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GEO-INFORMATION DEVELOPMENT FOR ENVIRONMENTAL MANAGEMENT IN THE GREATER MEKONG SUBREGION COUNTRIES

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Geo-information development for environmental management in the Greater Mekong Subregion Countries

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Abstract

Geoinformation are very important for environmental planning and management. Besides regular national initiatives in place in each GMS countries, number of subregional level initiatives aiming to improve data availability and build the capacity of each country, have taken place. Assessment of such subregional level initiatives in the GMS indicates that although some achievements are made, there are still significant data gaps in each country and lack of adequate infrastructure to efficiently make use of environmental data for decision-making purpose. Data availability at the subregional level is although satisfactory, considerable efforts are needed for achieving desired level of integration.

1. Introduction

The underlying reasons for compounded environmental problems in Asia are overpopulation, poverty, and lack of enforcement of policy measures (UNEP, 2002). Knowledge about our natural resources and environment has become increasingly important as we plan to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat and other global environmental concerns that require local actions.

The United Nations Conference on Environment and Development (UNCED) produced 'Rio declarations' a major strategic outlook for the 21st century in Agenda 21, which made some important observations on vital cross-cutting issues in addition to several sectoral declarations. Two of these vital issues are described in Chapter 8 on *Integrating environment and development in decision making*, and Chapter 40 on *Information for Decision Making*. In summary, the chapters emphasize the needs for - improved availability, improved collection as well as presentation of data and information on all aspects of environment and development for decision making towards sustainable development. The 'Aarhus convention' moves further to concisely recognize the basic right of every person to a healthy environment and grants the public rights regarding access to information and public participation and access to justice (UN, 2000).

As the party to Rio declarations, several Asian developing countries have tried to build the capacity for environmental management and necessary information generation. Increasing number of global partners showing commitments to Aarhus convention has further pressurized these countries to join the community to ensure access to information, public participation in decision-making and access to justice in environmental matters. This paper revisits the status of environmental information development and their use in environmental management in the Greater Mekong Subregion (GMS), one of the fastest growing economies of the world in the last decade.

2. The Greater Mekong Subregion

In 1992, with ADB's assistance, Cambodia, Lao PDR, Myanmar, Thailand, Vietnam, and Yunnan Province of the People's Republic of China, entered into a program of subregional economic cooperation, designed to enhance economic relations among the countries

(ADB, 2006). These six countries are collectively known as the Greater Mekong Subregion (Figure 1). The cooperation program has contributed to the development of infrastructure to enable the development and sharing of the resource base, and promote the freer flow of goods and people in the subregion. It has also led to the international recognition of the subregion as a growth area.

The GMS, covering a land area of 2.3 million km^2, has a total population of 240 million (in 1999) and growing by an average of 1.3 percent per year (SEI, 2002a). The unique feature of the GMS is that the mighty Mekong river is shared by all six countries and subregion contains very high levels of geographic, cultural, economic, and political diversity. The GMS is endowed with a rich and diverse natural resource base, which has historically supported economic development and sustained rural livelihoods. In recent years, however, this natural resource base has come under increasing stress from the combined effect of rapid demographic and economic change, thoughtless (and often illegal) exploitation, the impact of infrastructure projects, and the relative weakness of protective and regulatory institutions. Today, Mekong basin is among those losing greatest areas of original forest cover in Asia and elsewhere (WRI, 2000).

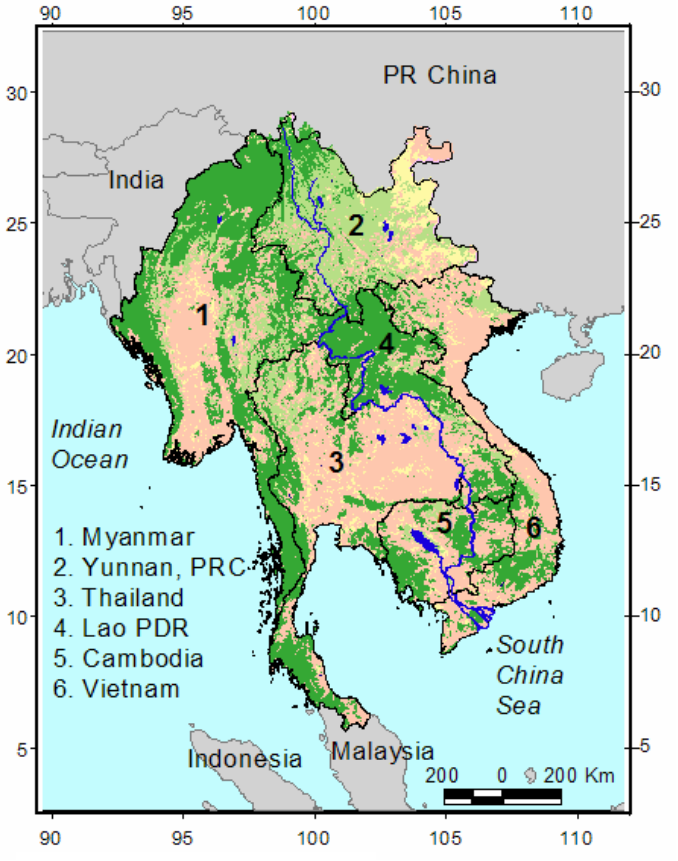

Figure 1. GMS countries.

3. Environmental data generation initiatives in GMS

Environmental data are any measurements or information that describe environmental processes, location, or conditions. Such data are typically found in use for State of Environmental Reporting (SoER). Environmental data can include wide range information on all the components of environment implying a huge amount of work. Specific data needs for SoER are identified in detail by UNEP EAP-AP (1995).

Given that every country has commitment to generate environmental data for informed-decision making and environmental management, this impetus resulted into collaboration between GMS countries with the help of international and regional organizations present in the region. There may be numerous studies and other initiatives conducted in GMS that aimed in developing environmental information and help better environmental management. Some of the major technical assistance projects that are launched at the subregional level involving all six GMS national governments were initiated by the Asian Development Bank (ADB) in cooperation with the United Nations Environment Programme (UNEP), Stockholm Environment Institute, the Global Environment Fund since 1995. Four of these major projects are:

1. Subregional Environmental Monitoring and Information Systems Phase I (SEMIS - I)
2. Strategic Environmental Framework Phase I (SEF-I)
3. Subregional Environmental Monitoring and Information Systems Phase II (SEMIS-II)
4. National Environmental Performance Assessment and Strategic Environmental Framework (SEF-II)

SEMIS-I provided mechanisms for sharing of information on environmental and natural resources issues. The major achievement was: a defined core dataset - the basic, frequently required data necessary for the range of environmental decisions which will arise in subsequent years based on series of consultation with stakeholders in each country (Table 1). In addition to core dataset, there are other groups of data identified, e.g. non-core Datasets: and auxiliary datasets also called "metadata or "codata". Other achievements included - development of a conceptual spatial database design which is flexible and expandable; and develop technical and human capacity.

Table 1. Core datasets of SEMIS I.

Core Dataset	Geo-referenced Object/Spatial Data
1. Infrastructure	• Major Roads; Railways; Canals; Pipelines; and Major Electric Transmission Lines
2. Soil Class (includes slope and terrain)	• Soil Map
3. Vegetation cover	• Forest Cover Map; Grassland/Wetland Map
4. Air Quality Measurements	• Location of Measurement Locations
5. Demography	• (Linked to administrative Boundary)
6. Climate zonation	• Climate (Agro-climatic Map)
7. Administrative Boundaries	• Administrative/Census Map; Management; Protected Areas
8. Topography	• Elevation Contours; Coastlines and lakes; Rivers
9. Land Use	• Land Use map
10. Geology	• Geology Map
11. Major Harvesting Activities	• (Linked to Administrative Boundaries)
12. Water Quality Measurements	• Location of Water Measurement Stations
13. Soil Analysis Samples	• Locations of Soil Samples

Source: UNEP RRC-AP (2003)

SEF-I took on from the achievements of SEMIS-I and was able to produce: i) Decision making tools – a set of database, general purpose software methodologies to help; decision making about infrastructure investment in the region, ii) Analytical methodologies – identification of hotspots, case studies, development scenarios, iii) Strategic interventions – an essential framework for guiding key action and interventions in the region.

Building upon the achievements of SEMIS-I and SEF-I, SEMIS-II, a follow-on project had an overall goal of helping GMS governments to make informed decisions regarding sustainable development through Integrated Economic and Environmental Development Planning (IEEDP). The major achievements included

- Review - i) the availability, accessibility and gaps of geospatial data, ii) data collection status, processing capabilities, and capacity building needs
- Produce guidelines and manual on - geospatial data collection and management for each participating country, ii) manual on Integrated Economic and Environmental Development Planning (IEEDP)
- Capacity building – i) human resource development with training on data collection methodologies, harmonization/standardization, GIS/RS application,

IEEDP methodologies, ii) hardware/software support, iii) and conducting case studies by the trained personnel

- Preparation of GMS atlas of the environment by updating the spatial and other database

SEF-II, recently completed is the last among four technical assistance projects, which was able to develop environmental indicators in the major thematic areas, and framework for conducting national environmental performance assessment (EPA). Although it was also set out to prepare regional EPA and Environmental Sustainability Index but no satisfying success was achieved due to range of complexity related to data and others (Anonymous, 2006).

4. Status of data generation and sharing

4.1 Data availability

In GMS countries, both spatial and non-spatial environmental data have been routinely generated by concerned sectoral agencies since long. These initiatives, e.g. SEMIS-I, simply attempted to organize them systematically and develop the capacity to do so wherever needed by providing guidelines and resources for capacity building. Later, follow-on projects attempted in putting the concerted efforts in equipping the GMS countries in developing the environmental data for national and subregional uses.

Early works, e.g. SEMIS-I, have recommended suitable database design and scale (1:50-250K) for the GMS. The assessment of status of data availability in each GMS country indicated that not all the countries have same level of achievements in terms of data generation and data management, yet the achievement is encouraging. The available data is for different thematic layers, different scales and in various format. Besides the data is used in the country at the national/sub-national level decision-making, the other purpose of the need of data generation is subregional level integration to support decision-making. Table 2 summarizes the available spatial data in different GMS countries.

Table 2. Scale of spatial data in GMS countries.

Country	Available thematic layers	Scale
Lao PDR	infrastructure, land use, topography, forest cover; watershed classification, soil types, and geology	1:50K-1:1M
Cambodia	protected areas; biodiversity; air and water quality monitoring stations; transportation; industrial; geology; soils; forest cover; land use; topographic maps; fishing lots; administrative boundary	1:50K-1:1M
Myanmar	geology; soil; infrastructure; urban centers; industrial zones; land use; topography; cadastral; township	1:18K-1:2M
Thailand	Almost all identified as core data set for GMS	1:4K-1:1M
Vietnam	infrastructure; transportation; soils; topography; administrative boundary; cadastral; land use; hydro-meteorology; air and water quality monitoring stations; industry; mineral; geology; production data on agriculture and forest, labor, health, and general statistics	1:50K-1:1M
Yunnan, China	infrastructure, soil, forest, land use, topography, geology population, and administrative boundaries	1:50K-1:0.5M

Source: UNEP RRC-AP (2002)

In *Cambodia*, the available environmental data are: protected areas; biodiversity; air and water quality monitoring stations; transportation; industrial; geology; soils; forest cover; land use; topographic maps; fishing lots; administrative boundary. The scale range from 1:50,000 to 1:1 million scale and some of them are available in digital format.

In *Lao PDR*, the basic thematic layers available are: topography, forest cover; watershed classification, soil types, and geology ranging from 1:50,000 to 1:1 million scale. Some other derived layers are irrigated land, land suitability, and irrigation project's flood extent. Basic and agricultural production statistics are also available. Some of the data, such as forest cover,

watershed classification, are available in digital format while rest of the data are in paper format. Catalogue of Environment Related Databases is available for Lao PDR, which shows that more than 20 Government departments and Lao PDR-based international organizations hold the data. National Geography Department is the authority to issue technical instructions and guidelines related to surveying, aerial photography and mapping activities in Lao PDR.

In *Myanmar*, different government departments have been involved in routine data generation. The collection of environmental data and information at the national level started after 1990 with the establishment of National Commission for Environmental Affairs (NCEA). Not all core data are available in Myanmar. Some of the core dataset available in Myanmar are: geology; soil; infrastructure; urban centers; industrial zones; land use; topography; cadastral; township boundary. Some layers are even available in digital format, such as geology soil, urban centers, and industrial zone. The available data range from 1:18,000 to 2 million scales.

In *Thailand,* almost all core dataset including thematic layers, as identified by SEMIS-I, are available. Most of the datasets range from 1:50,000 to 1:250,000 scale and in digital format. Road thematic layer is available at the scale of 1:4,000. Besides core dataset, there are plenty of additional and derived products, such as watershed basin and classification, agricultural economic zone, land suitability, drought area, and irrigation area.

In *Vietnam*, data layers on infrastructure; transportation; soils; topography; administrative boundary; cadastral; land use; hydro-meteorology; air and water quality monitoring stations; industry; mineral; geology; production data on agriculture and forest, labor, health, and general statistics are available. The scale of map layers range from 1:50,000 to 1:1 million and are stored in both hardcopy and digital formats. Some of the data on geology, underground water, air and water quality stations are not yet widely publicized. As in other GMS countries, there are many institutions, in most cases with a functional unit that are involved in environmental data collection.

In *Yunnan* province of PR China, data layers on infrastructure, soil, forest, land use, topography, geology population, and administrative boundaries are held by respective departments. The scales range from 1:50,000 to 1:500,000. Some of these layers, such as infrastructure, topographic map and administrative boundary exist in digital format. The other data available in paper format are production statistics on agriculture, forestry; water and air quality monitoring stations and the parameters being monitored.

A typical example of available data at the country level is presented in Table 3.

4.2 Data gaps

Assessment process also revealed that there are considerable data gaps in the following areas at the subregional level: i) Infrastructure (electric transmission lines, pipelines, dams, ports, and airports), ii) Air quality measurements, iii) Demography, iv) Water quality measurements, and v) Major harvesting activities.

Although guidelines on database design and data collection are available, the generated data still have enormous inconsistencies for use. Lot of efforts has been put in developing the human capacity who can contribute in data standardization and harmonization, yet it is not easy to integrate the generated data at the subregional level.

Table 3. Available data and their sources in Lao PDR.

S. N.	Theme/Type	Holding Organization	Scale	Format
1	Infrastructure *(specified as base map)*	National Geography Department	Various scales from 1:50K to 1:1,000K	Map/Digital
2	Soil	NAFRI	Various scales	Digital
3	Forest	Department of Forestry	Various scales	Digital
4	Land Use	National Agriculture and Forest Research Institute	Various scales	Digital

5	Topographic Map *(Base map)*	National Geography Department	Various scales from 1:50K to 1:1,000K 1:500K	Map and Digital Digital
6	Geology	Department of Mine	1:1,000K	Digital
7	Populatio n (Demography)	National Statistic Center		Paper (Report)
8	Administrative Boundary*)*			Digital
	Administrative Units	National Geography Department	Various scales	
	Protected Areas	Department of Forestry		Map
9	Production Statistics.	Statistic Data Division		Paper (Report)
	Agriculture	Department of Planning		
	Forestry	Department of Forestry/NAFRI		
	Mining	Department of Industry		Report
10	Water Quality	State of Environmental Report		Paper (Report)
11	Air Quality	State of Environmental Report		Paper (Report)
12	Watershed Classification	NAFRI		Map

Source: UNEP RRC-AP (2002)

The vast amount of data collected at the national/ subnational level is useful only when they are shared for making better decisions. Data sharing would also help reduce the redundant efforts of different sectors. But the existing inconsistencies including other reasons are big hurdle to realize an efficient data sharing in the country. It was found that no efficient data sharing is occurring within the country and between the countries. Some general observations that limit data sharing in the GMS are

- Lack of data and information – less data available that can be shared in the lack of appropriate standardization and harmonization,
- Information is 'power' tendency – no cultu re of data sharing is developed; sharing often considered as the free distribution, and
- Lack of policy and guidelines – in case data is available for sharing, no sharing is occurring as it is not clear that what can be shared, who can authorize to share, and how should be shared in the lack of policy and guidelines.

Some suggested improvements needed to fill the data gaps for an efficient data sharing are

- Separate topography and hydrography into separate layers or themes
- Consider feature classification schemes and tailor to meet requirements and existing data sources
- Consider applying a framework approach to the database activities;
- Possible additional core data layers include: i) Remotely sensed imagery, ii) Raster topographic maps, iii) Slope and aspect , and iv) Detailed hydrologic information
- Assign responsibility to various agencies for generating specific data layers;
- Generate metadata files for all data catalogue listings and use an easily populated metadata standard
- Decide on a suitable yet common data interchange format
- Devise and use a data validation and accuracy assessment plan
- Address the issues of multiple datums, projections, and coordinate systems
- Formulate data distribution policy and advertise for raising awareness of end users about such policy
- Strengthen procedures for maintenance of the database and the data catalogue

4.3 Access to information

Generally speaking, all the GMS countries have minimum necessary suite of laws and regulations for environmental management, however majority of them have their initial laws/regulation promulgated after Rio Declarations except Thailand and Yunnan of China. Yet, this is not a short period in terms of the existence of such instruments in the region. On the other hand, there is varying level of information access and public accountability in terms of consultation with civil society in decision-making process. There has been some progress in terms of data generation and sharing in GMS countries but there still exist the situation of incomplete datasets needed for environmental management with considerable data gaps and inadequate data sharing among the data users (Table 4).

Table 4. Environmental laws/regulations and information access.

Country	Initial environmental law/regulation	Access to information and public accountability
Cambodia	• Environmental act, 1993	• Widening consultation with civil society for natural resources management • Limited access to environmental information
Lao PDR	• National environmental action plan, 1994	• Environmental information seriously incomplete • Some sharing occurring but no updates and quality improvement
Myanmar	• National environment policy, 1994	• No laws restricting environmental information but needs prior approval • Information through mass media
Thailand	• Enhancement and conservation of national environment quality act (ECNEQA), 1975 repealed by ECNEQA, 1992	• Relatively greater openness in information sharing due to Official information act, 1997 on public access to information • Some incomplete information and gap still exits
Vietnam	• Law on environmental protection, 1994	• Incomplete data and gap still exists
Yunnan, China	• Environment protection law, 1979	• Strong technical capacity • Gaps still exist in terms of incomplete data, inconsistency • No easy exchange of information

Note: compiled from MoE (2006), STEA (2006), NCEA (2006), DEQP (2006), MoNRE (2006), YEPB (2006)

5. Use of geo-information for environmental management

With the rapid advancement in geocomputing technologies and increasing use of geoinformation in decision-making globally, GMS countries have also attempted to keep this pace. This has led to some encouraging progress and number of studies related to natural resources and environmental management have made use of geoinformation and geomatics. However, there has probably not been any significant use of such information at either the subregional level planning and management or the national level.

There have been attempts in using the data available at the national level for the subregional purpose. Two significant attempts include

5.1 GMS atlas of the environment

Development of GMS atlas of the environment was probably the first example of subregional level geoinformation put together with the help of six GMS countries. A tremendous work went into it by all the GMS Governments. The atlas is basically a compilation of environmental information provided and endorsed by each country which

was integrated at the subregional level. GMS atlas of environment presents geographic, economic and social profiles, states of natural resources and the environment, interaction between people and natural resources with rich collection of statistical information on a wide range of environmental aspects of the subregion (ADB/UNEP, 2004).

5.2 Indicators development and environmental performance assessment

The goal of SEF-II was to promote sustainable development through the creation of national performance assessment system (EPA) for the GMS countries and sub-regional EPA system for the GMS sub-region and to develop national and sub-national capacities for implementing EPA. Of the specific objectives, this project focused in developing environmental indicators for conducting environmental performance assessment both at the national and subregional level using the available environmental data and information. The purpose was to make use of available data at the national level for indicators development. Different countries of the GMS focused on different thematic areas of environment in developing the indicators depending upon their national priority environmental issues and considering the data availability.

Based on the experiences of carrying out the national environmental performance assessment, number of data gaps are identified while generating environmental indicators in each thematic areas in each country, which is summarized in Table 5. In general, the outcome has been satisfactory in terms of pioneering work of developing indicators in the subregion, perhaps in Asia. Nevertheless, several indicators do not exactly represent specific themes and thus holds little importance so far their policy importance is considered. For example, forest depletion rate is selected as the land degradation indicator, which does not give clear indication on the land degradation. This is basically due to the unavailability of relevant data for producing specific indicator. Similarly, some of the data of global and regional importance, e.g. GHZs, are not routinely collected in the developing countries including GMS countries, and the need of collecting such information is spelled out among others.

Table 5. Data gaps for developing environmental indicators in specific thematic areas.

Country	Areas				
	Forestry	Biodiversity	Water	Agriculture/ Land degradation	Air/Climate change
Cambodia	• Need of quality attributes, e.g. quality of forest	• Habitat composition data better than other countries but need of temporal data	• Reassessment of methodology to produce better dataset • Data on water quality	• Time series data on fisheries output • Need of data for secondary indicators, e.g. soil erosion, pollution	• Data need for accurate estimation of GHGs
Lao PDR	• Need to standardize forest data so that can be compared with other GMS countries	• Some data exists but not organized and also inadequate	• Water resources data need to be verified • Data on urban water supply, hydrological functions of watershed, etc. needed	• Verification of fish catch and price data • Need of sedimentation data	• Data for accurate estimation of GHGs
Myanmar	• Need of better information, e.g. fuel wood production and use	• National inventory of flora and fauna should be continued • GIS-based ecosystem assessment	• Irrigation systems efficiency	• Scattered information between MoF & MoAg • No information on land suitability, capability, soil erosion	• Key air quality parameters (TSP) should be resumed • Need of GHG emission inventory and Need of systematic organization available information
Thailand	• reconfirm reported forest area to international body using RS data • Compatible information on forest cover and quality			• Scattered information between MoF & MoAg • No info on land suitability, capability, soil erosion	
Vietnam	• Need of data on forest type and their quality • In-house data on wood extraction needed instead of global dataset	• Need of temporal data for monitoring (marine protected areas)	• Need of data on water quality parameters		• Update of pollution concentration data • Reassessment of GHGs
Yunnan, PRC	• Fuel wood consumption	• Info on principal ecosystems	• Status of water quality and wastewater volume	• Need of soil erosion risk maps	• GHGs estimation

Note: compiled from MoE (2006), STEA (2006), NCEA (2006), DEQP (2006), MoNRE (2006), YEPB (2006)

6. Concluding remarks

Planning requires access to information on all relevant variables. Environmental data play very important role in environmental planning/conservation as well as development planning. There have been numerous initiatives in the GMS countries to improve the data availability situation and their use in decision making for long time including some of the regional level technical projects started decade ago. While some achievements have been made at the national level in terms of data availability and capacity development, the real purpose of using such information for decision-making is not satisfactory to the level expected. It is because of unavailability of appropriate and quality information, which calls for an improvement in these areas. Access to information

also remains restricted for many GMS stakeholders because it is either non-existent or incoherent; based on different protocols; there is apprehension about information sharing; probable skewed (SEI, 2002b). Nevertheless, use of geoinformation at the subregional level is satisfactory; nevertheless, there is enough room for furthering the efforts.

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