# Environmental Performance Indicators

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UN CSD
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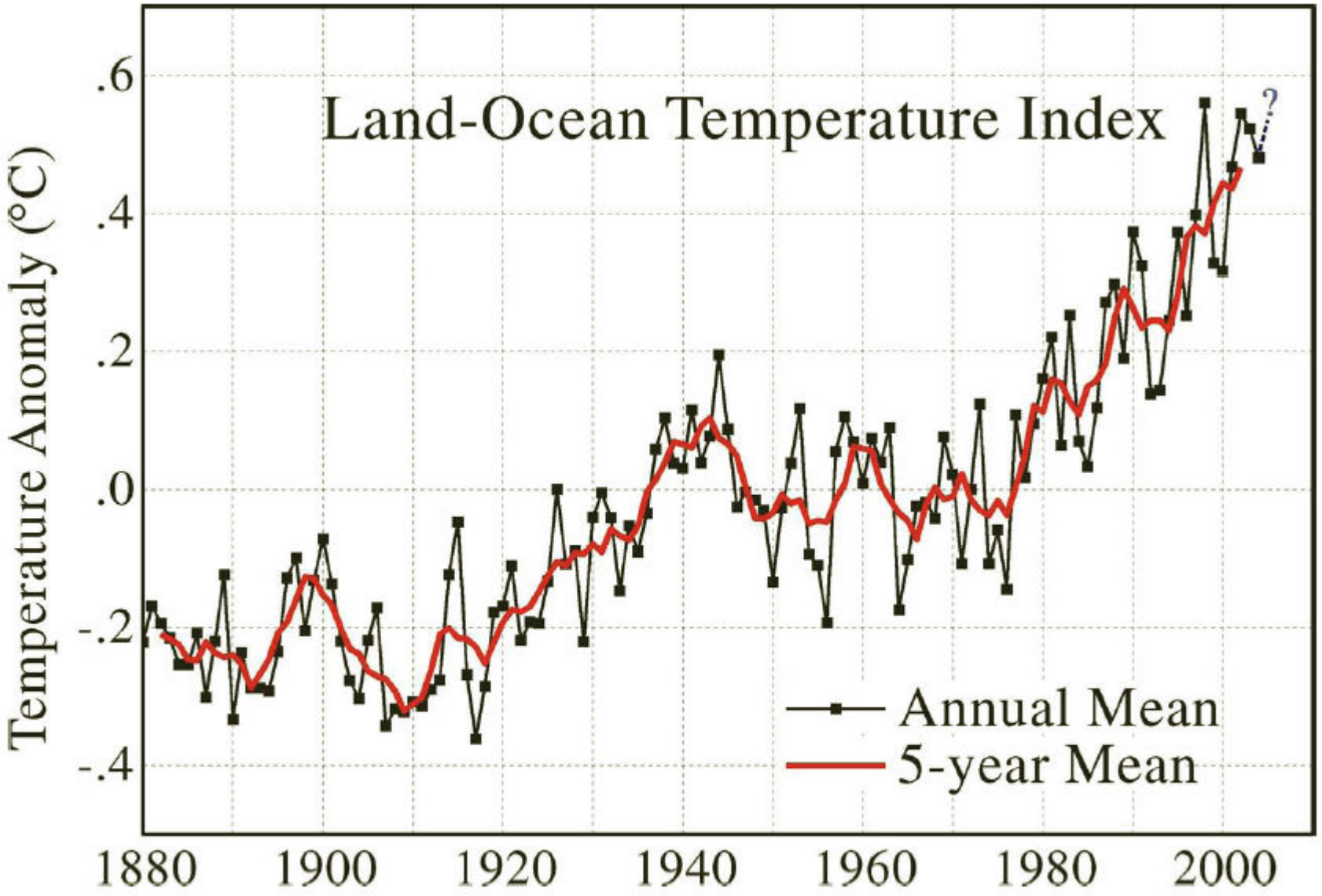
# Indicators serve multiple purposes

- **Describe**
  - Reduce complexity in policy-relevant ways
  - Not necessarily tied to any policy target
  - Answer the question “What’s happening”?




Global mean surface temperature change based on surface air measurements over land and SSTs over ocean

*Source:* Update of Hansen et al., *JGR,* **106**, 23947, 2001; Reynolds and Smith, *J. Climate,* **7**, 1994; Rayner et al., *JGR,* **108**, 2003.

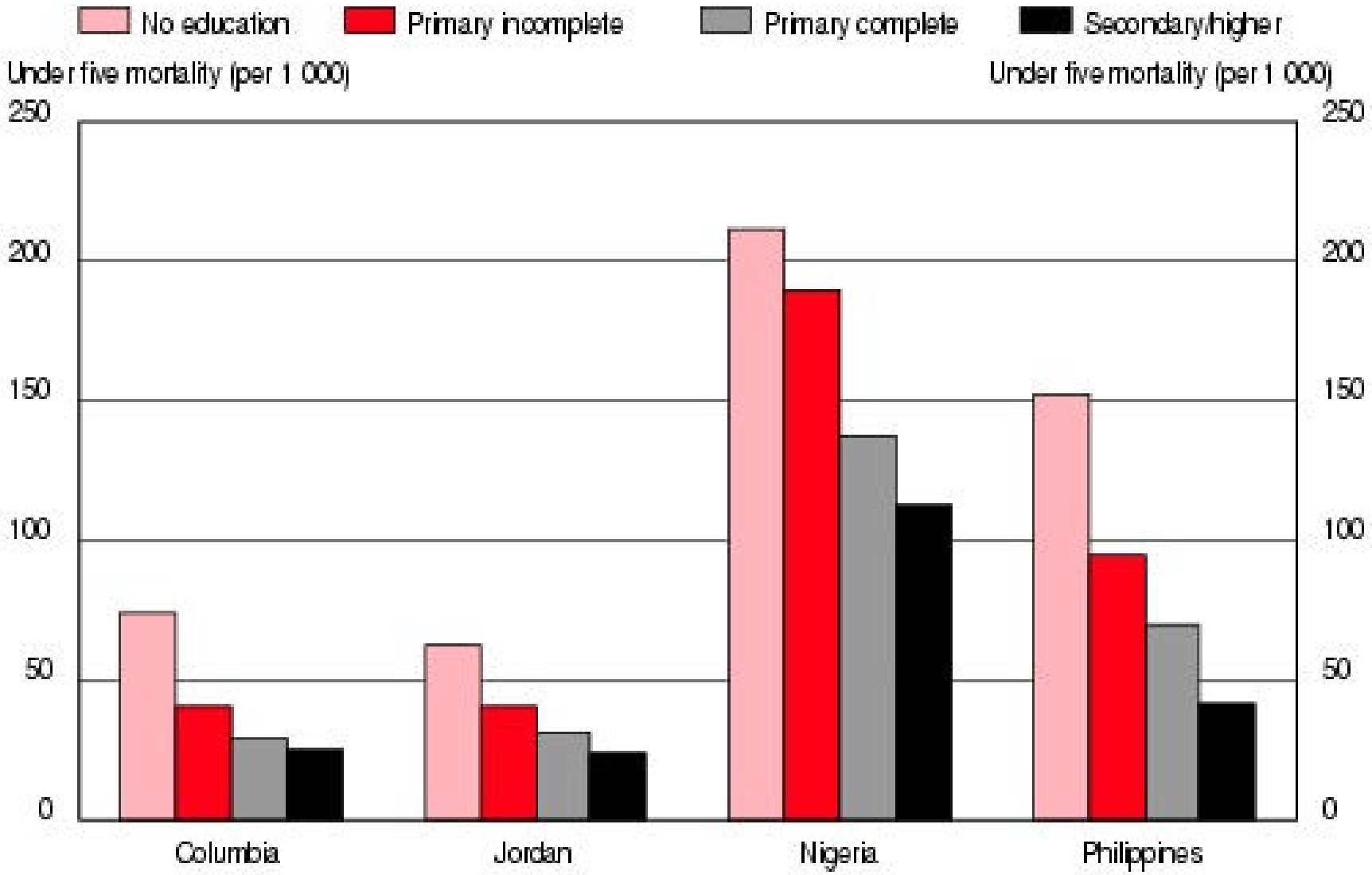
## Indicators serve multiple purposes

- **Diagnose**
  - Indicators make it possible to explore relationships between different phenomena, to explore competing trends, and to dig into anomalies

| Subject | Grade |
|---|---|
| Math | F |
| Language Arts | A+ |
| Social Studies | A+ |
| History | A+ |

# Educating girls save lives

Under-five mortality rates by mother's level of education, 1990-1994

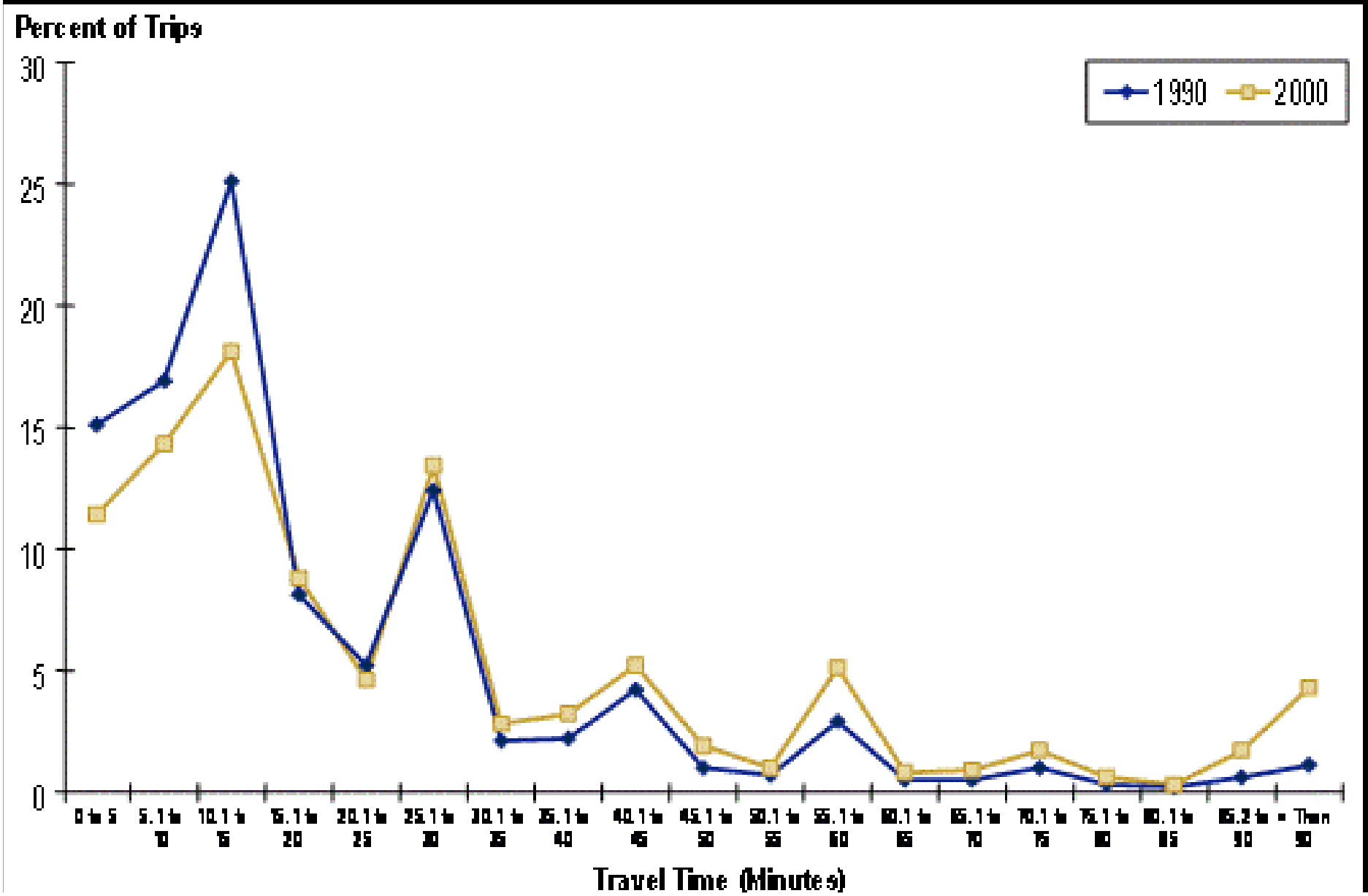


## Indicators serve multiple purposes

- **Deliberate**
  - Indicators help societies and decision-makers engage in dialogue about what kind of future they want to have.
  - They help ground discussion in empirical reality.
  - They set up goal posts whose desired positions can be debated.

| Subject | Grade |
|---|---|
| Math | B |
| Language Arts | B |
| Social Studies | B |
| History | B |

# Commuting time in San Francisco area



Indicators serve multiple purposes

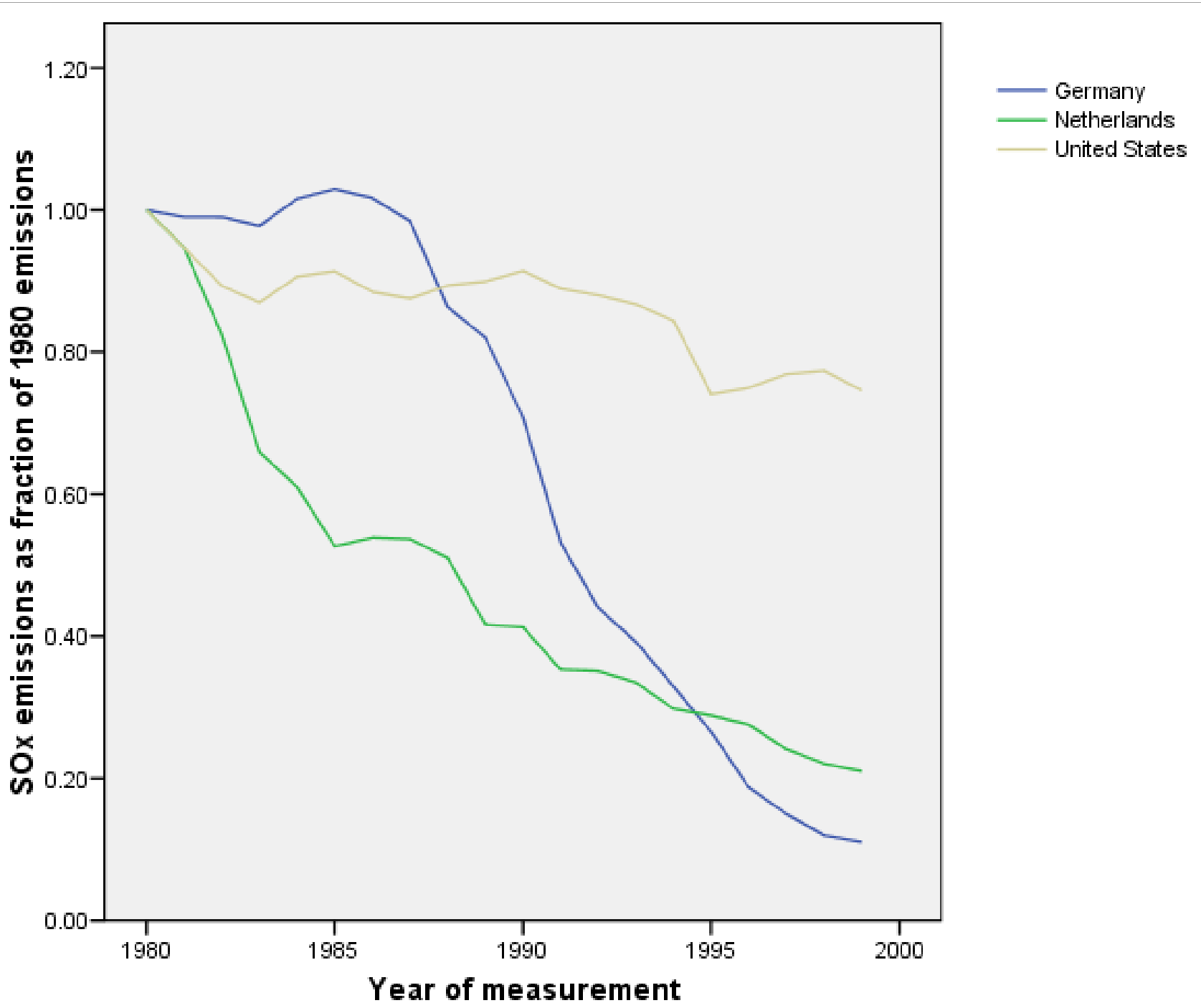
- **Drive** action
  - When you know where you want to go, indicators can help you navigate there
  - Hold decision-makers accountable
  - Reward progress and punish inaction

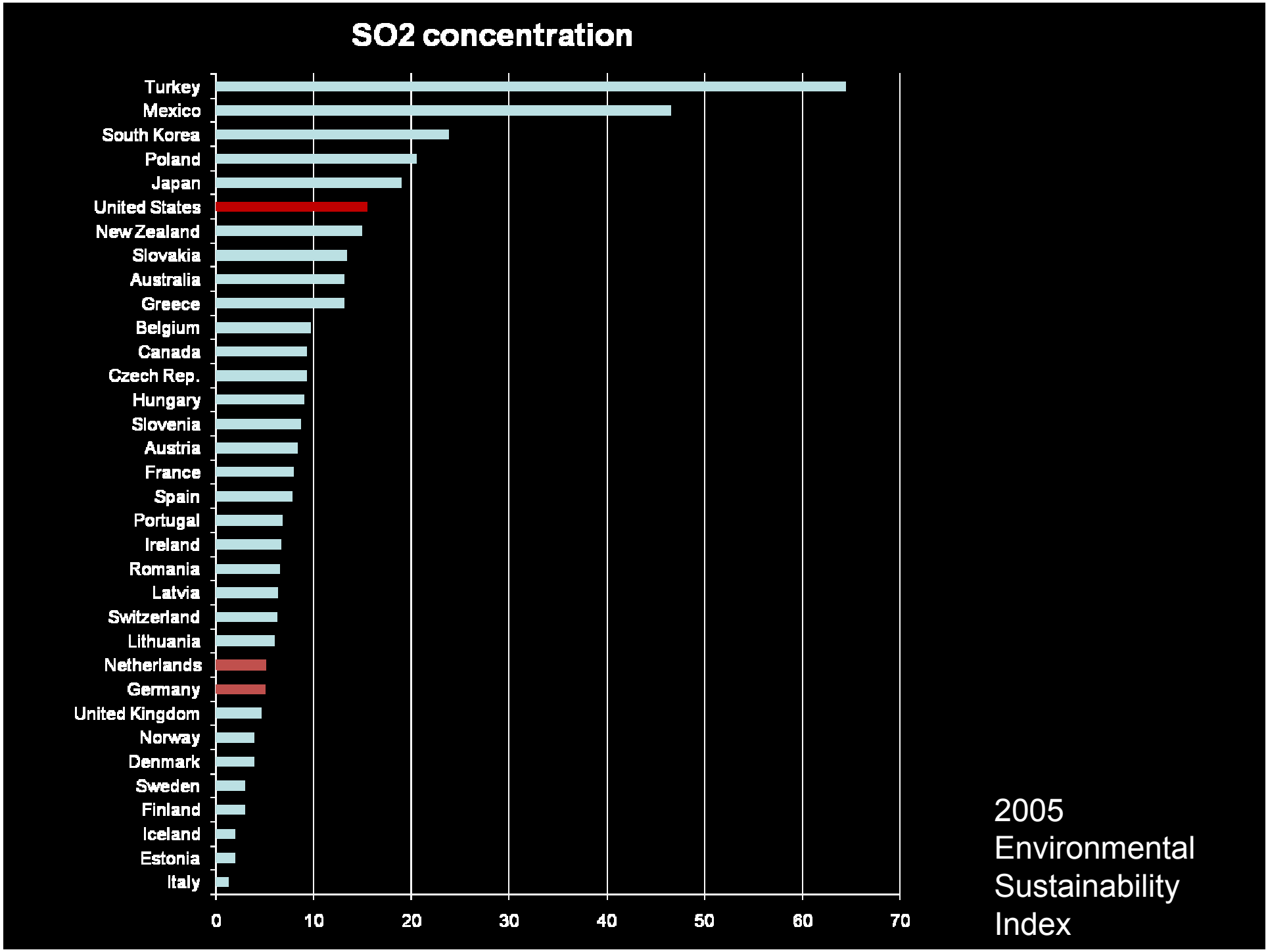
Indicators serve multiple purposes

- **Discover** patterns you didn't know where there
  - Who are the leaders and laggards?
  - What are the best and worst practices?

**C- Average**

**B+ Average**


SOx emissions as fraction of 1980 emissions
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1980
1985
1990
1995
2000
Year of measurement
Germany
Netherlands
United States


SO2 concentration
Turkey
Mexico
South Korea
Poland
Japan
United States
New Zealand
Slovakia
Australia
Greece
Belgium
Canada
Czech Rep.
Hungary
Slovenia
Austria
France
Spain
Portugal
Ireland
Romania
Latvia
Switzerland
Lithuania
Netherlands
Germany
United Kingdom
Norway
Denmark
Sweden
Finland
Iceland
Estonia
Italy
0
10
20
30
40
50
60
70
2005
Environmental
Sustainability
Index

# *What is the conceptual basis for the measure?*

- Performance / Distance-to-target
- Comparative
- National unit of analysis
- Hierarchical
- Multi-dimensional
- Aggregative

"How'm I doin'?"

# Lessons Learned from Environmental Performance Index

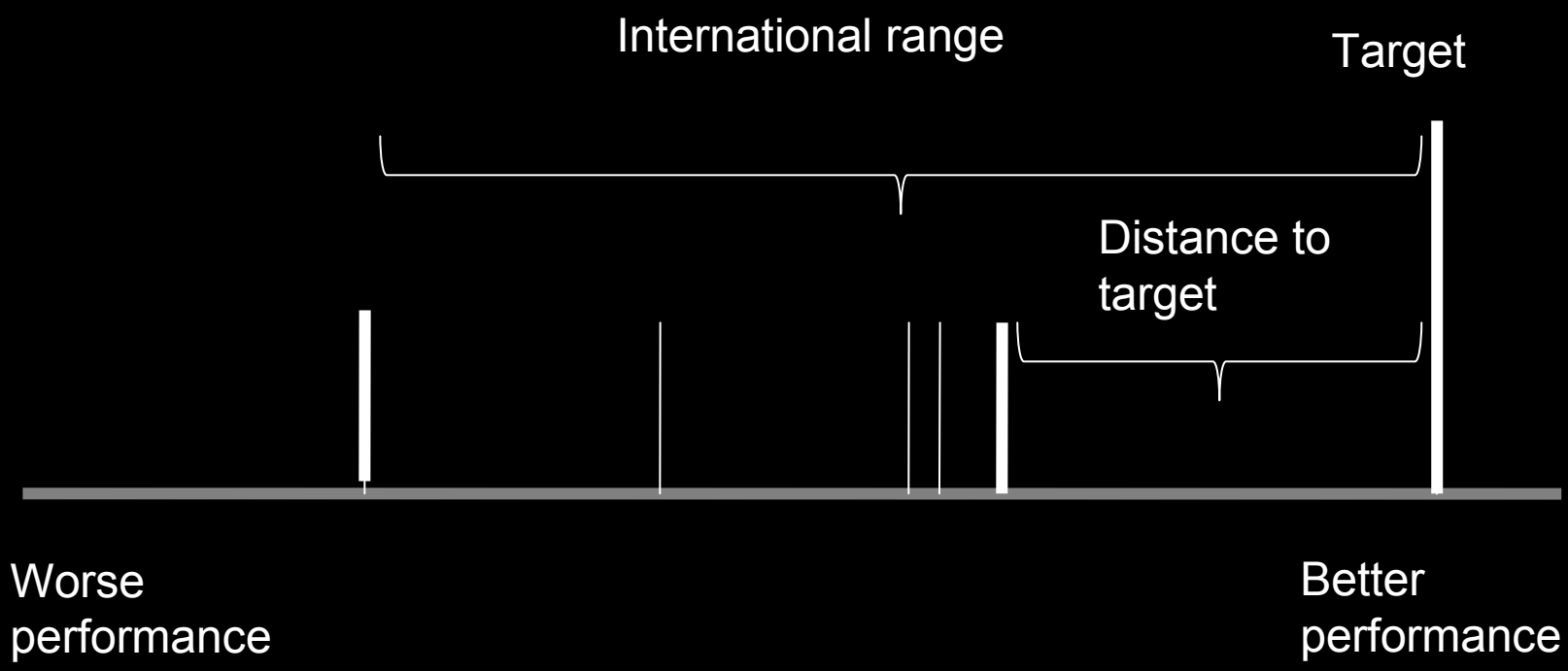
WORLD ECONOMIC FORUM

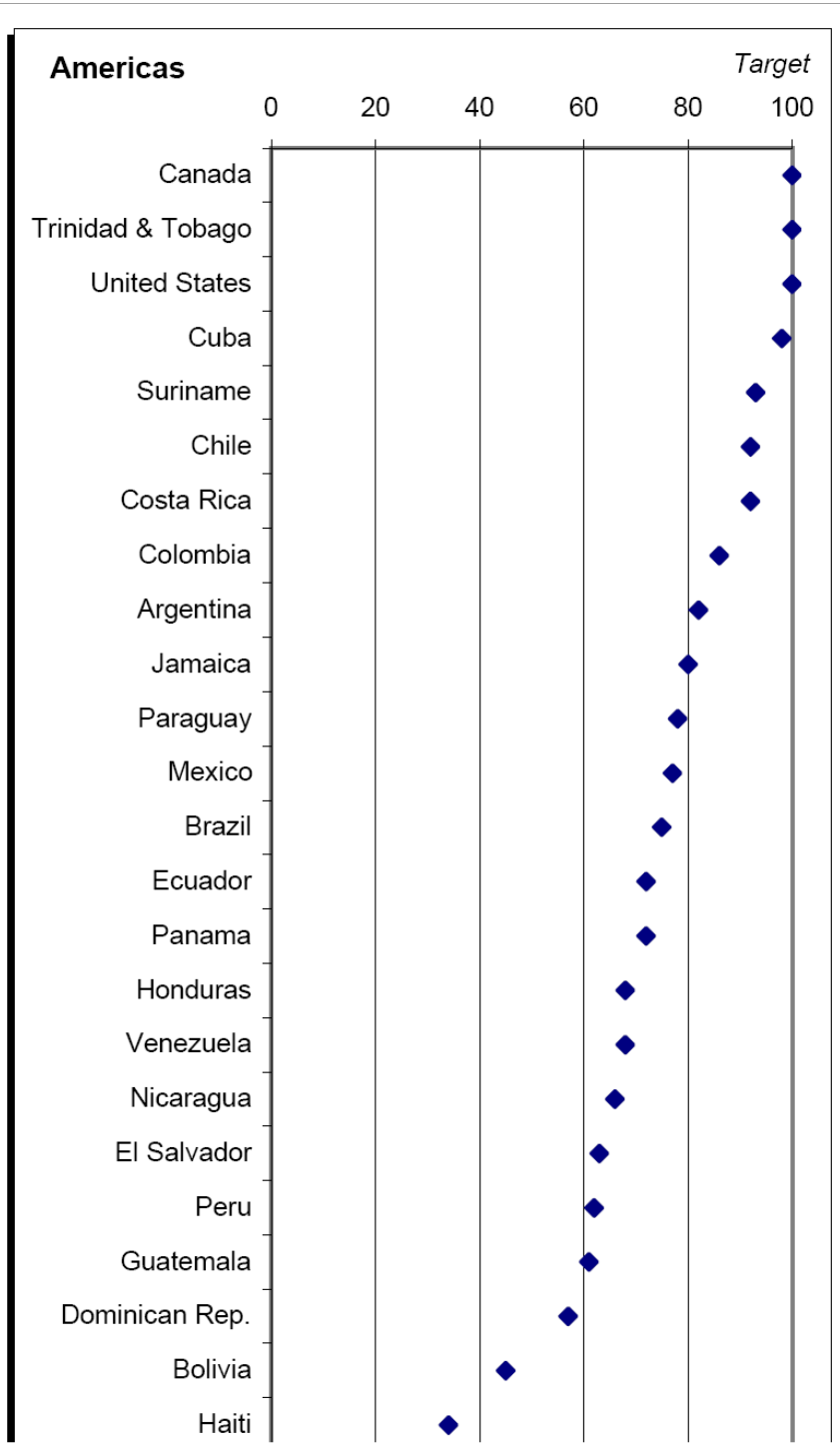
CIESIN
Columbia University

EUROPEAN COMMISSION
DG Joint Research Centre

YALE CENTER for
ENVIRONMENTAL LAW & POLICY

# Country scores are a function of distance to the target and the international range

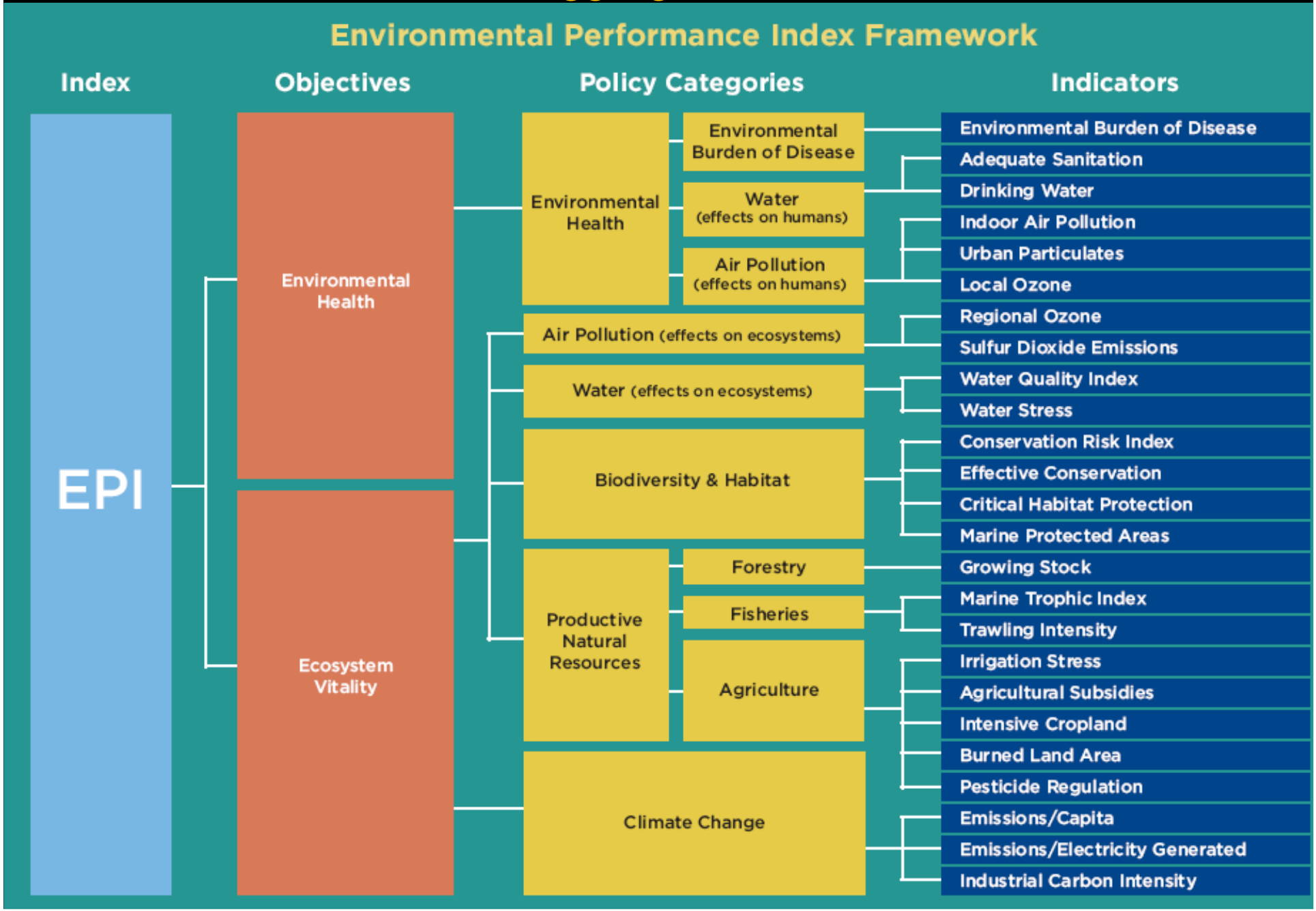





# Access to sanitation

# EPI is built on nested aggregations

2008 EPI



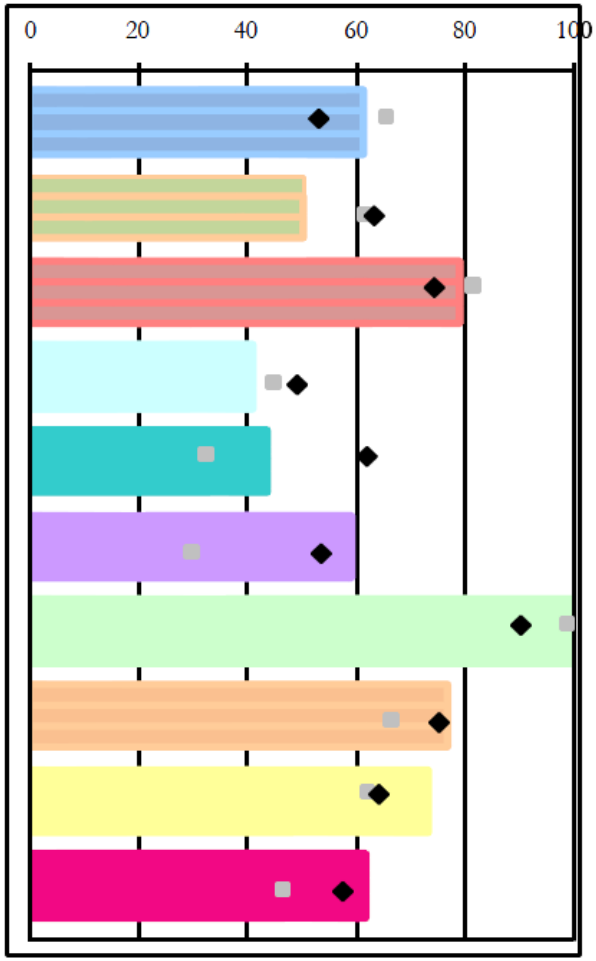
# Egypt 2010 EPI

REGION: MIDDLE EAST AND NORTH AFRICA

GDP/capita 2007 est. (PPP) $4,762
Income Decile 6 (1=high, 10=low)

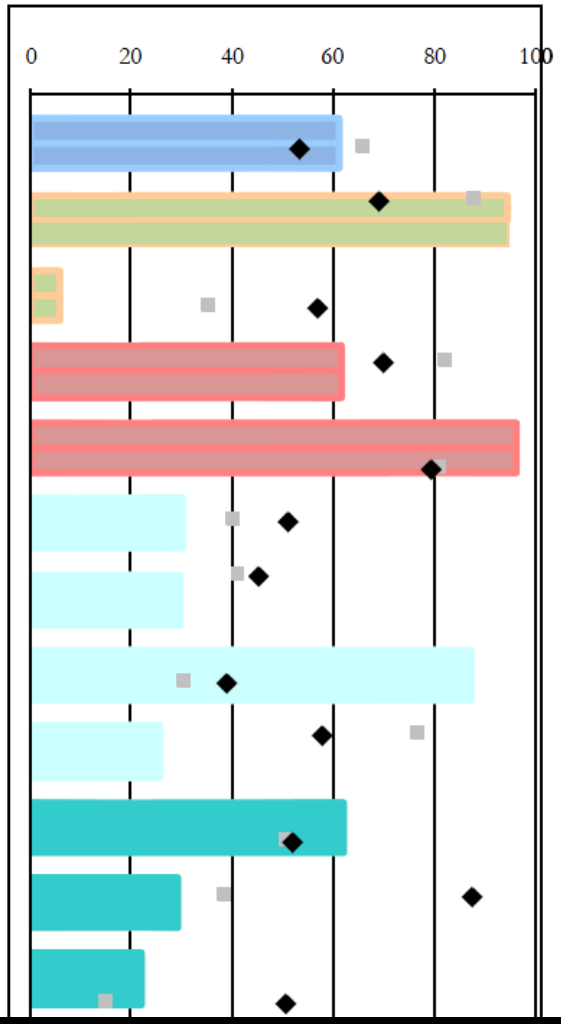
| | |
|---|---|
| **Rank:** | **68** |
| **Score:** | **62.0** |
| Income Group Average: | 58.7 |
| Geographic Group Average: | 54.1 |

## Policy Categories




| | Country | Income Group | Geographic Group |
|---|---|---|---|
| Environmental Burden of Disease (DALYs) | 61.32 | 53.3 | 66.0 |
| Air Pollution (impact on humans) | 50.3 | 63.4 | 62.0 |
| Water (impact on humans) * | 79.2 | 74.5 | 82.0 |
| Air Pollution (impact on ecosystem) | 41.0 | 49.0 | 45.1 |
| Water (impact on ecosystem) * | 43.9 | 61.9 | 32.5 |
| Biodiversity | 59.2 | 53.7 | 30.0 |
| Forestry | 100.0 | 90.4 | 98.9 |
| Fisheries | 76.8 | 75.4 | 67.0 |
| Agriculture | 73.5 | 64.3 | 62.32 |
| Climate Change * | 62.1 | 57.3 | 47.1 |

# Indicators, page 1 of 2




| | Value | Target | *Proximity to Target (100=target met)* |
|---|---|---|---|
| DALY: Environmental Burden of Disease (DALY) | 33.0 | *0* | 61.3 |
| INDOOR: Indoor air pollution (%) | 5.0 | *0* | 94.7 |
| OUTDOOR: Outdoor air pollution (µg/m$^3$) | 119.2 | *20* | 5.9 |
| ACSAT: Access to sanitation (%)* | 66.0 | *100* | 61.84 |
| WATSUP: Access to water (%) | 98.0 | *100* | 96.6 |
| SO2: Sulfur dioxide emissions (Gg/1000 sq km) | 8.3 | *<= 0.01* | 30.1 |
| NOX: Nitrogen oxides emissions (Gg/1000 sq km) | 7.8 | *<= 0.01* | 29.8 |
| NMVOC: Non-methane volatile organic compound emissions (Gg/1000 sq km) | 8.5 | *<= 0.01* | 25.7 |
| OZONE: Ecosystem ozone (ppb) | 0.0 | *0* | 100.0 |
| WQI: Water quality index * | 62.4 | *100* | 62.4 |
| WATSTR: Water stress index | 25.5 | *0* | 21.9 |
| WSI: Water scarcity index | 0.52 | *0* | 29.15 |

# *What are the methods by which data are acquired and aggregated to produce the measure?*

- Expert working groups make recommendations
- Utilize range of data sources
  - International organizations
  - Established international scientific institutes
  - Individual university / think-tank groups
  - Internal development
- Transform input data to generate cross-issue, cross-national, cross-time comparative indicators
  - Denominators, distribution-transformations, outliers, GIS aggregations

# *Strengths*

- Capable of capturing broad range of what matters most for sustainability challenges
  - Resilient against issue heterogeneity
- Gets attention
- Has something to offer once the wake-up call is received
  - Diagnostic tools to dig beneath the surface of the headlines
- Nobody gets off the hook.
  - Top performers in the aggregate are bad at something.
- Framework is adaptable to new circumstances

# *Weaknesses*

- Vulnerable to bad data
  - Small fraction of indicators are stable over time
  - Hard to make country indicators comparable (denominator problem)
- Vulnerable to weak targets
  - For things that are important but neglected, method is more arbitrary
- Does not directly inform priority-setting across issues (units and weights problem)
- Transnational and global phenomena challenging to ascribe to national performance (e.g. tropospheric ozone concentration)

# *What insights have been revealed by using this measure?*

- International measurement infrastructure is broken. A quarter century post-Brundtland, and our international monitoring system remains patterned on the customs houses and vital statistics registries of the 19th century.
    - The trend is getting worse, not better: dismantling of GEMS Air, divestment of stream gauge networks, killing RAINS-Asia, repeated death threats to GEMS-Water
- The gap between the pace at which international community creates targets and benchmarks, and the pace at which it identifies management challenges, is growing.
    - Environment MDGs as litmus test.
- **Our anxieties are 21st century, our management systems are 19th century.**

# *Insights, continued*

- Performance-oriented measurement is a useful tool
  - It is understandable
  - It fits into established modes of governance
  - It provides a useful entry point into discussions about how to improve outcomes
  - Evidence comes not just from our effort, but conceptually similar efforts: EEA, national exercises in S. Korea, Egypt, China, Mexico, Brazil, aquaculture

# *How has/could have the measure been used to inform decision-making?*

- Largest effects in low-performing off-diagonal countries (those whose scores are not just low but lower than expected)
  - E.g. UAE, S. Korea
  - Prompts diagnostic review, internal targets, management processes, policy change.
- Special case of U.S. Millennium Challenge Corporation
  - Used by MCC to evaluate candidate aid recipients
  - Used by candidate aid recipients to adjust behavior to improve eligibility
  - Four indicators: Child mortality, access water, access sanitation, biome protection.

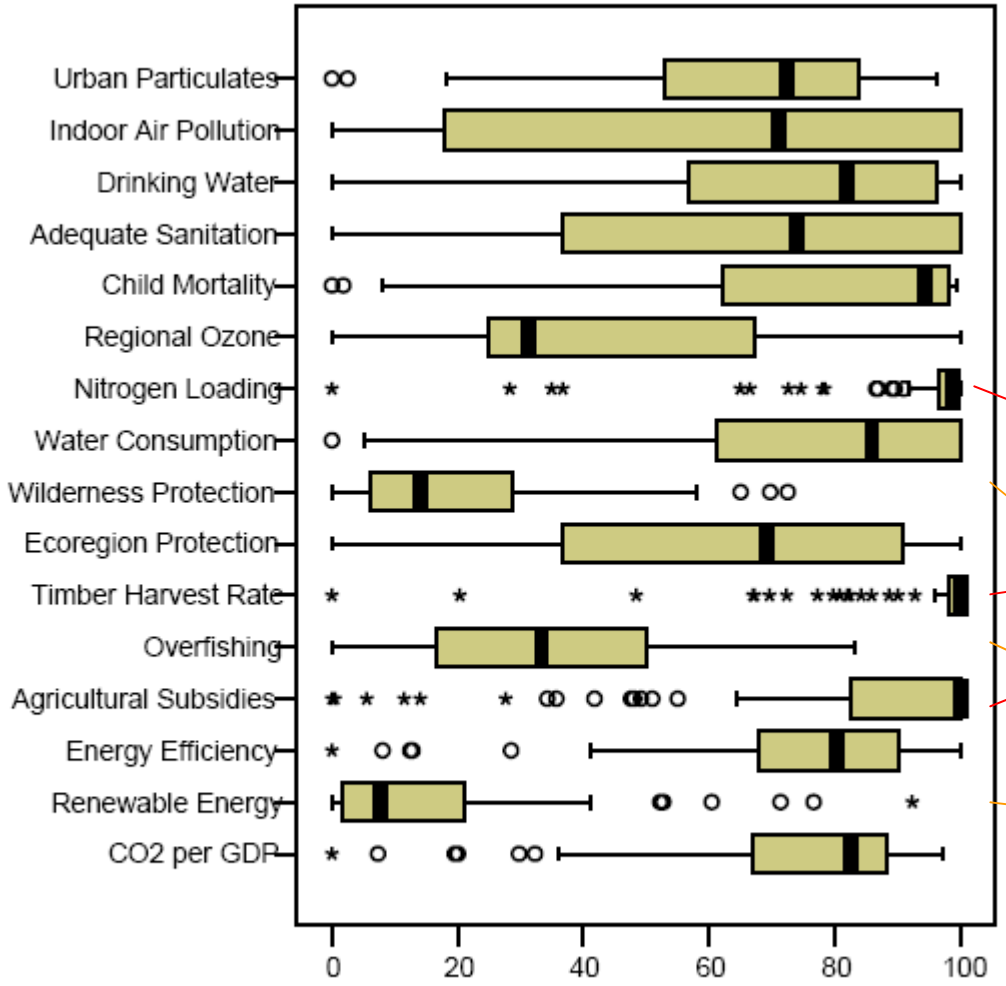


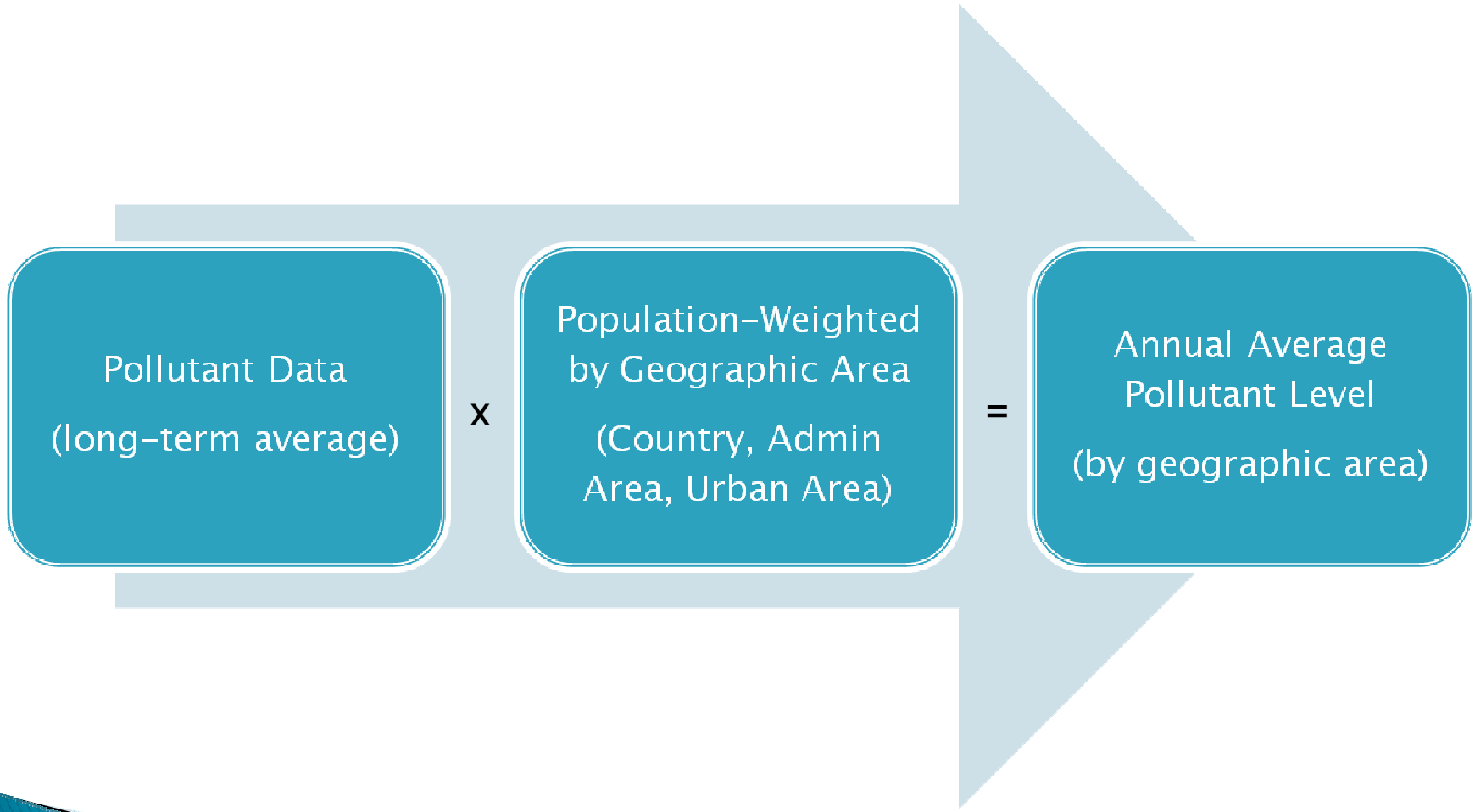

**Figure 15: Distribution of Proximity-to-Target Scores for All Countries**

Most countries near target: Global focus is on outliers

Most countries far from target: Global focus is on consensus building and action plans

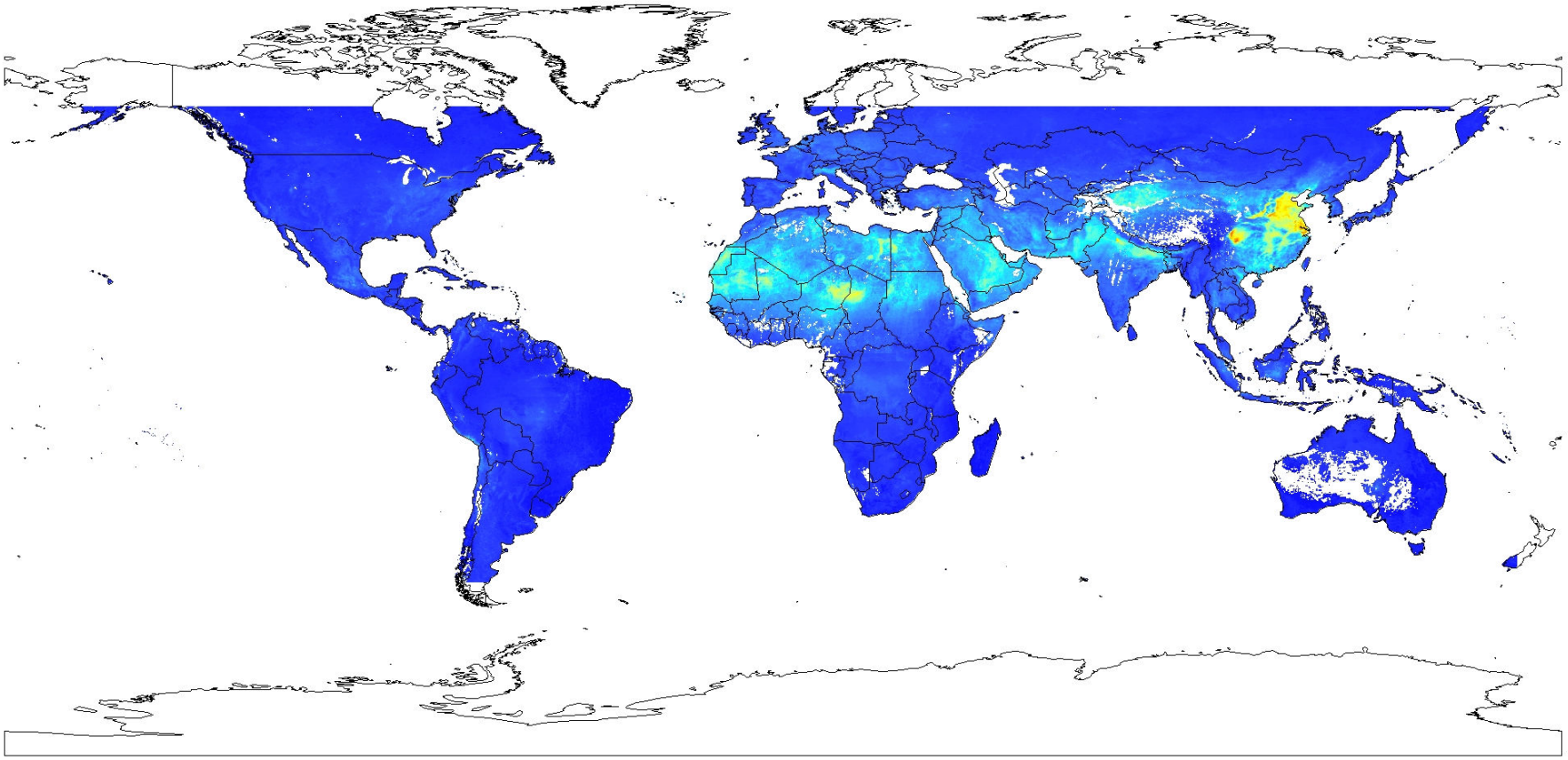
Illustration: using EPI as diagnostic tool for global environmental governance.

# Example of using satellite data to calculate indicators



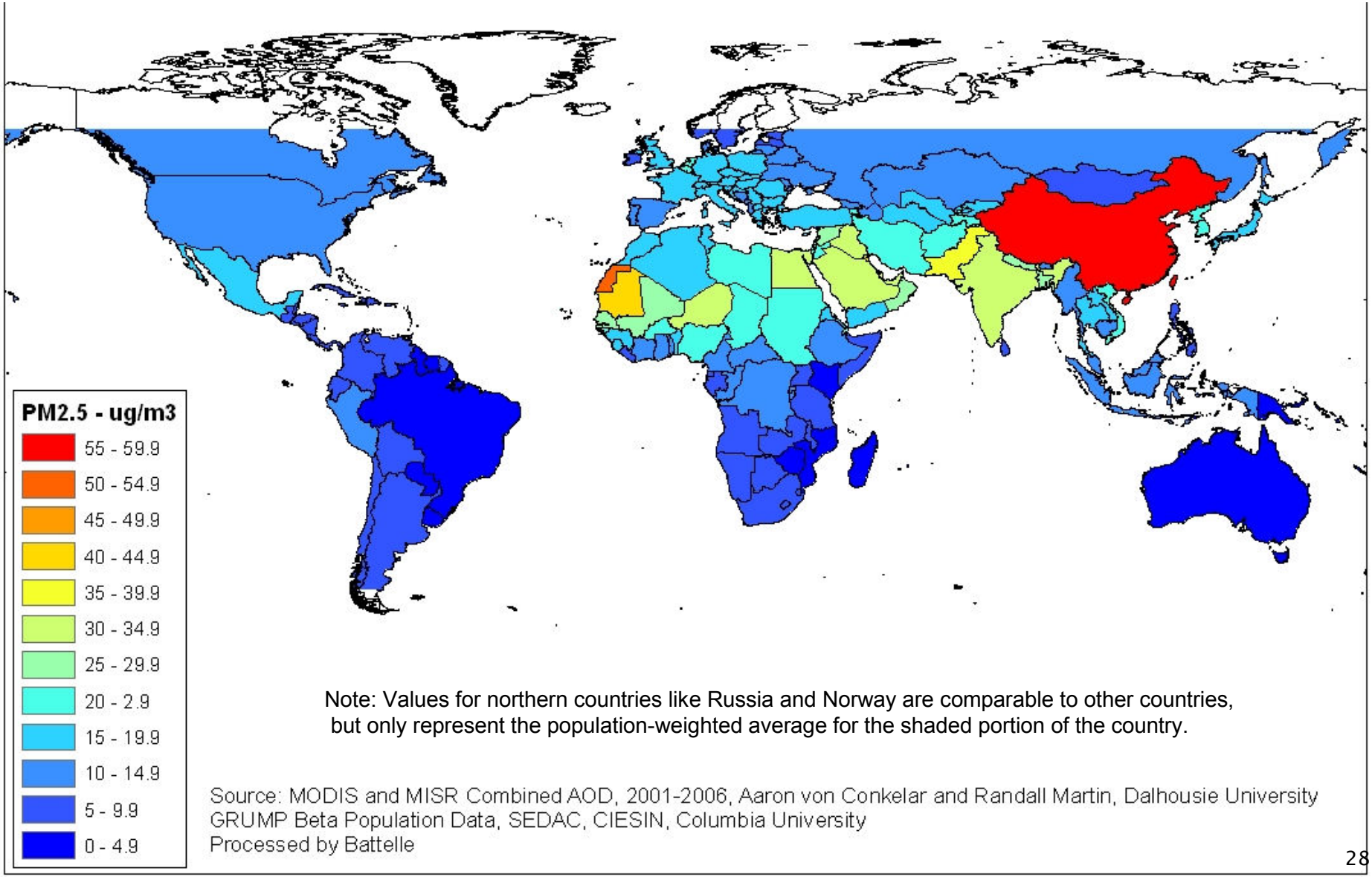
# Annual Average Surface-Level $PM_{2.5}$ (2001-2006)

*derived from MODIS/MISR AOD and GEOS-Chem Model*




Sources:
MODIS and MISR Combined AOD, 2001-2006 from Aaron van Donkelar, Dalhousie University,
GRUMP Beta Population Data, from SEDAC, CIESIN, Columbia University
Processing by Battelle

# Annual Average $PM_{2.5}$ Concentration Population-Weighted by Country

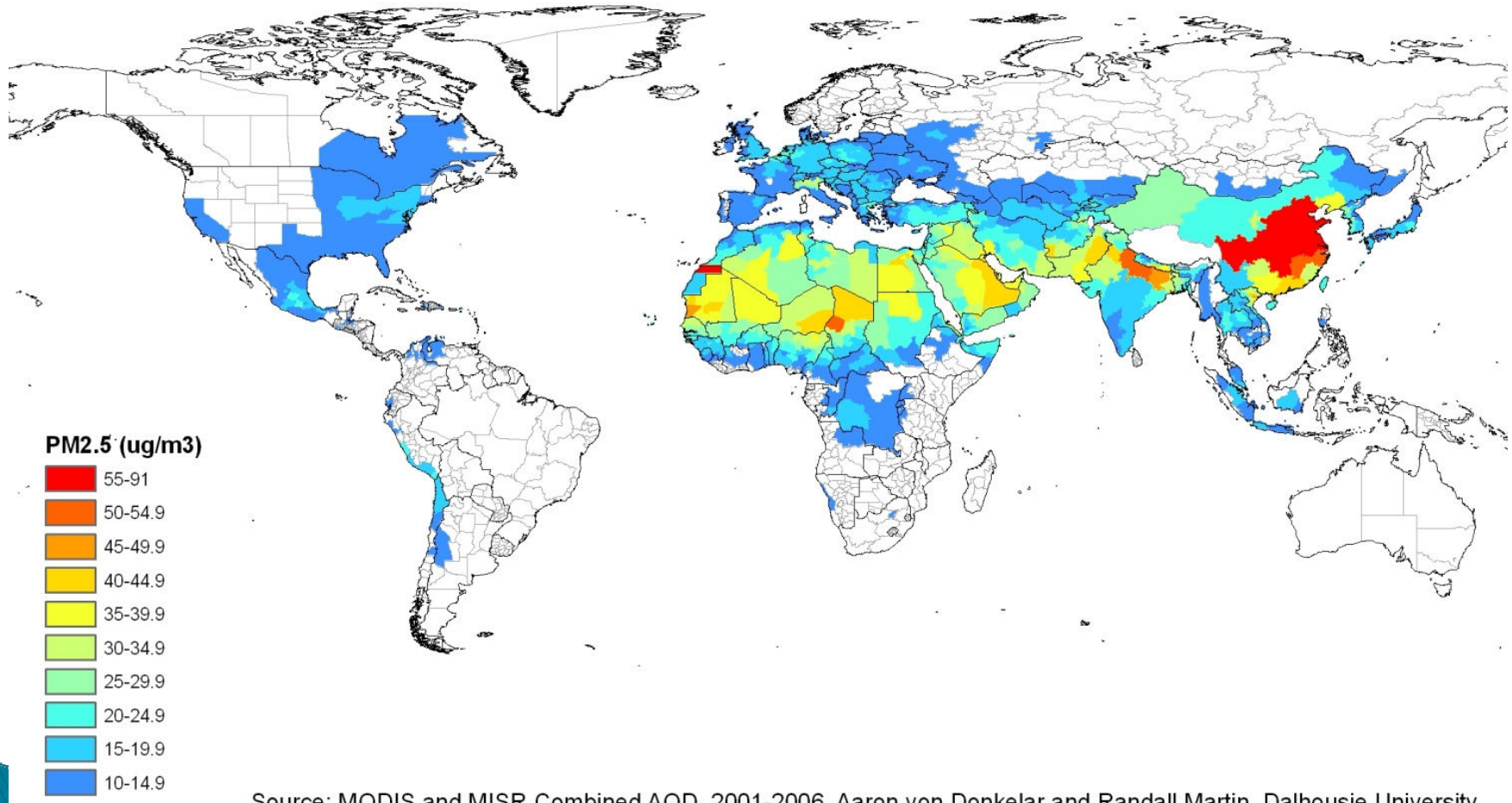



Note: Values for northern countries like Russia and Norway are comparable to other countries, but only represent the population-weighted average for the shaded portion of the country.

Source: MODIS and MISR Combined AOD, 2001-2006, Aaron von Conkelar and Randall Martin, Dalhousie University
GRUMP Beta Population Data, SEDAC, CIESIN, Columbia University
Processed by Battelle

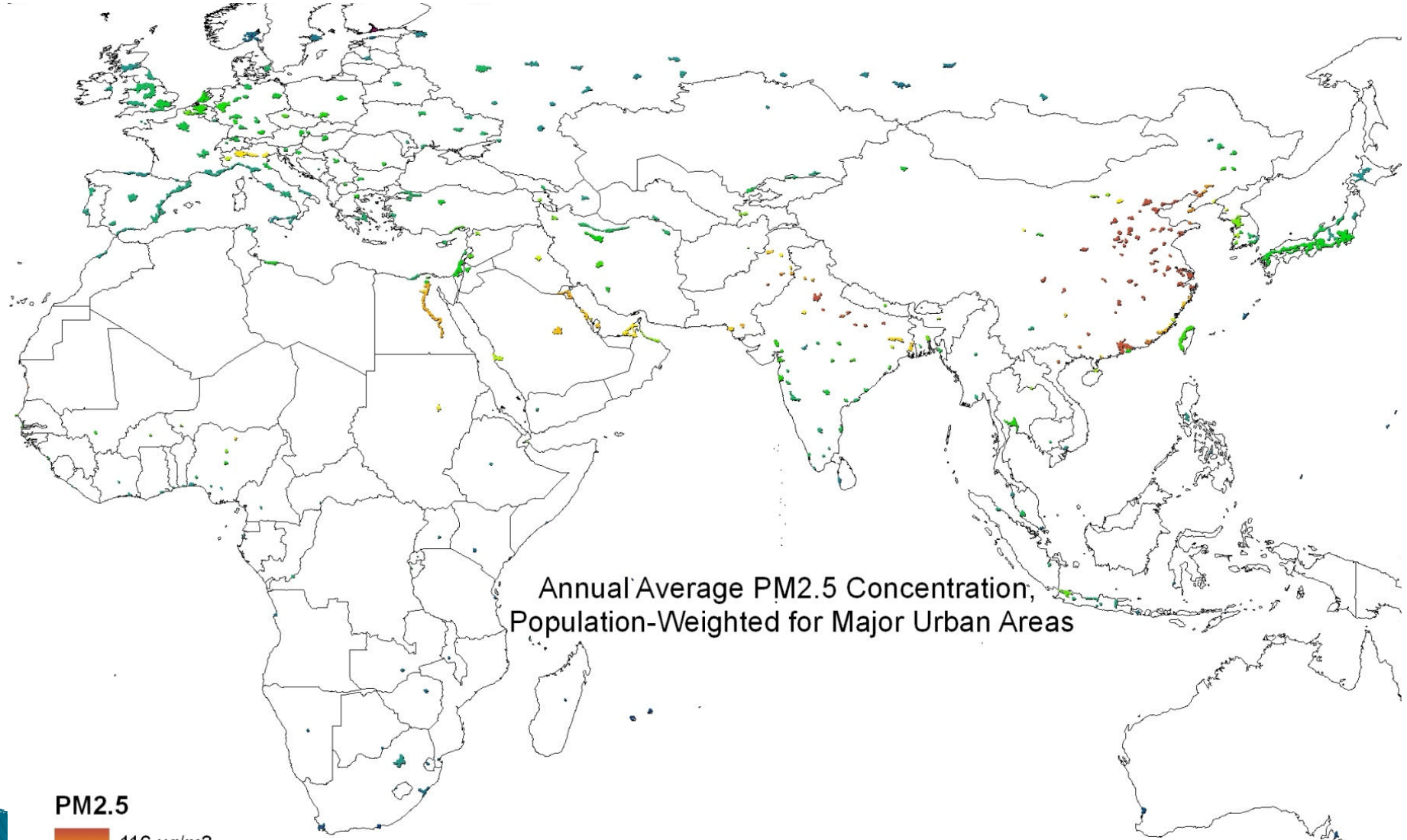
# Annual Average $PM_{2.5}$ Concentration Population-Weighted by Administrative Area

*excluding areas below WHO guideline of 10 µg/m³*



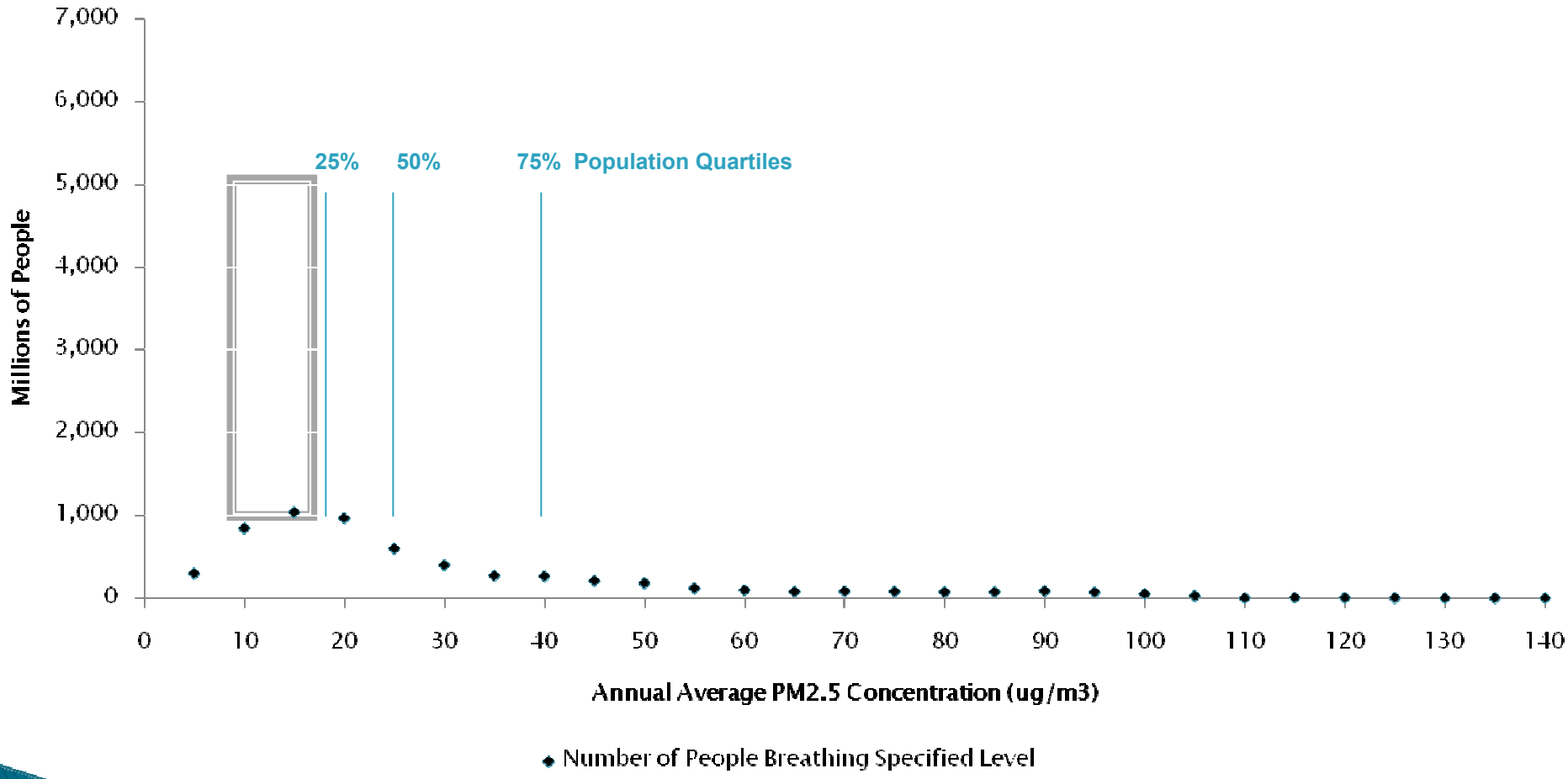

Source: MODIS and MISR Combined AOD, 2001-2006, Aaron von Donkelar and Randall Martin, Dalhousie University
GRUMP Beta Population Data, SEDAC, CIESIN, Columbia University
Processed by Battelle

# Major Urban Area Analysis




Source: MODIS and MISR Combined AOD, 2001-2006, Aaron von Donkelar and Randall Martin, Dalhousie University
GRUMP Beta Population Data, SEDAC, CIESIN, Columbia University
Processed by Battelle

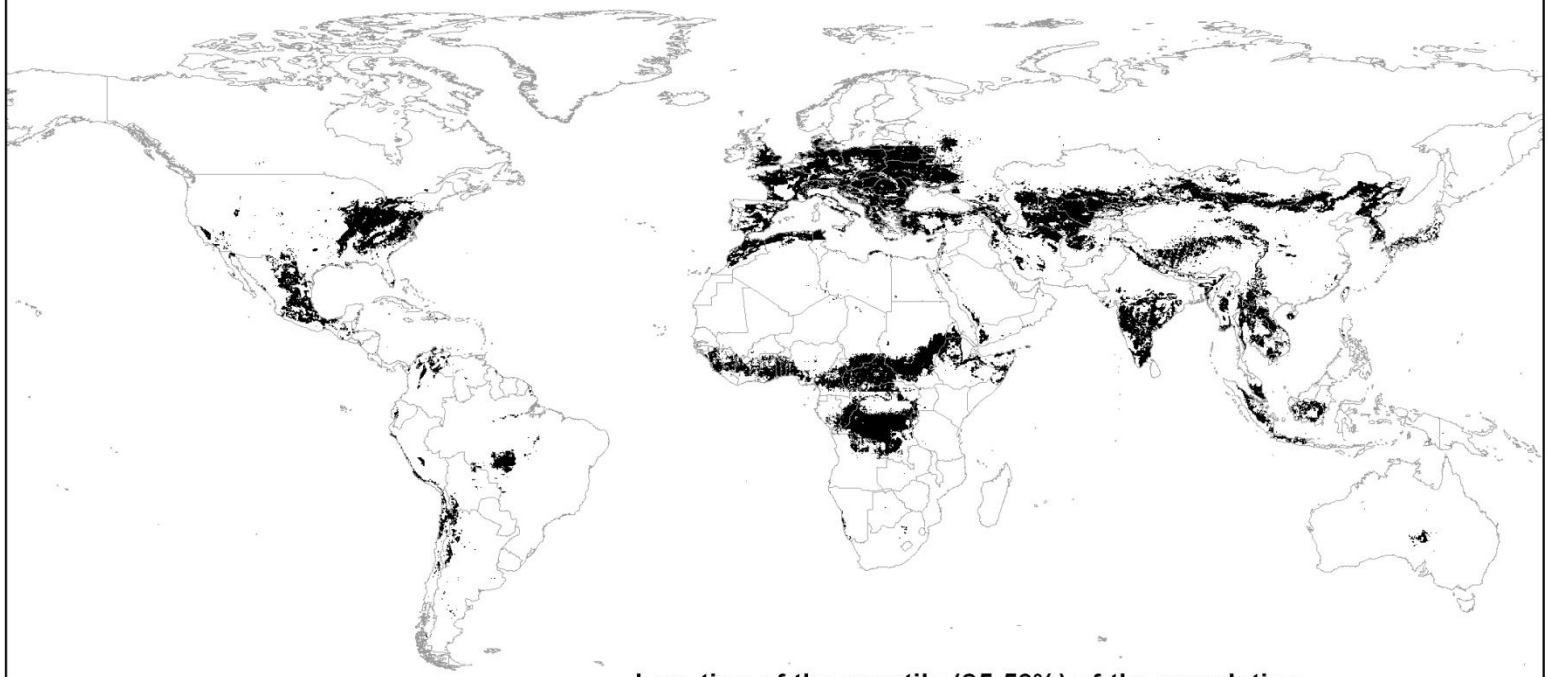
# Distribution of World Population According to Annual Average $PM_{2.5}$ Concentration



# Exposed Populations

3rd Most Exposed Quartile of Population
(Annual Average PM2.5 Levels of 11-19 ug/m3)

***WHO Guideline is 10 ug/m3 of PM2.5 (Annual Average)**



**Location of the quartile (25-50%) of the population breathing 11-19 ug/m3 of PM2.5**

Source: MODIS and MISR Combined AOD, 2001-2006, Aaron von Donkelar and Randall Martin, Dalhousie University
GRUMP Beta Population Data, SEDAC, CIESIN, Columbia University
Processed by Battelle

# Where next?

| Objectives of Environmental Indicators |
| --- |
| Describe |
| Diagnose |
| Deliberate |
| Drive Action |
| Discover Patterns |

**1980s Conceptual discussion**
**1990s Menus of indicators**
**2000s Experiments with operational systems**
**2010s Time to evaluate the experiments and make choices**

Bono and Jesse Helms discuss poverty and health MDGs, 2005

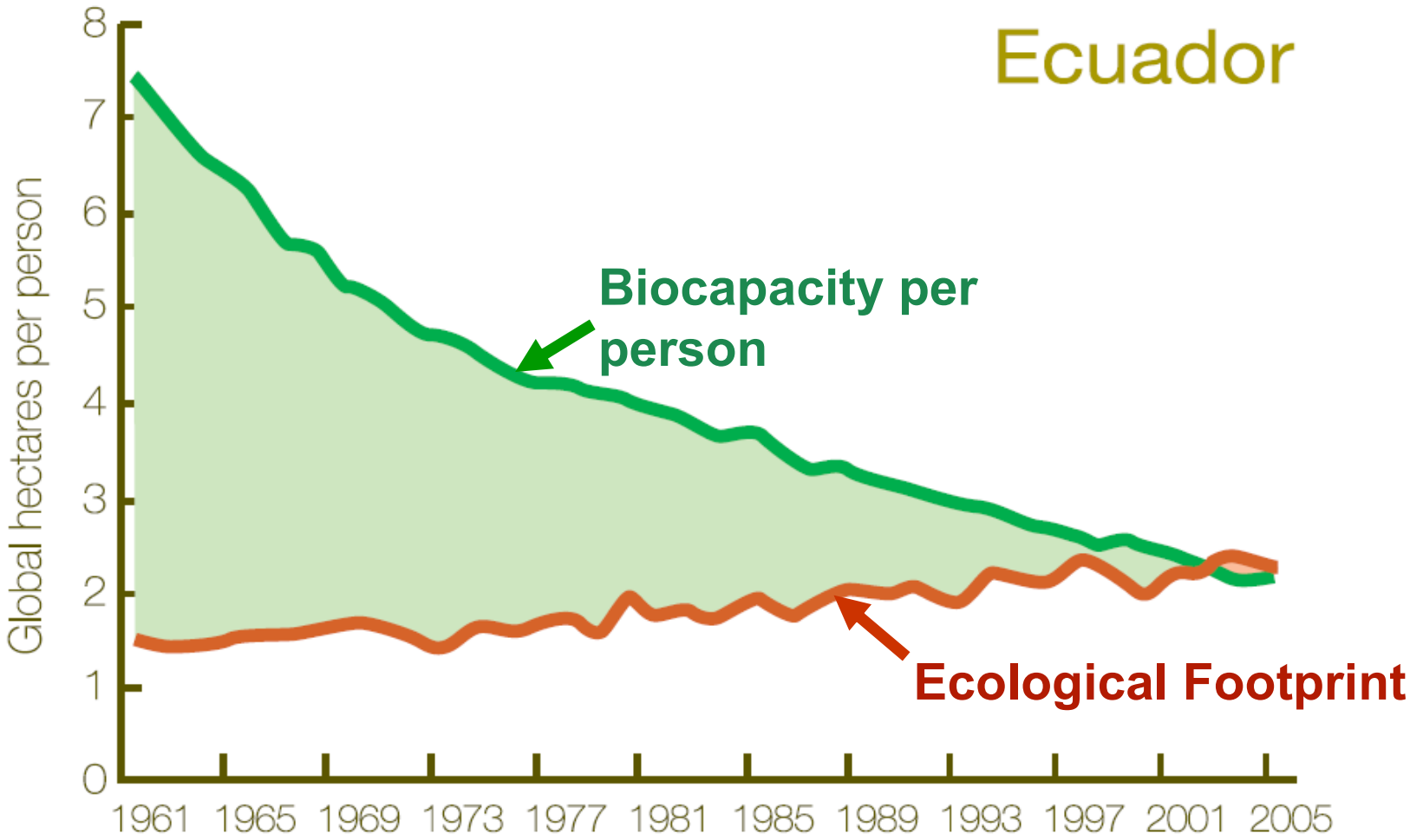

Hans Rosling evangelizes with poverty, health and education indicators

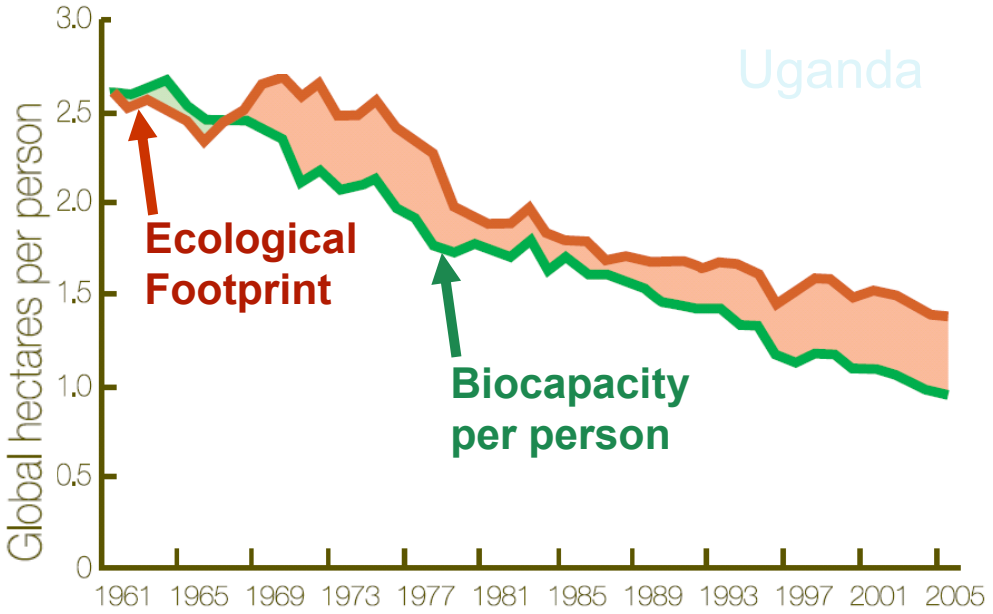
**What makes these pictures possible?**

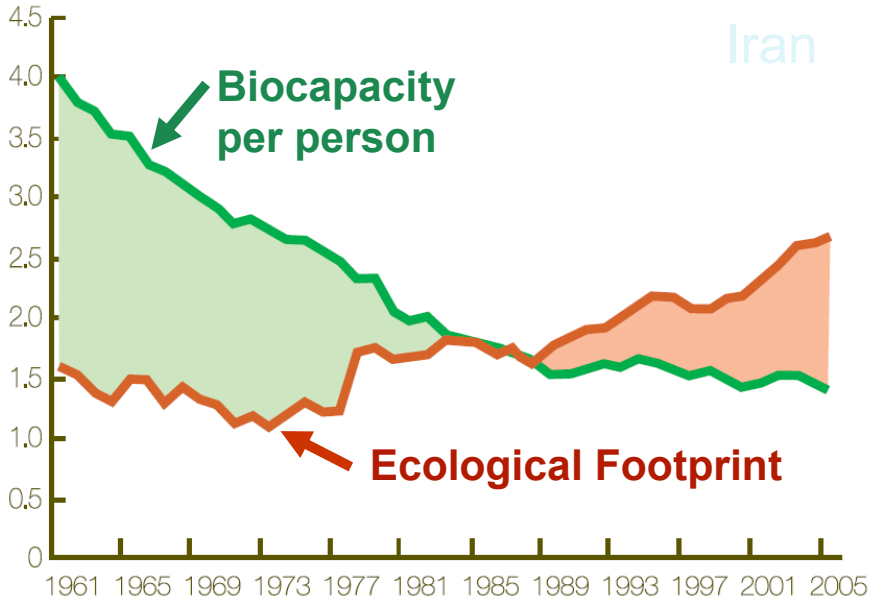
Clarity of vision
Specificity of actions
Intelligibility of benefits

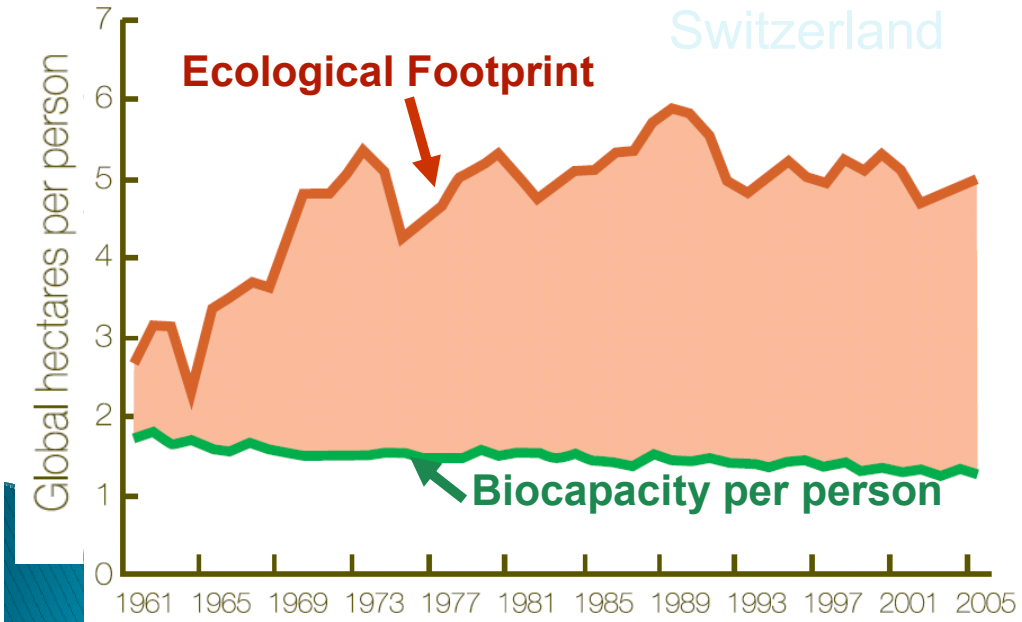
Operational monitoring programs
Measurement standards
Reporting platforms that work

One effort in this direction






The **Ecological Footprint** and **biocapacity** (per capita) of three countries from 1961-2005. A country runs an

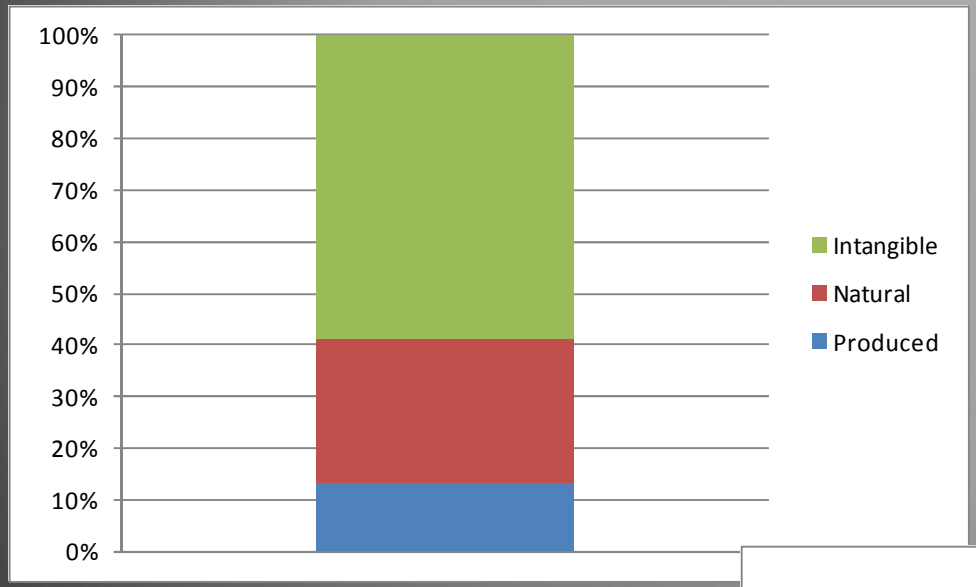
ecological deficit

if its **Footprint** exceeds **what its ecosystems can renew**. The deficit is made up through net-imports, net-carbon emissions to the global atmosphere, or local resource degradation.

Another effort in this direction

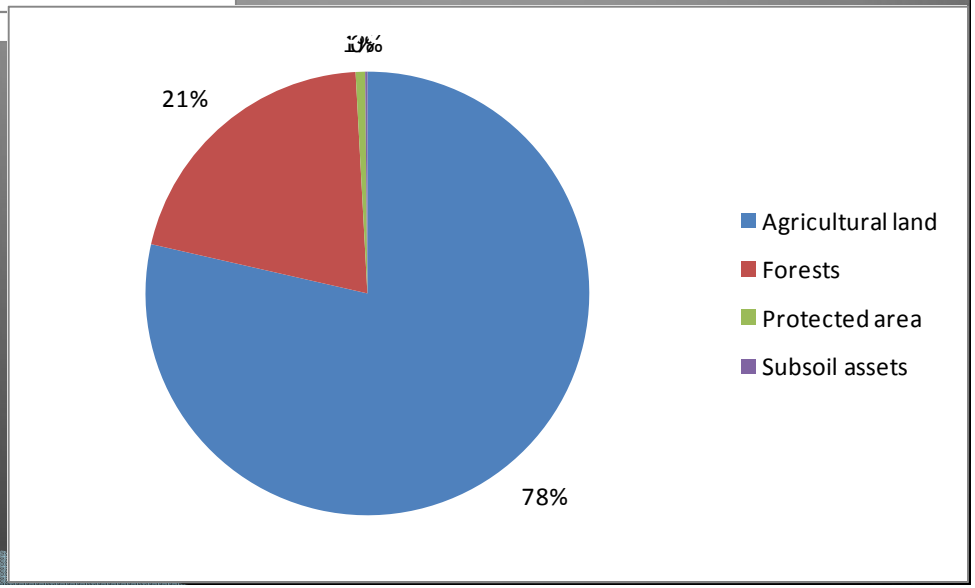
# Where is the wealth of Ghana?

Shares of total wealth, 2005




Total wealth / capita: $9,500

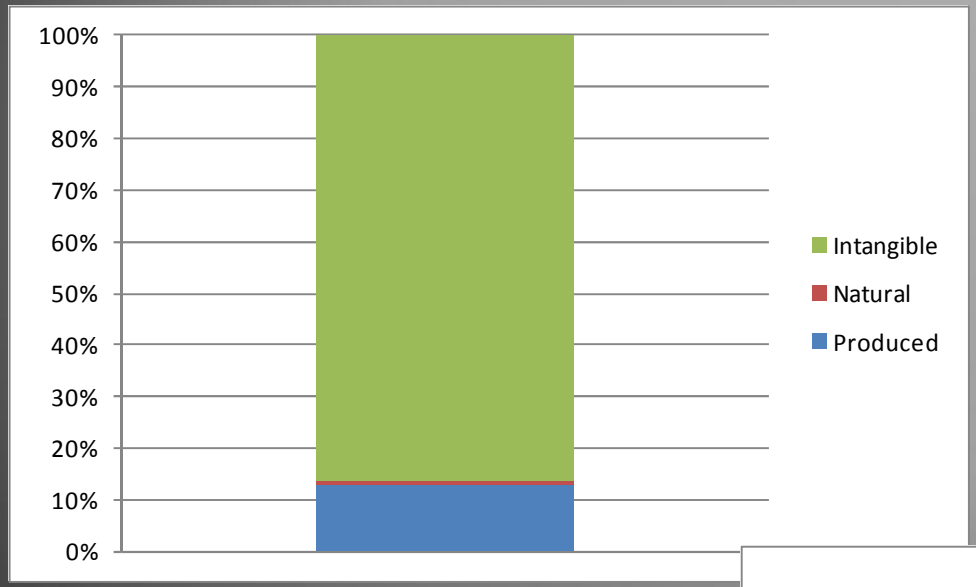
Shares of natural wealth,




Kirk Hamilton, World Bank

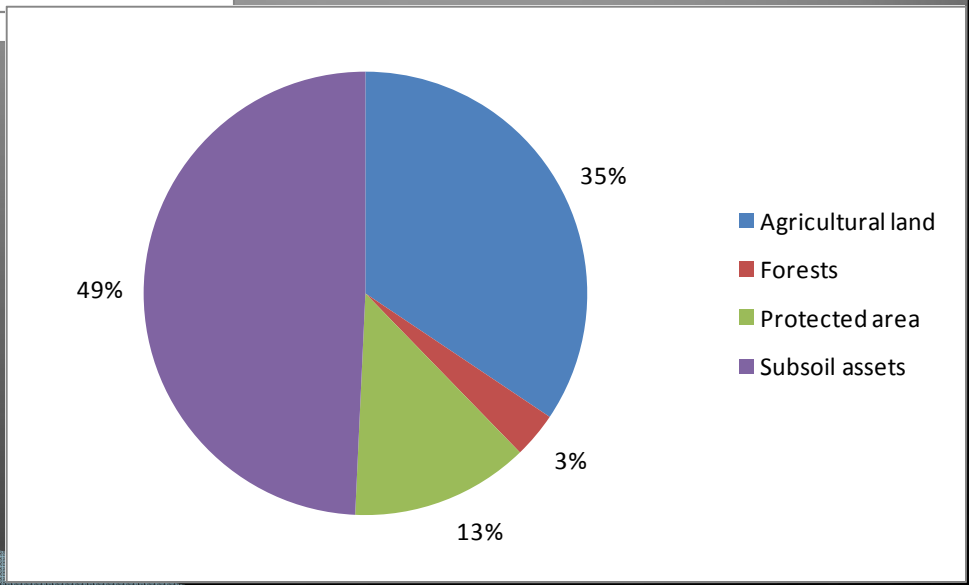
# Where is the wealth of the UK?

Shares of total wealth, 2005




Total wealth / capita: $663,000

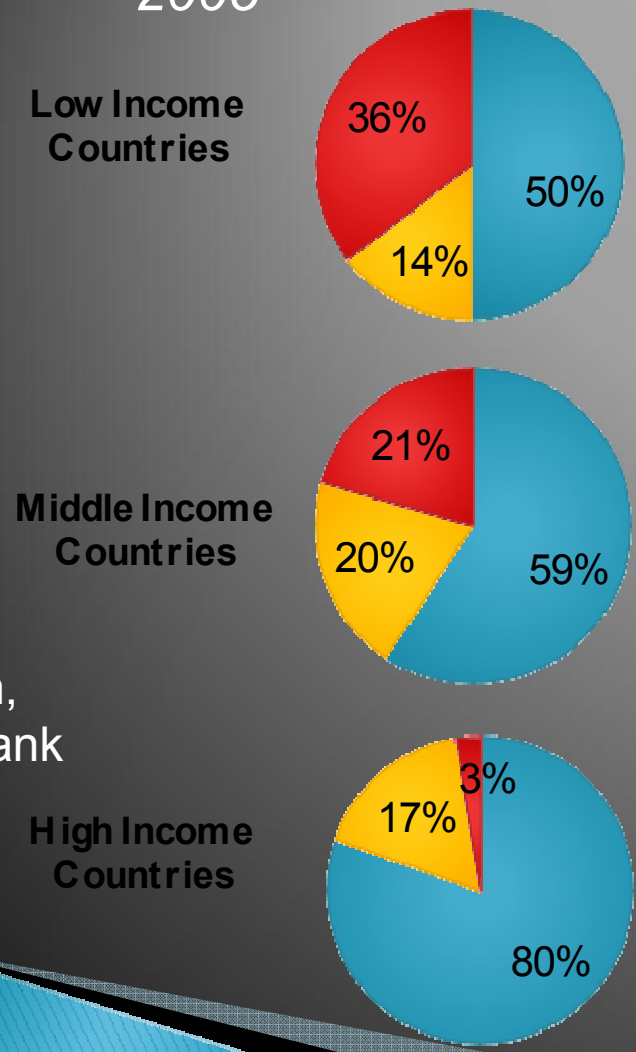
Shares of natural wealth,




Kirk Hamilton, World Bank

# Composition of total wealth

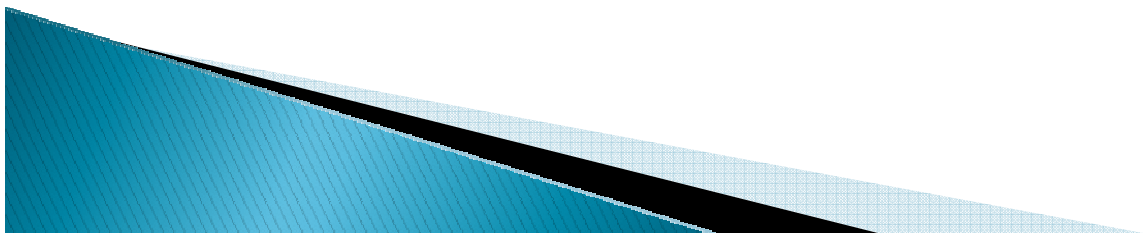
*Shares of comprehensive wealth, by income class, 2005*




- Natural capital is most important in low income countries—more than twice as large as produced capital
- In middle income countries natural capital and produced capital are roughly equal
- Intangible wealth dominates in all countries, especially in high income countries

Kirk Hamilton, World Bank

# We are still not hitting the mark



# Planetary Boundaries

## Rockström et al 2009

| Earth System | Reflection in Global Goals and Targets |
|---|---|
| Climate change |  |
| Ocean acidification |  |
| Stratospheric ozone depletion |  |
| Atmospheric aerosol loading |  |
| Biogeochemical flows |  |
| Global freshwater use |  |
| Land-system change |  |
| Rate of biodiversity loss |  |
| Chemical pollution |  |

**Figure 10.3 Global and regional targets and monitoring programmes**

| Issue | Targets | Monitoring |
|---|---|---|
| Biodiversity loss | | |
| Climate change | | |
| Degradation and loss of forests | | |
| Indoor air pollution | | |
| Integrated Water Resources Management (IWRM) | | |
| Land contamination and pollution | | |
| Land degradation/desertification | | |
| Large-scale marine fisheries | | |
| Long-range air pollution | | |
| POPs | | |
| Stratospheric ozone protection | | |
| Water and sanitation | | |
| Water security | | |

| Targets | Monitoring |
|---|---|
| No targets<br>Quantitative, time-bound targets; not legally binding<br>Legally-binding, quantitative, time-bound targets<br>*Exception: Long-range air pollution assigned yellow; legally-binding targets in Europe only* | No regular monitoring<br>Some monitoring takes place, but is less than complete<br>Relevant monitoring taking place globally |

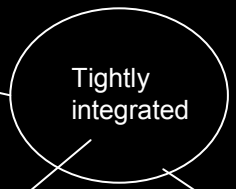
*Source: Chapters 2–5, review of MEAs at Ecolex 2007, UN 2002a*

Global Environmental Outlook – 4 (2007)

# Existence Proof: European Transboundary Air Pollution

**Monitoring:**
Integrated
National reports
Station measurements
Landscape / ecology measurements
Metereology

**Basic Science:**
non-uniform effects
thresholds
coupled systems
(emissions, transport, atmospheric chemistry, terrestrial chemistry, ecology)




**Applied Science:**
Model-based
Decision-support tools
Relates national policy behavior to ecological results

**Normal Politics:**
How big are my emission reductions?

**Frontier Politics:**
Deliberative processes
Where do we want to go?
How might we get there?
What are the tough obstacles?
What are possible solutions?

No single organizational form dominates
Experiments proliferate
Multiple steering mechanisms operate
Held together by complex issue network

# Thank you