that is the most complete data available in the country during the beginning of the study. Altogether, DALYs for specific ninety diseases have been calculated and presented in the report.

The national health data estimates published by WHO is available from the following website:
http://www.who.int/healthinfo/global_burden_disease/gbddeathdalycountryestimates2004.xls
These statistics represent the estimates of Deaths and DALYs for countries in the world for the year 2004.

4.1.4 Estimation of the Environmental Risk Attributable Fractions

The environment is defined as the physical, chemical and biological factors external to human host, and all related behaviours, but excluding those natural environments that cannot reasonably be modified. The definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, genetics, and parts of the natural environment. Attributable Fraction (AF) of risk factor is defined as the decline in disease or injury that could be achieved in a given population by reducing the risk. For example, if members of a community are exposed to a risk factor (e.g. agricultural pesticides) that causes health problems or deaths, and that risk factor is removed from the environment (e.g. by legislative action), we would expect that the overall number of health problems or deaths in the community would decline. The proportional reduction in the number of health problems or deaths as a result of reducing the risk factor is known as the "Attributable Fraction". In other words, it is the proportion of all health problems or deaths in the community that can be attributed to the risk factor.

The methodology for estimation of the burden of disease attributable to the environment has been published by WHO (2006) at
http://www.who.int/quantifying_ehimpacts/publications/preventingdisease/en/index.html
Estimation of the environment attributable burden of disease by Comparative Risk Analysis (CRA) was previously published by WHO (2002). However, CRA often provided partial results for one disease and a corresponding attributable risk. Estimation of the health impact of environmental risks worldwide was therefore conducted by updating the existing estimates by CRA for specific environmental factors. This was done by conducting a survey of experts who were asked to provide estimates of the Attributable Fractions for specific diseases in their area of competence involving more than 100 experts. The experts were provided with summaries of information and references on each disease, as well as an initial estimate that was based on pooled estimates from the literature. In total, 85 diseases and two risk factors were covered by the survey. The two risk factors are malnutrition and physical inactivity, included because they are themselves influenced by environmental factors and have been linked quantitatively to various diseases.

To estimate the attributable fraction in terms of *deaths and disability adjusted life years* (DALYs), the attributable fractions for each disease (obtained from the pooled expert estimates) was multiplied by the total number of deaths or DALYs for the disease. The global data were obtained from the WHO database1, www.who.int/evidence, under “Burden of Disease Project”, and “Global Burden of Disease Estimates”, or from Annex Tables 2 and 3 of the World Health Report (WHO, 2004a). The global estimate of the attributable fraction for the environmental risk factors included in this study was then obtained by adding all disease-specific deaths and DALYs obtained in this way.

4.1.5 Environmental DALYs Computational Result

Based on the regional environmental disease burden, Malaysia has been grouped into the West Pacific sub-Region (WPR-B) with low mortality developing countries together with Cambodia, China, Laos, Mongolia, Philippines, Korea, and Vietnam. Computation was carried out for the Environmental DALYs that represents deaths and disability preventable through healthier environments for Malaysia based on the available data that was published by the Ministry of Health Malaysia in 2004. However, the data used for the DALYs in this 2004 publication was gathered in 2000 since this was the only complete data available for the first Malaysian DALYs compilation. It is therefore, difficult to verify or compare the computation results between on-the-ground data and those given by 2010 EPI.

Table 4.1.3. Comparison of the Environmental DALYs from 2010 EPI and Local Data*

	DISEASES	PAF	DALYs ('000)		DALYs ('000) x PAF	
			2010 EPI	Local Data*	2010 EPI	Local Data*
1	Tuberculosis	0.19	97.74	34.96	18.57	6.64
2	STDs excluding HIV	0.17	37.58	2.38	6.39	0.40
3	HIV/AIDS	0.05	68.28	30.33	3.41	1.52
4	Diarrhoeal diseases	0.94	54.26	8.72	51.01	8.20
5	Childhood-cluster diseases	0.24	6.33	0.00	1.52	0.00
6	Meningitis	0.11	20.52	12.75	2.26	1.40
7	Hepatitis B (g)	0.02	12.82	5.74	0.26	0.11
8	Malaria	0.40	0.65	1.16	0.26	0.46
9	Chagas disease	0.56	0.00	0.00	0.00	0.00
10	Schistosomiasis	1.00	0.01	0.00	0.01	0.00
11	Leishmaniasis	0.27	2.01	0.00	0.54	0.00
12	lymphatic filariasis	0.82	2.96	0.00	2.42	0.00
13	Onchocerciasis	0.10	0.00	0.00	0.00	0.00
14	Dengue	0.95	7.71	2.31	7.33	2.19
15	Japanese encephalitis	0.95	4.95	0.00	4.71	0.00
16	Trachoma	1.00	0.05	0.00	0.05	0.00
17	Intestinal nematode infections	1.00	22.59	0.00	22.59	0.00
18	Lower respiratory infections	0.42	89.82	87.54	37.73	36.77
19	Upper respiratory infections	0.24	3.28	2.78	0.79	0.67
20	Perinatal conditions (h)	0.11	105.85	119.06	11.64	13.10
21	Protein-energy malnutrition	0.50	40.33	0.60	20.16	0.30
22	Trachea, bronchus, lung cancers	0.29	37.58	26.93	10.90	7.81
23	Other neoplasms	0.15	2.73	11.60	0.41	1.74
24	Neuropsychiatric conditions	0.13	707.72	71.71	92.00	9.32
25	Bipolar disorder	0.04	57.54	13.91	2.30	0.56
26	Schizophrenia	0.04	86.47	0.00	3.46	0.00
27	Epilepsy	0.23	26.69	0.00	6.14	0.00
28	Alcohol use disorders	0.10	65.16	0.00	6.52	0.00
29	Alzheimer and other dementias	0.04	25.44	0.00	1.02	0.00
30	Parkinson disease	0.05	3.38	0.00	0.17	0.00
31	Multiple sclerosis	0.03	5.16	0.00	0.15	0.00
32	Drug use disorders	0.03	13.67	0.00	0.41	0.00
33	Post-traumatic stress disorder	0.19	14.79	0.00	2.81	0.00
34	Obsessive-compulsive disorder	0.03	14.09	0.00	0.42	0.00
35	Panic disorder	0.06	29.65	0.00	1.78	0.00
36	Insomnia (primary)	0.20	9.45	0.00	1.89	0.00
37	Migraine	0.10	29.35	0.00	2.94	0.00

	DISEASES	PAF	DALYs ('000)		DALYs ('000) x PAF	
			2010 EPI	Local Data*	2010 EPI	Local Data*
38	Cataracts	0.07	119.45	34.84	8.36	2.44
39	Hearing loss, adult onset	0.21	131.99	83.56	27.06	17.13
40	Cardiovascular diseases	0.14	399.57	560.97	55.94	78.54
41	Chronic obstructive pulmonary disease (COPD)	0.56	61.83	60.73	34.32	33.70
42	Asthma	0.44	65.82	61.01	28.96	26.84
43	Musculoskeletal diseases	0.41	128.38	82.31	52.63	33.75
44	Congenital anomalies	0.05	48.61	91.97	2.43	4.60
45	Road traffic accidents	0.42	124.70	162.74	52.37	68.35
46	Poisonings	0.77	4.06	8.96	3.11	6.86
47	Falls	0.31	32.13	27.26	9.96	8.45
48	Fires	0.07	6.27	10.51	0.44	0.74
49	Drownings	0.74	24.92	20.90	18.44	15.47
50	Other unintentional injuries	0.45	77.26	42.07	34.77	18.93
51	Self-inflicted injuries	0.36	42.06	31.89	15.14	11.48
52	Violence	0.19	69.77	13.62	13.26	2.59
				TOTAL	682.14	421.04
				DALYs/1000 cap	**27**	**17**

- Diseases:
  - WHO Malaysia – Dr Harpal Singh
  - WHO 2006: PREVENTING DISEASE THROUGH HEALTHY ENVIRONMENTS by A. Prüss-Üstün and C. Corvalán (TABLE A2.2: pg80)
- Population: 25.3 mio
- PAF: Population Attributable Fraction derived from Table A2.1 Attributable Environmental Fractions For Each Disease Group, in "Preventing Disease Through Healthy Environments", WHO 2006)
- Local Data: Malaysian Burden of Disease and Injury Study 2004 ([Appendix 8]: DALYs by cause, age & sex, Malaysia 2000)

4.2 Access to Water

4.2.1 Indicator Description

Malaysia scored 98.3 and ranked 46 in Access to Water (**Appendix 4.2.1**). This indicator measures the percentage of a country's population that has access to an improved source of drinking water. The WHO defines an improved drinking water source as piped water into dwelling, plot or yard; public tap/standpipe; tubewell/borehole; protected dug well; protected spring; and rainwater collection (UNICEF and WHO 2008).

4.2.2 Indicator Methodology

The indicator is computed as the ratio of the number of people who use an improved drinking water source to the total population, expressed as a percentage. Estimates are based on data from nationally representative household surveys and national censuses, which in some cases are adjusted to improve comparability among data over time.

Data source for this indicator is available from UNICEF and WHO. 2008. Progress on Drinking Water and Sanitation: Special Focus on Sanitation. New York and Geneva: UNICEF and World Health Organization
(http://www.who.int/water_sanitation_health/monitoring/jmp2008/en/index.html).
The WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation is the official United Nations mechanism tasked with monitoring progress towards the Millennium Development Goal (MDG) drinking water and sanitation target. This JMP report presents global, regional and national estimates of the use of improved drinking water sources and improved sanitation facilities in 2006. These coverage estimates show what proportion of the population remained without improved drinking water sources and improved sanitation in 2006 and what the increase in use has been since the MDG baseline in 1990. In addition, the changes in coverage between 1990 and 2006 are used to assess progress towards the 2015 MDG targets for drinking water and sanitation. The population estimates in JMP report, including the proportion of people living in urban and rural areas, are those published by the United Nations Population Division (2006 revision). These estimates may differ from national estimates.

For each country, survey and census data are plotted on a time scale from 1980 to the present. A linear trend line, based on the least-squares method, is drawn through these data points to estimate coverage for 1990 and 2006. The total coverage estimates are based on the aggregate of the population-weighted urban and rural coverage numbers, divided by the total population. Trend analysis at the country level has been carried out for the following category:

- Drinking water:
- Piped water into dwelling, plot or yard
- Improved drinking water sources

An improved drinking water source is defined as a drinking water source or delivery point that, by nature of its construction and design, is likely to protect the water source from outside contamination, in particular from faecal matter. The JMP uses the following classifications to differentiate improved from unimproved drinking water sources.

Improved drinking water sources
- Piped water into dwelling, plot or yard
- Public tap/stand pipe
- Tube well/borehole
- Protected dug well
- Protected spring
- Rainwater collection

Unimproved drinking water sources
- Unprotected dug well
- Unprotected spring
- Cart with small tank/drum
- Tanker truck
- Surface water (river, dam, lake, pond, stream, canal,irrigation channel)
- Bottled water

Country Estimates on Water (based on JMP Report, 2008)

Country	Year	Population		Drinking water coverage (%)												
				Urban				Rural				Total				% of population that gained coverage (1990-2006) with respect to median population (year 1998)
		Total ('000)	Urban (%)	Improved	Piped into dwelling yard or plot	Other improved	Unimproved	Improved	Piped into dwelling yard or plot	Other improved	Unimproved	Improved	Piped into dwelling yard or plot	Other improved	Unimproved	
Malaysia	1990	18,103	50	100	98	2	0	96	-	-	4	98	-	-	2	36
	2006	26,114	68	100	98	2	0	96	87	9	4	99	95	4	1	

Current Available Country Data

YEARS	Access to Water (% Population Served)				
	Rural*	MWIG**			2010 EPI
		Urban	Rural	Total	
2004	95.27				99.0
2005	95.23	97.0	90.8	94.0	
2006	95.27	97.8	91.0	94.8	
2007	97.47	96.5	84.6	90.5	
2008	95.26	96.5	85.3	90.9	
2009	96.36	96.8	86.5	91.6	

* Data source: Ministry of Health Malaysia
**MWIG: Malaysian Water Industry Guide 2010, 2009, 2007

4.3 Access to Sanitation (ASCAT)

4.3.1 Indicator Description

Malaysia scored 93.3 and ranked 54 in Access to adequate sanitation indicator (**Appendix 4.3.1**). This indicator measures the percentage of a country's population that has access to an improved source of sanitation. "Improved" sanitation technologies are: connection to a public sewer, connection to septic system, pour-flush latrine, simple pit latrine, ventilated improved pit latrine. The excreta disposal system is considered adequate if it is private or shared (but not public) and if hygienically separates human excreta from human contact. "Not improved" are: service or bucket latrines (where excreta are manually removed), public latrines, latrines with an open pit. The total population of a country may comprise either all usual residents of the country (de jure population) or all persons present in the country (de facto population) at the time of the census (United Nations, DESA).

4.3.2 Indicator Methodology

The indicator is computed as the ratio of the number of people using improved sanitation facilities, to the total population, expressed as a percentage. Estimates are based on data from nationally representative household surveys and national censuses, which in some cases are adjusted to improve comparability among data over time.

Data source is available from UNICEF and WHO. 2008. Progress on Drinking Water and Sanitation: Special Focus on Sanitation. New York and Geneva: UNICEF and World Health Organization
http://www.who.int/water_sanitation_health/monitoring/jmp2008/en/index.html

For each country, survey and census data are plotted on a time scale from 1980 to the present. A linear trend line, based on the least-squares method, is drawn through these data points to estimate coverage for 1990 and 2006. The total coverage estimates are based on the aggregate of the population-weighted urban and rural coverage numbers, divided by the total population.
Trend analysis at the country level has been carried out for the following category:

- Sanitation:
- Improved sanitation facilities
- Open defecation

The coverage estimates for improved sanitation facilities presented in JMP report are discounted by the proportion of the population that shared an improved type of sanitation facility. The ratio (the proportion of the population that shares a sanitation facility of an otherwise adequate type among two or more households) derived from the latest household survey/census is subtracted from the trend estimates of improved sanitation facilities. This results in the estimates for shared sanitation facilities.

An improved sanitation facility is defined as one that hygienically separates human excreta from human contact. The JMP uses the following classifications to differentiate improved from unimproved sanitation facilities. However, sanitation facilities are not considered improved when shared with other households, or open for public use.

Improved sanitation facilities

- Flush or pour-flush to:
    - piped sewer system
    - septic tank
    - pit latrine
- Ventilated improved pit latrine
- Pit latrine with slab
- Composting toilet

Unimproved sanitation facilities

- Flush or pour-flush to elsewhere
- Pit latrine without slab or open pit
- Bucket
- Hanging toilet or hanging latrine
- No facilities or bush or field (open defecation)

Country Estimates on Sanitation (based on JMP Report)

Country	Year	Population		Sanitation coverage (%)												
				Urban				Rural				Total				% of population that gained coverage (1990-2006) with respect to median population (year 1998)
		Total ('000)	Urban (%)	Improved	Shared	Unimproved	Open defecation	Improved	Shared	Unimproved	Open defecation	Improved	Shared	Unimproved	Open defecation	
Malaysia	1990	18,103	50	95	4	1	-	-	-	-	-	-	-	-	-	-
	2006	26,114	68	95	4	1	-	93	4	3		94	4	2	-	

Current Available Country Data

YEARS	Access to Sanitation			
	Home Coverage*	% Population Served*	Population Equivalent (PE)**	2010 EPI
2004	1,677,171	98.57		94 (% Population)
2005	1,688,509	98.02		
2006	1,713,451	98.26		
2007	1,721,284	97.88	27,800,246	
2008	1,720,047	97.93	31,486,982	
2009	1,752,057	97.92	34,057,357	

* Data source: Ministry of Health Malaysia

** Data source: Malaysia Water Industry Guide 2010, 2009, 2007

4.4 Indoor Air Pollution

4.4.1 Introduction

Globally, Malaysia is ranked 36 with proximity-to-target score of 94.7 in the Indoor Air Pollution Indicator (**Appendix 4.4.1**). The effect of air pollution on human health is respiratory tract infections. The statement made by the World Health Organization (WHO) indicated that environmental factors attributed to the lower respiratory tract infections, which resulted in approximately 2 million premature deaths worldwide per year (WHO, 2006). The Environmental Performance Index for the year 2010 (2010 EPI) portrays the health risks due to air pollution using two indicators: Indoor Air Pollution and Outdoor Air Pollution (or Urban Particulates). These indicators represent environmental risks faced by countries at different positions on the economic spectrum.

Three billion people in the poorest developing countries rely on solid fuels as their cooking fuel, leading indoor air pollution to pose greater health risks in developing nations (Ezzati and Kammen, 2002). Indoor air pollution is a significant cause of respiratory disease.

4.4.2 Indicator Description

The Millennium Development Goals (MDG) indicator is defined as the "percentage of population using solid fuels" (United Nations 2005b). Solid fuels include biomass fuels, such as wood, charcoal, crops or other agricultural waste, dung, shrubs and straw, and coal (WHO 2005a). Solid fuels had long been used in the old age to make fire. During the industrial revolution, coal was used as fuel source, from firing furnaces to running steam engines. Wood was also extensively used to run steam locomotives. Both peat and coal are still used in electricity generation today. The use of some solid fuels (e.g. coal) is restricted or prohibited in some urban areas, due to unsafe levels of toxic emissions. The use of solid fuels in households is associated with increased mortality from pneumonia and other acute lower respiratory diseases among children as well as increased mortality from chronic obstructive pulmonary disease and lung cancer (where coal is used) among adults (WHO, 2007). art a coal fire.

4.4.3 Indicator Rationale

Burning solid fuel indoors releases harmful chemicals and particles that present an acute health risk. These chemicals and particles can become lodged in the lungs when inhaled, leading to numerous respiratory problems, including acute lower respiratory tract infections. One recent study concluded that 4.6% of all deaths worldwide are attributable to acute lower respiratory tract infections caused by indoor fuel use (WHO, 2006).

4.4.4 Sources of Data and Method of Calculation

Household surveys and national censuses. National energy statistics on the proportion of population using solid fuels are based either on data from surveys or censuses, or on modelling where no survey or census data are available. The data from surveys and censuses are used as reported in the surveys and censuses. A regression model based on gross national income, per capita petroleum consumption and rural population is being used for countries without survey data. All countries without survey data and with a GNP per capita above US$ 10,500 are assumed to have made a complete transition to cooking with non-solid fuels. For low- and middle-income countries with a GNI per capita below US$ 10,500.- and for which no household solid fuel use data are available, a regression model based on GNI, percentage of rural population and location or non-location within the Eastern Mediterranean Region is used to estimate the indicator.

This indicator is a measure of the percentage of a country's inhabitants using solid fuels indoors. The 2010 EPI uses data produced for the World Health Organization's EBD study that capture exposure to indoor smoke risks (Smith et al., 2004). The data are adjusted to account for reported ventilation in each measured home to best estimate actual exposure. The target for Indoor Air is set by expert judgment at zero, which reflects the opinion that any amount of solid fuel used indoors poses a risk to human health and is therefore considered undesirable. Many developing countries have already achieved this target, indicating that 100% coverage is not an unrealistic expectation.

Percentage of population using solid fuels: These data were collected from nation-wide household surveys in 52 countries. The rest of the data are generated from models predicting solid fuel use. The model used solid fuel use values from the household fuel use database, and assumed that as countries develop economically, people gradually shift up an energy ladder from solid fuels to cleaner fuels. The final exposed population is calculated as: Household equivalent solid fuel exposed population = population using solid fuel × ventilation factor.

Smith, K.R et. al. (2004) estimated exposure to smoke from solid fuel by combining a number of national surveys of household fuel use into a regression model that predicts use according to independent, development-related variables, such as income and urbanization. Although this method was necessary owing to the current paucity of quantitative data on exposure, we acknowledge that it overlooks the large variability of exposure within households using solid fuels. As pollution emissions from the use of solid fuel may not always indicate high exposures, we have adjusted exposure estimates by a second term, the ventilation factor, which is based on qualitative measures of ventilation.

According to the assessment made by Rehfuess et. al. (2006), 52% of the world's population uses solid fuels. This percentage varies widely between countries and regions, ranging from 77%, 74%, and 74% in Sub-Saharan Africa, Southeast Asia, and the Western Pacific Region, respectively, to 36% in the Eastern Mediterranean Region, 16% in Latin America and the Caribbean and in Central and Eastern Europe. In most industrialized countries, solid fuel use falls to the < 5% mark.

Disaggregation is by location (e.g. urban/rural, major regions/provinces) and socio-economic characteristics (e.g. education level, wealth quintile).

This Access database on indoor air pollution, commissioned by WHO and developed by researchers at the University of California at Berkeley, aims to provide the scientific community with an overview of measured household indoor air pollution levels in about 250 communities around the world. Researchers can review and analyze findings within and across studies, and can either query the database directly or export the files into a statistical programme for in-depth analysis. The database is available as Access 2000 and Access 1997 on the UC Berkeley web site:
- Global indoor air pollution database

Table 1. Percentage of population using solid fuels, by country and WHO region.

Region/country	Percentage
Africa	77
Algeria	< 5
Angola	> 95
Benin	95
Botswana	65
Burkina Faso	> 95
Burundi	> 95
Cameroon	83
Cape Verde	36
Central African Republic	> 95
Chad	> 95
Comoros	76
Congo	84
Cote d'Ivoire	74
Democratic Republic of the Congo	> 95
Equatorial Guinea	ND
Eritrea	80
Ethiopia	> 95
Gabon	29
Gambia	> 95
Ghana	89
Guinea	> 95
Guinea-Bissau	95
Kenya	81
Lesotho	83
Liberia	ND
Madagascar	> 95
Malawi	> 95
Mali	> 95
Mauritania	65
Mauritius	< 5
Mozambique	80
Namibia	63
Niger	> 95
Nigeria	67
Rwanda	> 95
Sao Tome and Principe	ND
Senegal	41
Seychelles	< 5
Sierra Leone	92
South Africa	18
Swaziland	68
Togo	76
United Republic of Tanzania	> 95
Uganda	> 95
Zambia	85
Zimbabwe	73
Latin America and the Caribbean	16
Antigua and Barbuda	46
Argentina	< 5
Bahamas	< 5
Barbados	< 5
Belize	43
Bolivia	25
Brazil	12
Chile	< 5
Colombia	15
Costa Rica	23
Cuba	< 5
Dominican Republic	14
Ecuador	< 5
El Salvador	33
Grenada	48
Guatemala	62
Guyana	59
Haiti	> 95
Honduras	57
Jamaica	45
Mexico	12
Nicaragua	58
Panama	33
Paraguay	58
Peru	33
Saint Kitts and Nevis	< 5
Saint Lucia	63
St Vincent and the Grenadines	31
Suriname	ND
Trinidad and Tobago	8
Uruguay	< 5
Venezuela	5
Eastern Mediterranean	36
Afghanistan	> 95
Bahrain	< 5
Cyprus	< 5
Djibouti	6
Egypt	< 5
Iran, Islamic Republic of	< 5
Iraq	< 5
Jordan	< 5
Kuwait	< 5
Lebanon	< 5
Libyan Arab Jamahiriya	< 5
Morocco	5
Oman	< 5
Pakistan	72
Qatar	< 5
Saudi Arabia	< 5
Somalia	ND
Sudan	> 95
Syrian Arab Republic	32
Tunisia	5
United Arab Emirates	< 5
Yemen	42
Central and Eastern Europe	16
Albania	50
Armenia	26
Azerbaijan	49
Belarus	19
Bosnia and Herzegovina	51
Bulgaria	17
Estonia	15
Georgia	42
Hungary	< 5
Kazakhstan	5
Kyrgyzstan	76
Latvia	10
Lithuania	< 5
Poland	< 5
Republic of Moldova	63
Romania	23
Serbia and Montenegro	ND
Slovakia	< 5
Tajikistan	75
TFYR of Macedonia	30
Turkey	11
Turkmenistan	< 5
Ukraine	6
Uzbekistan	72
Russian Federation	7
Southeast Asia	74
Indonesia	72
Sri Lanka	67
Thailand	72
Bangladesh	88
Bhutan	ND
India	74
Korea, Democratic People's Republic of	ND
Maldives	ND
Myanmar	95
Nepal	80
Timor-Leste	ND
Western Pacific	74
Cambodia	> 95
China	80
Cook Islands	ND
Fiji	40
Kiribati	ND
Korea, Republic of	< 5
Lao People's Democratic Republic	> 95
Malaysia	< 5
Marshall Islands	ND
Micronesia, Federated States of	ND
Mongolia	51
Nauru	ND
Niue	ND
Palau	ND
Papua New Guinea	90
Philippines	47
Samoa	70
Singapore	< 5
Solomon Islands	95
Tonga	56
Tuvalu	ND
Vanuatu	79
Viet Nam	70
World	52

ND, no data. Data from United Nations (2005b). For a more detailed explanation of WHO regions and epidemiologic subregions based on mortality strata, see WHO (2002).

4.5 Outdoor air pollution (Urban Particulates)

Meanwhile, outdoor air pollution tends to pose more severe risks in rapidly developing and developed nations with high levels of industrialization and urbanization. Thus, the air pollution indicators selected for use in the 2010 EPI identify the relevant environmental risks to countries at different development levels. Malaysia ranked 46 with a score of 92.9 in this indicator (**Appendix 4.5.1**).

4.5.1 Indicator Description

Particulate matter concentrations refer to fine suspended particulates less than 10 microns in diameter (PM10) that are capable of penetrating deep into the respiratory tract and causing significant health damage. Data for countries and aggregates for regions and income groups are urban-population weighted PM10 levels in residential areas of cities with more than 100,000 residents. The estimates represent the average annual exposure level of the average urban resident to outdoor particulate matter. The state of a country's technology and pollution controls is an important determinant of particulate matter concentrations. Source: Kiren Dev Pandey, David Wheeler, Bart Ostro, Uwe Deichmann, Kirk Hamilton, and Katherine Bolt. "Ambient Particulate Matter Concentrations in Residential and Pollution Hotspot Areas of World Cities: New Estimates Based on the Global Model of Ambient Particulates (GMAPS)," World Bank, Development Research Group and Environment Department (2006).

4.5.2 Indicator Rationale

Particles suspended in outdoor air contribute to acute lower respiratory infections and cardiovascular diseases, as well as lung cancer. Lung cancer adds more to the global disease burden for all cancers than any other cancer, and it is estimated that 5% of the lung cancer disease burden worldwide is attributable to outdoor air pollution (WHO, 2006 and Cohen, 2004). Urban Particulates measures the concentration of small particles, between 2.5 and 10 micrometers (PM 2.5 to PM10) in diameter, suspended in the air. These particles are dangerous to human health because they are small enough to be inhaled and become lodged deep in lung tissue.

To develop country level indicators, city level estimates of particulate concentrations were measured according the method developed by the World Bank (using a combination of in situ measurement and models), and created a weighted average with the weights being determined by city population size. The target for Urban Particulates is set at an annual mean of 20 micrograms per cubic meter, which is derived from the air quality guidelines set by the WHO (WHO, 2005). This target is set at the level necessary to minimize outdoor air pollution risks to human health. It is not feasible to set a zero target because many regions have substantial natural background concentrations of small airborne particles.

4.5.3 Sources of Data and Method of Calculation

PM10 data are acquired from modeling data. The model is based on reliable PM10 and TSP measurement with multiple determinants such as energy consumption, atmospheric and geographical factors, city and national population density, and others. Then concentration levels of each city are weighted according to their urban populations in residential areas of cities with more than 100,000 residents. The estimates represent the average annual exposure level of the average urban resident to outdoor particulate matter.

One important change in the 2010 EPI is the use of the logarithmic transformation for the calculation of many of the indicators. Most of these performance measures have a sizeable number of countries very close to the targets. The use of the logarithmic transformation has the effect of “spreading out” these leading countries, allowing the EPI to reflect important differences not only between the leaders and laggards, but also among leaders who achieve different degrees of high-end performance.

Scarce public resources have limited the monitoring of atmospheric particulate matter (PM) concentrations in developing countries, despite their large potential health effects. As a result, policymakers in many developing countries remain uncertain about the exposure of their residents to PM air pollution. The Global Model of Ambient Particulates (GMAPS) is an attempt to bridge this information gap through an econometrically estimated model for predicting PM levels in world cities (Pandey et. al.).

The estimation model is based on the latest available monitored PM pollution data from the World Health Organization, supplemented by data from other reliable sources. The current model can be used to estimate PM levels in urban residential areas and non-residential pollution hotspots. The results of the model are used to project annual average ambient PM concentrations for residential and non-residential areas in 3,226 world cities with populations larger than 100,000, as well as national capitals.

The study finds wide, systematic variations in ambient PM concentrations, both across world cities and over time. PM concentrations have risen at a slower rate than total emissions. Overall emission levels have been rising, especially for poorer countries, at nearly 6 percent per year. PM concentrations have not increased by as much, due to improvements in technology and structural shifts in the world economy. Additionally, within-country variations in PM levels can diverge greatly (by a factor of 5 in some cases), because of the direct and indirect effects of geo-climatic factors.

The primary determinants of PM concentrations are the scale and composition of economic activity, population, the energy mix, the strength of local pollution regulation, and geographic and atmospheric conditions that affect pollutant dispersion in the atmosphere.

4.6 Sulfur Dioxides Emissions per Populated Land Area

4.6.1 Air Pollution Effects on Ecosystem - Policy Focus

Air pollution is detrimental to ecosystems. Through direct exposure and accumulation, reactive compounds such as ozone (O3), benzene (C6H6), sulfur dioxide (SO2), nitrogen oxides (NOX), and volatile organic compounds (VOCs) negatively impact plant growth. Also, SO2 and NOX are the primary contributors to acid rain, which can diminish fish stocks, decrease biological diversity in sensitive ecosystems, degrade forests and soils, and diminish agricultural productivity.

A complete air pollution index for the EPI would contain indicators for particulate matter, ozone, NO2 and SO2, carbon monoxide (CO), lead, methane, ammonia, mercury, black carbon, persistent organic compounds, VOCs, and benzene. Unfortunately, reliable data for the remainder of the pollutants listed are not available. Therefore under this policy, four indicators have been used to assess the air quality of the countries. These indicators which have been summarized in **Table 6.1** are as follows:

1. Sulfur Dioxides **(SO2)** Emission per Populated Land Area;
2. Nitrogen Oxide **(NOX)** Emission per Populated Land Area;
3. Non-Metanave Volatile Organic Compounds **(NMVOC)** Emission per Populated Land Area;
4. Ecosystem Ozone **(Ozone)**.

Existing data sources for air pollution concentrations and emissions are either incomplete or difficult to use in global comparisons. Air quality monitoring systems vary significantly between countries, often producing fundamentally dissimilar data. In addition, many countries have too few monitoring stations to produce representative samples. In comparison with monitoring station data, air pollution transport models provide relatively easy access to data. The benefit of models is that they are able to generate values for large spatial domains, but they also carry with them a level of uncertainty, making it inadvisable to rely on them exclusively. An ideal performance measure for ecosystem vitality and air pollution would include time-specific emissions quantities, the mapping of pollutant movement, the ecological sensitivity to pollutants by area, and the level of clear policy commitments to emissions reductions. The European Union is a model in this regard because it meets all of these monitoring goals; however, there are no global datasets with all of these measures.

4.6.2 Methodology

In the Global EPI calculation of the SO2, NOX, and NMVOC, emissions data (**Appendix 4.6.1(a-d)**) in gigagram which were obtain from Emission Database for Global Atmospheric Research (EDGAR) website (http://www.mnp.nl/edgar/) as shown in **Figure 4.6.1**. Emissions published in EDGAR website are calculated (using EDGARv4.0 model) by individual countries using country-specific information. The countries as shown in **Figure 4.6.2** are organized in different world regions for illustration purposes. Emissions of some small countries are presented together with other countries (e.g. Monaco with France) depending on country definition and availability of activity statistics.

Table 4.6.1: Air Pollution Effects on Ecosystem

OBJECTIVES	POLICY CATEGORIES	INDICATORS	INDICATOR CODES	TARGET
Ecosystem Vitality (50%)	**Air Pollution (Effects on Ecosystem) (2.5%)**	Sulfur dioxide emissions per populated land area (2.1%)	SO_2	<= 0.01 Gg/km^2
		Nitrogen oxides emissions per populated land area (0.7%)	NO_X	<= 0.01 Gg/km^2
		Non-methane volatile organic component emissions per populated land area (0.7%)	NMVOC	<= 0.01 Gg/km^2
		Ecosystem ozone (0.7%)	OZONE	0 ppb exceedance > 3000 AOT40. AOT40 is cumulative exceedance > 40 ppb during daylight summer hours

Figure 4.6.1: EDGAR Website (http://www.mnp.nl/edgar/)

Emissions for each country including Malaysia are calculated by application of technology based emission factor calculation. This means that for each considered country-sector combination data is included for the parameters mentioned in the following equation:

$$\underset{[kton/yr]}{Emission_{x,c}(yr)} = \Sigma\{\underset{[e.g.\ TJ/yr]}{AD_{c,s}(yr)} * \underset{[100\%]}{TECH_{AD,c,s}(yr)} * \underset{[100\%]}{EOP_{AD,c,s,TECH}(yr)}\} * \underset{[kton/TJ]}{EF_{AD,c,s,TECH}} * \underset{[100\%]}{(1\text{-}RED_{EOP})}$$

where:

x: compound, c: country, s: sector, yr: year, AD: activity data (e.g. natural gas in power plant sector, number of animals), TECH: technology (e.g. gas turbine power plant), EOP: % of technologies that are controlled by end-of-pipe abatement measures, EF: uncontrolled emission factor by sector & technology, RED: reduction % on the uncontrolled EF by the installed abatement measure.

The calculated emissions were then divided by the land area populated at more than five persons per square kilometer. The set target was 0.01 Gg emissions per square kilometer of populated land area. In determining the land area, CIESIN has created a “mask” of land area with population density greater than 5 persons per square km using their gridded population of the world (http://sedac.ciesin.columbia.edu/gpw) which was done in a GIS. Gridded population of Malaysia which was obtained from the website is illustrated in **Figure 4.6.3**. Total land area was not used in order not to favour countries with very large land areas.

The ecological ozone measure was calculated using Model for Ozone and Related Chemical Tracers (MOZART). There are several versions of MOZART but for the EPI study, the data was calculated using MOZART-II based on the following method:

i) Latitudes>0 were assigned to the northern hemisphere and latitudes<=0 to the southern;

ii) Daylight hours were assigned to each band of latitude using information on sunrise and sunset times at http://aa.usno.navy.mil/data/docs/RS_OneYear.php;

iii) The database was subset to include only summer daylight hours (June-August in the north and December-February in the south;

iv) Exceedances above 40 ppb were summed;

v) Exceedance sums were multiplied by land area, for each grid cell.

vi) Using zonal statistics, these exceedance-square kilometre products by country were summed;

vii) Finally these sums were divided by total country area.

Figure 4.6:2: Illustration of the different world regions and countries organized by EDGAR

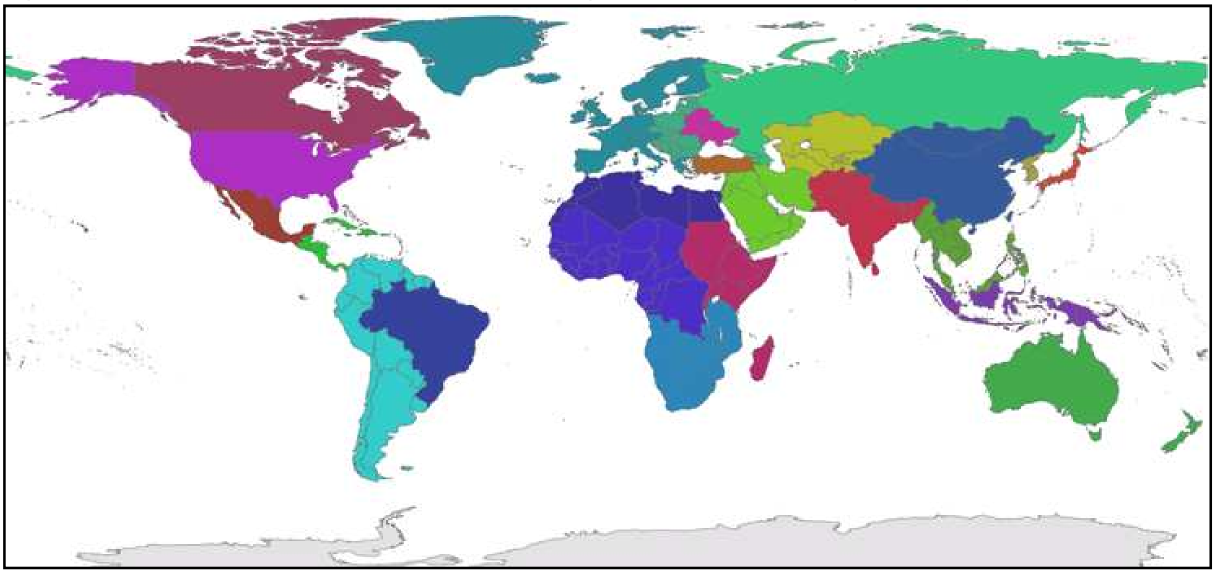
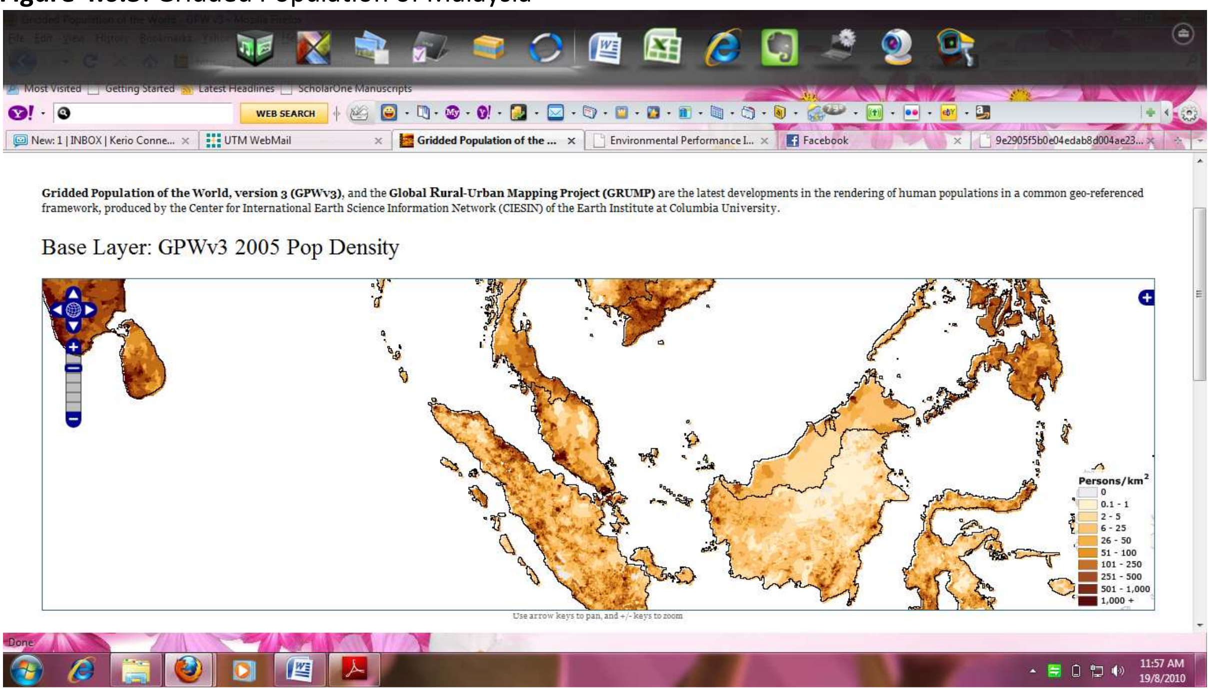


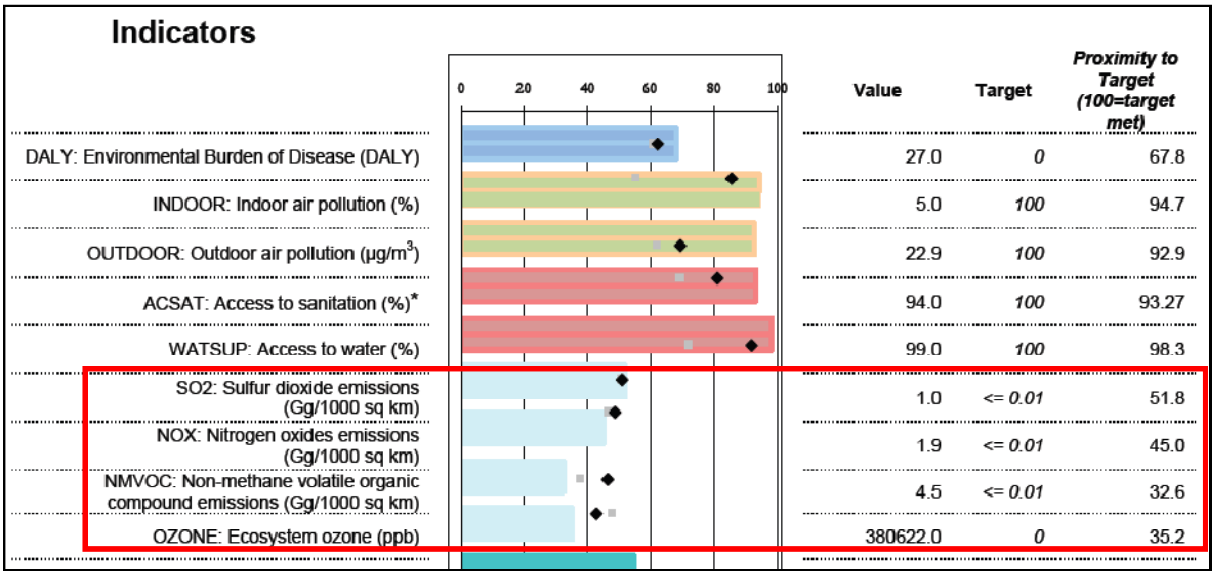
Figure 4.6.3: Gridded Population of Malaysia



4.6.3 Results

The result for Air Pollution Effects on Ecosystem Policy for Malaysia which comprises of the four indicators is as shown **in Figure 4.6.4**. As can be seen from the figure, marks that Malaysia has obtained for all four parameters are quite low hence there is room for improvement in these indicators in the future.

Figure 4.6.4: Results of Air Pollution Effects on Ecosystem Policy for Malaysia



4.6.4 Sulfur Dioxides Emissions per Populated Land Area – Indicator Performance

Nitrogen oxides are a group of highly reactive gases. They contribute to the formation of ground-level ozone, fine particulates, and acid rain. The damages associated with NOX overlap heavily with those listed for SO2 and acid rain. Additionally, nitrogen from NOX emissions can dissolve in water and lead to eutrophication. The NOX indicator is based on estimates of emissions compiled from the same three sources as for SO2. NOX emissions were not included in the 2008 EPI because sufficient data was not available, but the inclusion here reflects a step forward in emissions measurements and reporting. For the same reasons stated for SO2, there are no internationally agreed upon targets.

As discussed earlier, for this indicator, Malaysia has obtained fairly low marks of 51.8 which has put this country at the rank of 93/163 (see **Appendix 4.6.2**). Nonetheless, since the emission data was purely based on air modeling, it carries certain level of uncertainty, making it inadvisable to rely on them exclusively. Monitoring station data is more reliable in this sense. Therefore, in recomputing Malaysia's mark for this particular parameter, it is originally thought that this task could be carried out utilizing the air monitoring data obtained from Department of Environment (DOE) Malaysia Air Quality Monitoring Stations.

Although the data of SO2 emissions (refer **Appendix 4.6.1(a)**) obtained from these stations is perceived to be fairly accurate and represent the current situation of Malaysia's air quality, unfortunately the dataset cannot be used to recompute the SO2 indicator based on Global EPI approach. This is due to the fact that the data collected for the air monitoring stations is in the form of concentration given in part per million (ppm) compared to emission data from

EDGAR which is given in gigagram. Emissions data cannot be derived from concentration data in ppm although the concentration data is of greater relevance to human health and ecosystem impacts than the proxy measure of emissions in gigagrams/land area. Hence, this indicator cannot be recomputed due to unavailability of similar data.

4.7 Nitrogen Oxides Emissions per Populated Land Area

Nitrogen oxides are a group of highly reactive gases. They contribute to the formation of ground-level ozone, fine particulates, and acid rain. The damages associated with NOX overlap heavily with those listed for SO2 and acid rain. Additionally, nitrogen from NOX emissions can dissolve in water and lead to eutrophication.

The NOX indicator is based on estimates of emissions compiled from the same three sources as for SO2. NOX emissions were not included in the 2008 EPI because sufficient data was not available, but the inclusion here reflects a step forward in emissions measurements and reporting. For the same reasons stated for SO2, there are no internationally agreed upon targets. Consequently, the same target of 0.01 Gg emissions per square kilometer of populated land area has been adopted for this indicator. Malaysia obtained 45 marks for this indicator and is ranked at number 104 (see **Appendix 4.7.1**).

Similar to SO2, same issues and constraints are faced when this particular was to be recalculated using Malaysia's own data. Again, the NOX data (refer **Appendix 4.6.1(b)**) which was supplied by DOE based on their air quality measurement at the air quality monitoring stations is form of concentration with unit of ppm. Since the NOX emission data obtained by the EDGAR's air pollution model is in gigagrams the two data sets cannot be compared. Consequently Global EPI mark of Malaysia for this particular indicator cannot be recompute.

4.8 Non-Methane Volatile Organic Compound Emissions per Populated Land Area

Malaysia scored 32.6 and ranked 131 in this indicator (**Appendix 4.8.1**). Non-methane volatile organic compounds, or NMVOCs, are a sub-category of volatile organic compounds, which contain carbon and are active in atmospheric reactions. Notably, they often react with NOX to form ozone, which can damage plant surfaces and irritate animal tissues.

The NMVOCs indicator is based on estimates of emissions compiled from the same three sources as for SO2 and NOX, and the same target was used. Like NOx, NMVOCs emissions were not included in the 2008 EPI because sufficient data was not available.

For Malaysia, non NMVOC data cannot be found since this particular air quality parameter is not measured by DOE or any other agencies. So it is not possible to recalculate the Global EPI since the data is not available.

4.9 Ecosystem Ozone

In the troposphere, ozone shields the planet from dangerous ultraviolet radiation. At ground level, however, ozone is dangerous to living organisms. Ozone corrosively damages plant surfaces and irritates animal tissues. Plants can also directly absorb ozone through their pores, which can severely inhibit their functioning and growth. Ozone has the potential to degrade overall ecosystem health and productivity.

The ecological ozone metric seeks to specifically assess the impact of ozone on ecosystems. The Mozart- II measurement is not ideal because of its heavy reliance on modeled data rather than direct measurements and the outdated data (from the year 2000), but because of the significant impact of ozone on ecosystem vitality, the indicator is being included anyway. However, in situ monitoring of ozone according to CIESIN's experts is much more accurate.

The ecological ozone indicator measures the extent to which high ozone concentrations are present during the vegetative growing season. Because ozone acutely affects plant development, the growing season and daylight intensity are important factors. For the 2010 EPI we used the same indicator we developed for the 2008 EPI. This indicator was calculated by summing ozone exceedences for each summer daylight hour over areas of exceedence, and then dividing by the country area. Malaysia scored 35.2 and ranked 84 in this indicator (**Appendix 4.9.1**).

In recalculating the Global Index of ozone for Malaysia based on the given procedure, besides the in situ concentration data (even though this in situ monitoring of ozone data is much reliable to those obtained using MOZART-II), GIS method need to be employed to assign grid cell of equal size for Malaysia's land area in order to sum up any exceedance of ozone over 40 ppb during the day (refer **Appendix 4.6b** for data from DOE Malaysia). Therefore, this calculation will need to be reworked with the help of GIS expert.

4.10 Water Quality Index

4.10.1 Indicator Description

The Water Quality Index (WQI) is a proximity-to-target (PTT) composite indicator with station density adjustment. It represents 2.083% of the total EPI score. The index is represented by raw data for five parameters, namely dissolved oxygen (DO), electrical conductivity (EC), pH, total phosphorus (P) (or ortho phosphorus), total nitrogen (N) (or dissolved inorganic nitrogen, nitrate/nitrite, ammonia).

4.10.2 Indicator Rationale

Water quality is a critical indicator for measuring ecosystem health. The water quality parameters included in WQI calculation (dissolved oxygen, pH value, electrical conductivity, total nitrogen, and total phosphorus) were selected for two reasons. Firstly, they are good indicators of specific issues relevant on a global basis (i.e. eutrophication, nutrient pollution, acidification, salinization). Secondly, the parameters were chosen because they are the most consistently reported. Because water quality is a function of a number of different physical and chemical parameters measured during routine water quality monitoring, a global index of the general status of water quality, ranked on a country by country basis, is best developed as a composite index of several key parameters.

4.10.3 Sources of Data and Method of Calculation

The data for the calculation of WQI were obtained from United Nations Environment Program GEMS/Water Programme 2008 (http://www.gemswater.org/). As for Malaysia, the data were supplied by the DOE.

Only data for the period 1990-2009 were used in the calculation. The raw data were winsorized (set to the) at the 95th percentile for total nitrogen, total phosphorus, electrical conductivity, and at the upper and lower 2.5% for pH value, and the lower 5% for dissolved oxygen. Then proximity-to-target (PTT) values were calculated using the targets specified by UNEP/GEMS water such that 20 corresponds to meeting the target (or falling into the target range in the case of pH) and values between 0 and less than 20 indicate an increasing distance from the target (or target range in the case of pH). The individual targets used were as follows: DO of 6 mg/L for "warm waters" (>20C) and 9.5 mg/L for "cold waters" (<20C); pH of 6.5-9.0; EC of 500 micro-Siemens/cm; P of 0.05 mg/L; N of 1 mg/L. Station-level PTT values for stations with at least 3 of the 5 parameters were averaged to generate a station-level WQI that ranged from 0 to 20. Station-level WQI's were averaged to country WQI's. **Table 4.10.1** shows the score distribution for the parameters.

Table 4.10.1: Score distribution for parameter used in WQI calculation

Parameter	Target	Score 20	15	10	5	1
Dissolved oxygen (mg L^{-1})	9.5[a]	≥ 9.5	≥ 8.5 and < 9.5	≥ 7.5 and < 8.5	≥ 6 and < 7.5	< 6
	6[b]	≥ 6	≥ 5.5 and < 6	≥ 5 and < 5.5	≥ 4 and < 5	< 4
pH	6.5 - 9.0	≥ 6.5 and ≤ 9.0	≥ 6.0 and < 6.5 or > 9 and ≤ 9.5	≥ 5.5 and < 6 or > 9.5 and ≤ 10	≥ 5 and < 5.5 or > 10 and ≤ 10.5	< 5 or > 10.5
Conductivity (µS cm^{-1})	500	≤ 500	> 500 and ≤ 750	> 750 and ≤ 1000	> 1000 and ≤ 1500	> 1500
Nitrogen (mg L^{-1})						
Total	1	≤ 1.0	> 1.0 and ≤ 1.5	> 1.5 and ≤ 2.5	> 2.5 and ≤ 4	> 4
Dissolved inorganic	0.5	-	≤ 0.5	> 0.5 and ≤ 0.75	> 0.75 and ≤ 1	> 1
Nitrate + nitrite	0.5	-	-	≤ 0.5	> 0.5 and ≤ 1	> 1
Ammonia	0.05	-	-	≤ 0.05	> 0.05 and ≤ 0.1	> 0.1
Phosphorus (mg L^{-1})						
Total	0.05	≤ 0.05	> 0.05 and ≤ 0.10	> 0.10 and ≤ 0.15	> 0.15 and ≤ 0.25	> 0.25
Orthophosphate	0.025	-	≤ 0.025	> 0.025 and ≤ 0.035	> 0.035 and ≤ 0.05	> 0.05

Country WQI was adjusted for density of monitoring stations based on national water quality monitoring data collated by UNEP/GEMS Water. Country WQI scores were adjusted using the following multipliers based on the density of the monitoring station network per populated land area (land area populated at >5 persons per sq. km, as calculated by CIESIN, 2007). Countries received full credit (using a multiplier of 1) if they have a station density greater than or equal to 1 per 1,000 sq.km ($1x10^{-3}$); PTT scores were multiplied times 0.95 if they had a station density of 0.1-0.99 per 1,000 sq. km ($1x10^{-4}$); PTT scores were multiplied times 0.9 if they had a station density of 0.01-0.099 per 1,000 sq. km ($1x10^{-5}$); PTT scores were multiplied times 0.85 if they had a station density of 0.001-0.0099 per 1,000 sq. km ($1x10^{-6}$); and PTT scores were multiplied times 0.8 if they had a station density of <0.001 per 1,000 sq. km (< $1x10^{-6}$).

4.10.4 WQI Results and Discussions

The data that were used in determining the WQI for Malaysia was obtained from seven rivers, namely Sg. Klang, Sg. Gombak, Sg. Linggi, Sg. Skudai, Sg. Muda, Sg. Kelantan and Sg. Kinta. The data was taken from about 1980 to 1992 (depending on parameters). The winsorized data to 95% percentile are as shown in **Table 4.10.2**.

Table 4.10.2: The winsorized data used in the WQI calculation for Malaysia

River	Station No.	Year	DO (mg/L)	Elec. Cond. (µS/cm)	pH	Total P (mg/L)	Ortho-phosphate (mg/L)	Total N (mg/L)	Dissolved inorganic N (mg/L)	NH_3 (mg/L)	Nitrate + nitrite (mg/L)
Sg. Klang	082001	1981-92	3.6	199.4	6.8	0.1	1.3	5.7	4.3	2.7	1.5
Sg. Gombak	082002	1980-85	9.5	43.7	7.3	-	0.1	2.8	1.2	0.0	1.1
Sg. Linggi	082003	1981-92	3.7	377.5	6.3	0.1	0.3	5.1	1.9	0.8	1.2
Sg. Skudai	082004	1981-92	3.9	65.8	6.4	0.1	no data	5.2	2.4	0.9	1.5
Sg. Muda	082005	1980-87	6.9	54.7	7.2	0.0	0.0	0.6	0.2	0.0	0.2
Sg. Kelantan	082006	1981-87	34.4	47.3	7.1	0.1	0.1	5.1	8.2	7.7	1.7
Sg. Kinta	082007	1980-89	8.7	31.9	6.8	0.1	0.0	0.6	0.2	0.1	0.1

These data were then scored according to **Table 4.10.1** and computed for the WQI. The scores and the WQI are shown in **Table 4.10.3**. The average WQI for all the rivers considered was taken as the country's WQI which was 70.4.

Table 4.10.3: The scores and WQI for rivers of Malaysia

River	Station No.	DO	Elec. Cond.	pH	Total P (mg/L)	Ortho-phosphate (mg/L)	Total N (mg/L)	Dissolved inorganic N (mg/L)	NH_3 (mg/L)	Nitrate + nitrite (mg/L)	WQI
Sg. Klang	082001	1	20	20	15	1	1	1	1	1	57
Sg. Gombak	082002	20	20	20	0	1	5	1	10	1	66
Sg. Linggi	082003	1	20	15	15	1	1	1	1	1	52
Sg. Skudai	082004	1	20	15	15	0	1	1	1	1	52
Sg. Muda	082005	20	20	20	20	5	20	15	10	10	100
Sg. Kelantan	082006	20	20	20	10	1	1	1	1	1	71
Sg. Kinta	082007	20	20	20	15	15	20	15	5	10	95
Average WQI											70.4

The average WQI was then adjusted according to the density of the monitoring station. Based on the area with population density of more than 5 people of 242591.42 km^2 and data of seven sampling stations supplied to the GEMS, the density of the monitoring station was calculated as 2.89×10^{-5}. Using the criteria set for the multiplier (i.e. 0.9), the score for Malaysia WQI was computed as 63.4%. This however, is different than the one set to Malaysia, i.e. 54.6% which ranked Malaysia at the 79th place (**Appendix 4.10.1**). Based on recent inquiries to the Center for International Earth Science Information Network (CIESIN), Columbia University US, there were changes in the data and calculation method used in determining the WQI. This however, has not been resolved at the time the report is written.

Several issues arise with respect to the WQI computation for the Malaysian rivers. These include:

- Only data of seven rivers were used in the EPI calculation while more than 100 sampling stations are available in Malaysia. The use of these additional data could have different results in the WQI and increase the value of monitoring station multiplier used in the final calculation.

- Some of the data used for the 2010 exercise are questionable. These include a very high DO value (i.e. 34.4 mg/L) and an exceptionally high NH_3 value (i.e. 7.7 mg/L), both at Sg. Kelantan.
- The data that are used for the calculation are rather old (1980-1992). Hence, the WQI calculated does not represent the status of 2010.

4.11 Water Stress Index

4.11.1 Indicator Description

The Water Stress Index (WATSTR) represents 1.042% of the total EPI score. It is computed based on the percentage of a country's territory affected by oversubscription of water resources. While countries can to some extent accommodate oversubscription in one region with inter-basin transfers, these engender significant environmental impacts of their own. Thus, the ultimate target for each country is to have no area of their territory affected by oversubscription. In 2010 EPI, Malaysia was ranked 51 with the score of 86.8 (**Appendix 4.11.1**).

4.11.2 Indicator Rationale

A high degree of oversubscription is indicated when the water use is more than 40% of available supply (WMO, 1997).

4.11.3 Sources of Data and Method of Calculation

The data were obtained from University of New Hampshire, Water Systems Analysis Group (http://wwdrii.sr.unh.edu/). The data used were those from 1950 to 1995.

The WATSTR is presented as percentage of territory or region under water stress, i.e. water use is more than 40% of available water supply.

4.11.4 EPI Results and Discussions

Gridded fields of water stress indicators based on the ratio of human water use (sum of domestic, industrial and agricultural = DIA, in km^3 per year) to renewable water resources (Q) for 1995 (in km^3 per year) at 30 minute (latitude by longitude) resolution. Sectoral water use statistics were from WRI (1998). Domestic water demand was computed on a per capita basis for each country and distributed geographically with respect to the 1-km total population field (Vorosmarty et al., 2000). Industrial usage was applied in proportion to urban population. Country-level irrigation withdrawals were distributed over irrigated lands (aggregated from Doll and Siebert, 2000) based on estimated irrigation need (see Irrigation water use metadata). Irrigation need was computed as the difference between potential evapotranspiration (PET, which represents the crop water requirements under optimal conditions) and actual evapotranspiration (AET, see Irrigation water use metadata for details). Grid-based aggregates at 30' resolution were then determined for agricultural plus domestic plus industrial water demand. Discharge (Q) was computed as flow-accumulated composite runoff (Fekete et al., 2002) along a 30-min (latitude by longitude) digital river network (Fekete et al., 2001). A ratio of 0.4 or greater indicates conditions of water stress (Vorosmarty et al., 2000; UN 1997).

The indicator was calculated using GIS software. The total territory in grid cells with greater than 40% use of available supply were summed and divided by the national territory. **Figure**

4.11.1 shows the map generated by the GIS. Efforts are currently being made to compute and validate the index based on the given ASCII format data.

The data and method for the computation were based on:

a. Döll, P., Siebert, S. (2000): A digital global map of irrigated areas. ICID Journal, 49(2), 55-66.
b. Fekete, B. M., C. J. Vorosmarty, and R. B. Lammers. 2001. Scaling gridded river networks for macroscale hydrology: Development, analysis and control of error, Water Resources Research, 3 (77): 1955-1967.
c. Fekete, B. M., C. J. Vorosmarty, and W. Grabs. 2002. High-resolution fields of global runoff combining river discharge and simulated water balances, Global Biogeochemical Cycles, 16 (3): 15-1 to 15-10.

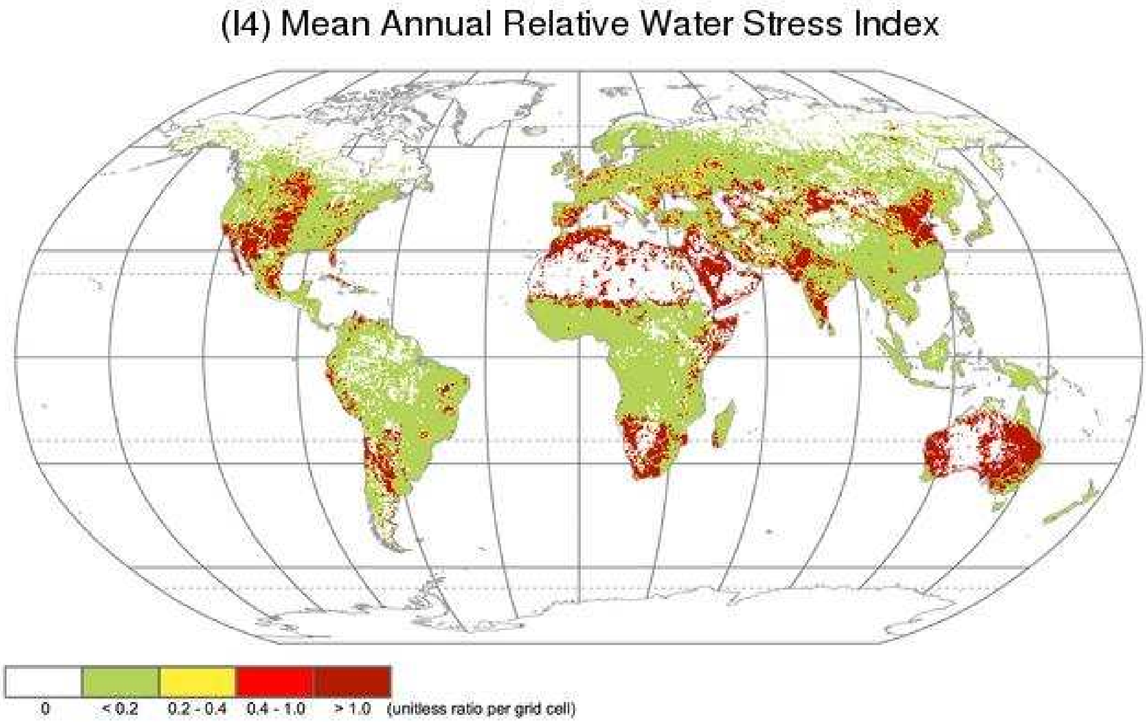


Figure 4.11.1: Maps of water stress index generated by GIS

d. Shiklomanov, I., ed. 1996. Assessment of water resources and water availability in the world: scientific and technical report, State Hydrological Institute, St. Petersburg, Russia.
e. United Nations, 1997. Comprehensive Assessment of the Freshwater Resources of the World (overview document). World Meteorological Organization, Geneva, Switzerland.
f. Vorosmarty, C. J., P. Green, J. Salisbury and R. B. Lammers. 2000. Global water resources: vulnerability from climate change and population growth, Science, 289: 284-288.
g. World Resources Institute (WRI). 1998. World Resources: A Guide to the Global Environment 1998-99, Washington, DC.

4.12 Water Scarcity Index

4.12.1 Indicator Description

Water scarcity index (WSI) is defined as the fraction of water overuse, weighted by alternative renewable water resources (desalinated water and treated wastewater). The target is to have 0% of water reuse for each country. The index represents 1.042% of the total EPI score.

4.12.2 Indicator Rationale

Overuse of water resources, including alternative renewable water resources is harming the natural environment. Hence, water reuse will be reflected by a lower score in WSI.

4.12.3 Sources of Data and Method of Calculation

The data were obtained from Food and Agricultural Organization of the United Nations, Aquastat (http://www.fao.org/nr/water/aquastat/data/query/index.html). The data used were those from 1975 to 2007.

The overuse of water is derived by substracting the target use fraction (0.4) from the ratio of total freshwater withdrawal (surface water + groundwater) to total renewable. The result is multiplied by the ratio of freshwater withdrawal in total withdrawals (freshwater, desalinated water and treated wastewater). These are summarized in the following equations:

$$OW = \frac{TFW}{TR} - TUF \qquad (1)$$

where	OW	=	overuse of water
	TFW	=	total freshwater withdrawal = surface water + groundwater
	TR	=	total renewable
	TUF	=	target use fraction
	D	=	treated water reused

$$WT = \frac{TFW}{TFW + DWP + TWW} \qquad (2)$$

where	WT	=	overuse wt
	DWP	=	desalinated water produced
	TWW	=	treated wastewater

$$WSI = OW \times WT \qquad (3)$$

4.12.4 WSI Results and Discussions

Table 4.12.1 provides the data from Aquastat used in the calculation. Based on the average value, the overuse of water (OW) is calculated as -0.38 which is taken as 0. Multiplying this value with the weightage (WT), i.e. 1, the WSI is computed as equal to 0%. Having fulfilling the target of 0% of water reuse, Malaysia is given the score of 100 (**Appendix 4.12.1**).

Table 4.12.1: Data used in Water Scarcity Index calculation

Variable	1988-1992	1998-2002	Average
Water resources, total renewable (10^9 m^3/yr)	580	580	580
Total freshwater withdrawal (surface water + groundwater) (10^9 m^3/yr)	10.12	9.016	9.568
Desalinated water produced (10^9 m^3/yr)	0.0043	0.0043	0.0043
Treated wastewater reused (10^9 m^3/yr)	0	0	0

The computed result agrees with the one calculated by the EPI. However, the data on the desalinated water production (i.e. 4.3 x 10^6 m^3/year) need further verification.

4.13 Biome Protection (PACOV)

4.13.1 Introduction:

Indicator Description: This indicator measures the degree to which a country achieves the target of protecting at least 10% of each terrestrial biome within its borders as stated by The 7th Convention on Biological Diversity (CBD). Currently Malaysia scored 100%. Describe the indicator based on the EPI

4.13.2 Indicator Metadata and Other Sources.

Indicator metadata/data is sourced from the total conservation area available from World Database of Protected Areas (WDPA) maintained by UNEP's World Conservation Monitoring Centre.

4.13.3 Indicator Methodology

1. Sum the total conserved area (TCA:terrestrial land) in WDPA for Malaysia
2. Calculate the percentage of TCA over total land mass with a minimum target of 10% conservation.

4.13.4 Results of Current Findings

Currently, Malaysia scored a 100% score and ranked 25 in the global EPI (**Appendix 4.13.1**). There are 722 sites recorded in WDPA with a total of 86327 hectares of conserved land as compared to the total land mass of 328,657 sq km, a 26% in land conservation.

4.13.5 Future Mitigation Work

1. Identify a mechanism to collate existing data from various government agencies.
2. Identify the mechanism to update the WDPA database by providing accurate and updated data representing Malaysia.

4.14 Marine Protection (MPAEEZ)

4.14.1 Introduction

This indicator assesses the area protected under marine protected areas as a percentage of a Malaysia's exclusive economic zone (EEZ). Marine protected areas (MPA) are any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural or cultural resources therein.

4.14.2 Indicator Metadata and Other Sources.

EEZ data are taken from boundaries found in VLIZ Maritime Boundaries Geodatabase at http://www.vliz.be/vmdcdata/marbound/index.php
Marine Protected Area (MPA) data taken from MPA Global: A database of the world's marine protected areas. Sea Around Us Project, UNEP-WCMC & WWF at http://www.mpaglobal.org

4.14.3 Indicator Methodology

1. Sum the total MPA area from MPA Global for Malaysia
2. Calculate the percentage of MPA over EEZ with a minimum target of 10% conservation.

Figure 1. Boundaries of EEZ extracted from VLIZ and visualised using Google Earth

4.14.4 Results of Current Findings

1. Malaysia scored only 29.6% and ranked 35 in the latest EPI (**Appendix 4.14.1**). Currently there are only 143 designated protected areas covering only 15382.954 km2 that translates to a 2.80 % from the 548,800 km2 of Malaysia's EEZ. There is a small discrepancy of 1.6%.
2. Total area data on designated protected areas are missing from the database. These are Balok Mangrove Forest Reserve (FR), Bebar Mangrove FR, Beserah FR, Cherating Mangrove FR, Kemaman FR, Kampar FR, Kuala Bernam FR, Kuala Sepang FR, Pulau Kechil FR, Pulau Kukup FR, Pulau Tiga FR, Pulau Tongkok FR and Tanjung Tualang FR.
3. The gazette 42 Marine Parks under Jabatan Taman Laut Semenanjung Malaysia are included in the list.
4. To achieve a full score, Malaysia needs to update and gazette a further 7% of marine area from the EEZ (54,880 km2).

4.14.5 Future Mitigation Work

1. Update the data on each repository (MPA)
2. Examine and increase the accuracy of each data.

4.15 Critical Habitat Protection (AZE)

4.15.1 Introduction

This indicator is designed to monitor and whether countries provide protection for sites designated by the Alliance for Zero Extinction (AZE). It is a joint initiative of 52 biodiversity conservation organizations, which aims to prevent extinctions by identifying and safeguarding key sites, each one of which is the last remaining refuge of one or more Endangered or Critically Endangered species. The Alliance for Zero Extinction has identified 595 sites that each represents the last refuge of one or more of the world's most highly endangered species.

4.15.2 Indicator Metadata and Other Sources.

Data are taken from Alliance of Zero Extinction website available at http://www.zeroextinction.org and compared with data taken from WDPA to examine the conservation status.

4.15.3 Indicator Methodology

The degree of protection was assessed by overlaying the World Database on Protected Areas on the AZE sites. Sites were coded 0 for unprotected, 0.5 for partially protected, and 1 for fully protected. For each country, the site codes values were summed and divided by the total number of sites to come up with a percent protection.

4.15.4 Results of Current Findings

Currently, there are only 3 sites identified by AZE as refuge for endangered species.

No	Site	Species	
1	Klang	*Hipposideros nequam*	Malayan roundleaf bat
2	Lipaso Forest Reserve	*Leptobrachella palmate*	Palm Borneo Frog
3	Mount Kinabalu	*Rattus baluensis*	Summit rat
		Suncus ater	Black Shrew

Malaysia scored 66.67% and ranked 21 (**Appendix 4.15.1**) where one designated site is considered not protected.

The site designated as Klang is actually near Kuala Berang,Terengganu (Longitude 103º E : Latitude 5º N) (**Figure 4.15.1**)

Figure 4.15.2. Position on "Klang" data containing trigger species *Hipposideros nequam* (Malayan roundleaf bat) which is in Terengganu visualised in Google Maps.

4.15.5 Future Mitigation Work

1. Correct the erroneous Klang data.
2. Examine the accuracy and status of each site and update with AZE.

4.16 Forest Cover Change(FORCOV)

4.16.1 Introduction

Forest cover changes fall under Forest Policy category. It contributes 2.1% of the total EPI mark.

4.16.2 Indicator Description

This indicator represents the annual percent change in forest cover between 2000 and 2005. Forest cover change is an important metric concerning the abundance of forest ecosystems. Forest cover statistics are being compiled by the Peninsular Malaysia Forestry Department and Forestry Department for the states of Sabah and Sarawak.

The global ranking for FORCOV was made for 216 countries and the of data was taken from the following sources

Food and Agriculture Organization of the United Nations (FAO). 2009. State of the World's Forests 2009. Rome: FAO.

URL: http://www.fao.org/docrep/011/i0350e/i0350e00.HTM
Present source of data
After Mongabay.com
url: http://rainforests.mongabay.com/deforestation/2000

Total forest cover change for Malaysia 2000 and 2005

Year	**Area (ha)**
2005	21,591,000
2000	20,890,000
Change	(140,200) or -0.65%

4.16.3 Indicator Methodology

New FORCOV data for Malaysia is winsorized together with other data at 97.5 and 2.5 percentile. The formula is as follow:

Formula = [(target-min)-(target-FORCOV_raw)]x100/(target-min)
=[(0+2.5)-(0-FORCOV_raw)]x100/(0+2.5)
=(2.5+FORCOV_raw)x100/2.5

The target value is ≥ 0 which refers to countries that registered net increase in their forest cover.

4.16.4 Results of Current Findings

Malaysia scored 78.2 and ranked 115 in the Forest Cover Change Indicator (**Appendix 4.16.1**). The Malaysian score drop from 78.2% to 74% when the data in EPI 2010 is replaced with the new one (see Table below). The ranking also drop, by 52 runks to 167. A total of 130 countries scored 100%. These countries are those which register no changes or net increase in their forest cover. This indicator is purely based on changes in forest cover between 2000 and 2005. Therefore a country that has only small percentage of forest cover may score 100% if there is no further reduction in its forest area. Malaysian position is expected to be unchanged in the near future because deforestation especially forest conversion to plantation is taking place. A large track of forest conversion is still taking place in Sarawak.

The original and new ranking for Malaysia

EPI	**Max Score**	**Malaysian Score**	**Malaysian Rank**
Original	100	78.2	115
New	100	74	167

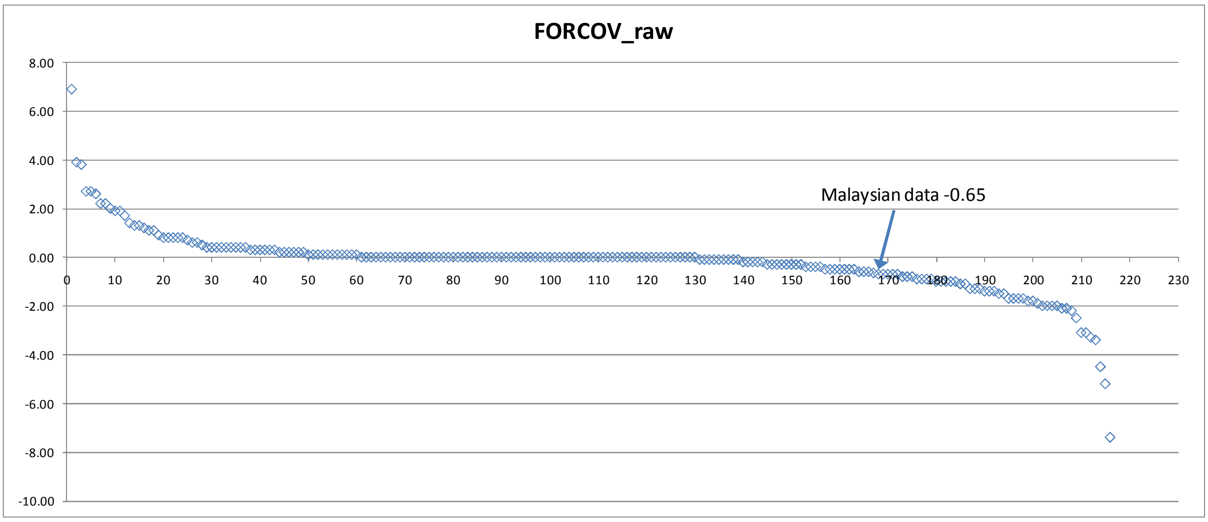


Figure 4.16.1: Data of global forest cover changes

4.17 Growing Stock Change (FORGRO)

4.17.1 Introduction

Similar to Forest cover changes, the Growing Stock indicator falls under Forest Policy category. It contributes 2.1% of the total EPI mark

4.17.2 Indicator Description

Growing stock is a volumetric measure that measures the cubic meters of wood over bark of all living trees more than X cm in diameter at breast height. Growing stock is defined as the standing tree volume of the forest resources. An increase in growing stock usually means higher quality forests, whereas a decrease in growing stock generally indicates degrading forest conditions.. For simplicity in measurement and explanation of the forest resources condition, growing stock is a good choice

The global EPI 2010 ranking for FORGRO was performed for 151 countries using data from the following sources

Food and Agricultural Organization of the United Nations. (2005). Global Forests Resources Assessment 2005. Rome, FAO.
URL: http://www.fao.org/forestry/site/32183/en/

The present analysis use information derived from growth and yield plots that have been summarised by Harun et al (2010). The average rate of forest growth is 2 m^3/ha/yr.

4.17.3 Indicator Methodology

Growing stock is a volumetric measure that measures the cubic meters of wood over bark of all living trees more than X cm in diameter at breast height. It includes the stem from ground level or stump height up to a top diameter of Y cm, and may also include branches to a minimum diameter of W cm. Countries indicate the three thresholds (X, Y, W in cm) and the parts of the tree that are not included in the volume. Countries must also indicate whether the reported figures refer to volume above ground or above stump. The diameter is measured at 30 cm above the end of the buttresses if these are higher than 1 meter.

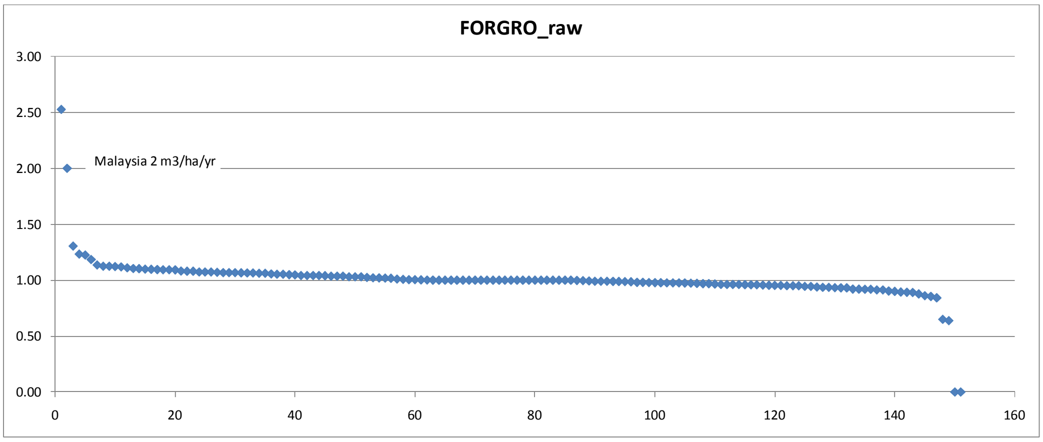
Growing stock includes windfallen living trees but excludes smaller branches, twigs, foliage, flowers, seeds, and roots.

Formula = [(target-min)-(target-FORGRO_raw)]x100/(target-min)
=[(1-0.842271)-(1-FORGRO_raw)]x100/(1-0.842271)
=[0.157729-(1-FORGRO_raw)]x100/0.157729

4.17.4 Results of Current Findings

The Malaysian rank under this category is good with 100% score together with other 86 countries (**Appendix 4.17.1**). The position is expected to remain good in the future as Forest Growth data is independent from forest cover changes.
The original and new ranking for Malaysia

EPI	Full Score	Score	Rank
Original	100	100	79 countries score 100%
New	100	100	



4.18 Marine Trophic Index

4.18.1 Introduction

In February 2004, the Conference of the Parties to the Convention on Biological Diversity (CBD) identified a number of indicators to monitor progress toward reaching the target to “achieve by 2010 a significant reduction in the current rate of biodiversity loss. The Marine Trophic Index is one of the eight indicators that the Conference of the Parties of the CBD identified for “immediate testing” of their ability to measure progress towards the 2010 target. It is based on trophic level (TL) of fisheries landings to demonstrate that fisheries, since 1950, are increasingly relying on the smaller, short-lived fish and on the invertebrates from the lower parts of both marine and freshwater food webs. MTI is based on fisheries data and quantifying changes in marine food webs, which is one of eight measures of biodiversity to be used by countries party to the Convention on Biological Diversity (Pauly and Watson 2005). In addition to being an indicator of the sustainability of fisheries, the marine trophic index provides a measure of ecosystem integrity. Declining trophic levels result in shortened food chains, leaving ecosystems less able to cope with natural or humaninduced change. The long term sustainability of fisheries is, in turn, directly linked to human livelihoods and well-being.

4.18.2 Indicator Description

The marine trophic index is a state indicator. The mean trophic level of landings is a numerical value. Trophic levels range from a definitional value of 1 for primary producers up to a level of 5 for marine mammals and humans. Trophic level is defined as the position of an organism in the food chain, determined by the number of energy-transfer steps to that level. The role of fishes within ecosystems is largely a function of their size: small fish are more likely to have a vast array of predators than very large ones. On the other hand, various anatomical and physiological adaptations may lead to dietary specialization, enabling different fish species to function as herbivores, with a trophic level of 2.0, or as carnivores, with trophic levels typically ranging from 3.0 to about 4.5.

Trophic levels change during the life history of fishes. Larvae, which usually feed on herbivorous zooplankton (TL= 2.0) consequently have a trophic level of about 3.0. Subsequent growth enables the juveniles 1 to consume larger, predatory zooplankton and small fishes or benthic invertebrates; this leads to an increase in trophic level, often culminating in values around 4.5 in purely piscivorous, large fishes.

Because of the close relationship between trophic level and size, mean trophic levels reflect changes in both size composition and position in the food chain, and therefore ecological roles. Overfishing tends to lead to decline in large, high trophic level fish relative to low trophic level small fish and invertebrates. This leads to “fishing down marine food webs”, where fisheries, first having removed the larger fishes at the top of various food chains, must target fishes lower and lower down, and end up targeting very small fishes and plankton.

Trophic decline, combined with decreasing biomass, leads to changes in the structure of ecosystems. Long food chains are being replaced by shorter ones, which expose top predators to strong environmentally-driven fluctuations exhibited by plankton organisms at the base of food webs. Such fluctuations were previously dampened by food webs with a variety of strong and weak links. Thus the biomass of fish species targeted by fisheries will fluctuate more widely than before, making fisheries increasingly difficult to manage and increasingly vulnerable to environmental changes, such as climate change.

4.18.3 Indicator Methodology

Two data sets are needed to calculate the indicator: (i) catch data by taxonomic groups, and (ii) one estimate of trophic level for each of these groups.

One of the sources for (i) (catch data by taxonomic group) are the FAO, which created and maintains a global data set, available online (at www.fao.org). This data set can be used for calculating the indicator, from 1950 to the present minus 2 years, for the landings of individual countries, the landings of 18 statistical areas largely representing ocean basins, and globally. Another source of data for (i) is the online database of the Sea Around Us Project (www.seaaroundus.org), whose geo-referenced data pertain to the Exclusive Economic Zones (EEZ) of all maritime countries, to Large Marine Ecosystems (LME) and to the High Seas, outside of EEZ.

Trophic level estimates for fish, based on their diet composition, may be found in FishBase, the global online database on fish, and for invertebrates, in the Sea Around Us database. Another source are the ecosystem food web models constructed using the widely used

Ecopath software (www.ecopath.org). Stable nitrogen isotopes of stomach contents have also been used in one study. By combining these two data sets, mean trophic levels of landings can be estimated for any of the world's country or area.

The FAO has collected data on capture fisheries from all maritime countries and analysed global trends in fisheries stocks since 1950. These data are reported in aggregated format, by 18 broad FAO regions, and present a solid basis for undertaking a global analysis of mean trophic level change. In an effort to provide fisheries data on a finer scale, the Sea Around Us Project (SAUP) (www.seaaroundus.org) has disaggregated the FAO data into spatial cells measuring ½ a degree latitude by ½ a degree longitude. This procedure makes it possible to report landings taken with a range of statistical boundaries, including by country EEZs, large marine ecosystems, and high seas areas.

The raw data calculated by EPI for MTI is 0.005466 with a score of 100 point this shows that Malaysia have a high value for EPI under MTI (**Appendix 4.18.1**). However the data used were up to year 2004 by EPI. Recently SAUP has released the data up to year 2006.

4.18.4 Results of Current Findings

Data were obtained from Department of Fisheries Malaysia (DOF) website (http://www.dof.gov.my/). DOF data is available up to year 2008 which is up to date compared to data from FAO which is only available up to year 2006 or 2007. However trophic level data is still not available by DOF. Therefore calculation for MTI have to start from the very basic calculation. The data from DOF have common fish names in Malay and all the names have to be translated or searched at Fishbase database. If the names were not available at Fishbase a second search have to be conducted at http://zipcodezoo.com/. If the search provides common English name for more than one fish species, the lowest value for the trophic level is selected. As for the EEZ area, data from SAUP was used since the EEZ in Malaysia have not changed. The calculation and estimation carried out has a raw value of 0.0048 which is similar to the data calculated by EPI.

4.19 Trawling Intensity

4.19.1 Introduction

Bottom trawling is a common method for catching bottom-dwelling species such as shrimp and flounder. Bottom trawling boats are equipped with large nets held open by heavy metal equipment, which are dragged across the sea floor. The nets devastate marine fauna such as coral and sponges. Bottom trawling equipment has been described as the most destructive fishing gear in use today. The environmental destruction caused by trawling is mirrored by the economic and social impacts it has on human communities that depend on marine resources for food and income. When nursery habitats such as seagrass beds are destroyed, the entire local environment is impacted and the productivity of local fisheries decreases.

Trawling is also extremely wasteful. The nets used in trawling catch more than just the species that are commercially valuable, and this by catch (which can include other fish and invertebrate species, marine mammals, seabirds, and turtles) is most often discarded. Bottom trawled fisheries have the highest discard rates of all fisheries.

4.19.2 Indicator Description

The 2010 EPI Trawling Intensity indicator consists of the percentage of the shelf area in each country's EEZ that is fished using trawling. There are no direct data available for the area trawled on a country by-country basis. However, fish landings data are acceptable as a proxy for each country's fishing fleet. Thus trawling ships can be counted and incorporated into this trawling metric. The target level selected for this indicator is 0% area trawled, reflecting the opinion that any use of this fishing method is ecologically undesirable.

Attributing country responsibility for overfishing and destruction of what is in essence a global commons is a difficult task. Many commercial fishing fleets fish well beyond their EEZs, and some countries under-report their fish catches. Poor countries often have difficulties monitoring and controlling the fishing going on within their EEZs. Another possible approach to measuring sustainability of fishing would be to measure fish consumption per capita, especially of the rarest and most economically valuable species. However, this would tend to penalize countries that have high proportions of fish protein in their diets and that may also have abundant fishing grounds relative to their populations.

4.19.3 Indicator Methodology

This indicator is calculated based on the amount of catch that is trawled per one-half degree (30 arc-minute) grid cells. This results in a metric of the area (sq km) associated with combined bottom trawl or dredge catch (supergears 8 or 9) rates >0.05 tonnes/sq km/year within declared EEZ areas. The marine area of the cells are added up to find the total area trawled and then divided by total EEZ. Cells that have a minimal catch are not included in the analysis.

Little has changed since the 2008 EPI. Many of the global datasets on fisheries are out of date or incomplete. Major data sources employed in this section of the 2010 EPI were the United Nations Food and Agriculture Organization's (FAO) fishing vessel database, and the Sea Around Us Project's fish landings database and Marine Trophic Index. Exclusive economic zone (EEZ) areas were taken from the Global Maritime Boundaries database. Though the FAO vessel database is used in one of this sections indicators, it should be noted that it is somewhat out of date. Malaysia scored 5.7 and ranked 112 in this indicator (**Appendix 4.19.1**)

4.19.4 Results of Current Findings

Data were obtained from Department of Fisheries Malaysia (DOF) website (http://www.dof.gov.my/). DOF data is available up to year 2008 which is up to date compared to data from FAO which is only available up to year 2006 or 2007. Data is only available for licensed fishing vessels. However it is expected that there are also unlicensed fishing boats using trawl nets. Landings of marine fish by trawl nets in Malaysia for year 2008 is 705, 644 tonnes. This is 50% of the total landings of fish in Malaysian water. The highest percentage of landings is recorded in Perak at 125, 509 tonnes whereas in Melaka and Negeri Sembilan there was no landings recorded.

4.20 Agricultural Water Intensity

4.20.1 Introduction

This indicator falls into the Agriculture Policy. The objective of this indicator is to evaluate the Ecosystem Vitality of the country. This parameter is an indication of the pressure on the renewable water resources caused by irrigation and livestocks. Yale University (Yale Centre for Environmental Law and Policy) and Columbia University obtain data under this section from AQUASTAT. AQUASTAT is Food and Agriculture Organisation (FAO) of The United Nation's global information system on water and agriculture, developed by the Land and Water Division. The main mandate of the programme is to collect, analyze and disseminate information on water resources, water uses, and agricultural water management with an emphasis on countries in Africa, Asia, Latin America and the Caribbean. This allows interested users to find comprehensive and regularly updated information at global, regional, and national levels.

4.20.2 Indicator Description

Agricultural water withdrawal (coded as AGWAT) is the annual quantity of water withdrawn for irrigation and livestock purposes. It includes renewable freshwater resources as well as potential over-abstraction of renewable groundwater or withdrawal of fossil groundwater, use of agricultural drainage water, desalinated water and treated wastewater. It includes water withdrawn for irrigation purposes and for livestock watering, although depending on the country this last category sometimes is included in municipal water withdrawal. As far as the water withdrawn for irrigation is concerned, the value far exceeds the consumptive use of irrigation because of water lost in its distribution from its source to the crops. The term "water requirement ratio" (sometimes also called "irrigation efficiency") is used to indicate the ratio between the net irrigation water requirements or crop water requirements, which is the volume of water needed to compensate for the deficit between potential evapo-transpiration and effective precipitation over the growing period of the crop, and the amount of water withdrawn for irrigation including the losses. In the specific case of paddy rice irrigation, additional water is needed for flooding to facilitate land preparation and for plant protection. In that case, irrigation water requirements are the sum of rainfall deficit and the water needed to flood paddy fields. At scheme level, water requirement ratio values can vary from less than 20% to more than 95%. As far as livestock watering is concerned the ratio between net consumptive use and water withdrawn is estimated between 60% and 90%. By default, livestock water use is accounted for in agricultural water use. However, some countries include it in municipal water withdrawal.

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between 60% and 90%. By default, livestock water use is accounted for in agricultural water use. However, some countries include it in municipal water withdrawal.

4.20.3 Indicator Methodology

The methodology used was to calculate the Agricultural water withdrawal as percentage of total renewable water resources, or

$$\text{Percentage AGWAT} = \frac{\text{Agricultural water withdrawal}}{\text{Water Resource}} \text{ x } 100$$

The water resources here means the total renewable water which can be the surface water, groundwater and desalination water. The target for the EPI is less than 10% of all the water resource to be used in the agriculture sector.

4.20.4 Results of Current Findings

In the AQUASTAT database inquiry, the general water data for Malaysia's is listed from 1988-1992, 1993-1997, 1998-2002 and 2003-2007. However, the water withdrawal data listed are only for 1988-1992 and 1998-2002. The information given (related to this indicator) is listed in the **Table 4.20.1**.

Table 4.20.1 : Malaysia's Data for Water in AQUASTAT

Items	1988-1992	1993-1997	1998-2002	2003-2007
Surface Water	566 bmc		566 bmc	566 bmc
Ground Water	64 bmc		64 bmc	64 bmc
Water Resource (Total)	580 bmc		580 bmc	580 bmc
Agricultural Water Withdrawal	8.3 bmc (F)		5.6 bmc (L)	5.6 bmc
Industrial Water Withdrawal	0.818 bmc	1.342 bmc	1.52 bmc (L)	
Municipal Water Withdrawal	0.999 bmc	1.641 bmc	1.9 bmc (L)	
Total Water Withdrawal (sum of sectors)	10.12 bmc (F)		9.02 bmc (L)	
Agriculture Water Withdrawal (as % of total water withdrawal)	82.02 (F)		62.08 (L)	
Percentage of	1.431		0.965	

Items	1988-1992	1993-1997	1998-2002	2003-2007
total actual renewable water resources withdrawn by agriculture (%)	(F)		5 (F)	

The score for Malaysia in this category was 0.9655 (100% i.e full points) for this indicator (**Appendix 4.20.1**). Although the EPI points gained by Malaysia is 100%, it need to be emphasize that the data released by AQUASTAT seems to have an error. The value for 'Total Water Resource' is recorded as 580 bcm whereas the actual value is supposed to be 630 bcm. With this value, the score should be 0.8889 (still having full marks but with better i.e lower agricultural water withdrawl percentage).

4.21 Agricultural Subsidies

4.21.1 Introduction

Malaysia scored 90.9 and ranked 60 in the Agricultural Subsidy Indicator which falls into the Agriculture Policy (**Appendix 4.21.1**). According to a report by the OECD (2004), public subsidies for agricultural protection and agrochemical inputs exacerbate environmental pressures through the intensification of chemical use, the expansion of land into sensitive areas, and overexploitation of resources

4.21.2 Indicator Description

Agricultural subsidies (coded as AGSUB) is an indicator seeks to assess the magnitude of subsidies in order to assess the degree of environmental pressure they exert. The NRA is defined as the price of their product in the domestic market (plus any direct output subsidy) less its price at the border, expressed as a percentage of the border price (adjusting for transport costs and quality differences).

4.21.3 Indicator Methodology

Where available, we used data on the Nominal Rate of Assistance (NRA) from the World Development Report 2008. NRA is defined as the price of a product in the domestic market, less its price at a country's border, expressed as a percentage of the border price, and adjusted for transport costs and quality differences (WDR 2009). These were converted to the standard EPI proximity-to-target indicator.

For OECD countries, we converted their Producer Nominal Assistance Coefficient (NAC) values to fill in missing values. According consultation with agricultural trade experts, Kym Anderson (University of Adelaide), NAC is almost the same as NRA (a 50% NRA = a NAC of 1.50, eg). It is also similar to the PSE, since in % our NRA = 100*PSE/(100+PSE). The NAC for the EU27 was 0.33 but we deferred to the values in the WDR2009 for EU countries that had both a NRA and NAC value. For all other missing values, we assumed a zero. Low and middle-income countries without agricultural subsidies data were imputed a proximity to target score of 0 on the basis that most non-OECD countries do not subsidize their agricultural sector

4.21.4 Results of Current Findings

No concrete results can be retreived from the reference given. Discussion with Columbia University is still in progress

4.22 Pesticide Regulation

4.22.1 Introduction

This indicator falls into the Agriculture Policy. The parameter is an indication of the pressure on the Pesticides are a significant source of pollution in the environment, affecting both human and ecosystem health. The indicator is coded as AGPEST. Pesticides damage ecosystem health by killing beneficial insects, pollinators, and fauna they support. Human exposure to pesticides has been linked to increases in headaches, fatigue, insomnia, dizziness, hand tremors, and other neurological symptoms. Furthermore, many of the pesticides included in this index are persistent organic pollutants (POPs), endocrine disruptors, or carcinogens. Yale University (Yale Centre for Environmental Law and Policy) and Columbia University obtain data under this section from The Pesticide Action Network (PAN) Pesticide Database. The database and website are updated and enhanced by Pesticide and Action Network North America (PANNA).

4.22.2 Indicator Description

The indicator of pesticide use examines the legislative status of countries on two landmark agreements on pesticide usage, the Rotterdam and Stockholm conventions, and also rates the degree to which these countries have followed through on the objectives of the conventions by limiting or outlawing the use of certain toxic chemicals.

The indicator encompasses 11 criteria, each of which have a maximum of two possible points. The first two criteria measure whether, and to what degree countries have participated in the conventions. Under the Rotterdam Convention, countries receive 2 points if they are a party and have designated a national authority for its implementation, 1 point if they are a party but have no national authority, and 0 points if they are not a party. Under the Stockholm Convention on Persistent Organic Pollutants, countries receive 2 points if they are a party and have created a national implementation plan (NIP), 1 point if they are a party but have no NIP, and 0 points if they are not a party. These data are available via the respective convention secretariats.

4.22.3 Indicator Methodology

The next nine criteria indicate whether countries have banned (for a score of 2), restricted (for a score of 1), or taken no action (for a score of 0) on regulating the nine of the "dirty dozen" persistent organic pollutants. These include aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, and toxaphene. Data for these criteria were collected from the United Nations Environment Programme Chemicals. Country performance is a simple sum of the scores across the 11 criteria for a maximum possible score of 22.

4.22.4 Results of Current Findings

Information search on this website shows that >90% of the countries listed do not have registration of chemicals available (stated in website as “No registration data available”). However, detail information on pesticides area available in this website. Detail information on countries participation in the two conventions can only be obtained in their respective websites (Rotterdam Convention and Stockholm Convention). The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade was adopted on 10th September 1998 in Rotterdam. At present, 73 countries 'Signed' the conventions while 134 entered as 'Parties'. Malaysia did not enter as Signatories but entered as 'Party' on 4 September 2002 under Accession.

The Convention was adopted on 22 May 2001 at the Conference of Plenipotentiaries on the Stockholm Convention on Persistent Organic Pollutants, Stockholm, 22-23 May 2001. At present, there are 151 countries who enter as Signatories and 172 as Parties. Malaysia did enter as Signatories on 16 May 2002 but did not enter as Parties. The score for Malaysia in this category was 20 out of 22 points (90.9%) for this indicator (less two points since Malaysia did not enter as Signatories in the Rotterdam Convention). Similarly, in this section, the total marks that should be obtained by Malaysia is should be 21 (95.45) instead of 20 since Malaysia entered as 'Party' for the Rotterdam Convention (which gives Malaysia one point). See **Appendix 4.22.1** for Malaysia's performance in this indicator.

4.23 Greenhouse Gas Emissions Per Capita (GHGCAP)

4.23.1 Introduction

Climate change has significant impacts on global environment. The most obvious is global warming for it increases the average temperature of lower atmosphere. Anthropogenic activities has cause large increase of green house gases in atmosphere, including Carbon Dioxide (CO2), Methane (CH4), Nitrous Dioxide (N2O), Sulphur Hexafluoride (SF6), Hydroflurocarbons (HFC) and Perflurocarbons (PFCs), all of them contribute to global warming. The effects of global warming is numerous, include drought, flood, rising of seal level, reduced of farm output, tropical cyclone, glacier retreat, ocean acidification, heat waves and bush fire.

Global warming could have many different causes, but most of them are associated with human interference, such as electricity generation, transportation, industrial process, waste, fuel combustion, agriculture and other human activities that generate greenhouse gases. By referring to different emission sources, the climate change indicators are designed to evaluate the performance of green house gases emission in a country. In this case, high emission is equates to bad performance, meaning that more green house gases is released to the atmosphere.

Malaysia has demonstrates the willingness and seriousness to reduce green house gases emission by up to 40 percent by 2020 as compared to 2005 levels during Copenhagen Climate Change Summit. In the global EPI, Malaysia is given a total score of 42.3 in the overall climate change performance. This exercise is aims to verify Malaysian climate change performance by referring to existing local data sources of greenhouse gases emission. Computation is based on the compilation of available emission data from local agencies, no field study is conducted for this exercise. **Table 4.23.1** summarizes the findings for this exercise.

Table 4.23.1: Summary of findings for Climate Change Indicators

Indicators	**Findings**	**EPI Target**
Indicator Greenhouse Gases Emission per Capital (GHGCAP)	8.02391 Metric Tons CO2 Equivalent per Person (Mt CO2 eq)	2.5 Mt CO2 eq.
Indicator Industrial Greenhouse Gas Emission Intensity (GHGIND)	117.7525 Metric Tons CO2 Equivalent per $mil, (USD 2005 PPP) of industrial GDP	36.3 tons of CO2 Equivalent per $mill (USD, 2005, PPP) of industrial GDP
CO2 Emission for Electricity Generation (CO2KWH)	619.0755 g CO2 per kWh	0 g CO2 per kWh

4.23.2. Indicator Description

For computing the climate change indicator, Yale University and Columbia University adapt the data from Climate Analysis Indicators Tool (CAIT) version 7 developed by the World Resources Institute (Refer to http://cait.wri.org/).

The CAIT compiles and analyze data of CO2 emission of fossil fuels from other renowned international agencies, such as International Energy Agency (IEA), Carbon Dioxide Information Analysis Center (CDIAC) and Energy Information Administration (EIA). For the CO2 emission from land use change, the CAIT rely on research works from Dr Houghton. The study of Dr Houghton covered year from 1950-2000 for most countries of the world.

The CAIT database covered 186 countries, including Malaysia. In the case of Malaysia, the CAIT rely the following information: the CO2 from fossils fuels for the years 1971-2006 are from EIA whereas data for the years 1890-1970 are from CDIAC; For the CO2 emission from land use change and forestry, it is rely on the works from Dr Houghton (1990-2005); For non-CO2 gases, CH4 and N20 is from the Emission Database for Global Atmospheric Research (EDGAR); HFCs, PFCs and SF6 are from EPA.

As there are many aspects of environmental performance, the global EPI has set three climate change indicators:

1) Greenhouse Gases Emission per Capital (GHGCAP)
2) Industrial Greenhouse Gas emission Intensity (GHGIND)
3) CO2 Emission for Electricity Generation (CO2KWH)

As reported in the global EPI, the total weight of climate relevant EPI is 25.7%, which is a compilation percentage of Greenhouse gases emission per capital (12.5%); Industrial greenhouse gas emission intensity (6.3%) and CO2 emission for electricity generation (6.3%). Following sections examines and details each of the indicators.

Greenhouse gases emissions contribute to climate change, the indicator greenhouse gases emission per capital provide an insight on how much greenhouse gases that a person release into atmosphere in a single year. The greenhouse gases emission per capital is the sum of emissions of six major types of greenhouse gases, including: Carbon Dioxide (CO2), Methane (CH4), Nitrous Oxide (N20), Fluorinated gases (SF6, PFCs, and HFCs) in CO2 equivalents, divided by total population in a country. The lower per capital emissions, meaning less average person of a country contributes to climate change.

4.23.3 Indicator Methodology

The formula to compute Greenhouse Gases Emission per Capital is as below:

$$\frac{(Sum\ of\ Emissions\ of\ Six\ Green\ House\ Gases^{*}\ +\ Emission\ Attributable\ to\ Land\ Use)}{Total\ Population\ in\ year\ 2005}$$

* The coverage of the sources of green house gases are very wide, including electricity and heat, manufacturing and construction, transportation, other fuel combustion, fugitive emissions, industrial processes, agriculture, land use change and forestry, waste, international bunkers. Each of them can be further subdivided into more details as following:

i. Electricity and Heat (Yearly CO2 Emission)

- Main Activity Electricity and Heat Production: Emissions from main activity producer electricity generation, combined heat and power generation, and heat plants.
- Auto producer: Emissions from producer which generate electricity or heat for their own used,
- Other Energy Industry: emissions from fuel combusted in petroleum refineries, for the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries.

ii. Manufacturing and Construction (Yearly CO2 Emission)

- Iron and Steel
- Chemicals and Petrochemicals
- Non-Ferrous Metals
- Non-Metallic Minerals
- Transport Equipment
- Machinery
- Food and Tobacco
- Paper, Pulp and Printing
- Wood and Wood Products
- Construction
- Textile and Leather
- Non-specified Industry
- Non- Energy Use Ind/ Transf/ Energy

iii. Transportation (Yearly CO2 Emission)

- Domestic air transport
- Road vehicles
- Rail

- Pipeline transport
- National navigation
- Non-specified transport
- Non-energy use in transport

iv. **Other Fuel Combustion (Yearly CO2 Emission)**
- CH_4 and N_20 from biomass combustion
- CH_4 and N_20 stationary and Mobile combustion
- CO_2 from other sectors

v. **Fugitive Emission (Yearly CO2 Emission)**
- Gas venting/ Flaring
- Oil and Natural gas systems
- Coal Mining

vi. **Industrial Process (Yearly CO2 Emission)**
- CO_2 emissions from cement manufacture
- N_20 emissions from Adipic and Nitric Acid Production
- N_20 and CH_4 emissions from other industrial

vii. **Agriculture (Yearly CO2 Emission)**
- CH_4 from Livestock
- CH_4 and N_20 from livestock manure management
- CH_4 from rice cultivation
- N_20 from agriculture soils
- CH_4 and N_20 from other Agriculture Sources

viii. **Land Use Change (Yearly CO2 Emission)**
- Clearing of natural ecosystems for permanent croplands (cultivation)
- Clearing of natural ecosystems for permanent pastures (no cultivation)
- Abandonment of croplands and pastures with subsequent recovery of carbon stocks to those of the original ecosystem
- Shifting cultivation
- Wood harvest (industrial wood as well as fuel wood). It is important to note that these estimates include the emissions of carbon from wood products (burned, stored in long term pools, decayed over time)

ix. **Waste (Yearly CO2 Emission)**
- CH_4 from landfills (solid waste)
- CH_4 from wastewater treatment
- N_20 from human sewage
- CH_4 and N_20 from other (waste)

x. **International Bunker (Yearly CO2 Emission)**
- Aviation Bunker
- Marine Bunker

In global EPI 2010, Malaysia has been ranked as 127 with total emission of 14.472072 Metric Tons Equivalent per Person. **Table 4.23.2 and Appendix 4.23.1** summarize the relevant information for the indicator Greenhouse Gases Emission per Capital (GHGCAP) as reported in the EPI 2010.

Table 4.23.2: Summary of Indicator Greenhouse Gases Emission per Capital (GHGCAP)

Code	GHGCAP
Description	Sum of greenhouse gases emissions (in CO2 equivalents) and emissions attributable to land use, divided by total population.
Unit of Measurement	Metric Tons CO2 Equivalent per Person (Mt CO2 eq)
Weight of indicator (x/100)	12.5
Rationale	Greenhouse gas emissions contribute to climate change. Emissions per capita, per GDP, and per electricity generation are relevant; other indicators in this category are denominated by industrial GDP and electricity generation.
Year Available	2005
Target	2.5 Mt CO2 eq. (Estimated value associated with 50% reduction in global GHG emissions by 2050, against 1990 levels)
Malaysia raw data	14.472072 Mt CO2 eq
Malaysia Ranking	127
Proximity to target	41.9

Source: *Environmental performance index* (2010).

4.23.4 Results of Current Findings

For this exercise, we use the emission data of the year 2004. The justification is that so far, the most comprehensive and available data set for greenhouse gases emission in Malaysia is in 2004. It is the closer year in comparing to year 2005 in global EPI. Department of Environment (DOE) and Malaysia Green Tech Cooperation, previously known as Malaysia Energy Centre (PTM) contributes and serves as the main agencies in providing data relevant to greenhouse gases emission. The following data has been obtained and serve as the input for calculating **Greenhouse Gases Emission per Capital (GHGCAP)** in Malaysia, refer to Appendix Table A1 for the comparison between CAIT and Malaysia data.

i. Energy Industries (Yearly CO2 Emission)
- Public electricity and heat production
- Petroleum refining
- Manufacture of solid fuels and other energy industries

ii. Manufacturing Industries and Construction (Yearly CO2 Emission)
- Manufacturing
- Mining
- Construction

iii. Transportation (Yearly CO2 Emission)
- Road
- Rail
- Aviation
- Navigation/ Maritime
- Military transport

iv. **Emission from Biomass fuels (Yearly CO_2 Emission)**

v. **Fugitive Emissions from Fuels (Yearly CO_2 Emission)**
- Coal mining and Handling
- Oil and Gas System
  - Oil
  - Natural Gas
  - Venting and Flaring

vi. **Industrial Processes (Yearly CO_2 Emission)**
- Mineral Product
  - Cement Production
  - Lime Production
  - Limestone and Dolomite Site
- Chemical Industry
  - Ammonia Production
  - Nitric Acid Production
  - Carbide Production
  - Petrochemicals
- Metal Production
  - Iron and Steel Production

vii. **Agriculture, Fishery and Forestry (Yearly CO_2 Emission)**
viii. **International Bunkers (Yearly CO_2 Emission)**
ix. **Commercial (Yearly CO_2 Emission)**
x. **Residential (Yearly CO_2 Emission)**
xi. **Other Relevant Greenhouse Gases (Yearly CO_2 Emission)**
- Emission from halocarbon and Sulphur Hexafluoride
  - Consumption of HFC 134a for Mobile Air Conditioning (MAC)
  - Consumption of SF_6 (Not Specific)

CO_2 equivalence factor is used to convert greenhouse gases to CO_2 equivalent. For this exercise, the CO_2 equivalence factor for CH_4 is 21; N20 is 310; HFC is 11700 and SF_6 is 23900. For the population statistic, Department of Statistics Malaysia reveals that the total population for year 2004 is 25.5809 million.

The finding reveals that the Greenhouse Gases Emission per Capital for Malaysian is **8.02391 Metric Tons CO_2 Equivalent per Person (Mt CO_2 eq)**. Our projection is lower than the Global EPI projection, which is 14.472072 Mt CO_2 eq. There are few likely explanations for the obtained results.

First, there are differences in between the raw data for Greenhouse Gases Emission per Capital (GHGCAP) in Malaysia in comparing to global EPI data. For examples, the Malaysia EPI has included the fishery, forestry, commercial and residential sector as part of the computation. Nevertheless, there is two major data has not been accounted for Malaysia EPI, (1) Emission from waste and (2) Emissions attributable to land use. For the former, there is no relevant local emission data associated with waste could be obtained in Malaysia. Also, the emission data from land use change has been excluded. The justification to exclude land use change data is because local data is not available whereas there are uncertainties of the international data. The 2010 global EPI report has mentioned that the Greenhouse Gas Emission per capita cannot be reliably assessed due the fact that the land use emissions were imputed in some cases (Environmental Performance Index report 2010, page 70). Another explanation is that we using the year 2004 instead of the year 2005. Over one year, there might be some changes in the consumption patterns and industrial processes.

4.24 Industrial Greenhouse Gas Emission Intensity (GHGIND)

The industrial carbon intensity is represented by the carbon dioxide emissions per Gross Domestic Product (GDP) of industrial sector. It is important to consider the emission from industrial sector for them contributes economic growth in a country. Industrial activities is often associated with pollution and carbon emission, obtaining lower score for this indicator reveals industry adapt clean technology and have lower carbon footprint. The target for emissions intensity of the industrial sector is 36.3 tons of CO2 Equivalent per $mill (USD, 2005, PPP) of industrial GDP.

4.24.1 Indicator Methodology

The formula to compute Industrial Greenhouse Gas Emission Intensity (GHGIND) is as below:

$$\frac{Industiral\ Green\ House\ Gas\ Emissions, 2005\ (Metric\ Tonnes\ Carbon\ Dioxide)}{Industrial\ GDP, PPP, 2005\ (Current\ International\ Dollar)}$$

The industrial green houses gases include the following:

i. CO2 emissions from Cement Manufacture
ii. N2O emissions from Adipic and Nitric Acid Production
iii. N2O and CH4 emissions from Other Industrial (non-agriculture)
iv. HFCs, PFCs, and SF6

For conversion purpose, Purchasing Power Parities (PPP) is used to convert the industry GDP. There are drawbacks of using exchange rates to convert GDP to common currency. First, the currency exchange rate is varying from time to time, perhaps, day to day. Another drawback is that exchange rate is not a good reflector of the relative prices of goods and services. In global EPI 2010, Malaysia has been ranked as 81 with total emission of 59.416066 Metric Tons CO2 Equivalent per $mil, USD 2005 PPP. The relevant information for the indicator Industrial Greenhouse Gas Emission Intensity (GHGIND) as reported in the EPI 2010 in **Table 4.24.1 and Appendix 4.24.1.**

Table 4.24.1: Summary of Indicator Industrial Greenhouse Gas Emission Intensity (GHGIND)

Code	GHGIND
Description	Total GHG emissions from industry sector, divided by industrial GDP.
Unit of Measurement	Metric Tons CO2 Equivalent per $mil, USD 2005 PPP
Wight of indicator (x/100)	6.3
Rationale	Greenhouse gas emissions contribute to climate change. Emissions per capita, per GDP, and per electricity generation are relevant; other indicators in this category are denominated by population and electricity generation.
Year Available	2005

Target	36.3 tons of CO2 Equivalent per $mill (USD, 2005, PPP) of industrial GDP (Estimated value associated with 50% reduction in global GHG emissions by 2050, against 1990 levels)
Malaysia raw data	59.416066 Metric Tons CO2 Equivalent per $mil, USD 2005 PPP
Malaysia Ranking	81
Proximity to target	76.6

Source: *Environmental performance index* (2010)

4.24.2. Results of Current Findings

For Industrial Greenhouse Gas Emission Intensity indicators, data are collected from Malaysia Green Tech Cooperation, formerly known as Malaysia Energy Centre (PTM), Department of Environment (DOE), World Bank and Department of Statistic Malaysia. The following data has been obtained and serve as the input for calculating Industrial Greenhouse Gas Emission Intensity (GHGIND) in Malaysia, see **Appendix 4.24.2** for the comparison of data between CAIT and Malaysia Data.

i. **Mineral Product**
   - Cement Production
   - Lime Production
   - Limestone and Dolomite Site

ii. **Chemical Industry**
   - Ammonia Production
   - Nitric Acid Production
   - Carbide Production
   - Petrochemicals

iii. **Metal Production**
   - Iron and Steel Production

The finding reveals that the Industrial Greenhouse Gas Emission Intensity (GHGIND) for Malaysian is **117.752454 Metric Tons CO2 Equivalent per $mil, USD 2005 PPP of industrial GDP**. This projection is much higher than the prediction from global EPI which is 59.416066 Metric Tons CO2 Equivalent per $mil, USD 2005 PPP.

Justification for the results is that available local data is far more comprehensive and details in comparing to EPI raw data. For local data, we have included the chemical industry and iron and steel production whereas Global EPI have exclude them for the reason of lack of data. Also, we have included lime production in the Malaysia EPI for it is one of the industry process that release greenhouse gases. If we exclude these add-in data (lime production; limestone and dolomite use; ammonia production; iron and steel production), we obtain a value of 57.139 Metric Tons CO2 Equivalent per $mil, USD 2005 PPP of industrial GDP which is very close to Global EPI results.

For this exercise, the year 2004 is used for it has the most available and comprehensive local emission data, this may contributes to the differences between Malaysian EPI and Global EPI results. In overview, the results indicates that greenhouse gases emission from industrial sector is still behind the EPI target which is 36.3 tons of CO2 Equivalent per $mill (USD, 2005, PPP). It is suggested a details action plans should be conducted to mitigate the greenhouse gases emission from industry sectors.

4.25 CO2 Emission for Electricity Generation (CO2KWH)

Electricity generation is refers electricity generation from public utilities as well as independent power producers (IPPs) and private installations & co-generation plants which obtain licenses from the Electricity and Gas Supply Department. In global EPI 2010, Malaysia has been ranked as 108 with g CO2 emission per kWh of 619.0755. The following table summarized the relevant information for the indicator **CO2 emission for electricity generation** as reported in the EPI 2010. **Table 4** summarizes the indicator CO2 Emission for Electricity Generation (CO2KWH) and Malaysia's performance in terms of proximity-to-target score and ranking is given in **Appendix 4.25.1**).

Table 4: Summary of Indicator CO2 Emission for Electricity Generation (CO2KWH)

Code	CO2KWH
Description	Carbon dioxide emissions from public electricity and heat production include the sum of emissions from combustion of all fossil fuel types used for public electricity generation, public combined heat and power generation, and public heat plants.
Unit of Measurement	g CO2 per kWh
Wight of indicator (x/100)	6.3
Rationale	Greenhouse gas emissions contribute to climate change. Emissions per capita, per GDP, and per electricity generation are relevant.
Year Available	2007
Target	0 g CO2 per kWh
Malaysia raw data	619.0755 g CO2 per kWh
Malaysia Ranking	108
Proximity to target	8.9

Source: *Environmental performance index. (2010)*

4.25.1 Indicator Methodology

The formula to compute Greenhouse Gases Emission per Capital is as below:

$$\frac{Green\ House\ Gases\ Emissions\ 2007\ from\ public\ electricity\ and\ \text{heat production}\ (Metric\ Tonnes\ Carbon\ Dioxide)}{Electricity\ and\ Heat\ Output\ (kWh)}$$

Coal, natural gas, diesel, oil, hydro and biomass are the sources to generate electricity in Malaysia. Fossil fuels i.e coal, natural gas, diesel and oil dominate the electricity generation by 16,946 MW from total installed capacity 18,896 MW. Natural gas and coal generate 66% and 23.3% of the total electricity generation. In this study, the emission factor for different types of fossil fuel is as follow:

Table 5: CO_2 emission factor for different fossil fuel types

Fuel	CO_2 emission coefficient (t Co2/ t fuel)
Diesel oil	74.1
Fuel oil	77.4
Coal	94.6
Natural gas	56.1

Source: 2006 IPCC Guidelines for National Greenhouse Gas inventories

4.25.2 Results of Current Findings

For CO_2 emission from electricity generation indicators, the detailed calculation has been performed by Malaysia Green Tech Cooperation, formerly known as Malaysia Energy Centre (PTM) under research title 'Study on Grid Connected Electricity Baselines in Malaysia Year: 2006 and 2007' and publicly available. The main sources of data were the Energy Commission (EC), Sabah Electricity Supply Board (SESB) and the Sarawak Electricity Supply Corporation (SESCo). For this exercise, the year 2007 has been chosen as the baseline and the results were divided into three separate regions, namely Peninsular Malaysia, Sabah and Sarawak. The justification of doing so is that their main grid is not interconnected with one other. Therefore the baseline calculations will be calculated based on individual region and their electricity system. The findings reveals that the CO_2 emission per kWh electricity generation is **0.757 tCO_2/MWh for peninsular Malaysia, 0.882 tCO_2/MWh for Sarawak, 0.787 tCO_2/MWh for West Sabah.** However, Global EPI projection only report one figure which is 619.0755 g CO2 per kWh and this figure was lower than our projection. The different could be due to different sample selection of power generation plants

In this study, the CO_2 emission per kWh electricity generation based on the set of five power units that have been built most recently for 3 different regions, Peninsular Malaysia, Sarawak & Sabah as shown in Table 5, 6 and 7.

Table 5. Electricity generation plant in Peninsular Malaysia

Name of Power Plants/ Fuel Types	Year of Operation	Capacity (MW)	Total Generation (MWh)	CO_2 Emission (tCO_2)
1. SKS Prai Power Station/Gas & Distillate	2002	350	2,483,310	1,049,809
2. Panglima Power Station/Gas & Distillate	2003	720	5,419,930	2,186,230
3. Janamanjung Power Station/Coal	2003	2070	11,248,290	11,363,743
4. Tuanku Jaafar Power Station/Gas & Distillate	2005	714	5,759,730	2,361,373
5. Tanjung Bin Power Station/Coal	2006/2007	1400	8,295,580	8,184,319
Total			**33,206,840**	**25,145,474**

Source: Energy Commission, 2007

4.25.3 Limitation of Study

The major challenge of computing climate change indicator for Malaysia EPI is lack of compilation of yearly emission data. It is suggest that in coming future, more comprehensive data collection and compilation efforts should be conducted by appointed agencies on yearly basics. The rationale is to produce and sustain a reliable greenhouse gases emission sources. Also, local emission data such as waste and land use change should be established and collected as well, for it is complementary of overall emission.

Table 6. Electricity generation plant in Sarawak

Name of Power Plants/ Fuel Types	Year of Operation	Capacity (MW)	Total Generation (MWh)	CO_2 Emission (tCO_2)
1. Miri Power Station/Gas & Diesel	1994	79	434,170	352,017
2. Bintulu Power Station (SESCO)/Gas & Distillate	1997	64	462,870	327,393
3.Sejingkat Power Station (SPC 1) / Coal	1998	100	719,260	838,299
4. Bintulu Gas Power Station (IPP) / Gas & Distillate	1999	220	1,384,340	926,702
5.Sejingkat Power Station (SPC 2)/Coal	2004	110	693,760	814,433
Total			3,694,400	3,258,844

Source : Sarawak Electricity Supply Corporation, 2007

Table 7. Electricity generation plant in Sabah

Name of Power Plants / Fuel Types	Year of Operation	Capacity (MW)	Total Generation (MWh)	CO_2 Emission (tCO_2)
1. Patau-Patau Power Station /Gas	1995	112	664,570	560,413
2.ARL Tenaga Power Station /MFO	1996	50	123,029	87,765
3.Powertron Resources /Gas & Diesel	1998	136	793,247	621,238
5. Sepanggar Bay Power Corporation (SBPC)/Gas	2006	72	508,204	378,027
5. Sutera Harbour /Diesel	2006	40	116,980	89,159
Total			2,206,030	1,736,601

Source: Sabah Electricity Sdn. Bhd. and Energy Commission (2007)

5.0 SUMMARY OF THE CURRENT FINDINGS

The preliminary findings of the present study on the EPI for Malaysia are summarized as follows:

- Overall, Malaysia remains top 60 out of 163 countries in the terms of EPI global raking.
- Malaysia is clustered together with most advanced countries such as Australia, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Italy, Japan, Netherlands, New Zealand, Norway, Singapore, South Korea, Sweden, Switzerland, United Kingdom, and the United States. Countries of this cluster are mostly developed, wealthy nations that perform the best in the environmental health categories.
- Malaysia's performance in individual EPI indicators range from excellent (100% achieving the targets) to the lowest performance with less than 10% of the target.
- Seven indicators or 28% of the indicators (or 23.9% of the total EPI weight) performed less than 50% of their respective targets.
- Two indicators (Trawling intensity *(EEZTD)* and CO_2 emissions per electricity generation *(CO2KWH)*) that performed below 10% of their respective targets.
- Six indicators (or 38.6% of total EPI weight) performed between 50 – 80% of their respective targets
- Seven indicators (or 29.4% of the total EPI weight) performed better than 80% of their respective targets and only 5 indicators with only 8.1% of the total EPI weight met 100% of the their respective targets.

The findings with respect to each indicator are summarized as follows:

No.	Indicator	Summary of Findings
1	Environmental burden of disease Target: 10 DALYs per 1,000 population Raw = 27 PTT = 67.8 Rank = 57	• EPI data source – WHO 2006 – used data 2004 • Global/Regional estimates of Population Attributable Fractions • KKM published Malaysian Burden of Disease and Injury Study 2004 - used data 2000 • Further DALYs
2	Access to water (Target: 100% of population with access) Raw = 99 PTT = 98.3 Rank = 46	• Two sources of data: o SPAN: Malaysian Water Industrial Guide - % Population with access to public water supply, Urban and Rural (2005 – 2009). Note: Kelantan (low %), Melaka & Labuan (all Urban) o KKM: Rural data only - % home coverage (2004 – 2009)
3	Access to sanitation (Target: 100% of population with access) Raw = 94 PTT = 93.3 Rank = 54	• Two sources of data: o SPAN: Malaysian Water Industrial Guide - % Population Equivalent (PE) connected to public/private sewerage, septic tank and pour flush (2007 – 2009). Note: Kelantan (low %), Melaka & Labuan (all Urban) o KKM: Rural data only - % home coverage (2004 – 2009)

No.	Indicator	Summary of Findings
4	Indoor air pollution (Target: 0% of population exposed) Raw = PTT = Rank =	• Lack of data on the ground
5	Outdoor air pollution (Urban Particulates) (Target: <= 20 ug/m^3) Raw = PTT = 92.9 Rank =46	• Calculation based on DOE data in progress
6	Sulfur dioxide emissions per populated land area (Target: <= 0.01 Gg/1000 sq km) Raw = 1.0 PTT = 51.8 Rank =	• Different data formats: o Malaysian data set from air monitoring stations are in ppm o EPI computation based on EDGAR air pollution model used proxy measure of emissions in gigagrams/land area
7	Nitrogen oxides emissions per populated land area (Target: <= 0.01 Gg/1000 sq km) Raw = 1.9 PTT = 45 Rank =	• Different data formats: o Malaysian data set from air monitoring stations are in ppm o EPI computation based on EDGAR air pollution model used proxy measure of emissions in gigagrams/land area
8	Non-methane volatile organic compound emissions per populated land area (Target: <= 0.01 Gg/1000 sq km) Raw = 4.5 PTT = 32.6 Rank =	• Different data formats: o Malaysian data set from air monitoring stations are in ppm o EPI computation based on EDGAR air pollution model used proxy measure of emissions in gigagrams/land area
9	Ecosystem ozone (Target: 0 ppb exceedance above 3000 AOT40. AOT40 is cumulative exceedance above 40 ppb during daylight summer hours) Raw = 380622.0 PTT = 35.2 Rank =84	• GIS method need to be employed to assign grid cell of equal size for Malaysia's land area in order to sum up any exceedance of ozone over 40 ppb during the day
10	Water quality index (Target: Dissolved oxygen: 9.5mg/l (Temp<20ºC), 6mg /l (Temp>=20ºC); pH: 6.5 - 9mg/l; Conductivity: 500µS; Total Nitrogen: 1mg/l; Total phosphorus: 0.05mg/l; Ammonia: 0.05mg/l) Raw = PTT = 54.6 Rank =79	• Only data of seven rivers were used in the EPI calculation while more than 100 sampling stations are available in Malaysia. The use of these additional data could have different results in the WQI and increase the value of monitoring station multiplier used in the final calculation. • Some of the data used for the 2010 exercise are questionable. These include a very high DO value (i.e. 34.4 mg/L) and an exceptionally high NH_3 value (i.e. 7.7 mg/L), both at Sg. Kelantan. • The data that are used for the calculation are rather old (1980-1992). Hence, the WQI calculated does not represent the status of 2010.
11	Water stress index	• Lack of data on the ground

No.	Indicator	Summary of Findings
	(Target: 0% territory under water stress) Raw = PTT = 86.8 Rank =51	
12	Water scarcity index (Target: 0% water overuse) Raw = PTT = 100 Rank =	• The computed result agrees with the one calculated by the EPI. However, the data on the desalinated water production (i.e. 4.3 x 10^6 m^3/year) need further verification.
13	Biome protection (Target: >= 10% weighted average of biomes protected) Raw = PTT = 100 Rank =25	• There are 722 sites recorded in WDPA with a total of 86327 hectares of conserved land as compared to the total land mass of 328,657 sq km, a 26% in land conservation • Future Mitigation Work o Identify a mechanism to collate existing data from various government agencies. o Identify the mechanism to update the WDPA database by providing accurate and updated data representing Malaysia
14	Marine protection (Target: >= 10% of country's exclussive economic zone protected) Raw = PTT = 29.6 Rank =35	• Currently there are only 143 designated protected areas covering only 15382.954 km2 that translates to a 2.80 % from the 548,800 km2 of Malaysia's EEZ. There is a small discrepancy of 1.6%. • Total area data on designated protected areas are missing from the database. These are Balok Mangrove Forest Reserve (FR), Bebar Mangrove FR, Beserah FR, Cherating Mangrove FR, Kemaman FR, Kampar FR, Kuala Bernam FR, Kuala Sepang FR, Pulau Kechil FR, Pulau Kukup FR, Pulau Tiga FR, Pulau Tongkok FR and Tanjung Tualang FR. • The gazette 42 Marine Parks under Jabatan Taman Laut Semenanjung Malaysia are included in the list. • To achieve a full score, Malaysia needs to update and gazette a further 7% of marine area from the EEZ (54,880 km2). • Future Mitigation Work o Update the data on each repository (MPA) o Examine and increase the accuracy of each data
15	Critical habitat protection (Target: 100% of critical habitats protected) Raw = PTT = 66.67 Rank =21	• Currently, there are only 3 sites identified by AZE as refuge for endangered species • Malaysia scored 66.67% and ranked 21 where one designated site is considered not protected. • The site designated as Klang is actually near Kuala Berang,Terengganu (Longitude 103º E : Latitude 5º N) • Future Mitigation Work o Correct the erroneous Klang data. o Examine the accuracy and status of each site and update with AZE
16	Forest Cover Change (Target: no decline in forest cover) Raw = PTT = 78.2	• This indicator is purely based on changes in forest cover between 2000 and 2005. • Therefore a country that has only small percentage of forest

No.	Indicator	Summary of Findings
	Rank =115	cover may score 100% if there is no further reduction in its forest area. • Malaysian position is expected to be unchanged in the near future because deforestation especially forest conversion to plantation is taking place. • A large track of forest conversion is still taking place in Sarawak.
17	Growing Stock change (Target: ratio of growing stock in time2 to time1 >=1) Raw = PTT = Rank =	• The Malaysian rank under this category is good with 100% score together with other 86 countries • The position is expected to remain good in the future as Forest Growth data is independent from forest cover changes.
18	Marine trophic index (Target: no decline) Raw = PTT = Rank =	• Fisheries data are available from the Department of Fisheries Malaysia (DOF) • Trophic level data is still not available by DOF. • The calculation and estimation carried out (using DOF data) has a raw value of 0.0048 which is similar to the data calculated by EPI
19	Trawling intensity (Target: 0% of exclusive economic zone traweled) Raw = PTT = 5.7 Rank =112	• Data are available from Department of Fisheries Malaysia (DOF) • Data is only available for licensed fishing vessels. • However it is expected that there are also unlicensed fishing boats using trawl nets. • Landings of marine fish by trawl nets in Malaysia for year 2008 is 705, 644 tonnes. This is 50% of the total landings of fish in Malaysian water. • The highest percentage of landings is recorded in Perak at 125, 509 tonnes whereas in Melaka and Negeri Sembilan there was no landings recorded.
20	Agricultural water intensity (Target: <= 10% of all water resources) Raw = PTT = 100 Rank =	• Although Malaysia scored 100%, the data released by AQUASTAT seems to have an error. • The value for 'Total Water Resource' is recorded as 580 bcm whereas the actual value is supposed to be 630 bcm. • The score should be 0.8889 (still having full marks but with better i.e lower agricultural water withdrawl percentage).
21	Agricultural subsidies (Target: 0 subsidies) Raw = PTT = 90.9 Rank =60	• No concrete results can be retrieved from the reference given. • Discussion with CIESIN, Columbia University is still in progress
22	Pesticide regulation (Target: 22 points) Raw = PTT = Rank =	• The score for Malaysia in this category was 20 out of 22 points (90.9%) for this indicator (less two points since Malaysia did not enter as Signatories in the Rotterdam Convention). • Similarly, in this section, the total marks that should be obtained by Malaysia should be 21 (95.45) instead of 20 since

No.	Indicator	Summary of Findings
		Malaysia entered as 'Party' for the Rotterdam Convention (which gives Malaysia one point).
23	Greenhouse gas emissions per capita (Target: 2.5 Mt CO2 eq. (Estimated value associated with 50% reduction in global GHG emissions by 2050, against 1990 levels)) Raw = PTT = Rank =	• The most comprehensive and available data set for greenhouse gases emission in Malaysia is in 2004 • It is the closer year in comparing to year 2005 in global EPI. • Data source: DOE and Malaysia Green Tech Cooperation • The data serve as the input for calculating **Greenhouse Gases Emission per Capital (GHGCAP)** in Malaysia
24	Industrial greenhouse gas emissions intensity (Target: 36.3 tons of CO2 Equivalent per $mill (USD, 2005, PPP) of industrial GDP (Estimated value associated with 50% reduction in global GHG emissions by 2050, against 1990 levels)) Raw = PTT = 76.6 Rank =81	• data are collected from Malaysia Green Tech Cooperation, DOE, World Bank and Department of Statistic Malaysia • serve as the input for calculating Industrial Greenhouse Gas Emission Intensity (GHGIND) in Malaysia • The Industrial Greenhouse Gas Emission Intensity (GHGIND) for Malaysian is much higher than the prediction from global EPI . • Justification: available local data is far more comprehensive and details in comparing to EPI raw data
25	CO2 emissions per electricity generation (Target: 0 g CO2 per kWh) Raw = PTT = Rank =	• calculation performed by Malaysia Green Tech Cooperation - 'Study on Grid Connected Electricity Baselines in Malaysia Year: 2006 and 2007' • data sources: EC, Sabah Electricity Supply Board (SESB) and the Sarawak Electricity Supply Corporation (SESCo) • baseline data: 2007 • separate regions for Peninsular Malaysia, Sabah and Sarawak because their main grid is not interconnected with one other. • the CO_2 emission per kWh electricity generation is higher than the Global EPI projection • The difference could be due to different sample selection of power generation plants

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