ADB, GEF, UNEP

in collaboration with IGES and NIES

National Performance Assessment and Subregional Strategic Environment Framework in the Greater Mekong Subregion

ADB T.A. No. 6069-REG

THAILAND
NATIONAL ENVIRONMENTAL PERFORMANCE ASSESSMENT (EPA) REPORT

Prepared by

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and

Project Secretariat UNEP Regional Resource Center For Asia and the Pacific

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Executive Summary

Thailand's strong economic performance of recent years, the 1997 financial crisis notwithstanding, has continued to exert major influence on the country's natural resources and quality of life of its citizens. Thailand has a long history of efforts to safeguard its environment in the midst of rapid economic change. After a long period of shaping the institutional and regulatory responses and committing public resources to the task of environmental protection the need to take stock of the effectiveness of the various responses and to repeat such an assessment at regular intervals has grown stronger. This environmental performance assessment (EPA) is the first attempt to generate a concise picture of how much Thailand has achieved and how much more it could perhaps achieve under certain conditions.

The overall picture is one of substantially increased funding for remedial and preventive measures, notable progress in some areas (e.g. greater water security, slowing down and a possible reversal of the forest cover loss, good performance in solid waste management in Bangkok), average or stagnating performance in dealing with surface water pollution or the management of hazardous substances as well a below-average and stagnating performance in areas such as waste management in smaller municipalities. Thailand deserves high marks for policy integrity and continuity and weaker marks for translating some of the announced policy principles (e.g. PPP) into practice. Thailand has moved further than any of its GMS neighbors along the road of decentralization and rightly recognized that many environmental responsibilities are best managed by local governments and communities even if the process is recognized to face initial obstacles. Thailand was one of the pioneers of creating and using environmental funds to support mitigation by industrial polluters but the experience has been a mixed one. As the leading market economy within GMS, Thailand has gone far in involving the private sector in a variety of environmental initiatives. The success of the ISO program is worth highlighting.

In terms of individual environmental concerns, deforestation pressures continue, especially the encroachment for agriculture. Nonetheless, the decline of the forest area appears to have been halted and the forest cover even slightly increased from the historical low of 26 per cent in 1998. Reforestation programs have had played a positive role.

Water shortages loom as a serious potential threat to future prosperity. Agriculture continued to be the principal and wasteful user of water. In 2003, irrigated areas served by small, medium and large-size scale reservoirs represented approximately 21% of the total cropped area. The Government has been relatively successful in averting serious water shortages so far but this performance cannot be taken for granted.

The population and economic growth of Thailand have been behind a steadily increasing demand for land, including agricultural land. In the absence of strict enforcement, this has resulted in forest encroachment and expansion of agriculture into environmentally unsuitable areas. Approximately 34% of the total agricultural area (or 17.4 million ha) experienced serious soil erosion at the end of the last decade. In addition, land or poor-quality accounted for approximately 44% (or 12.9 million ha). The Land Development Department rehabilitated 1.7 million ha of eroded lands between 1997 and 2003 and 1.2 million ha of marginal lands. Such pace of rehabilitation is clearly insufficient.

Domestic wastewater discharges continue to dominate the overall picture of surface water quality. A large percentage of domestic wastewater in Thailand is still not treated. However,

with increasing investment in wastewater treatment, the water quality of major rivers and lakes in Thailand has shown a general improvement. Broadly speaking, water quality in the northern and the northeastern regions was satisfactory, while central, eastern and the south regions reported average conditions. Some segments such as the lower Chao Praya and lower Ta Chin rivers had relatively poor and deteriorating water quality. Ta Chin river and Songkhla lake are severely polluted with BOD values exceeding the PCD standards. The functioning of existing wastewater treatment plants leaves much to be desired as does the implementation of the “polluter pays” policies in the sector.

There has been a steady increase in the volume of solid waste generated. Overall, waste collection in Thailand is relatively good in Bangkok, where more than 95% of waste generated is collected, while in municipalities where collection rates average 75-85%. Separation of waste, appropriate disposal and creation of additional waste disposal facilities are among the principal challenges. The rate of waste reuse and recycling has been low. The government has gradually been developing policies and regulations for dealing with hazardous substances. Despite these and other efforts, the percentage of hazardous waste treated and properly disposed has remained relatively low, never reaching more than half of the total volume generated.

List of Abbreviations

ADB	Asian Development Bank
BMA	Bangkok Metropolitan Administration
BMR	Bangkok Metropolitan Region
BOD	Biological Oxygen Demand
DAE	Department of Agricultural Extension
DEQP	Department of Environmental Quality Promotion
DIW	Department of Industrial Work
DMCR	Department of Marine and Coastal Resources
DNP	National Park, Wildlife and Plant Conservation Department
EE	Environmental education
EIA	Environmental Impact Assessment
EPA	Environmental Performance Assessment
EQMP	Environmental Quality Management Plan
FAO	Food and Agricultural Organization of the United Nations
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GMS	Greater Mekong Subregion
GWPs	Global warming potentials
IGES	Institute of Global Environmental Strategies
IPCC	Intergovernmental Panel on Climate Change
ISRIC	International Soil Reference and Information Center
LDD	Land Development Department
MCM	Million Cubic Meters
MOH	Ministry of Public Health
MONRE	Ministry of Natural Resources and Environment
MOSTE	Ministry of Science and Technology
NEB	National Environmental Board
NEQA	Enhancement and Conservation of National Environmental Quality Act
NESDB	National Economic Social Development Board
NESDP	National Economic Social Development Plan
NGO	Non Governmental Organization
NIES	National Institute for Environmental Studies of Japan
OECD	Organization for Economic Co-operation and Development
ONEP	Office of Natural Resources and Environmental Policy and Planning
NSO	National Statistic Office
PCA	Pollution Control Area
PCD	Pollution Control Department
PEAP	Provincial Environmental Quality Management Action Plan
PPP	Polluter Pays Principle
RFD	Royal Forest Department
RID	Royal Irrigation Department
UNEP	United Nations Environment Program
RRCAP	Regional Resource Center for Asia and the Pacific
TFSMP	Thai Forestry Sector Master Plan
UNFCCC	United Nations Framework Convention on Climate Change
USLE	Universal Soil Loss Equation

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I. INTRODUCTION

1.1 Project Background

1. The Asian Development Bank (ADB) is implementing a technical assistance (TA) project for the Greater Mekong Subregion (GMS) named the National Performance Assessment and Subregional Strategic Environment Framework ("SEF II"), in collaboration with the Global Environmental Facility (GEF) the United Nations Environment Program's Regional Resource Center for Asia and the Pacific (UNEP RRC.AP), the Institute of Global Environmental Strategies (IGES) and the National Institute for Environmental Studies of Japan (NIES).

2. The purpose of GMS programs is to promote sustainable economic growth in the subregion and improve the living standards of the people of the subregion. GMS consists of Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, Viet Nam, and Yunnan and Guanxi Provinces of the People's Republic of China[1]. The GMS populations share not only the resources of a major river basin but also –with some qualifications-- certain traditions, lifestyles and aspirations.

3. Each of GMS's countries has vigorously pursued economic development within national boundaries. In addition, a number of transboundary development initiatives have been implemented in sectors such as transportation energy, tourism, and trade. As a result, a complex pattern of environmental impacts is emerging both within each country and across the subregion's boundaries. These developments are taking place at a time of increased recognition throughout GMS of potential threats to the resource base posed by fast economic growth and the negative environmental externalities often associated with it. Most GMS countries as well as their development partners are keen to assess the degree of success each country and the subregion have had in addressing the principal environmental concerns.

4. The primary objectives of SEF II project are to (1) promote sustainable development in the GMS through the creation of national and sub-regional environmental performance assessment systems and (2) develop national and sub-regional capacities for implementing this assessment. The project is expected to contribute to:

1. Informed decision-making through better understanding of environmental conditions, trends and impacts of existing policies and institutional provisions
2. Improved public accountability for such environmental issues as biological diversity, climate change, use of water bodies, air and water pollution and solid waste disposal; and
3. Meeting the national, sub-regional and international demand for environmental information and performance assessment on issues of regional and global importance, including protection of biodiversity or the fight against land degradation.

1.2 Selection of Environmental Concerns

5. Based on extensive consultation with local stakeholders, six environmental concerns were selected as being central to Thailand's environmental management. The results of the ranking of 13 internationally accepted ("OECD") concerns in terms of perceived importance

[1] The SEF II project was initiated before Guanxi Province formally joined GMS (December 2004). No references to Guanxi therefore appear in this or other SEF II documents.

for Thailand is given in Table 1 below (the lowest number corresponds to the highest importance). Climate change was added as a concern at the request of GEF, one of the Project sponsors, despite low national priority assigned to it during the initial national consultations.

Table 1. - Ranking of 13 environmental concerns during the First National Workshop, 3 – 5 September 2004.

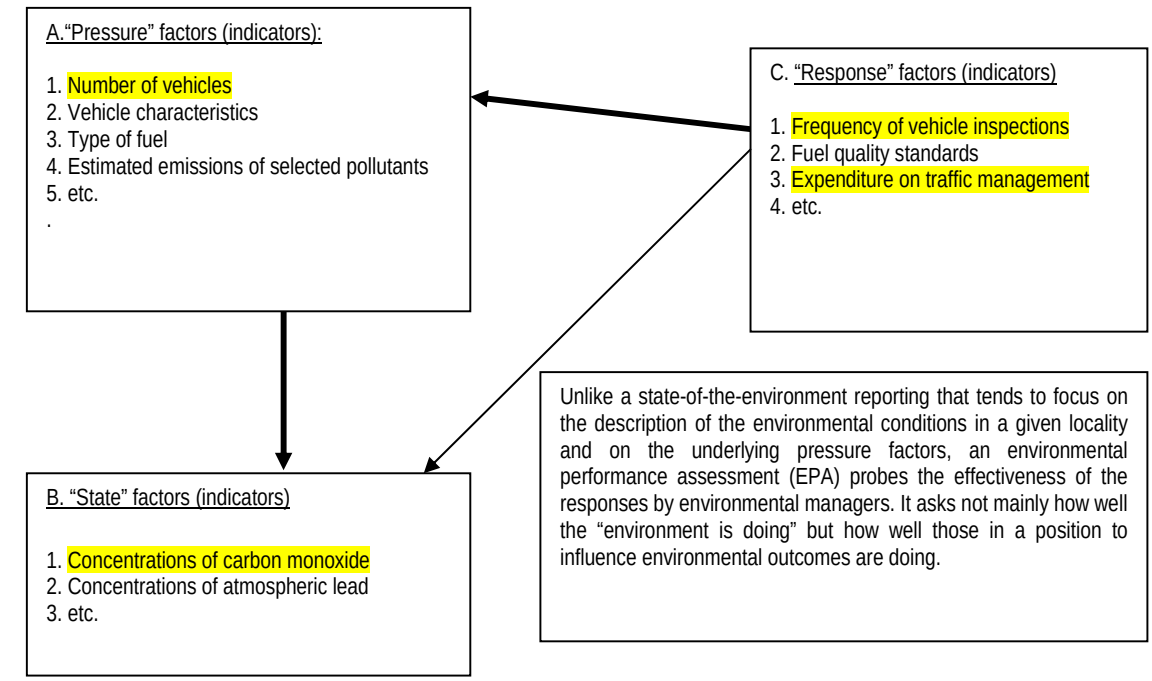
Concerns	Combined score of the National Workshop	Ranking
1. Land degradation	70	6
2. Threats to biodiversity	87	8
3. Inland water pollution	42	1
4. Solid waste management	67	4
5.Toxic contamination*	68	5
6. Air pollution by stationary sources	85	7
7. Mobile source pollution	96	9
8. Threats to coastal zones	103	11
9. Climate change	118	12
10. Ozone layer depletion	140	13
11. Water resources	50	2
12. Fish resources	100	10
13. Forest resources	66	3

* This category is used interchangeable with hazardous substance management

1.3 The Method Used

6. Performance assessment in this report is understood to be an introspective look at the degree of success that environmental and other policies and instruments used during the period of evaluation had, in reaching set environmental targets. The assessment is structured around a pressure-state-response (P-S-R) model that identifies the principal sources of pressure (P) on the variable under assessment, the resulting state (S), and the responses (R) adopted to influence the pressure and the state (see Figure 1 below). In most situations, the number of pressure factors, state variables and types of responses will be large. Complex inter-relationships will often exist among them. Full analysis of each concern is demanding and many specialists devote their time to describing selected segments of the P-S-R "circle". At the same time, there is a clear need for a simplified picture of "what is going on" if national environmental authorities are to communicate with others in positions of influence and the public at large. The simplification is a matter of selecting only the most telling of the P, S, and R factors and using them to describe past trends and through them, performance.

Figure 1. Simplified representation of a P-S-R model (hypothetical example of air quality management with four indicators of performance, marked in yellow)



7. The assessment itself is a matter of rating (1) individual indicators (each supported by a "factsheet") under a given concern and (2) the overall performance –an interplay of all indicators-- under that concern. A rating structure has been developed for this purpose.

8. A double-word description is utilized to rate each indicator. The first word describes the magnitude of the indicator relative to some benchmark (such as an international standard, an average for several countries etc.). The second word describes the observed trend of the indicator value, as depicted by long or short-term historical data. The magnitude and the trend keywords are typically combined (e.g. "relatively poor and deteriorating"). In the case of baseline indicators with only one or few observations, the trend-keyword (and the "and" conjunction) are omitted. The descriptions applied to each class of indicators are contained in Tables 2 to 5 below.

Table 2. Rating used in evaluating “state” indicators

STATE INDICATOR			
In order to qualify the magnitude of the state indicator using the recommended keywords below, the values of the state indicator are compared against known benchmark figures. The national policy target for the indicator is one such possible benchmark. In many cases, a GMS average values or an international standard would be more suitable if the indicator is to tell us something about the relative performance of each GMS country. If no such figures exist, the magnitude keyword is omitted. The “poorness” or “goodness” of the magnitude is dependent on the interpretation of the indicator value. In some cases a high state indicator value is “good” (e.g. % forest cover); at other times a low value is preferred (e.g. # threatened species). The trend of the State indicator is easy to rate as either deteriorating, stabilizing or improving, provided it is based on long-term historical data. In other cases or for benchmark indicators, the indicator value may not show any trend at all, in which case the trend keyword is left blank or specified as “Undetermined Trend”.			
Relatively Poor and ….	Average and ...	Relatively Good and ….	Unknown State and ….
As evidenced by an indicator value which is far below (or far above) the same indicator value for other GMS countries or far below (or above) other benchmark figures such as international standards or national targets	As evidenced by an indicator value which is close to the same indicator value for other GMS countries or within the range of other acceptable benchmark figures such as international standards or national targets	As evidenced by an indicator value which is far above (or far below) the same indicator value for other GMS countries or far above (or below) other benchmark figures such as international standards or national targets	This rating is used if the value of the indicator cannot be compared against the value of the same indicator in other countries or regions and there are no other benchmark figures, such as international standards or national targets
Deteriorating	Stabilizing	Improving	Undetermined Trend
As evidenced by a steady long-term deteriorating trend and with no immediate signs of improvement.	As evidenced by a steady long-term deteriorating trend but with short-term signs of leveling or even improvement, or a long-term level trend.	As evidenced by a long-term deteriorating trend but with sure signs of improvement based on more than one observation in the positive trend.	This rating is used if the selected indicator in inconclusive in terms of long or short-term trends or if the indicator is based on a single observation over time.

Table 3. Rating used in evaluating “pressure” indicators

PRESSURE INDICATOR			
There will always be some magnitude of pressure and the trend over time can simply be rated as increasing or decreasing. Qualifying the magnitude of the indicator value may at times be difficult, especially if the pressure indicator is unique to one country and no comparative figures are available from other countries. It is also unlikely that international benchmark figures will exist for pressure indicator. Judgment is required to rate the magnitude of unique pressure indicators. The trend of pressure indicators should be easy to rate, provided that long-term historical data exists. If only one or few observations exist, the trend keyword can be left blank.			
High and	Medium and	Low and	Non-Comparable and
As evidenced by the value of an indicator which is much higher than the value of the same indicator in other GMS countries or much higher than other benchmark figures, such as international standards or national targets	As evidenced by the value of an indicator with a value more or less equal to that of other GMS countries or other benchmark figures such as international standards or national targets.	As evidenced by the value of an indicator which is much lower than the value of the same indicator in other GMS countries or much lower than other benchmark figures, such as international standards or national targets.	This rating is used if, through lack of comparative numbers or other information, an order of magnitude cannot be assigned to the value of the indicator.
Increasing	Steady	Decreasing	(blank)
As evidenced by a long-term trend of increasing pressure, with very little sign of relief or stabilization.	As evidenced by a long-term steady or near-constant pressure that shows no sign of increase or decrease in the past or future.	As evidenced by a long-term trend of declining pressure, with perhaps fluctuating short-term oscillations.	The keyword is left blank if there is only one observation, or if there is no observed trend over time in the indicator value.

Table 4. Rating used in evaluating “response” indicators

RESPONSE INDICATOR			
Since responses tend to be very diverse, there may be few benchmarks to rate the magnitude of response indicators other than the national targets for the indicator selected. Once more, judgment is required to rate the magnitude of unique indicators to say how “big” or “small” the response was.			
Low and	Average and	Significant and	Non-Comparable
If the magnitude of the response is significantly below the national target or below the average in other GMS countries or other comparable regions.	If the magnitude of the response is in line with national targets or the average responses of other GMS countries or comparable regions.	If the magnitude of the response exceeds national targets of the average of other GMS countries or comparable regions.	This rating is used (or the keyword left blank) if there are no data or information to compare the magnitude of the response with, or there are no other benchmark figures.
Sporadic	Intermittent	Consistent	(blank)
If the response has been irregularly applied over time with no set program or budgets to continue the response in the future.	If the response has not been consistently applied but there are programs and budgets to continue the application of the response in future.	If the response has been consistently applied, calibrated to the pressure, with plans to continue until the pressure has been reduced to a desired level	The keyword is left blank if there is only one observation, or if there is no observed trend over time in the indicator value.

The description used to rate overall performance under each concern is given in Table 5 below.

Table 5: Rating used to evaluate performance under a selected environmental concern

ENVIRONMENTAL CONCERN			
For purposes of communicating the EPA results, rating of performance under each priority concern is required. In this EPA, a star-rating system is used where any performance counts but with different levels of merit. The star-rating is based on what the indicators are saying, backed up by hard evidence presented in factsheets, not on what a consensus view or expectations may be.			
1-Star *	2-Stars **	3-Stars ***	Un-Rated
If the pressure continues to increase, the state continues to deteriorate and the response(s) do not appear to have any effect on the pressure or the state. Additional criteria for 1-Star rating: 1) Reasonable targets have not been set or have not been met. 2) International conventions have not been ratified or adhered to. 3) No ongoing monitoring or data collection. 4) No clear institutional role and responsibilities for environmental management of environmental concerns have been assigned or where they have been, no tangible progress has been achieved suggesting an appropriate response and non-achievement of the target.	If there are signs that the responses will or have had an effect on releasing the pressure, even though the state does not yet show signs of improvement. Additional criteria for 2-Star rating: 1) Targets have been set and generally met. 2) International conventions have been or will be ratified and most of the reporting requirements have been met 3) Plans exist for ongoing monitoring and data collection. 4) Institutional responsibilities assigned though limited progress achieved due to weaknesses in institutional arrangements e.g. lack of coordination, duplication of roles, multiplicity of authorities etc.	If there is clear evidence that the responses have reduced the pressure and/or there is a clear sign that the state is improving. Additional criteria for 3-star rating: 1) Effective targets have been set and met. 2) International conventions have been ratified and reporting requirements have been met. 3) Ongoing monitoring and databases exist. 4) Specific institutions with targeted roles and responsibilities assigned. Institutional measures in place for the management of the concern e.g. EIA process, adequate budgetary and resources for environment monitoring, staff with appropriate technical skills and know-how, regular interaction with industry and NGOs on environmental management matters etc.	If the trend in the state indicator cannot be explained by the pressures or the responses. The label "unrated" is a sign that we have failed to identify appropriate indicators backed by factsheets, and/or have failed to apply the PSR model, and/or have failed to apply the PSR model to performance assessment.

1.4 Report overview

9. The report was prepared under the guidance of a national coordination committee (NCC). Three national workshops were held during EPA's preparation and extensive consultation and comment characterized the process. The composition of NCC is as follows:

- Department of Environmental Quality Promotion
- Pollution Control Department

- Department of Mineral Resources
- Department of Water Resources
- Department of Ground Water Resources
- National Park Wildlife and Plant Conservation Department
- Department of Marine and Costal Resources
- Office of Natural Resources and Environmental Policy and Planning
- Bureau of International Cooperation for Natural Resources and Environment
- Department of International Economic Affairs
- Department of East Asian Affairs
- National Economic and Social Development Board
- Ayeyarwaddy-Chao Praya-Mekong Economic Cooperation Strategy (ACMECS) Business Cooperation

10. In addition to the guidance of NCC, the report also gained by a technical review by the following national EPA members:

1.	Mr. Sirithan Pairoj-boriboon Solid waste management expert,	Chairman
2.	Assoc. Prof. Dr. Charlie Navanugraha Land degradation expert, Mahidol University	Member
3.	Mr. Somchai Ruchacharaswong Land degradation expert, Department of Land development	Member
4.	Representative Land degradation expert, Department of Mineral Resources	Member
5.	Dean or Representative Forest resources expert, Kasetsart University	Member
6.	Assoc. Prof. Dr. Sura Pattanakriat Forest resources expert, Mahidol University	Member
7.	Representative Forest resources expert, National Park, Wildlife & Plant Conservation Department	Member
8.	Assist. Prof. Dr. Kampanad Bhaktikul Water resources expert, Mahidol University	Member
9.	Mr. Lersak Rewtarkulpaiboon Water resources expert, Department of Irrigation	Member
10.	Mrs. Pakawan Chulamanee Water resources expert, Department of Water Resources	Member
11.	Assoc. Prof. Dr. Sitichai Tantasarit Water pollution expert, Kasetsart University	Member

12.	Representative Water pollution expert, Department of Industrial Works	Member
13.	Representative Water pollution expert, Pollution Control Department	Member
14.	Representative Water pollution expert, Wastewater Management Authority	Member
15.	Representative Solid waste management expert, Pollution Control Department	Member
16.	Assist. Prof. Dr. Patana Thavipoke Hazardous substances management expert, Mahidol University	Member
17.	Ms. Napawat Buasuang Hazardous substance management expert, Pollution Control Department	Member
18.	Mrs. Malee Hutacharoen DEQP	Member and Secretary
19.	Miss Udomlak Sritasanee DEQP	Member and Secretary

The EPA report was drafted by

Assoc. Prof. Dr. Suvaluck Satumanatpan Mahidol University	Member and Secretary
Assist. Prof. Dr. Yongyut Trisurat Kasetsart Univerity	Member and Secretary

The report was reviewed by the subregional expert group and international consultants, and edited by Messrs. Mike Comeau, Mohit Kumar and Ivan Ruzicka.

11. The report consists of this Introduction (Part I) and three main sections: Part II contains seven chapters each assessing performance under the priority concern chosen. Part III is a review of factors that influence environmental performance while cutting across individual concerns. They deal with the topics of policy and institutional integration, environmental expenditure and financing, regulatory and economic instruments, enforcement, environment health and safety, access to information and public accountability and environmental awareness and education. Part IV draws conclusions and makes recommendations for the chosen priority concerns.

The statistical material underpinning the analysis is organized in the form of indicator factsheets. All factsheets are cross-referenced to the text and contained in a single appendix. The appendix also contains EPA case studies with their associated factsheets.

II: MANAGEMENT OF PRINCIPAL ENVIRONMENTAL CONCERNS

FOREST RESOURCES

The context

12. Forests are recognized as an indispensable component of resource-based sustainable development and a source of livelihood of rural people in Thailand. The rapid economic growth in Thailand of the last few decades accompanied by healthy agricultural and industrial exports, has had a major impact on the country's forest resources. In the past, logging supported the construction boom, generated foreign exchange and government revenue, as well as making land available for agriculture. This development resulted in a significant loss of forest cover and depletion of the standing stock. Conversion of forests to agriculture and other land uses has had complex repercussions, environmental and otherwise. Its adverse impacts on the hydrological regimes, biodiversity and livelihood have been widely commented on. Attempts to arrest forest depletion based solely on protection measures and law enforcement (e.g. enactment of the nation-wide logging ban in 1989) proved relatively ineffective. More recently, greater emphasis has been placed on increasing public awareness and on active measures to rehabilitate degraded watersheds. Forest management has shifted away from catering mainly to the needs of the wood-based industries towards safeguarding of forests' environmental functions. Currently, the national forest land has been classified into three categories: conservation forest, production forest, and "agricultural land reform area". The Thailand National Forest Policy and the 8th National Economic and Social Development Plan 91997-2001) aims to protect 25% of the total land area under conservation forest and 15% as production forest. In addition, long-term guidelines for forest preservation and sustainable use are formulated but forest encroachment continues both in conservation and production forests.

Pressure

The indicator: Available Agriculture Land per Capita 1975 to 2000 with Projections to 2030 (see Factsheet No. 1.1)

13. Forest resources in Thailand have been under a variety of pressures including conversion to large scale monoculture plantations (e.g. cash crops, para rubber), fuelwood collection, clearing driven by land speculation, forest fires, illegal logging, as well as infrastructure development.

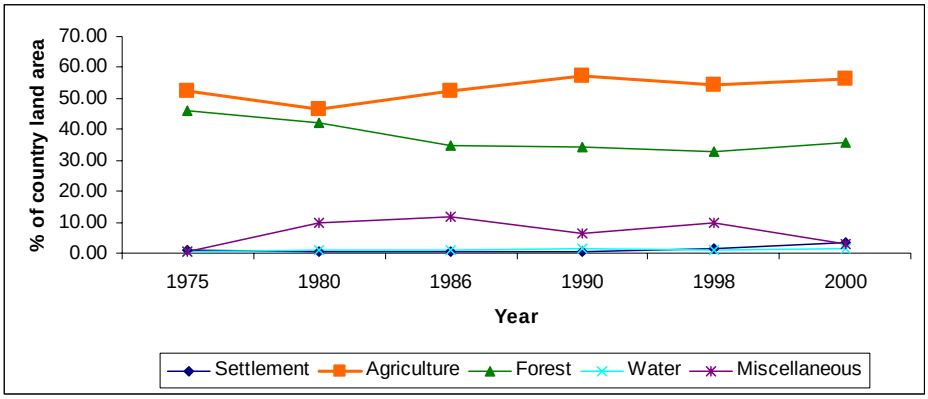
14. Among those pressures, encroachment for agriculture, especially large scale monoculture plantation appears to be the most significant driver of deforestation in Thailand showing close negative correlation with forest cover. In addition, the demand for agricultural land is also positively related to the price of main crops and the numbers of farm population, and negatively related to agricultural productivity and degree of industrialization.

15. Available agricultural land per capita was developed as an indicator of the pressure that the agriculture sector imposes on a limited land resource often in conflict with other sectors, especially forestry. It is expressed as the ratio of available agricultural area divided by the total population, in hectares per person.

16. The Land Development Department (LDD) is the agency responsible for classification of land and land cover using aerial photo and satellite image. Agriculture area classified by LDD includes paddy fields (irrigated and rainfed paddy), cash crops, permanent crops (cocoa, coffee, fruit trees, flowering shrubs, and rubber), and permanent pasture & aquaculture. The first land use map was produced in 1975 and the current land cover map was interpreted in 2000. Land cover statistics are generated at approximately 5-6 year intervals.

17. Figure 1 shows the agricultural area to have increased in the last 25-year period from 270,130 km^2 or 52.6% of the country's total land area in 1975 to 288,555 km^2 or 56.2% in 2000. It is expected that the agricultural area will continue to increase in future and put pressure on the remaining forest cover.

Figure 1 Percentage of land use - 1975 to 2000



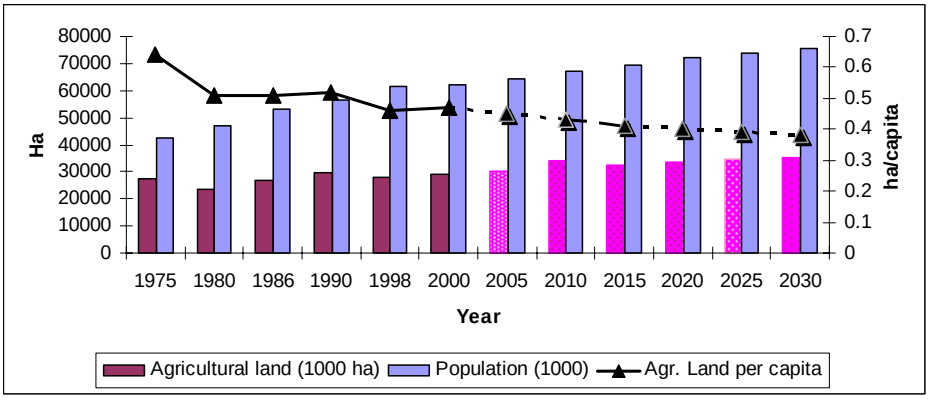
18. Figure 2 shows that the overall per capita agricultural area availability was on the decline for all of the studied period. The rate of decline was the most pronounced between 1975 and 1980, when the agricultural land per capita dropped from 0.64 ha to 0.51 ha. During 1980-1990, the value of the indicator was relatively stable but declined again after 1998 in response to strong GDP growth during 1989-1994 when large areas of arable land were converted to housing and other infrastructure (see Table 1 Factsheet No. 1.1).

19. If agricultural land per capita were frozen at 2000 values – 0.47 ha per capita, the percentage of agricultural land in the country's total would increase to 63.70% in 2015 and 69.09% in 2030 assuming the current rates of population growth. (see Table 2c in Factsheet No. 1.1). Such a situation would create a serious conflict with existing targets of 40% forest cover in 2006 (9^{th} NESDP) and 50% in 2016 (20 year Environmental Policy). The pattern of future population growth and the extent to which it is likely to follow the declining trend characteristic of industrializing societies will clearly play a role.

20. If, on the other hand, the policy objective were to stabilize the percentage of agricultural land at the 2000 level, the agricultural land per capita would have to fall to 0.41 ha in 2015 and 0.38 ha in 2030 to make this happen. In order for this to be possible without threatening the overall level of agricultural output, significant increases in crop productivity would have to be achieved. Here, too, the results are conditional on the

pattern of future population growth. The possibility of food imports as a serious policy option should not be excluded.

Figure 2 Available agricultural land per capita – 1975 to 2000, and projected to 2030



Rating: High and steady

Justification: The growing population is exerting significant pressure on a limited land resource for the purpose of agricultural production and food self-sufficiency. This pressure is often in conflict with the demand for land for forestry, urbanization and conservation. It is expected that available agricultural land per capita will decline from 0.47 ha to 0.41 ha and 0.38 ha in 2000, 2015 and 2030, respectively.

State

The Indicator: Forest Cover as Percent of Total Land Area – 1961 to 2000 (see Fact sheet No. 1.2)

21. The Royal Forest Department (RFD) has the official responsibility for monitoring of forest cover. Since 1961, it has been classifying land into forest and non-forest based on aerial photos and, later on, satellite images. The latest detailed classification by forest types was made in 2000.

22. The first estimates of forest cover a scale of 1:10,000 were produced in 1961 based on interpretation of aerial photographs. No other estimates were produced in the 1960's. Starting in 1973, the RFD undertook successive inventories approximately every two to three years, mainly based on the interpretation of satellite imagery (Landsat) on a scale of 1:250,000. The last of these on this scale was produced in 1998. In 2000, RFD obtained high resolution Landsat-7 ETM+ images on a scale 1:50,000. At the time of this report's preparation, DNP was in still the process of interpreting them and for this reason, the 2003 estimates are not included in this assessment.

23. As can be observed from Figure 3, the rate of deforestation was high during the period 1961 to 1982, with an average loss of 3.2% or 8,827 km^2 per annum. At this rate, Thailand would have been void of all forest cover by the year 2012. The sharpest rate of

decline during this period was in the Northeast and Southern regions where the percentage forest cover dropped by 12% and 16% respectively.

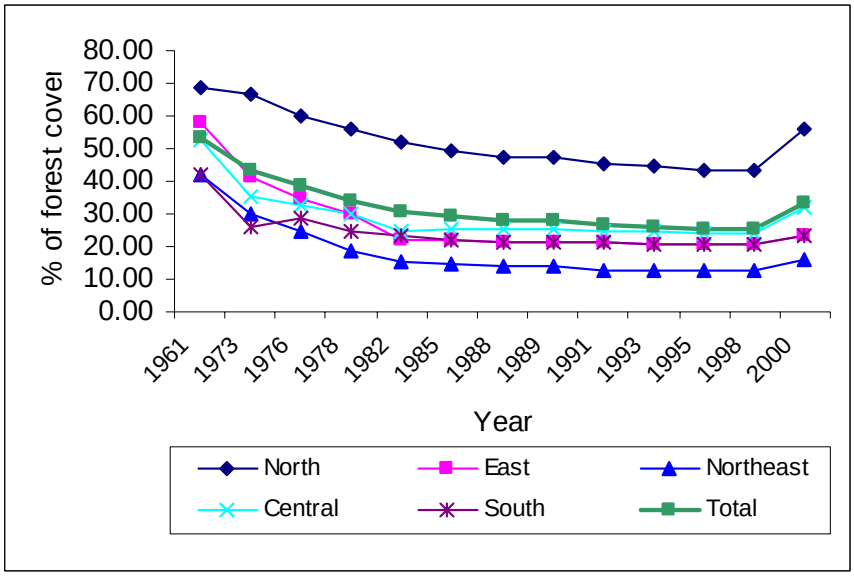
24. The rate of decline leveled off from 1982 to 1998, to a rate of 1.2% or 1,678 km^2 per annum. At this rate, Thailand would have maintained some forest cover until the year 2070. The largest loss of forest area during this period occurred in the Northern region, historically the most forested part of Thailand. The northern region suffered a combined 8% loss of forest during this period.

25. The results of image interpretation in 1998 put the total forest area, excluding rubber plantations, at 129,715 km^2 or 25.3% of the country's total land area. The highest percentage of forest cover was found in the northern region, covering 73,049 km^2 or 43.1% of the total land area. Only 12.4% of forest cover remained in the northeast the original forests had been converted for agriculture. The percentages of forest cover in the east and south were equal at 20.6% each (see Figure 1 and Table 2 in Factsheet No.1.1).

26. The latest completed (2000) assessment indicates that approximately 33.1% of the country's total area remained under forest representing an increase of approximately 7.8 percent from 1998. Of the total forest, the natural forest covered approximately 163,540 km^2 or 31.9% while secondary growth covered about 3,093 km^2 or 0.6%. Approximately 3,477 km^2 or 0.7% of the total land area was classified as afforested. Forest cover increased in all regions. For instance, the percentage of forest area in the north increased from 43.1% in 1998 to 56.7% in 2000.

27. The rapid increase observed between 1998 and 2000 demands explanation. One is the fact that the 2000 estimates were based on new and improved methods of measuring forest cover and may not be representative of future trends. Changing the scale of the assessment may have made it possible to count small areas of forest that would be overlooked at the broader scale. The additions of small scattered areas of forest may or may not matter depending on the view taken of their role in generating landscape- and other values. Upcoming 2003 estimates will confirm whether the earlier estimates, prepared with lesser accuracy and resolution, under-estimated the total forest cover. If so, this would lower the extent of improvement suggested by the data. In the opposite case, however, the result would inspire confidence in the effectiveness of restraint and conservation measures adopted by Thai authorities in late 1990s, or as a minimum, present a more positive picture of rural landscapes in Thailand without attributing it to any particular policies.

Figure 3 Forest Cover as Percent of Total Land Area – 1961 to 2000



(Source: RFD and DNP)

28. The government of Thailand has formulated three national policy targets related to forest cover in Thailand are as follows:

- Thailand National Forest Policy adopted by the Cabinet on December 3rd, 1985 formulates the target of 40% of the country area under forest (25% Protected Forest and 15% Production Forest).
- The 9th National Economic and Social Development Plan (2002-2006) re-confirms the targets of 25% of total land area under protection forest and at least 15% of the area of the Kingdom under production forest by the end of 2006.
- Thailand Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997-2016 aims to increase forest cover to 50% of the country by the final year of the planning period. At least 30% is to be designated as conservation forest, and 20% as production forest.

29. These targets are clearly ambitious not least because land currently used for agriculture already accounts for 56 percent of the country's total land area. Given the latest figure of 33 per cent forest cover, the 2006 goal of 40% forest cover formulated in the 9th NESDP and the National Forest Policy is unlikely to be reached.

Rating: Relatively poor and deteriorating

Justification: Percentage forest cover declined from 53.3% in 1961 to 25.3% in 1998. If the long-term trend continues, Thailand will have difficulty achieving the target of 40% forest cover in 2006 and 50% in 2016. A recent year 2000 estimate hints at a reversal of this trend towards the end of 1990s, but the 2003 estimates have yet to validate this result. Unless concerted measures are taken to increase forest cover, Thailand will fall way short of its 2016 target of a 50% forest cover. The justification of the target itself is not assessed in this EPA.

The state: Cross-country and GMS comparisons

30. According to the Global Forest Resources Assessment 2000 by the Food and Agricultural Organization of the United Nations (FAO), the forest cover in Lao PDR was the highest in GMS, amounting to approximately 54.4% of total land. Forest cover in Cambodia and Myanmar exceeded 50% of the country's land area. The lowest forest cover was observed in Thailand and Vietnam. Among the GMS countries, Thailand experienced the highest rate of decline of forest cover between 1990 and 2000 (Table 2). Small discrepancies exist between detailed figures of Thailand's forest cover as reported by national authorities (see para. 25) and those used by FAO that do not, however, change the overall conclusion.

Table 2 Change in forest cover in GMS, 1990-2000

Country	Total forest 1990	Total forest 2000	Forest cover change 1990-2000	
	ha %	ha %	Annual change ha	Annual change rate (%)
Cambodia	9,869 56.1	9,335 52.9	-56	-0.6
Yunnan Pr., PRC	13,423 33.7	12,873 32.4	-55	-0.4
Lao PRD	13,088 56.7	12,561 54.4	-53	-0.4
Myanmar	39,588 60.2	34,419 52.3	-60	-0.5
Thailand	15,886 31.1	14,762 28.9	-112	-0.7
Vietnam	9,303 28.6	9,819 30.2	52	0.5

Sources: http:///www.fao.org/forestry/site/fra/en ; data for Yunnan from ICEM (International Federation of Chemical, Energy, Mine and General Workers' Union) database

Response

First indicator: Areas reforested 1997-2002 (see Factsheet No. 1.3)

31. Forest protection measures have their legal basis in the Forest Act of 1960 and the National Forest Reserve Act of 1964. Other acts of relevance include the National Park Act of 1961 and the Wild Animal Reservation and Protection Act of 1992. A number of policies, regulations and supplementary rules complete the regulatory structure. Commitment to forest protection is routinely re-stated in national development plans.

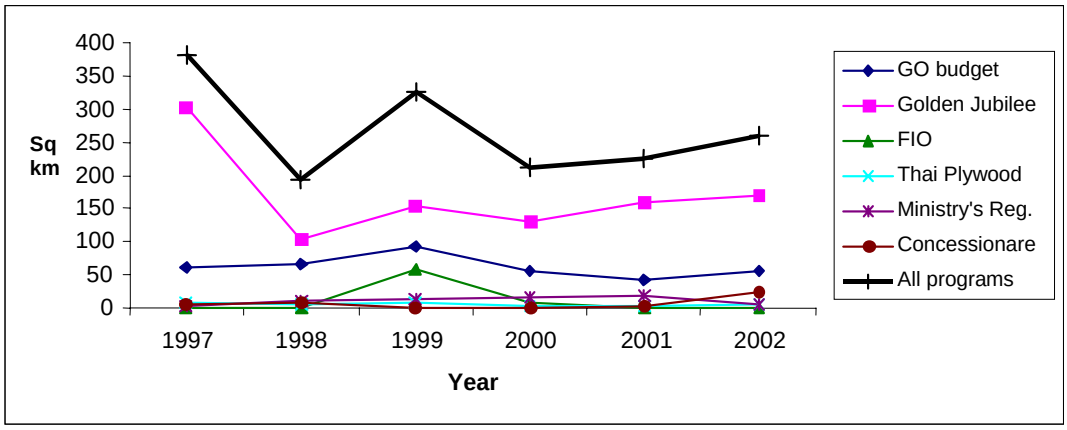
32. The list of measures adopted by Thai authorities to counter the loss of forest resources includes continued and increased funding of forest protection, temporary restriction or bans on commercial logging, additions to areas accorded protection forest within the total forest area, stepped-up pace of the inventories of residual stand on logged areas, reforestation and afforestation investments, and others. The pace of reforestation activities and the progress of establishing protected areas have been chosen as the response indicators in this EPA because both indicators are measurable and considered as effective means of forest rehabilitation in Thailand. Below, we look at reforestation first. Reforestation is understood here to mean planting of trees on areas previously forested or any other (i.e. afforestation, to purists).

33. Reforestation in Thailand started in 1906. From then until 1960 small areas were planted annually. Approximately 85 km^2 ha were planted by 1960, of which 70% was teak. After 1961, the reforestation program was significantly expanded and was included in the 5-year NESDPs. The cumulated area planted reached 6,630 km^2 by 1986 and 7,140 km^2 by 1990. About 52% of the planting was done by private sector (TFSMP, 1993). The main reforestation species were teak, pine and eucalyptus. Reforestation is mainly concentrated in the north and northeast Thailand where large areas suffered deterioration due to expanding agriculture activities.

34. Since 1994, six major reforestation programs have been initiated and the purpose of plantation significantly shifted from growing industrial wood to biodiversity conservation and rehabilitation of degraded watersheds. The six programs are 1) Afforestation by Government budget, 2) The Reforestation Campaign in Commemoration of The Royal Golden Jubilee, 3) Planting by Forest Industry Organization (FIO) 4) Planting by Thai Plywood Co.,Ltd., 5) Reforestation under ministerial regulations (Ministry of Agriculture and Cooperatives and Ministry of Natural Resources and Environment), and 6) Reforestation by forest concessionaires. Reforestation Program (5) is an obligation placed on individuals or agencies that are allowed to use reserve forest land. Reforestation by forest concessionaires (6) is financed though logging concession fees. Following the enactment of logging ban in 1989 this component has now been largely discontinued. The '*Reforestation Campaign'* in Commemoration of The Royal Golden Jubilee targets 5 million *rai* or 8,000 km^2 in protected areas. This project started in 1994 and is expected to be completed by 2006. The total reforested by 2002 was approximately 11,662 km^2 and the total accumulated expenditure by then was 15,075 million baht.

35. Reforestation by RFD has decreased significantly since 1994 from 320 km^2 per year until then to less than 60 km^2 annually since then (see Factsheet No. 1. 3). Government budgetary limitations in the last ten years linked to the financial crisis of 1997 also played a role.

Figure 4 Areas reforested, 1997-2002



(Source: Royal Forest Department)

36. By comparing the reforestation totals with the average annual deforestation rate, it becomes clear that deforestation outpaced reforestation for at least three decades. The forest cover was being lost at a rate of 8,800 km^2 p.a. from 1961 to 1982, and 1,678 km^2 per annum from 1982-1998, while reforestation under six programs combined ranged from 192-380 km^2 per annum from 1997-2002 (Fig. 4). In addition, the survival of newly planted seedlings is only about 66% according to FAO and World Bank estimates and therefore the areas effectively reforested are smaller that suggested by the totals quoted above. This may be mitigated somewhat by natural regeneration (significant in the days of large forest cover before 1980 but less significant now that total forest area is relatively small).

37. Reforestation is also faced with a number of controversies and constraints, familiar to other countries of the region with only small modifications. The more significant among them are:

- The land controversy: Much of the deforested state land targeted for reforestation is occupied by villagers who claim it for their livelihood. Linked to that is opposition of villagers to large-scale government reforestation schemes and commercial plantations.
- The eucalypt controversy: planting of eucalyptus is opposed by many villagers and NGOs ostensibly on environmental grounds.
- Viability of tree cropping as a land use alternative: The long gestation period, the risks and the size of the profit margin tend to make tree cropping financially unattractive for farmers.
- Unsupportive legislation: The laws including Reforestation Act of 1992 impose unnecessary bureaucratic controls on those willing to invest.

Nevertheless, reforestation programs have had an impact on rehabilitation of degraded natural ecosystem in watersheds, national parks and wildlife sanctuaries. These programs need to be continued with increasing budgetary and institutional support of the Government, the private sector and the NGOs.

Rating: Low but consistent

Justification: Overall, reforestation programs have had a positive impact on maintaining forest cover and slowed down the pace of deforestation. However, more progress needs to be achieved. The major impact of reforestation programs, it is felt, is on the rehabilitation of degraded natural ecosystem in watersheds, national parks and wildlife sanctuaries.

Second indicator: Protected areas as a percent of total land area 1961-2004 (see Factsheet No. 1.4)

38. In Thailand, the system of protected areas includes national parks, wildlife sanctuaries, forest parks, non-hunting areas, conservation mangrove forests, protected lakes, marine protected areas, "Class 1" watersheds, as well as botanical gardens and arboreta.

39. Starting with Khao Yai National Park in 1962 and Salak Pra wildlife sanctuary in 1965, the end of the 1st NESDP (1961-1966) saw 4 national parks, 1 wildlife sanctuary and 7 forest parks covering a total of about 1% of the country's land area. By the end of 6th NESDP (1987-1991), there were 15 national parks, 5 wildlife sanctuaries, 7 non-hunting areas and 1 forest park. In addition, there were significant events and developments that affected protected areas in Thailand such as the nationwide logging ban introduced in 1989 and the initiation of forest zoning policy. The preliminary national forest reserve zoning approved by the cabinet in 1992 set the target of 27.5% of the country under protection.

40. Thailand National Forest Policy adopted by the Cabinet on December 3rd, 1985 formulated the target of 40% of the country area under forest (25% Protected Forest and 15% Production Forest). The 9th National Economic and Social Development Plan (2002-2006) re-confirms the targets of 25% of total land area under protection forest and at least 15% of the area of the Kingdom under production forest by the end of 2006. It is not clear whether the small discrepancy between the 7th NESDP's figure of 27.5% and the 25.0% figure of 9th NESDP's target is just that (i.e. loss of accuracy) or whether the 2.5% difference represents the target for non-forest protected areas.

41. Table 3 illustrates the development of protected areas and forest cover in Thailand during the period of nine NESDPs (i.e. since 1966). The last column of the table is the value of the chosen indicator expressed as percentage of protected areas in the total forest area. That percentage has grown rapidly both as a result of more areas being placed under protection as well as continued loss pf forest cover during the same period. The values greater than 100 per cent mean that not all protected areas are forests. This indeed is the situation in Thailand as shown in Table 3 below.

Table 3 Forest cover and protected areas 1961-1991

National Economic and Social Development Plan (NESDP)	Protected areas			Forest cover			Protected areas as per cent of total forest land
	Year	1,000 km^2	Protected areas as per cent of total land area	Year	1,000 km^2	Forest land as percent of total land	
1st NESDP, 1961-66	1966	4.62	**0.9**	1961	273.64	53.33	1.69
2nd NESDP, 1967-71	1971	5.13	**1.0**				
3rd NESDP, 1972-76	1976	25.14	**4.9**	1973	221.72	43.21	11.34
				1976	198.42	38.67	
				1978	175.23	34.15	19.91
4th NESDP, 1977-81	1981	34.89	**6.8**	1982	156.60	30.52	33.42
5th NESDP, 1982-86	1986	52.34	**10.2**	1985	149.06	29.05	
6th NESDP, 1987-91	1991	65.17	**12.7**	1988	143.83	28.03	45.31
7th NESDP, 1992-96	1996	141.11	**27.5**	1989	143.42	27.95	
8th NESDP, 1997-01	2001	141.11	**27.5***	1991	136.69	26.64	103.23
				1993	133.56	26.03	
				1995	131.46	25.63	
9th NESDP, 2001-06	2004	141.11	**27.5***	1998	129.72	25.28	108.78
				2000	170.11	33.15	

* Conservation forest land under forest land zoning approved by the cabinet in 1992

41. The current (2004) protected realm consists of 81 terrestrial parks, 22 marine parks and 55 wildlife sanctuaries, 69 forest parks and 55 non-hunting areas, covering approximately 18% of the country's land area, or 24.4% of Class 1 watershed areas are included (see Figure 5). There are some other smaller but ecologically important areas protecting wildlife, special ecosystem, water resources and scenic spots. In addition, "Class 1" watersheds cover approximately 18% of the country's total area[2]. However, about 50% of national parks and wildlife sanctuaries overlap with Class 1 watersheds. When national parks and wildlife sanctuaries are superimposed on Class 1 watersheds, it is found that the protected area system in Thailand covers 24.4% of the country's land area nearly meeting the objective the 9th NESDP of 25% protected areas and 27.5 % as conservation forest. Terrestrial national parks, marine parks, wildlife sanctuaries and watershed class 1 areas encompass 37.6%, 3.5%, 26.1%, and 74.4% respectively of the total area of protected areas. In sum, approximately 83% of national parks, wildlife sanctuaries and watershed class 1 are under forest cover.

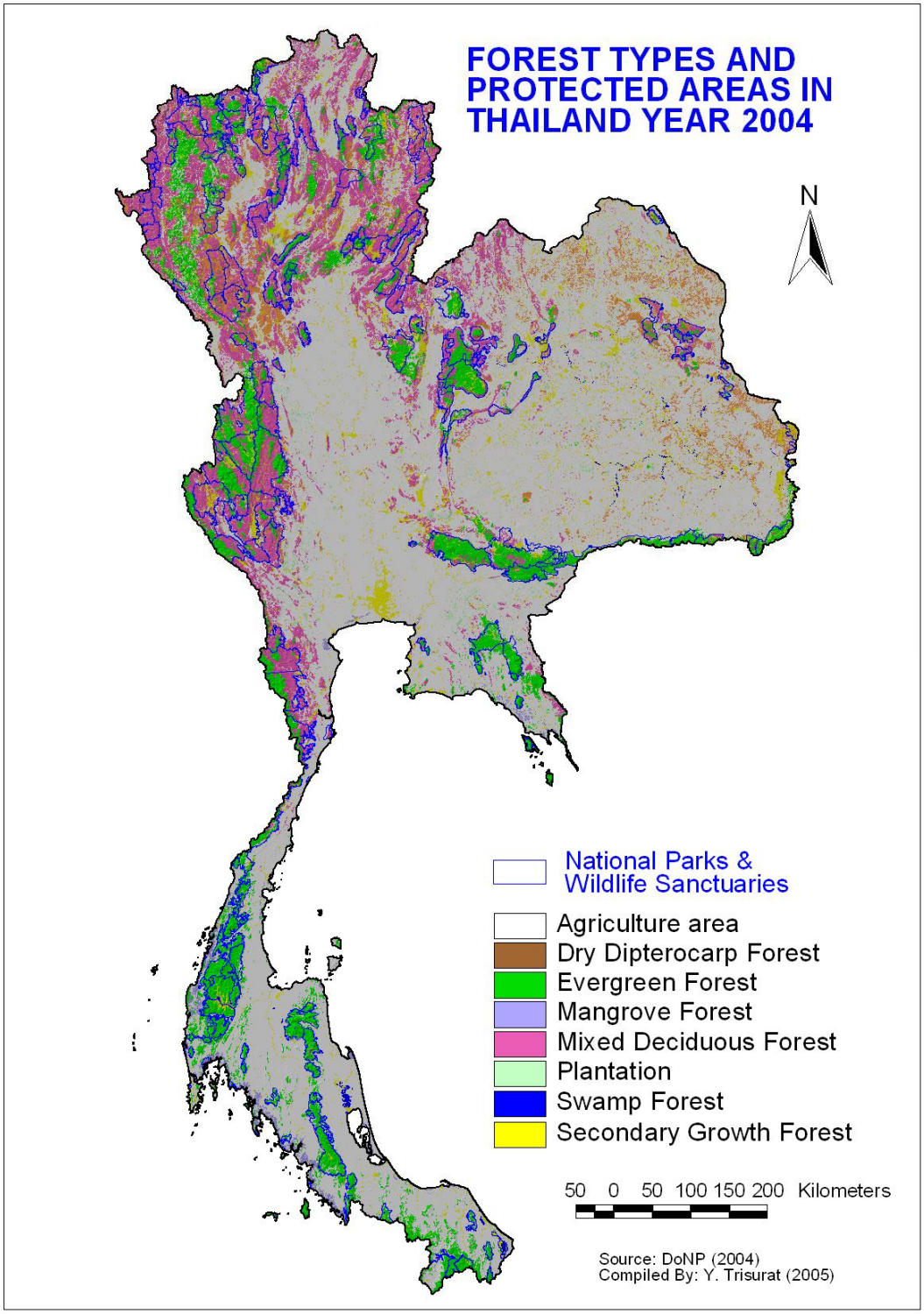
[2] Class 1 watershed areas are managed like other protected areas. The difference lies in their legal status: Class 1 watershed protected area system is decided by a Cabinet resolution; national park and wildlife sanctuary are protected by law.

Table 4 Forest cover by type (in 2000) and in protected areas in 2004 (km^2) -

Forest Type	Country	National Park	Marine Park	Wildlife Sanctuary	Watershed Class 1	Protected Areas
Forest cover						
Evergreen forest [1/]	52,679.5	18,217.6	761.5[2/]	15,229.5	33,882.3	43,352.2[3/]
Pine forest	462.0	252.9	0.0	44.2	324.1	393.8
Peat swamp	304.0	0.0	0.0	74.0	1.4	75.4
Mangrove forest	2,452.0	3.1	124.7	0.0	0.0	144.2
Inundated forest	256.8	1.6	0.0	0.0	16.4	1.5
Beach forest	125.0	9.0	17.8	0.0	0.7	26.8
Mixed deciduous	87,444.5	20,192.3	0.0	12,138.6	40,971.5	51,184.3
Dry dipterocarp	18,569.5	2,539.8	0.0	2,113.2	3,713.2	6,386.2
Bamboo	1,503.5	842.8	0.0	446.6	990.7	1,459.4
Plantation	3,477.0	158.3	0.0	190.2	177.5	444.2
Rehabilitated forest	2,836.5	558.9	7.6	579.2	621.3	1,397.4
Sub-total	170,110.3	42,776.3	911.6	30,815.6	88,079.0	104,861.5
Non-forest	343,004.7	8,355.5	3,868.1	4,686.5	12,397.4	20,220.9
Total land area	513,115.0	51,131.8	4,779.7	35,502.2	93,090.0	125,082.4
% country land area	33.2	8.3	0.2	6.0	18.1	24.4
% of protected areas		37.6	3.5	26.1	74.4	100.0
% forest cover	33.2	83.7	19.1	86.8	86.7	83.8

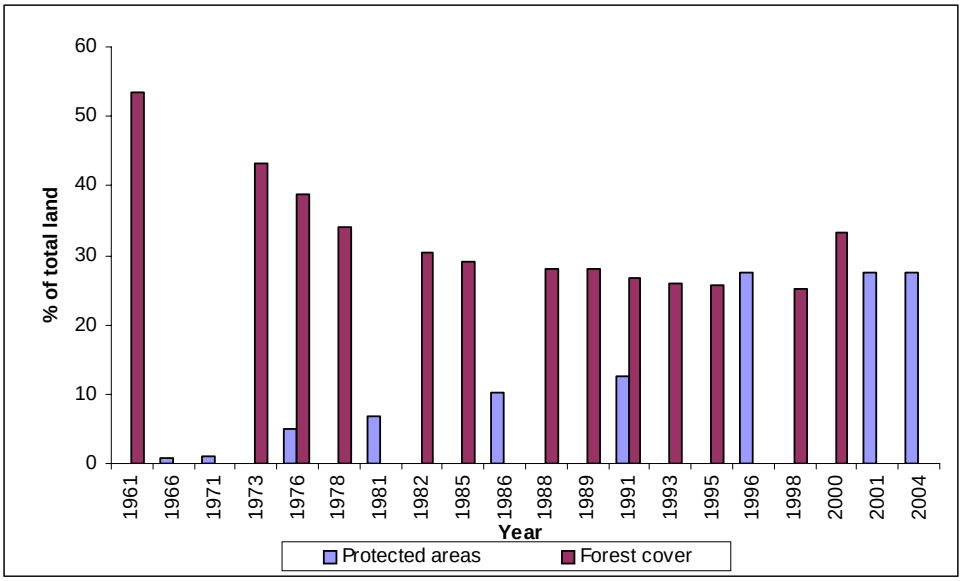
Source: Department of National Parks, Wildlife and Plant Conservation
* Area calculated by GIS grid resolution 200 m x 200 m
[1/] Tropical rain forest, dry evergreen forest, and hill evergreen forest
[2/] Includes forest on islands
[3/] The totals of protected areas are not a simple sum of columns 3 to 6 of the table since varying percentages of watershed class 1 are included in the protected realm.

Figure 5 Forest types in year 2000, national parks and wildlife sanctuaries in year 2004



42. Tropical evergreen forest, pine forest, and bamboo forest are well represented in the existing protected area system. Mixed deciduous forest and dry dipterocarp forest are less well represented and in practice, often disturbed by illegal logging and the pressure of adjacent communities for cultivation. Swamp forest is protected but it remains only in one sanctuary that is critical in the face of pressure exerted by stochastic events, especially forest fire, and human intrusion. Only small areas of mangrove forest remain in Thailand and the class is both poorly represented and exploited for aquaculture and tourism. Worth noting is that Thailand's approach to protected area establishment did not systematically consider balanced representation of ecosystems, and biodiversity. The establishment was ad hoc aiming to protect forest cover rather than protect biodiversity. Therefore, partial successes under the forest cover heading may have in part been achieved at the cost of a more balanced support for biodiversity protection.

Figure 6 Protected areas against forest cove, 1961 to 2004



(Source: Department of National Park, Wildlife and Plant Conservation)

Conclusions

43. Forest cover in Thailand has been declining over the last 40 years. From 53.3% of the country's land area in 1961, forest area shrank to 25.8% in 1998 The percentage of forest cover declined at a rate of 3.2% or 8,827 km^2 per annum during the period 1961-1982 and at a rate 1.2% or 1,678 km^2 per annum from 1982 to 1998 (Fig.6). The 2000 data of RFD put the percentage of forest cover (inclusive of reforested area and secondary growth) at a much higher 31.9% of the total land area and 33.1% of the total land area if all remaining forest categories are included. This reversal of the trend is important to confirm and determine whether the encouraging result is a reflection of field realities or advances in remote sensing technology in recent years or other factors.

44. Currently, there are more than 281 protected areas in Thailand (excluding botanical gardens and arboreta). If Class 1 watershed, are counted (they are not at present but ideally

would be), the total area involved is approximately 24.4% of the country nearly meeting the 25% target as defined in the 9th NESDP and the National Forest Policy. Mangrove forest, swamp forest and lowland evergreen forest are not well represented in the protected area system and their total is probably too low to safeguard their biodiversity and survival.

45. Reforestation in Thailand started in 1906. The total area planted reached 6,630 km^2 by 1986, 7,140 km^2 by 1990 and 11,662 km2 by 2002. Since 1994, the focus has significantly shifted from support to wood-based industry to biodiversity conservation and rehabilitation of degraded watersheds. Among the six, the "Reforestation Campaign in Commemoration of The Royal Golden Jubilee" has been the most effective.

46. Considering the trend of reforestation and the progress of protected areas coverage, as well as the remaining forests against deforestation rate, Thailand is unlikely to meet the 2016 target of a 50% forest cover. The basis for the 50% target would deserve to be made public and better justified if greater commitment on the part of many is to be secured.

Rating: 2 stars, target of conservation areas has been set and generally met but the target of production forest is likely ambitious.

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WATER RESOURCES

The context

47. Water resources are vital assets in the development of Thailand. With a total area of 513,115 km^2 and an average annual rainfall from 1951-2003 of about 1,356 mm, Thailand receives a total of 737,000 million cubic meters (MCM) of rainwater annually. However, the rainfall is not evenly distributed. The West Peninsular region receives the highest rainfall of 2,507 mm/year followed by the eastern region of 1,846 mm/year, while rainfall in the East Peninsular region, north and central is 1,140 mm 1,200 mm and 1,248 mm, respectively (see Table 1 below). After subtracting losses from evaporation and infiltration of approximately 600,000 MCM, the remaining approximately 140,000 MCM is left as surface water resources to be used. The distribution of rainfall for each region is shown in Table 5.

Table 5 Average annual rainfall volume by region (1951-2003) and change of rainfall (mm)

Region	Average rainfall (mm)	Area (km^2)	Rainfall volume (MCM)	Rainfall in 2002 (mm)	Rainfall in 2003 (mm)	Change between 2002-2003 (mm)
North	1,200.4	168,854	202,692	1,303.4	1,068.7	-234.70
Northeast	1,404.9	169,644	238,333	1,586.5	1,341.7	-244.80
East	1,846.6	36,503	67,406	1,670.3	1,803.4	133.10
Central	1,248.1	67,399	84,121	1,121.0	1,296.5	175.50
West Peninsular	2,507.3	46,760	117,241	2,034.2	2,534.2	500.00
East Peninsular	1,140.5	23,950	27,315	843.6	1,314.2	470.60
Total	-	513,115	737,109	1,364.4	1,322.7	-234.70

Source: Meteorological Department (2003)

48. With the exception of the south, approximately 80% of the rain falls during the four month long rainy season from May to October.

49. Water shortages are common in the north and northeast. This is exacerbated by these areas' mountainous character (lowlands cover only about 10% of the total area unlike the central region), well-drained soils and rainfall's irregularity. Flooding in the wet season and severe water shortage in the dry season are a frequent occurrence. Added to this are the pressures exerted by growing local water demand by the industry and the push for greater dry season crop production.

Pressure

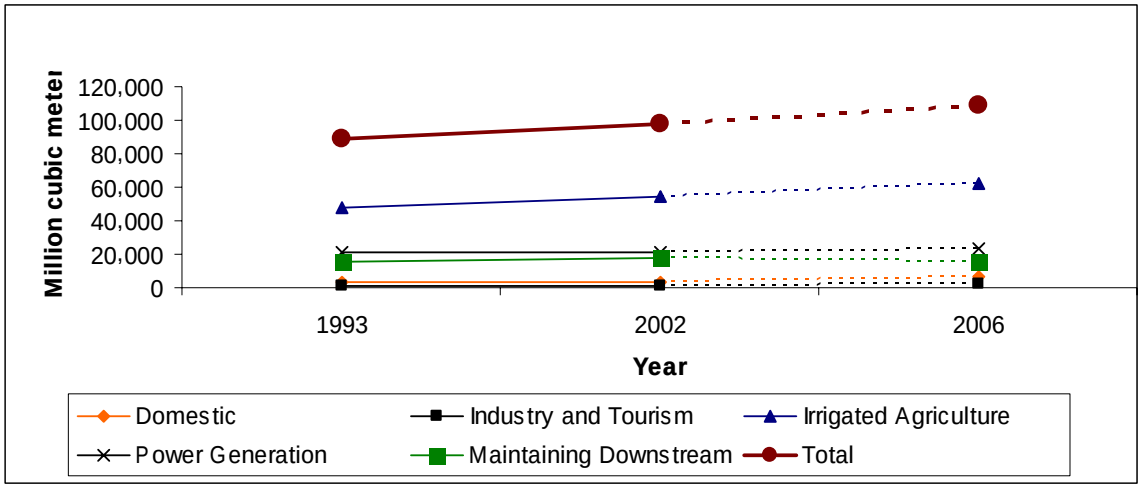
The Indicator: **Water consumption by agriculture 1993-2003 (see Factsheet No. 2.1)**

50. The quantity and quality of water resources in Thailand have been under pressure over the years due to deterioration of watersheds, disappearance of wetlands, and agricultural and industrial pollution. In addition, the demand for water grew fast in line with

the expansion of Thailand's economy while the amount of water available remained stable. Water shortages in virtually every region loom as a serious potential threat to future prosperity.

51. The Royal Irrigation Department (RID) divides water consumption into five classes: domestic consumption, industry and tourism, irrigated agriculture, power generation and maintenance of downstream ecosystem. Agriculture is by far the highest consumer of water and water consumption by agriculture is a logical choice of an indicator of pressure on available water resources. (see Figure 7)

Figure 7 Water consumption 1993-2002 and projected 2006



52. The agricultural water consumption rose from 48.2 billion cubic meters or 54.3% of the total in 1993 to 61.7 billion cubic meters or 56.5% in 2006. According to the Water Resource Development Master Plan 1997-2016, water consumption by all sectors combined is projected to increase from 76.7 billion cubic meters in 2002 to approximately 109.3 billion cubic meters in 2006, or by nearly 23%, led by greater consumption by agriculture. Domestic water consumption is projected to increase at an even faster rate. Most of future increases are expected to come at the expense of the maintenance of downstream ecosystem, a worrying projection.

Rating: High and increasing

Justification: The total water consumption by all sectors is projected to increase from 76.7 billion cubic meters in 2002 to approximately109.3 billion cubic meters in 2006 against the background of a falling trend of annual rainfall, probably a short-term phenomenon. It is likely that conflicting demands on water from agriculture, commercial, institutional and other sectors is exerting a severe pressure on water availability and distribution.

State

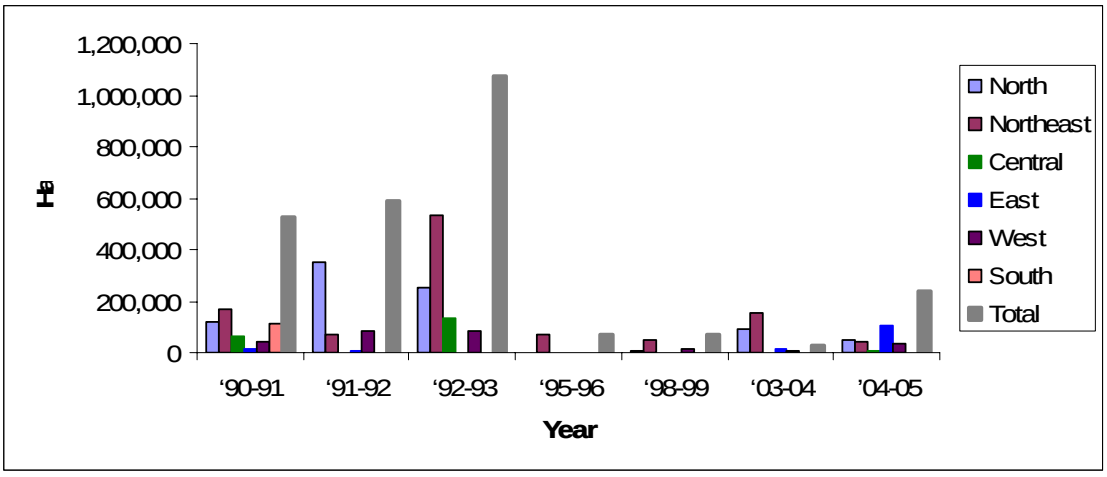
Indicator chosen: Area of "under-irrigated" lands 1990-2004 (see Factsheet No. 2.2)

53. There are several indicators that can be used to assess the state of water resources such as frequency, duration and extent of water shortages, long-term marginal cost of water supply, and water storage, etc. In Thailand agriculture plays a leading role in the economy of all regions and the extent of water shortage for agriculture seems an appropriate measure of the state of adequacy of water resources to support the Thai economy and society. Farm areas in principle irrigable but not receiving the normal quantity of water in any given year have been selected to supply the values of the indicator.

54. The data of water shortage are compiled by the Department of Agricultural Extension. Figure 8 shows that during the dry season (October – May) in 1990-1991, the water shortage for agriculture affected more than 524,226 ha (and affected 930 sub-districts in 39 provinces). In 1991-1992, approximately 600,000 ha of cultivation area was affected in 35 provinces and the most severe shortage was experienced in 1992-1993 when almost a 1.1 million hectares and 2,174 sub-districts of 46 provinces were affected. Between 1995 and 1998, the water deficits were less serious mainly because of a more favorable time profile of rainfall during those years.

55. The extent of water shortages is clearly not static and depends not only on the quantity and distribution of rainfall but also on cropping patterns, in particular the relative importance of the water-demanding paddy cultivation, and available storage capacity and its management.

Figure 8 Area of "under-irrigated" lands 1990-2004



Source: Department of Agriculture Extension

Rating: Average and stable

Justification: The extent of water shortages is not static and depends not only on the quantity and distribution of rainfall. During the dry season (October – May) in 1990-1991, water shortage affected more than 524,226 ha of farmland, in 1991-1992, approximately 600,000 ha, and the most severe shortage was experienced in 1992-1993 when almost a 1.1 million ha experienced water shortage. Agricultural areas in the north and northeast tend to be the most seriously affected because of steep terrain and soil texture.

The state: Cross-country or GMS comparisons

56. Nilsson and Segnestam (2000) found significant differences in water availability and freshwater withdrawals among GMS countries (Table 6). Thailand's and Vietnam's availability of freshwater for agricultural, industrial, or domestic uses is well below the world average and other countries of the Mekong region but both countries are using a much larger share of their water resources than other countries. The same pattern of a relatively low availability and high usage can be observed in China. At the opposite end, Cambodia and Laos have an abundance of freshwater resources and are consuming very little compared to Thailand and Vietnam.

57. Laos and Cambodia attempt to become self-sufficient in rice production while Thailand and Vietnam aim to secure and increase rice export revenues. In both cases, this drives the demand for irrigation water. The irrigation needs are proportionately the highest in Thailand. The potential for reservoir development in the basin is large since less than 50% of the potential sites has been developed. Dry-season irrigation is also an essential feature of agriculture in Yunnan.

Table 6 Water availability, withdrawals and irrigation land (% of crop land) in the Mekong region

Country	Availability (m^3 per capita)	Withdrawal (% of resources)	% of crop land
Cambodia	41,407	<0.5	8
Laos	56,638	1	19
Myanmar	23,515	<0.5	15
Thailand	6,698	16	25
Vietnam	11,647	15	32
Yunnan-PRC	*NA*	*NA*	*NA*
China	2,285	16	37
GMS (Average)	23,698	~8.2	32
World (Average)	8,354	-	-

Source: Nilsson and Segnestam (http://pdf.wri.org/mekong_governance_reg_nilssonsegnestam.pdf)

Response

The Indicator: Irrigation Water Storage Capacity (see Factsheet No. 2.3)

58. There are many ways to counter the looming water shortage ranging from greater irrigation efficiency, more efficient use of non-agricultural water, improved water supply, economic incentives to conserve water (charging for irrigation water the most obvious among them), better management of water resources by the State, improved planning (e.g. master plans for river basin development), groundwater development, and others.

59. Among the large number of potential indicators, irrigation water storage capacity can be used to evaluate the national efforts to lessen the extent of irrigation water shortage. Time series data are available and the indicator can complement other measures such as establishment of water user group to manage small catchment.

60. The existing structure of irrigation storage capacity is given in Table 7.

Table 7 Water storage capacity and irrigation area constructed by RID until 2002

Region	Capacity Storage (mcm)				Irrigation area (km^2)	% of agricultural area
	Large Scale	Medium Scale	Small Scale	Total		
North	23,206	550	351	24,107	11,009	16.58
Northeast	3,037	1,646	841	5,524	8,786	13.09
Central	1,185	176	61	1,422	13,329	49.92
East	372	373	65	810	5,572	25.92
West		74	47	121	4,660	*
South	1,225	301	63	1,589	6,616	15.55
Total (Aug)	29,025	3,120	1,428	33,573	49,973	21.39

(Source: Royal Irrigation Department (2003); * % of agricultural area merged with central region)

61. The figures point to a concentration, at present, of irrigation storage capacity in the central plains and to smaller average sizes of storage facilities in the north and northeast of Thailand compared to the central plains. This is due in part to the geomorphologic features in the north and northeast that are not conducive to the development of large structures. The response to water shortage in the North and Northeast therefore rests on medium and small scale reservoirs. The existing irrigation water storage capacity under the RID serves approximately 21% of the agricultural land or about 9.7% of the whole country's land area. The irrigation area in the central plain in 2002 covered 13,329 km^2 or 50.0 % of the total agricultural land area compared to 11,009 km^2 or 16.6% in the north, and 8,786 km^2 or 13.1% in the northeast, 5,572 km^2 or 25.9% in the east, and 6616 km^2 or 15.5% in the south. The Northeast contains the lowest percentage of irrigation system but there are a number of potential areas for water resources development, especially small and medium scale ones.

62. To respond to the threat of drought, the government has set a target of utilizing about 50% of total rainwater (The Mater Plan of Water Resources Development of the RID, 1997-2016), of which only 40,000 million m^3 or 20% are used at present. Therefore, there are still 100,000 m^3 water resources to be further developed for the country's use.

63. The Mater Plan of Water Resources Development of the RID (1997-2016) sets the targets of increased water storage and irrigation area in the next three NESDPs. This coexists with the government's objective of increasing the percentage of irrigated lands to

approximately 27% of the cropland total by the end of the 9th NESDP. At the end of the 9th NEDSP (2002-2006), the irrigated area is to increase by 98,080 ha via small-scale water storage projects, and by 976,000 ha via medium and large-scale water storage projects. Additional 355,200 ha of irrigation area are expected from medium and large-size scales project at the end of the 10th NESDP. The RID is to develop water storage of 4,286 MCM and 2,653 MCM at the end of 9th NESDP and 10th NESDP, respectively.

Table 8 Capacity of water storage for irrigation project from 1st NESDP and projected until 10th NESDP

NESDP	Cropping area (%) 1/	Small-size scale reservoir 2/		Medium & Large scale Reservoirs 2/		% of irrigated crop land	Water storage 2/	
		Irr. area (km^2)	Increase (%)	Irr. area (km^2)	Increase (%)		MCM	Increase (%)
1st, 1961-66				15552.0			14472.3	
2nd, 1967-71				17536.0	12.8		15078.6	4.2
3rd, 1972-76				23008.0	31.2		24346.6	61.5
4th, 1977-81	37.8	3916.8	111.1	25344.0	10.2	15.1	25461.5	4.6
5th, 1982-86	40.5	8267.2	33.3	29936.0	18.1	18.4	28668.9	12.6
6th, 1987-91	41.5	1101.8	18.9	33136.0	10.7	20.7	30200.2	5.3
7th, 1992-96	41.3	13094.4	5.1	34688.0	4.7	22.5	31662.1	4.8
8th, 1997-01	56.2	13764.8	7.1	36208.0	4.4	21.4	33573.0	6.0
9th, 2002-06		14745.6		45584.0	25.9	27.0	36599.5	9.0
10th, 2007-11				49136.0			39252.7	7.3

Notes: 1/ Actual planting area derived from the Department of Agricultural Economics
2/ Gathered from the RID

64. In addition, the recently formulated Strategic Plan for Water Resource Development of RID for the period 2003 to 2007 provides more specific targets of irrigation system development by 2007as follows:

- Increasing the irrigation area by 4,121,799 *rai* or 660,000 ha
- Developing 241 new medium and large scale water resource development projects in order to store 3,803 million cubic meter; and
- Rehabilitating deteriorated irrigation area on 3,709,000 *rai* or 593,000 ha

Rating: Significant and consistent

Justification: The existing water storage for irrigation covers approximately 21% of the total arable land. The pace of water resource development declined since the period 1994-1997. This is due to the increasing shortage of suitable sites for large-scale projects. The remaining undeveloped sites are situated either in the heavily populated areas or in protected areas. The government has initiated a policy of increasing the coverage of irrigated areas by approximately 27% the arable land by the end of the 9th NESDP.

Conclusions

65. Thailand receives a large amount of rainfall, averaging some 737 billion cubic meters each year. Subtracting losses from evaporation and infiltration, there is approximately 140 billion m^3 of surface runoff distributed unevenly among the regions and seasons. The total water consumption reached 76.7 billion cubic meters in 2002. Of this, the share of agriculture was about 65%. The total amounts of surface waters used, as well as agricultural water consumption are project to grow. The existing irrigation provided by small, medium and large-size scale reservoirs service supplies approximately 21% of cropland, the rest is rainfed agriculture**.**

66. The pattern of water shortage is not static but depends on the type and area of cropping, especially the share of irrigated rice. The area affected by water shortages has been declining, especially since 1993. It is expected that water shortages will decline further due to a structural shift of Thai economy away form water-intensive agriculture towards industry. The government's target is to increase water storage by 21 % and irrigated area to 27% of total cropland in the next 10 years. Construction of medium and large scale water resource development projects may be difficult, however, because most potential sites are in protected areas, creating a conflict between conservationists and the "pro-rice" segments of the society. Other alternatives to avoid or mitigate water shortages during dry season include charging for water at its actual cost, effective management and protection of watersheds, improvement of administration and management of surface water resources, and promotion of more effective water utilization.

Rating: 2-stars, effective targets have been set and generally met even if the approach has been overwhelmingly engineering-driven (meeting a pre-determined level of demand) rather than efficiency-based (meeting an optimum level of demand) .

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LAND DEGRADATION

The context

67. In Thailand, like in its GMS neighbors, land resources have long been a key factor in the socio-economic development. Increasing population and acceleration of economic activities have had an impact on most natural resources, including land resources. This impact has been mixed: positive in many cases as a result of investment in irrigation and drainage but also negative in many locations where land productivity and potential have been lost due inappropriate use and destructive farm practices. During the past three decades, the problems of land availability, land classification and land degradation have come to the fore in Thailand mainly as a result of population pressure and continued conversion of forest to agriculture.

68. Agriculture has been the major export earner for Thailand for decades. However, its growth has come mainly from the expansion of cultivated area rather than an increase in the yield per unit of land area. Indeed, average crop yields have been stagnating or falling due to soil exhaustion in some areas and poor management. In 1992, the Land Development Department (LDD) estimated that "marginally suitable" (for agriculture) lands covered approximately 57% of the total land area (or about 300,000 km^2) consisting of 1) saline soils; (2) extreme acidic soils, (3) sulfate soils; (4) sandy soils, (5) shallow soils, (6) acidic soils; and (7) mountainous soils. Furthermore, some productive lands have been used in a manner incompatible with the principles of soil conservation. The 57% target seems out of touch with the underlying situation in which the *total* agricultural area fluctuated between 53 and 56 per cent of the total land area (see para. 17)

69. The principal government policies related to prevention of soil erosion and land degradation in Thailand include:

- The Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997-2016 that aims at accelerating rehabilitation of infertile soils on 59.5% of the total land area or 305,000 km^2 through a variety of soil conservation and rehabilitation measures undertaken by agricultural enterprises, and giving a greater support to applied research into environmental and ecological aspects of land use. The doubts about the merit of this target already expressed in the previous paragraph apply with an even greater force here and the target is to be understood as no more than a generalized injunction (with a small element of statistical imprecision) to maintain land productivity of all farmed lands.
- The 9^{th} NESDP (2002-2006) that targets improvement of land quality on 10 million rai (16,000 km^2) via (a) greater local and community participation under a transparent administration, (b) placing land rehabilitation within a broader objective of restoration of natural resource ecosystems, and (c) promotion of sustainable and organic agriculture as a means of dealing with deteriorated and problem soils.
- The Strategy of the Land Development Department (2004-2008) that targets rehabilitation of degraded farmland in every household on approximately 100 million rai or 160,000 km^2. Three approaches have been proposed including (a) use of Vetiver grass , (b) construction of farm ponds to relieve water shortage, and (c) adoption of HRM's "New Theory" that promotes diversification of farm activities in which cropping is combined with fish, livestock and poultry-raising, and maintenance of soil fertility is assigned an importance place.

Pressure

The Indicator: Loss of Forest Area 1961 to 2000 (see Factsheet No. 3.1)

70. The causes of land degradation are several. The direct causes in Thailand are mainly deforestation and removal of natural vegetation, over grazing and expansion of inappropriate land uses and management practices, e.g. the cultivation of steep slopes without soil conservation measures. The underlying causes, i.e. the reasons why these inappropriate practices take place, include inappropriate cultivation of sloping lands and absence conservation measures driven by landlessness and lack security of tenure.

71. In Thailand, deforestation followed by unsuitable farming is the main direct cause of degradation, especially when taking place in on steep slopes or on lands having shallow or easily erodible soils. In general, the higher the percentage of land removed from natural ecosystems (forest or wetlands) to agriculture the greater will tend to be the land degradation. A total of 8.51 million ha under moderate to extremely severe levels of soil loss occurred on highland (Factsheet No. 3.1). In addition, loss of forest area contributes to the expansion of saline soils in the northeast. Therefore, loss of forest area was selected as an indicator of the underlying pressure causing land degradation even if a case could be made for anchoring the indicator not in areas of recently converted forest but in areas long farmed and exhausted, in view of what was said earlier about the loss of land productivity. The Royal Forest Department (RFD) has monitored forest and non-forest since 1961 using aerial photography and remote sensing techniques and therefore a suitably long time series of data exists.

72. The policy targets with respect to forest encroachment (as the precursor of land degradation) were seen earlier (para. 28) to include:

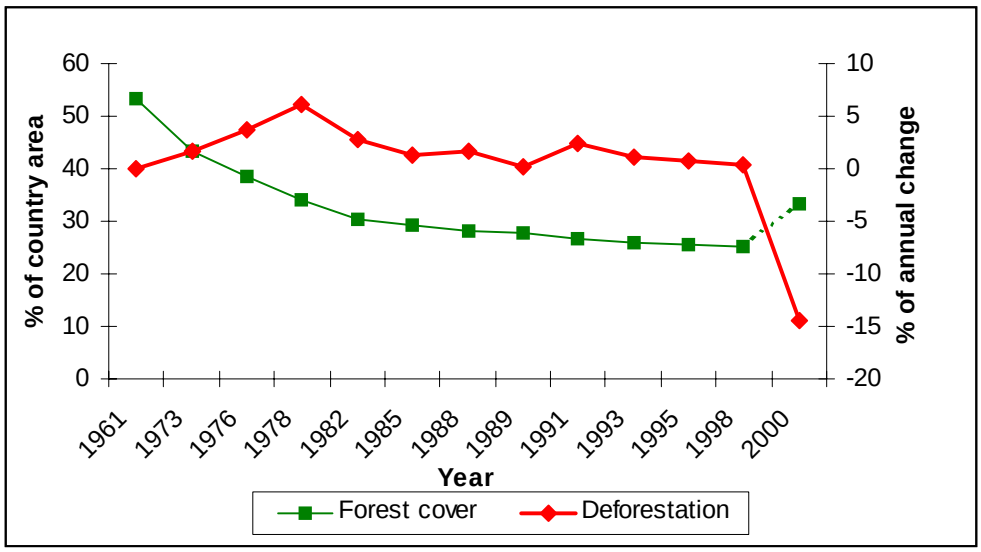
- The 1985 National Forest Policy's target of forty percent of the country area under forest (25% Protected Forest and 15% Production Forest).
- The 9th (2002-2006) National Economic and Social Development Plan's target of 25% of total land area under protection forest and at least 15% of the total land area by the end of 2006.
- Thailand Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997-2016 and its target to increase forest cover to 50% of the country by the final year of the planning period of which no less than 30% is to be designated as conservation forest, and 20% as production forest.

Agriculture in Thailand changed from a predominantly subsistence activity to an export-oriented activity ever since the 1st NESDP (1961-1966). The agricultural area grew from 46.3% of the total land area to 54.6% in 2000. This trend is likely to continue albeit at a lower rate as suitable potential areas are fast disappearing while the protected lands have increased.

73. In 1960, the Royal Thai Government established the National Land Classification Committee to carry out soil surveys and subsequent land classification. A total of 259,535 km^2 or 50% of the country's land area was classified as permanent forest and 43.7% as forest reserves under the National Forest Reserve Act of 1964. The results of the land classification have formed the basis for issuing land

titles. However, the granting of land titles has not kept with actual land use. A large proportion of farmers operate without a land title and continue to encroach the reserve forest. As the previous data showed, the area currently farmed (54%) already exceeds the maximum permissible under the Land Classification rules.

Figure 9 Loss of forest area during 1961-2000 **(**Sources: RFD & DNP)



74. The results of image interpretation by the RFD (Figure 9) reveal that the forest cover in Thailand declined from 53.3% in 1961 to 25.3% in1998. The total loss of forest area during this 37 year period was 143.9 million ha and the average annual loss was 399,955 ha or 2.0%. Deforestation peaked in the mid-1970s, when the annual loss was about 776,000 ha or 6.0 percent. Table 1 (Factsheet No. 3.1) indicates that deforestation during 1961-1982 accounted for 81% of the total forest loss in 4 decades. By comparison, the forest loss in the period 1985-1998 was relatively modest. In 1989, the Government banned commercial logging nationwide; however the rate of deforestation was not substantially reduced particularly during 1991-1993 because rapid economic growth in Thailand encouraged additional pressure on Thai forests. Figure 1 suggests that forest cover increased between 1998 and 2000 reversing the long-term trend. The upcoming interpretation of 2003 data is expected to confirm this finding.

Suggested Rating: High and Steady

Justification: Forest cover in Thailand continued to decline from 53.3% in 1961 to 25.3% in 1998. The total loss of forest area during this 37-year period was 143.9 million ha and the average annual loss was 2.0%. The highest rate of forest loss was found during the initial part of this period (1961-1982). The decline of forest area directly contributes to land degradation on sloping lands and in upper watersheds through soil erosion. Not surprisingly, the bulk of the total of 8.5 million ha under moderate to extremely severe levels of soil loss is found in the country's hilly and mountainous regions.

State

First indicator: Vulnerable farm land as percent of total farmland (see Factsheet No. 3.2)

Second indicator: Marginal land as a percentage of total farmland (see Factsheet No. 3.3)

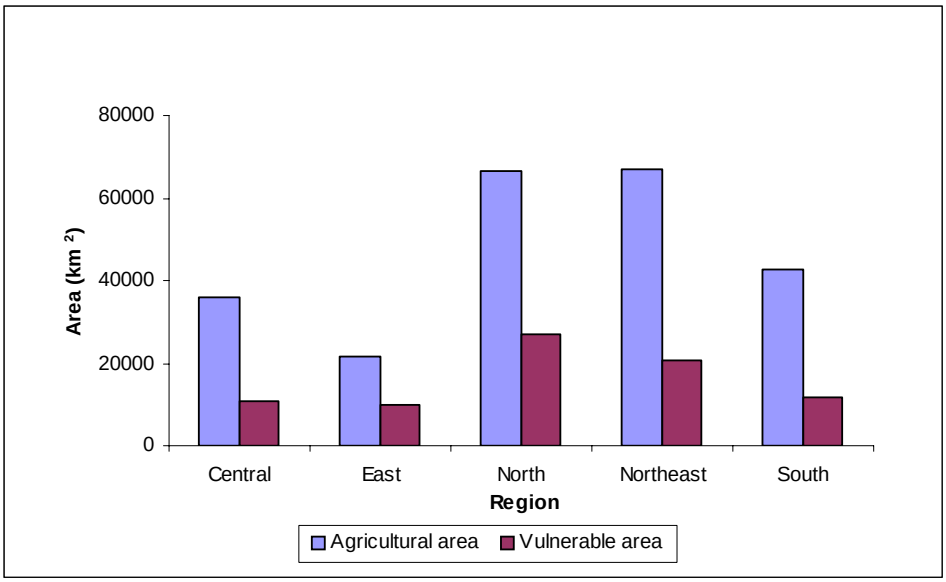
75. There are several possible ways of assessing the state of land degradation. Indicators such as the percentage of vulnerable farmed land, value of non-irrigated agricultural output per ha, average rice yield, degree of topsoil losses and real prices of rainfed farmland suggest themselves. In this EPA, two indicators have been used, namely 1) the percentage of vulnerable land in the total farmland and 2) the percentage of marginal land in the total farm land. The first indicator measures the percentage of cropped area (inclusive of tree crops) on land considered erodible (top soil erosion greater than 2 ton/*rai*/year or 0.96 mm/year (6.25 *rai* = 1 ha) while the second measures the percentage of cropped area known to yield low returns (on average). The higher the value of one or the other indicator, the greater the challenge of sustainable land use.

76. The national policy targets related to land degradation in Thailand are as follows:

- Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997-2016 aims to accelerate rehabilitation of infertile soils that are said to affect approximately 59.5% of the total land area or 305,000 km^2. The dubious nature of this target was commented on earlier (paras. 68 and 69).
- The 9th National Economic and Social Development Plan (2002-2006) targets the problem soils such as acidic, saline and low productivity soils on 10 million *rai* or 16,000 km^2.
- The Land Development Department's target for the period 2003-2008 is to rehabilitate degraded farmland in every household on approximately 100 million *rai* or 160,000 km^2 during 2003-2008.

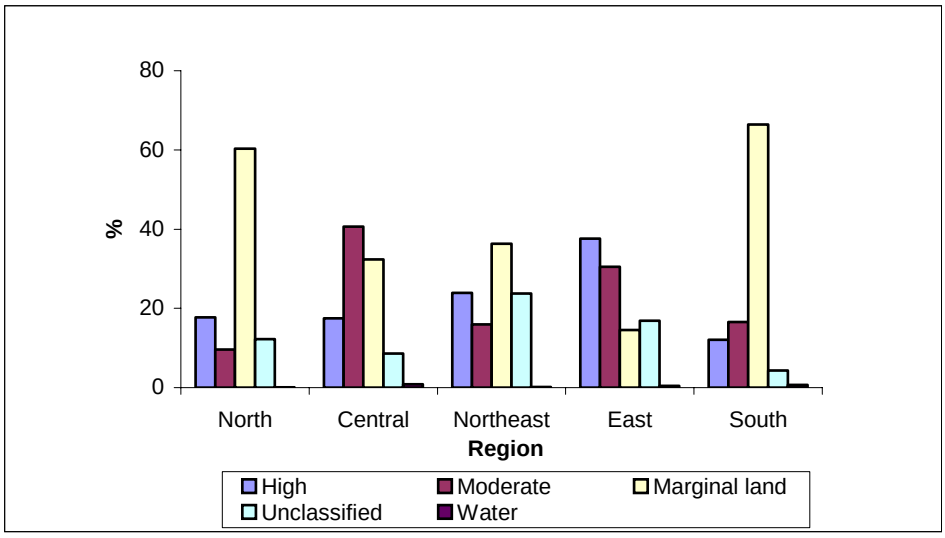
77. As can be observed from Table 2 (Factsheet No. 3.1) and Figure 10, approximately 34% of the country's land area or 17.4 million ha experienced significant topsoil erosion in 2002. The highest rate was found in the mountainous western and northern regions where approximately half of all farmed land is affected. The lowest soil erosion was found in the northeast. A change in formal vulnerability criteria between 2000 and 2002 and data weaknesses affecting the early (2000) attempts to quantify vulnerability make it difficult to reliably compare the extent and level of soil erosion impacts between 2000 and later years.

Figure 10 Farm land vulnerable to soil erosion in year 2002



78. As to the second indicator, the percentage of marginal land in the total farmland was approximately 44% of the total farmland (or 12.9 million ha) in 2000 (Figure 11). The highest percentage of marginal land was in the south covering approximately 66% of the region for the most part coinciding with areas planted to para rubber normally planted in hilly areas. The north ranked second (60%). However, the situation in the north may be more serious for beside poor financial returns, the choice of crops (upland crops such as cabbage and corn) results in heavy topsoil losses. Marginal lands in the northeast and the east cover approximately 36% and 14%, respectively.

Figure 11 Marginal land in year 2000



79. The soil erosion map covering the whole of Thailand was completed only in 2000 and no trend of vulnerable and marginal land can be established for the preceding period.

Rating: Relatively poor but undetermined trend

Justification: Approximately 17.4 million ha or 34.0% of the existing cultivation area is classified as vulnerable to soil erosion, and the highest risk area is found in the eastern region followed by the northern region. In addition, the total marginal land or poor-quality land covers approximately 12.9 million ha or 44.3% of the total agricultural area. The highest percentage of marginal land is found in the south followed by the north. The situation in the north is likely more serious because farmers grow annual crops which not only offer a low margin of profitability but also result in high rate of soil erosion. With limited data no trend could be established but is reasonable to expect the situation to be getting more serious because of continued expansion of agriculture into lands unsuitable for farming.

Cross-country or GMS comparisons

80. At the end of the 1980s, some 15 percent of the world's land area was estimated to have been degraded by human activities. GMS as a whole came close to the world average at the turn of the decade (see Table 9), but the extent of land degradation was much higher than the average in Thailand, Vietnam and China. Only Laos was markedly better off than the GMS or Asia average (The proportion degraded lands for Asia as a whole was 18 percent).

81. It is also well to consider the varying intensities of degradation. The situation of Thailand and Vietnam-- with about 30 percent and 20 percent of their lands strongly or extremely degraded in the early 1990s--is quite serious.

Table 9 The pattern of land degradation in GMS, 1990**.**

Country	Level of degradation (%)				Cause of degradation (%)		
	Total	**Light**	**Moderate**	**Strong**	**Deforestation**	**Over grazing**	**Agriculture activities**
Myanmar	14	2	12	0	62	0	38
Laos	9	1	7	1	100	0	0
Viet Nam	31	5	6	21	66	0	34
Cambodia	16	0	5	11	80	0	20
Thailand	41	1	10	29	82	1	17
China	30	13	14	3	50	16	35

Source: ISRIC/UNEP (1991), UN (1994)

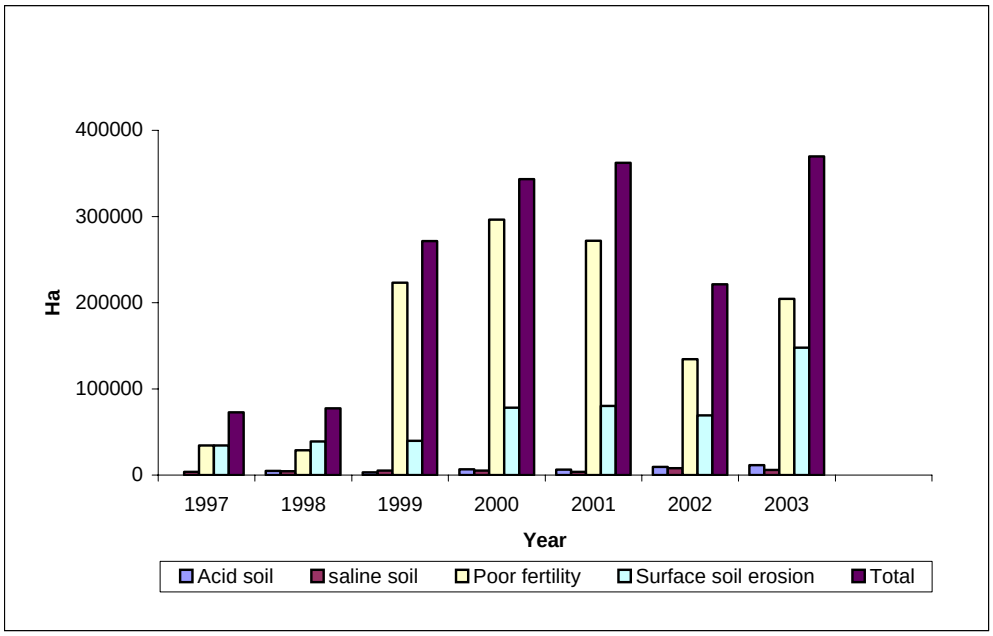
Response

The Indicator: Rehabilitation of degraded land, ha, 1997-2003 (see Factsheet No. 3.4)

82. Thailand officially started to combat land degradation after the establishment of Land Development Department in 1963. In 2001, Thailand became a party to the United Nations Convention to Combat Desertification (UNCCD) with LDD as at the UNCCD focal point**.** At present, LDD's activities are rooted in the 9th National Economic and Social Development Plan (2001 to 2006). The plan focuses on promoting local and community participation and a transparent system of local administration as key institutional preconditions for sustainable management of natural resources. The Plan sees improved land management in the context of an ecological balance. It calls for a reversal of the trend of land deterioration and for a greater role of organic agriculture.

83. Among several ways of measuring responses to land degradation, rehabilitation of degraded farmland was selected as the most suitable. It is tangible and can be measured unlike less tangible (though possibly important) responses such as greater local and community participation.

Figure 12 Rehabilitation of degraded lands (ha) 1997 to 2003



(Source: Land Development Department, 2004)

84. Figure 12 presents the values of the indicator. It shows a rapid growth in the pace of rehabilitation after 1998. Attention to poor fertility initially eclipsed attention to soil erosion but by 2003, the two received about the same amount of attention (measured by the area rehabilitated). The total area rehabilitated during 1997 to 2003 was 1.72 million ha. This is about 10 per cent of the total farmland vulnerable to erosion (17.4 million ha). In addition, the total area of marginal land rehabilitated was 1.19 million ha out of the total amount of such lands of approximately 12.9 million ha. Thus, in the last 5 years, LDD improved about

9% of the total poor-quality land. If future rehabilitation programs are implemented at this rate, it will take about 50 years to solve the soil erosion problem (under a bold assumption of no future increase in soil erosion) and 40 years to improve marginal lands in Thailand. The LDD realizes this and has formulated the Strategy of Land Development Department and National Action Programs for combating desertification (2004-2008). The Strategy aims at rehabilitating degraded farm land in every household on approximately 16.0 million ha (100 million *rai)*, as well as constructing 200,000 farm-level water storage units to increase productivity within 5 years by means of, among others, soil and water conservation, use of green manure, and "Volunteer and Young Soil Doctor" program (education of farmers by LDD staff).

Rating: Significant and intermittent

Justification: Rehabilitation of degraded cultivation area has increased in significance after 1998. The total area rehabilitated during 1997 to 2003 was 1.72 million ha. If future rehabilitation programs are implemented at this rate, it will take about 50 years to solve the soil erosion problem and 40 years to improve marginal lands in Thailand. LDD has formulated the Strategy of Land Development Department and National Action Programs to combat desertification (2004-2008) and accelerate land rehabilitation by targeting individual households on about 16.0 million ha within 5 years.

Conclusions

85. The population and economic growth of Thailand result in a steadily increasing demand for land, including agricultural land. In the absence of strict enforcement, this has led to deforestation, forest encroachment and expansion of agriculture into environmentally unsuitable areas. Approximately 34% of the total agricultural area (or 17.4 million ha) experienced serious soil erosion. In addition, land or poor-quality accounted for approximately 44% (or approximately 12.9 million ha). These two categories overlap to some extent and the total of degraded land is therefore less than the sum of the two categories.

86. LDD rehabilitated 1.72 million ha of eroded lands between 1997 and 2003 and 1.19 million ha of marginal lands. Although positive the scale of the rehabilitation efforts was clearly insufficient to reverse the trend. With more time the many complexities of both the degradation and rehabilitation process and ways of measuring either of them reliably could be addressed.

87. Land degradation is a complex issue both in a physical and institutional sense. There are many organizations directly and indirectly involved in land management. A complex problem typically calls for complex solutions. In Thailand's case this means that a coherent and comprehensive land use policy needs to be agreed by relevant agencies and stakeholders.

Rating: 2 stars

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INLAND WATER POLLUTION

The context

88. Rivers have always played an important role in Thai culture and long been the source food, transportation and water supply. With the growing level of economic activity of recent decades, the demands on inland water resources, both as sources of water supply and environmental "sinks", have increased. Water quality has been declining especially in the densely populated sections of the two main rivers, i.e. the Chao Praya, and the Tha Chin. To address water pollution, Thailand has put in place policies, plans, water quality standards and budgets. A number of wastewater treatment plants have been constructed and operate mainly in municipalities with varying degrees of efficiency.

Pressure

The indicator: Discharge of untreated domestic wastewater (see Factsheet No. 4.1)

89. Organic discharges dominate the pressures on inland waters in Thailand. Unlike the declining trend of organic wastewater discharges in advanced economies, Thailand's organic discharges increased by more than 60 percent between 1980 and 1997. Thailand ranked ninth in the world in terms of BOD effluent per square kilometer of the country's surface area (World Bank 2001)

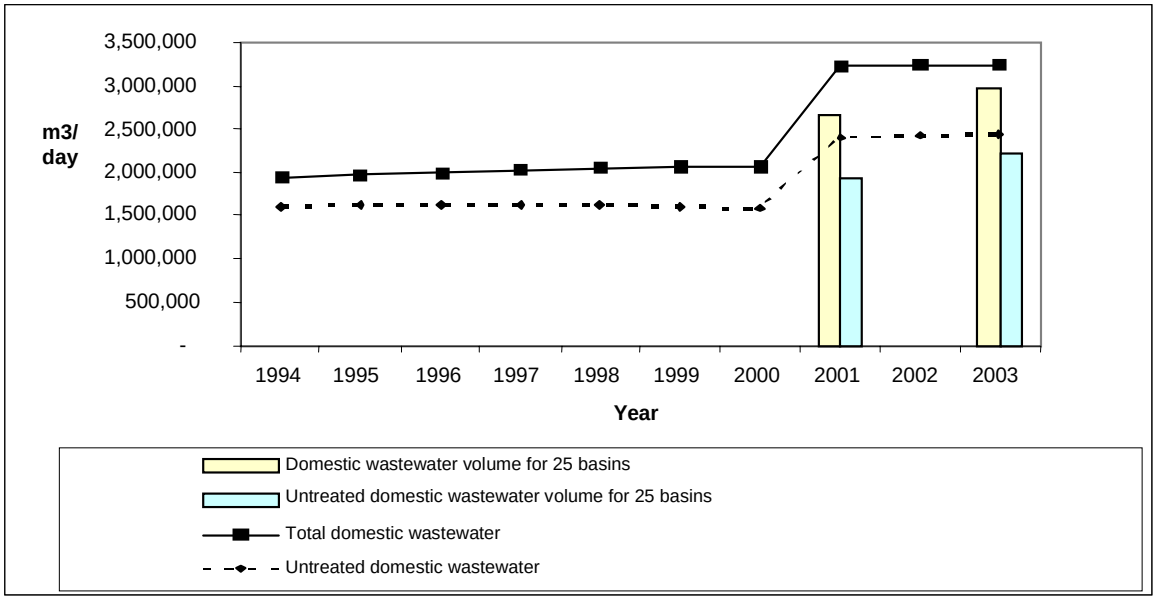
90. Agricultural runoff and domestic wastewater are the main contributors to poor water quality in Thailand, industrial discharges playing a subsidiary and spatially well defined role (mainly Central and Eastern regions). Agricultural pollution (in terms of BOD) is highest in the Northeastern and Central regions. The dominant source of organic pollution is domestic wastewater responsible for 54% of total national discharges (World Bank 2001). The total domestic wastewater discharges based on only urban population of *Muang* municipalities increased slightly during between 1994 and 2000 to about 2 million m^3/day before increasing significantly from 2001 to 2003 (Fig. 13). A similar trend was also illustrated for untreated domestic wastewater. When total population of all municipalities located on 25 major river basins is included, total wastewater discharged increased from 2.6 million m^3/day in 2001 to 2.9 million m^3/day in 2003 (Fig. 13). Nevertheless, approximately 25% of total urban domestic wastewater was treated in 2001 and 2003 (PCD 2003), i.e. the true total of untreated domestic wastewater discharge was between 1.9 and 2.2 million m^3/day in 2001 and 2003 respectively[3] (Fig. 13). For the latest year 2004, estimated urban domestic wastewater discharge generated by municipalities and Bangkok was about 5 million m^3/day, and 37% of this volume was generated in areas with existing wastewater treatment plant (PCD, 2005).

91. World Bank (2001) reported that 79 % of total organic pollution load (as measured by BOD) in Thailand's surface waters in 1999 was generated by ten water basins, namely the Moon, Chao Phraya, Chi, Mekong, Tha Chin, Mae Klong, Pasak, East Coast-Gulf, Nan, and Bangpakong basins. These basins are characterized by large populations and agricultural

[3] In estimating the percentage of untreated domestic wastewater for prior years (1994-2000) for which data are not available, the 2001 figure of 75 % of untreated domestic wastewater was increased by one per cent for every preceding year. The projections were based on urban population for the entire country during 1994-2003, and urban population of 25 water basins in years 2001 and 2003.

activities, along with industrial activities in the Central region. A survey by PCD conducted between 2001 and 2003 revealed that the Chao Praya basin was the most polluted among the ten.

Figure 13 Discharges of untreated domestic wastewater, 1994 – 2003



92. For the central region as a whole, domestic (39%) and agricultural sources (37%) constituted the largest contributors to BOD, while industry contributed 24 % of the totals discharged. In this region, the discharges are the greatest in the BMR (Bangkok Metropolitan Region including Bangkok, and Pathum Thani, Nonthaburi, Samut Sakhon and Samut Prakan Provinces), especially in the lower reaches of the Chao Praya and Ta Chin rivers due to large population, heavy use of fertilizer for agriculture and limited wastewater treatment capacity. For BMR as a whole, BOD generated by households accounted for 81% of the total, industry for 19% and agriculture for a negligible percentage (World Bank 2001).

Rating: High and increasing

Justification: As evidenced by the high amount of untreated domestic wastewater, as compared to the low percentage of treated wastewater. Rapid growth of urban population will generate more domestic wastewater.

State

The indicator: Water quality in designated water bodies, 1993-2003 (DO, BOD, FCB) (see Factsheet No. 4.2)

93. The overall state of water quality is normally judged by three parameters namely Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Fecal Coliform Bacteria (FCB) compared to the standard (Table 10).

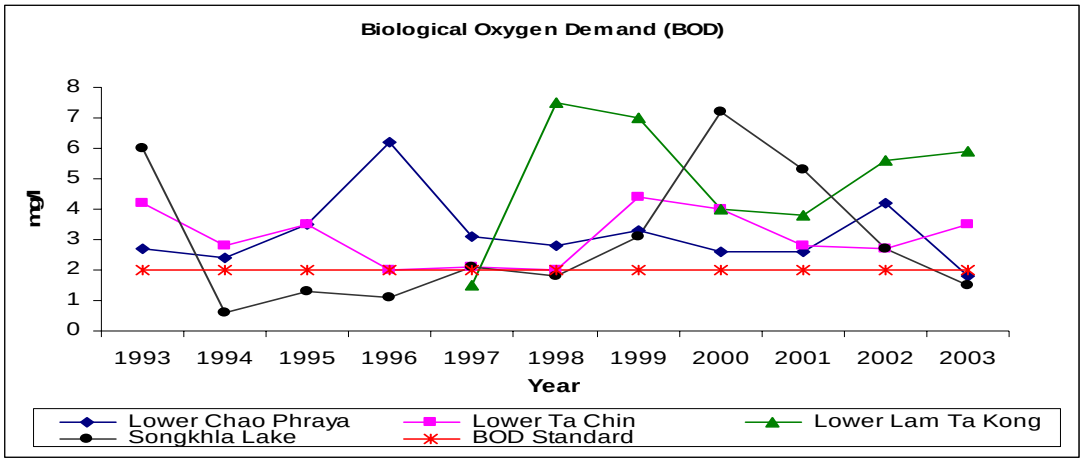
Table 10 Thailand's DO, BOD and FCB standards

Parameters	Standard Value				
	Class 1 Very good	Class 2 good	Class 3 moderate	Class 4 Poor	Class 5 Very poor
Dissolved oxygen (DO)	Natural	6	4	2	-
Biochemical Oxygen Demand (BOD)	Natural	1.5	2	4	-
Fecal Coliform Bacteria (FCB)	Natural	1000	4000	-	-

Source: Notification of the National Environmental Board, No. 8 issued under the NEQA (1992). Definition of classifications see[4]

94. The Pollution Control Department (PCD) has been monitoring water quality in major rivers since 1990. The overall results show that the average quality of the country's rivers during the period 1993-2003 was average and stabilizing. This observation coexisted with poor quality of some receiving water bodies such as the four heavily polluted water bodies namely, the lower Chao Praya, the lower Ta Chin, the lower Lam Ta Kong and Songkhla Lake as illustrated in Figure 14.

Figure 14 BOD in Lower Chao Praya, Lower Ta Chin, Lower Lam Ta Kong and Songkhla Lake during 1993-2003



95. The nation-wide trends in water quality are a composite of uneven regional trends: In the northern region, water quality generally remains good largely reflecting agricultural underdevelopment and the generally low presence of industry. Agriculture and industry together account for 17% of total BOD generation there while domestic wastewater discharges account for 83% (World Bank 2001). Overall, DO of the northern rivers during 1993-2003 show signs of an increase, while BOD was quite low. Contamination of FCB was

[4] Class 1: Extra clean fresh surface water resources used for (1) conservation no water treatment process is required only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally; Class 2: very clean fresh surface water resources used for (1) consumption that requires ordinary water treatment processes before use (2) aquatic organism of conservation (3) fisheries (4) recreation; Class 3: medium clean fresh surface water resources used for (1) consumption requiring special water treatment process before use (2) agriculture; Class 4 : fairly clean fresh surface water resources used for (1) consumption requiring special water treatment process before use (2) industry; and Class 5 : resource not classified as class 1-4 that can be used for navigation

critical for some rivers such as the Wang and the Nan, which had FCB values greater than 4000 MPN/100 ml. (Factsheet No. 4.2, Fig. 1, 2, 3).

96. In the Central Region, the quality of its 12 main rivers during 1993-2003 was moderate in terms of DO and BOD except for the Lower Chao Praya, and the middle and lower Ta Chin, where the quality of water was relatively poor and deteriorating. DO values were decreasing and fell to less than 2 mg/l, and BOD to 2-4 mg/l. As discussed further below, many remedial steps have been taken to improve the surface water quality there. The FCB count was greater than 4000 MPN/ 100ml (Factsheet No. 4.2, Figs. 4, 5, 6).

97. In the Eastern Region, water quality during 1993-2003 was broadly average and stabilizing with a decreasing trend of DO and BOD (Factsheet No. 4.2, Figs. 7, 8, 9). The FCB contamination was high for most rivers of the region except the Walu and Trad rivers.

98. In the Northeastern Region, the overall quality of most rivers was relatively good and improving with a high DO, and low BOD (Factsheet No. 4.2, Table 1, 2). Overall, FCB were quite low for most of the rivers. Poor water quality (low DO, high BOD and high FCB) was observed in the Lam Ta Kong Lake especially its lower section.

99. In the Southern Region, the quality of river waters was average and stabilizing with high DO level and fair BOD (Factsheet No. 4.2, Fig. 13, 14). A relatively poor and deteriorating water quality was observed in Songkhla Lake, where low DO, high BOD and high contamination of FCB were recorded (Fig. 15). In this region, domestic wastewater discharges, primarily from the tourism industry, were responsible for nearly two-thirds of total BOD generation, agriculture (including aquaculture) accounted for 26% and industry for the remaining 11% (World Bank 2001).

Rating: Average and stabilizing

Justification: Most rivers have indicator values which are close to the medium water quality standard. There were four severely polluted water bodies, namely the lower Chao Praya, the lower Ta Chin, the lower Lam Ta Kong and Songkhla Lake.

Response

The indicator: Amount of wastewater treated (see Factsheet No. 4.3)

100. Management of inland water quality in Thailand, i.e. a set of responses to the problem of water pollution, has had several principal components among which the legislative, policy-related and investment-based are the most important.

Policy, plans and legislation development

101. The Thai government has put into place policies, plans and water quality standards[5] in an effort to reduce water pollution. The Ninth National Economic and Social Development Plan (2002-2006) places emphasis on rehabilitation of the country's natural resources and makes improved water quality an important component of that effort. The Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality (1997-2016) recognizes the role of local governments and civil society in improving and protecting water quality. It sets the general objectives of

- Accelerating the rehabilitation of water quality in important water bodies;
- Reducing water pollution originating from the communities, agriculture, and industry;
- Applying the polluter pays principle; and
- Promoting private sector investment in water pollution management

102. PCD has drafted three plans for improving water quality. The Water Pollution Management Plan (2003) identifies 5 strategies and 15 mitigation approaches for better surface water quality. The Plan's stated goal is achieve DO values greater than 2mg/l and BOD values smaller than 4 mg/l in all main rivers by 2005. By 2005 also, the quality of water bodies in densely populated areas is to meet the national standards.

103. Second, the Domestic Waste Water Management Plan (2003) increases the responsibilities of local administrations in mitigation, rehabilitation, protection and day-to-day management of water pollution control facilities. The plan sets the objectives of :

- Making local administration ready for wastewater management by themselves by 2011,
- By 2001, placing 344 urban communities in charge of at least 50% of total wastewater generated and ensuring that 1,130 urban communities have appropriate wastewater treatment system by 2017.

The plan recognizes that urban or municipal areas exert more pressure on water bodies than peri-urban areas (area areas outside municipalities). Therefore two groups are distinguished, i.e.:

- Group 1 that includes the river basins of Ta Chin and Chao Praya, and Songkhla Lake with serious water pollution problems.
- Group 2 has less water pollution with good to fair water quality

104. Third, the Rehabilitation and Improvement Plan for Collection and Wastewater Treatment System for the Municipalities of Thailand (2003) aims at improving the efficiency of wastewater treatment systems operated by local administrations.

105. The legislation relating to water pollution control is extensive (Table 11). Enforcement is agreed to have been weak, due to lack of political will in some cases, inadequate coordination among various agencies, low technical capability for proving violations, and limited access to information. To initiate regulatory reforms and improve firms' compliance with environmental standards, existing command-and–control measures are to be complemented by market based instruments and public disclosure tools (World Bank 2001)

[5] Surface water quality standards contain values of 27 parameters, and 5 classifications by conditions and beneficial use

Table 11 Legislation relating to water pollution (World Bank, 2001)

Legislation	Regulated activities
Enhancement and Conservation of National Environment Quality Act (NEQA) 1992	Regulates specific point sources of wastewater discharges into public water resources, or the environment, based on effluent standards
Factory Act of 1992	Limits level of effluent discharged and restricts concentration levels of chemical and/or metal pollutants
Navigation in Thai Waterways Act (Volume 14) as amended in 1992	Prohibits dumping of any refuse including oil and chemicals into rivers, canals, swamps, reservoirs, lakes or waterways that may pollute the environment or disrupt navigation in Thai waterways
Public Health Act 1992	Regulates nuisance activities related to water pollution such as odor, chemical fumes, and wastewater discharges by buildings, factories or animal feedlots that have harmful health effects
Cleanliness and Tidiness of the Country Act of 1992	Prohibits dumping or discharging of wastewater in canals
Building Control Act of 1979	Regulates discharge of water pollution from buildings
Penal Code of 1956	Prohibits adding harmful substances to water resources reserved for consumption
Fisheries Act of 1947	Prohibits dumping or discharging of hazardous chemicals into water resources reserved for fishing
Royal Irrigation Act of 1942	Prohibits dumping of garbage or discharging polluted water or chemicals into irrigation canals

Wastewater treatment

106. There has been significant progress in constructing wastewater treatment plants in Thailand over the past 20 years; by 2002, the government had invested a total of 67,290 million baht in wastewater treatment systems (PCD, 2003). In 2003, 78 wastewater treatment plants were under operation, 6 are under construction and construction of three wastewater treatment systems (Saraburi, Nakornsrithammarat, Samut Prakarn Provinces) was pending. In all (see Table 1 in Fact sheet No. 4.3), the total installed capacity of wastewater treatment plants is approximately 2.2 million m^3/day. However, the amount of waste water actually treated was only 739,307 m^3/day), either because of the high cost of connections or poor functioning of some treatment plants. Looking at the pressure indicator in Fig. 13, a large amount of untreated domestic wastewater continued to be discharged to the water bodies, approximately 1.9 and 2.2 million m^3/day in year 2001 and 2003. Only about 25% of domestic wastewater was treated and the balance discharged untreated to the water bodies. According to the evaluation report of Ministry of Natural Resources and Environment (MONRE 2003), 65% of wastewater treatment plants were in fair condition, 20% were in good condition and 15% operated poorly. The main causes of this low utilization included poor wastewater collection system, shortage of budget for O&M, lack of appropriately trained and experienced personnel for O&M, unclear wastewater treatment fee legislation[6], lack of enforcement of standards, poor public relations and insufficient public involvement (World Bank, 2001, PCD 2003).

[6] Thailand has been collecting wastewater treatment fee from selected urban areas including, Pattaya, Patong, Hadyai and Sansuk municipalities. However the collected fee does not cover operation and maintenance system. More recently (2003, PCD) Ministry of Natural Resources and Environment has considered a revised wastewater treatment fee based more explicitly on the Polluter Pays Principle. The best mechanism of collecting the fee (e.g. including it in the electricity or drinking water bills, making it part of the tax system, or collecting it

107. A number of relatively simple and low cost treatment technologies exist (oxidation ditches, aerated lagoons and stabilization ponds) that can generate significant improvements under competent local management. The activated sludge process is more complex and costly, but it requires less land making it more suitable for urban areas of the central region or the BMA.

Suggested rating: Low and intermittent

Justification: The amount of wastewater treated is quite low compared to the total amount of domestic wastewater discharged despite substantial financial resources committed by the Government to creating a wastewater treatment infrastructure and develop appropriate policies and practices.

Conclusions

108. Domestic wastewater discharges continue to dominate the overall picture of surface water quality. There is still a large percentage of domestic wastewater in Thailand that finds its way to the water bodies without undergoing treatment. One of the factors contributing to this are the rapidly growing population in the far reaches of the country where the environmental infrastructure still needs to be established. In addition, it is very important to increase the level of utilization of existing WWT facilities. Among the causes are inefficient wastewater collection system, shortage of budget for O&M, and a lack of appropriately trained and experienced personnel for O&M.

109. The water quality of major rivers and lakes in Thailand is in average condition and has shown a general improvement. In general, water quality in the northern and the northeastern regions was satisfactory, while central, eastern and the south regions reported average conditions. However, some sub-sections such as the lower Chao Praya and lower Ta Chin rivers in the central region of Thailand had relatively poor and deteriorating water quality. Here the performance fell short of the national target. However, Thailand has put much effort into addressing water pollution in these two rivers.

Rating: **2 stars**
As evidenced by the high amount and non-declining percentage of untreated domestic wastewater. Most of the existing WWT plants in the country work with low efficiency.

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separately) is still under discussion. Wastewater treatment fee incorporated into drinking water fee is probably the most practical (PCD, 2003). However, for this happen, additional legislative powers need to be given to local administrations.

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SOLID WASTE MANAGEMENT

The context

110. Solid and hazardous waste is a serious problem in many urban and industrial areas of Thailand. Considerable progress has been made in the past decade to improve waste management in the country. In this section we limit ourselves to municipal solid waste. In Thai practice, however, it is difficult to separate non-hazardous from hazardous waste. Given insufficient levels of waste separation, most waste is mixed. Data on waste collection will therefore typically combine the volumes of solid (non-hazardous) and some hazardous waste. Information on hazardous waste is presented separately in the section on hazardous substance management.

Pressure

The indicator: Generation of municipal solid waste, 1993-2003 (see Factsheet No. 5.1)

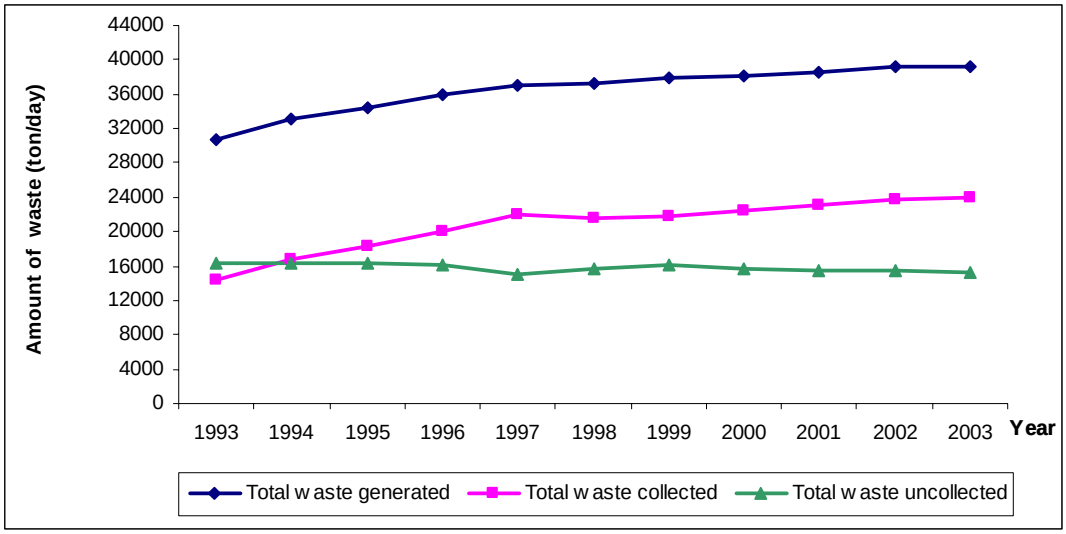
111. In 2002, Thailand produced about 22 million tons of solid waste annually (Table 12). Municipal solid waste, from both households and businesses, makes up 67% of the total waste generation, while industrial non-hazardous waste accounted for 27%. The remainder 6% is considered hazardous or toxic. This includes infectious waste from hospitals and hazardous waste produced by industries and communities (households and small business such as gas stations).

Table 12 Waste generation in Thailand, 2002 (World Bank, 2003)

Type	Waste Generation (1000 tons/year)		Largest-producing provinces (% Total)
	Total	Total minus reuse & recycling	
Municipal Solid Waste	14,400	12,800	Bangkok 27% Nakhon Ratchasima 3.3% Samut Prakan 2.3% Khon Kaen 2.1%
Infectious Waste	21.3	21.3	Bangkok 21% Chiang Mai 3.9% Nonthaburi 3.4% Nakhon Ratchasima 3.0%
Industrial Hazardous Waste	963	788	Samut Prakarn 19% Bangkok 18% Pathumthani 11%
Industrial Non-Hazardous Waste	5,890	1,271	Samut Prakan 13% Bangkok 11% Samut Sakorn 8.5% Patumthani 5.2%
Community Hazardous Waste	372	182	Bangkok 34% Nakhon Pathom 2.6% Nonthaburi 1.4% Pathum Thani 0.8%
Total	21,646	15,062	

112. Over the period 1993-2002, the amount of solid waste generated increased approximately 28% from 30,640 tons per day in 1993 to 39,240 tons per day in 2003. (Figure 15)

Figure 15 Total waste generated, collected and uncollected in Thailand 1993-2003



113. Data of solid waste generation in the latest year for which information is available (2003) showed that 45 % of solid waste was generated outside the municipalities (rural areas), 30% by municipalities and Pattaya, and the remaining 25%, by Bangkok. World Bank (2003) reported that BMR (includes Bangkok, Pathum Thani, Nonthaburi, Samut Sakhon, and Samut Prakan) produced 30 % of municipal waste, 30% of infectious waste and 40% of industrial waste of the country. High waste generation is recorded in the more populated and industrialized provinces such as Songkhla, Nakhon Ratchasima, Chon Buri and Chaingmai.

114. The volume of solid waste tends to increase with the growth of population, domestic consumption, and tourist development. Draft National Solid Waste Management Plan (2003) estimated that the rate of waste generation will increase by 2% per year (or by 700-900 tons per day). Management of solid waste in Thailand has had to deal with a number of familiar problems including:

- Mixing of municipal solid waste and municipal hazardous waste
- Public resistance to the siting of waste disposal sites
- Shortage of suitably located land for construction waste disposal sites
- Lack of collection, transportation and disposal facilities
- Shortage of funding
- Lack of public involvement in solid waste management

115. With the underlying rate of population growth, between 17 and 20 million tons of waste will need to be disposed of in 2010 if recycling and reuse rates remain constant, and per capita solid waste generation increases by 50% over current levels. (World Bank, 2003).

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Table 13 Waste Composition in Thailand (World Bank, 2003)

Type of Waste	Major sources	Major Composition
Municipal Solid Waste	Residential Commercial/Tourism Agriculture	Kitchen waste (51%) Plastic & Foam (22%) Paper (13%) Glass (3%)
Infectious Waste	Hospitals (93%) Education & Labs (7%)	Tissue samples Blood & other liquids Surgical waste & syrings
Industrial Hazardous Waste	Metal industries (33%) Electronic industries (28%) Plastic industries (8%) Chemicals & Petroleum industries (7%)	Filter materials, waste sludge (35%) Fuel, oil and grease (28%) Liquid organic compounds (8%)
Industrial Non-Hazardous Waste	Metal industries (36%) Food industries (13%) Furniture (7%)	Metals and metal alloys (30%) Parts of wood (16%) Animal parts (13%)
Community Hazardous Waste	Automotive station (54%) Residential (19%) Agricultural (10%) Gas stations (10%)	Recyclable waste oils (27%) Lead acid batteries (21%) Other toxic chemicals (8%) Other waste oils (6%)

116. Table 13 summarizes waste composition in Thailand at the turn of the last decade. 60% of industrial hazardous waste was generated by metal and electronic industries, while half of the community hazardous waste was produced by automotive service stations, and 10% by gas stations. Nearly all infectious waste came from hospitals. Municipal solid waste was produced by residential and other sources such as commercial and tourism establishments.

Rating: High and increasing

Justification: The volume of municipal solid waste continues to increase in Thailand largely in line with the trend of population and economic growth

State

The indicator: Percentage of collected municipal solid waste, 1993-2003 (see Factsheet No. 5.2)

117. Country-wide, during 1993-2003, the volume of collected waste fluctuated between 46 and 61 per cent of the total waste generated (Fig. 15). Solid waste collection was better in urban than non-urban areas. The rate of solid waste collection in Bangkok has increased from about 95% in 1994 to almost 100% now. This places is well inside the target of the Draft National Solid Waste Management Plan (2003) of 95% collection. However, in other municipalities and Pattaya district, collection was lower than in Bangkok, with an average of 75-85% of generated waste. This falls short of the national target of 95% collection for non-BMR municipalities (Draft National Solid Waste Management Plan, 2003). World Bank (2003) reported that larger cities (*Muang* Municipalities) typically had more efficient collection than smaller towns (*Tambon* municipalities). Collection rates in rural areas are estimated to be no more than 20-30%.

118. A high rate of waste collection in Bangkok is the result of large investments in waste collection trucks in the early 1990s and improved management by district offices (World Bank 2003). Waste collection in Bangkok has two stages:

- Primary collection: Collection at households is undertaken by the BMA. Collection takes place at night to avoid traffic and uses approximately 2200 vehicles to collect roughly 8,800 tons of waste per day. The collected waste is transported to transfer stations
- Secondary transport: At the transfer stations, waste is put into large hauling trucks and weighed in order to determine the amount of waste processed. Private sector operators transfer the waste to disposal sites

119. While collection trucks are sufficient for most municipalities, many problems remain; spillage of garbage and leachate from trucks, difficulty of access in congested, narrow, or disorganized roads. To resolve such problems, some municipalities have adapted the collection trucks for easier access to their areas and opted for night collection to avoid traffic congestion.

Rating: Average and stabilizing

Justification: Overall, waste collection in Thailand is average, but relatively good in Bangkok, where more than 95% of waste generated was collected, while in municipalities, collection efforts average 75-85% of the waste generated. The lowest collection rate, estimated at 15-25%, is in rural areas.

Response

The indicator: Percentage of waste disposal and utilization, 1993-2003 (see Factsheet No. 5.3)

120. The aims of waste management are to minimize waste generation, collect all waste and dispose of it appropriately, as well as reuse and recycle a significant share. Nationally, the volume of waste disposal has been increasing in Thailand (see Table 2 in Factsheet No. 5.3), although not yet fully matching the volume of waste generated. However, Thailand still has low ability to dispose of waste, as clearly shown in Fig. 16. At most, 65% of amount of waste collected was disposed of for the country as a whole in contrast to Bangkok where nearly 100% of waste generated was collected and disposed since 1997 (Fig. 17). In smaller municipalities and rural areas, the percentage of waste disposed of was assumed to be roughly 45-55% and 5-15% respectively of the waste collected.

Figure 16 Total waste generated, collected and disposed of for Thailand during 1993-2003

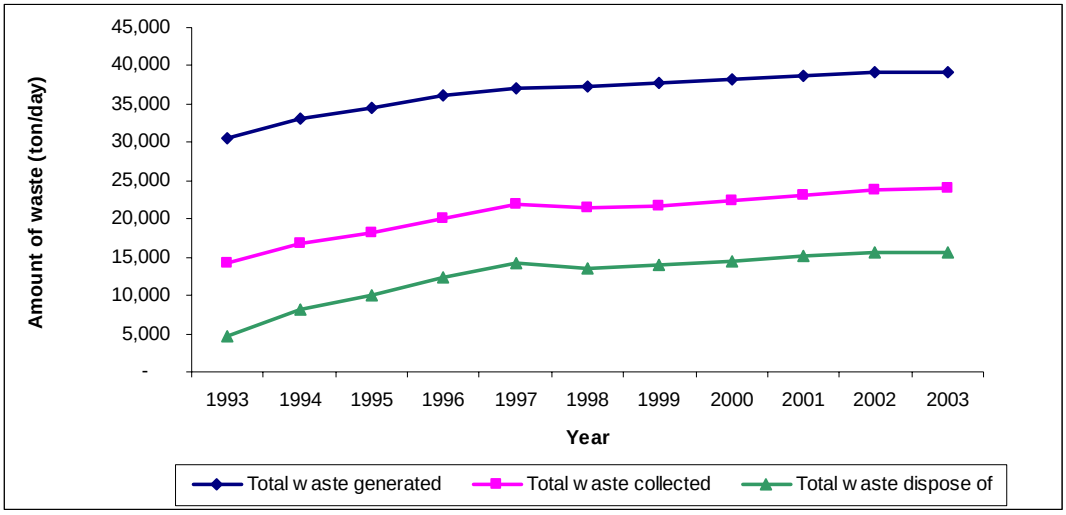
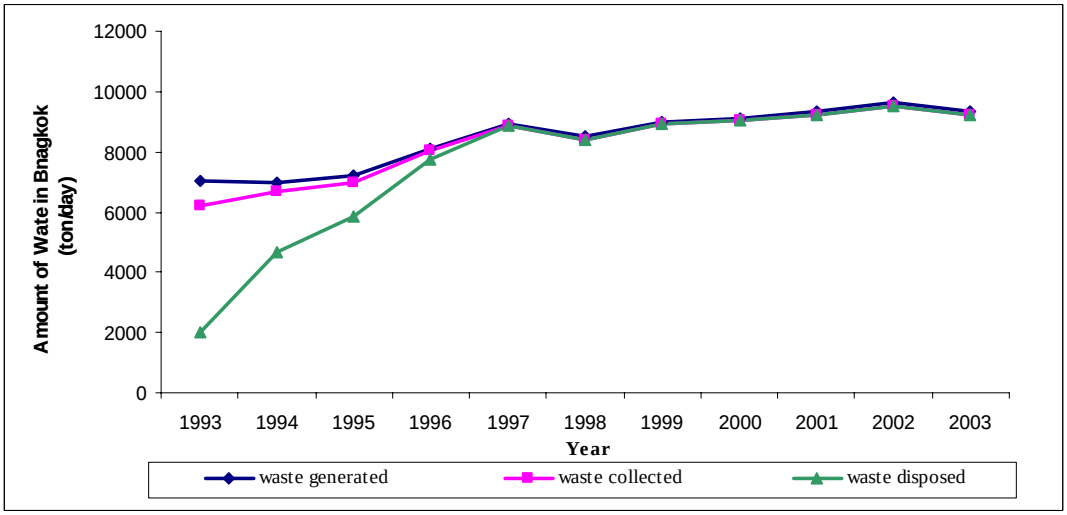


Figure 17 Comparison amount of waste generated, collected and disposed of in Bangkok during 1993-2003



121. The number of disposal sites in Thailand increased from 12 in 1997 to 107 in 2003. (see Table 1 and Fig. 1 in Factsheet No. 5.3). Country-wide, more than 1,000 disposal sites were reported although only 104 of them, constructed with national government funding, met the necessary environmental safeguards. (World Bank, 2003). In 2005, PCD count included 93 operating municipal disposal sites, 12 non-operational and one closed site. Among the operating sites, most are sanitary landfill, the rest are incinerators, integrated facilities (with waste separation, fertilization and sanitary landfill), and combinations of biogas with a sanitary landfill (PCD, 2005).

122. Many of new disposal sites are located in the *Muang* Municipalities of the 76 provincial capitals. Approximately 57% of these have engineered or sanitary landfills. In contrast, only 4% of over 1000 *Tambon* municipalities have landfills, the rest using open

dumps. Currently unsafe disposal practices cause health problems to the people living in adjacent areas. Disease can be spread through insect and rodent vectors, or by contact with water that has been polluted by solid waste.

123. Table 14 gives information on safe and unsafe waste disposal practices. Overall, disposal sites commonly lack environmental controls. Only 5 provincial capital sites (Songkhla, Rayoung, Sri Sa Ket, Bangkok-Rachathewa and Mukdahan) operate with due environmental control or are truly sanitary landfills. In addition, World Bank (2003) estimated that 70,000 toms of community hazardous waste and 80,000 tons of infectious waste were disposed in combination with municipal waste. Only about half of *Muang* municipalities (34 provinces) were finding land for the construction or safe landfills in the face of strong public opposition. Approximately a third of all projects to establish new landfill sites have been postponed or abandoned. To cope with such problems, three alternatives are being considered. First, existing provincial capital disposal capacity could be upgraded, albeit at a high cost. Second, some of the waste can be better distributed among existing disposal facilities. Better sharing of existing disposal capacity could save over THB 20 billion in investment nationwide, and over 20 years, there would be a saving of THB 160 billion in operations and maintenance (World Bank 2003).

124. The third alternative would be to minimize waste by incineration. However, incinerators tend to be cost-effective only where land is scarce and where suitable local pre-conditions exist concerning the composition of waste and availability of staff and equipment for the operation, oversight, and environmental monitoring of the incinerators. These are often not present in Thailand. Moreover, municipalities currently recover only a small portion of the operation and maintenance cost of the landfill-based system. Collecting additional amounts for the operation of incinerators might pose an obstacle. Given the option of transferring waste to landfills outside of the land-scarce urban areas and islands, it is likely that investments in recycling and landfill-based disposal systems will be more cost-effective than incineration.

Table 14 Safe and unsafe disposal practices (World Bank 2003)

Type of disposal practices		**Operational Procedures**	**Environmental Controls**
Unsafe	Open Dump	No formal operational procedures	No environmental controls. Scavengers are commonly living on site
	Control Dump	Some basic waste accounting, placement and compaction procedures, limited facilities such as fencing and staff on site.	Limited or no environmental controls. Waste pickers are commonly living on landfill.
Safe	Engineered landfill	Some basic waste accounting, placement, cover, and compaction procedures, fencing and staff on site. Waste pickers may be living on landfill	Some environmental monitoring and environmental controls such as liner, drainage, leachate treatment, and gas ventilation. Controls may be dysfunctional or not operated
	Sanitary landfill	Waste accounting, placement, cover, and compaction procedures, fencing and staff on site. No scavengers living on landfill.	Regular environmental monitoring. Environmental controls, including liner, drainage, leachate treatment, and gas ventilation that are able to maintain sanitary environmental conditions.

125. As to waste utilization (include reuse and recycling), an area of rich potential worldwide, its level has been quite low in Thailand until now. Only 10-18% of the total waste

generation was recycled during 1996-2002 (See Table 3 and Fig. 6 in Factsheet No. 5.3). This fell short of the 30% target of National Solid Waste Management Plan by 2005. World Bank (2003) reported a figure of 1.5 millions tons of waste recycled each year in Thailand, amounting to 11% of the total waste generation. Municipal waste had a higher recycle rate than non-municipal areas' waste (16% vs. 4-8% respectively). More than 70% of recycled waste was informally collected by three main groups namely Sa Leng (using tricycles to collect waste), municipal collectors (collecting and sorting waste for sale as an informal source of income supplementation) and waste pickers (collecting waste from the landfill and selling it for income). Over 50% of municipal waste is considered "re-cyclable". Almost 4.5 million tones of potential recyclable waste are discarded each year in Thailand.

Rating: Low and sporadic

Justification: Overall, Thailand has low ability to dispose of waste and utilize it. For waste disposal, an exception is Bangkok, where all waste was disposed of. Lower ability to dispose of waste with 45-55 % and 5-15% are estimated in municipalities and rural areas respectively.

Conclusions

126. As it grows, Thailand continues to produce more solid waste. Solid waste collection is generally better in urban than in non-urban areas, and better in Bangkok than in other cities. Bangkok was able to collect and transport almost 100 % of waste generation, while municipalities and rural areas with more limited financial resources could collect only about 75-85% and 15-25% respectively of the waste generated. Increasing the number of collection trucks especially in smaller municipalities could rapidly increase the collection rates especially if accompanied by adaptation of the trucks to special conditions of smaller municipalities.

127. Thailand's record of waste collection and disposal was mixed. Bangkok was able to dispose of nearly 100% of the waste generated while this percentage was only 45-55% and 5-15% respectively in municipalities and rural areas, where some of collected waste was disposed with unorganized sites. For some time now, Thailand has been putting emphasis on the construction of more waste disposal facilities, but finding land for the construction of landfills is becoming increasingly difficult. Upgrading of existing disposal capacities and greater sharing of them may ease the public opposition and provide short-term relief.

128. The longer-term remedies must rely at least in part on waste reduction. The rate of waste reuse and recycling has been low in Thailand. In order to increase it, more active public participation in solid waste reduction, supported by information campaign, is needed.

Rating: **2 stars**

Justification: During the last decade (1993-2003), there were significant improvements in waste collection and disposal for the country as a whole, especially in Bangkok and larger cities. Much remains to be done to improve waste disposal in smaller towns and rural areas, and improving the generally low rates of waste re-cycling.

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HAZARDOUS SUBSTANCE MANAGEMENT

The Context

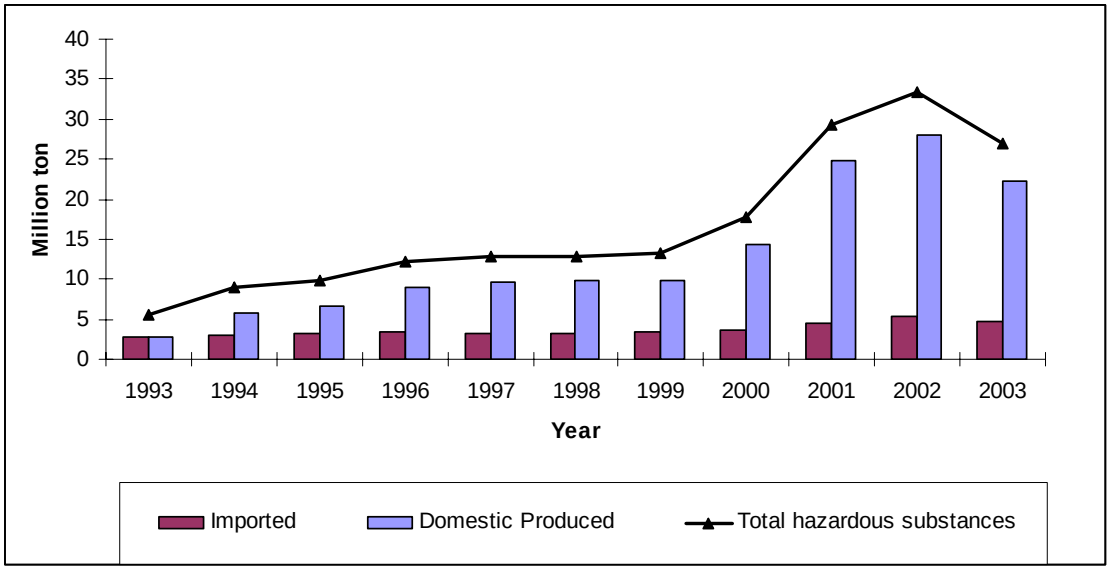
129. Recent instances of serious adverse impacts of hazardous substances on ecosystems and people's health in Thailand reflect the continuing increase of such substances in use under conditions of insufficient safeguards. Several governmental agencies have been active in establishing the necessary legal and regulatory environment, drafting management plans for high-risk areas, and dealing with such problems as hazardous substances' transportation. Despite these efforts, illegal disposal of hazardous wastes in public lands has not disappeared. In part this is due to a shortage of suitable treatment facilities and insufficient knowledge of improved methods of waste treatment by individual facilities. The traditional focus on treatment rather than prevention or waste minimization has also contributed to the observed pattern of outcomes.

Pressure

The indicator: Amount of hazardous substances used 1993-2003 (see Factsheet No. 6.1)

130. Hazardous substances are extensively used in Thailand both in industrial and agricultural sectors. Available statistics indicate that yearly imports of hazardous substances steadily climbed from 2.79 million ton in 1993 to 5.38 million ton in 2002. During the same period, domestic production of hazardous substances increased even faster, from 2.74 in 1993 to 28 million tones in 2002 (Fig. 18). In 2003, however, a slight decline was observed.

Figure 18 Total amount of imported and domestic production of hazardous substances in Thailand, 1993-2003 (ONEP 1994-2004, PCD 1993-2002)

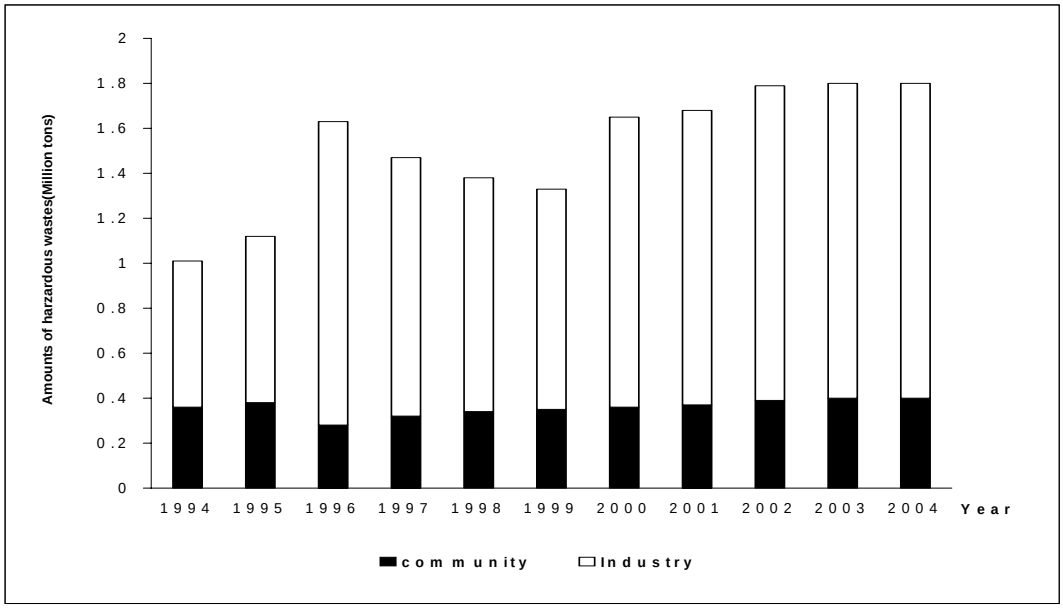


131. The Hazardous Substance Act, 1992 is the principal legal instrument governing a broad range of hazardous materials, including hazardous and infectious wastes. Provisions regulating the handling, storage, transport, and disposal of hazardous wastes are contained

in ministerial decrees. For importation purposes, a total of 1,308 hazardous substances are currently controlled under the Act. Some hazardous substances, by now prohibited in advanced industrial countries such as acrylonitrile, alpha-naphtyl thiourea (ANTU), atrazine, Bromacil and Carbaryl can still be legally still imported to Thailand. Given Thailand's important agricultural sector, the use of hazardous substance in that sector deserves attention. 11 groups of agricultural hazardous substances, including insecticides, bio-pesticides, fungicides, herbicides, acaricides, rodenticides, plant growth regulators (PGR), molluscicides, fumigants, nematocides and methyl chloride have been imported in recent years, the total volume increasing from 48,624 tons in 1996 to 79,857 tons in 2002. A slight decline in imports was observed in the year 2003 attributable to a vigorous promotion of safe practices in agriculture by Thai Government and policies favoring the usage of organic fertilizers, as well as those promoting substitution of biotechnology for chemical agents.

132. Of the total amount of hazardous wastes generated in Thailand, 75-80% originated in the industrial sector. They consist mostly of filter materials and sludge, followed by fuel, oil, grease and liquid inorganic substances. The rest are generated by households, farms or community sources (households and commercial establishments such as gas stations). ONEP (2005) reported an increasing trend of generation of industrial, as well as community hazardous wastes in Thailand during 1994-2003 (Fig. 19). By 2003, 1.4 million tons of hazardous waste was generated by the industrial sector, while approximately 0.4 million tons was generated by communities (see below). About 60 per cent of the total amount of hazardous wastes was generated by the Bangkok Metropolitan Region (ONEP 2004).

Figure 19 Volume of hazardous waste originating in community and industrial sources, 1994-2003 (ONEP, 2005)



133. Hazardous wastes generated by households include items such as used batteries, mobile phones, light bulbs, and spray cans. To this must be added wastes generated by gas stations and automotive repair workshops (petroleum distillates, greases, solvents), as well as dry cleaners and photo processing shops. Community waste is projected by ONEP to increase to 0.60 million ton in 2017 with electronic waste the fastest growing category.

Rating: High and increasing

Justification: Rapid industrial growth has resulted in a rapid increase in imports and domestic production of hazardous substances

State

The indicator: Number of health related incidents relating to hazardous substances (see Factsheet No. 6.2)

134. Hazardous substances used in the industry and in agricultural sectors pose significant health risks both for those handling these substances as well as for the population at large.

135. Data of the Epidemiology Bureau on sickness and deaths resulting from exposure to agricultural chemicals indicate declining trend in health related incidents. From 3,299 cases of sickness and 44 deaths in the year 1993, the number of cases fell to 2,406 sickness cases and 9 deaths in the year 2003. The number of incidents linked to industrial hazardous substances was smaller than that resulting from agricultural activities. During the ten year assessment period (1993-2003), the peak of sickness episodes caused by industrial hazardous substances, 1,170 cases, was observed in 2000. For the rest of the period, the number of incidents ranged from 104 to 365 cases. After the year 2000, abrupt reduction was observed.

136. In addition to health effects resulting from exposure to hazardous substances, three main types of chemical disasters including leakage, fire and explosion also occur. During the observation period, the frequency of incidences rose from 6 times in year 1999 to 28 times in 2003 (see Table 1 in Factsheet No. 6.2)

Rating: Relatively good and improving

Justification: A declining trend in health related incidents was observed

Response

The indicator: Amount of treated hazardous waste 1994-2004 (see Factsheet No. 6.3)

137. Due to the increasing amount of hazardous substances used by the Thai industry and agriculture, complete elimination of the negative impacts associated with hazardous waste is unlikely. The attention has rightly shifted to developing ways of minimizing the risks and effectively managing the situation.

138. Agencies that have some responsibilities for hazardous waste management include: Hazardous Substance Control Bureau (Department of Industrial Works, Ministry of Industry), Waste and Hazardous Waste Management Bureau (Pollution Control Department, Ministry of Natural Resources and Environment); Office of “Atoms for Peace” (Ministry of Science

and Technology).; Office of Agricultural Regulation ; Hazardous Substance Control Group (Food and Drug Administration, Ministry of Public Health); Department of Disaster Prevention and Mitigation (Ministry of Interior); Department of Labor Protection and Welfare (Ministry of Labour); Ministry of Defense; and Ministry of Commerce.

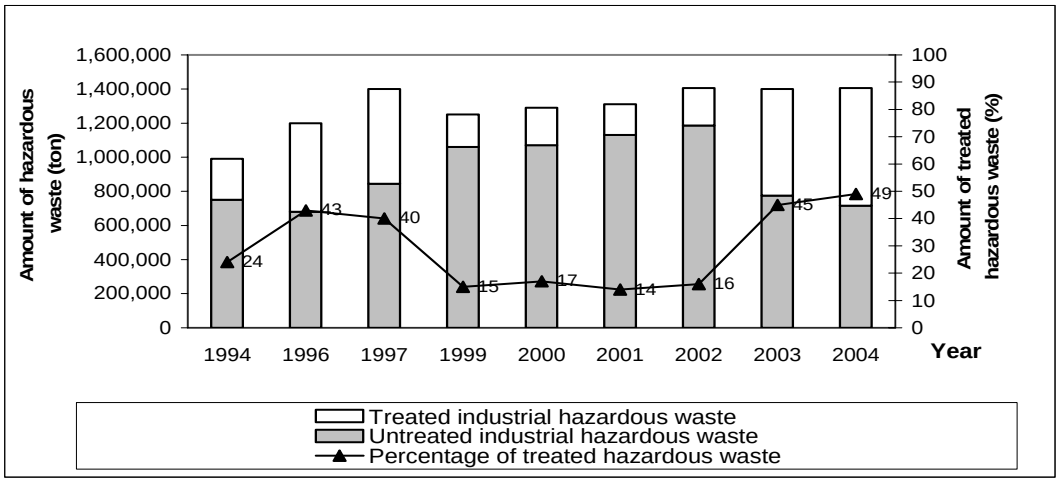
139. At least eight legislative documents related to hazardous substances and their management have been enacted. They include: Enhancement and Conservation of National Environmental Quality Act 1992; Factory Act 1992; Hazardous Substance Act 1992; Atomic Energy for Peace Act 1961; Food Act 1979; Cosmetic Act 1992; Act Preventing and Fire Fighting 1999; Labour Protection Act 1998; Arms Control Act 1987; Import and Export of Goods Act 1979. Among these, the Hazardous Substance Act 1992 is considered the most important.

140. MOH was the main agency responsible for drafting the first National Master Plan in Safety Development of Chemical Substances 1997-2001. The Plan set the tone for other plans for hazardous substances management prepared since then. Among them is the Plan for Round-the-Clock Warning and Notification of Chemical Accidents; and a database of chemical accident risks. At present, management of hazardous substance is based on the National Master Plan for the Development of Chemical Safety 2002-2006.

141. Throughout most of the 1990s, only two hazardous waste disposal facilities existed. As a result of strong government encouragement, the number of disposal facilities rose to 13 in 2002 and the total treatment capacity increased from 0.5 million tons in 2001 (ONEP 2003) to 10.5 million tons in 2003 (ONEP, 2004).

142. The volume of hazardous waste treated fluctuated during the period 1994 -2004 (Fig. 20). Between 1996 and 1997, more than 40% of the total amount of hazardous waste produced was treated properly. However, this percentage declined 15%, during the period 1999-2002, the low treatment coinciding with the period of economic crisis. By 2004, the percentage treated was back up, reaching an all time high of 49% (ONEP, 2005). Strong GDP growth therefore seems to be “good” for hazardous waste treatment, rather than being its enemy as sometimes suspected.

Figure 20 Amount of industrial hazardous waste generation in comparison to amount of treated waste 1994 to 2004



143. There have been other responses. DIW-established Waste Utilization Data Center (see www.diw.go.th) helps deal with problems relating to untreated waste. The database on hazardous waste is made accessible to both waste generators and waste consumers. In November 2001, the database contained 879 hazardous waste generators and identified 43 enterprises requesting waste for recycling or processing.

144. Since considerable amounts of hazardous wastes are still not being treated or disposed of improperly, source reduction is seen as an important additional path to follow, especially by the industry. Setting up standards for products, technology used and for waste generated can assist this process. Such steps can be combined with a growing environmental awareness of the public that may respond to companies' publicized efforts to adopt "clean" processes. Green-labeled products[7], and environmental management system voluntary standards (ISO 14001, TSI 18001, OSHAS 18001) have increasingly featured in Thailand (see www.tei.or.th). Table 15 shows the increasing number of ISO-certified companies. From only 4 officially certified in 1996, the total climbed to almost 1000 in 2004.

Table 15 The Number of Thai companies certified under ISO14001, ISO 18001 and OSHAS 18001 since 1996

Standard	Certified year and relevant number of certified companies										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
ISO14001	4	27	30	114	105	142	220	156	133	29	961
ISO18001	-	-	-	-	12	56	34	40	8	-	150
OSHAS 18001	-			1	2	13	34	34	20	2	106

Source: www.tei.or.th and www.diw.go.th

Rating: Average and intermittent

Justification: Roughly 49% of industrial hazardous waste was being treating; the government has provided continuous annual investment for controlling hazardous substances and hazardous waste. Clean technology and environmental management system voluntary standards have been promoted to help waste reduction.

Conclusions

145. During the evaluation period 1993-2003, there was an increasing trend of the volume of hazardous substances imported and domestically produced in Thailand. The volume of hazardous waste generated closely followed the trend in imports and domestic production.

[7] Green label is assigned to a product that is shown to have minimal adverse effects to the environment compared to similar products. The prospect of earning the designation and attracting the interest of environmentally conscious customers encourages enterprises to introduce cleaner processes or develop "cleaner" products.

146. The government has been active and prepared several policy and strategic documents dealing with hazardous substances in addition to creating the legislative and regulatory basis for hazardous substances management. The National Master Plans for Development of Chemical Safety 1997-2001 and 2002-2006, respectively, favor an integrated approach to hazardous waste management. .

147. Yet there is no evidence pointing to a worsening of the incidence of sickness or death linked to hazardous substances. If anything, the record has been slightly improving.

Rating: 2-Stars

Justification: A relatively low amount of hazardous is treated in Thailand. The Thai government has put much effort into improving hazardous waste management including a strong promotion of source reduction.

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CLIMATE CHANGE

The context

148. By now it is accepted by most that the global warming phenomenon is strongly linked to man-made activities. Thailand is well aware of the risks posed by global warming and climate change, especially its potential repercussions for the sea level rise and for average temperatures. The country signed the United Nations Framework Convention on Climate Change (UNFCCC) on 12 June 1992, and ratified it on 28 December 1994. Subsequently, Thailand signed the Kyoto Protocol on global warming on 2 February 1999 and ratified it on 20 August 2002. Having committed itself to these global agreements, the Thai Government launched several projects aimed at conservation of energy and mitigation of greenhouse gases (GHG) emissions, as well as creation of carbon sinks.

Pressure

The Indicator: Emission of Greenhouse Gases (see Factsheet No. 7.1)

149. At least three studies have been undertaken on the national greenhouse gas (GHG) inventory and the potential for GHG mitigation in Thailand, namely 1) Thailand's National Greenhouse Gas Inventory, 1990 (OEPP, 1990); 2) Thailand's National Greenhouse Gas Inventory, 1994 (OEPP, 1994); and 3) National Clean Development Mechanism Strategy Study (Ministry of Natural Resources and Environment or MONRE, 2004) (see Factsheets No. 7.1 and 7.2). These reports give data on emissions of the four key greenhouse gases with a global warming potential, i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs). Annual emissions of GHGs in gigagrams were inventoried in five main sectors, i.e. energy, industrial processes, agriculture, land use change and forestry, and wastes. These were then converted into CO_2 equivalents by using theses gases' global warming potential (GWP). The 1998 GHG inventory and the projections for 2000-2020 were compiled using the 1996 Revised IPCC Guidelines for National Greenhouse Gas Inventory. The figures for 2000 and projections for subsequent years assume an average economic growth of 4-5% per annum.

Table 16. Past and projected net GHGs emissions from five principal sectors

GHGs	CO_2-e Emissions (Gg)*					
	1990 [1/]	1994 [2/]	1998 [3/]	Proj. 2000 [3/]	Proj. 2010 [3/]	Proj. 2020 [3/]
CO_2	163,996	202,458	204,292	202,610	268,722	414,938
CH_4	57,695	66,598	79,537	79,070	88,726	100,584
N_2O	3,506	17,317	13,646	15,063	17,771	18,507
HFCs	NA	NA	136	241	443	668
Total	225,297	286,373	297,611	296,984	375,661	534,697

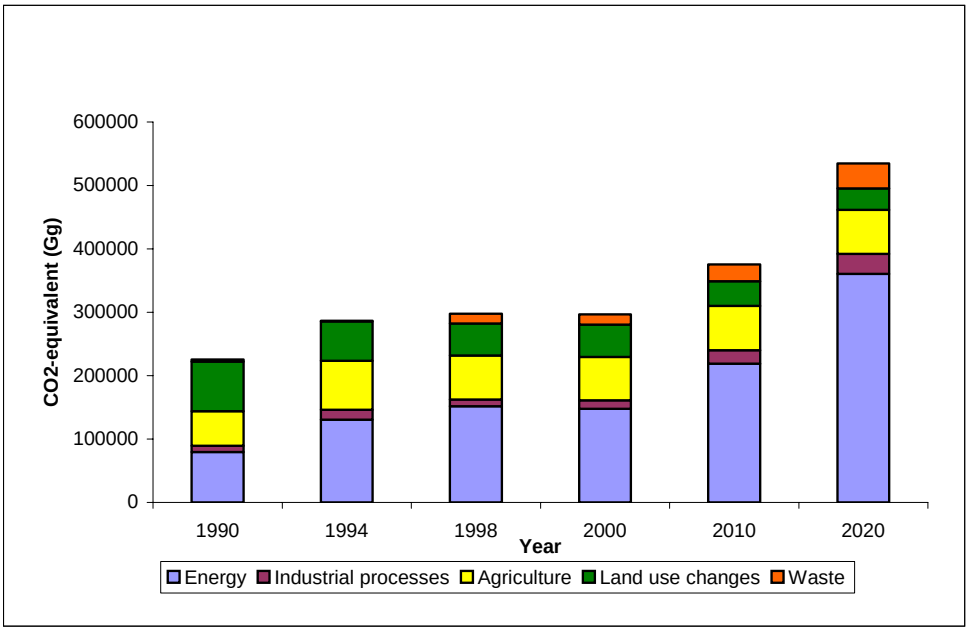
Remark: * 1,000 tones = 1 gigagram (Gg)

Source: 1/ OEPP (1990); 2/ OEPP (2000); 3/ MONRE (2004)

Table 17. Greenhouse gas emissions by sector from 1990-2020

Sector	Percentage of CO_2-e Emissions					
	1990 [1/]	1994 [2/]	1998 [3/]	Proj. 2000 [3/]	Proj. 2010 [3/]	Proj. 2020 [3/]
Energy	35.37	45.54	51.06	49.77	58.32	67.44
Industrial processes	4.36	5.58	3.61	4.54	5.62	5.86
Agriculture	24.21	27.03	23.26	23.08	18.64	12.99
Land use changes	34.71	21.60	17.02	17.03	10.36	6.37
Waste	1.36	0.26	5.05	5.59	7.05	7.34
Total	100.00	100.00	100.00	100.00	100.00	100.00

Figure 21 Past and Projected CO_2-equivalent emissions by Sector, 1990-2020



150. Table 16 and Figure 21 show that in 1990, the contribution of three main greenhouse gas emissions (CO_2, CH_4, and N_2O) was equivalent to 225,297 Gg of carbon dioxide (CO_2). Emissions of CO_2 (carbon dioxide) were the largest contributor with 73% of total emissions followed by CH_4 (methane) and N_2O (nitrous oxide) with 25% and 3% of the total emissions, respectively. The energy sector was the greatest contributor to GHG emissions, accounting for approximately 35% of the total emissions, followed by land use changes (34%), agriculture (24%), industrial processes (4%) and waste (1%).

151. The gross GWP of the three main GHGs in 1994 amounted to 286,373 Gg of CO_2 equivalent or an increase of approximately 61,000 Gg from 1990. CO_2 contributed

approximately 71%, CH_4 about 23% and N_2O about 6 % of the total emissions in Thailand. It is observed that the proportion of CO_2 and N_2O emission significantly increased from 1990. Table 17 and Figure 21 also reveal that energy sector remains the main contributor of GHG emissions but the second largest contributor has changed from land use change and forestry (forest conversion, slash-and-burn, fuelwood use) to agricultural sector (rice, livestock and agricultural soils).

152. Similar to the period 1990-1994, emissions of CO_2 in 1998 were the greatest GHG contributor with 68% of the total emissions, followed by CH_4 and N_2O with 27% and 5% of the total, respectively. HFCs (hydrofluorocarbons) were not measured in the emissions. The energy sector accounted for 51% of the total emissions followed by agriculture, and land use changes with 23% and 17% of the total net CO_2-equivalent emissions, respectively.

153. The CO_2-equivalent emissions in Thailand are projected to be about 534,697 Gg of CO_2 equivalent in 2020, i.e. approximately twice the 1994 emission total. The projections anticipate 414,938 Gg of carbon dioxide, 100,584 Gg of methane, 18,507 Gg nitrous oxide and 668 Gg of hydrofluorocarbons. All emissions except for those of N_2O are projected to increase. The growth rate of N2O emissions is expected to diminish during 2010-2020 compared to 2000-2010 under an anticipated shift in the government's policy towards greater use of chemical (rather than biological) fertilizers. As we saw earlier when dealing with land degradation, however, the policy has moved in the opposite direction.

154. Taken together, the energy, agriculture, and waste sectors account for some 78% of GHG emissions in Thailand in 2000 and are expected to rise to 84% in 2010 and 87% in 2020. Consumption of energy is the most significant cause of GHG emissions in Thailand and is projected to remain so. Emissions of CH_4 from rice paddy are expected to continue as the second largest source of total GHG emissions and if anything, increase further. Emissions from forest conversion and burning are projected to decline over time due to expansion of forest plantation areas and reduced deforestation. On the other hand, waste and industrial processes are projected to gain in importance. Contribution of land use change, waste & industrial processes is projected to be about 10% each of the total emissions.

155. As Thailand moves its economic structure further toward an industry-based economy, emissions from energy sector will be significant. The rapid growth of the economy will worsen the situation, if nothing is done to reverse present trends. The most significant opportunities for clean development mechanism (CDM) projects will likely be found in the energy sector. In addition, most of the opportunities for GHG emission reduction in other sectors involve conversion of emission-generating practices to energy-conservation practices.

Rating: High and increasing

Justification: The total emissions of CO_2 equivalent rose by about 30% during the last decade but the increase slowed down markedly during the end of the 1990s in part reflecting the economic slowdown of that period. The energy sector remained the main contributor of GHG emissions, accounting approximately 51% of the total GHGs in Thailand at the turn of the decade.

State

156. The status of climate change is determined by factors that are overwhelmingly outside the control of Thai or GMS authorities. In principle, a single report on climate changes is prepared for the whole world by the likes of IPCC. For that reason, this EPA report does not attempt to formulate a separate state indicator at a national level. That said, certain parameters –in particular the sea level changes-- would deserve to be monitored in Thailand's own interest as well as a contribution to the global understanding of the climate change-related phenomena

Response

The Indicator: Emission of CO_2 equivalent per unit of GDP (see Factsheet No. 7.2)

157. Three main laws that facilitate responses to global climate change in Thailand are:

- The Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (A.C. 1992) or NEQA. The NEQA authorizes the National Environmental Board (NEB) to set environmental quality standards and to strengthen the rules that govern the monitoring and control of pollution, including emission performance.
- The Energy Conservation Promotion Act B.E. 2535 (A.C. 1992) or ECPA. ECPA: 1) identifies general measures that factory owners should adopt to reduce energy uses, 2) compels owners of large buildings to conduct energy audits and monitor energy consumption, 3) establishes energy conservation promotion funds to support energy efficiency initiatives, renewable energy projects, etc.
- The National Energy Policy Council Act, B.E. 2535 (A.C. 1992) promotes study and analysis of energy policies, management and development plans of the country.

158. At the international level, Thailand signed the United Nations Framework Convention on Climate Change (UNFCCC) on 12 June 1992 and ratified the convention on 28 December 1994, which came into effect on 28 March 1995. Thailand has since signed the Kyoto Protocol on 2 February 1999 and ratified it on 20 August 2002.

159. In Thailand, mitigation options have been explored and analyzed for the key GHG emitting sectors. Government policies to reduce GHG emissions by the energy sector in Thailand have targeted three principal areas: (a) measures to reduce demand for energy, (b) measures to increase energy efficiency (energy consumption per unit of output), and (c) a switch from high to low carbon fuels. In addition, the 20 Year National Environmental Policy (1997-2016) encourages the development of renewable energy and bio-diesel as alternative sources of energy.

160. In the land use change and forestry sector, the principal mitigation options are: the protection of existing forest cover and creation of new forest through reforestation and/or afforestation.

161. As to the reduction of methane emissions from paddy fields, the options include: 1) using enhanced rice production technologies (such as minimizing the use of green manure and substituting pre-fermented compost from farm residues, adding nitrate or sulfate-containing nitrogen fertilizer to suppress CH_4 production, and several others) and 2)

reducing methane emissions by changing rice cultivation practices. This involves a progressive move away from tall (traditional) rice varieties that with high CH_4 emissions towards high yielding rice varieties with more productive tillers and shorter cropping period. The 1988 findings of the Natural Resources Management Program of Asian Institute of Technology established that lower use of green manure can reduce methane emissions associated with rice production. In addition, the application of sulfate fertilizer has been proven effective in decreasing CH_4 emissions. The ALGAS Report (ADB, 1998) recommended nation-wide chemical treatments to reduce methane in rice production. However, those approaches are not in harmony with traditional practices and the promotion of sustainable agriculture by using organic fertilizers in cultivation.

162. Emissions of CO_2 per unit of GDP is chosen as the indicator of response as it captures the degree of success national authorities have had in controlling GHG emissions –through a variety of steps described above-- at the time of rapid economic growth. The lower the CO_2-emissions per unit of GDP, the better the performance of the country in contributing to the global objective of reducing GHG emissions and their impacts.

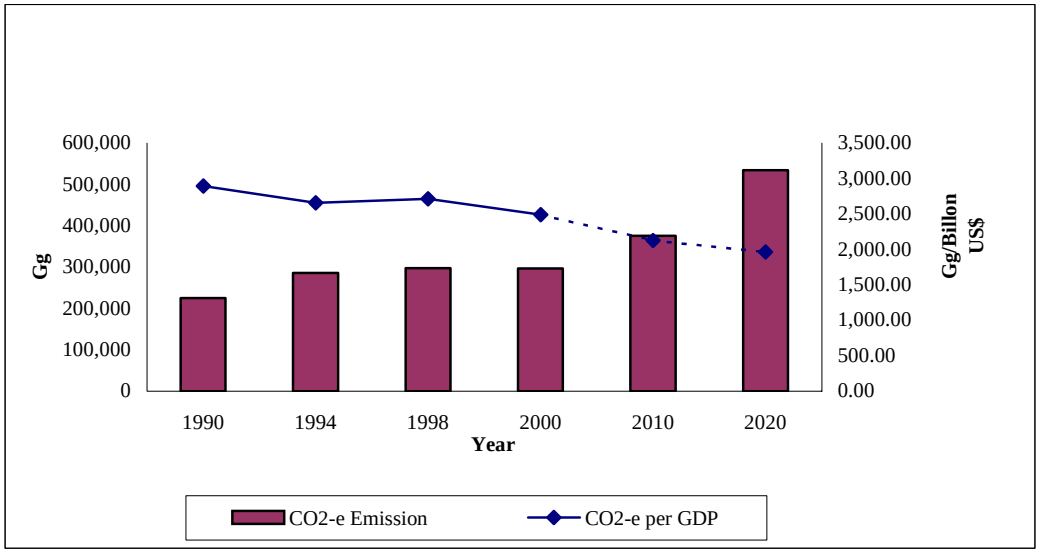
163. Table 18 and Figure 22 show the past and projected net emissions in carbon dioxide equivalent (CO_2-e) from 1990 to 2020. Where projections for 2000-2020 rather than actual values are used, an average GDP growth rate of 4-5% p.a. has been assumed.

Table 18 CO_2-e Emissions per unit of GDP

Year	CO2-e (Gg) [1/]	Annual growth rate (%) of CO_2-e	GDP (billion US$) [2/]	Annual growth rate (%) of GDP [2/]	CO_2-e per unit of GDP (Gg/Billion US$)	Annual growth rate (%) of CO_2-e/GDP
1990	225,297	-	77.81	11.17	2,895.29	-
1994	286,373	6.18	107.82	8.95	2,656.11	-2.13
1998	297,611	0.97	109.73	-1.45	2,712.10	0.52
2000	296,984	2.80 (assumed)	119.29	4.31	2,489.57	-4.19
2010	375,661	2.38 (assumed)	176.79 (projected)	4.14	2,124.96	-1.57
2020	534,697	3.59 (assumed)	272.09	4.62	1,965.14	-0.78

Remarks: 1/ See calculation in P-indicator factsheet No. 7.1; 2/ NESDB

Figure 22 Emission of CO2-equivalent per GDP



164. Rapid growth of GHGs emissions was observed during 1990-1994. Net GHG emissions substantially increased from 225,297 Gg in 1990 to 286,397 Gg in 1994 with a growth rate of 6.18 % p.a. However this trend was reversed during after 1997, due to economic crisis in Thailand. The latest estimate of GHG emissions (1998) put the net CO_2-e at 297,611 Gg or an increase of approximately 1 % p.a. over 1994. With further economic growth expected to raise Thailand's 2000 GDP of US$119 billion to US$ 177 billion in 2010 and US$ 272 billion in 2020 GHG total emissions cannot but rise.

165. However the "CO_2 intensity", i.e. CO_2-e per unit of GDP is expected to continue to decrease, continuing the trend observed from 1990 to 1998, only briefly interrupted between1994 and 1998. The CO_2-e per GDP in Thailand declined from 2,895 Gg/billion US$ in 1990 to 2,656 Gg/billion US$ in 1994 and was 2,712 Gg/billion US$ in 1998. The projections assuming a 4-5% GDP growth per annum placed the value of this indicator at 2,451.2 Gg/billion US$ in 2000 and expect it to decline substantially to 1,965 Gg/billion US$ in 2020. These projections anticipate a positive impact of public awareness campaigns on energy conservation, wider use of alternative energy sources (solar cell), and higher prices of oil acting as a major incentive to seek energy efficient solutions. As an example of active response, the government has allocated approximately $10 million for a revision of the school curriculum to include energy conservation and environmental awareness, as well as including climate change concerns into its National Economic and Social Development Plan (8^{th} NESDP-1996-2001).

Table 19 Growth rates of GDP, energy consumption and the ratio of energy consumption to GDP

Data	1997	1998	1999	2000	2001	2002
Energy demand growth (%)[1/]		-4.39	-0.90	26.66	9.62	3.07
GDP growth [2/]	-1.45	-10.77	4.22	4.31	3.72	4.83
Ratio of energy consumption growth to GDP growth		0.41	-0.21	6.18	2.59	0.63

Sources: 1/ National Energy Policy Office; 2/ NESDB

166. With technical assistance of the Asian Development Bank, the Global Environment Facility and the United Nations Development Program, Thailand has prepared its national action plan for climate change. Based on the results of least-cost analyses scenarios, 15 financially viable projects in the energy sector and in the non-energy sectors were proposed for investment consideration. The total estimated incremental cost of CO_2 mitigation was US$ 32.26 million (ADB, 1998). Besides, the World Bank in association with the Office of Natural Resources and Environmental Policy and Planning (ONEP) also conducted the National Clean Development Mechanism Strategy (CDM) study. As a non-Annex 1 country of the Kyoto Protocol , Thailand can benefit from CDM projects and receive financial support of Annex 1 countries for activities that reduce GHG emission reductions in Thailand.

Rating: Non-comparable and consistent

Justification: The "CO_2 intensity", i.e. CO_2-e per unit of GDP has declined moderately between 1990 and 1998. This suggests that the Government policies have played a small but positive role in slowing down the growth in total Thailand's GHG emissions.

Conclusions

167. The GHG emissions of Thailand have been estimated for four principal greenhouse gases (GHGs), i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs). The net GHG emissions grew in conditions of fast economic growth registered in the country during the 1990s and are projected to grow further from 225,297 Gg CO_2-e in 1990 to 534,696 Gg in 2020 (corresponding to a 3% growth p.a.) CO_2 emissions are the largest category followed by CH_4. The primary sources of GHG emissions were the energy sector (51% of the total) and land use changes, mainly deforestation. In 1998, GHG emissions from the energy sector were 151,953 Gg CO2-e and are projected to grow to 360,625 Gg in 2020.

168. While the total of GHG emissions is likely to increase in the future, but the "CO_2 intensity", i.e. CO_2-e per unit of GDP is expected to continue to decrease The CO_2-e per GDP in Thailand declined from 2,895 Gg/billion US$ in 1990 to 2,712 Gg/billion US$ in 1998. The value of this indicator is projected decline further to 1,965 Gg/billion US$ in 2020. This anticipates a positive impact of several initiatives by the Thai Government to meet its commitment under UNFCCC.

169. By now it is accepted by most that the global warming phenomenon is strongly linked to man-made activities. Thailand is well aware of the risks posed by global warming and climate change, especially its potential repercussions for the sea level rise and for average temperatures. The country signed the United Nations Framework Convention on Climate Change (UNFCCC) on 12 June 1992, and ratified it on 28 December 1994. Subsequently, Thailand signed the Kyoto Protocol on global warming on 2 February 1999 and ratified it on 20 August 2002. Having committed itself to these global agreements, the Thai Government launched several projects aimed at conservation of energy and mitigation of greenhouse gases (GHG) emissions, as well as creation of carbon sinks.

Rating: 2-stars

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III. ENVIRONMENT AND ECONOMIC DEVELOPMENT : CROSS-CUTTING ISSUES IN AN EPA

3.1 The purpose

170. The purpose of Part III is not to comprehensively review the existing institutional and legislative basis of environmental management in Thailand. Several summaries exist (including the Institutional Gap Analysis Report prepared as part of the SEF II Project)[8]and the reader is referred to them for details. Rather, the purpose is to identify those elements of the existing "superstructure" that have had a noticeable effect on overall environmental performance. This is no small task for in a complex and relatively sophisticated economy such as that of Thailand, many things will have had an impact, those outside the traditional narrow scope of environmental enquiry often no less than the more familiar ones.

171. The heading of Part III deliberately links environmental outcomes to a strong commitment to economic development found in all GMS countries. It is in the interplay of the measures designed to stimulate economic growth and the structure of environmental safeguards that environmental performance is typically determined.

3.2 Integration of environmental concerns in economic decisions

172. Environmental considerations are not new in Thai policy making even if they are periodically overshadowed by other priorities or short-term emergencies. By now, Thailand's continued commitment to GDP growth coexists with a relatively well developed structure of environmental safeguards that has many features found in more advanced economies even if the effectiveness of their use in is often weak as argued further below. The concern with resource depletion or degradation is articulated at the highest levels by the Royal family and echoed in different ways by the lively press. Integrating environmental decisions into the economic mainstream has long been recognized as a way of improving environmental performance. Luckily, the debate in Thailand has moved past a general acceptance of that notion to shaping the actual mechanisms of that integration.

3.2.1 Policy and institutional integration

173. It is in the National Economic and Social Development Plans (NESDPs) where the environmental considerations meet the development vision and policy. Besides key economic objectives grouped around (1) promotion of economic stability, (2) creation of strong foundations for continued development (mainly through attention to education), (3) improved governance and (4) poverty alleviation, the current (ninth, 2002-2006) NESDP also spells out the direction of natural resource- and environmental management. This, simplified and shortened, includes (1) natural resource management that allows for greater local participation; (2) heightened public awareness regarding environmental quality (3) more efficient enforcement of environmental laws; (4) development of databases at the local level to facilitate efficient monitoring and evaluation; (5) continued support for protection and demarcation of protected areas; (6) formulation of a master plan for the rehabilitation of Thai coastal and marine environments; (7) greater attention to biodiversity conservation in any new natural resource strategies; (8) more efficient utilization of water resources; (9)

[8] See the references at the end of this section.

restoration of soil fertility to boost agricultural productivity; (10) more efficient utilization of energy; (11) greater attention to matching land use to land capability.

174. The 9th NESDP's objectives are largely those formulated in 1996 at the time of the adoption of NEQA[9]. This is no accident. The Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality (1997-2016), approved in 1996 has remained an environmental policy guide for the top environmental body (now the Ministry of Natural Resources and Environment) and a pool of ideas for subsequent NESDPs. There is thus continuity of policy, an important precondition of good performance.

175. The Policy and Prospective Plan consists of six sets of policies (natural resources, pollution, natural and cultural environments, community environment, environmental education and promotion, and environmental technology). The breadth of NEQA's concerns suggests that environmental management in Thailand is understood to be more than a set of narrow conservation or pollution control concerns, a conceptual plus although something that adds to the complexity of the management tasks. Complex objectives of policy are the right ones but they place additional coordination, explanation and monitoring demands on the managers.

176. This is recognized in the 9th NESDP that adopts a pragmatic approach to quantifying several key natural resource and environmental objectives: By 2006, Thailand is to

- Have at least 25% of the country area under protected forests
- Have at least 1.25 millions *rai* (200 km^2) of mangrove areas
- Reduce the area prone to soil erosion to no more than 9.7% of the country's total land area
- Bring the area degraded (acidic, saline, other) soils to no more than 9.5% of the country's total
- Ensure that all main rivers have the level of dissolved oxygen of at least 2 mg/liter
- Collect and treat at least 50% of all hazardous waste generated
- Properly dispose of at least 50% of solid waste generated in the provinces.
- Recycle at least 30 % of the total solid waste generated.
- Bring air quality in all urban area to within existing (and quantified) air quality standards

177. Clear statement, and preferably quantification of policy targets, is a "friend" of performance assessment and indeed its precondition. This positive feature is not negated by occasional inconsistencies of targets in Thai government policy documents or their changes over time (for instance, those of forest areas). Nevertheless attention to, and discussion of, the policy targets and their formulation would deserve to be given more prominence in future.

178. NEQA has been a unifying act without however superseding other environmental legislation. This includes instruments such as the Factories Act 1992, Public Health Act

[9] The National Environmental Quality Act or NEQA (last amended in 1992) is the Act that directs the National Environmental Board (NEB) to submit environmental policy to the Cabinet for approval. The Policy and Perspective Plan 1997-2016 was the first such policy submitted. NEQA further directs NEB to convert the policy into environmental quality management plans of varying durations. At present, the Environmental Quality Management Plan 1999-2006 is the vehicle of implementing the policy. Following EQMP's approval, the governors of provinces shall have the duty to formulate Annual Provincial Environmental Quality Management Action Plans. Among other things, provincial EQMPs pay considerable attention to financing of environmental activities at the local level, a theme that was argued earlier to play a central role in performance under, for instance, inland water quality concerns.

1992, Hazardous Substances Act 1992, Energy Conservation Promotion Act 1992, Forest Reserve Act 1964, National Park Act 1961, Forestry Act 1947, Fishery Act 1945 etc. No fewer than nine major laws relate to water pollution, at least four to solid waste management, five to toxic contamination, six to land degradation, four to water resources and six to forest resources. Among other things, sector fragmentation apparent in this complex legislation, gaps of coverage, inconsistent terminology, and dispersion of supervision responsibilities across different agencies weaken enforcement, a standard criticism of the Thai environmental practice.

179. Dispersion of authority over natural resources is not a problem unique to Thailand. The Thai answer was the establishment in 1975 of the National Environmental Board (NEB), chaired by the Prime Minister. NEB brings together the sectoral ministries whose activities impinge upon the environment, the heads of relevant government boards and the private sector as a way of fostering inter-agency communication and policy coherence. Significantly, NEB's stated objective is also to improve the vertical line of communication between the central and local levels of the government. NEB's powers are extensive. Besides those mentioned earlier they include changes of environmental standards, amendment of environmental laws, and prescribed changes in monitoring by the State of environmental compliance.

180. Another example of a conscious effort to "mainstream" is found at a more detailed level, namely in overseeing pollution control matters. NEQA provides for the establishment of the Pollution Control Committee under MONRE's chairmanship with representation by 10 Directors General of key environment-linked departments, the Secretary General of ONEP and the Permanent Secretary of BMA.

181. Integration of environmental decisions into the economic mainstream in Thailand at lower levels of government has been part of a much wider effort by Thailand to change governance. Effective decentralization is seen by many to hold the key also to improved environmental performance in areas such as wastewater management as well as natural resource management. The 1997 Constitution provides for substantial fiscal and administrative decentralization. However, the process of converting the Constitutional provision into action has been relatively slow[10]. The incomplete and slow decentralization has probably had an adverse effect on performance especially on environmental service activities (such as wastewater treatment, solid waste management) that require clarity regarding the pattern of local cost recovery.

182. One of potential aids to environmental performance in Thailand has been the room existing policy and legislation create for calibrating interventions to the location and scale of the problem. Under NEQA, NEB can declare locations experiencing serious Pollution Control Areas (PCAs). Such areas then qualify for a possible support by the Government of mitigation measures and result in additional obligations placed on the relevant local government (e.g. to draw up a suitable remedial action plan). Similar arrangements apply to environmentally-fragile areas that can be declared Conservation and Environmentally Protected Areas.

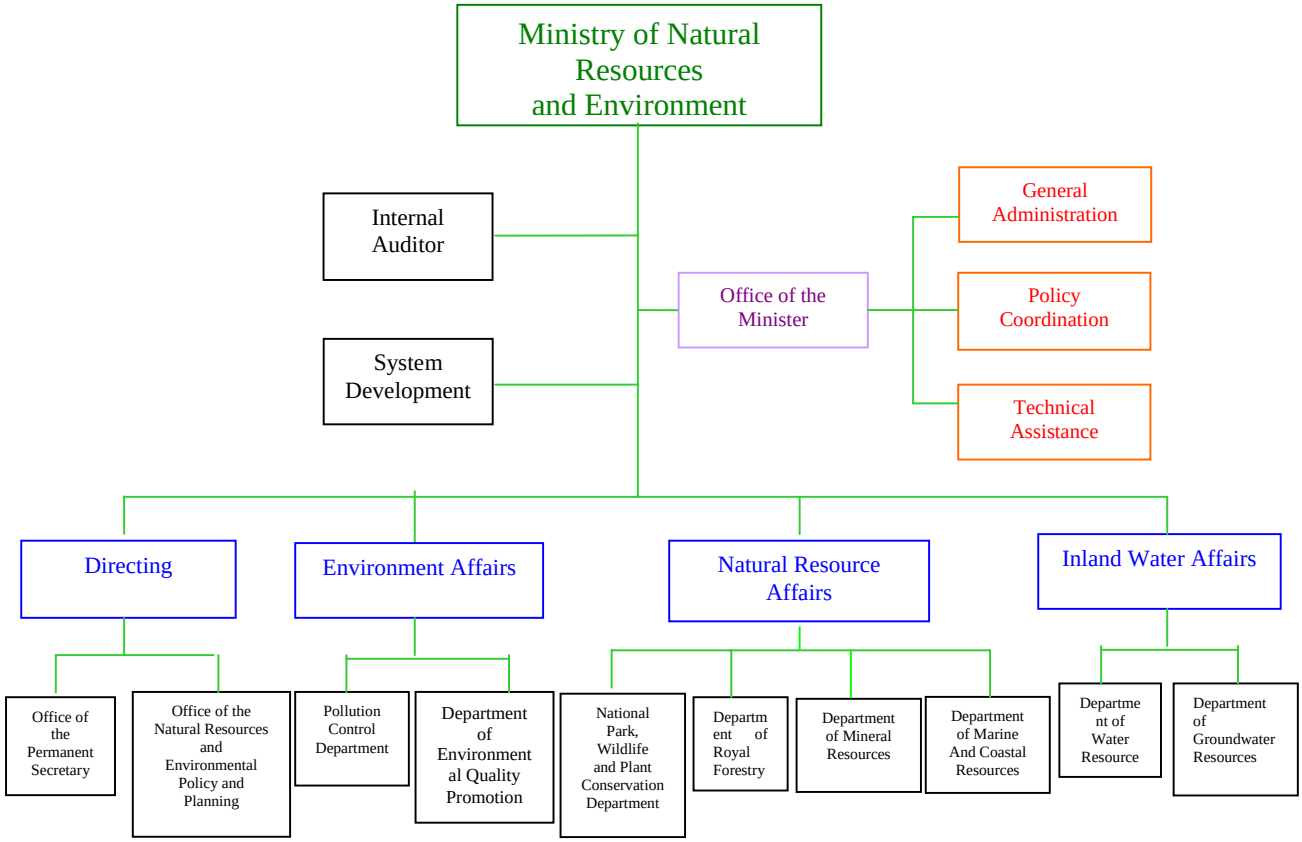
[10] The Decentralization Act became effective at the end of 1999 and the body expected to prepare a plan to implement the decentralized mode of governance, define the institutional relationships between the central and local governments, and improve local tax and revenue mobilization, namely the National Decentralization Committee, is yet to be formed.

183. Performance is affected in a number of ways by existing institutional and administrative structure. Features such as clear and unambiguous delineation of responsibilities, or efficient arrangements for horizontal and vertical communication among different agencies and between them and the direct stakeholders can make a difference.

184. In October 2002 the latest re-structuring of the environment ministry was completed to further reduce the overlap of responsibility and authority among government agencies. The former MOSTE was reorganized as MONRE[11] around three key units, namely the Office of Natural Resource and Environmental Policy and Plan (ONEP), Pollution Control Department (PCD) and Department of Environmental Quality Promotion (DEQP) (Fig. 23). The organizational re-alignment has probably created foundations for better performance as it placed environmental policy development on a problem-solving (rather than technical) basis. The continued concentration of all pollution control activities in a single department (PCD) also has the merit of clear focus. On the whole the new institutional structure is conducive to effective implementation of policies, plans and strategies at both national and local levels as well as enforcement of laws and regulations.

[11] MONRE's principal units are the Office of Natural Resource and Environmental Policy and Plan (ONEP), the Pollution Control Department (PCD), Department of Marine and Coastal Resources, Department of Mineral Resources, Department of Water Resources, Department of National Parks, Wildlife and Plants, and Department of Environmental Quality Promotion, the "home" of the SFE II under which this report has been prepared.

Figure 23 Organizations under MONRE



3.2.2 Environmental expenditure and financing

185. The Government's annual investment for pollution control increased from 500 million baht in 1990 to the maximum of 12,368 million baht in 1997 and then declined to 7,928 million baht in 2001 (Table 20). These funds have been used mainly for controlling urban pollution, i.e. dealing with wastewater, air and noise pollution and managing solid and hazardous waste. The Government's expenditure on other environment-related activities was much lower during the last decade and was dominated by operating rather capital expenditure costs.

Table 20 Government environmental expenditure 1990-2000 (PCD, 1990-2001)

Million Baht

Year	Water Pollution	Air & Noise Pollution	Hazardous & Hazardous waste	Solid waste	Others	Total
1990	143.27	3.42	-	-	342.25	500.94
1991	295.44	36.79	-	1.63	503.02	836.88
1992	810.36	52.90	8.43	26.58	1,902.01	2,800.28
1993	2,690.54	93.34	26.4	144.35	2761.85	5,761.48
1994	3,645	528	896	na	1213	6,282
1995	4,037	347	1,435	-	1116	6,934
1996	5,948	472	1,193	-	2386	9,999
1997	7,258	439	1,192	-	2391	12,368
1998	6,562	183	369	795	446	8,355
1999	4,586	105	404	639	435	6,469
2000	6,630	158	915	587	675	8,965
2001	5,169	132	631	802	1,194	7,928

186. Another source of funding is the Environmental Fund[12], established 1992, to support efforts to solve urgent environmental problems, in particular the provision of air pollution and wastewater treatment facilities systems and waste disposal system, with participation of all stakeholders.

Significant investments on pollution control have been made by the private sector both as a response to government pollution control policy as well as under voluntary programs such as ISO 14001. At present, 961 companies have been certified ISO 14001(www.diw.go.th).

187. The old question whether insufficient funding or something else was the main reason for poor performance (in those cases where performance was poor) has not been answered. Tentatively, this EPA suggests that funding alone is rarely a full answer to complex environmental problems. Many in Thailand understand that making a case for greater government expenditure on anything (including environment-related activities) requires a comparison of that expenditure with its expected benefits. Ideally it also requires a

[12] The Environmental Fund started in 1992 with an initial capital of 5,000 million Baht (US$ 200 million) approved by the government, consisting 500 million Baht (US$ 20 million) from the Revolving Fund for Environmental Development and Quality of Life, and 4,500 million Baht (US$ 180 million) from the Fuel Oil Fund. During 1993-1995, the government contributed another 1,250 million Baht. In 1994, the Japan Bank for International Cooperation also provided loan to the Environmental Fund of 100 million USD. The Office of the Environment Fund is responsible for the management and administration of the Fund and is a division under the ONEP.

comparison of different ways of achieving the same objective. The habit to make and articulate those (difficult) comparisons is not entrenched in Thailand. Without it, it is hard to say whether insufficient financing has been a key constraint on performance or not. That more could have been achieved with more funds would be a trivial conclusion.

188. Earlier on, it was suggested that rather than absolute amounts of funds, it is often the pattern of financing (with the structure of incentives and disincentives that it implies) that can be the dividing line between good and poor performance. Considerable room seems to exist in Thailand to improve the financing mechanisms especially in environmental service activities (such as wastewater treatment, solid waste management). The effect of decentralization and Government programs such as Agenda for Livable Cities on performance in activities such as solid waste management is also not easy to assess. Unlike Bangkok and Chieng Mai, where the high population density lowers the cost per capita of service provision (and thus improves the chances of financial sustainability of WWT and SWM in these areas), the per capita cost may be much higher in other areas. Greater attention to the cost recovery (financing) issues would seem be a pre-condition of improved performance in second-tier urban areas.

3.3 Implementation issues

189. At present, Thailand is implementing the 9th NESDP B.E. 2545-2549 (AD 2002-2006). The 9th NESDP is a strategic plan that serves as a framework for medium term national development, consistent with a long term vision. It builds on the Eighth Plan that advocated a holistic people-centred development approach. In the 9th Plan, major emphasis is placed on balanced development of human, social, economic, and environmental resources. A priority goal is pursuance of good governance at all levels of Thai society in order to achieve real sustainable people-centered development. Key policy targets have been set under this plan and some of them quantified as mentioned earlier on paragraph 164.

190. Key objectives of NEQA were to enhance the standing of the NEB as a pivotal policy-making body; to introduce the Polluter Pay Principle; establish the Environmental Fund to assist polluters in financing their mitigation activities; create more stringent environmental standards and establish legal liability for environmental offences, to mention only the most important. This is a demanding agenda but also one that does not lend itself to an easy assessment of performance unlike the more physically based targets such as forest cover etc.

3.3.1 Regulatory and economic instruments

191. Environmental performance depends on a number of things, the types of instruments used to achieve the policy objectives among important variables. In this connection, Thailand has been an active party to the debate about the balance of advantages and disadvantages of “economic” (or “market-based”) instruments as opposed to the more tradition “command-and-control” instruments of environment policy (see AET, 2000). That debate is relevant here. If one type of instruments can achieve more with less or achieve the same objective at a lower cost, then clearly its wider adoption will improve performance.

192. Thailand began using some of these instruments (though not those given the greatest international publicity such as pollution levies) during the 1990s. They included, for instance, subsidies for hazardous waste treatment, wastewater treatment charges in some

locations, or price differentiation between leaded and unleaded gasoline prior to the complete phase out of the former. The experience so far falls into four broad areas, namely

- Resource pricing
- User charges for water pricing, municipal solid waste disposal, hazardous waste disposal,
- Wastewater charges for selected industrial clusters, IEAT, Centralized municipal wastewater treatment plants and
- others (Tax and price differentiation, green taxes, voluntary compliance mechanism and clean production initiatives)

193. The experience with their use has been mixed. Until the logging ban in 1989 (and 1996 in the case of mangrove forest) fees were used to regulate access ("restrain the appetite for") to the country's timber resources. A pricing approach is used to this day for mining concessions. The experience of Thailand suggests that resource fees by themselves do not guarantee good performance.

194. User charges for water pricing, municipal solid waste disposal and hazardous waste disposal have been used in combination with other instruments such administrative rationing (e.g. of groundwater use permits). Prices of piped water in BMA are set in the form of a two-tier tariff differentiated by customer categories (residential, government, industry and commercial). Service charges for municipal solid waste collection have been in existence in Thailand for many decades, and are complemented by private sector-led recycling. Treatment of hazardous waste in Thailand has been a mixture of a government subsidy and private cost operations. Wastewater treatment by industrial estates is largely financed by charges levied on the estate tenants. Selected municipalities (Pattaya, Patong) have introduced differentiated wastewater treatment charges.

195. At several times in the past, excise taxes were a tool of environmental policy (e.g. to indirectly influence SO2 emissions associated with the use of diesel). Excise taxes on petroleum products also had the function of capitalizing the Environmental Conservation Promotion Fund ("ENCON Fund"). Unlike the Environmental Fund mentioned in paragraph 182, used mainly to support the construction of centralized wastewater treatment plants, the proceeds of ENCON Fund have been channeled towards energy conservation schemes.

196. ISO certification has had considerable positive impact in Thailand and clean production schemes were introduced into Thailand in late 1980s.

197. The sketch of Thailand's experience of combining economic with more traditional policy instruments suggests that the menu of tools available to government to pursue different policy objectives will widen over time. Introduction of new approaches does not necessarily guarantee better performance since it often requires not a simple replacement of one set of tools by another but their combination.

198. As to the (by now) more traditional tools such as widening of EIA obligations, the evidence presented in Part II suggests that this has had a positive impact on parameters such as surface water quality (that remained static of slightly improved at a time of rapid GDP growth).

3.3.2 Enforcement

199. Enforcement of environmental and related legislation has had a mixed record in Thailand. In some cases (e.g. maintenance of forest cover) it was handicapped by slow progress of land titling, political patronage as well as unclear allocation of supervision responsibilities in some cases. There can be little doubt that insufficient enforcement was one of the reasons for the depletion of natural resources observed over the past two decades (the loss of mangroves being the most convenient example). It seems equally clear that uncertain legal provisions and tenure contributed to the relative ineffectiveness of enforcement.

200. The debate about how effective the EIA process has been in Thailand either on its own or in combination with other approaches such as voluntary compliance has been relatively extensive. There seems to be room for further increasing the effectiveness of the EIA practice. The role of public participation in that is yet to be properly evaluated.

3.4 Environment and civil society

201. NEQA recognizes the role and standing of environmental NGOs. Environmental NGOs have been an ambiguous force in Thailand's environmental management, their activities ranging from one-issue extremism to a constructive and healthy alternative to a sometimes fatigued and desk-bound government. Registration requirements as a legal precondition for obtaining outside financial support may have made some NGOs weaker, though probably not the most creative ones. NGOs continue to be viewed with suspicion for their real or perceived "anti-development" stance. It is difficult to say whether, on balance, NGOs have been a forward-looking or fundamentally conservative force (despite the rhetoric) on issues such as siting of waste disposal sites and the balance between that and greater waste re-cycling spurred on by greater awareness or economic incentives.

202. There are many NGOs that supplement Government activities in important ways, especially at the local level. They include things such as waste recycling banks, conduct of local environmental studies, "sustainable-city"-type activities, organic agriculture introduction, public awareness and participation and others

3.4.1 Environment, health and safety

203. By most accepted criteria Thai people's overall health status has improved during the past two decades (WHO, 2000). The changes in the pattern of health concerns suggest that better nutrition and good performance in areas such as rural water supply have played a role. The evidence presented in Part II also suggests that the deterioration in surface water (as well as air quality in Bangkok) has been arrested even if water pollution remains a serious concern in some water bodies (as does air quality in parts of the country of during certain times).

204. WHO has reported seven occupational diseases in the workplace in Thailand (lead poisoning, silicosis, byssinosis, asbestosis, pesticide poisoning, solvent poisoning and hearing loss due to excessive noise levels). Most of these have little to do with environmental management conventionally understood but not all. Section 2.6 of Part II dealing with hazardous waste indicated a creditable performance under that category at a

time of fast economic growth. In addition, ONEP (2002) reported greater awareness of Thai communities of the negative impacts of mining activities on public health. This was the case, for instance with lead contamination in Klity village in Khnachanaburi Province, or arsenic poisoning at Raunphiboon district in Nakhon Sri Thammarat Province.

205. Public health perspective has featured little in the formulation of environmental policy with an important exception of the leaded gasoline phase-out where it was public health perspective that moved policy and its implementation resulting in the eventual phasing out of leaded gasoline.

3.4.2 Access to information and public accountability

206. Thailand has taken significant steps to make environmental information available to the public. The Official Information Act B.E. 2540 (1997) compels all public bodies to make information (except security information) accessible to the public. In the case of MONRE, its website <http://www.monre.go.th> has become the principal tool of information access. It consists of the websites of

1. Office of Natural Resources and Environmental Policy and Planning: http://www.onep.go.th
2. Pollution Control Department: http://www.pcd.go.th
3. Department of Environmental Quality Promotion: http://www.deqp.go.th
4. Royal Forest Department: http://www.forest.go.th
5. National Park, Wildlife and Plant Conservation Department: http://www.dnp.go.th
6. Department of Mineral Resources: http://www.dmr.go.th
7. Department of Marine and Coastal Resources: http://www.dmcr.go.th
8. Department of Water Resources: http://www.dwr.go.th
9. Wastewater Management Authority: http://www.wma.or.th
10. Department of Groundwater Resources: http://www.dgr.go.th

Other key ministries, have followed a similar model. Ministry of Energy http://www.energy.go.th and its Energy Policy and Planning Office http://www.eppo.go.th; Ministry of Industry http://www.industry.go.th and its Department of Industrial Works: http://www.diw.go.th; Ministry of Agriculture and Cooperatives: http://www.moac.go.th and its 1. Royal Irrigation Department: http://www.rid.go.th, 2. Department of Fisheries: http://www.fisheries.go.th and 3. Land Development Department: http://www.ldd.go.th and the National Economic and Social Development Board: http://www.nesdb.go.th

The State of the Environment Report (prepared by ONEP) and State of the Pollution report (prepared by PCD) are prepared annually, and after submission to the Cabinet, are placed in the public domain.

207. The evolution of policy and practice in the direction of greater openness has been a positive for environmental performance. It has made it possible for the political constituency to get a partial view of the actual performance. As the experience of preparing this report has demonstrated, however, the gap between information available and information sufficient to meaningfully assess performance remains large. The advent of the electronic age cannot easily make up for gaps in data coverage and lack of the accountability habit.

3.4.3 Environmental awareness and education

208. Environmental education (EE) has been part of the curriculum of Thai primary and secondary schools since at least 1970s with elements of conservation awareness introduced much earlier still. An EE action program was developed by the Ministry of Education in the early 1990s, with a target of 60% of students and the public to become aware of environmental conservation by 1996. After 2002, EE was introduced into non-formal and informal education.

209. There are 55 environmental education (EE) centers, supported by the Department of Environmental Quality Promotion. EEs' partners are local administrative organizations, national agencies, schools and teachers, women's groups, monks, NGOs and the private sector. The centers organize and conduct teachers' training, training of local government staff, serve as discussion centers etc.

210. In addition to formal education, non-formal education through media, public forums, community learning centers, and internet communication has played a role and has improved performance. The impacts on attitudes and behavior are partly blunted in Thailand by a strong consumerism (also actively promoted) but the combined effect has probably been to the advantage of the former.

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IV. CONCLUSIONS AND RECOMMENDATIONS

211. Environmental stresses have long been recognized in Thailand and Government responses to them have a long history. The first environmental law ('Enhancement and Conservation of National Environmental Quality Act) dates back to 1975 and the history of some concerns (e.g. with forest degradation) is older still. After nearly three decades of policy formulation and shaping of institutional and implementation arrangements the need to take stock of how effective the various responses have been --and to repeat such an assessment at regular intervals—has grown stronger. This EPA is the first attempt to generate a concise picture of how much Thailand has achieved and how much more it could perhaps achieve under certain conditions.

212. The overall picture is one of substantially increased funding for remedial and preventive measures, notable progress is some areas (e.g. greater water security, slowing down and a possible reversal of the forest cover loss, good performance in solid waste management in Bangkok), average or stagnating performance in dealing with surface water pollution or the management of hazardous substances as well a below-average and stagnating performance in areas such as waste management in smaller municipalities. Thailand deserves high marks for policy integrity and continuity, and weaker marks for translating some of the announced policy principles (e.g. PPP) into practice. Thailand has moved further than any of its GMS neighbors along the road of decentralization and rightly recognized that many environmental responsibilities are best managed by local governments and communities even if the process is recognized to face initial obstacles. Thailand was one of the pioneers of creating and using environmental funds to support mitigation by industrial polluters but the experience has been a mixed one.

213. As the leading market economy within GMS, Thailand has gone far in involving the private sector in a variety of environmental initiatives. The success of the ISO program is worth highlighting.

214. The conclusions and recommendations under each priority concern are summarized in the sections that follow. The recommendations are divided into two groups: the first concerns the management of the relevant environmental concern. The second contains recommendations involving the technical basis of this and future EPAs.

4.1 Forest Resources

215. Forest cover in Thailand was in a steady decline for over nearly 40 years from 53.3% of the country's land area in 1961 to 25.8% in 1998. The assessment made in 2000 using higher resolution satellite image placed the remaining forest cover is 33.1% of the total land area. This reversal of the trend is important to confirm and determine whether the encouraging result is a reflection of the field realities, advances in remote sensing technology or other factors. Deforestation pressures show no signs of lessening especially the encroachment for agriculture. Under median assumptions about the future pattern of rural population growth and average farm size, a conflict with the targets of 40% forest cover in 2006 (9^{th} NESDP) and 50% in 2016 (20 year Environmental Policy) is inevitable.

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Environmental management recommendations

Recommendation 1: Readjust the 50% forest cover target and the 30% conservation forest target defined in the Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997-2016 to 40%, and 25%, respectively. Be prepared to explain this recommendation to the NGO community.

Recommendation 2: RFD to formulate and announce a phased policy of on-the-ground demarcation of all protected areas to deter encroachment into these areas. The cost of such a program should be estimated and converted into annual RFD budgets. The program should not be seen as a substitute for developing models and practices of co-management of protected areas with local communities.

Recommendation 3: The Government to step up the process of converting all land title- and land lease documents to a digital format of the same scale in order to reduce land disputes that provide a loophole for further encroachment and occupation of forest lands. Particular attention should be paid to tenure disputes inside protected areas. Consider setting up a special independent protected-area tenure claims tribunal.

216. Reforestation programs and establishment of protected areas as principal means of countering deforestation have had some impacts as the latest figures on the percentage of forest cover suggest. Further improvements are possible, however, especially in attracting private investment into forestry and in regarding protected areas as more than simple forest reserves. Within protected areas, natural rehabilitation and enrichment planting using native species should be undertaken to enhance these areas' biodiversity and landscape values.

Recommendation 4: The government to consider providing financial incentives for the use of private land, especially the vulnerable or marginal deforested land outside protected areas, for forestry purposes and agro-forestry (including rubber plantations). A review should be undertaken of the relevant administrative procedures in place in order to simplify and streamline them. Special attention should be paid to abuses of in-country controls on transport of illegal timber that is a disincentive to investment in tree planting, and innovations such as bar coding of legal timber should be considered. The issue of illegal imports from Myanmar and imports of Thai timber through Myanmar should command separate attention.
Community forest and buffer zone management outside protected areas with the involvement of local communities residing in the buffer zone should be promoted as well.

Recommendation 5**:** RFD and other government agencies to assess the degree to which existing protected areas represent existing ecosystems and identify priority areas in terms of biodiversity hotspots and role in safeguarding watershed environmental functions. Based on such assessment a program of future re-categorization or boundary adjustments of existing protected areas to better fit the underlying biological characteristics and objectives should be formulated. Biodiversity conservation corridors to be established between protected areas, in which landowners are paid to modify their land use practices to allow animals with large range requirements, like tigers and elephants, to pass freely from one protected area to another.

Recommendations relating to technical aspects of EPA

Recommendation 6: RFD to complete the interpretation of 2003 remotely sensed images of forest cover to confirm or qualify the seeming reversal of deforestation trend in Thailand during the past five years.

Recommendation 7: RFD to ensure that figures on forest cover reported to international bodies such as FAO agree with the figures reported nationally.

Recommendation 8: RFD and MONRE to play an active role in GMS-wide efforts to achieve comparability of information concerning forest cover and forest quality

4.2 Water Resources

217. The quantity and quality of water resources in Thailand have been under pressure over the years due to deterioration of watersheds, disappearance of wetlands, and inefficient allocation of water resources. Demand for water grew broadly in line with Thailand's GDF growth during the recent two decades often outstripping the local capacity to store and supply water to final users. Water shortages loom as a serious potential threat to future prosperity. Agriculture continued to be the principal and wasteful user of water. In 2003, irrigated areas served by small, medium and large-size scale reservoirs represented approximately 21% of the total cropped area. The Government has been relatively successful in averting serious water shortages so far but this performance cannot be taken for granted.

Environmental management recommendations

Recommendation 1: Less water-consuming crops during the dry season to be promoted as a way of reducing peak demand for irrigation water. This to be accompanied by improved reporting on the water resource situation before each cropping season, and a review of marketing prospects for the crops grown. Ultimately, however, the adjustment to water scarcity should be market driven: the farmers (let alone the industry and commerce) should be required to pay the true cost of water, including externalities, as one of their main production inputs. Water should be used in the most valuable production systems, not wasted in low value production. The advantages to the society of irrigation (and non-irrigation) water pricing need to be better explained to the Thai public and the financial and possible environmental cost of creating additional water storage capacity more fully discussed.

Recommendation 2: More efficient and sustainable provision of water to ultimate users requires the establishment of river-basin committees with the participation of the principal stakeholders. MONRE and RID should forge a common approach to promoting river-basin committees. The committees should formulate strategies of rehabilitating degraded upper watersheds for the maintenance of watershed value and functions, and to properly allocate water resources to different users residing in the catchment. Consideration could be given to compensating upstream landholders for any restrictions on their land use practices (such as mandatory soil conservation works) that benefit downstream water- and land users.

Recommendation 3: Where an industrial estate is to be located in a river basin vulnerable to water shortage, the appropriate Industrial Development Authority should be

asked to demonstrate that water consumption by the prospective industrial tenants is compatible with water availability (carrying capacity) of the watershed. Industrial estate managers should be represented on the river basin committees.

Recommendation 4: RID and MONRE to undertake a review of instances where development of additional water storage capacity would require entering protected areas. A policy clearly stating the circumstances where this would be possible, together with the structure of accompanying environmental safeguards, should be formulated.

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4.3 Land Degradation

218. The population and economic growth of Thailand have been behind a steadily increasing demand for land, including agricultural land. In the absence of strict enforcement, this has resulted in deforestation, forest encroachment and expansion of agriculture into environmentally unsuitable areas. Approximately 34% of the total agricultural area (or 17.42 million ha) experienced serious soil erosion at the end of the last decade. In addition, land or poor-quality accounted for approximately 44% (or 12.87 million ha).

219. LDD rehabilitated 1.7 million ha of eroded lands between 1997 and 2003 and 1.2 million ha of marginal lands. Such pace of rehabilitation is insufficient and more needs to be done.

Environmental management recommendations

Recommendation 1: Develop and enforce a structure of agricultural land use zoning that prevents planting of all or selected crops on land susceptible to soil erosion (watershed class 1). Accompany such policy by credit and tax incentives to framers growing the "right" crops or not growing destructive annual crops.

Recommendation 2: Continue to promote increased crop productivity as a way of reducing the "mining" of land. Strengthen the capacity of Volunteer Soil Doctors at village and sub-district levels to transfer to farmers the technology on sustainable agriculture and soil improvement.

Recommendation 3: Promote tree planting on marginal lands or under carbon-trading schemes through long-term credit, tax incentives or subsidies earmarked for forestry uses only.

Recommendation 4: Promote the planting of Vetiver and other C_4 grasses to keep soil moisture and to reduce top soil erosion in line with the Royal Initiative Project; and promote sustainable and organic agriculture using compost, green manure and organic fertilizer as a means of dealing with deteriorated and problem soils

Recommendations relating to technical aspects of EPA

Recommendation 5: Future EPAs would benefit from additional indicators of pressure on land resources. Loss of forest cover is only one of them and possibly not the best. Indicators such as the cropping intensity (or average number of crops p.a.) on non-irrigated land should be considered.

Recommendation 6: Assessment of land degradation is affected by inconsistency of policy targets in different documents, in particular NESDPs and LDD plans. These targets should be reviewed and a unified position and numbers agreed upon.

4.4 Inland Water Pollution

220. Domestic wastewater discharges and agro-industries dominate the overall picture of surface water quality, particularly along the densely populated segments of rivers. A large percentage of domestic wastewater in Thailand still finds its way to the water bodies without undergoing treatment. Continuing urbanization and a gap between it and the speed of environmental infrastructure build-up is a major contributing factor. However, the authorities' knowledge of the pollution load contributed by different classes of WW dischargers is partial at best as the experience of this EPA has shown.

221. To justify further expansion of WWT network as a seemingly obvious way of dealing with the problem of surface water pollution, the existing capacity first needs to be utilized more fully and efficiently and the obstacles to such improved functioning need to be removed. The obstacles may in part be technical (insufficient or inappropriate collection network) but they are predominantly of an institutional character and are linked to the financing and enforcement framework in place. Shortage of budget for O&M, or lack of appropriately trained and experienced personnel for O&M are merely symptoms of a wider challenge of how best to ensure the financial sustainability of WW. The polluter-pays-principle (PPP) is enshrined in the Government's official policy as a favored approach to pollution control but the principle has not been applied consistently (or at all) in practice. The respective roles of the state and the polluters in the financing of WWT need to be re-stated and spelt out more clearly.

Environmental management recommendations

Recommendation 1: The Government to monitor more closely the extent to which the PPP is being applied in WWT and publish its findings in regular intervals alongside the statistics of the quantity of WW discharges and surface water quality. If public policy arguments are believed to exist for modifying the application of PPP in certain areas such as municipal WWT (e.g. in the form of continuation of a de facto subsidy to municipal polluters), such arguments should be presented more openly and systematically.

222. Lasting functioning and further expansion of wastewater treatment infrastructure in Thailand demands adequate understanding by the society of the financial dimensions of the WWT challenge, the scale and distribution of financial contributions by different parties and the advantages and disadvantages of different approaches to cost recovery.

Recommendation 2: PCD, DEQP and ONEP to make additional efforts to explain the topic of cost recovery in wastewater treatment (and especially its municipal component) to the Thai public in a way that generates greater public support for paying for wastewater treatment as a precondition for further expansion of WWT infrastructure.

Recommendations relating to technical aspects of EPA

Recommendation 3: Recent administrative reforms have resulted in a loss of comparability of some pollution statistics (including untreated wastewater discharges)

before the year 2000 and thereafter. This makes it extremely difficult to assess long-term trends in WWT performance in different parts of the country. A working group of PCD staff should be established to overcome the problem.

4.5 Solid Waste Management

223. As it grows, Thailand continues to produce more municipal solid waste. Solid waste collection is generally better in urban than in rural areas, and better in Bangkok than in other cities. Bangkok was able to collect and transport almost 100 % of waste generation, while municipalities and rural areas with less financial resources could collect only about 75-85% and 15-25% of waste, respectively. As for the disposal, Bangkok was able to dispose of nearly 100% of collected waste at designated landfills, while the percentages were much lower in municipalities and rural areas (45-55% and 5-15% respectively), the difference represented by opportunistic dumping of waste in open spaces or water bodies. With increasing difficulties in finding new suitable landfill sites, longer-term remedies will have to feature also waste reduction. The rate of waste reuse and recycling has been low in Thailand. In order to increase it, more active public participation in solid waste reduction, including separation at source, supported by information campaign, is needed

224. A large number of regulatory measures and incentives have been suggested in recent years in Thailand to support the objectives of waste reduction. The better known among them include (a) Regulations to compel manufacturers and the public to segregate waste at source; (b) Regulations mandating strict supervision of waste segregation in treatment and disposal areas; (c) Promotion of waste recycling centers; (d) A more flexible use of disposal fees to encourage greater recycling and discourage its opposite; (e) Tax incentives to enterprises that recycle; (f) Greater use of the deposit-refund system; (g) R&D into new forms of easy-to-dispose-of packaging; and (f) mandatory take-back of packaging.

225. At a time of greater decentralization of environmental responsibilities to local governments the inadequate knowledge of the pattern of waste collection and disposal in smaller municipalities (that emerged also in the course of this EPA) is a major drawback.

Environmental management recommendations

Recommendation 1: Greater emphasis should be placed on those parts of the 2005 National Strategic Plan for General and Hazardous Municipal Solid Waste that deal with waste reduction and recycling, specifically the four main avenues to local waste reduction, i.e. (1) waste segregation for recycling, (2) promotion of products manufactured from recycling, (3) support for packaging waste reduction, and (4) clean technology for waste reduction.

226. The various means of improving solid waste management at the local level are reasonably well known. They include elements such as: (a) technical and management back-up for local government organizations, (b) building up the local human capacity in the field of waste disposal, (c) adapting existing technology to suit local conditions (e.g. modification of waste collection trucks) and (d) greater consideration to sharing of facilities (e.g. landfills) by several municipalities.

227. The importance of generating and maintaining public support for better waste management is beginning to be appreciated in Thailand. Future activities should build

further on the initial encouraging experience. Future public awareness activities might focus on (a) educational campaigns targeting consumer packaging, re-cycling and deposit-refund schemes; (b) reduced use of plastic bags; and (c) awareness and knowledge of waste separation, especially hazardous from non-hazardous waste.

Recommendations relating to technical aspects of EPA

Recommendation 2: Consider using percentage of waste re-cycled and re-used as an indicator of response and begin to adjust data collection efforts accordingly.

Recommendation 3: PCD and DEQP should periodically report on the progress of waste minimization efforts in Thailand by reference to the types of initiatives listed above (para. 225).

Recommendation 4**:** PCD and DEQP should initiate a periodic survey of the pattern of solid waste collection and disposal in all municipalities to establish a benchmark against which future progress can be measured. The results of this survey should be published and leading municipalities recognized for their effort.

4.6 Hazardous Substance Management

Environmental management recommendations

228. The results presented in Part II of this EPA suggest that considerable scope exists in Thailand both for increasing the percentage of treated hazardous waste as well as reducing the volumes of utilized hazardous substances and discharged. No specific recommendations are made here but a general support is given to several possibilities expressed in governmental documents. These include:

a) Reduction of pesticides and other hazardous chemicals utilization for agricultural purposes through new technologies in pest control

b) Greater emphasis on waste separation on both community and industrial levels

c) Promote and support additional hazardous waste disposal facilities, the financial viability of which could be improved by tightening regulations on hazardous waste generation, tracking and disposal

d) Improvement in recording data relating to amount of generated hazardous waste both from community and industrial source is urgently needed

e) Better data segregation on health related incidences through epidemiology study, accessible information on chemical related sickness among governmental and private hospitals

4.7 Climate Change

229. The net GHG emissions [carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs)] grew in conditions of fast economic growth registered in Thailand during the 1990s and are projected to grow further from 225,297 Gg CO_2-e in 1990 to 534,696 Gg in 2020. CO_2 emissions were the largest category followed by CH_4. The primary sources of GHG emissions were the energy sector (51% of the total) and

deforestation. Mitigation measures in Thailand targeted these two principal sources. By contrast, relatively little has been achieved in practice in reducing methane emissions from rice fields and pastures.

230. Previous work on the national GHG inventory and the analysis made under ALGAS Project recommended several mitigation options. These included, under the land use and forestry sector, (a) Forest protection and reforestation (b) Afforestation on private lands and in degraded state forest lands driven by suitable incentives (long-term credit, tax incentives etc.) (c) Planting trees for carbon trading (d) Prevention of forest fires and reduction of open-burning on farmland. Under the energy sector, they included: (a) Strengthening human resource capacity and promoting research into GHG emission mitigation, (b) promoting renewable energy development or low-carbon fuels, (c) Increasing process efficiency in various sectors (e.g. thermal efficiency in power plants, boiler efficiency and use of cogeneration); and (d) Participation in clean development mechanism (CDM) project.

Environmental management recommendations

Recommendation 1: Provide economic incentives to reduce energy consumption per capita by continued attention to energy pricing. Use alternative energy sources that release low CO_2 contents such as bio-diesel and clean energy; and monitor the efficiency of energy consumption in industrial sectors.

Recommendation 2: Promote tree plantation in marginal land as a carbon sink, and prevent forest fires

Recommendation 3: MONRE to formulate a strategy of adaptation to climate change with recommendations for the most appropriate planning and other measures and their phasing. Such measure might include elements such as zoning provisions (planning setbacks from the coastline, changes to building regulations, revision of engineering assumptions about return periods for floods and maximum rainfall etc.)

Recommendations relating to technical aspects of EPA

Recommendation 4:. Question the relevance and quality of GHG projections to the year 2020, especially the assumptions that underlie it. Re-work the ALGAS-type analyses from time to time using the latest methodologies and assumptions. Explore the climate implications of the recent shift away from the use of inorganic to organic fertilizer in Thai agriculture. Ensure that the results of the initial GHG inventory are more easily accessible to the Thai public.

Recommendation 5: In conjunction with ongoing efforts to improve natural disaster preparedness, MONRE to begin to monitor the sea levels in the Gulf of Thailand as a state indicator for the purposes of reporting on climate change and its effects.