Greater Mekong Subregion Environmental Performance Assessment and Sustainable Development Planning - Performance Indicators

Discussion paper prepared by
Institute for Global Environmental Strategies (IGES)

Inception Workshop Greater Mekong Subregion (GMS)
Core Environmental Program (CEP) Phase 1 (2006-2009)
Component 3-Environment Performance Assessment (EPA)

IGES GMS Conference Paper Series GMS-2007-2

May 2007

This component was completed as part of ADB RETA 6289 in a collaboration effort between Greater Mekong Subregion Environmental Operations Center: Asian Development Bank, United Nations Environment Programme and IGES.

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Abbreviations and Acronyms

ADB	Asian Development Bank
BOD	biochemical oxygen demand
Cd	cadmium
CEP	core environment program
COD	chemical oxygen demand
Cr	chromium
Cu	copper
DEQP	Department of Environmental Quality Promotion
EEA	European Environment Agency
EIA	environmental impact assessment
EPA	environmental performance assessment
EPI	environmental performance indicator
EPR	environmental performance review
GDP	gross domestic product
GMO	genetically modified organism
GMS	Greater Mekong Subregion
GNA	green national accounting
Hg	mercury
ISO	International Standards Organisation
IUCN	World Conservation Union
JICA	Japan International Cooperation Agency
MDG	millennium development goals
MoNRE	Ministry of Natural Resources and Environment
MRC	Mekong River Commission
NBS	National Bureau of Statistics
NDP	net domestic product
NESDB	National Economic and Social Development Board
Ni	nickel
NO_x	nitrogen oxides
ODS	ozone depleting substances
OECD	Organisation for Economic Cooperation and Development
ONEP	Office of Natural Resources and Environmental Policy and Planning
Pb	lead
PM	particulate matter
POP	persistent organic pollutant
PRC	People's Republic of China
RMB	yuan renminbi (currency of PRC)
SEEA	system of integrated environmental and economic accounting
SEF	strategic environment framework
SEPA	State Environmental Protection Administration
SNA	system of national accounts
SO_2	sulphur dioxide
SO_x	sulphur oxides
SOE	state of environment
UN	United Nations
UNEP	United Nations Environment Programme
VOC	volatile organic compounds

1. Background

From the outset of the **National Performance Assessment and a Strategic Environmental Framework for the Greater Mekong Subregion (SEF II)** in 2003 the selection of the right set of indicators was seen as the key step in the conduct of an environmental performance assessment (EPA) as shown in Box 1.

Box 1 SEF II Framework
Step One: Selecting policy concerns
Step Two: Adapting priority concerns to GMS conditions and quantifying policy targets
Step Three: Selecting indicators and matching them to priorities
Step Four: Selection of core and headline indicators
Step Five: Preparation of indicator "fact sheets"
Step Six: The conduct of EPA

In providing guidance to the national teams, SEF II reviewed global experience in developing environmental indicators and that overview is repeated here (with some light editing) as Appendix 1. Four broad categories of environmental performance were identified (i) evaluation of environmental performance by enterprises built around the ISO 14000 series; (ii) assessments of the performance of governments and public bodies in general (i.e. not primarily environment-related); (iii) environmental performance assessment (EPA) by (or of) individual countries; and (iv) environmental performance by (or of) supra-national entities. SEF II focused on environmental performance of Greater Mekong Subregion (GMS) countries at the national level and, to a lesser extent, environmental performance at the subregional level.

In starting this work for Component 3 of the Core Environment Programme (CEP) several key decisions need to be made in relation to the choice of indicators. First, a decision will need to be made on whether the set or priority concerns remains as in SEF II or whether new priority concerns have emerged over the past few years. Second, will each country be able to stick with their existing indicators (bearing in mind some of the points made in Discussion Paper No. 1) or will they change them? Third, for those countries which did not select certain priority concerns but wish to do so this time around, which indicators will be chosen? Fourth, where there were missing concerns in SEF II will the GMS countries be able to fill them and if so, what indicators will be chosen? Fifth, for the sub-national level are the priority concerns the same as at the national level and if not, what are the appropriate indicators? Sixth, is there any appetite among the GMS countries to extend the EPA methodology to the sectoral level? Seventh, is there any need to extend the aggregate index approach that was tentatively explored in SEF II? Eighth, is there a need to go beyond the environmental indicators and extend the analysis to sustainability assessment, covering social and economic indicators? Finally, is the Pressure-State-Response (PSR) model still regarded as adequate or should it be extended to the more comprehensive Drivers-Pressure-State-Impact-Response model used in the Global Environmental Outlook (GEO)?

The purpose of this discussion paper is to explore how others have dealt with the choice of environmental indicators, to draw out the lessons learned, and to provide guidance to GMS countries as they grapple with the answers to the difficult questions outlined above.

2. Approach to Indicators in SEF II

In SEF II, the project team spent considerable time and effort in trying to select indicators that would not only reflect progress towards achievement of national objectives and targets but would also contribute to a harmonised set of indicators which could be used across the subregion. Table 1 illustrates the kind of debate that was undertaken in the process of deciding on which indicators to choose.

Table 1 Debate over selection of indicators in SEF II

Priority	Type	Possible shared indicators	Remarks	Comments
Land degradation - *what is the target – zero land degradation, reduced rate of land degradation, or reversal of the rate of land degradation?*	P	Rate of deforestation Population density in the uplands	Feasible everywhere, but low score given by Yunnan Feasible everywhere, but Thailand mentioned statistical problems caused by shifting population (Vietnam and Lao PDR did not but they could have)	*Land degradation may be due to conversion from one use to another, or may be due to inappropriate use beyond the inherent land capability. Land degradation can be just as common and often more important in lowland areas than in upland areas. Deforestation is not equivalent to land degradation – perennial pasture cover may be just as stable as forest cover.*
	S	Average rice yields	Feasible everywhere. Attention needed to definition (upland yields? country-wide yields?)	*Rice is grown in rain-fed upland areas as well as irrigated lowland areas. Yield changes are due to variety selection, fertiliser inputs, pest and weed control, and rainfall/irrigation, as well as on-farm practices. What proportion of degraded lands is used for growing rice?*
	R	Rehabilitated areas	Feasible except for Lao PDR. Ensuring same definitions bound to be difficult	*The area of land rehabilitated would be an outcome of the response. Responses could be reforestation, soil erosion control programmes, restoration of soil fertility, manipulation of the carbon/nitrogen balance in the soil, conversion to organic agriculture practices, or other forms of soil remediation.*

A rather theoretical framework was proposed to guide selection of indicators as shown in Figure 1.

Criteria				
1. Current use of the indicator	Is an indicator (are indicators) matched to selected policy priority already in use?			
	If yes, work with the **existing indicator(s)**		If not, consider developing **new indicator(s)**	
2. Balance of indicators to assess each chosen policy priority	Is there (should there be) more than a single indicator for the priority selected?		Should there be more than a single indicator for the priority selected?	
	If not	If so, do complementary indicators exist and are they in use now?	If not	If so,
3. Statistical soundness of existing indicators or available examples	Is the existing indicator "sound"? If so, **adopt the existing indicator**. If not,	If so, are all of these indicators "sound"? If yes / If not,		
4. Existence of suitable examples from outside the country	Does a suitable example exist that can be readily adopted? If so, **adopt the "imported" indicator** If not		Does a suitable example exist to "import"? If so / If not	Do suitable complementary indicators exist to import? If so / If not,
5. Cost of improvement or development of indicators	Is the cost of modifying "imported" indicators acceptable? If so**, modify and adopt the "imported " indicator** If not, **abandon search and do not use the indicator**		Is the cost of modifying "imported" indicators acceptable? If so,	Is the cost of modifying "imported" complementary indicators acceptable? If so, If not **abandon search and do not use the indicators**

Figure 1 Approach to selecting environmental performance indicators
Source: TP 2 in SEF II

The indicators, selected using this process, are shown in Table 2. The recommended structure for GMS thus consisted of 48 principal indicators (of which 9 were transboundary ones), 25 core indicators (of which one was transboundary) and 11 headline indicators. Headline indicators are intended “*to provide a broad overview of trends in the country's environment in areas that are important to the citizens. The indicators do not represent a comprehensive report on the state of our environment, but rather are a series of snapshots that can raise public awareness and act as signposts for our path towards environmental sustainability.”*

Table 2 Environmental performance indicators recommended for EPA in GMS

	Type of indicator recommended			**Amendments adopted during SEF II**
Policy concern/theme	**Pressure**	**State**	**Response**	
Country-level indicators				
Land degradation	**Population density in the uplands**	Percentage of vulnerable farmed areas	Expenditure on promoting sustainable farming and sedentarisation programmes	Most GMS countries adopted this as a priority concern. Pressure indicators included agriculture, upland population, shifting cultivation, and loss of forest area. State indicators also varied widely from direct measures of sediment load to indirect measures like rice yield. Most response indicators relate to area rehabilitated.
	Land use changes; Ratio of land exploitation; Rate of deforestation; Human-induced soil degradation	Value of non-irrigated agricultural output per ha Average rice yield; Degree of top soil losses; Real prices of rainfed farmland	Rehabilitated areas	
Threats to biodiversity	Rate of loss of designated ecosystems	Threatened species	**Per capita public expenditure on protected areas**	Most GMS countries (except Thailand) adopted this concern. Loss of forests was seen as the main pressure. Most used the IUCN Red Book threatened species list for the State indicator. Protected areas were viewed as the best Response indicator.
	Clearance of native and semi-native forest; Land use changes		Protected areas as % of total area by ecosystem type; Protected species as % of threatened species	
Inland water pollution	BOD5 in designated water bodies	**Incidence of waterborne diseases**	Expenditure on secondary and/or tertiary water treatment	Only 3 GMS countries adopted this concern. Discharge indicators included untreated domestic wastewater, BOD, and municipal wastewater. Various ambient quality measures were used as State indicators. Only one country used fees as a Response indicator.
	Other pollutants on designated water bodies	% of municipal wastewater undergoing secondary or tertiary water treatment; Access to safe drinking water	User charges for wastewater treatment	
Inadequate waste management	Population density in principal urban areas	**Burden of uncollected waste**	Charges for waste disposal	Most GMS countries adopted this concern. Most used urban waste generated as the

	Generation of municipal solid waste; Generation of industrial solid wastes	Percentage of municipal solid waste collected	Expenditure on landfill development; Waste re-cycling and recovery rates; Cost recovery in municipal waste handling	Pressure indicator. Waste collected was used in preference to waste uncollected. Expenditure on waste management was the most common Response indicator.
Toxic contamination	Generation of hazardous wastes	Concentration of Pb, Cr, Cu and Cd in rivers and coastal areas	Completeness of toxic material inventory	Two countries selected toxic contamination, although Lao PDR included unexploded ordnance in this category. Thailand included health incidents related to toxic chemicals as a State indicator. The Response indicator was the amount of treated hazardous wastes.
	Consumption of Pb, Hg, Cd, Ni; Imports and exports of hazardous wastes; Apparent consumption of pesticides; Emissions of organic compounds	Area of land contaminated by hazardous wastes	Rehabilitated sites as percent of contaminated; Market share of unleaded petrol; Share of car battery recycling	
Air pollution by stationary sources	Volume of SO_2 and PM emissions	SO_2 and PM concentrations above international ambient standards	Total outstanding volume of SO_2 and PM emissions in industrial permits	None of the GMS countries adopted this concern or indicators.
	Index of acidifying substances Emissions of NO_x and SO_x Emissions of particulate matter	Excess over critical loads of pH in water and soil; Per cent of industrial facilities found in violation of permit conditions	Capacity of SO_x & NO_x abatement equipment of stationary sources Per cent of industrial pollution permit holders inspected Expenditure on air pollution abatement equipment	
Mobile source pollution	**Per capita volume of automotive fuels sold in urban areas**	Excess of PM and NO_x over international ambient standards in the capital city	Per cent of registered cars undergoing pollution inspection	Only 2 GMS countries adopted this concern. Car density is used as proxy Pressure indicator. Ambient concentrations are used as State indicators rather than excess over standards. Only Myanmar had a Response indicator – number of vehicles inspected.
	Mobile source emissions Urban air emissions SO_x, NO_x, VOC Emissions of NO_x Car-equivalent-units per head of population	Incidence of respiratory diseases	Expenditure for noise abatement; Per cent of car fleet equipped with catalytic converters; Emission and noise regulatory levels for vehicles	

Threats to coastal zones	**Population density along the coast**	Relative real prices of dwellings in the coastal zone	Zoning regulations	Only Viet Nam chose this as a priority concern, with an emphasis on mangrove loss for aquaculture.
	Area of coastal aquaculture per km of coast; Oil pollution; Heavy metals discharges; Shore build-up	Quality of coastal water		
Climate change	**Emissions of CO_2 per unit of GDP**	Excess of CO_2 over international ambient standards	Fossil and wood energy intensity	Most GMS countries used emissions per unit of GDP as a Response indicator. No GMS country adopted a State indicator. Baseline years were mostly 1990 in accordance with the Kyoto Protocol. No GMS country used average consumption of fuel wood or slash-and-burn area.
	Emissions of GHGs per unit of GDP; Average consumption of fuel wood; Average area of slash-and-burn		Ratio of current GHG emissions to a 1995 benchmark	
Ozone layer depletion	Apparent consumption of CFC	Atmospheric concentrations of ozone-depleting substances	CFC recovery rate	No GMS country adopted this concern, although most have in place ODS elimination programmes under the Montreal Protocol.
	Apparent consumption of ozone-depleting substances	Ground-level UV-B radiation		
Water resources	Agricultural water; consumption per capita	**Access to safe potable water**	Water and wastewater charges as percentage of full production cost	Four of the six GMS countries chose water resources. Population was chosen as a proxy for the Pressure indicator. Thailand used agricultural consumption of water as its indicator set, rather than potable water. Response indicators were based on public expenditure.
	Groundwater abstraction; Urban water consumption per capita; Ratio of water withdrawals to flows	Frequency, duration and extent of water shortages; Long-term marginal cost of urban water supply		
Fish resources	Volume of fish catches	**Real domestic prices of fish**	Expenditure on fish stock and catch monitoring	Only 2 GMS countries adopted this concern. Cambodia used number of community fisheries as a response indicator.
	Value of inshore fisheries output; Value of offshore fisheries output	Overfished areas; Size of spawning stock		
Forest resources	Ratio of actual to sustainable harvest	**Real domestic prices of fuel wood**	Budgets on forest protection	All the GMS countries chose forest resources as a priority concern. A

	Per capita fuel wood production; Rate of deforestation	Real prices of timber; Forest cover Timber balance	Per cent of protected forest area in total forest area; Per cent of production forest inventoried; Per cent of harvested area successfully regenerated or afforested	wide range of Pressure indicators was chosen. Forest cover was the main State indicator for all countries. Protected areas and reforested areas were chosen as Response indicators.
Transboundary concerns				
Threats to the Mekong's vital functions	Total water withdrawals by GMS members	Deviations from long-term flow average in lower reaches	GMS countries contributions to MRC budget	
		Maintenance of environmental flow target		
Illegal trade in resources, wildlife	Price index of illegal items outside GMS	Threatened species in GMS	Local budgets to fight illegal trade	
	Local prices of illegal items			
Absence of harmonisation of policy targets and evaluation tools	Deviations of country pollution norms from GMS average	Percentage of land that is classified using GMS-wide criteria	Budgets allocated to environmental harmonising initiatives	
		Percentage of common air and water pollution Standards		

Legend: [yellow] core indicator **bold** = headline (or key) indicators

For each concern selected the SEF II team identified the most suitable principal indicator(s), based on (a) "proven track record" internationally, (b) use or partial use of the indicator in at least one GMS country, (c) the cost of developing proposed indicators where none exist now; (d) the degree of "statistical" fit between the indicator and the identified concern and (e) reporting demands placed on GMS country by global environmental conventions. As indicated in Discussion Paper 1, at least 92 indicators were ultimately chosen for 12 different environmental "concerns" compared to the 48 initially recommended.

The SEF II consultant team also proposed several environmental indicators for the key economic sectors in the GMS (Table 3). No attempt was made in SEF II, however, to develop a sectoral performance assessment.

Table 3 Recommended environmental indicators for sector assessment

Sector	Type of indicator			Notes
	Pressure	State	Response	
Agriculture	Use of fertilisers per ha of arable land	Arable land per capita	Expenditure on introduction of improved farm practices	References: Dumanski and Pieri (1995); Parris (2002)
	Apparent consumption of pesticides; Agricultural water consumption per capita; Emissions by intensive livestock sector	Degree of top soil loss; Share of intensive livestock subsector in total organic pollution	Expenditure on wastewater treatment in intensive livestock sector	
Transport	Consumption of petrol and diesel by road transport	Structure of energy use by the transport sector	Fuel prices and taxes	References: EEA (see Appendix B) ADB (2002), Blue Skies for Metro Manila
	Road traffic by mode; Mobile source emissions	Road traffic fatalities	Relatives taxes on vehicles and vehicle use	
Energy	Energy intensity	Energy sector air emissions per GDP and per capita	Share of consumption of renewable energy	References: OECD (1993),Indicators for the Integration of Environmental Concerns into Energy Policy Environment Canada (1997), Energy Consumption. National Environmental Indicator Series
	Energy balance		Real energy end-use prices by fuel type; Relative taxation by different fuel types; Implicit and explicit tax on energy/CO_2; Expenditure on energy efficiency, alternative energy, climate change research	
Tourism	Number of tourist nights per domestic population	Share of tourism receipts in exports	Public expenditure on conservation of heritage sites	References: MCSD (2000), Plan Bleu

Legend: [green box] principal indicators

3. Experience in Thailand

Thailand has made several additional forays into the world of environmental and sustainability indicators beyond its involvement in SEF II. These indicate that there is neither national consensus on which indicators should be routinely collected nor on how various indicators might be aggregated into indexes.

In 2003, the National Economic and Social Development Board (NESDB) computed an economic strength and level of development index (Social Research Institute 2005). This index combined indicators of economic self-reliance, economic immunity, adaptability to global changes, stability growth, and development decentralisation. The results showed that prior to the financial crisis in 1997, the overall economic strength was at 69.5%, dropping to 66.9% in 1997-1998, and recovering to 71.1% in 2002.

Also in 2003, to comply with Agenda 21, NESDB commissioned Thailand Environment Institute and Kenan Institute of Asia to develop appropriate sustainable development indicators. They assembled 23 indicators (economic – 9; social – 7; and environmental – 7). The indicators are shown in Table 4. The combined sustainable development index increased from 57.7% in 1999 to 64.3% in 2003. Environmental quality is consistently ranked lower than progress in economic and social indicators. Through expert brainstorming in 2007, these indicators were reviewed and revised, with one new environmental indicator (chemicals used in the agriculture sector) added.

Table 4 Thailand's Sustainable Development Index

Economic Indicators	**Social Indicators**	**Environmental Indicators**
Total factor productivity Ratio of energy use/GDP Renewable energy Waste recycling Total employment Public debt/GDP Current account/GDP Gini coefficient Poverty reduction	Average years of education Achievement in education Life expectancy at birth Human health Life security Participation index Corruption index	Percent forest area Mangrove area/1961 area Marine fauna within 3 km Groundwater use % Good water quality Air quality Treated hazardous wastes *Chemicals used in agricultural sector**
1999 – 70.2%	1999 – 61.9%	1999 – 40.8%
2003 – 79.1%	2003 – 65.4%	2003 – 48.6%

* added in 2007
Source: Social Research Institute 2005

Along with most other countries Thailand is a signatory to the millennium development goals (MDG) and is committed to submitting regular reports on progress. As Thailand will meet most of the MDGs by 2015, it has gone further than many other countries and adopted the MDG+ targets. The environmental measures for MDG 7 included in this set of indicators include (i) % of land covered by forests; (ii) % protected areas; (iii) energy use per Baht 1,000 of GDP at 1998 prices; (iv) carbon dioxide emissions per capita; (v) ozone depleting substances (ODS) consumption; and (vi) proportion of the population using solid fuels.

Progress in relation to the MDG 7 targets is given in Table 5. These indicators show some progress on the environmental front but point to the difficulty of decoupling energy consumption and economic growth.

Table 5 Thailand's MDG 7 indicators

Indicators	1990	1995	2000	2002
Land area covered by forest (%)	28	25.6	25.3 (1998)	33 (2000)
Protected area as percent of total area (%)	12.4	15	17.6	n.a.
Energy use per Baht 1,000 of GDP (kg of oil equivalent – kgoe)	15.7	15.5	15.7	15.9
Carbon dioxide emissions (tonnes/capita)	2.4	3.6	2.3	n.a.
Consumption of ODS (tonnes)	7,262	8,314	3,586	n.a.
Proportion of population using solid fuel (%)	65.5	47.2	36.3	30.5

Source: Government of Thailand 2004

In 2004, NESDB commissioned consultants to establish indicators that would help monitor environmental trends (Social Research Institute 2005). Three sets of indicators were proposed (i) an aggregate indicator for environment and natural resources together; (ii) an index for natural resources; and (iii) an index for environment. Each of the two latter indices consisted of 6 underlying indicators, weighted by expert judgement of a project steering committee. The indicators chosen were (i) proclaimed protected areas; (ii) soil rehabilitation; (iii) surface water per capita; (iv) mangrove area; (v) catch per unit effort; (vi) budget share for natural resources and environment; (vii) ratio of water sources of acceptable quality to water of very low quality; (viii) proportion of treated municipal wastewater; (ix) reuse or recycling of solid wastes; (x) proportion of treated industrial hazardous wastes; (xi) air quality; and (xii) number of protected areas and cultural heritage sites.

In its 2005 monitoring report for the 9th social and economic development plan, NESDB reported assessment results after 3 years (2002-2004) of experience in implementation of three sets of indicators, including sustainable development indicators, economic strength and level of development index, and national well-being indices.[1] The results are depicted in Figure 2. Sustainable development as a whole in that period has improved continuously due to economic and social development progress. However adverse impacts on environment were detected which could be interpreted from the low score (Level 2 or <70%).[2] The following trends on environmental quality were reported as:

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[1] National well-being indices consist of 7 components (health, knowledge, working life, income and its distribution, environment, families, and good governance) with 25 indicators.

[2] Assessment score was categorized into 5 levels. The interpretation of each level could be explained as follows:
Level 5 = the trend has been improved at a high level (90-100%)
Level 4 = the trend has been improved at a moderate level (80-89.9%)
Level 3 = there is no improvement (70-79.9%)
Level 2 = the trend has regressed (<70%)
Level 1 = undefined

(i) Continued deforestation and annual reforestation not keeping up with annual losses;
(ii) Reduced biodiversity in both quantity and species numbers;
(iii) Lack of knowledge of genetically modified organisms (GMO) and lack of clarity on GMO policy;
(iv) Increased severity of water shortages;
(v) Continued land degradation and inappropriate land use;
(vi) Deterioration of marine and fisheries resources;
(vii) Increasing energy use and associated pollution;
(viii) Increased urban solid waste and weak capacity of local governments to deal with it;
(ix) Water quality from major sources below the standards required for use;
(x) Continued air quality deterioration in major cities;
(xi) Increased amount of hazardous wastes and inability to cope with the problem; and
(xii) Increased import of hazardous substances for use in agriculture and manufacturing industries.

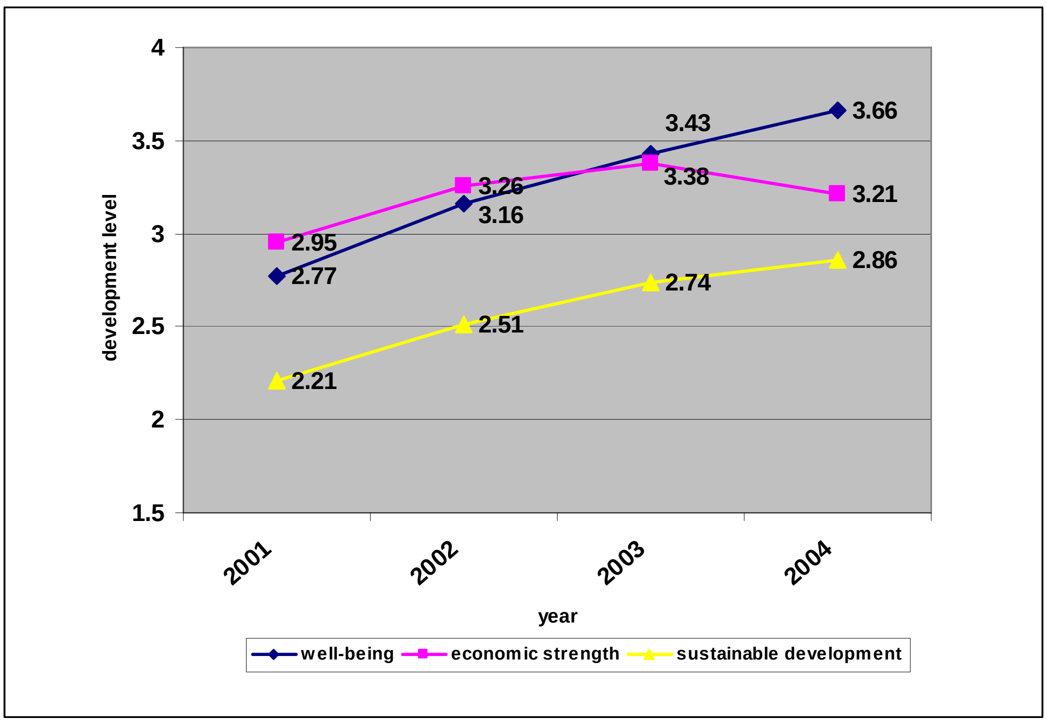

Figure 2 Assessment results on development in Thailand from 2001-2004
Source: NESDB (2005)

The Office of Natural Resources and Environmental Policy and Planning (ONEP) State of Environment Report 2005 reiterates many of these problems and adds some emerging issues including (i) recovery from the 2004 tsunami; (ii) drought; (iii) declining watershed conditions in the Ta Chin watershed; (iv) contribution of open burning to climate change and reduced air quality; (v) sea level rise and subsidence in the Chao Phraya River basin; (vi) coastal erosion; (vii) contamination from mining; (viii) coastal zone deterioration; (ix) open dumping and burning of municipal solid wastes; (x) a 50% reduction in good water quality; (xi) high levels of fine particulates in air quality of urban areas; (xii) excessive roadside noise levels in urban areas and at the new airport; (xiii) slums and other urban planning problems; and (xiv) degradation of the cultural environment (ONEP 2005).

ONEP has evaluated the effectiveness of long term environmental policy and plans, such as the Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality: 1997-2016, and the previous five-year environmental plan, the Environmental Quality and Management Plan 2002-2006. ONEP conducted a study on environmental policy implementation as well as established a monitoring and appraisal system. In the monitoring and appraisal system, environmental indicators which were developed by ONEP in 2004 under the Pressure-State-Response Framework have been reviewed and examined. Out of 182 indicators, consisting of 75 status indicators, 39 pressure indicators, 56 response indicators, and 12 process indicators, ultimately 58 indicators were considered as proper indicators to be utilised in the monitoring and appraisal system, although only 43 indicators are ready to use. The results of applying these 43 indicators were classified into three groups (i) the result was in the same direction as the target; (ii) the result was in the opposite direction as the target; and (iii) the result was unable to draw a clear conclusion from current information. Major obstacles identified for the use of indicators were (i) unclear relationships between indicators and specified targets, (ii) inappropriate indicators, (iii) inadequate data support for the assessment at the national level, and (iv) lack of a database system at the provincial level (ONEP 2007).

In the 2007-2011 Environment Quality Management Plan, indicators have been selected for each of the 6 strategies of the plan in different environmental sectors[3] and used as key performance indicators of all levels of government. The 6 strategies include (i) promoting participation in natural resources and environmental management; (ii) enhancing management efficiency; (iii) creating driving forces for local governments to more aggressively manage the environment; (iv) providing better access and utilisation of resources for alleviating poverty; (v) encouraging balanced and sustainable utilisation of natural resources; and (vi) monitoring, maintaining and rehabilitating environmental quality. Indicators for Strategy 1 are shown as examples in Table 6. The plan will be evaluated annually through the selected indicators. Likewise assessment of the plan to indicate target achievement will take place in the second half of the plan period. The Ministry of Natural Resources and Environment advocates creating a broad-based monitoring and evaluation committee for the plan, using SOE reports and media releases to disseminate the findings.

[3] The “sectors” include (i) forests, (ii) biodiversity, (iii) soil and land, (iv) mineral resources and energy, (v) aquatic and coastal resources, (vi) water resources, (vii) pollution, (viii) urban environment and community, (ix) natural environment and historic sites, (x) and multilateral environmental agreements.

Table 6 Indicators for Strategy 1 in Environment Quality Management Plan 2007-2011

Strategy 1: Promoting participation in natural resources and environmental management	
Indicator	Environmental sector
1. Keeping the current forest area (including mangrove) and creating new area not less than 0.5% within 5 years	Forests
2. Managing biodiversity through participatory process in 80% of important ecosystems	Biodiversity
3. Approving the land right in 80% of target households	Soil and land
4. Managing mineral resources through participatory process in every province and preventing target villages in disaster prone areas	Mineral resources and energy
5. Managing aquatic and coastal resources through participatory process in every province 6. Successful level of participation in aquatic and coastal resources management	Aquatic and coastal resources
7. Managing through participatory process in 50% of target water basins	Water resources
8.Manaing environmental quality through participatory process in every province	Pollution
9. Increasing 50% of urban community outputs from activities relating to environmental management	Urban environment and communities
10. Creating networks of natural and historical site conservation not less than 5 agencies per years	Natural environment and historic sites
11. Increasing public participation in multilateral environmental agreements	Multilateral environmental agreements

NESDB is now examining international experience with development of a happiness index (following Bhutan's lead) as the 10th Plan (2006-2011) focuses on achieving a "green and happy" society in Thailand. According to the definition of happiness, six components have been elaborated to cover all aspects of happiness. Each component consists of various sub-components as shown in Table 7. There are 35 core indicators which could reflect objectives for each component and be measured quantitatively, together with 44 supplementary indicators which could be used to explain the reasons underlying change of assessment results measured by the core indicators.

Table 7 Components, sub-components and indicators of happiness in Thailand

Component	Sub-component	Core Indicator	Supplementary indicator
1. Well- being			
	Physical health		
	-Healthy body	Ratio of population with no illnesses	-Ratio of newborns with birth weight ≥ 2,500 grams -Population with unhealthy behavior (%) -Population exercising (%) -Population with over nutrition (%)
	-Longevity	Life expectancy at birth (year)	
	Mental health		
	-Healthy mind	Ratio of mental disorder patients	
	-Sense of moral	Criminal cases per 1,000 population	Population with religious activities (%)
	Knowledge		
	-Educational attainment	Functional literacy rate	Mean years of schooling for people aged 15 years and over (years)
	-Quality of education	Test scores on class subjects	Ratio of people enrolled in education to those who are not
	-Information acknowledgement		-Population with reading -Population access to internet
2. Economic strength and equality			
	Honest livelihood		
	-Employment	Unemployment rate	-Ratio of low income labour -Working hours per month or year
	-Sufficient income	Ratio of households with incomes exceeding expenses over 10%	-Households saving money (%) -Average debt per household
	-Job security and occupational safety	Ratio of employees covered by social welfare	-Disabled employees caused by occupation (%) -Ratio of employees with chemical injuries
	Income distribution	-Ratio of poor in economic terms	-Gap of income distribution

		-Gini coefficient	
	Economic strength	-Economic growth -Total factor productivity -Inflation rate -Current account/GDP	-Ratio of international reserves to short-term external debt
3. Family life			
	Proper roles of family	-Ratio of abandoned elders (per 100,000 elders) -Ratio of abandoned children (per 100,000 children)	-Ratio of domestic violence cases -Ratio of family and child cases -Ratio of families where all members stay together
	Healthy family	Divorce rate	Rate of registration of marriage
4. Strong community			
	Self-reliance		
	-Economic aspect	-Ratio of strong co-operatives	-Working capital of community groups -Ratio of community capital utilisation over 50%
	-Problem solution		-Number of group activities -Ratio of communities with development plans
	Community with integrity	Ratio of communities with social security	Ratio of communities/ villages with domestic social welfare
	Community participation	-Ratio of households with members of community groups -Ratio of communities/villages with self-learning system	-Ratio of households participating in public activities
5. Good living environment with balanced ecosystem			
	Basic needs for living		
	-Habitat	Ratio of households with home ownership	
	-Infrastructures and services	Ratio of households with access to tap water	Ratio of households with electricity
	Safety in life and property	-Ratio of criminal cases -Ratio of drug trafficking cases	Loss of life and property from accident/fire
	Good environment	-Ratio of water bodies	-Ratio of main rivers

		with moderate quality -Volume of properly treated wastes	with DO, BOD and TCB parameters below standard -Dust with particle size $\leq$ 10 µm -Greenhouse gases emission -Solid waste production -Leftover solid waste -Ratio of domestic per hazardous wastes -Volume of chemical products in agricultural sector
	Balanced ecosystem	-Volume of captured economic aquatic animals per hour -Forest cover	-Number of endangered species -Ratio of conserved forest per total land area
6.Democratic society with good governance			
	Pubic awareness	-Traffic rules violation statistics -Ratio of voters participating in elections	-Number of networks for environment and natural resources conservation -Number of organisations at community level per 100,000 population -Number of households with members of community group or local administrative organisation
	Good governance	-Transparency index -Number of cases considered by the Administrative Court and the National Counter Corruption per 100,000 population	-Enterprise governance -Number of complaints submitted to independent organisations
	Solidarity society	Ratio of human rights violation cases and complaints per 100,000 population	Ratio of cases in 3 provinces of the deep south

Source: NESDB (2007)

The set of happiness indicators has been gradually amended to be appropriate to the Thai context through consultation with the government, but also from civil society particularly at the grass root level. Opinion surveys underpinning development of the happiness index show that Thai people value (i) sufficient earnings without debt; (ii) good health; (iii) a good environment; and (iv) a chance to send their children to school. In the troubled Southern regions, residents included peace and security as priorities.

Due to differences of urban and rural societies, variations in the composition of the happiness indices are needed. Therefore NESDB has developed different sets of happiness indices to correspond to actual conditions of urban and rural areas. There may be some indicators which could be applied in both rural and urban situations, while other indicators have been adjusted as shown in the example in Table 8.

Table 8 Happiness indicators for Component 1 in urban and rural societies

Component	Sub-component	Urban indicator	Rural Indicator
1. Well- being			
	Physical health		
	-Healthy body	Ratio of population with diseases caused by stress and urban pollution i.e. cancer, heart failure, allergy	Ratio of population with diseases caused by poverty and poor sanitation i.e. parasitic infection, malnutrition
	-Longevity	Life expectancy at birth (years)	
	Mental health		
	-Healthy mind	Ratio of mental disorder patients	*No indicator*
	-Sense of moral	Criminal cases per 1,000 population	-Population with religious activities (%) -Participation in the community group activities (%)
	Knowledge		
	-Educational attainment	Ratio of secondary school enrollment	Mean years of schooling outside municipal area
	-Quality of education	Test scores on class subjects in secondary school	Test scores on class subjects in primary school
	-Information acknowledgement	-Population access to internet	- Population reading newspapers

Source: NESDB (2007)

Even though the happiness index is not yet completed (scheduled to be completed by July 2007), preliminary assessment of the happiness of Thai society has been conducted based on available data from 2001-2005. Currently the 6 components were given equal weight for the composite index.

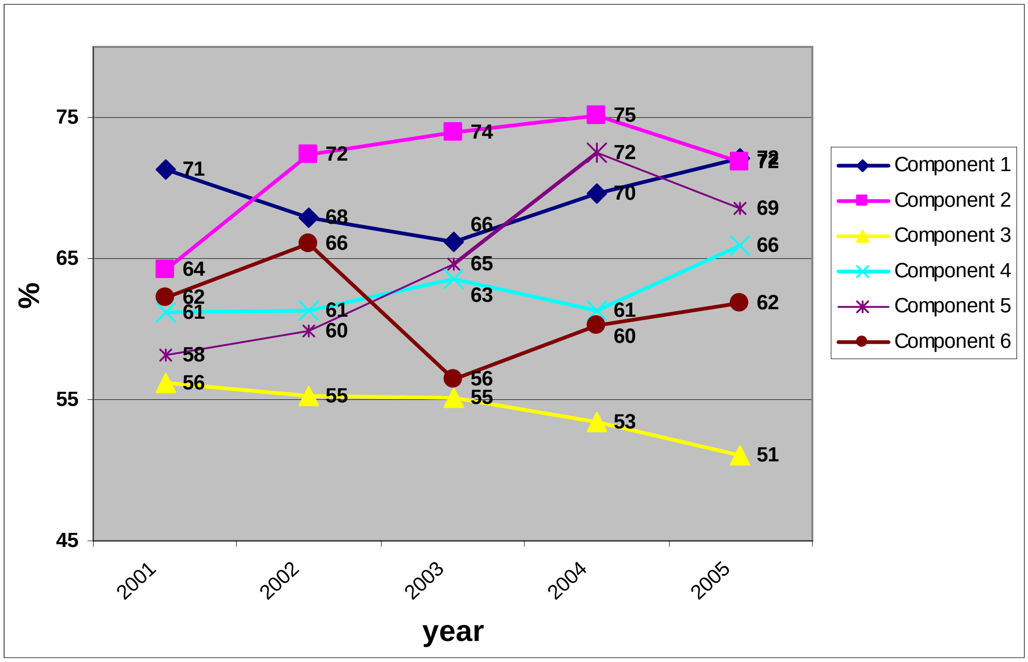

Figure 3 Thailand's happiness index assessment 2001-2005

Component 1 = well-being, component 2 = economic strength and equality, component 3 = family life, component 4 = strong community, component 5 = good living environment with balanced ecosystem, component 6 = democratic society with good governance
Source: NESDB (2007)

The assessment results showed that the overall trend of happiness level of Thailand increased from 62.2% in 2001 to 66.0% in 2005. The components which showed greatest change were well-being, economic strength and equality, good living environment with a balanced ecosystem, and strong community. The components which had worsened were family life and democratic society with good governance. The details of assessment results for each component are shown in Figure 3.

4. Experience in PRC

Two efforts contributing to mainstreaming EPA in PRC are (i) environmentally extended national accounting based on an aggregate indicator, the so-called green GDP, and (ii) recognising excellence of urban development based on an integrated assessment of quantitative and qualitative indicators. The former functions like a thermometer to indicate where the nation is now and how far it can go on the track towards sustainability, while the latter if adopted on a voluntary basis can serve as an incentive to stimulate good performance. A third aspect of EPA on which little public information is available is the recently completed OECD peer review of PRC's environmental performance. Further details on this will be included in this paper as details are made available.

4.1 Aggregate Indicator: Green GDP

To promote integrated environment and development decision making the State Environmental Protection Administration (SEPA) and the National Bureau of Statistics

(NBS) jointly initiated a study on PRC's Green National Accounting (GNA) in March 2004. Technically supported by the Chinese Academy for Environmental Planning, SEPA and Renmin University, the system of environmental and economical accounting is now established and pilot projects on GNA and on the valuation of environmental damages have been conducted at the national level and for ten selected provinces/municipalities[4] since 2005.

Accounting method and components of GNA - Based on the *Systems of National Accounts 1993* (United Nations et al. 1993), the United Nations (UN), the Commission of the European Communities, the International Monetary Fund, the Organisation for Economic Co-operation and Development (OECD), and the World Bank, published a system of integrated environmental and economic accounting (SEEA) (United Nations 1993). In 2000, the UN prepared an operational manual on SEEA (United Nations 2000) and a final version of the handbook of national accounting for SEEA (United Nations et al. 2003) was published in 2003.

A satellite system of the System of National Accounts (SNA), SEEA brings together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment. It provides policy makers with indicators and descriptive statistics to monitor these interactions as well as a database for strategic planning and policy analysis to identify more sustainable paths of development.

A simplified expression of green GDP = GDP - Consumption of Fixed Capital – (depletion + defensive expenditure + degradation), or in other words, net domestic product (NDP) less costs for natural resources and for the environment. PRC's GNA adopts a similar accounting method but substitutes GDP for NDP as GDP is more familiar to policy makers and the public. GNA thus consists of three components (i) physical accounting of environmental pollution; (ii) valuation of imputed environmental degradation cost; and (iii) environmental adjusted national accounting.

The physical accounting of environmental pollution is divided into three sub-accounting tasks, water pollution, air pollution and solid wastes, accounting for physical amounts of generation, disposal and discharge/emission. The survey to generate input data for each item is conducted for 42 sectors at national level, regional level[5] and in 10 selected provinces/municipalities led by SEPA and NBS in collaboration with other departments including Ministry of Health, Ministry of Agriculture, Ministry of Water Resources, Ministry

[4] The 10 provinces/municipalities selected for conducting the pilot projects include Beijing Municipality, Tianjin Municipality, Chongqing Municipality, Hebei Province, Liaoning Province, Anhui Province, Zhejiang Province, Sichuan Province, Guangdong Province and Hainan Province.

[5] PRC's mainland is grouped into three main regions, representing the east, the central and the west. (i) Eastern region includes Beijing Municipality, Tianjin Municipality, Hebei Province, Liaoning Province, Shanghai Municipality, Jiangsu Province, Zhejiang Province, Fujian Province, Shandong Province and Hainan Province. (ii) Central region includes Shanxi Province, Jilin Province, Heilongjiang Province, Anhui Province, Jiangxi Province, Henan Province, Hubei Province and Hunan province. (iii) Western region includes Inner Mongolia Autonomous Region, Guangxi Zhuang Autonomous Region, Chongqing Municipality, Sichuan Province, Guizhou Province, Yunnan Province, Tibet Autonomous Region, Shannxi Province, Gansu Province, Qinghai Province, Ningxia Hui Autonomous Region and Xinjiang Uigur Autonomous Region.

of Construction and Ministry of Communications. Nearly 30% of major industrial polluters, all sewerage plants, municipal solid waste disposal plants, large-scale livestock and poultry farms and 30,000 households were included in the provincial/municipal survey.

The valuation of imputed environmental degradation cost is conducted by two alternative methods based on the former physical environmental accounting. One alternative is estimating maintenance costs. Maintenance costs are the additional imputed costs that would have been incurred if the domestic economic activities of an accounting period had been modified or their impacts mitigated in such a way as not to have impaired the long-term quantitative and qualitative levels of the domestic and worldwide natural environment. In PRC's GNA, maintenance costs are based on domestically available and prevailing abatement/mitigation technology to avoid any environmental degradation in the accounting period. The aggregate of maintenance costs can represent the lower bound of the value of environmental degradation. The second alternative is estimating the imputed environmental damage costs, including loss of agricultural productivity, health damage cost and cost of damage to the ecological functions. Compared with the former alternative, this is regarded as a more appropriate way to reflect the imputed environmental degradation cost.

The national accounts adjusted by the environmental satellite account, or the green GDP, is then obtained by deducting the cost of environmental degradation from the conventional GDP.

Limitations - Compared with other estimates of SEEA, which cover broad categories of natural resource depletion including land, minerals, forests, water and fishery resources, and two categories of environmental degradation (environmental pollution cost and ecological damage cost), PRC's GNA 2004 only accounted for environmental pollution costs, while natural resource depletion and ecological damage are not yet embedded due to limitations in data and valuation techniques. In addition, environmental pollution costs in SEEA includes more than 20 items, while PRC's 2004 estimate only covers 10 items such as (i) health damage, loss of agricultural productivity and material loss caused by air pollution; (ii) health damage, loss of industrial and agricultural productivity, and shortage in water supply caused by water pollution; and (iii) cost caused by land appropriation by solid wastes. Groundwater and soil contamination among other key items are not yet taken into account. Accordingly this accounting version reflects only partial environmental satellite account comparing with a more complete SEEA.

Preliminary accounting results - The preliminary results show that environmental degradation caused by pollution costs about RMB ¥511.8 billion, while imputed maintenance cost is RMB ¥287.4 billion, accounting for 3.05% and 1.8% of national GDP in 2004, respectively. Of the environmental degradation costs, water pollution, air pollution, and solid wastes account for 55.9%, 42.9% and 1.2%, respectively. Though incomplete and underestimated for some items, the striking results indicate the severe situation that PRC is facing to combat environmental damage. It also highlights that published economic growth rates are largely illusory. Regional accounts of environmental damage caused by pollution are shown in Figure 3.

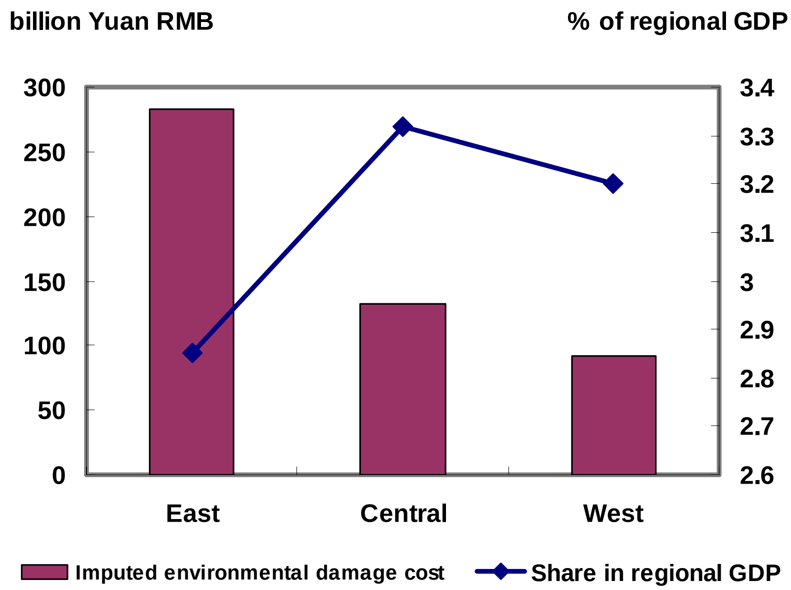

Figure 4 Regional account of environmental damage caused by pollution in 2004

The share of environmental degradation cost in regional GDP ranges from 2.85% in eastern PRC to over 3.2% in both western and central regions. As the biggest contributor to the national total environmental degradation and the biggest contributor to national economic growth, the eastern region, which is the most developed region in PRC, has less pollution offset to regional development compared with the less developed central and west regions, possibly reflecting the relative size of the economy in the east.

Future perspectives - PRC's effort to develop an integrated economic and environmental national accounting system is one of the first among developing nations. SEPA and NBS plan to extend the accounting scope, improve valuation techniques and gradually establish a routine accounting and reporting system instead of a one-off exercise. SEPA will conduct three successive surveys on (i) nationwide pollution sources; (ii) nationwide groundwater pollution; and (iii) nationwide soil contamination, in collaboration with other governmental sectors concerned.

Moreover, a nationwide survey on economic loss caused by ecological damages will be launched in order to lay the foundation for accounting for the total cost of environmental degradation. In parallel, SEPA will initiate research on integrated environmental and economical policies related to effective pollution control, raising revenue for environmental protection, establishing ecological compensation mechanisms, and linking existing EPA of government offices with the green national accounting work.

Based on the 2004 accounting exercise 2004, SEPA will set region-specific priorities for industrial pollution control and demarcate functional zones to facilitate industrial pollution control by integrating regional development plans to promote regional sustainable development.

4.2 Performance Incentives: Environmental Model City Programme

One of the blueprints described in PRC's 9th Five-year Master Plan (1996-2000) for Environmental Protection and Perspective Objectives for 2010 aimed at sustainable urban development through construction of environmental model cities. In 1997, to realise this target, SEPA initiated a programme to award the title of Environmental Model City to cities with a civilised and prosperous society, rapid and sound economic development, good environmental quality, appropriate resource utilisation, sound ecological cycle, clean and beautiful urban environment, adequate infrastructure and convenient living conditions (China Environmental Statistics Editing Committee, 1998, 1999, 2000, 2001 and 2002).

Indicators, criteria, procedures and stakeholders - Aimed at setting a good example to promote sustainable urban development, this award programme, although on a voluntary participation basis, involves an official assessment by SEPA against criteria set for 28 indicators covering social, economic and environmental aspects and environmental concerns such as resource consumption, environmental investment, environmental quality, pollution control, ecological conservation and environmental management, among others. In the 11th Five-year Master Plan period (2006-2010), the scope of assessment will extend to 36 indicators and some of the criteria will be upgraded (see Table 10).

The procedure followed in making the awards includes (i) formal application by the municipal government together with nomination by the provincial environmental protection bureau; (ii) preparation of an action plan towards a qualified Environmental Model City based on the criteria set by SEPA (see Table 10); (iii) implementation of the action plan with proven improvement; (iv) on-site investigation by SEPA; (v) official assessment by SEPA; (vi) public reporting of the assessment results; (vii) decision on the city's eligibility made by SEPA; (viii) annual award ceremony; and (ix) periodic re-examination by SEPA to ensure maintenance and encourage continuous improvement.

Stakeholders involved in the whole process include SEPA, municipal government, municipal environmental protection bureau, provincial environmental protection bureau, related sectors, and the public.

Table 9 Indicators for official assessment of an Environmental Model City

Category	No.	Indicator	Criteria
Basic requirement	1	Quantitative assessment of integrated urban environmental management	keep top 3 record in province / municipality ranking for the last 3 years
	2	Occurrence of major pollution accident or ecological disaster	None
	3	Environmental investment	> 1.5% of GDP
Social and economic indicator	4	GDP per capita	> RMB 20,000
	5	Annual economic growth rate	> national average level
	6	Birthrate	< national planned quota
	7	Energy consumption per unit GDP	< level of an average city
	8	Water consumption per unit GDP	< level of an average city
Environmental quality	9	Days with air pollution index (API) < 100 (or the annual average daily level of major air pollutants)	> 85 % of total days in a year (or attains national air quality criteria grade II)
	10	Quality of water resources providing concentrated drinking water	compliance rate > 96%
	11	Quality of inland water (including near-shore seawater)	compliance rate 100%, no occurrence of Grade V (including blackness, odor, total phosphorus, total nitrogen, and active phosphate)
	12	Ambient noise	average level < 60dB (A)
	13	Noise of the trunk of transportation system	average level < 70dB (A)
	14	Construction of conservation area for drinking water resources	qualified rate > 90%
	15	Share of natural reserve area	> 5% of urban land area
	16	Share of vegetation area (area of gardens and parks per capita for western region)	> 35% of urban build-up area (> national average level)
	17	Rate of urban sewage treatment	> 70% (> 60% for western region)
	18	Compliance rate of major industrial polluters	> 95%
	19	Rate of access to gas utility	> 90%
	20	Rate of central heating in north PRC	> 65%
	21	Compliance rate of vehicle emissions	> 90%
	22	Rate of safety disposal of municipal solid wastes	> 85%

	23	Rate of disposal and utilisation of industrial solid wastes; rate of disposal of hazardous industrial solid wastes (including hazardous chemical wastes)	>90%; >90% and no release of hazardous wastes (including medical hazardous wastes)
	24	Rate of disposal of remnant hazardous wastes	> 90%
	25	Share of urban area implemented particulate control measures	> 90%
	26	Share of urban area complying with ambient noise criteria	> 60%
Environmental management	27	Environmental performance assessment of government officers; accountability system for achieving urban environmental management target; plan to ensure improvement against the benchmarks set for Environmental Model City	Environmental indicators included in performance assessment of government officers; environmental accountability system should be implemented; targets should be broken down into pragmatic action plans.
	28	Environmental protection institution and environmental capacity building	Independent environmental protection institution should be established and normalised
	29	Public satisfaction with urban environmental quality; proper response to public denouncement of environmental pollution	> 85%; 100%
	30	Environmental education in primary and elementary schools	> 80% and the minimum hours for environmental curriculum should be 12.
	31	Share of green community	> 20% of total number of community and should improve continuously
	32	Action plan for achieving total emission control goal	Properly designed action plan and major polluters should achieve specific abatement target based on the total emission control goal
	33	Sanitary condition	Pragmatic action plan to improve sanitary condition should be drafted and should be ranked as a provincial level Sanitary City; and satisfies the requirements for the nomination by the National Sanitary Committee to enter the screening process of national level Sanitary City.
	34	Environmental management on the outskirts of the city	Complies with state requirements and prepares governmental documents, drafts relevant rules and makes progress report

	35	Environmental information disclosure system; and emergency response scheme for environmental accidents	Environmental information disclosure system should be established; and an emergency response scheme should be drafted; special budget should be appropriated; and staff should be in place with skills enhanced by regular emergency drills.
	36	Rate of enforcement of key environmental projects (ratified by the State Council and/or by the Provincial Government)	> 80%

Source: http://www.zhb.gov.cn/cont/mhcity/

Success factors – With increasing public environmental awareness, many municipal governments have recognised that a better urban environment is not only important to sustain sound social and economic development but also to open up opportunities for expanding domestic and foreign direct investment. The Environmental Model City award programme functions as a platform to recognise, award, and publicise municipal efforts towards sustainable urban development by providing concrete criteria of performance. Obvious progress has been observed during the last decade since the scheme's debut in 1997. From 1997 to April 2007, 72 cities were recognised as Environmental Model City by SEPA (Figure 4) and twice as many have submitted their applications or are in the process of evaluation.

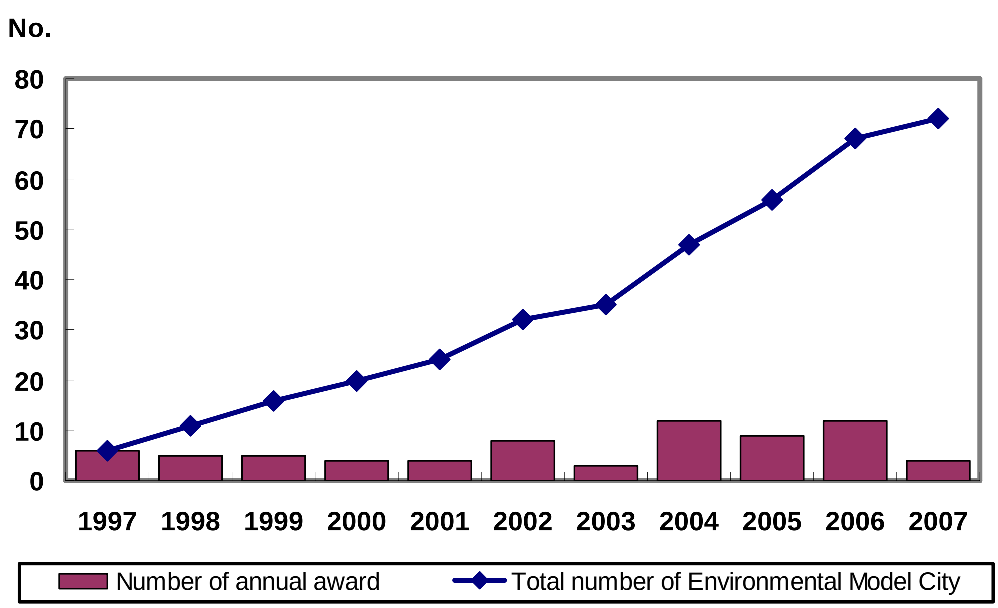

Figure 5 Progress of Environmental Model City award programme (1997-2007)
Source: http://www.zhb.gov.cn/cont/mhcity/

Cities that have already been awarded the title of Environmental Model City and those in the process show tangible improvement in urban environmental quality and have established positive cooperation mechanisms among different sectors towards a common goal.

Though SEPA plays important role in defining the indicators, setting up criteria, conducting on-site investigation and coordinating assessment and implementing monitoring, one of the keys to success of this programme is that local government takes the initiative on a voluntary basis. In the process, both SEPA and municipal governments have learned how to achieve sustainable urban development. Some aspects of success include:

- Environmental awareness of local governments and the public has increased;
- Environmental Model Cities have also been rewarded with more rapid economic growth through expanding foreign trade and attracting more domestic and/or foreign direct investment;
- The programme saves substantial transaction costs for its implementation and has financial sustainability for its continuous implementation;
- Economic structural adjustment has been accelerated;
- The indicators set for performance assessment stimulate municipal governments to integrate environmental considerations into economy-wide decision-making and establish effective cooperation mechanisms among different sectors;
- The 10-day public reporting in the media before a final decision makes the process more transparent and encourages public participation;
- Voluntary approaches rather than command and control measures encourage innovations of environmental governance and a mixture of various policy measures according to each city’s own specific conditions; and
- There is continuous improvement encouraged by periodic re-examination.

Limitations and future perspectives - The effectiveness of this programme in promoting sustainable urban development depends on well designed indicators and selection of criteria/benchmarks. Both the scope of indicators and the level of criteria/benchmarks need further research.

So far, Environmental Model Cities are geographically concentrated along the eastern coastal region of PRC, where the economy is more developed (Figure 5). As PRC is a big country with evident regional discrepancies, indicators and criteria/benchmarks tailored for different regions are needed but have not yet been addressed in the current programme. Another concern is that there is no effective mechanism to ensure sustained improvement after the award is granted.

Figure 6 Spatial distribution of Environmental Model Cities

5. Lessons Learned

From the above review and experience in SEF II, several key lessons have been learned. In SEF II, from the outset of the project, there was a healthy debate over the choice of priority concerns and indicators. While some observers might claim that the eventual indicators chosen were not always the best, the process of examining a range of possible indicators and evaluating their advantages and disadvantages helped to define the nature and magnitude of the performance measurement issue. It will be advantageous to re-examine the priority concerns and indicators chosen in SEF II, if only to reinforce the central place that indicator choice takes in EPA.

Most countries seem to have chosen too many indicators for different purposes, leading to inadequate focus on achieving measurable results for priority environmental concerns. All of the international experience suggests that a limited number of indicators should be chosen, usually with a core set of indicators identified for public communication. If too many indicators are selected then the burden of monitoring will become unsustainable and trend analysis over the medium-term to long-term will fall by the wayside. In SEF II over 90 indicators were chosen and there is clearly a need to reduce that to a more manageable number.

Where institutional arrangements for sustainable development planning are different from the national environment agency, there is a danger that multiple sets of environmental indicators may be selected. In Thailand, NESDB is experimenting with a wide range of indicators, which include various environmental indicators. Some of these tend to be difference from the indicators that the national environment agencies use. As ONEP has identified 182 indicators, the need for rationalisation of the multiple approaches in Thailand is clear. One way for this to be done is to more consistently involve NESDB in Component 3.

In PRC, the aggregation of indicators for the green GDP demonstrates some of the advantages and disadvantages of using an aggregate index. The main advantage is that GDP is an index with which most people are already familiar. Therefore, a significant reduction in GDP by incorporating environmental costs is intuitively accepted by the public. However, green GDP is less useful as an environmental management tool, except in the broadest sense that more effort is needed. As the partial approach adopted by PRC leaves out significant elements, such as natural resource depletion, it could even be misleading if the omitted aspects are significant contributors to overall environmental damage. The good news is that SEPA plans major data collection efforts on groundwater pollution, soil contamination, other forms of pollution, and ecological damage that will all contribute to enhanced EPA reporting.

The main advantage of using an aggregate index is that it can indicate what environmental costs are incurred in achieving economic growth, by integrating or internalising environmental costs into the conventional economic accounting system. This can highlight optional growth paths based upon a society's preference for more economic growth but more environmental degradation, or less economic growth compensated by better environmental quality. However, one caution in using an aggregate index is that there may be a misleading in the message conveyed by the green GDP, i.e. environmental degradation and economic growth can be perfectly substitutable for each other. Man-made capital and natural capital are not necessarily substitutable and some environmental degradation or ecological damage is irreversible.

The Environmental Model City programme in PRC is a good example of shifting responsibility for environmental management to lower levels of government, where stakeholders are closer to the real environmental conditions. The voluntary nature of the programme and the public reporting are also interesting approaches, although how to spread the programme to the often highly polluted western region cities without any mandatory regime is not clear. While there is periodic re-examination of the award, a useful addition to the approach would be to raise the hurdle progressively so that there is continuous improvement across all cities and leading cities would be appropriately recognised and rewarded. As there are more than 500 cities spread across PRC, one possibility would be to use a star rating system, similar to the Programme for Pollution Control Evaluation and Rating (PROPER) programme in Indonesia that ranked individual enterprises on their environmental performance (Garcia Lopez 2004). In Indonesia, even the threat of being awarded a "black star" was often enough to trigger change.

A similar rating system to PROPER for rating enterprises is being implemented at a pilot stage in some PRC cities in collaboration with the World Bank. This is operated on a voluntary basis, but mixed with a mandatory requirement for major polluting enterprises. As most of the major polluters are marked by a brown or black color star, few of them are willing to join this programme on a voluntary basis. However, considering the effectiveness of this kind of programme, not only as an incentive to improve corporate environmental behavior, but also contributing to emission reduction, the inclusion of these lagging enterprises is crucial. While voluntary based environmental performance assessment programmes have shown their effectiveness in recognising excellent performance or good governance, for rating purposes or assessment against benchmarks, a voluntary regime tends to be weak and either mandatory or a mixture of mandatory and regulatory regimes might be more effective.

6. Possible Alternatives to Current Set of GMS Indicators

6.1 Land Degradation

Land degradation is one of the major concerns observed in many developing countries and most GMS countries also agree on its importance. FAO (2003) reports that in South Asia 30-40% of the agricultural land is degraded to some degree from water erosion (25%), wind erosion (18%), soil fertility decline (13%), salinisation (9%), lowering of the water table (6%), and waterlogging (2%).

However, selection of appropriate environmental indicators for land degradation is not an easy matter. FAO (2003) states that there are no internationally agreed criteria for estimating the severity of degradation and most surveys do not make reliable assessment. Given this situation, selection and collection of appropriate environmental indicators should consider various factors including (i) types of indicators, (ii) implementability of collection, and (iii) consistency among *pressure, state, and response* indicators.

Regarding the *state* indicator, there are broadly two types of indicators: physical measurement (both direct and indirect) and non-physical measurement, e.g. those expressed in monetary terms. The former indicates the state of land productivity directly while the latter indicates it indirectly by the value attached to land productivity. As recognised during SEF II, physical measurement of the degree of degradation at the national scale would be difficult, and would inevitably involve some sampling regime. Direct physical measurement would involve biophysical evaluation of soil conditions that need to be carried out in laboratories or on-site measurement of soil erosion with land use held constant. Neither would be very suitable because of the large variation among samples and the lack of implementation capacity in GMS countries. In addition, erosion itself is not necessarily representative of all forms of land degradation.

Indirect physical measurement such as crop yield is not perfect either due to its dependency on biological conditions such as varieties of crops and weather conditions as well as capital, labour and technological inputs (e.g., level of mechanisation/irrigation, application of fertilisers and pesticides, crop rotation cycles). For instance, a decline of yield can be observed if labour availability decreases (e.g., from out-migration), land availability increases, rotation is more frequent, or agricultural inputs decrease.

In spite of the various drawbacks of crop yield as an indicator, efforts to collect crop yield data such as that of rice, which is a commonly grown staple food in the region, may be of some use as a latent aggregate indicator that represents the *state* of soil conditions. Yield is a common term used among farmers, the primary stakeholder. A challenge would be how to screen out the aforementioned biological and human-induced “noise.” For this reason, it is preferable to have the attainable yield under field conditions or similar benchmark/baseline yield as a parallel indicator, which can be derived from simulation of actual agro-climatic factors with scenarios of mixes of farming technology and management options. Such efforts may need to be sought region-wide. Actual yield as a ratio of “attainable” yield may then provide a more robust indicator.

Since human-induced agricultural activities are closely related to crop yield as mentioned above, some of these factors can be used as *pressure* indicators and potential *response* indicators that represent rehabilitation countermeasures. This way, the linkage between human activities and environmental impacts is clear and consistency among the three types of indicators will be maintained (i.e., consistent linkage of *pressure*, *state*, and *response*). Human-induced soil degradation includes mechanisation, irrigation, application of fertilisers and pesticides. However, it should be noted that farming technology and management can influence land productivity both positively and negatively in a nonexclusive and simultaneous way. For example, increasing the level of mechanisation can contribute to an upgrade of land productivity while at the same time causing compaction of soil which results in land degradation. Application of fertilisers and pesticides contribute to an increase in land productivity and yields, while excessive application could cause soil degradation. For this purpose, some benchmark (or ideal input level) would be necessary to determine the excessiveness of human activities.

Alternatively, a set of indicators can be expressed in monetary terms. Crop market prices can be used as both *pressure* and *state* indicators. For instance, if domestic prices of export-oriented crops are above international levels, there would be considerable pressure to produce a large amount of them at lower costs. Also, levels of subsidies on fertilisers may imply a certain level of *pressure*. In this regard, other factors such as population, rates of inflation/deflation are also factors that influence the value of agricultural output which in turn affect land productivity and land degradation. An advantage of using monetary indicators is that they can be integrated into an aggregate indicator scheme such as the GNA system (or green GDP) outlined for PRC. Some of the disadvantages are that cause-effect relations with land degradation remain somewhat indirect and comparison among countries would be affected by exchange rates and inflation rates.

Finally, as is the case of most indicators, efforts to collect time series data are vital to analyse changes over time. It is also possible to express indicators in terms of a ratio compared to the previous year or a base year. This may be useful for a *state* indicator so that it can indicate the dynamic nature of indicators rather than a static snapshot.

6.2 Water Issues

Inland water pollution is treated as separate priority area from water resources in Table 2. The former is more closely related to quality of the water resource after use (selected by only three GMS countries) while the latter relates to quantity of water resources before use (selected as a priority by six GMS countries). However, both are equally important and related each other. Polluted water can imply poorer water availability.

Inland water pollution - As *state* indicators for inland water, BOD_5 and COD are commonly used standard measures across the world. As a *pressure* indicator, the volume of end-of-pipe wastewater discharge can be used as a measurement of one direct cause of pollution (the other main source is diffuse polluted runoff from agriculture and urban areas). Sources of wastewater are usually categorised as industrial (point-source), agricultural (non-point source), and household (non-point source in nature but can be regarded as point-source if a sewage collection system is in place). Information that reflects industrialisation (such as the number of water-use intensive factories), agriculture (such as the number of livestock or amount of fertiliser applied) or urbanisation (such as the number of households) may be used as *pressure* indicators. The agricultural sector will be responsible for a large portion of water pollution caused by inappropriate fertiliser use and increasing organic waste generation from livestock and food processing industries. Shindo et al. (2006) simulate and project, for example, that nitrogen loads from the agricultural industry in 2020 would become 1.4-1.7 times that of the present load in the ASEAN+3 countries.

Regarding the implementability of data collection, non-point source pollution data would require an independent monitoring group since this data is usually not voluntarily monitored by polluters. Point-source data could be collected at the discharge sites of potential polluters and this can be done by making such monitoring a mandatory condition of an operating license, especially for enterprises of commercial scale.

For *response* indicators, except for expenditure on wastewater treatment, figures associated with capacity building such as the improvement of the monitoring system, inspection frequency and institutional measures such as policy/standards/regulations or legislation are also important in assessing the performance of effective responses to reduce inland water pollution.

Consistency among *pressure, state,* and *response* indicators would be enhanced if data collection efforts are increased for the three source categories (industrial, agricultural, and municipal). For example, volumes of wastewater discharge, measurement of water pollution, and expenditure on pollution control for each of these categories may be useful. Also, this set of data would be beneficial to water resource issues (quantity issues).

Water resources - Water resources is one of three priority indicators that deal with quantity issues listed in Table 2 (fish and forest resources being the other two). Quantity issues often require (i) assessing the size or stock of resources, (ii) planning and management the extent of allowable use prior to resource allocation, and (iii) making efforts to conserve (water resources) or expand the stock of resources to the maximum possible extent (fish and forestry resources). OECD (2001) predicts that the overall increase in water use in non-OECD countries between 1995 and 2020 is likely to be approximately 25%. Agriculture being the largest water user, FAO (2003) predicts about one-third of the harvested area in developing countries in 2030 is projected to be irrigated land, up from 29% in 1997/1999 (about 14% increase). However, *pressure* on water use is from multiple users (agricultural, industrial, and municipal use), depending on the country's economic profile. It may be preferable to have *pressure*, *state,* and *response* indicators such as volume of water demand, volume of water use/shortage, and expenditure spent to secure water resources for each of these categories, similar to the set of indicators for inland water pollution. Grasping the overall demand for water use at the national level is particularly important in the watershed of the Mekong River where the main water source is shared by many countries for various uses. As fishery resources are considered important in the Mekong basin not only for economic activities but also nutrition, water use for fishery purposes (in lakes, rivers, or fish farms) may need to be differentiated from agricultural uses.

6.3 Forest Resources

All the GMS countries agreed on the importance of forest resources. In recent years there has been a growing recognition of the importance of forestry in providing environmental goods and services such as protection of watersheds, conservation of biodiversity, recreation, and mitigating climate change (FAO, 2003). FAO also states that nearly all forest loss is occurring in the tropics. Population growth coupled with agricultural expansion (especially in Africa and Asia) and agricultural development programs (in Latin America and Asia) are major causes of forestry cover changes (ibid.). Since wood production is usually categorised into fuel and non-fuel purposes, as *pressure* indicators it may be preferable to have domestic prices for fuel and non-fuel wood as well as their associated volumes demanded. To select *state* and *response* indicators, different types of forest (commercial use or conservation) need to be considered. A ratio of these types of forest as a composite *state* indicator may be indicative, however, the severity of changes in composition may not be shown clearly if one denominator (conserved forest) is extremely large. In the case of *state* indicators for forestry resources, one expressed in terms of changing rates of forest cover can be meaningful since one of the global concerns is the speed of deforestation.

6.4 Waste Issues

Inadequate waste management is one of the few concerns on which many GMS countries agreed and are collecting associated data. Dealing with the total quantity of wastes seems to be an appropriate step to start with, however, as separation and recycling of wastes progress in GMS countries, issues related to quality of wastes (toxic contamination) may soon become important, although only two GMS countries rated this as a current priority.

As *pressure* indicators of general waste generation, population and economic growth may be useful. As *state* indicators, the volume of municipal solid waste would represent the general situation of the nation's waste generation, although this could be used as direct *pressure* indicator and the percentage of municipal solid waste collected (identified in Table 2) as the *state* indicator of waste management. Among other possible indicators, expenditure on municipal solid wastes would make all three *pressure*, *state*, and *response* indicators consistent. It should be noted that industrial wastes would need to be paid increased attention as economies develop.

Regarding toxic contamination, except where raw toxic materials are extracted from mines in GMS countries, many of the complex chemical compounds originate in foreign countries. These are already accumulating as trade flows increase in the subregion. In this sense, an increased volume of material flow can be a *pressure* indicator and the current levels of toxic contamination from materials such as persistent organic pollutants

(POP) and banned pesticides which are not properly disposed in GMS countries can be *state* indicators. Since hazardous wastes and materials, such as medical wastes and industrial wastes (batteries and electronic parts) which pose larger risks to human health in small quantities, may increasingly penetrate GMS countries, data collection may be soon required. In this context, an inventory of toxic materials would be a suitable *response* indicator.

6.5 Biodiversity

As Mike Comeau pointed out in SEF II the top five threats based on citations of major threats to endemic species are habitat loss (ranked highest), harvesting, intrinsic factors, pollution, and human disturbance. The loss of forests was seen as the main pressure in the GMS in terms of natural habitat, followed by wetlands, shrubland, grassland, and artificial terrestrial (ADB, 2006).[6] Most GMS countries, except for Thailand, considered this as a significant concern.

There are still technical difficulties in the measurement of biodiversity. A consensus on the definition of "threatened" and how it is measured needs to be reached among GMS countries. The OECD Key Environmental Indicators for 2004 noted that "threatened" refers to species in danger of extinction and species likely to be in danger of extinction soon." In measuring the *state* of biodiversity, the number of threatened or extinct species is compared to the number of known or assessed species—a problematic measure when the number of known species is known to be wildly underestimated in the GMS. OECD and IUCN stated that trends in protected area should be provided as a complement, although this looks more like a *response* indicator.

OECD identifies habitat alteration and land conversion from the natural state as its core set of indicators for *pressures*, area of key ecosystems as a *state* indicator, and protected areas as a *response* indicator. A challenge in assessing the effectiveness of protected areas as a *response* indicator is the number of "paper parks", the varying and actual protection levels, management effectiveness and related trends where new areas are designated, or where boundaries are revised, and/or some sites destroyed or changed by pressures from economic development or natural processes.

6.6 Fish resources

The volume of fish catch was identified as the principal *pressure* indicator by GMS countries. OECD (2004) suggests that fish catch expressed as a percentage of world captures and changes in total catches since 1980, excluding fish production from aquaculture, may be a more effective measure. However, given the importance of fishery resources in GMS in freshwater capture and increasing aquaculture, GMS countries need to address how to incorporate both aspects into their data collecting. Fish catch in rivers, coastal zones and lakes are quite different, so total catch may not point to environmental deterioration in specific fisheries.

As OECD (2004) points out that this *pressure* indicator should be complemented with information on the status of fish stocks and the proportion of fish resources under

[6] Presentation on "Sub-Regional Wildlife Biodiversity Assessment" at the SEF II Final Workshop in Bangkok, 26 April 2006.

various phases of fishery development. Estimation of stock size, though it is often accompanied by technical difficulties, could be used as *state* indicator, while management of the resource or efforts to expand the stock of resources could be used as a *response* indicator.

Alternatively, the real domestic prices of fish could be used as *state* indicator, as identified during SEF II, reflecting scarcity. Over-fished areas and size of spawning stock could also be used as *state* indicators and expenditure on fish stock and catch monitoring as a *response* indicator, as suggested by OECD (2004).

6.7 Coastal Zones

The relative real prices of dwellings in the coastal zone were identified by some GMS countries as one *state* indicator. However, use of prices of dwellings may be criticised because property prices in GMS countries are imperfect and may not be directly related to environmental conditions. Distance from a major city, for example, may be more important in determining price than environmental quality. Measurement of quality of coastal water as a *state* indicator could be dealt with as an extension of the inland water quality assessment. Saline and brackish waters, however, may have different environmental parameters of concern. For example, the presence of red tides due to algal blooms may be more important than measures of salinity or turbidity. Mangrove removal is the main *pressure* indicator identified in the GMS countries, but this fails to capture the environmental degradation associated with hotels and other tourism developments along sandy beaches. The existence, compliance and enforcement with coastal zoning plans may be a suitable *response* indicator.

7. Recommendations

Section 1 of this paper outlined some critical choices that need to be made at the commencement of this project. Some recommendations for each of these choices are as follows.

<u>Question 1</u>: A decision will need to be made on whether the set or priority concerns remains as in SEF II or whether new priority concerns have emerged over the past few years.

For the priority concerns, it is unlikely that much has changed since the completion of SEF II, but it is worthwhile examining recent SOE and other reports to see if there are any priority concerns that need to be addressed now.

<u>Recommendation 1</u>: It should not be automatically assumed that the priority concerns adopted at the outset of SEF II remain the top priority concerns today. If new concerns need to be added or a re-ordering of priorities is needed, then adequate time and space needs to be devoted to this question.

<u>Question 2</u>: Will each country be able to stick with their existing indicators (bearing in mind some of the points made in Discussion Paper No. 1) or will they change them?

In the process of indicator selection the importance of *state* indicators is re-emphasised. Ruzicka and Mohit pointed out in SEF II that the best policy targets are generally those that are related to *state* indicators (although see the discussion on *state* and *impact* indicators below). As identifying *pressure* indicators tends to be more difficult due to their divergent nature (i.e., multiple factors can affect one environment *state*), initial efforts could focus on selecting and agreeing on a common set of *state* indicators.

Recommendation 2: To the extent that there is agreement on the need to develop a core set of common indicators at the subregional level, then the emphasis should be on *state* or *impact* indicators. Some possible alternative indicators are suggested in Section 6.

Question 3: For those countries which did not select certain priority concerns but wish to do so this time around, which indicators will be chosen?

The three discussion papers presented to the Inception Workshop reflect in different ways on the applicability and relevance of the indicators chosen in SEF II. As an input to the choice of indicators, it is suggested that GMS country teams review these observations, discuss them with other GMS teams, and conduct their own brainstorming to come up with a suitable set of indicators.

Recommendation 3: The experience of SEF II plus additional information provided at the Inception Workshop should guide GMS country teams in adopting new indicators for priority concerns that they did not choose in SEF II.

Question 4: Where there were missing concerns in SEF II will the GMS countries be able to fill them and if so, what indicators will be chosen?

The review of Thailand and PRC outside the SEF II process suggests that there is a wide range of concerns that were not addressed. A complete review of other indicators based performance assessment is needed to identify a new long list of possible priority concerns. This long list can then be reduced to a workable set of priority concerns through national workshops involving a wide range of stakeholders.

Recommendation 4: The list of priority concerns should be revisited by all GMS countries as it is clear that other planning processes have identified a wider range of environmental issues. A long list of additional concerns should be reduced to a workable set through national consultation with a wide group of stakeholders.

Question 5: For the sub-national level are the priority concerns the same as at the national level and if not, what are the appropriate indicators?

As indicated by the Environmental Model City programme in PRC, the sub-national level priority concerns are not always the same as at the national level.

Recommendation 5: For the conduct of EPA at sub-national level, a separate process of identifying priority concerns should be undertaken, preferably retaining a core set that is common to both national and sub-national levels.

Question 6: Is there any appetite among the GMS countries to extend the EPA methodology to the sectoral level?

In SEF II, there was understandable emphasis on building capacity within the national environment agencies. Now there is a need to extend this approach to all sectoral agencies that impinge on environmental quality. The importance of developing institutional capacity for conducting EPA in a wide range of agencies in each GMS country is stressed, keeping in mind the longer term goal of developing a harmonised set of environmental indicators that will promote sustainable development in the subregion. One of the conclusions and recommendations made in the SEF II report states:

> "Environmental standards and policies are not uniform in a developing region like GMS, where most of the member countries are still at relatively early stages of their economic development and where different development priorities affect the way in which available resources are allocated towards environmental management. Policy and environmental standards harmonisation is desirable but will best be achieved through a sustained process of institutional strengthening and capacity building of environmental institutions in the GMS and appropriate stakeholder participation (ADB, 2006)."

Recommendation 6: It would be beneficial for the GMS countries not to focus on comparing national performance at this stage, nor to benchmark performance, but to build capacity in the key government agencies and focus on reducing environmental impacts of the sectors. Sectoral agencies should also share the experience and lessons gained from their development of institutional capacity and conduct of national and provincial level EPAs, through a process of continuous self-improvement, with their counterparts in other GMS countries.

Question 7: Is there any need to extend the aggregate index approach that was tentatively explored in SEF II?

The PRC experience with the green GDP, global systems like the ecological footprint or the wealth of nations, Thailand's happiness index and others demonstrate that there is a fascination with trying to come up with an environmental index that will achieve global acceptance in the same way as GDP or the Human Development Index. An aggregate index might grab political attention and help raise general awareness, and in this sense it can be useful addition to separate indicators for each environmental concern.

Recommendation 7: There have been so many attempts at drawing up new "sustainability" indexes, there should be no attempt made under Component 3 to develop any new aggregate index. Experimentation with existing schemes, such as green GDP, however, may be encouraged as such aggregate indexes will help to raise public awareness and political attention.

Question 8: Is there a need to go beyond the environmental indicators and extend the analysis to sustainability assessment, covering social and economic indicators?

In SEF II, there was a view expressed that EPR should extend to sustainability assessment. In practice, most GMS countries wisely stuck to environmental concerns. There are ongoing assessments of economic and social performance in most countries and the MDGs are perhaps the best example of a global effort in this regard. Integration of economic, social, and environmental assessments into a common assessment has generally failed, not only in developing countries. As such an extension would significantly expand the workload of the project, care must be taken before going down this road.

Recommendation 8: Component 3 should stick to assessment of environmental performance, while recognising its importance in contributing to broader sustainability assessments.

Question 9: Is the Pressure-State-Response (PSR) model still regarded as adequate or should it be extended to the more comprehensive Drivers-Pressure-State-Impact-Response (DPSIR) model used in the Global Environmental Outlook (GEO)?

Continued effort is needed to identify the cause-effect relationships between *pressure* and *state* indicators, as well as the efficiency and effectiveness of *responses* in changing the *state* conditions in the desired direction. Improved knowledge of these linkages would be beneficial to link EPA, NSDS and subregional development strategies. By expanding the PSR model to DPSIR some of these linkages will become clearer.

Recommendation 9: Even though some DPSIR indicators may be rejected at this stage because of inadequate data, research into cause-effect relationships should continue. As the relationships become clearer, then indirect or proxy indicators should be replaced with more direct indicators.

As the GMS countries begin to realise that environmental *response* measures are not always best directed at the proximate causes, the need to distinguish between "ultimate *drivers*" and "proximate *pressures*" will become clearer. Similarly, it will become clearer that countries are only concerned with the *state* of the environment because of the *impact* that a changed state has on a group of people or some ecosystem function, on which we depend.

Recommendation 10: Mechanical adoption of the DPSIR approach to replace the PSR approach would result in almost doubling the number of indicators needed. Therefore, it is recommended that a more selective approach is adopted. If the chosen *response* indicator is aimed at an underlying *driver*, then an indicator at the level of *driver* should be chosen, in preference to a *pressure* indicator. If the environmental goal or target is directed at minimising the *impact* on a group of people or some ecosystem function, then an indicator at the level of *impact* should be chosen in preference to a more indirect or remote *state* indicator. The key decision criterion should be that there is always a logical connection between the indicators chosen and they, in turn, should have a logical connection to an acknowledged environmental goal or target. There is no need to have an indicator for every element of the DPSIR framework.

Appendix 1

Review of Environmental Indicator Development
(an abridged version of Technical Paper 1 Appendix B from SEF II)

Introduction

Interest in monitoring environmental conditions and assessing performance against stated policies has followed on the heels of growing public interest in environmental matters and concerns over unsustainable development. “Delivering concise, scientifically credible information in a manner that is readily understood and communicated to decision-makers and other audiences” (WRI)—the purpose of indicators—has claimed a big share of attention in these efforts.

In the process, at least four broad categories of work on—or related to—environmental performance have emerged, namely (1) evaluation of environmental performance by enterprises built around ISO 14000; (2) assessments of the performance of governments and public bodies in general (i.e. not primarily environment-related); (3) environmental performance assessment by (or of) individual countries and (4) environmental performance by (or of) supra-national entities.

Below, the first two are reviewed very briefly reserving most attention to categories (3) and (4).

(1) Environmental performance by enterprises

> "if only governments were run like businesses" …, policy-type objectives arising from UN Conventions could be used as guidelines for establishing continuous improvement programmes at lower level "functions" - as in ISO 14001 systems. Unfortunately, these UN sanctioned goals, boldly agreed to by our governments during UN forums, seem to fade into the background once the party is over. Governments need a lesson from ISO management systems. Executing global initiatives, assuming that they are reasonable to begin with, is really no different from implementing any continuous improvement programme
> (From a review of M. Strong’s Where on Earth Are We Going?” Alfred A. Knopf, Canada)

Business managers have been drawn to assessment systems supported by environmental performance indicators (EPI) by the rising interest in environmental management systems (EMS) particularly as these systems relate to the new international standards of ISO 14000 and ISO 14031, and Europe's Eco-Management and Audit Scheme (EMAS). Some communities and environmentalists approach EPIs from the standpoint of their "right to know," emphasising public disclosure at the facility level. Skillius and Wennberg (1998) note the proliferation of different types of environmental assessment conducted by the corporate sector (environmental auditing, environmental accounting, life-cycle assessment, environmental reporting, development of EPIs and environmental benchmarking to mention only the most common) often conducted without much thought given to the interrelationships among them and the potential synergetic or counteractive effects they could have on each other.

Among numerous EPA initiatives by the corporate sector, worth listing are WRI's Corporate Sustainability State-of-Play initiative developing sustainable development indicators for business, extensive ISO 14031 documentation, OECD-developed guidelines on pollutant release and transfer registers, the SustainAbility approach developed in collaboration with UNEP, the eco-efficiency metrics project by WBCSD, The European Chemical Industry Council (CEFIC) guidelines, and WRI- and INECE-developed approaches. WRI (1998) notes "notable efforts to standardise corporate environmental reporting" but also finds that most corporate environmental managers continue to rely mainly on compliance-oriented EPIs and mandatory reporting of pollutant releases. However, a majority of respondents "regularly used" other unregulated metrics, including greenhouse gas emissions, water and energy use, and chemical inputs.

It is important to recognise the methodological similarities: the quest for a small number of environmental scores that would capture the underlying complexity (in this case, complexity at a facility or company level), search for agreement on the fundamentals of measuring performance that allows meaningful comparisons across facilities and industries, and a hierarchy of assessments that exists both in the corporate and public policy domains. (see the diagram below, reproduced from WRI).

(2) Assessment of the performance of governments and public bodies

This work ranges from tasks as varied as measurement of the efficiency of public expenditure (with a large numbers of examples furnished by, e.g. World Bank and IMF websites) to performance of local governments [see, e.g. the work sponsored by the Sloan Foundation]. Interesting dissenting opinions also emerge from this work, such as doubts about the merits of overly aggregated indicators. [see, e.g. Hatry (1999)]

Differences in labeling apart, the approach to performance assessment by the Government of New South Wales is fairly typical of the situation in OECD countries. The NSW Government has an advisory body, the Council on the Cost and Quality of Government, that periodically prepares State of Effort and Accomplishment Reports, assisted in this task by the Government's own Review and Reform Division. Four types of indicators are used for this purpose, i.e.

Resource indicators that quantify levels of expenditure (and where possible unit costs) on the delivery of services, the number of staff employed and the value of assets owned;

Service indicators measure the type and amount of outputs produced (service efforts) and the outcomes that have been achieved in terms of broad government goals for the policy area (service accomplishments);

Satisfaction indicators measure the personal assessment of services by clients and/or community stakeholders based on their own expectations; and

Community indicators measure broad social, economic and environmental trends relevant to the Government's goals in each policy area. They reflect the influence of a range of factors and often require a long time to show significant change.

Source: http://www.occg.nsw.gov.au/performance

(3) Country-level environmental performance assessment

Asian Development Bank

Though somewhat overshadowed by recent ascendancy of poverty alleviation as an area demanding methodological and practical attention, ADB mid-1990s efforts to develop approaches to facilitating comparisons of environmental performance [*Measuring Environmental Quality in Asia*, ADB and HUP (1997)] deserve to be revisited. Its greatest appeal (and possibly weakness, too) lies in the derivation of single measures of national environmental performance, to some the ultimate prize in EPA work. Since then, much work on aggregate score of environmental (and sustainable development) performance has gathered pace [see UN (2001)].

Three ADB environmental technical assistance projects in GMS (SEMIS, SETIS and SEF I), well-known to GMS environmental authorities, each in their own way dealt with environment-related information, its prioritisation and comparability. More recently, the completion of the *GMS Environmental Atlas* was preceded by extensive review of available indicators for inclusion into the Atlas, both in Manila and in GMS capitals. Whether prompted by ADB or by UNEP under its own indicator compiling activities, national environmental authorities in GMS countries have been made well aware of the state of their environment-related data.

Organisation for Economic Cooperation and Development and its member governments

Development of the methods and practical applications of environmental performance assessments by OECD member countries has nearly a twenty-year history and continues unabated. It is also OECD that has institutionalised the process of country environmental performance assessments based on a peer review. The work by most OECD national governments in this domain is extensive and backed by formidable scientific and institutional capacity. Several semi-government institutions supplement the work of specialised government agencies (e.g. RIVM, the National Institute of Public Health and the Environment in the Netherlands).

OECD has also been in the forefront of efforts to formulate indicators measuring the success of integrating environmental concerns into various economic sectors (transport, agriculture, energy) (http://www.oecd.org/env/soe/indicators.htm)

A number of initiatives by individual OECD countries or groups of these countries have added to the body of work dealing with EPIs and their role in EPA. Swedish Indicators of Sustainable Development (http://www.hallbarasverige.gov.se/eng/index.htm) are fairly typical of these efforts.

Perhaps best known are OECD *environmental performance reviews* of individual member countries that draw on the work done by national governments (including development of indicators and their values) and through a peer review process offers an independent evaluation of progress.

UNEP

In 1973, UNEP introduced *Earthwatch*, as a means of coordinating and acting as a catalyst for all environmental monitoring and assessment activities throughout the entire UN system. The raison d'être was and remains to provide information gathered from across the UN system relevant for policymaking by building essential partnerships across the UN system with the scientific community, governments and NGOs. At the global level, UNEP prepares regular Global Environment Outlooks (GEO), taking information from all regions. Recently UNEP has started to prepare GEO Yearbooks to address emerging environmental issues.

Through its *State-of-the-Environment* reporting, UNEP has assisted a large number of countries in generating and systematically presenting environment-related information, and has contributed significantly to the development and use of environmental indicators. UNEP has been involved in a number of influential collaborative projects aimed at improved EPA such as *Plan Bleu* (see below) and development of rural sustainability indicators in Central America (with CIAT and World Bank).

UNEP CEROI (Cities' Environment Reports on Internet) initiative. It is based on Urban State-of-the-Environment reports[7] and is accompanied by indicators ("Encyclopedia of Urban Environmental Indicators", a matrix of 29 core indicators and other 61 indicators) grouped into 6 categories (DPSIR, external impacts, economic sector, physical environment, social environment, instruments). A related effort to facilitate cross-urban comparisons has been supported by the EU Directorate General Environment ("European common indicators", tested by 100+ local and regional authorities).

UNCSD

UNCSD Indicators on Sustainable Development. Chapter 40 of *Agenda 21* calls for the development of indicators of sustainable development realising that commonly used economic performance indicators such as gross national product and measures of resources and pollution flows, do not provide adequate indications of sustainability. Through its Work Programme on Indicators, UNCSD intends to measure the full spectrum of sustainable development issues. The CSD uses indicators to translate physical and social science knowledge into manageable units of information that can facilitate the decision-making process; measure and calibrate progress towards sustainable development goals; provide an early warning, and sound the alarm in time to prevent economic, social and environmental damage. 134 indicators were initially

[7] Of all GMS cities, only Bangkok has so far prepared such a report

developed for testing in over twenty developing countries. Of these, 55 were environmental indicators. In testing, about 50 out of the initial 134 indicators were found relevant and applicable, and perhaps another 50 not in the original list were considered worthy of consideration.

UNHSP (Habitat)

UNHSP's Global Urban Indicators (GUONET) uses 23 key urban indicators and 9 qualitative data sub-sets plus an extended set of indicators. The indicators respond to six categories of Habitat's commitments (shelter, social development eradiation of poverty, economic development, governance, environmental management and international cooperation)

UNSD

UN Statistics Division (UNSD) compiles *Millennium Indicators Database.* A framework of 8 goals, 18 targets and 48 indicators to measure progress towards the Millennium Development goals was adopted by a consensus of experts from the United Nations Secretariat and IMF, OECD and the World Bank. In 1996, UNSD also developed a list of environmental indicators in collaboration with the Inter-governmental Working Group on the Advancement of Environment Statistics.

WHO

Since late 1990s, *WHO* has been using up to 48 environmental health indicators using an expanded DPSEEA framework. [see Briggs (1999) and von Shirnding (2002)]

FAO

FAO, too, has contributed to the indicator development, especially in areas of sustainable agriculture and rural development as well as in more specialised fields such as marine capture fisheries

The World Bank

The World Development Indicators (WDI) is the World Bank's annual compilation of data about development. WDI 2003 includes approx. 800 indicators in 87 tables, organised in six sections: World View, People, Environment, Economy, States and Markets, and Global Links. The tables cover 152 economies and 14 country groups-with basic indicators for a further 55 economies.

The Environmental Economics and Indicators Unit (EEI) was formed in 1995 as a response to the increasing demand in this area. EEI is involved in various indicator projects, both within and outside the World Bank.

In some cases, World Bank-supported activities include environmental indicators as part of a broader set of indicators used to monitor project performance and impact. To respond to this need, the EEI prepared a *manual on environmental performance indicators* (EPIs). First issued in 1996, and updated in 1999, the note discusses indicator frameworks, selection criteria for environmental project indicators, and issues to consider for various environmental areas. [see Segnestam (1999) (2002)]. This work uses a project-based framework (modified input-output-outcome-impact approach) in contrast to the PSR model adopted by most other indicator work. Several other indicator-related initiatives are on-going within such as work on Land Quality Indicators (see www.ciesin.org/lw-kmn) and the Africa Live Database.

Rural sustainability indicators. This project, which is a collaboration between CIAT, UNEP and the World Bank, has as its objective to develop, test and refine environmental, land quality and other related indicators and information tools in a geographic information system (GIS) interface, for integrating rural sustainability considerations into policy-making and planning and improve environmental management at different scales in Central America countries. [www.ciat.cgiar.org/indicators/index.htm].

Wealth estimates and genuine saving. This is World Bank's attempt to derive "synthetic" indicators that measure environment and economic factors in one indicator. The *wealth measure* is a stock measure and is a new way of estimating a country's total resources, including both produced assets, natural capital, and human resources (both human and social capital). *Genuine saving*, a flow measure, adjusts gross savings numbers by deducting the value of depletion of the underlying resource asset and pollution damages, and considers current educational spending as an increase in saving, since this spending may be considered to be an investment in human capital (rather than consumption, as in the traditional national accounts).

European Union

European Environment Agency (EEA) and the *European Information and Observation Network (EIONET)* uniting the networks of individual EU countries. EEA environmental indicators, accessible on EIONET are at present being evaluated by clients to determine the final core set. Short-term indicators identified within the core set with high policy relevance, well developed methodology, capable of illustrating temporal trend and comparability between countries became operational in 2003/2004.

EC Joint Research Centre (JRC) consists of 8 scientific institutes including the Ispra-Based Environment Institute and Space Application Institute.

European System of Environmental Pressure Indicators, effort by *Eurostat.* The Project aims at a comprehensive description of environmental, economic and social "policy performance". Under the first-mentioned group, ten "policy fields" are defined and for each, six pressure indicators are defined. Research on further aggregation and extension of the system to CSD-style sustainable development indicators (SDI) is done at the European Commission's Joint Research Centre (JRC).

In addition to the work already mentioned, EEA and Eurostat have developed specialised sets of indicators such as coastal zone development indicators.

Other organisations

A large number of national and international non-government and research organisations are involved in the work on environment and sustainable development measurement. Some of these are cross-referenced throughout this document. To mention only a few, they include:

World Resources Institute (http://www.wri.org). "*In any country, people know their fate is tied to such economic indices as GNP or inflation rates. People believe that these numbers are a good indication of whether we are moving toward greater prosperity or hard times -- something they care about. Yet, no such significant indicators exist to tell us how the environment is faring, so WRI is striving to establish clear, understandable indicators for the environment that effectively represent whether we are moving toward sustainability or not".*' WRI biennial *World Resources Report* is something of a classic in the field.

Worldwatch Institute and its *State of the World Report* and *Vital Signs.* As in the case of World resource Report, a large number of environment and sustainable development parameters and indicators are used, their values tracked in time and an assessment is offered of selected underlying trends.

World Wide Fund for Nature (WWF) (and its "Living Planet Index"; http://www.panda.org/livingplanet/home.shtml),

International Institute for Sustainable Development (IISD) and its "dashboard of sustainability"; www.iisd.ca/cgsdi/dashboard.htm),

International Union for the Conservation of Nature (IUCN) and its "barometer of sustainability";www.iucn.org/themes/ssp/baromsum.htm and "well-being assessment."

Redefining Progress and its "index of sustainable economic welfare."

Columbia University International Earth Science Information Network (CIESIN), and *Yale Center for Environmental Law and Policy* (YCELP) and their work on "environmental sustainability index" [Esty (2002)]

The South Pacific Applied Geoscience Commission *(SOPAC)* and its work to develop an Environmental Vulnerability Index (EVI).

International Network for Environmental Compliance and Enforcement *(INECE)* and its work on compliance indicators.

(*4) Environmental performance assessment in a transboundary context*

Here we look at activities conducted in support of transboundary management tasks rather than aimed at simply assembling environment-related parameters from different parts of the world as is the case with much of the comparative and statistical work of U.N. agencies including their regional programmes (e.g. Baltic State of the Environment Report (http://www.bef.lv/baltic/default.htm), to give an example form outside Asia).

Great Lakes Water Quality Agreement (GLWQA)

Through this 1972 agreement, the governments of the U.S. and Canada have committed themselves "to restoring and maintaining the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem." For more than two decades, numerous programmes and measures have been undertaken towards this purpose including the analysis of data on ambient conditions and pollutant loadings leading to state-of-the-lakes reports. Among other things, the two governments (at both the federal and provincial/state levels) have been seeking to identify the core needs of their data collection and the indicators to evaluate the Agreement's progress. An Indicators-for-Evaluation Task Force was formed in 1993 to develop a framework within which to conduct this evaluation. The initial focus on state-of-the-lakes reporting has been gradually giving way to the consideration of indicators of ecosystem integrity as well as social cost, equity and other considerations. This was in line with the evolution of the objectives of the governments and other interest groups from narrow regulatory and remedial targets to preventive programmes and sustainable development of the entire Great Lakes area.

The ecosystem and sustainable development approaches introduce considerable complexity that threatens to overwhelm policymakers. Paradoxically, this enhances the appeal of clear, easily understood indicators of progress that capture a broad spectrum of issues in a few key and even dramatic figures.

Worth noting is the ordering of policy objectives (concerns) formulated for the Great Lakes. They include

1. *Fishability.* There shall be no restrictions on the human consumption of fish in the waters of the Great Lakes basin ecosystem as a result of anthropogenic (human) inputs of persistent toxic substances.
2. *Swimmability.* No public bathing beaches closed as a result of human activities or, conversely, all beaches are open and available for public swimming.
3. *Drinkability.* Treated drinking water is safe for human consumption; human activities do not result in application of consumption restrictions.
4. *Healthy Human Populations.* Human populations in the Great Lakes basin are healthy and free from acute illness associated with locally high levels of contaminants, or chronic illness associated with long-term exposure to low levels of contaminants.
5. *Economic Viability.* A regional economy that is viable, sustainable and provides adequate sustenance and dignity for the human population of the basin.
6. *Biological Community Integrity and Diversity.* Maintenance of the ability of biological communities to function normally in the absence of severe environmental stress (ecosystem health) and to cope with changes in environmental conditions which impose stress, *i.e.* to be able to maintain their processes of self-organisation on an ongoing basis (ecological integrity). Maintenance of the diversity of biological communities, species and genetic variation within species.
7. *Virtual Elimination of Inputs of Persistent Toxic Substances.* Virtual elimination of inputs of persistent toxic substances to the Great Lakes system.
8. *Absence of Excess Phosphorus.* Absence of excess phosphorus entering the water as a result of human activity.
9. *Physical Environment Integrity.* Land development and use compatible with maintaining aquatic habitat of a quantity and quality necessary and sufficient to sustain an endemic assemblage of fish and wildlife populations.

The State of the Lakes Ecosystem Conference report [SOLEC (2002)] provides an excellent illustration of the huge advances made in the quality of performance assessment and reporting systems in those circumstances where political commitment is strong (and where formidable technical expertise exists, as it does in the Great Lakes region).

Environmental Plan for the Mediterranean ("Plan Bleu")

To facilitate the understanding of the links between development and the environment in the Mediterranean region, and to support policy objectives, the "Blue Plan" has undertaken several projects relating to indicators with the support of METAP, EU, Agencies for Environment Monitoring and Development in various Mediterranean countries and the Mediterranean Commission on Sustainable Development.

The EPI Project aims at promoting the use of selected indicators as a means of assessing the success of environmental goals in 13 Mediterranean countries or territories. The project has focused on 4 topics (waste, air quality, water quality and water resources). The exercise took place successively on three geographical levels: the Mediterranean region, 1996–1998, sub-regional, 1998, and, more recently, national. Four priority topics have been explored in depth: (i) air pollution, (ii) solid waste, (iii) quantitative management of water resources and demand, and (iv) water pollution. A minimum set of EPIs were selected in common (5 EPIs/topic). A need was confirmed for a uniform definition of the EPIs to facilitate cross-country and longitudinal comparisons. Mediterranean thematic networks on air, water and waste have been created.

The Indicators-for-Sustainable-Development Project aims at developing indicators of progress towards sustainable development in the 20 Mediterranean-rim countries, the Contracting Parties to the Barcelona Convention. Here, the goals are broader than under EPI Project: it is not just a matter of measuring environmental performance but of integrating the more complex concepts of sustainable development. The Mediterranean Commission on Sustainable Development has served as a preferred forum for this work, which is also enriched by national tests (Morocco, Slovenia and Tunisia). A "joint set" of 130 indicators of sustainable development in the Mediterranean was adopted in 1999 from a list of some 250 indicators, 134 of which came from the UNCSD. Only 40 indicators of these 134 were retained for the Mediterranean countries. National tests for relevance and availability were carried out.

The North American Commission for Environmental Cooperation (NACEC)

NACEC, created in support of NAFTA (including U.S., Mexico and Canada), placed emphasis on the development of indicators capable of reflecting the environmental impacts of NAFTA, including the impacts in the border areas of the three NAFTA signatories. Unlike the traditional focus of environmental indicators on the status of environmental media like air and water, waste management and land use, NACEC targeted implementation, enforcement and compliance.

In 1997, NACEC initiated a project to develop indicators and criteria for evaluating the performance of the Parties in implementing policies and programmes for effective environmental enforcement. The Project has documented work in the area of enforcement indicators, provided a forum for dialogue, and established a baseline. NACEC went on to develop indicators for use by the three parties.

Environmental Indicators for Central America

During the period 1995-1997, The International Center for Tropical Agriculture (CIAT), and UNEP, working with 6 regional and 50 national institutions, developed *Central American Environmental and Sustainability Indicators.* With additional support by the

World Bank, this effort was extended to the development of *Rural Sustainability Indicators for Central America* The indicators tool kit for Central America includes 11 indices that help analyse development and environmental problems; 68 "core" indicators for determining the causes and effects of these problems; and 114 "complementary" indicators that help apply the analysis to decision making. With a "spatial land-use model" developed at Wageningen University in The Netherlands, users can explore the potential impact of specific policies, strategies, and actions under different scenarios, such as "business as usual," "natural disasters," or "sustainable rural development”. (http://www.ciat.cgiar.org/indicators/.) The project has also produced a computerised *Atlas of Environmental Indicators and Sustainable Development for Central America and the Caribbean.* In addition, and based on the work described above, an Environmental Indicators Toolkit to Help Prepare for Natural Disasters in Central America was launched.

Appendix 2

Cities awarded the title “Environmental Model City” (1997-2007)

Year	No. of Cities awarded	City
1997	6	Zhang-jiagang city, Shenzhen city, Dalian city, Zhuhai city, Xiamen city, Weihai city
1998	5	Kunshan city, Yantai city, Laizhou city, Rongcheng city, Zhongshan city
1999	5	Haikou city, Shantou city, Suzhou city, Dagang district of Tianjin Municipality, Wenxing district of Shanghai Municipality
2000	4	Qingdao city, Jiangyin city, Daqing city, Wendeng city
2001	4	Hangzhou city, Ningbo city, Changshu city, Taicang city
2002	8	Huizhou city, Zhaoyuan city, Shaoxing city, Rushan city, Haimen city, Changchun city, Yangzhou city, Jiaozhou city
2003	3	Wujiang city, Nanjing city, Dongying city
2004	12	Mianyang city, Wuxi city, Jintan city, Suyang city, Fuzhou city, Zhenjiang city, Changzhou city, Shenyang city, Kelamayi city, Kuerle city, Jiangmen city, Yubei district of Chongqing Municipality
2005	9	Chengdu city, Fuyang city, Baoji city, Guilin city, Jiaonan city, Laixi city, Rizhao city, Penglai city, Weifang city
2006	12	Tianjin Municipality, Ma-anshan city, Langfang city, Pudong new district of Shanghai municipality, Beipei district of Chongqing Municipality, Nantong city, Huzhou city, Shaoqing city, Quanzhou city, Yixing city, Jimo city, Pingdu city
2007*	4	Taizhou city, Guangzhou city, Yiwu city, Shouguang city

Number of awards in 2007 is to April 2007.
Source: http://www.zhb.gov.cn/cont/mhcity/

References

EPA, indicators, general

Bakkes J. A., G.J. van den Born, J.C. Helder and R.J. Swart, C.W. Hope and J.D.E. Parker (2000), *An Overview of Environmental Indicators: State of the art and perspectives,* UNEP

Environment Canada, *Environmental Indicator Bulletin, State of the Environment Bulletin*, various issues

Garcia López, Jorge H. (2004), *The Effectiveness of Indonesia's Public Disclosure Program PROPER for Industrial Pollution Control*, Göteborg, Department of Economics.

Hammond, A., A. Adriansee, E. Rodenburg, D. Bryant and R. Woodward (1995), *Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development,* World Resources Institute, Washington, D.C.

Hardi, P. and P. Muyatwa (2001), *Review Paper on Selected Environmental Reporting and Indicator Practices*, International Institute for Sustainable Development, Winnipeg

Jesinghaus J. (1999) *The European Environmental Pressure Indices Project*, A Case Study Prepared for the IISD Workshop "Beyond Delusion: Science and Policy Dialogue on Designing Effective Indicators of Sustainable Development", Costa Rica, 6 – 9 May 1999

Moldan. B. and S. Bilharz (1997), *Sustainability Indicators; Report on the Project on Indicators of Sustainable Development,* prepared by SCOPE, John Wiley and Sons, Chichester and New York

OECD (1993), *OECD Core Set of Indicators for Environmental Performance Reviews*, Paris

OECD (2001), *OECD Environmental Indicators: Towards Sustainable Development,* Paris

Segnestam, L. (1999), *Environmental Performance Indicators: A Second Edition Note,* Environment Department Paper No. 71, World Bank, Washington, D.C.

Segnestam, L. (2002), *Indicators of Environment and Sustainable Development,* Environmental Economics Series, Paper No. 80, World Bank, Washington, D.C.

United Nations Commission on Sustainable Development, (2001) *Indicators of Sustainable Development: Guidelines and Methodologies,* New York, available at http://www.un.org/esa/sustdev/indisd/

U.S. Environmental Protection Agency (1990). *Environmental Indicators*. Environmental Monitoring and Assessment Program, Office of Research and Development, Washington, D.C. Report No. EPA/600/3-90/060.

EPA in the corporate sector

Ditz, D. and J. Ranganathan (1997), *Measuring Up: Toward a Common Framework for Tracking Corporate Environmental Performance*, World Resources Institute, Washington, D.C.

Ranganathan, J. (1998), "Sustainability Rulers: Measuring Corporate Environmental and Social Performance", *Sustainable Development Perspectives*, Sustainable Development Initiatives Project, World Resources Institute, Washington, D.C.

Skillius Å. and U. Wennberg (1998) *Continuity, Credibility and Comparability: Key challenges for corporate environmental performance measurement and communication*, a consultant report to EEA

www.inece.org/enforcement_documents

Performance measurement in government organisations

Hatry, H. (1999), *Performance Measurement: Getting Results,* Urban Institute Press, Washington, D. C.

OECD (1994), *Performance Management in Government: Performance Measurement and Results-Oriented Government.* Public Management Occasional Papers No. 3, Paris

World Bank (continuous), *The Administrative and Civil Service Reform website* (http://www.worldbank.org/publicsector/civilservice)

Thailand

Government of Thailand (2004) *Millennium Development Goals Report, 2004*.

National Economic and Social Development Board of Thailand (NESDB) (2005) *Three years of the 9th plan: Development Impact* (in Thai).

NESDB (2007) *Development of Happiness Index for Thai Society (*draft - in Thai).

Office of Environmental Policy and Planning of Thailand (ONEP) (2005) *State of Environment Report, 2005*. Office of Natural Resources and Environmental Policy and Planning, Bangkok Thailand. (http://www.onep.go.th)

ONEP (2007) *Policy Implementation, Monitoring and Appraisal* (in Thai).

Social Research Institute Chiang Mai University (2005) *Environmental Sector Priority in Thailand (Phase II): Setting Priorities in Thai Environmental Policy*. Report submitted to Japan International Cooperation Agency

People's Republic of China

SEPA and NBS (2004) *China Green National Accounting Study Report 2004* (public version). http://www.sepa.gov.cn/plan/gongwen/200609/P020060908545859361774.pdf

United Nations, et al., (1993) *Systems of National Accounts 1993*.
http://unstats.un.org/unsd/sna1993/foreword.asp

United Nations (1993) *Handbook of National Accounting - Integrated Environment and Economic Accounting 1993*.
http://unstats.un.org/unsd/publication/SeriesF/SeriesF_61E.pdf

United Nations (2000) *Studies in Methods: Handbook of National Accounting - Integrated Environmental and Economic Accounting – An Operational Manual.* http://unstats.un.org/unsd/publication/SeriesF/SeriesF_78E.pdf

United Nations, et al. (2003) *Studies in Methods: Handbook of National Accounting - Integrated Environmental and Economic Accounting 2003.*
http://unstats.un.org/unsd/envAccounting/seea2003.pdf

China Environmental Statistics Editing Committee (1999) *Environmental Yearbook 1998*, pp.82, pp.228. China Environmental Statistics Press, Beijing, PRC

China Environmental Statistics Editing Committee (2000) *Environmental Yearbook 1999*, pp.199. China Environmental Statistics Press, Beijing, PRC

China Environmental Statistics Editing Committee (2001) *Environmental Yearbook 2000*, pp.283. China Environmental Statistics Press, Beijing, PRC

China Environmental Statistics Editing Committee (2002) *Environmental Yearbook 2001*, pp. 189. China Environmental Statistics Press, Beijing, PRC

China Environmental Statistics Editing Committee (2003) *Environmental Yearbook 2002*, pp. 265. China Environmental Statistics Press, Beijing, PRC

Sub-regional and transnational EPA

GLWQA International Joint Commissions (1996*), Indicators to Evaluate Progress*, Report of the Indicators-for-Evaluation Task Force, Washington, D.C., and Ottawa

MCSD and UNEP (2001), *Indicators for the Sustainable Development in the Mediterranean Region: A Glossary,* Plan Bleu, Sophia Antipolis

Segnestam, L., Winograd, M. Ad A. Farrow (2000), *Developing Indicators: Experience from Central America*, WB/UNEP/CIAT (Centro Int. De Agricultura Tropical)

Winograd, M. (1994), *Environmental Indicators for Latin America and the Caribbean Towards Land-Use Sustainability*, World Resources Institute, Washington, D.C.

Agriculture and land quality

Dumanski, J. and C. Pieri (1995) *Application of the pressure-state-response framework for the land quality indicators (LQI) programme,* FAO Rome, available at www.fao.org/docrep/W4745E/w4745e08.htm

FAO (2003) *World Agriculture: Towards 2015/2030 An FAO Perspective*. London: Earthscan Publication Ltd.

New Zealand Ministry of Environment (1998): *Environmental Performance Indicators: Confirmed Indicators for Air, Fresh Water and Land*, Wellington

OECD (2001) *OECD Environmental Outlook 2001*. Paris: OECD

Parris K. (2002), *Environmental Impacts in the Agriculture Sector: Using Indicators as a Tool for Policy Purposes,* Paper to the Meeting of the Commission for Environmental Cooperation, Montreal, Canada, 17-18 January 2002

http://srdis.ciesin.org/annobib/references.html *Annotated Biography of Land Quality Indicators*

Tschirley, J. (1996), *Use of Indicators in Sustainable Agriculture and Rural Development*, Sustainable Development Dimensions, Sustainable Development Department, FAO, Rome

Health

Briggs, D. (1999), *Environmental Health Indicators: Framework and Methodologies*, Occupation and Environmental Health Series, WHO, Geneva

Shirnding von, Y. (2002) *Health in Sustainable Development Planning: The Role of Indicators,* WHO, Geneva

Water

EEA (2003), *Europe's Water: An Indicator-based Assessment, Summary*, EEA, Copenhagen

Fisheries

Charles, A.T. (1995), *Sustainability Indicators: An Annotated Bibliography with emphasis on Fishery Systems, Coastal Zones and Watersheds,* Report under the Strategy for International Fisheries Research Program, Saint Mary's University, Halifax, Nova Scotia

Environment Australia (2000*), Environmental Performance Assessment: Essential for all Fisheries*, Canberra

Forestry

Ruzicka I. (1994), *Policy Change in Environment-Oriented Forestry: Impact Indicators and Valuation,* consultant report to ADB, Manila

Biodiversity

Reid, W.V, Mc Neely, Tunstall, Bryant, and M. Winograd (1993), *Biodiversity Indicators for Policy Makers,* WRI and World Conservation Union