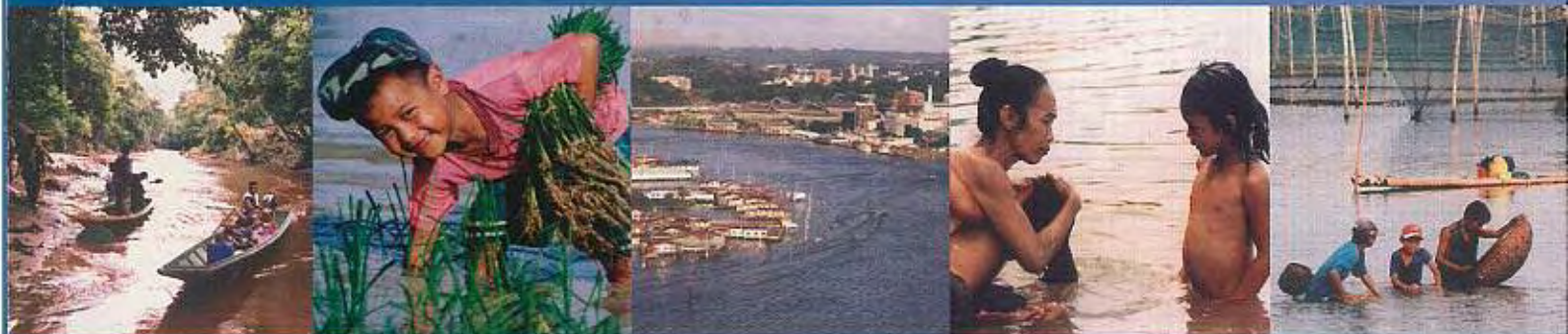




ASSOCIATION OF SOUTHEAST ASIAN NATIONS

# STATE OF WATER RESOURCES MANAGEMENT IN ASEAN

October 2005



Australian Government

AusAID

ASEAN Australia Development Cooperation Programme -  
Regional Partnership Scheme



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## 1 Summary

This report presents the following data and analyses:

- An analysis of the statistics and information on water quantity and quality in terms of their significance for future water resources policy development, strategic planning and management.
- An analysis of the potential impact of extreme events on water resources and the environment.
- An overview of key governance and capacity building issues of concern to water resources management.
- A compendium of hydrological statistics for ASEAN Member Countries.

Whilst the statistics collected are extremely useful in terms of giving an overview of water supply and demand in most countries, their utility has to be qualified because they are annual figures and do not reflect seasonal variation and because there are significant gaps in some figures and estimates for several countries. These gaps are apparently real, that is, data or estimates do not exist. The overriding conclusion from the analysis is that most ASEAN Member Countries need to increase effort in the collection of hydrological data and its storage in modern data-base systems. Without access to high quality temporal data, policy development and integrated water resources management will be significantly hindered. Other key findings are:

- Whilst most ASEAN Member Countries do not have a physical scarcity of water, seasonal scarcity does occur. This needs to be examined in more detail and the results be used as a basis for the planning of water supply strategies for the future.
- Overall demand for water is expected to increase by about one-third over the next 20 years.
- Three countries have not given projections of water demand for 2025. This is of concern because good water resource management is dependent upon the development of future use estimates or scenarios.
- As a response to seasonal water scarcity and growing urban centres, demand for groundwater will increase. Management plans need to be developed to ensure the sustainable exploitation of this critical resource and to maintain its quality.
- Given good overall water availability, most ASEAN Member Countries are in a strong position to plan how water will be managed for environmental purposes including the maintenance of key inland fisheries.
- Fragmentation of the management of water between several agencies within countries needs to be examined to determine if improved institutional arrangements can be developed. It is particularly important that surface water and groundwater are managed by the same agency given their usual physical interconnectivity.
- Protection of the quality of water supplies is and will be a significant activity for all ASEAN Member Countries over the 20 years.
- The fragmentation referred to above also impacts negatively on the need to harmonise monitoring programmes for water quantity and quality.
- In many ASEAN Member Countries it is considered that the impacts of extreme events and climate change and variability will be of as much concern to governments as many of the above issues. Subsistence farmers and the poor are generally more severely impacted by such factors and consequently they may increase poverty levels and risk of starvation unless adequately planned for.
- Several ASEAN Member Countries are unlikely to meet the Millennium Goals relating to drinking water and sanitation based on the figures presented here.
- With respect to governance of water resources, whilst many countries are aware of the need for change to improve water resources management, there needs to be continued support at all levels to ensure that this happens.
- Capacity building at a range of levels is also a general need in most countries.
- Finance requirements and availability to facilitate the sustainable development of water resources will be a significant issue requiring further examination for many ASEAN Member Countries

To date, much has been accomplished by ASEAN Member Countries with respect to a range of water management and governance issues. There is, however, still a lot to be done particularly with respect to data gathering, institutional reform and capacity building in order to meet forthcoming challenges.

## 2 Introduction

The key objective of the report is to inform ASEAN on the current state of knowledge regarding water resources data and information, data gaps and needs, and major issues that are arising in terms of water resources management in Member Countries and across ASEAN.

The response to the above information and this report in terms of actions required is given in the Strategic Plan of Action on Water Resources Management 2005-2010.

This status of water resources report has been developed based around two fundamental inputs:

1. A questionnaire circulated to the core water agency in each ASEAN Member Country
2. Additional research conducted by members of the project consultancy team

### 2.1 The Questionnaire

The questionnaire was designed around the following topics:

- Major issues and principles governing water resources management in each Member Country
- Water supply and demand
- Water quality and sanitation
- Allocation
- Extreme events
- Societal issues and capacity building
- Governance
- Priorities for Action.

It was distributed in April, 2004 and most Member Countries returned completed questionnaires by early July 2004. The data was then collated and analysed and is presented here. The questionnaire is included with this report as Appendix 4.

### 2.2 Additional Research

Where insufficient data or information was provided by Member Countries, the project team endeavoured to obtain further information. An indication is given in this report where data was obtained from sources other than the questionnaire.

## 3 Water Supply and Demand

### 3.1 Overview of Major Issues

Regional statistics are shown in Tables 1-4. Key national issues are indicated in Appendix 1. With the exception of the island state of Singapore, where demands represent 73% of available internal surface water, questionnaire responses show other countries to be relatively water abundant in relation to demands. For countries with no access to the international watercourse of the Mekong River, demands range from 2% (Malaysia) to 13% (Philippines) of available internal water resources (Table 3). For countries with riparian access to the Mekong River, demands range from 1% (Cambodia) to 31% (Thailand) of available internal, sovereign water resources. The implications of the projected increase in demand by 2025 are considered in Section 3.6.

For the five Mekong River riparian countries of ASEAN (Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam), the water availability situation is quite complex. Four of these countries (Cambodia, Lao PDR, Thailand and Viet Nam) are signatories to the 1995 *Agreement on Cooperation for the Sustainable Development of the Mekong River Basin*. Although the Agreement provides for the members to agree on such things as the minimum acceptable monthly natural flows along the mainstream, it contains no specific provision for volumetric water sharing. Instead, it relies on the principle of international water law known as "reasonable and equitable utilisation" and specifies a range of agreed cooperative actions such as data exchange, and notification and prior consultation concerning various water uses. The net result

of all this dynamic approach to Mekong water sharing is that it is not possible to state with certainty the annual volumes of water available to these countries.

The special case of Viet Nam is worthy of mention. Whilst it is true that 22% of sovereign or internal resources are currently used, Viet Nam in addition to having part of its territory in the middle reaches of the Mekong Basin (and from whence Viet Nam contributes some 11% of the total Mekong flows) is also the most downstream nation and occupies the majority of the Mekong (Cuu Long) Delta where the Mekong system enters the South China Sea. This means that subject to environmental flow requirements, including control of salinity intrusion, Viet Nam in effect has access to all of the flows leaving the southern borders of Cambodia. When these flows are taken into account, current water demands in Viet Nam fall to well below the 22% of internal supplies mentioned above.

Whilst Myanmar (and also the non-ASEAN nation of China) is not a signatory to the Mekong Agreement, international water law still applies, including the principle of reasonable and equitable utilisation, and thus Myanmar also has access to an undefined portion of the flow of the Mekong River, in addition to its own internal water resources.

Furthermore, such nationally-aggregated annual data on supply and demand, whilst broadly interesting, are also highly deceptive and mask critical seasonal and location-specific variations. With all ASEAN Member Countries experiencing wet and dry seasons typical of the region, localised water stress in the dry season is widespread. Much of the stress can be attributed to agricultural extractions (irrigation) which commonly represent 70 to 90% of total demand. However, many urban areas including major cities in the region are also subject to increasing water stress in varying degrees – sometimes severe.

Water supply difficulties of the tropical wet/dry season cycle are exacerbated in many ASEAN Member Countries by the short, steep nature of many rivers which results in characteristic short, sharp hydrographs. Dry season water supply difficulties in such situations are typically accompanied by wet season flooding problems. Consequences of watershed de-forestation, including resultant bed-load changes and siltation which alters river channel capacities and degrades water quality, all add to the problems of surface water supply.

Groundwater resource availability is typically in the range 10-20% of the magnitude of internal surface water resources. Unfortunately, in a globally familiar way, when cities cannot access sufficient surface water, or when reticulation coverage is limited and reliability is poor, consumers turn to groundwater (legally or illegally) and overdrafts are common around major ASEAN cities. Groundwater resource management is sometimes not as well developed as surface water management and progress is sometimes hindered by the fact that it may be managed by a mining agency rather than a water resource agency. This tends to hide the reality that water, whether in rivers or in aquifers, is all part of a unitary water cycle and a "one resource" policy is not usual in ASEAN Member Countries in such circumstances. Achieving reduction of groundwater extractions to match sustainable yield levels remains a common challenge.

The "one resource" issue points to a need for caution in the use of groundwater and surface water data. River flows always contain some proportion of groundwater which flows beneath the surface from the surrounding watershed and eventually enters the river channel. Indeed, at times when it is not raining and there is no above-ground runoff, the entire flow of a river can be sourced from groundwater. Care must be taken therefore to avoid double-counting and to adequately assess the "overlap" of groundwater and surface water.

Population growth rates (Table 5) in some ASEAN Member Countries are relatively high, urbanisation and industrialisation are accelerating and it is common for national food security policies to have an emphasis on irrigated food production. These factors all contribute to a situation of increasing demand on finite and already stressed water resources. In addition, the realisation of the benefits of maintaining ecological health of aquatic systems is leading to demands for environmental flows – sometimes merely as dilution flows for water quality purposes, but increasingly for ecosystem maintenance of both riverine

and estuarine systems. Without an integrated approach to management of water supply and demand, including the difficult issue of allocation planning associated with national socio-economic goals, physical water stress is increasingly being accompanied by societal conflicts. Furthermore, even if water is available for increasing irrigation, it is also important that land suitable for irrigation is available (Table 6 and Table 7). This may encroach on rainfed agriculture and other land uses and so trade-offs to assess net benefits from increasing irrigation are also required. As part of the planning process for integrated water resources management a key need is for countries to estimate areas of potentially irrigable land.

Water demand growth estimates to 2025 were not reported by all countries, but it appears that most ASEAN Member Countries are estimating around a one-third increase in demand over this period. This creates significant, although not insurmountable, challenges.

Table 1: Water availability and demand for ASEAN Member Countries from questionnaire returns (2004 data unless otherwise indicated)

Water availability and demand (mcm/year)	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Available Internal Surface Water	3,425	*116,000	1,847,246	270,000	566,000	873,000	125,790	See total	213,423	275,000
Available Internal Groundwater	0.06	*17,600	5,330	*38,000	64,000	28,000	20,200	See total	2,700	60,000
<b>TOTAL AVAILABLE INTERNAL WATER RESOURCES**</b> (Ignoring overlap of common resources)	3,425	*133,600	1,852,576	308,000	630,000	901,000	145,990	600	216,123	335,000
<b>CURRENT DEMANDS</b>										
Industry	35	30	2,759	570	1,909	80	2,233	197	1,311	3,074
Mining	0	No data	0	0	0	0	No data	0	0	0
Ag/Irrigation	No data	455	78,272	4,674	7,300	28,000	25,533	0	48,172	62,200
Domestic	48	136	5,125	456	2,413	153	2,189	250	3,188	1,042
Environment	No data	146	4,500	0	No data	10	No data	0	15,326	7,283
<b>TOTAL CURRENT DEMAND</b>	83	767	90,656	5,700	1,622	28,243	29,955	447	67,997	73,599
<b>DEMANDS estimated for 2025</b>										
Industry	51	100	5,040	No data	3,946	184	4,998	See total	No data	6,168
Mining	0	146	0	0	0	0	0	0	0	No data
Ag/Irrigation	No data	1,000	94,370	No data	6,324	No data	72,793	No data	No data	80,084
Domestic	100	350	9,360	No data	4,234	495	7,430	See total	No data	3,098
Environment	No data	146	14,670	No data	No data	106	No data	No data	No data	***10,907
<b>TOTAL DEMAND ESTIMATED FOR 2025</b>	151	1,742	123,440	No data	14,504	No data	138,571	664	No data	100,257

NOTES

\* Data marked with an asterisk have come from sources other than questionnaires – principally Food and Agriculture Organisation (FAO) Aquastat ([www.fao.org/waicent/qaicinfo/agricult/agl/aglwa/aquastat/main/index.stm](http://www.fao.org/waicent/qaicinfo/agricult/agl/aglwa/aquastat/main/index.stm))

\*\* Countries riparian to the Mekong River (Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam) also have access to undefined shares of this international watercourse.

\*\*\* Viet Nam estimates for 2020

Data was provided by countries in 2004, and is assumed to be from the most recent measurements except for the Philippines who provided data for 1995. Where countries indicated nil usage this is reported as '0'. If no data is provided, this is reported as no data. However, it is suspected in some cases that water use in these categories is actually not recorded rather than actually being nil usage.

Table 2: Comparison between FAO Aquastat, World Bank, World Resources Institute and Country Questionnaire Data on water resources

Data Source	FAO AQUASTAT (2003)										World Bank Little Green Book (2003)		World Resources Institute (1977-2001)			Country Questionnaires (2004 unless otherwise indicated)			
	Internal Renewable (Average Annual)					Shared External Resources (Mekong River)		Natural Renewable Water Resources (Internal plus external)			Natural Renewable Water Resources		Total Internal Water Resources		Total including flows from other countries		Total annual available groundwater		
	Surface Water (mcm)	Ground-water (mcm)	Overlap (common resources) (mcm)	Total (mcm)	Total (mcm)	Total (mcm)	Per capita (m <sup>3</sup> per person)	Total (mcm)	Per capita (m <sup>3</sup> per person)	Total (mcm)	Per capita (m <sup>3</sup> per person)	Total (mcm)	Per capita (m <sup>3</sup> per person)	Total (mcm)	Per capita (m <sup>3</sup> per person)	Total (mcm)	Per capita (m <sup>3</sup> per person)	Total (mcm)	Per capita (m <sup>3</sup> per person)
Brunei	9,000	100	100	8,500	na	na	9,000	25,915	25,148	9,000	24,922	9,000	24,922	9,000	24,922	9,000	24,922	3,425	0.06
Cambodia	116,000	18,000	13,000	121,000	355,000	355,000	476,000	34,561	39,613	121,000	8,752	476,000	8,752	476,000	476,000	116,000	116,000	17,600	17,600
Indonesia	2,793,000	455,000	410,000	2,838,000	na	na	2,838,000	13,046	13,759	2,838,000	13,046	2,838,000	13,046	2,838,000	2,838,000	1,847,246	1,847,246	5,330	5,330
Lao PDR	190,000	38,000	38,000	190,000	143,000	143,000	334,000	60,318	63,175	190,000	34,435	334,000	34,435	334,000	334,000	270,000	270,000	38,000	38,000
Malaysia	566,000	64,000	50,000	580,000	na	na	580,000	25,178	24,925	580,000	25,178	580,000	25,178	580,000	580,000	566,000	566,000	64,000	64,000
Myanmar	875,000	156,000	150,000	881,000	165,000	165,000	1,046,000	21,358	21,898	1,046,000	17,988	881,000	17,988	1,046,000	1,046,000	873,000	873,000	28,000	28,000
Philippines	444,000	180,000	145,000	479,000	na	na	479,000	6,083	6,251	479,000	6,093	479,000	6,093	479,000	479,000	125,790	125,790	20,200	20,200
Singapore	See total	na	na	600	na	na	600	149	nd	600	nd	600	nd	600	600	600	600	na	na
Thailand	199,000	42,000	31,000	210,000	200,000	200,000	410,000	6,371	6,750	410,000	3,264	410,000	3,264	410,000	410,000	213,423	213,423	2,700	2,700
Viet Nam	354,000	48,000	35,000	367,000	525,000	525,000	589,000	11,109	11,350	589,000	4,568	589,000	4,568	589,000	589,000	275,000	275,000	60,000	60,000

These external resources are shared. The country does not have the right to access all of this volume. Nor are the quantities cumulative. na= not applicable, nd= no data available.

<sup>2</sup>Viet Nam considers this an overestimate and that the true figure is 835 km<sup>3</sup>/yr

<sup>3</sup>The Philippines data (1995) for the Country Questionnaires is based on a 50% probability of availability for surface water and annual sustainable yield for groundwater

Table 3: Water used and predicted use in 2025 (Questionnaire data) as a percentage of TOTAL available INTERNAL water resources (includes water allocated to the environment)

COUNTRY	Total Water Use			Total Available Internal Water Resources			% Used		PREDICTED Water Use		Total Available Internal Water Resources		Predicted % use	
	2004			2004			2004		2025		2025		2025	
	mcm/yr	FAO	This Study	mcm	mcm	%	%	mcm	%	mcm	%	mcm	%	%
Brunei Darussalam	nd	nd	nd	3,425	3,425	2	2	151	4	3,425	4	3,425	4	4
Cambodia	455	4,000	73	133,600	133,600	1	1	1,742	1	133,600	1	133,600	1	1
Indonesia	78,272	75,600	91	90,656	1,852,576	5	5	123,440	7	1,852,576	7	1,852,576	7	7
Lao PDR	4,674	2,700	82	5,700	308,000	2	2	nd	-	308,000	-	308,000	-	-
Malaysia	7,300	5,600	63	11,622	630,000	2	2	14,504	2	630,000	2	630,000	2	2
Myanmar	28,000	32,640	99	28,243	901,000	3	3	nd	-	901,000	-	901,000	-	-
Philippines	25,533	21,100	85	29,955	226,430	13	13	84,557	37	226,430	37	226,430	37	37
Singapore	0	nd	0	447	600	74	74	664	110	600	110	600	110	110
Thailand	48,172	82,750	92	67,997	216,123	31	31	nd	-	216,123	-	216,123	-	-
Viet Nam	62,200	48,620	94	73,599	335,000	22	22	100,257	30	335,000	30	335,000	30	30

Table 4: Water use as determined from Questionnaires (2004) and FAO AQUASTAT (2000)

COUNTRY	Agriculture			Industry			Domestic			
	mcm/yr			mcm/yr			mcm/yr			
	This Study	FAO	%	This Study	FAO	%	This Study	FAO	%	
Brunei Darussalam	nd	nd	nd	nd	nd	nd	48	nd	58	nd
Cambodia	455	4,000	73	35	20	5	136	60	22	2
Indonesia	78,272	75,600	91	2,759	560	3	5,125	6,620	6	8
Lao PDR	4,674	2,700	82	570	170	10	456	130	8	4
Malaysia	7,300	5,600	63	1,909	1,900	17	2,413	1,520	21	17
Myanmar	28,000	32,640	99	80	180	<1	153	410	<1	1
Philippines	25,533	21,100	85	2,233	2,690	8	2,189	4,730	7	17
Singapore	0	nd	0	197	nd	44	250	nd	56	nd
Thailand	48,172	82,750	92	1,311	2,140	2	3,188	2,140	6	2
Viet Nam	62,200	48,620	94	3,074	17,230	5	1,042	5,540	1	8

nd = No data; % calculated as a percentage of total use excluding environmental water  
% for Brunei Darussalam calculated assuming agricultural water use is zero



**Table 5:** Estimated Population figures and growth rates for ASEAN Member Countries in 2004

Country	Population (million)	Growth Rate (% per year)
Brunei Darussalam	0.374	2.8
Cambodia	14.131	2.4
Indonesia	215.265	1.2
Lao PDR	5.758	2.5
Malaysia	25.671	2.5
Myanmar	54.745	2.3
Philippines	82.664	2.0
Singapore	4.198	0.3
Thailand	64.470	0.8
Viet Nam	82.222	1.3

Source: ASEAN Statistical Yearbook <http://www.aseansec.org/syb2004.htm>

**Table 6:** Land use statistics for ASEAN Member Countries

Country	Area of Country	Arable and Permanent Crops	Arable Area	Permanent Crops
	(ha)	(ha)	(ha)	(ha)
Cambodia	18,104,000	3,807,000	3,700,000	107,000
Indonesia	190,457,000	33,546,000	20,500,000	13,046,000
Lao PDR	23,680,000	958,000	877,000	81,000
Malaysia	32,975,000	7,605,000	1,820,000	5,785,000
Myanmar	67,658,000	10,495,000	9,900,000	595,000
Philippines	30,000,000	10,050,000	5,550,000	4,500,000
Singapore	62,000	1,000	1,000	0
Thailand	51,312,000	18,000,000	14,700,000	3,300,000
Viet Nam	33,169,000	7,350,000	5,750,000	1,600,000

Source: From FAO Aquastat database (2000)

**Table 7:** Land availability per capita in ASEAN (derived from Table 5 and Table 6)

Country	Land (million ha)	Land Availability (ha/capita)
Brunei Darussalam	0.6	1.6
Cambodia	18.1	1.3
Indonesia	191.9	0.8
Lao PDR	23.7	4.1
Malaysia	33.0	1.3
Myanmar	67.7	1.2
The Philippines	30.0	0.4
Singapore	0.07	0.02
Thailand	51.4	0.8
Viet Nam	32.9	0.4

### 3.2 Responses to the Supply-Demand Imbalance Challenges for ASEAN

Individual country responses to inadequate supplies to meet local demands range from a traditional "engineering" response (let's build more dams and reservoirs) which merely spreads the problems over a wider geographical area, to highly sophisticated demand management techniques and recycling technology. Best practice responses consist of a well-thought out mix of all available methodologies – physical, technical and economic (incentives and market-based methodologies). ASEAN contains some world's best practice in supply-demand management and this represents an excellent opportunity for other ASEAN Member Countries to learn and to benefit from not repeating the mistakes of the past.

Other responses within ASEAN include reformed institutional mechanisms such as embracing integrated water resource management (IWRM) principles and experimenting with new institutional arrangements such as national water councils and river basin organisations (RBO). However, none of these worthy initiatives will succeed unless they are designed to address specific actual problems. There are examples elsewhere of IWRM and RBO being prematurely and unsuccessfully applied as amorphous concepts, whilst failing to address real fundamental underlying problems, such as poor data, inadequate human resources, lack of a modern water allocation and water-sharing system, and so forth. In such situations, attempts at IWRM and at the creation of RBOs can actually make the water management problems worse. These institutional initiatives are not cure-alls. It is critically important, especially where funding is scarce, to put a major focussed effort into getting the fundamentals right first before embarking on sophistication.

### 3.3 Environmental Water Demands

It was clear from questionnaire responses relating to the quantum of environmental water demands that many ASEAN Member Countries do not yet have a well-developed environmental flows policy, and further that there is no consensus among ASEAN Member Countries as to what might constitute environmental flows and the principles for determining such flows. In this latter regard, ASEAN might consider the definition of environmental flows that has emanated from South Africa and which is rapidly being adopted around the world. The Mekong River Commission (MRC) has already adopted this methodology under its Integrated Basin Flow Management programme. Spreading this concept to other ASEAN Member Countries would therefore not be difficult, especially where there is not a national policy in place as yet.

This environmental flows definition is:

*Water that is left in a river system, or released into it, to manage the health of the channel, banks, wetlands, floodplains or estuary.*

Whilst most ASEAN Member Countries are focussing on the high priority task of managing natural water quality through pollution control, the wider matter of river health needs to be addressed as soon as possible. The world has many examples of neglect of river health that are now costing massive amounts of money to remediate. It is obviously much more economic to get it right from the start.

### 3.4 The Need for Improved Water Allocation and Water-sharing

All ASEAN Member Countries are displaying an internationally familiar scenario of localised, sometimes severe, water stress, coupled with an increasing inability of traditional water sharing systems to cope with growing demand, with new users, and with competition between sectors and between individual users. The need for a new approach to water allocation and sharing is clear. The most successful solution to this situation has been shown to be the introduction of government-managed rights-based water sharing, where water use rights are formalised and better specified.

Most ASEAN Member Countries today recognise their water resources as being in public ownership with governments having the overall responsibility for management. In some countries the Constitution makes this explicitly clear. The national Government does not "own" the water, the people do. What government has is the right to control the use, control and flow of water. It can grant or delegate these rights to individuals or corporations, who then may use the water under conditions set by the government. Lawyers call this a "usufruct" right.

Internationally, countries generally recognise at least two reasons why they should regulate the rights to use water. These are:

- the need to protect reliability of water supply for existing users when additional water users are allowed to take water from the same source; and
- the need to ensure that water is used in ways that result in the greatest community benefits – this includes the need to ensure that use of the water resource is ecologically sustainable.

The first task of a water resources manager is the establishment of water allocations that achieve a sustainable use of the resource. Water rights are a means of formalising most, if not all, of these allocations and in turn protecting the rights, well-being and investments of individual water users, be they individual people, businesses, or corporations both public and private. Rights-based water sharing in ASEAN is however essentially in its infancy. The Philippines has had formal water rights in place for

some time but these have some shortcomings. Viet Nam has introduced water use rights in its 1999 Water Law and is presently implementing this initially for groundwater. Indonesia has had a water use permit system for some time, and has in 2004 proclaimed a more comprehensive Water Resources Law to extend the system. Elsewhere traditional systems survive, often supplemented by a management of water resources centred in an irrigation agency and which carries the risk of not facilitating a multi-sector and economically efficient national water allocation pattern.

A significant challenge for ASEAN then is to improve water allocation and sharing so as to achieve equity, sustainability and economic efficiency. There is a real opportunity for ASEAN Member Countries to work together on development of principles and in the sharing of experience.

### 3.5 Water Data Issues for ASEAN

"You cannot manage what you do not measure" is a well-known saying amongst water resource professionals. Statistics reported in this study differ to some extent from data reported by FAO, World Resources Institute (WRI) and the World Bank (Table 2). Questionnaire responses showed that available water data are fragmented, incomplete and sometimes contradictory. This situation is quite common around the world and can usually be explained by different authors reporting different sources and years, but for ASEAN to be able to present a consistent and complete picture of its water resource management and of its environmental credentials in support of its "clean and green" image, there is considerable work required to be done.

Clearly a pressing and early requirement for an ASEAN water resource management strategy is to develop useful, consistent and credible datasets to support regional water policy and water management. Such datasets must be backed up with detailed metadata that describes the methods used, year and locations of different measurements and so on.

The work behind establishing such a dataset should not be under-estimated. Even something as seemingly simple as a measure of "available water" has technical complexity. What is to be the measure? Long-term average runoff? Long-term median? Or perhaps (as quoted by the Philippines) the 80<sup>th</sup> percentile? Even the hydrological definition of runoff has many variants. ASEAN needs a consistent definition. Water demand is also troublesome. It has seasonal and probabilistic characteristics, and is made doubly difficult by the fact that reliable measurement of irrigation water use (by far the largest water use sector) is not common. Water quality poses even more challenges. Monitoring and measuring techniques are variable, and there needs to be agreement on the parameters which are to be monitored.

A number of countries (for example, Indonesia) have pointed out that many institutions are involved in water quality monitoring. As well as water resource agencies, public works agencies, irrigation agencies, environmental agencies, and so forth, public health agencies are typically involved in drinking water monitoring along with local government. This is also typical of the rest of the world, but does represent an opportunity for rationalisation and cost-saving.

In cooperatively developing a consistent ASEAN water resource management dataset, the first step will be establishing the rationale and goals of the dataset. Critical among this is the selection of the minimum necessary parameters. Water data, especially water quality data, can be very expensive to acquire and the temptation to be comprehensive must be resisted. There are two clear purposes for collecting consistent regional data – to guide regional policy, and to form performance indicators for regional water resource management goals. It should be possible to do both of these with no more than about ten parameters.

A summary of other water supply and demand issues is included in Appendix 1.

### 3.6 Water scarcity and associated issues – Southeast Asian issues in the world context

Rijsberman and Molden (2001) indicate that the fundamental fear of food shortages encourages ever greater use of water resources for agriculture, whilst at the same time pressures to divert water to other users are growing significantly. Given the finite nature of freshwater resources this presents the world with a major challenge we have to overcome if we are to feed everybody and sustain the economy and the environment. By 2025, the International Water Management Institute (IWMI) has estimated that 1.8 billion people will live in countries with absolute water scarcity. This currently includes most countries in the Middle East and Africa and by 2025, these countries will be joined by Pakistan, South Africa and large parts of India and China. The IWMI data (Seckler et al. 1998) estimates scarcity based on criteria relating to the percentage increase in water withdrawals over the 1990-2025 period and water withdrawals in

2025 as a percentage of annual water resources of each country. However defined, the impact of scarcity is that countries affected will neither have sufficient water resources to maintain their current level of per capita food production from irrigated agriculture, even at high levels of irrigation efficiency, nor to meet reasonable water needs for domestic, industrial and environmental purposes.

This will increase these countries dependence on imported food. Pressures on water supplies will be further exacerbated by more people moving to and living in large cities; by 2025, 2 billion people will move to cities. Furthermore, currently 1 billion people lack clean drinking water, 2.4 billion lack adequate sanitation. In the face of all the above challenges, water will have to be transferred out of agriculture into other sectors.

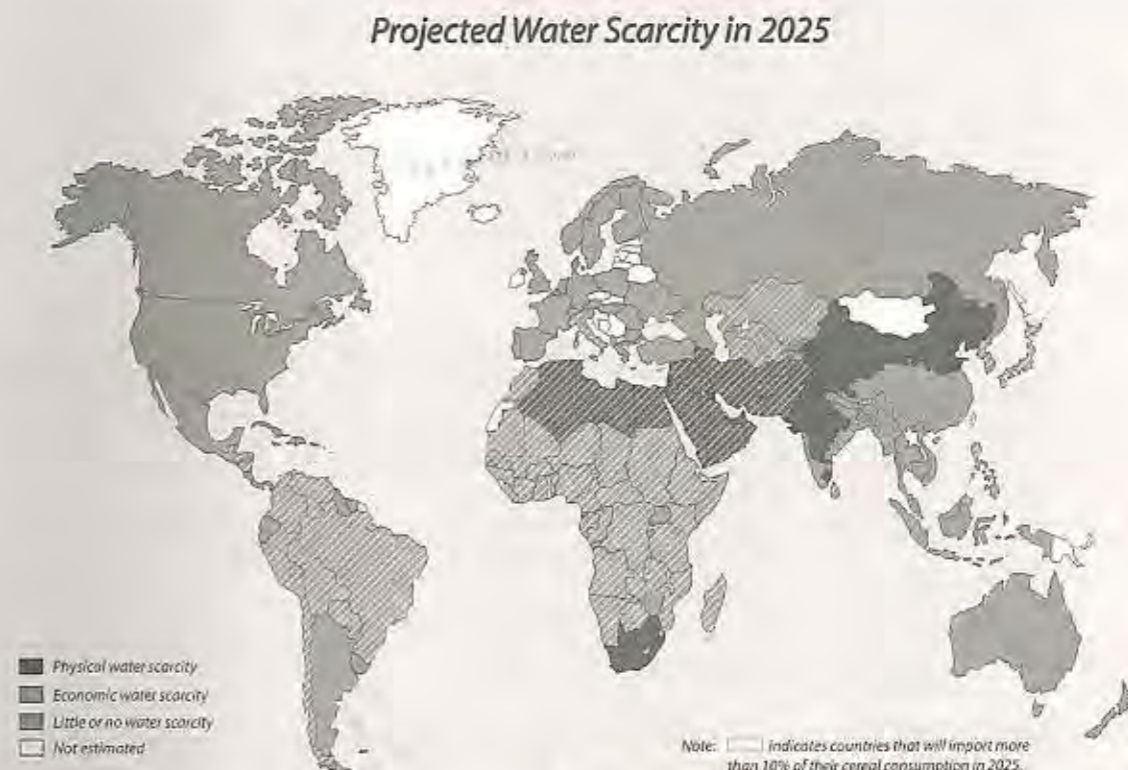


Figure 1: Projected water scarcity by 2025 (after IWMI)

IWMI's data ((Seckler et al., 1998, 1999) groups countries into three categories of water scarcity: Physical water scarcity, Economic water scarcity, and little or no water scarcity

**Physical Water Scarcity:** This is defined in terms of the magnitude of primary water supply (PWS) development with respect to potentially utilisable water resources (PUWR). Physical water scarce condition is reached if primary water supply of country exceeds 60% of its PUWR. This means that even with highest feasible efficiency and productivity, PUWR of a country is not sufficient to meet the demand of agriculture, domestic, industrial sectors while satisfying its environmental needs. Countries in this category will have to transfer water from agriculture to other sectors and import food or invest in costly desalination plants.

**Economic Water Scarcity:** Economic water scarce countries have sufficient water resources to meet their additional PWS needs, but require to increase their PWS through additional storage and conveyance facilities by more than 25%. Most of these countries face severe financial and development capacity problems for increasing PWS to those levels.

The third category includes countries with little or no water scarcity. These countries are not physically water scarce and also need to develop less than 25% of additional PWS to meet their 2025 needs.

The IWMI data indicates that the remaining 118 countries included in their study will theoretically have enough water resources to meet their needs, but many will require significant investment to develop water supplies by 25% or more.

#### Water and Food Production

In order to meet increasing demand for food, irrigation has been expanding quite rapidly over the period from 1960-1998. (Figure 2).

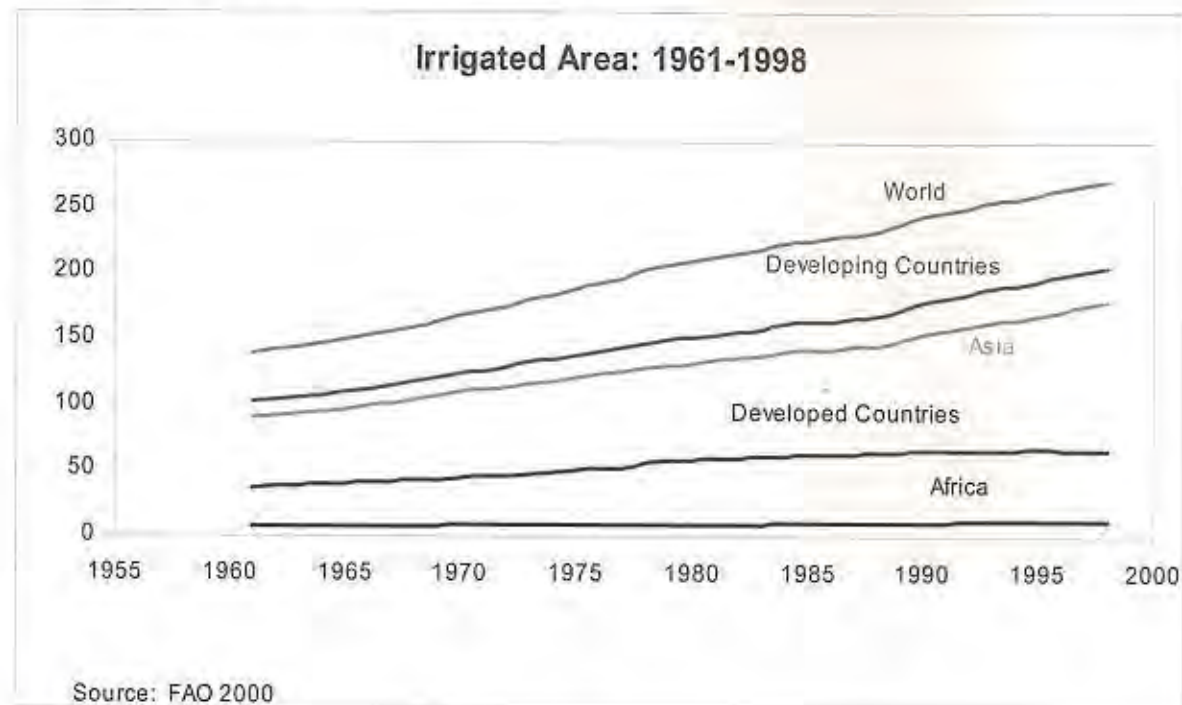


Figure 2: Global expansion of irrigation 1955-1998

However, IWMI and FAO estimate that we will need 18% and 14% more irrigation respectively to feed the world by 2025 (Table 1). The International Food Policy Research Institute (IFPRI) comes up with a lower percentage increase, but this is based on a predicted concomitant increase in dryland food production, which could be optimistic. Given the demands on water resources coming from other sectors and the environment it is important to limit withdrawals yet grow more food. Thus the target should be for a zero percentage increase in irrigation area and water withdrawals, but for an up to 18% increase in water productivity. However, also of concern is the level of calories consumed. Whilst the developed world is trying to tackle over nutrition large numbers of people in Africa and South Asia are still undernourished (Figure 3).

Table 8: World Total Irrigation Withdrawals in km<sup>3</sup>, 1995 and 2025 (FAO uses 2030 as the projection year)

Source	1995	2025	Increase 1995-2025
Schiklomanov (2000)	2,488	3,097	24%
IWMI (Molden and de Fraiture 2004)	2,469	2,915	18%
FAO (2003)	2,128	2,420	14%
IFPRI (Rosegrant et al. 2002)			4%

Furthermore, the trends for increasing meat consumption as countries develop will also create further issues for water planners and managers because of the significantly higher water needs of meat compared with cereals and vegetables (Table 9).

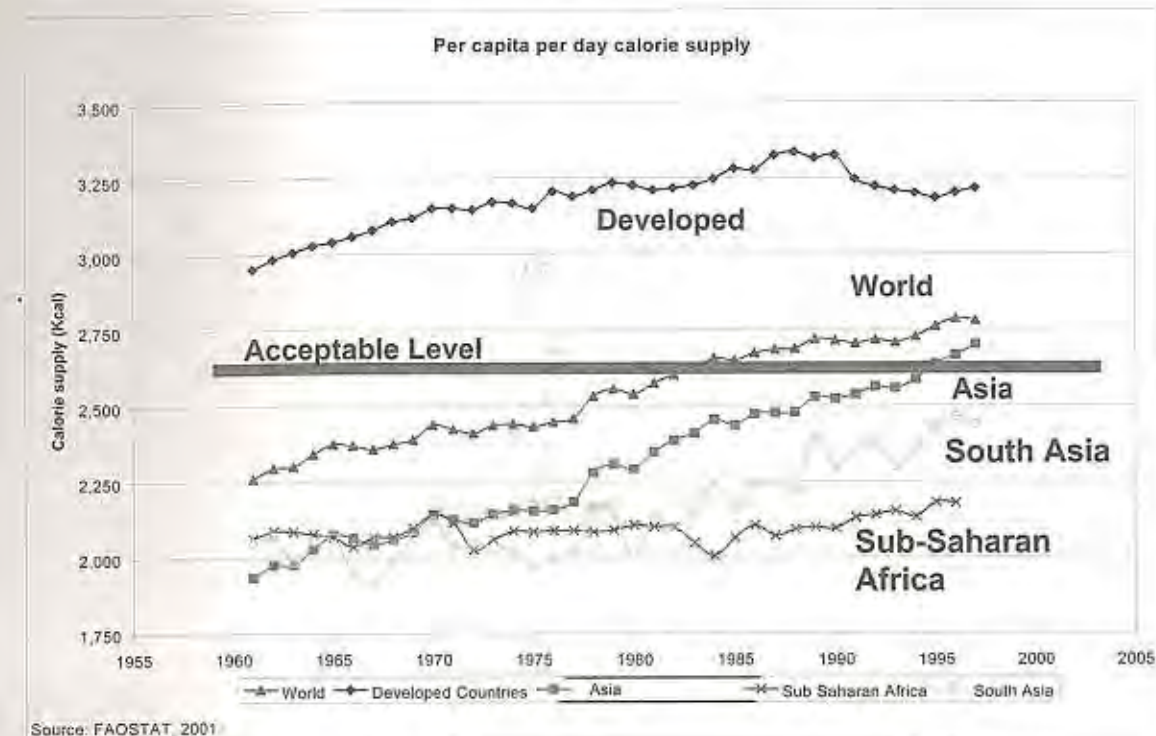


Figure 3: Calorific intake across different regions

Table 9: Food water requirements (litres evapotranspired per kilogram). After Fraiture et al. 2004, Chapagain and Hoekstra, 2003 and Renault and Wallender, 2000

	USA	China	India	World
Wheat	1,390	1,280	2,560	1,790
Rice	1,920	1,370	3,700	2,380
Maize	670	1,190	4,350	1,390
Beef	10,060	12,600	14,379	9,680
Pork	3,370	2,520	7,560	3,680
Onions	140	1,280	2,560	1,790
Tomatoes	130	1,370	3,700	2,380

#### The situation in Southeast Asia

##### Water resource availability and use

It is important to note that there are some differences between similar data sets for the region collected by different agencies (Table 2), partly because of the date of collection, but also possibly because of measurement and statistical errors. According to the IWMI criteria and data from Seckler et al. (1998), of the 10 ASEAN Member Countries only the island state of Singapore, constrained by its small size and limited catchment area, lies in the group of water scarce (physical scarcity) countries whose estimated water withdrawals exceed 50% and who have a high rate of growth in demand. Cambodia, Indonesia, Malaysia, and Myanmar lie in a group of countries with adequate water resources, but projected rates of increase in withdrawals of 100% or more (economic water scarcity). The Philippines, Viet Nam and Thailand also have adequate water and are grouped with countries whose expected water withdrawals will increase between 25-99% for the Philippines and Viet Nam and less than 25% for Thailand (economic scarcity). Lao PDR and Brunei Darussalam were not considered in the IWMI study.

Data in Table 1 and Table 3 indicate that Brunei Darussalam has adequate water, but rates of increase of extraction lie in the 25-99% range, whilst Lao PDR only utilises about 2% of its currently available water, and there are no accurate predictions about its increases in extraction. Currently, with the exception of Singapore, the predominant water use across the region is for agriculture (generally 80-90%) with smaller amounts being used for industrial and domestic users. Averaged across ASEAN as a whole, increases in

water extraction are expected to increase by about one-third over the next 20 years. Whilst with the exception of Singapore, the water resource base of ASEAN Member Countries is sufficient to enable this to occur without major environmental impact, the costs associated with infrastructure development will be considerable. However, most data available for Southeast Asia is in the form of annual averages. These mask seasonal differences and there are areas in the region where seasonal climates exacerbate water availability problems during the dry season and in drought periods.

The outcomes of this analysis have some major ramifications for ASEAN Member Countries with respect to the availability of capital and in some cases, development aid, required to finance water infrastructure development. The key issue for ASEAN is that further investigations are needed to define the capital investment requirements at country level to enable them to keep pace with the improvements in water supply and sanitation predicated by the UN Millennium Development Goals. If these capital requirements can be broadly established, they can be considered at national and regional level in terms of where funds may be sought, the relative importance of private versus public sector investment. The best planning in the world with respect to water resources will be of little use if the financing requirements are not given adequate priority and discussion at policy level.

## 4 Water Quality

### 4.1 Overview of Water Quality Issues

Numerous studies related to water quality and the ecological state of aquatic ecosystems have been and are being undertaken in the ASEAN region. These range from a focus on biodiversity, eutrophication and dissolved oxygen to deforestation and associated catchment degradation, and water quality for irrigation and human consumption. The fragmented nature of these studies, mostly funded by external donor organisations, poses a significant constraint to the internalisation/ institutionalisation and sustainable implementation of the lessons learned from them.

**Table 10:** Summary of water quality related responses to the questionnaire

#### Indonesia

Indonesia's Clean River Program (Prokasih) aims to a) increase quality of river flows, b) restore function, utilisation and efficiency of river environment, and c) increase capacity of human and institutional resources in the field of water pollution control. Some contradiction in selection of indicators for this programme, e.g. healthy river ecology and biodiversity is an indicator of success and at the same time stable river flows (small fluctuation of flows between dry and wet seasons) are desired.

Monitoring programmes are highly fragmented and distributed among various Ministries. It seems that the State Ministry of Environment has the overall responsibility for environmental monitoring and may be the appropriate body for providing consolidation or harmonisation.

Special health related problems: blood fever carrying mosquito; highly populated urban and rural areas with poor drainage.

#### Lao PDR

Water Law implementation requires development of a classification system based on quality, quantity and geographic location – standards should be derived according to designated use objectives. Effluent discharge from pulp and paper, timber, food processing and garment manufacturing industries is being licensed by the Science Technology and Environment Organization (STENO). Piggeries, abattoirs and tanneries represent growing industry and potential water quality problem.

The Government Water Quality Laboratory (WQL) is responsible for monitoring of Mekong River and its major tributaries, as well as for urban wastewater.

#### Malaysia

Three major programmes were reported: Pollution Prevention and Water Quality Improvement Program for Rivers; National Drinking Water Quality Surveillance Program; Environmental Health Protection Program.

The above are backed up by a number of monitoring programmes, for river water quality, water supply quality, drinking water quality, groundwater

#### Myanmar

Main sources of deteriorating water quality are sewerage, solid waste, industrial waste and agrochemical waste. Deforestation and catchment degradation is a significant problem. Effluent quality standards need to be established.

Myanmar Agenda 21 could serve as a vehicle or forum for water quality issues related to sustainable development.

#### Philippines

Some relevant programmes: Drinking Water Quality Surveillance and Regulation; Food and Water Borne Disease Prevention and Control; Water Quality Management Programs of the Environmental Management Bureau (EMB); Improvement of National Data Collection Network for Water Quality

#### Singapore

Ongoing programmes on source protection and upgrading of water treatment plants.

Various programmes to monitor water in catchments, reservoirs, water treatment plants and distribution network.

#### Thailand

Five classes of surface water quality standards for managing compliance with different beneficial uses.

Relatively comprehensive monitoring network for surface water quality. Considers minimum flow requirements for environmental protection.

#### Viet Nam

Increasing evidence of surface as well as groundwater pollution, especially associated with downstream sections of rivers. Strong need for strengthening of policy and institutional framework, improving compliance and enforcement capabilities, and deepening public participation.

Most if not all ASEAN Member Countries subscribe to the concept of integrated water resource management. However, water quality related activities (monitoring, reporting, regulation) are fragmented within the institutional arrangements of most countries, with another layer of fragmentation presented by different institutional designs and approaches followed by different countries. This poses a significant challenge for developing and implementing an ASEAN-wide strategy for water resource management, namely to harmonise monitoring activities (e.g. development and implementation of a standard suite of water quality indicators) and decision-making models across sectors as well as countries.

Related to the need for institutional alignment – as opposed to institutional fragmentation – water quality management is only one component of water resource management and cannot be dealt with effectively without considering the broader context. An integrated water resources perspective ensures that social, economic, ecological and technical dimensions are considered in the management and development of water resources. This requires cooperation and coordination between planners, specialists and institutions.

Although several countries have water quality monitoring and classification initiatives, statistically sound monitoring designs, long-term data storage facilities with accessible data, and standardised reporting systems for water quality seem to be lacking or do not exist. In general, it is not evident from responses to the questionnaire whether or how water quality monitoring and reporting is linked to water resource policy, planning and decision-making frameworks. For example, the European Environment Agency developed the Driving force-Pressure-State-Impact-Response (DPSIR) framework. According to this framework, social and economic activities (*driving forces*) exert *pressure* on an ecosystem, and as a consequence, the *state* of that ecosystem changes. This change in state leads to various *impacts* (e.g. on socio-economic enhancement). These impacts can result in *responses* from society that ultimately aim at mitigating these impacts by addressing the driving forces, pressures, the state or impacts directly.

The water quality focus in ASEAN is on user groups, most notably for potable water, recreational use, commercial fisheries and irrigation. Water quality indicators most commonly used are pH, dissolved oxygen, chemical and biological oxygen demand, ammonia, total suspended solids and faecal coliform

counts. Protection of the ecological resource, i.e. ecologically sustainable development of water resources, receives little if any explicit water quality attention. Water resources for ecosystem services are generally viewed as a competing user of water, in competition with water for drinking and irrigating crops, dilution of waste, self-purification, and provision of food.

Finally, it is important to note that ASEAN has already adopted a set of River Classification and Long Term Water Quality Goals. These are shown in Table 11.

**Table 11: ASEAN river classification and long term water quality goals**

Pollutant or Parameter	Class I Potable	Class II Recreational	Class III Commercial fisheries	Class IV Irrigation
pH	6-9	6-9	5-9	5-9
BOD (mg/l)	5	5	10	10
COD (mg/l)	30	30	100	100
Amm-N (mg/l)	0.3	0.3	1	3
TSS (mg/l)	50	50	150	300
DO (mg/l)	5	5	3-5	3
Faecal Coliform (counts per 100ml)	-	1,000	-	-

Note: Class 1 drinking water requires conventional water treatment  
TSS = total suspended solids

The above system is user based and do not consider the protection of the resource base *per se*. It is suggested that the classification of water resources (rivers) be extended to reflect various levels of protection and associated physical and biological parameters. Generic standards for each class should describe the conditions that need to be met for achieving any designated class.

**Table 12: Millennium Goals – Water Supply and Sanitation Progress – reported August 2004**

Country	Year	Population			Improved Drinking Water Coverage						Improved Sanitation Coverage		
		Total 000's	Urban %	Rural %	Total Household Connection %	Total %	Urban Household Connection %	Total %	Rural Household Connection %	Total %	Urban %	Rural %	
Brunei Darussalam	1990	257	66	34	-	97	100	-	-	-	-	-	
	2002	350	75	25	99	100	100	2	-	-	-	-	
Cambodia	1990	9,744	13	87	-	-	-	1	-	-	-	-	
	2002	13,810	18	82	34	58	31	29	1	16	53	8	
Indonesia	1990	182,117	31	69	71	92	26	62	3	46	66	38	
	2002	217,131	44	56	78	89	31	69	5	52	71	38	
Laos PDR	1990	4,132	15	85	-	-	-	4	-	-	-	-	
	2002	5,529	20	80	43	66	25	38	4	24	61	14	
Malaysia	1990	17,845	50	50	-	96	-	-	-	96	94	98	
	2002	23,965	63	37	95	96	-	94	64	-	-	98	
Myanmar	1990	40,506	25	75	48	73	11	40	1	21	39	15	
	2002	48,852	29	71	80	95	23	74	2	73	96	63	
Philippines	1990	61,104	49	51	87	93	37	82	6	54	63	46	
	2002	78,580	60	40	85	90	60	77	22	73	81	61	
Singapore	1990	3,016	100	0	-	100	100	-	-	-	100	-	
	2002	4,183	100	0	-	100	100	-	-	-	100	-	
Thailand	1990	54,389	29	71	81	87	69	78	11	80	95	74	
	2002	62,193	32	68	85	95	80	80	12	99	97	100	
Viet Nam	1990	66,074	20	80	72	93	51	67	1	22	46	16	
	2002	80,278	25	75	73	93	51	67	1	41	84	26	

World Health Organisation (WHO)- United Nations International Children's Emergency Fund (UNICEF) Joint Monitoring Program (Brunei Darussalam Improved Drinking Water Coverage from Government of Brunei Darussalam)  
(Note that population estimates differ from those given in Table 5, partly because of date selected; note also that some data collected during this study and presented in the appendices shows some discrepancies from the above data)

**Table 13: Poverty Levels**

Values are based on individual country's criteria; population figures for same year as poverty data. All data from the ASEAN Statistical Yearbook <http://www.aseansec.org/syb2004.htm>

Country	Population (million)	Poverty (% of population)	Year
Brunei Darussalam	0.363	0	2003
Cambodia	11.599	35.9	1999
Indonesia	213.494	17.4	2003
Lao PDR	4.846	38.6	1997
Malaysia	22.673	8.1	1999
Myanmar	46.402	22.9	1997
Philippines	76.348	28.4	2000
Singapore	4.185	0	2003
Thailand	63.430	9.8	2002
Viet Nam	75.456	37	1998

## 5 Poverty Levels, Sanitation and Drinking Water Quality

### 5.1 Summary of Progress

The results shown in Table 12 indicate considerable differences across ASEAN with respect to both improved sanitation and access to safe drinking water. However, there appears to be a range of different official statistics regarding progress towards the Goals. The current data with respect to drinking water indicate that while Thailand, Malaysia and Singapore (and probably Brunei Darussalam, but no data is currently available) have good to excellent access, several other countries have to make major strides to achieve the rate of progress required as part of the Millennium Goal. A similar pattern exists with respect to sanitation. In the countries which need to make progress in the water supply and sanitation areas, rural areas are lagging behind the urban areas. Whilst there have been significant improvements between 1990 and 2000, some countries have a fair way to go towards the targets.

Whilst provision of drinking water and sanitation are important aspects of poverty alleviation, most countries have also developed their own indices of poverty as shown in Table 13. As in the case for water and sanitation, Brunei Darussalam, Singapore and Malaysia have largely eradicated poverty, whilst Thailand considers about 12.5% of its population to live below the poverty line. Elsewhere, the number of people living in poverty is still considerable. Clearly, the sustainable development of water resources and provision of sanitation programmes over the next few years will be a continuing priority in these countries as one of the means of decreasing poverty levels.

## 6 Extreme Events in Southeast Asia

### 6.1 Strategic Outlook

Issues of extreme events and climate change have been discussed in the context of food security, public health and infrastructure. Without exceptions, all the countries in ASEAN have experienced floods and droughts at one time or another, some more often than others. Flood and drought issues are increasing and there are heightened expectations from the public for the authorities to address these two problems. While floods can be predicted to a certain extent such that there can be protection accorded to lives and property before they occur, droughts are insidious, and often their onset is little more than a dry spell which is not taken seriously until the effects are serious. In either case, the impacts on lives, property and the environment can be devastating.

In the face of these two contrasting devastating situations (floods are perceived to be more serious than droughts in ASEAN), the need for strategic planning in ASEAN is urgent because of its large population (Table 5), a majority of whom lives in river valleys where such areas are also most vulnerable to floods. Their reliance on the fertile river valleys is also a tragedy, for very often their cultivated crops are washed away by floods or destroyed by droughts, leaving them with no means of support. Rising populations, spiralling demand for food, water and other resources, and environmental degradation will likely magnify their plight.

A related issue is land availability (Table 7), and land fragmentation, which have resulted in very low productivity with very little advantages to be derived from economies of scales from the small farmlands. When there are incidences of too much or too little water in these farms, the impacts could be serious, reducing a majority to below the poverty level (Table 13) with the exception of Singapore and Brunei Darussalam, which are not dependent on home grown crops.

Urbanisation has also expanded into the agricultural heartlands, while farmlands near to the coastal areas are subjected to saltwater intrusions and desertification, rendering them impossible to cultivate. Many of these marginal farms are or will be abandoned that could lead to further food shortages. There are concerted efforts by some countries develop to a policy of self-sufficiency by encouraging the cultivation of staple food as part of food security measures. For example, Malaysia aims to achieve a certain minimum target level of sufficiency in staple food production, which is currently 65%. Other countries such as Thailand, Cambodia, Viet Nam, Myanmar and Lao PDR, which are currently self sufficient in staple food, are reviewing ways to intensify their agricultural productivity in the face of shrinking farmlands and the impacts of climatic variability.

Listed below are some common significant features relevant in ASEAN Member Countries with respect to the consequences of extreme events and climate change vis-à-vis food security.

- Whilst it is uncertain how climate change and variability may affect ASEAN Member Countries, it may lead to greater incidence of drought, floods, disease, food shortages and rising sea levels. These are likely to have the greatest impact on those living at or close to the poverty line. According to Malcolm Duthie, country director of the UN's World Food Program in Lao PDR, even small changes in weather patterns, such as a delay in on-set of the monsoon of just a few weeks is a threat to subsistence farmers.
- All lowland areas will be threatened by extreme events (Table 14). As much as a third of the agricultural areas in ASEAN Member Countries may be affected by floods (such as paddy crops) and in other areas by droughts due to a shifting of the monsoons causing drier soils to reduce crop yields.
- During the past two years, Cambodia, Indonesia and the Philippines, have experienced food shortages caused by droughts brought on by the *El Nino* weather phenomenon.
- In Indonesia, floods reduced food production by a quarter in 1998 whereas on other occasions severe droughts have led to over 1.5 million Indonesian families facing acute food shortages and malnutrition.
- Population growth rates in ASEAN are high ranging from 2% to 3.0% per annum and its growth is not slowing down. By the year 2010 for example, Indonesia's population is expected to rise to 250 million from 238 million in 2004, and the share of arable land per capita and productivity are reducing at a rate in tandem with population growth and occurrences of natural disasters (see Table 5).

Some examples of the potential risks and impacts of extreme climatic events are given in Table 14 and Table 15 and Map 1 and Map 2.

**Table 14:** Areas vulnerable to the impacts of extreme events in ASEAN

Cambodia	Tonle Sap Lake and the Mekong River The southern region of the country Koh Kong town	-cultivated areas -coastal zone
Thailand	Rayong in the eastern region The coast north of Songkhla, between Hua Hin and Cha-am, and in bays on the east coast, notably Rayong Bay East Bangkok along the Bangpakong River Pattaya, Cha-Am and Hua Hin. Bangkok	-sandy coastal plain  - tourist industry
The Philippines	Navotas, Malabon, Parañaque, Las Piñas, Manila and Pasay in Metro Manila; and the provinces of Bulacan [Hagonoy, Paombong, Ma-lolos, Bulacan, Marilao, Bocaue, Obando, Meycauayan, Guiguinto] and Cavite [Kawit, Noveleta, Rosario, Bacoor, Cavite City].	-areas along the coast
Viet Nam	Mekong and Red River deltas Provinces in the south of Viet Nam Ca Mau province, Ho Chi Minh City, Vung Tau and Xuan Thuy sea areas (in Nam Dinh Province) South Viet Nam	- cultivation areas - mangrove forest - the wet land in coastal zone/ arena forest - agricultural area
Singapore	Much of Singapore's land is less than 15 metres above sea level.	

**Map 1:** Examples of vulnerable low-lying areas subjected to extreme events in Cambodia



**Potential impacts of 1 m sea level rise in Koh Kong province**

**Map 2:** Areas inventoried for physical and natural systems responses to sea level rises in the Philippines



Note: Identified low-lying vulnerable areas are shown in Table 15

**Table 15:** Areas endangered in the Philippines

Location	No of Municipalities/Cities	Area in ha	Population
1. Llocos Norte	6	2,169	9,170
2. Llocos Sur	5	2,849	6,580
3. Cagayan	5	9,516	18,175
4. La Union	2	204	2,420
5. Pangasinan	5	24,018	246,000
6. Zambales	5	3,478	48,493
7. Aurora	2	1,060	5,036
8. Quezon	5	3,107	23,550
9. Cavite	3	5,512	230,506
10. Metro Manila	5	1,508	429,600
11. Bulacan	2	1,240	130,000
12. Leyte	4	1,683	27,596
13. Samar	4	20,596	80,710
14. Bohol	6	11,934	74,912
15. Negros Occidental	6	9,061	204,972
16. Mindoro Oriental	3	2,954	3,169
17. Davao del Sur	5	1,683	5,020
18. Davao Oriental	2	864	7,910
19. Surigao del Norte	3	6,412	23,585
20. Capiz	1	2,714	103,171
21. Iloilo	2	1,728	74,661
22. Cebu	2	1497	146,194
23. Agusan del Norte	2	3,494	26,211

Location	No of Municipalities/Cities	Area in ha	Population
24. Misamis Oriental	5	1,939	19,350
25. Misamis Occidental	4	3,536	19,582
26. Cagayan de Sur	4	1,893	13,005
27. Negros Occidental	3	1,498	23,337
28. Maguindanao	1	1,057	2,500
	<b>TOTAL</b>	<b>129,114</b>	<b>1,995,415</b>

Source : National Mapping and Resource Information Authority (NAMRIA) 1992

## 6.2 Major Challenges

The major challenges faced by the countries in ASEAN are discussed in the context of finding a solution to adapt to, or mitigate against, the extreme events. These are listed as follows:

### (a) Shift in climatic patterns

Although centered in the Southern Pacific, the El Niño/Southern Oscillation (ENSO) phenomenon affects the weather and climate in much of the tropics. Climate change could intensify the droughts and floods that are associated with El Niño events in the region. Similarly, new patterns could emerge for the Asian summer monsoon, which affects large areas of tropical Asia. Likely impacts would include a greater annual variability in the monsoon's precipitation levels, leading to more intense floods and droughts.

### (b) Consequences of climate extremes

On timescales of days, months, and years, climatic variability can produce heat waves, frosts, floods, droughts, avalanches, and severe storms, and the record-breaking extremes will occur from time to time in the region. According to weather predictions, storms will become more intense and insect and water-borne diseases will move into new areas. The Philippines for example, experienced the most number of super typhoons in 2004 compared to other years, releasing a phenomenal amount of rain and causing serious loss of lives and damage to the environment (Table 15). The rising sea levels will cause sea water to inundate fertile rice-growing areas and fresh-water aquifers, making some areas unproductive. In other areas, the locust populations for example, are now shifting further eastwards to Asia at a much faster rate than before due to the warmer summers, damaging crops along their paths rendering a new food security issue for ASEAN.

### (c) Control greenhouse gases

There is an increasing quantity of greenhouse gases emitted from the region. The increasing use of fossil fuels in tandem with industrialisation throughout ASEAN, coupled with emissions from vehicles has contributed to a change in the CO<sub>2</sub> in the atmosphere. Deforestation has also been a major problem. For example, in Thailand, forest cover has shrunk from 55% to 28% during the period from 1961 to 1988. Similarly, in Cambodia roughly half of the forests have been felled within the past twenty years. The recent damage caused by Typhoon Nanmadol, in the Philippines (December 2004) has been exacerbated by deforestation.

Stabilising atmospheric concentrations of greenhouse gases will demand a major effort. Without emissions-control policies motivated by concerns about climate change, atmospheric concentrations of carbon dioxide are expected to rise. Given the rate of deforestation, expanding populations and an increase in infrastructure, ASEAN Member Countries would require a dramatic improvement in their energy efficiency programmes and to implement fundamental structural changes in their economic sectors to realign themselves to the requirements of the Kyoto Protocol, which they have already ratified to reduce greenhouse gases. This seems to be a major issue in ASEAN today.

### (d) Improve technological skills and information

Some of the countries are already taking steps to overcome changes to such extreme conditions (Appendices 2 and 3). A major challenge in many of the ASEAN Member Countries in responding to the extreme events is hampered by a host of exclusion factors such as lack of trained personnel, lack of early warning systems, training and knowledge and most important of all, financial capability to mitigate against floods and droughts.

## 6.3 Seeking a Solution to Extreme Events

The questionnaire responses showed that there have been attempts by all the governments to reduce damage due to floods and droughts in their countries. The approaches they have taken include flood warning, and in the case of damages to properties, to provide for structural and non-structural methods to reduce the impacts (Appendix 3). Others include a list of adaptation strategies, some of which have been implemented. The Philippines is the only country in ASEAN with an inter-agency El Niño Task Force that is concerned with research and mitigation against the effects of extreme events. Lao PDR has developed a good set of simulated flood maps that are used for planning purposes, especially needed when severe floods occur once in every 6 years and common floods occur once every 1.6 years in the country. Myanmar through its Department of Meteorology and Hydrology conducts weather forecasting, and issues daily reports while the Townships and the Irrigation Department has preventive contingency plans for flood control.

Below is a list of actions to actualise the various strategies and challenges discussed in the Workshop in Bangkok in November 2004:

### 6.3.1 To reduce the rate of vulnerability arising from extreme events

It has been found that most low-lying areas are prone to floods and droughts in the coastal and riverine areas, most of which are also fertile areas for food production. The most high-risk groups of population are those living in these low-lying areas. Rising sea levels are already contaminating underground fresh water supplies in Thailand and Myanmar and the productive Mekong Delta where a great deal of food is produced. In coastal areas, the effects include making fisheries, aquaculture, tourism and human settlements particularly vulnerable.

#### Plan of Action:

The prudent response to climate change is to adopt a portfolio of actions aimed at controlling emissions, adapting to impacts, and encouraging scientific, technological, and socio-economic research. The plan of action proposed includes:

#### (a) Diagnostic Studies

Provision of diagnostic studies by country and region on floods and droughts that include all parameters related to vulnerability and risks resulting from the two extreme events. All the countries including Singapore felt that there is a need for flood and drought classification in terms of severity and types of impacts and how the population copes with the events. Specific terms of reference include geographical coverage, population affected, land use and mapping these in the form of risk maps (can be geographic information systems (GIS) format) to provide for early warning and forecasting of the events. Flood assessment and reporting through National Disaster Coordinating Councils as in the case of Philippines at regional, provincial, municipal and barangay levels, will ensure that all areas are covered. Flood mapping as has been undertaken in Lao PDR would be a good source of information and example for the region in the short and long term.

#### (b) Training in Telemetry

A major recommendation is to have a telemetry system in all the countries for forecasting purposes. Some countries that do not have such a system recommended that training be given on the use of the system. This can take the form of a pilot project for best practices in forecasting, to be given by countries using the system. Malaysia, Singapore and Thailand have been requested to start the pilot project to provide training.



### (c) Training and capacity building on the use of Climate Change Models

There are needs for ASEAN Member Countries to develop regional cooperation and promote exchange of information and sharing of experiences among personnel involved in disaster management in the region. The training will enhance national disaster management capabilities, ease resource mobilisation and provide communication networking. There is a specific recommendation to study the potential effects of climate change impacts through better prediction models basically for food security. In this respect, capacity building is needed to use the global climate models and adapt these to their country if found useful. The structure of intellect (SOI) model from Australia has been favourably singled out for use in training. All agreed that eventually local models may have to be developed to analyse the impacts on food security, public health and infrastructure in their own country in ASEAN.

### (d) Capacity building in Integrated River Basin Management

There is also a call for introducing integrated river basin management concepts in the ASEAN region more vigorously so that planning can be done in an integrated manner. The concepts include decentralisation in the management of water resources through river basin organisations. Some countries such as Indonesia and Thailand already have river basin organisations that administer water resources of specific rivers. There is only one gazetted river basin organisation in Malaysia that administers all aspects of the environment in the basin. There is also a proposal on a need to review some of these integrated river basin management projects especially river basin organisations, and how they could be adopted in other countries in ASEAN.

The Mekong River Basin is an important shared river basin between China, Viet Nam, Thailand, Lao PDR and Cambodia. Administered through the MRC, the riparian countries shared the water resources, its development and flood control. As there are not many other examples of inter-country river basins, the MRC was singled out as a good example of integrated shared river basin organisation. This is not to preclude the ASEAN Committee on Disaster Management (ACDM), which provides the platform for discussions on ways to overcome the consequences of natural disasters. The Global Water Partnership Southeast Asia (GWP-SEA) is also now actively involved in creating awareness on IWRM. If each country adopts this strategy, water could be better managed to prevent water shortages and flooding. Malaysia is already moving ahead by having started the Integrated River Basin Management (IRBM) systems for the whole country. All these information could be packaged for training and capacity building in ASEAN.

### 6.3.2 To ensure adequate water resources for escalating demands

Changing precipitation patterns will affect how much water can be captured through runoff. Although the region as a whole will still receive an average of 1500 to 3500 mm per annum (being located in the tropics), there will be an increased variability in any one location in the region due to changing patterns of rainfall. This would increase the variability of runoff in the river basins and consequently, the regional distribution of both ground and surface water resources. Rising seas could invade coastal freshwater supplies causing aquifers to be polluted by saline intrusions as salty groundwater rises. The movement of the saltwater would affect upriver freshwater-pumping plants, brackish-water fisheries, and agriculture. Thailand, Myanmar, Cambodia and southern Viet Nam experienced this problem more keenly than the rest of the countries in the region. Any reduction in water resources will make the situation worse and reduce the water supplies to meet demands, placing additional stress on people, agriculture, and the environment. The most vulnerable regions are the low-lying coasts, deltas, and small islands.

#### Potential solutions:

(a) **Use of Best Practices for water resources planning:** The use of Best Practices has been proposed for planning water resources in the future. In addition, the use of river basins as a unit of planning has been advocated strongly. Among the most pressing problems that need attention are improvements in the delivery system of water and a reduction in non-revenue water, both of which will reduce pressures on the country's water resources. Non-revenue water is very low in Singapore but very high in the rest of the countries in ASEAN, with some reaching as high as 60%. Best practices would be required therefore for reduction in non-revenue water and for a more effective delivery system in the face of limited and variable water resources.

Demand management has also been advocated to reduce pressures on the limiting water resources, which in recent years are also subjected to pollution with the expansion of industries and urban population within the river basins. Singapore, through the Drainage Department, Public Utilities Board (PUB) provides a first-rate drainage system to harness rainwater for Singapore's needs, while at the same time to keep it flood free and protect the country against public health risks. All these are vital information for best practices and are encouraged to be disseminated to the public.

(b) **Use of Best practices for droughts:** Responses focused on short and long term best practices for drought situations. In Indonesia for example, the short-term practice is to change its landuse practices, regulate irrigation from reservoir and aquifers, provision of relief programmes and protecting priority users. For a longer term, changing the crop types, building more storage reservoirs, building security at local and community level is advocated to tie over the drought periods. In Malaysia, there are recommendations to construct water impoundment storages, inter-basin water transfer (from water rich states), rainfall harvesting, and groundwater withdrawals (within permissible limits), to tap extra water for use. In the event of a drought, drinking water trucks are provided, water supply rationing is effected, and strict adherence to paddy planting schedules is implemented. In the Philippines, livelihood programmes, lending mechanisms and emergency loans are provided. In Singapore, the public can call the 24-hour call centre offered by the PUB. All these practices have also been used in the other countries depending on the severity of the drought situation. Some of these measures could be disseminated as best practices for training purposes.

### 6.3.3 To ensure that lives are not undermined by health problems

Any increase in the frequency or intensity of extreme weather events would pose a threat to public health. Heat waves, flooding, storms, and drought can cause deaths and injuries, famine, the displacement of populations, disease outbreaks, and psychological disorders. There is also evidence of an association between El Niño (which warms the waters of the Southwest Pacific) and epidemics of malaria and dengue. Warmer waters would also increase the occurrence of toxic algal blooms. Extreme events and declines in food production could lead to more malnutrition and hunger, undermining long-term public health with grave consequences, particularly in children and high-risk groups of population.

#### Plan of Action:

In a natural disaster cycle, the most serious of all is the impact during and after the occurrence of flooding or drought. In this case, **national preparedness measures** include search and rescue operations, evacuation and emergency support during floods. National policies and a good coordination system become important to minimise loss of properties and lives. In Malaysia, there is a Disaster Management and Relief Committee and a Special Malaysian Disaster Relief and Rescue Division under the National Security Division of the Prime Minister's Department. Lao PDR has a disaster management office at the district level and plans to set up such offices at the village levels in the future. Indonesia has an activated National Board for Coordination of Disaster Mitigation and Refuge Management while Myanmar has set up a National Preparedness, Relief and Resettlement Committee. The other ASEAN Member Countries may also have such committees but fail to mention the existence of such committees in their responses. These committees, either adhoc or permanent, are important to save lives and reduce damages caused by extreme events. There is therefore a call to review such operations in each country in ASEAN.

### 6.3.4 Protection of infrastructure, industry, and human settlements

Protection of infrastructure, industry, and human settlements from floods are mostly in the form of flood mitigation measures that are classified into structural and non-structural measures. The more traditional structural measures include the construction of dams, dykes, revetments, polders and bunds for flood plains in order to reduce flood volumes and peaks, and thereby protect people against flood damages. Non-structural approach strives to reduce flood impacts without altering the flood characteristics whilst focusing more on policies and emergency measures. The questionnaire responses clearly showed that attention is paid more on structural measures. However, they are not always efficient or safe. Dams might break, resulting in flash flooding and sudden inundation. These two types of measures should go hand in hand in order to create the best solution in mitigating floods and droughts.

## Potential Solutions:

(a) **Structural measures:** Reducing the risk through technological measures includes construction of dykes, bunds, dams, river improvement works and revetments to prevent flooding. Viet Nam has taken a greener approach by planting mangroves in Northern Viet Nam to prevent coastal flooding. These act as buffers against the sea, reducing 1.5 m waves into harmless, centimetre-high ripples. In order to prevent food shortages, ASEAN Member Countries such as Lao PDR and Viet Nam have adopted the practice of crop shifting, building of storage reservoirs, withdrawal from groundwater and construction of impounding dams to store water. In the case of Indonesia, river training and construction of dykes have gone underway, but due to lack of funds, only 300 km of river training and 150 km of dykes were developed. In Malaysia, structural measures include river improvement works to increase drainage efficiencies, construction of bunds, drainage channels and retention ponds. Myanmar and Singapore have efficient systems of drainage channels for outflows of the stormwater. All these measures provide examples that can be applied by other countries.

(b) **Non-structural measures:** Non-structural measures have not been fully exploited and therefore responses from the questionnaires showed that there is a need to adopt more non-structural measures for flood and drought control. These include:

- Landuse planning
- Flood preparedness programmes
- National Disaster Preparedness, Relief and Resettlement Committee
- Information dissemination through the media
- Plan, design and implement drainage schemes to prevent flooding
- National water policy and strategy
- Awareness raising, capacity building, training

Some of the responses showed that although not the end-all in terms of non-structural measures, integrated river basin management is one of the means to an end to ensure that water resources in the country are effectively planned to benefit a greater number of population.

## 7 Governance and Capacity Building

### 7.1 Overview of Governance and Capacity Building Issues

Governance and capacity building issues are often quite different between countries, this is to be expected given the different landscape, cultures and the nature and availability of water resources. For example Singapore is in a situation of having highly developed their water resources and therefore finds challenges such as demand management, recycling of water resources and innovative sources of future supply to meet projected demand to be of high priority. A high priority issue is "doing more" with a limited internal supply. On the other hand Myanmar conceives that the development of existing water resources may make a significant contribution to future socio-economic development. Water is an under utilised resource in many areas. Thus the issues of governance and capacity building are likely to differ between countries and according to initiatives already undertaken to achieve integrated water resources management. This section therefore briefly summarises the trends evident from the questionnaire responses and presents some of the basic questions we will need to examine as we develop governance and capacity in relation to the priority water management areas.

The questionnaire responses universally report support for the principles of effective integrated water resources management. These principles have been built into policy documents and in some cases into water law reform. There have been many aspects of integration and reform that have been identified from the questionnaire responses and other documentation. The responses have given a very useful indications of the direction and intent of nations to improve decision making at all levels including, for example, clearer focus on water resources within and between institutional structures and through the incorporation of community input at a catchment or regional level. But it is evident that as may be expected the stage of change is variable between countries. Both Thailand and Viet Nam have been vigorous in their governance reform but even here reforms are only about two years old. Therefore as a region we are a long way from asserting what works and what doesn't. In any event this will depend on

the water resources, economy and social needs of each nation. Nevertheless, from an overall perspective is also an obvious need for a change management strategy to ensure that the aspirations expressed in the questionnaires are to be achieved.

Listed below are the key responses from each country in terms of the progress that has been made. It must be emphasised that while a number of very promising new initiatives have been made in the areas of capacity building, community involvement, awareness raising, coordination between government departments and statutory bodies, these initiatives are largely in the developmental phases.

In many cases skills and resources are required at both community and government level to ensure the ongoing development of some highly promising initiatives. It is obvious, however that issues of capacity and governance are crucial if the issues discussed elsewhere in this report are to be successfully addressed.

Table 16: Progress in regard to capacity building and governance

<b>Indonesia</b>
<ul style="list-style-type: none"><li>• National Campaign to Safeguard Water Resources in educational institutions and in general public</li><li>• National Workshop on IWRM issues to establish Indonesia Water Partnership</li><li>• Creation of Indonesia Development Vision 2020 through government</li><li>• Moves towards polycentric governance</li><li>• Over past 20 years 11 River Basin Initiatives</li><li>• 1999 Creation of River Basins Unit</li><li>• Proposed National Water Council</li></ul>
<b>Lao PDR</b>
<ul style="list-style-type: none"><li>• Recent introduction of Water and Water Resources Law, 1996-enforcement to follow</li><li>• Use of traditional community practice and knowledge within new law</li><li>• Plan to develop education and community involvement programme</li><li>• Encouragement of community involvement in scoping stages of hydro-electric programmes</li><li>• 1998 formation of a National Water Resources Coordination Committee</li><li>• Plans to develop Basin Management Committees.</li></ul>
<b>Malaysia</b>
<ul style="list-style-type: none"><li>• Educational programmes now active through initiatives such as National Water Week</li><li>• Establishment of Water User Groups for input into management</li><li>• Implementation of measures by the Ministry of Natural Resources and Environment in March 2004 to encourage coordination of water resources governance.</li><li>• A National Water Resources Council to support Integrated River Basin Management was established in 1998.</li></ul>
<b>Myanmar</b>
<ul style="list-style-type: none"><li>• A national IWRM programme to establish capacity for government institutions has been established.</li><li>• Recent development of the Myanmar National Womens' Affairs Federation will encourage involvement of women in water resources management.</li></ul>
<b>Philippines</b>
<ul style="list-style-type: none"><li>• Heavy emphasis on increasing capacity through training at a number of levels, ie, Barangay Water and Sanitation programmes</li><li>• Training is also emphasised through the World Bank funded Water Resource Development Projects</li><li>• A Water Sector Management and Visioning strategy has been developed</li><li>• The National Water Resources Board has been strengthened changing the Board membership from user to non-user agencies and transferring the regulatory functions of the Local Water Utilities Administration (LWUA) to the National Water Resources Board (NWRB) in 2002.</li><li>• The NWRB is the lead agency in the implementation of IWRM</li><li>• Conduct of the National Water Forum in 2004</li><li>• Conduct and development of programmes/projects related to water resources development and management with the assistance of donor agencies</li></ul>

- Development of improved regulatory practices.

#### Singapore

- A strong and mature public education programme is in existence
- IWRM has been well established in a nation where demand management is critical

#### Thailand

- Developing programmes in participatory management in irrigation districts
- A National Water Policy has been established
- A National Water Resource Committee established in 1989
- Piloting a River Basin Dialogue Programme
- Establishment of River Basin Committees

#### Viet Nam

- Active encouragement of all citizens to become involved in Water Resources Management and there is some statutory support.
- Recent creation of river Basin Management Boards

While all developments in terms of capacity building and governance are not shown in Table 16, some emerging common trends have been identified from questionnaire data. These include:

- Creation of a national peak body—mostly for coordination and policy development—but sometimes to make decisions.
- Creation of a separate water resources agency not associated with ministries responsible for water development (e.g. as in Malaysia where the Ministry of Energy, Water and Communications is separate from the ministries responsible for water development and water utility services ie, the Department of Irrigation and Drainage).
- Attempts to coordinate and/or integrate water and environmental agencies
- Devolution of management to decentralised operations (sometimes in conjunction with a number of other government functions).
- Increased recognition of the advantages of managing water at a basin and catchment level.
- Programmes to raise public awareness of water issues, followed by forms of public participation.
- Participatory irrigation management in various forms.
- Attempts at integrated land and water management in the face of recognition of the consequences of degraded catchments and watersheds.
- The potential for water use rights to assist in the equitable allocation of water between competing demands in the face of growing water use.
- A range of reforms aimed at financial sustainability ranging from cost recovery to private sector involvement.

For this reason we summarise here, some of the key roles and responsibilities that will have to be examined.

There are a number of drivers in this arena, for example:

- Locus of water resource management – there seems to be a general move from centralised management to decentralised management (basin agencies).
- Focus on supply or demand management – both are valid but again it seems as if the focus is shifting to demand management.
- Building infrastructure or building institutions – the nations are unanimous in identifying the need for and high priority of building institutions (institutional reform).
- Style of management – the dominant shift appears to be from a central command-and-control style (with weak regulation or policing capability) to a participatory style (approaching elements of self regulation).

What is Water Resource Governance? Perhaps a partnership between:

- Government (at national, provincial and basin operational levels; also policy and operational levels)
- Society (organised through NGOs, sector forums, private organisations)

- Scientific community (academia and contract R&D firms)

Where partnership implies a shared purpose, coordinated actions, and sharing of risk and benefits. Should we engage representatives of all partners in the development of the strategy? These partners have to start to “train” together if they want to successfully play the game together. By the way, the need to fully understand the [rules of the] game of IWRM was also strongly articulated by most nations.

## 7.2 Specific Capacity Development Issues

Most responses referred to the need for building capacity at individual and organisational levels. What is this capacity? Two basic elements appear to be intrinsic, namely:

- Individual “knowledge or ability” – constituted by some theoretical basis together with experience of how things work in the real world that allows new information to be put in a proper context and that leads to a “capacity for informed action”.
- Organisational capability – the aggregate of all the knowledge that resides in the members of a particular organisation, and the integration of this knowledge with tools, technology and business processes.

At the individual level, there must be opportunities to learn about the technical issues but also about social processes and even about how to effectively learn in multi-sector groups (collaborative learning). The development of learning capability must be addressed in the strategy. An element of this is, as Malaysia said, “to facilitate exchange of information and experience regarding IWRM success stories. The strategy may well have to address the development of a regional learning capability, highlighting issues such as:

- Learning as a social process – interventions for social interaction where stakeholders from the same nation can learn from each other’s experiences as well as learning across ASEAN Member Country boundaries. There is a tremendous diversity in contexts here, and opportunities to debate mutual relevance/meaning will probably build more social capital for the future than any technological intervention.
- Participation in broad learning systems – to acknowledge that there will always be more knowledge out there than within our organisation, country or region. The challenge is for the individuals and organisations of concern to learn how to participate (engage their knowledge) in broader learning system (e.g. through Australian R&D programmes) for mutual benefit and faster learning and absorption of relevant external knowledge into this region.

## 7.3 Concluding Comments

For a successful ASEAN wide programme of IWRM to be developed it is obvious that it must be underpinned by appropriate levels of capacity and governance at the community, basin wide and national level in each of the ASEAN Member Countries. The task for this report is to define how each country can benefit from cooperating at a regional level within an implementation context. In this area there is great scope for benefit for ASEAN Member Countries. While each country has a different landscape and a different culture we have described above how each is moving toward similar goals in terms of advancing IWRM. In addition, each country has particular strengths in reaching those goals. But each also has a similar path of learning and development which can use the strengths of individual nations by information sharing and creating ways to evaluate where critical difficulties lie. For this reason a number of projects have been nominated that can encourage such exchange at a Southeast Asian level.

Furthermore, it is evident that a number of countries have adopted the principles of integrated water resources management that have been promulgated from United Nations and other international forums on water resources. To report back to these ongoing forums about progress and needs at a regional level would be a very effective way by which to attract the resources so urgently required to underpin the development and implementation of the concept of IWRM in the ASEAN region.

## 8 Discussion and Conclusions

A number of fundamental issues have been pointed out during the compilation of this review on the status of water resources in ASEAN. These include:

- The need to ensure that data of the highest quality is obtained to facilitate integrated water resources management. There are real concerns that the data made available for this study is of insufficient quality to allow the above.
- Whilst most ASEAN Member Countries do not have a physical scarcity of water, seasonal scarcity does occur. This needs to be examined in more detail and the results be used as a basis for the planning of water supply strategies for the future.
- Overall demand for water is expected to increase by about one-third over the next 20 years.
- Four countries have not given projections of water demand for 2025. This is of concern because good water resource management is dependent upon the development of future use estimates or scenarios.
- As a response to seasonal water scarcity and growing urban centres, demand for groundwater will increase. Management plans need to be developed to ensure the sustainable exploitation of this critical resource and to maintain its quality.
- Given good overall water availability, most ASEAN Member Countries are in a strong position to plan how water will be managed for environmental purposes including the maintenance of key inland fisheries.
- Fragmentation of the management of water between several agencies within countries needs to be examined to determine if improved institutional arrangements can be developed. It is particularly important that surface water and groundwater are managed by the same agency given their usual interconnectivity.
- Protection of the quality of water supplies is and will be a significant activity for all ASEAN Member Countries over the 20 years.
- The fragmentation referred to above also impacts negatively on the need to harmonise monitoring programmes for water quantity and quality.
- In many ASEAN Member Countries it is considered that the impacts of extreme events and climate change and variability will be of as much concern to governments as many of the above issues. Subsistence farmers and the poor are generally more severely impacted by such factors and consequently they may increase poverty levels and risks of starvation unless adequately planned for.
- Several ASEAN Member Countries are unlikely to meet the Millennium Goals relating to drinking water and sanitation based on the figures presented here.
- With respect to governance of water resources, whilst many countries are aware of the need for change to improve water resources management, there needs to be continued support at all levels to ensure that this happens.
- Capacity building at a range of levels is also a universal requirement with the probable exception of Singapore.

The above issues are discussed in terms of strategies to deal with them in the ASEAN Strategic Plan of Action on Water Resources Management that accompanies this report.

## 9 Country Data Tables

Throughout these tables the following terms are used:

*Not estimated:* indicates that country respondents were unable to provide appropriate data.  
*No data:* indicates that no data was available from any available sources other than the country questionnaires (e.g. FAO Aquastat)

### 9.1 Brunei Darussalam

#### Water Supply and Demand

<b>Supply</b>	
Available internal s/w annual (MCM/year)	3,425
Available g/water (MCM/year)	0.06
<b>TOTAL</b>	3,425
<b>Demands - current</b>	35
Industry	
Mining	0
Ag/Irrigation	Not estimated
Domestic	48
Environment	Not estimated
<b>TOTAL</b>	83
Industry 2025	51
Mining 2025	Not estimated
Ag/Irrigation 2025	Not estimated
Domestic 2025	
FAO Aquastat	100
Environment 2025	Not estimated
<b>TOTAL 2025</b>	151

#### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	No data	No data	No data
Urban	No data	No data	No data
Total	No data	No data	No data

The response to the questionnaire indicated that there are no areas of the country or populations groups without access to water of adequate quality with 99% of the population having household connections.

## Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Rural	No data	No data
Urban	No data	No data
Total	No data	No data

Data from the questionnaire indicated that 0.2% Rural, 98.2% Urban and 99% Total had Household connection in 2002.

### Strategic issues, needs and priorities:

- Continuous treated water supply
- Reduction/minimisation of unaccounted for water
- Increase water revenue and reduction of unpaid water bills
- Ensure that treated quality is in accordance with WHO guidelines

### Country agencies (Government and Non-Government) involved in WRM:

- Water Services Department, Ministry of Development

### Missing data

- No data for irrigation, but this is very limited in Brunei Darussalam
- No data on environmental water

### Future country requirements re data analysis

- There appears to be little information available with respect to the protection of aquatic environments. Given Brunei Darussalam's potential for ecotourism, this area may warrant further attention.

### Key issues arising from the data

The data available for Brunei Darussalam indicate that it is currently abstracting less than 0.4% of its available water resources for domestic and industrial uses. Even with the projected rate of increase of industrial demand, this will only rise to about 1%. This is in accordance with the authorities' view that Brunei Darussalam has plentiful water resources. Answers in the questionnaire suggested that Brunei Darussalam's main concerns are to maintain a high quality domestic supply and to reduce losses in the distribution system with an overall aim of reducing domestic demand by 30% by 2025.

Apparently Brunei Darussalam does not have any problems with respect to provision of a adequate supply of good quality drinking water. With respect to sanitation, there are some gaps in country districts that are being addressed via a rural sanitation programme.

With respect to environmental water, Brunei Darussalam does have some plans with respect to protection of aquatic environments.

Flooding is a recognised risk in low lying areas and there are pumping stations to minimise flood damage.

Societal issues appear to be focused on the impact of flooding on the quality of supply.

Brunei Darussalam indicated that it requires research on leakage detection technology and on the mechanisms for the establishment of integrated water resources programmes.

## 9.2 Cambodia

### Water Supply and Demand

<b>Supply</b>	
Available internal s/w annual (MCM/year)	116,000
Available g/water (MCM/year)	17,600
<b>TOTAL<sup>(1)</sup></b>	<b>121,000</b>
<b>Demands - current</b>	
Industry	30
Mining	Not estimated
Ag/Irrigation	455
Domestic	136
Environment	146
<b>TOTAL</b>	<b>767</b>
Industry 2025	100
Mining 2025	146
Ag/Irrigation 2025	1,000
Domestic 2025	350
Environment 2025	146
<b>TOTAL 2025<sup>(1)</sup></b>	<b>1,742</b>

### Water Usage in Cambodia (2000) (FAO Aquastat Database)

Agricultural water use AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water use AQUASTAT (cubic km/year)
4.00	98	0.06	2	0.02	1	4.09

### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	26	29	1
Urban	54	58	31
Total	30	34	6

## Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Rural	10	8
Urban	56	53
Total	17	16

### Strategic issues, needs and priorities:

- Management and improvement on human resources development
- Water resources information, management and development
- Flood and drought management
- Legislation enforcement and implementation

### Country agencies (Government and Non-Government) involved in WRM:

- Ministry of Water Resources and Meteorology
- Department of Potable Water Supply (Ministry of Industry, Mines and Energy)
- Ministry of Rural Development

### Missing data

- Mining water demand for 2004

### Future country requirements re data analysis

- Cambodia has a major need to obtain high quality data regarding its surface and groundwater resources.

### Key issues arising from the data

- The data provided by Cambodia for Supply appear to match current demand. This is not logical. Therefore the data presented in the Supply and Demand Table for supply are taken from the FAO Aquastat database.
- Apart from no available data from the mining sector, Cambodia has basic statistical data because of its position on the Mekong system and a partner of the MRC. It is suspected that groundwater data is limited and yet this may be an important need given the reliance of domestic water supplies and irrigation on this source.

### Other key issues raised in questionnaire

A number of priorities for action were raised by Cambodia:

- Preparation and rehabilitation of irrigation schemes to increase water supply to the agricultural sector.
- Development of domestic water supply for all towns and urbanising areas.
- Improved coordination mechanisms for water resources management.
- Strengthening capacity throughout water organisations.
- Establishment of river basin organisational structures (domestic).

### FAO Aquastat Notes

Cambodia has a unique hydrological system. The Mekong River and Lake Tonle Sap are connected by the Tonle Sap River which twice a year reverses its direction of flow. From July to the end of October, when the level of the Mekong is high, water flows into the Tonle Sap River, which fills Lake Tonle Sap, thereby increasing the size of the lake from 2 600 km<sup>2</sup> to about 10 500 km<sup>2</sup> at its maximum. The storage capacity of Lake Tonle Sap is estimated at 72 km<sup>3</sup>. In early November, when the level of the Mekong decreases, the Tonle Sap River reverses its flow, and water flows from Lake Tonle Sap to the Mekong River and thence to the Mekong Delta. About 86% of Cambodia's territory (156 000 km<sup>2</sup>) is included in the Mekong River basin, the remaining 14% draining directly towards the Gulf of Thailand.

The average annual discharge of the Mekong River entering Cambodia is estimated to be close to the discharge at Paksé (324.45 km<sup>3</sup>/year) in Lao PDR, some 120 km upstream from the border with

Cambodia. Other inflows to the Mekong-Tonle Sap system from outside the country amount to 29.9 km<sup>3</sup> from Viet Nam and 1.2 km<sup>3</sup> from Thailand. On average, 471.4 km<sup>3</sup>/year flow out of the country in the Mekong channels and tributaries to Viet Nam.

The internal renewable surface water resources (IRSWR) have been computed as the difference between outflow and inflow, i.e. 115.9 km<sup>3</sup>. This figure does not include the unknown discharge of small rivers to the Gulf of Thailand and is thus probably an underestimate. Groundwater resources are estimated at 17.6 km<sup>3</sup>, most of which (an estimated 13 km<sup>3</sup>/year) is drained by the rivers and cannot be considered as additional water resources. The total renewable water resources of Cambodia are therefore estimated at 476 km<sup>3</sup>/year.

The quality of groundwater is generally satisfactory, although high iron concentrations and increased salinity levels have been encountered in some provinces (Svay Rieng, Prey Veng and Takeo).

Author's comment: Data supplied by Cambodia in the questionnaire suggested total water resources of 767,000 MCM, which is higher than the FAO estimate.

### 9.3 Indonesia

#### Water Supply and Demand

<b>Supply</b>		1,847,246
Available internal s/w annual (MCM/year)		
Available g/water (MCM/year)		5,330
<b>TOTAL</b>		<b>1,852,576</b>
<b>Demands - current</b>		
Industry		2,759
Mining		Not estimated
Ag/Irrigation		78,272
Domestic		5,125
Environment		4,500
<b>TOTAL</b>		<b>90,656</b>
Industry 2025		5,040
Mining 2025		Not estimated
Ag/Irrigation 2025		94,370
Domestic 2025		9,360
Environment 2025		14,670
<b>TOTAL 2025</b>		<b>123,440</b>

#### Water Usage in Indonesia (2000) (FAO Aquastat Database)

Agricultural water use in 2000 AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use in 2000 AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use in 2000 AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water use in 2000 AQUASTAT (cubic km/year)
75.60	91	6.62	8	0.56	1	82.77

#### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	69	69	5
Urban	90	89	31
Total	78	78	17

#### Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	
Year	2000	2002	
Rural	46	38	
Urban	69	71	
Total	55	52	

Indonesian Data: Recent Indonesian statistics indicate 59.51% of population with access to improved sanitation (with an average of the urban area at 73.82% and 52.63% at the rural area).

#### Improved Sanitation Data

No.	Region	Urban Area (%)		Rural Area (%)		(% Total)
		Private	Public	Private	Public	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Sumatra	71.94	2.69	42.76	6.33	59.65
2.	Java and Bali	69.94	5.06	38.89	5.29	61.74
3.	Kalimantan	73.38	8.23	41.81	6.63	63.87
4.	Sulawesi	69.02	2.83	44.53	2.09	57.22
5.	NTB, NTT, Maluku, Papua	29.85	1.46	12.87	1.74	35.98
6.	West Indonesian Region	70.51	4.79	40.25	5.70	61.37
7.	East Indonesian Region	53.57	2.17	38.99	1.90	47.10
8.	<b>INDONESIA</b>	<b>69.12</b>	<b>4.70</b>	<b>45.31</b>	<b>7.32</b>	<b>59.51</b>

Source: BPS 2000

#### Water Borne Diseases

Agent	Disease
<b>Virus:</b> Rotavirus Virus Hepatitis A Virus Poliomyelitis	Diarrhea for infants Hepatitis A Polio (myelitis anterior acuta)
<b>Bacteria:</b> Vibrio cholerae Escherichia coli Enteropathogenic Salmonella typhus Salmonella paratyphoid Shigella dysenteries Protozoa: Entamuba histolytica Balantidia coli	Cholera Diarra/Dysenterie Typhus abdominales Paratyphus Dysenterie Dysenterie amoeba Balantidiasis
Giarda lamblia	Giardiasis
<b>Metazoa:</b> Ascaris lumbricoides Clonorchis sinensis Diphyllobothrium latum Taenia saginata/solium Schistosoma	Ascariasis Clonorchiasis Diphyllobothriasis Taeniasis Schistosomiasis

#### Strategic issues, needs and priorities:

- Threats to water availability and sustainability
- Food security
- Watershed degradation
- Floods and droughts
- Preparation of IWRM Plan addressing national, provincial and river basin levels [to harmonise roles, responsibilities, actions between levels] to make implementation of water resources policy effective and sustainable.
- Preparation of background information and analysis to guide national dialogue on water food and environment
- Development of a water resources database
- To increase quality [or integrity] of river flows
- To restore function, utilisation and efficiency of river environment
- To increase capacity of human and institutional resources in field of water pollution control

- Counter water borne disease
- Priority areas for improvement of health and water management are slumps and highly populated urban and rural areas with poor drainage
- Effective land and water [river basin] governance, and that this governance should be polycentric and include the following necessary conditions:
  - Policy and regulatory frameworks that acknowledge complex stakeholder interests
  - Management framework for polycentric governance
  - Capacity building for institutional and human resources

#### Country agencies (Government and Non-Government) involved in WRM:

- Directorate General of Water Resources, MoSRI
- BAPPENAS (National Planning Development Board)
- Ministry of Agriculture
- State Ministry of Environment
- Ministry of Forestry

#### Missing data

Mining water demand

#### Key issues arising from the data

Indonesia's Clean River Program (Prokasih) aims to a) increase quality of river flows, b) restore function, utilisation and efficiency of river environment, and c) increase capacity of human and institutional resources in the field of water pollution control. Some contradiction in selection of indicators for this programme, e.g. healthy river ecology and biodiversity is an indicator of success and at the same time stable river flows (small fluctuation of flows between dry and wet seasons) are desired.

Monitoring programmes are highly fragmented and distributed among various ministries. It seems that the State Ministry of Environment has the overall responsibility for environmental monitoring and may be the appropriate body for providing consolidation or harmonisation.

Special health related problems: blood fever carrying mosquito; highly populated urban and rural areas with poor drainage.

#### FAO Aquastat Notes

Indonesia has over 5,590 rivers. The catchment areas and annual average river runoff by major island are presented in the following table.

#### Average Annual Rainfall

Island	mm/year
Sumatra	2,600
Java	2,600
Nusa Tenggara	1,500
Kalimantan	2,800
Sulawesi	2,100
Maluku	2,200
Irian Jaya	3,200

Source: Adapted from Ministry of Public Works Data (1993)

The groundwater resources are estimated at 455 km<sup>3</sup>/year, although most (an estimated 90%) return as base flow to the rivers. The groundwater potential in Indonesia is, therefore, limited and can meet only part of the urban and rural needs for water supply, while providing irrigation water for very limited areas in the eastern part of Indonesia. In some places, overexploitation of groundwater has led to critical problems. In Jakarta, total groundwater abstraction in 1993 was 32.6 million m<sup>3</sup>. Groundwater abstraction has caused saline groundwater to reach about 10 km inland from the coastline and led to land subsidence at a rate of 2-34 cm/year in east Jakarta.

#### Annual Average River Runoff

Island	Catchment Area (km <sup>2</sup> )	Annual Average River Runoff	
		(m <sup>3</sup> /s)	(km <sup>3</sup> /year)
Sumatra	409,000	19,710	622
Java	139,000	6,950	220
Nusa Tenggara	88,500	1,550	49
Kalimantan	539,500	28,000	883
Sulawesi	191,000	5,930	187
Maluku	75,000	2,320	73
Irian Jaya	422,000	24,090	759
Indonesia	1,864,000	88,550	2,793

Source: Adapted from Ministry of Public Works data (1993)

Although water resources are abundant, the seasonal and spatial variation in the rainfall pattern and lack of adequate storage create competition and conflicts among users. The annual renewable water resources are estimated to be about 2.838 km<sup>3</sup>. Municipal and industrial wastewater is discharged virtually untreated into the waterways causing rapid deterioration in the quality of river water.

#### Additional Information Supplied by Indonesia

Indonesia has started to pursue an integrated, holistic approach to water and sanitation problems, with attention at the river basin and ecosystem level, involving different sectors of government and civil society. Such an approach is recognised as being compatible with initiatives for greater decentralisation and devolution of responsibility to the most appropriate levels.

Major initiatives have been taken in formulating a national water policy. The Government of Indonesia has formulated a national water policy with five key elements to:

- Promote a national focus on water sector reform
- Improve and expand the delivery of water service
- Foster the integrated management of water resources
- Foster the conservation of water and increase system efficiency
- Improve governance

Water resources sector reform in Indonesia has achieved an important milestone by the enactment of the new water resources law (No 7/2004) on March 2004 and some of its implementing regulations such as government regulations on water resources management, drinking water and sanitation, river and lake, irrigation, water resources management corporatisation and water quality management and pollution control, are now under formulation and hopefully will be enacted by the end of this year (2005).

- Development of National IWRM Plan/Strategy

Indonesia Water Partnership received a grant from United States Department of State to facilitate formulation of a draft of National IWRM Plan/Strategy which also includes the water efficiency plan. However, this plan/strategy is part of the future activities, other activities (such as education, ie formal and non-formal education on IWRM, strengthening hydrological networks etc) also need external donor support. The following information will assist in understanding the current water resource management issues.

- Water Management in Indonesia

Indonesia's water resources and irrigation sector faces increasingly complex long-term investment and management challenges arising from rapid population growth, urbanisation and industrialisation. The key water challenges are:

- Increasing local water shortages due to growth of non-irrigation water demand
- Inadequate urban access to piped water supply – investment is unable keep up with the growth in demand
- Water pollution and other adverse impacts of untreated municipal wastewater discharge including industrial and mining effluent disposal



- Adverse impacts of watershed degradation, including increased flood peaks causing economic damage, decreased dry season flow and sedimentation damage to water infrastructure.

These problems, unless effectively addressed, will increasingly constrain the country's economic development and lead to a deterioration of food security, public health and irreversible damage to the environment. Inappropriate and ineffective legal structures, regulations, policies and institutions limit national ability to respond to these issues. Comprehensive reform of sector policies, along with development of a more effective institutional framework, improved planning and management systems and increased stakeholder participation, is required to meet the challenges.

- Opportunities for Improved Water Management

The sector reform started in May 1999. It sought improvements in:

- The national institutional framework, including the existing law for water resources development and management
- The organisational and financial framework for river basin management
- Regional water quality management and regulatory institutions
- Irrigation management policy, institutions and regulations

A Presidential Decree (9/1999) called for a team of 11 ministers, chaired by the Minister of Public Works, to coordinate and guide the reform. Two changes of government (end 1999 and July 2001) necessitated renewal of the team. Another Presidential Decree (123/2001) mandated a new coordination team of 12 ministers for formulating water resources management policy, chaired by the Minister for Economic Affairs, the Minister for National Development Planning as a Vice Chairman and Minister of Settlement and Regional Infrastructure as a Day-to-Day Chairman. Minister of Home Affairs, Agriculture, Forestry, Transportation, Energy and Mineral Resources, Sea and Fisheries, Health, Industry and Trades, Finance, and State Ministry of Environment participated as members.

The reform process of the water resources management policy culminated in March 2004 with the adoption of a new Law on Water Resources that includes general Integrated Water Resources Management (IWRM) principles (Law No 7/2004). The background to this reform includes:

- Shift from centralised to decentralised water management and devolution of operational authority to local governments, with a larger role for communities
- Alignment with principles of IWRM and sustainable development
- Need to balance water uses with conservation of water resources
- Promotion of good governance including increased democracy, transparency and accountability in water management as mandated by the national reform principles of the People's Consultative Assembly (MPR) Decrees
- Preparation for increased private sector involvement in water service delivery

IWP recently completed a status report on implementation of IWRM principles for management and development of water resources in Indonesia, which identifies both ongoing activities and areas where further capacity building is required.

The following activities are recommended to strengthen integrated water resource management in Indonesia:

- Develop a master strategy or plan for implementing the general principles of IWRM at national, provincial and river basin levels
- Create guidelines for ongoing IWRM planning
- Create awareness and build capacity among decision makers and policy makers
- Identify key agencies and positions requiring capacity building on IWRM and conduct training needs assessment
- Conduct short-term capacity building programmes on key topics for identified agencies
- Develop academic curricula that includes aspects of IWRM (university level)
- Conduct broader public awareness and stakeholder training on IWRM
- Strengthen knowledge management mechanisms in relation to the IWRM process

- Global Commitment for IWRM

The Millennium Development Goals (MDGs) were agreed upon by the International Community in 2000. Access to safe drinking water and basic sanitation is one of the 18 targets. Closely linked to the achievement of this and most if not all of the other MDGs, is sustainable water resources management. IWRM will be key to eradicating extreme poverty and hunger, ensuring environmental sustainability and improving health conditions.

The 2002 World Summit on Sustainable Development (WSSD) confirmed the importance of water, its critical relationship to all other development issues and reinforced the importance of achieving the MDGs. With regard to water resources management, a key target was agreed at the Conference.

Preparation of National Integrated Water Resources Management and Water Efficiency plans are to be prepared by 2005.

Within this framework the United States Department of State provided funding to the Global Water Partnership Organisation to sponsor the IWRM planning process in Indonesia, Ethiopia and El Salvador. The grant provides support to development of an IWRM strategy that is to facilitate the dialogue among all stakeholders on national water management; provide targeted technical support and to work with issues in revising economic development plans such as poverty reduction plans or other development strategy documents. The study to formulate a national IWRM Plan/Strategy in Indonesia will take 18 months commencing April 2005, following completion of two multi-stakeholder consultations in December 2004 and February 2005. As a result of this grant, there should be improved management of water resources and increased access to safe drinking water and sanitation in each focus country – including greater engagement by countries with the donor and NGO communities to develop specific activities to address priority needs.

## 9.4 Lao PDR

### Water Supply and Demand

<b>Supply</b>	
Available internal s/w annual (MCM/year)	270,000
Available g/water (MCM/year)	38,000
<b>TOTAL</b>	<b>308,000</b>
<b>Demands - current</b>	
Industry	570
Mining	Nil
Ag/Irrigation	4,674
Domestic	456
Environment	Not estimated
<b>TOTAL</b>	<b>5,700</b>
Industry 2025	Not estimated
Mining 2025	Not estimated
Ag/Irrigation 2025	Not estimated
Domestic 2025	Not estimated
Environment 2025	Not estimated
<b>TOTAL 2025</b>	<b>Not estimated</b>

### Water Usage in Lao PDR (2000) (FAO Aquastat Database)

Agricultural water use AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water AQUASTAT (cubic km/year)
2.70	90	0.13	4	0.17	6	2.99

### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	29	38	4
Urban	61	66	25
Total	37	43	8

### Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Rural	19	14
Urban	67	61
Total	30	24

### Strategic issues, needs and priorities:

Not addressed re water sector, but para-phrasing from the principles –

- Establishment of coordination systems at provincial and sub-sector level with respect to the development, exploitation and use of water
- Coordination of arrangements between water and water resource and land and forestry sub-sectors of the economy
- Development of appropriate regulation with respect to water resources and planning processes

### Country agencies (Government and Non-Government) involved in WRM:

- Water Resources Coordination Committee (WRCC), Prime Minister's Office

### Key issues arising from the data

- Water Law implementation requires development of a classification system based on quality, quantity and geographic location – standards should be derived according to designated use objectives.
- Effluent discharge from pulp and paper, timber, food processing and garment manufacturing industries is being licensed by STENO.
- Piggeries, abattoirs and tanneries represent growing industry and potential water quality problem.
- Water Quality Laboratory (WQL) is responsible for monitoring of Mekong River and its major tributaries, as well as for urban wastewater.

### FAO Aquastat Notes

The Mekong River is the main river in Lao PDR. Forming the border with Thailand, in Lao PDR it flows for about 1 860 km, of which almost every part is navigable. The Mekong River basin covers 90% of the total area of the country. About 25% of the Mekong River basin is located in Lao PDR, which contributes 35% of the Mekong's total flow. The main tributaries of the Mekong River in Lao PDR are, from north to south, the Nam Ou (11% of the area of the country), Nam Ngoun (6%), Nam Theun (7%), Xe Banghieng (9%) and Xe Kong (10%). The Lao PDR section of the Mekong River basin is divided into 32 sub-basins for planning purposes.

In addition to the Mekong, six small river basins drain from Lao PDR towards Viet Nam: the Tale, Nam Ma, Nam Mat and Nam Xa rivers, and two others, the Nam Luang and Nam Mô, meet in Viet Nam before reaching the sea.

### Water Resources

A significant part of the water resources of Lao PDR come from neighbouring countries, namely 73.63 km<sup>3</sup>/year from China and 17.6 km<sup>3</sup>/year from Myanmar while the outflow from Lao PDR to other countries consists mainly of the Mekong River to Cambodia (324.45 km<sup>3</sup>/year at Paksé) and small rivers, the Ca and Ma rivers (9.1 km<sup>3</sup>/year), to Viet Nam.

The internal surface water resources have been estimated as the difference between the outflow and the inflow to the country, i.e. 190.42 km<sup>3</sup>/year, while groundwater resources are roughly estimated at 38 km<sup>3</sup>/year, most forming the base flow of the rivers. The total renewable water resources are therefore estimated at 333.5 km<sup>3</sup>/year.

9.5 Malaysia

Water Supply and Demand

<b>Supply</b>	566,000
Available internal s/w annual (MCM/year)	
Available g/water (MCM/year)	64,000
<b>TOTAL</b>	<b>630,000</b>
<b>Demands - current</b>	
Industry	1,909
Mining	0
Ag/Irrigation	7,300
Domestic	2,413
Environment	No data
<b>TOTAL</b>	<b>11,622</b>
Industry 2025	3,946
Mining 2025	Not estimated
Ag/Irrigation 2025	6,324
Domestic 2025	4,234
Environment 2025	Not estimated
<b>TOTAL 2025</b>	<b>14,504</b>

Water Usage in Malaysia (2000) (FAO Aquastat Database)

Agricultural water use AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water use AQUASTAT (cubic km/year)
5.6	62	1.52	17	1.90	21	9.02

Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	No data	94	64
Urban	No data	96	No data
Total	No data	95	No data

Malaysian input to the current work estimates that in 2002: rural 77 %, urban = 99%, and the total 90%.

Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	1990
Rural	No data	98
Urban	No data	94
Total	No data	98

Malaysian input to the current study estimated the above figures to be rural 72%, urban 94% and total 85%.

Strategic issues, needs and priorities:

- Formulation of a national water resources policy in order to provide the framework for water conservation and management in a holistic manner
- Development and implementation of Integrated River Basin Management as well as Integrated Coastal Zone Management Plans for the country
- Greater attention needed with respect to capacity building to cope with the challenges of implementing IWRM including enhancing level of environmental awareness and civic consciousness among the public
- Greater emphasis to be given to the demand side of water management with the view to improve on the efficiency of supply and use
- Development and use of stakeholder engagement processes
- Effective ecosystem protection and rehabilitation of degraded ecosystems
- Enhanced food production capability
- Ecosystem approach; resource accounting; spatial planning capabilities

Country agencies (Government and Non-Government) involved in WRM:

- Ministry of Energy, Water and Communications
- Department of Irrigation and Drainage
- Minerals and Geoscience Department
- Forestry Department (Peninsular Malaysia)
- Engineering Services Division, Ministry of Health
- Department of the Director General of Lands and Mines

Missing data

Environmental water demand

Key issues arising from the data

There could be greater coordination between the three programmes on water quality: Pollution Prevention and Water Quality Improvement Program for Rivers; National Drinking Water Quality Surveillance Program; and Environmental Health Protection Program

Additional Malaysian data for Peninsular Malaysia

Demand	Units	1998	2000	2010	2020	2030	2040	2050
Domestic and Industrial	Million m <sup>3</sup> /year	3,093	3,483	5,578	7,423	8,936	10,267	11,543
Irrigation	-ditto-	7,350	7,350	6,517	6,517	6,132	6,132	5,912
Total Demand	-ditto-	10,443	10,833	12,095	13,940	15,068	16,399	17,455

Ref: Masterplan for the Development of National Water Resources Study, 2000 – 2050 (1999), Peninsular Malaysia

### Water Resources and Supply

- There are 89 river basins in Peninsular Malaysia and a further 100 river basins in East Malaysia.
- The total available water resources for Peninsular Malaysia is approximately 315 billion m<sup>3</sup> and the demand is 17.5 billion m<sup>3</sup> in 2050, giving an extraction rate of about 6% of the annual average supplies.
- Groundwater contributes only 0.5% of the total current water demands.
- In 2000, a total of 16.4 billion m<sup>3</sup> of storage capacity was provided by 48 dams for different purposes. Out of this number, a total of 5.6 billion m<sup>3</sup> of storage capacity was provided by 40 dams designated for irrigation and water supply purposes, representing about 52% of the current annual water supply and irrigation water demand of 10.8 billion m<sup>3</sup>.
- Planning has assumed a non-revenue water of 40% but measures have been taken to reduce it to 25% as the years go by.

### Water Quality

The Department of Environment has graded raw water quality in five classes.

Class	Details
i	Representing water of excellent quality
ii A and ii B	Representing water of good quality, which may be used for water supply with conventional treatment.
iii	Representing water that may be used for water supply but with extensive advanced treatment.
iv	Representing water that can be used for major agricultural irrigation activities.
v	Very poor water quality.

River water quality conditions of 77 rivers in Peninsular Malaysia are:

No of Rivers	Condition
9	Polluted
37	Slightly Polluted
31	Clean

### FAO Aquastat Notes

Peninsular Malaysia is drained by a dense network of rivers and streams (there are 89 river basins), the longest being the Pahang River which follows a course of 434 km before reaching the South China Sea. It drains a catchment area of 29 000 km<sup>2</sup>. Other major rivers that also drain into the South China Sea are the Kelantan, Terengganu, Dungun, Endau and Sedili rivers. Major river basins in the east of Malaysia tend to be larger than those in Peninsular Malaysia. Malaysia's longest river is the Rajang River (563 km) in Sarawak.

Out of an annual rainfall volume of 990 km<sup>3</sup>, 360 km<sup>3</sup> (36%) are lost to evapotranspiration. The total surface runoff is 566 km<sup>3</sup>, and about 64 km<sup>3</sup> (7% of the total annual rainfall) contribute to groundwater recharge. However, about 80% of the groundwater flow returns to the rivers and is therefore not considered an additional resource. The total internal water resources of Malaysia are estimated at 580 km<sup>3</sup>/year.

Major floods occurred in 1967, 1971, 1973 and 1983. Some 29 000 km<sup>2</sup> are considered as flood-prone areas, affecting about 2.7 million people. The average annual economic damage caused by floods was estimated at US\$40 million in 1980.

The annual internal renewable water resources are estimated at 630 km<sup>3</sup>. As surface water is readily available throughout the year, it is abstracted mainly for irrigation and domestic uses. The groundwater potential is limited to some pockets of the coastal region and is generally exploited by rural people to supplement their piped water supply. Surface water represents 97% of the total water use, while groundwater represents 3%. About 60-65% of groundwater utilisation is for domestic and/or municipal purposes, 5% for irrigation and 30-35% for industry.

In 1995, the total production of drinking water from treatment plants was 3.95 km<sup>3</sup>, while the quantity supplied to domestic and industrial sectors was only 2.98 km<sup>3</sup>. About 32% of the water produced is lost in the distribution system due to several factors such as pipe leakage, under-metering, and other unaccounted water losses.

Water supply is undertaken by government agencies and privatised water companies. The coverage for water supply is 99% for urban areas and 77% in the rural areas.

9.6 Myanmar

**Water Supply and Demand**

<b>Supply</b>	873,000
Available internal s/w (MCM/year)	
Available g/water (MCM/year)	28,000
<b>TOTAL</b>	<b>901,000</b>
<b>Demands - current</b>	
Industry	Not estimated
Mining	Not estimated
Ag/Irrigation	28,000
Domestic	153
Environment	10
<b>TOTAL</b>	<b>28,243</b>
Industry 2025	184
Mining 2025	Not estimated
Ag/Irrigation 2025	Not estimated
Domestic 2025	106
Environment 2025	Not estimated
<b>TOTAL 2025</b>	<b>Not estimated</b>

**Water Usage in Myanmar (2000) (FAO Aquastat Database)**

Agricultural water use AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water use AQUASTAT (cubic km/year)
32.64	98	0.41	1	0.18	1	33.22

**Drinking water**

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	66	40	1
Urban	89	73	11
Total	72	48	3

**Sanitation**

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Rural	57	63
Urban	84	96
Total	64	73

**Strategic issues, needs and priorities**

- Establishment of a high level water commission
- Cooperation and coordination among and between institutions in the water sector
- Continuous actions for water supply and sanitation in accordance with the targets
- Promote community and private sector participation and regional cooperation

**Country agencies (Government and Non-Government) involved in WRM:**

**Line Agencies Responsible for Water Resources Management/Conservation in Myanmar**

Interest	Agency in Charge
<b>Water Supply</b>	
Irrigation	Irrigation Department (Ministry of Agriculture and Irrigation)
Pump Irrigation	Water Resources Utilisation Department (Ministry of Agriculture and Irrigation)
Industrial	Industries (Ministry of Industry No 1, Ministry of Industry No 2, Ministry of Mines)
Domestic	City Development Committees Department of Development Affairs (Ministry of Progress of Border Areas and National Races and Development Affairs)
<b>Drainage</b>	
Natural	Townships Irrigation Department
Waste Water	Townships City Development Committees
<b>Flood Control</b>	Townships Irrigation Department
<b>Navigation</b>	Directorate of Water Resources and Improvement of River Systems (Ministry of Transport)
<b>Hydropower</b>	Department of Hydropower (Ministry of Electric Power) Irrigation Department
<b>River Basin Conservation</b>	Dry Zone Greening Department (Ministry of Forestry) Directorate of Water Resources and Improvement of River Systems Irrigation Department Township
<b>Data Collection and Analysis</b>	Department of Meteorology and Hydrology (Ministry of Transport) Directorate of Water Resources and Improvement of River Systems Irrigation Department
<b>Pollution</b>	Directorate of Water Resources and Improvement of River Systems Myanmar Investment Commission City Development Committees Department of Health
<b>Fishery</b>	Myanmar Fishery Enterprise (Ministry of Livestock Breeding and Fishery)

- National Commission for Environmental Affairs (NCEA)
- Yangon City Development Committee (YCDC)

### Missing data

Agricultural/irrigated water use in 2025

### Key issues arising from the data

Main sources of deteriorating water quality are sewerage, solid waste, industrial waste and agrochemical waste. Deforestation and catchment degradation is a significant problem. Effluent quality standards need to be established.

### Other key issues raised in questionnaire

Myanmar Agenda 21 could serve as a vehicle or forum for water quality issues related to sustainable development.

### FAO Aquastat Notes

The north-south direction of Myanmar's mountain ranges is reflected in the flow of its major rivers, of which two are international rivers. There are six river basins:

- the Ayeyarwady and Chindwin river basin, which is almost entirely located in Myanmar and drains 58% of the territory.
- the Sittoung River basin, which is also entirely located in Myanmar to the east of the Ayeyarwady, drains 5.4% of the territory.
- the Thanlwin (Salween) River basin, which drains 18.4% of the territory, mainly the Shan plateau in the east of the country. The river comes from China and after entering the country forms the border with Thailand for about 110 km.
- the Mekong River basin, which drains 4.2% of the territory in the far east and forms the border with Lao PDR. The Mekong River has 2% of its catchment area in Myanmar. Myanmar is not a member of the Mekong River Commission.
- the Rakhine (Arakan) coastal basin in the west draining into the Bay of Bengal.
- the Tanintharyi (Tenasserim) coastal basin in the south draining into the Andaman Sea.

### Average Annual River Runoff in Myanmar

River Basin	Catchment area for each stretch (000 km <sup>2</sup> )	Average Annual Flow for each stretch (km <sup>3</sup> /year)
<b>Aeyarwady River</b>		
Chindwin (Monywa)	115.3	146.3
Upper Ayeyarwady (Sagaing)	193.3	244.8
Lower Ayeyarwady (Pyay)	95.6	85.8
<b>Other Rivers</b>		
Bago, Sittoung, Bilin	48.1	81.1
Streams of Rakhine State	58.3	139.2
Streams of Tanintharyi	40.6	130.9
Thanlwin	158.0	157.1
Mekong at Myanmar border	28.6	17.6
<b>Total</b>	<b>737.8</b>	<b>1,002.8</b>

Source: Government of Myanmar (1995)

The inflow from other countries is estimated at 128.2 km<sup>3</sup>/year from Chinese and Thai information and includes: 20 km<sup>3</sup>/year from India, 68.7 km<sup>3</sup>/year (Yuan Yang) and 31.3 km<sup>3</sup>/year (Lancang) from China, and 8.2 km<sup>3</sup>/year from Thailand. The total surface water produced internally (total runoff minus inflow from other countries) is estimated at 874.6 km<sup>3</sup>/year. Groundwater resources have been estimated at 156 km<sup>3</sup>/year but a large part of this water (estimated at 150 km<sup>3</sup>/year) constitutes the base flow of the rivers and is also accounted for as surface runoff.

The Mekong River forms the border with Lao PDR over 170 km, from which 36.815 km<sup>3</sup>/year can theoretically be considered as an additional external resource. The total natural renewable water resources (including flow from incoming or border rivers) are estimated at 1 045.6 km<sup>3</sup>/year.

## 9.7 Philippines

### Water Supply and Demand

<b>Supply</b>	206,230
Available internal s/w <sup>1</sup> (MCM/year)	
Available g/water <sup>2</sup> (MCM/year)	20,200
<b>TOTAL</b>	<b>226,430</b>
<b>Demands - current</b>	2,233
Industry	
Mining	Not estimated
Ag/Irrigation	25,533
Domestic	2,189
Environment	Not estimated
<b>TOTAL</b>	<b>29,955</b>
Industry 2025 <sup>3</sup>	4,154
Mining 2025	Not estimated
Ag/Irrigation 2025	72,973
Domestic 2025	7,430
Environment 2025	Not estimated
<b>TOTAL 2025 <sup>(1)</sup></b>	<b>84,557</b>

<sup>1</sup> The Philippines estimate that surface water resources are 206,230 and 125,790 mcm/yr for probabilities of exceedence of 50% and 80% respectively

<sup>2</sup> The total groundwater potential (sustainable yield) and storage are estimated at 20,200 and 1,222, 896 mcm respectively

<sup>3</sup> Mean of a high economic growth scenario of 4997.7 mcm/yr and a low growth scenario of 3310 mcm/yr

### Water Usage in the Philippines (2000) (FAO Aquastat Database)

Agricultural water use AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water use AQUASTAT (cubic km/year)
21.10	74	4.73	17	2.69	9	28.52

### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	79	77	22
Urban	91	90	60
Total	86	85	44

### Sanitation

% of population with access to improved sanitation

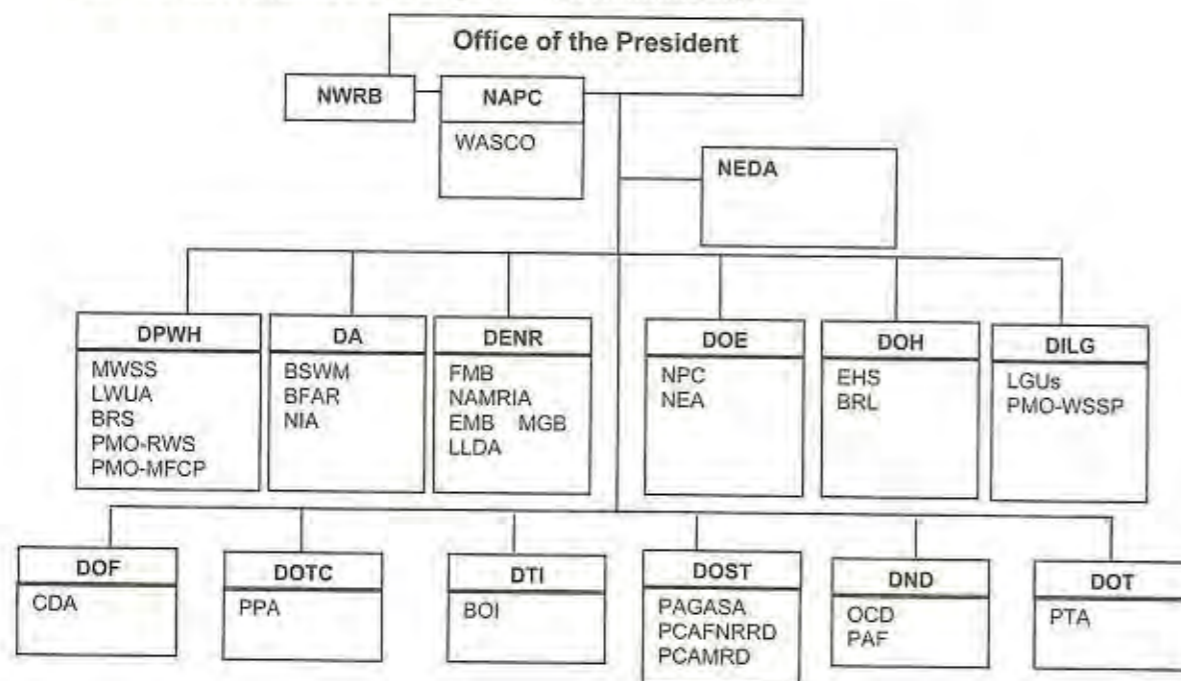
Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Rural	69	61
Urban	93	81
Total	83	73

### Strategic issues, needs and priorities:

- There is a need to streamline the water sector for effective coordinated planning and implementation of river basin or watershed approaches
- There is a need to strengthen and reorganise NWRB as an interim option while waiting for the creation of an autonomous, independent water resources authority
- There is a need to clearly define the role of river basin organisations and to create and strengthen River Basin Organisations (RBOs)
- There is a need to incorporate the economic value of water in pricing raw water to ensure sustainability of water resources development and management
- There is a need for further study on transfer and trading of water rights

### Country agencies (Government and Non-Government) involved in WRM:

#### Water Related Agencies and Organisation Relationships



### Acronyms:

NWRB	National Water Resources Board
NAPC	National Anti-Poverty Commission
WASCO	Water and Sanitation Coordination Office
NEDA	National Economic and Development Authority
DPWH	Department of Public Works and Highways
MWSS	Metropolitan Waterworks and Sewerage System
LWUA	Local Water Utilities Administration
DPWH-BRS	DPWH – Bureau of Research and Standards DPWH
DPWH – PMO-RWS	DPWH – Project Management Office – Rural Water Supply

DPWH – PMO-MFCP	DPWH – Project Management Office – Major Flood Control Project
DA	Department of Agriculture
BSWM	Bureau of Soil and Water Management
BFAR	Bureau of Fisheries and Aquatic Resources
NIA	National Irrigation Administration
DENR	Department of Environment and Natural Resources
FMB	Forest Management Bureau
EMB	Environmental Management Bureau
LLDA	Laguna Lake Development Authority
NAMRIA	National Mapping and Resource Information Authority
MGB	Mines and Geosciences Bureau
DOE	Department of Energy
NPC	National Power Corporation
NEA	National Electrification Administration
DOH	Department of Health
EHS	Environmental Health Sciences
BRL	Bureau of Research and Laboratories
DILG	Department of Interior and Local Government
LGUs	Local Government units
DILG-PMO-RWSS	DILG – Project Management Office – Rural Water Supply and Sanitation Project
DOF	Department of Finance
CDA	Cooperative Development Authority
DOTC	Department of Transportation and Communication
PPA	Philippine Ports Authority
DTI	Department of Trade and Industries
BOI	Bureau of Investment
DOST	Department of Science and Technology
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PCAFNRRD	Philippine Council for Agriculture Forestry, Natural Resources and Resource Research and Development
PCAMRD	Philippine Aquatic and Marine Research and Development
DND	Department of National Defense
OCD	Office of Civil Defense
PAF	Philippine Air Force
DOT	Department of Transportation
PTA	Philippine Tourism Authority

### Missing data

Environmental Water Demand: An NWRB Board Resolution was passed/approved in 2001 to require a minimum 10% of dependable flow to be released at all times to the environment for protection of fisheries downstream at the point of diversion in any river system. For groundwater, is to grant the volume of water applied for domestic use only based on the capacity of the well. At present we have no available data on environmental water demand.

### Future country requirements re data analysis

Continued support of the Improvement of National Data Collection Network for Water Quality Program.

### Key issues arising from the data

Some relevant programmes: Drinking Water Quality Surveillance and Regulation; Food and Water Borne Disease Prevention and Control; Water Quality Management Programs of the Environmental Management Bureau (EMB).

### FAO Aquastat Notes

There are 421 rivers in the country, not counting small mountain streams that sometimes swell to three times their size during rainy months. The rivers are an important means of transportation and a valuable source of water for irrigation for the fields and farms through which they pass. There are also 59 natural lakes and more than 100 000 ha of freshwater swamps.

The five principal river basins (more than 5 000 km<sup>2</sup>) are: the Cagayan River basin in north Luzon (25 649 km<sup>2</sup>); the Mindanao River basin (23 169 km<sup>2</sup>) in Mindanao island; the Agusan River basin (10 921 km<sup>2</sup>) in Mindanao island; the Pampanga River basin (9 759 km<sup>2</sup>) near Manila in Luzon island; and the Agno River basin (5 952 km<sup>2</sup>) in Luzon island. Only 18 river basins have an area greater than 1 000 km<sup>2</sup>: 8 of them are in Mindanao island, 7 in Luzon island, 2 in Panay island and 1 in Negros island. The smallest river basins are frequently under 50 km<sup>2</sup>.

In order to maintain manageable units for comprehensive planning of water resources, the National Water Resources Council (now known as the National Water Resources Board) divided the country into 12 water resource regions. Major considerations taken into account in this regionalisation were the hydrological boundaries defined by physiographic features and homogeneity in climate. However, these water resources regions generally correspond to the existing political regions in the country. Minor deviations dictated by hydrography affect only northern Luzon and northern Mindanao.

The country's annual average runoff is estimated at 444 km<sup>3</sup>. In nine years out of ten, the annual runoff exceeds 257 km<sup>3</sup>.

#### Groundwater Resources

There are four major groundwater reservoirs (Cagayan, 10 000 km<sup>2</sup>; Central Luzon, 9 000 km<sup>2</sup>; Agusan, 8 500 km<sup>2</sup>; Cotobato, 6 000 km<sup>2</sup>) which, when combined with smaller reservoirs already identified, would aggregate to an area of about 50 000 km<sup>2</sup>.

Private wells are extensively used in rural areas for domestic purposes. Municipal waterworks wells are drilled by the Local Water Utilities Administration for domestic purposes and deep wells have been drilled by the National Irrigation Administration (NIA) for irrigation purposes.

The groundwater resources are estimated at 180 km<sup>3</sup>/year, of which 80% (145 km<sup>3</sup>/year) would constitute the base flow of the river systems. The total internal water resources would therefore amount to 479 km<sup>3</sup>/year.

## 9.8 Singapore

### Water Supply and Demand

<b>Supply</b>	See total
Available internal s/w annual (MCM/year)	
Available g/water (MCM/year)	See total
<b>TOTAL</b>	<b>600</b>
<b>Demands - current</b>	
Industry	197
Mining	Not estimated
Ag/Irrigation	Not estimated
Domestic	250
Environment	Not estimated
<b>TOTAL</b>	<b>447</b>
Industry 2025	See total
Mining 2025	Not estimated
Ag/Irrigation 2025	Not estimated
Domestic 2025	See total
Environment 2025	Not estimated
<b>TOTAL 2025</b>	<b>664</b>

### Water Usage (FAO Aquastat Database)

No Aquastat data for 2000



### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Urban	100	100	100
Total	100	100	100



### Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Urban	100	100
Total	100	100

#### Strategic issues, needs and priorities:

- Protection of scarce water resources
- Cost-effective production of safe drinking water
- Minimisation of water wastage in the water supply system
- Promotion of water conservation
- Adoption of water technology to close the hydrological cycle

#### Country agencies (Government and Non-Government) involved in WRM:

Public Utilities Board (PUB)

#### Missing data

Estimates of water use for 2025.

#### Key issues arising from the data

- Ongoing programmes on [re]source protection and upgrading of water treatment plants.
- Various programmes to monitor water in catchments, reservoirs, water treatment plants and distribution network.

### 9.9 Thailand

#### Water Supply and Demand

Supply	213,423
Available internal s/w annual (MCM/year)	
Available g/water (MCM/year)	2,700
<b>TOTAL</b>	<b>216,123</b>
<b>Demands - current</b>	
Industry	1,311
Mining	Not estimated
Ag/Irrigation	48,172
Domestic	3,188
Environment	15,326
<b>TOTAL</b>	<b>67,997</b>
Industry 2025	Not estimated
Mining 2025	Not estimated
Ag/Irrigation 2025	Not estimated
Domestic 2025	Not estimated
Environment 2025	Not estimated
<b>TOTAL 2025</b>	<b>Not estimated</b>

#### Water Usage in Thailand (2000) (FAO Aquastat Database)

Agricultural water use AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water use AQUASTAT (cubic km/year)
82.75	95	2.17	2	2.14	2	87.07

#### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural	81	80	12
Urban	95	95	80
Total	84	85	34

#### Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Rural	96	100
Urban	96	97
Total	96	99

### Strategic issues, needs and priorities:

- Provision of water both in sufficient quantity and good quality for safe drinking water and other purposes
- Equitable sharing of allocation of water with related law and efficient institutions
- Water related hazards mitigation and ecological balance maintained
- Individual capacity building
- Public-private partnerships
- Financing water institutions
- Management of extreme events – floods, droughts, pollution, water use conflicts.
- To cope with geographic as well as demographic diversity [or heterogeneity]

### Country agencies (Government and Non-Government) involved in WRM:

- Department of Water Resources
- Office of Natural Resources and Environmental Policy and Planning (ONEP)
- Royal Irrigation Department, Ministry of Agriculture and Cooperatives
- National Economics and Social Development Board (NESDB)
- Pollution Control Department

### Missing data

Estimates of water usage in 2025

### Key issues arising from the data

- Five classes of surface water quality standards for managing compliance with different beneficial uses.
- Relatively comprehensive monitoring network for surface water quality. Considers minimum flow requirements for environmental protection

### FAO Aquastat Notes

Thailand can be divided into seven river basins, but in the literature it is generally divided into 25 sub-basins. The table below shows the characteristics of the seven major river basins and indicates the total surface water resource of the country, i.e. 198.8 km<sup>3</sup>/year.

### Mean Annual Run-off of Rivers in Thailand

River Basin	Catchment Area Within the Country		Mean Annual Runoff (Country's Contribution)	
	km <sup>2</sup>	%	km <sup>3</sup>	%
Mekong	188,623	36.8	51.9	26.1
Chao Phraya	157,923	30.8	30.1	15.1
Peninsula – East Coast	63,278	12.4	65.7	33.0
East Coast	32,289	6.3	20.1	10.1
Mae Klong	30,837	6.0	12.9	6.5
Peninsula – West Coast	21,172	4.2	9.9	5.0
Salawin (Thanlwin in Myanmar)	17,920	3.5	8.2	4.2
<b>Total</b>	<b>512,042</b>	<b>100.0</b>	<b>198.8</b>	<b>100.0</b>

Aquifer recharge from rainfall is estimated at 41.9 km<sup>3</sup>/year (about 5-6% of the total precipitation). Approximately 30.7 km<sup>3</sup>/year are estimated to return to the river system and are included in the surface water resources. The total internal water resources of Thailand are therefore estimated at 210 km<sup>3</sup>/year.

By adding the internal and external resources together, the total renewable water resource are estimated at approximately 410 km<sup>3</sup>/year.

## 9.10 Viet Nam

### Water Supply and Demand

<b>Supply</b>	
Available internal s/w annual (MCM/year)	275,550
Available g/water (MCM/year)	60,000
<b>TOTAL</b>	<b>335,000</b>
<b>Demands - current</b>	
Industry	3,074
Mining	Not estimated
Ag/Irrigation	62,200
Domestic	1,042
Environment	7,283
<b>TOTAL</b>	<b>73,599</b>
Industry 2025	6,168
Mining 2025	Not estimated
Ag/Irrigation 2025	80,084
Domestic 2025	3,098
Environment 2025	10,907
<b>TOTAL 2025</b>	<b>100,257</b>

Note: Viet Nam indicated that the totals in the above table are uncertain because of lack of estimates for mining.

### Water Usage in Viet Nam (2000) (FAO Aquastat Database)

Agricultural water use AQUASTAT (cubic km/year)	Agricultural water use AQUASTAT (%)	Domestic water use AQUASTAT (cubic km/year)	Domestic water use AQUASTAT (%)	Industrial water use AQUASTAT (cubic km/year)	Industrial water use AQUASTAT (%)	Total water use AQUASTAT (cubic km/year)
48.62	68	5.54	8	17.23	24	71.39

### Drinking water

% of population with access to improved drinking water

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program	WHO-UNICEF Household connection
Year	2000	2002	2002
Rural		72	67
Urban		95	93
Total		77	73

Country data from the current questionnaire indicates 56% of the population have access to piped water supply with a further 14% not directly connected but within reach of supplies

## Sanitation

% of population with access to improved sanitation

Data source	UN Statistical Division	WHO-UNICEF Joint Monitoring Program
Year	2000	2002
Rural	38	26
Urban	82	84
Total	47	41

### Strategic issues, needs and priorities:

- Nationwide socio-economic growth, hunger eradication and poverty reduction
- Capacity building and education, human resource development and public health
- Development of science and technology
- Protect water resources against "pollution and exhaustion" [over-exploitation]
- Strengthening the policy and institutional framework for IWRM
- Expanding and diversifying investment in infrastructure for the water sector, while paying more attention to the financing for the management side
- Improving compliance and enforcement
- Deepening public participation and involvement
- Provision of sufficient quantity and quality for safe drinking and other purposes
- Provision of sanitation
- Development of water resource management institutions
- Mitigation of water-related disasters
- Control water borne diseases

### Country agencies (Government and Non-Government) involved in WRM:

- National Water Resources Council, Ministry of Natural Resources and Environment
- Department of Water Resources Management
- Ministry of Agriculture and Rural Development
- Ministry of Construction
- Ministry of Fisheries
- Ministry of Industry

### Missing data

- Water usage by mining

### Key issues arising from the data

- Increasing evidence of surface as well as groundwater pollution, especially associated with downstream sections of rivers.
- Strong need for strengthening of policy and institutional framework, improving compliance and enforcement capabilities, and deepening public participation.

### FAO Aquastat Notes

There are 16 river basins larger than 2 000 km<sup>2</sup>, 9 of which are considered major rivers, each with a catchment area larger than 10 000 km<sup>2</sup>. These 9 major basins are the Bang-Ky Cung, Red River/Thai Binh, Ma, Ca, Thu Bon, Ba, Dong Nai and the Mekong Delta. Other basins are either small in area (the Tien Yen and Muc) or have several small rivers grouped together such as the Giang/Huong, Tra Khuc and Cai-Luy. The 9 major basins represent 80% of the country's area and 70% of its water resources. The largest basins are the Mekong and the Red River/Thai Binh, covering half of the country's territory.

Viet Nam has abundant surface water resources in terms of total runoff, of which the Red and Mekong rivers carry 75%, while each of the other basins carries 1-3% of the water resources. The mean annual runoff totals approximately 878 km<sup>3</sup>/year, of which about 354 km<sup>3</sup>/year (40%) are generated within the country (corresponding to a runoff coefficient of 0.5).

About 60% of the total flow in Viet Nam originates outside the country. More than 90% of the Mekong basin lies outside Viet Nam. Half of the Red River basin lies outside the country. The Ma and Ca rivers both have about 40% of their basin area outside the country and the Dong Nai has 15% of the basin area outside the country. The contribution from neighbouring countries to the runoff in Viet Nam is estimated at 524.7 km<sup>3</sup>/year, including 470.1 km<sup>3</sup>/year (Mekong) and 1.4 km<sup>3</sup>/year (Dong Nai) from Cambodia, 44.1 km<sup>3</sup>/year (Red) from China, 9.1 km<sup>3</sup>/year (Ca and Ma) from Lao PDR.

The distribution of water resources in the country during the year is highly variable due to unevenly distributed monsoon rainfalls. High variations combined with limited storage and flood control infrastructure result in devastating floods in the wet season and extreme low flows in the dry season. About 70-75% of the annual runoff is generated in three to four months.

The groundwater recharge in the country is estimated at 48 km<sup>3</sup>/year. Over 50% of these resources are in the central part, about 40% in the north and 10% in the south. A large amount of water is stored in unconsolidated alluvial sand and gravel geological formations found in plains and valleys. A substantial part of these resources (estimated at 35 km<sup>3</sup>/year) returns to the rivers as base flow. The exploitable reserves (the volumes of flows of satisfactory quality which can be extracted economically given the present technology) are estimated at about 6-7 km<sup>3</sup>/year.

By adding together the internal and external water resources, the total renewable water resources are estimated at 891 km<sup>3</sup>/year<sup>1</sup>

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Appendix 1: Major Water Supply and Demand Issues

Significant issues	Brunei	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
What is being done about it	Maintenance of treated water supply Contamination prevention Need IWRM programme	Significant groups without access to high quality water and sanitation Competition for water away from the Mekong	Low incidence of piped supplies (35% urban, 10% rural) Industry short of water sources Ag water transferring to M&I No real environmental flows Seasonal probs	All "adequate" Coverage by reticulation is high as 70%? Urban. Less rural. Remoteness is an issue.	Remote rural areas (domestic) Industry supply inadequate due to concentration in certain towns Ag water "adequate" Domestic supply generally inadequate due to pop growth 25 to 38 in 2025.	Very dry central zone Salinity intrusion in deltas Reticulated WS may be 50%? No sign of environmental flows	Incomplete WSS coverage Ag shortfall. Domestic shortfall	Environment and Agriculture "n/a"	Large dams now difficult to build. DSF needs 30% supplementation from storages for agriculture alone. No water rights system (allocation now by officials)	na
Demand mgmt	Flood warning systems Infrastructure replacement Increasing public awareness of issues	Strategic plan to promote investment in water supply projects Internal collaboration between relevant Ministries	Multi-purpose dams plus industrial park style reservoirs Mill Goal to reduce pop w/out reticulated water by 50% - 2015 Environmental allocations supported by law.	Bi-lateral WSS projects	Usual WSS projects Building dams - 47 planned over the next 50 years	Usual WSS projects Water development plans both for irrigation and hydropower	International Monitoring Team Implement Clean Waters Act Priority given to areas of <60% WSS- Innovative financing under Master Plan Rain harvesting, some dams (limited S), g'dwater reg'n. Watershed mgmt.	na	On-farm storages etc Diversion from neighbouring countries being discussed.	na
Area km2			1,826,440	236,800	329,750	676 578 km2	300,000	692.7	512,000 km2	329,560
Water / capita M <sup>3</sup> /yr			13 046	60 318	25 178	21 358	6 093	143	6371 (3300 internal)	11 109

Appendix 2: Adaptation Strategies from ASEAN Member Countries to Climate Change

<p><b>Cambodia</b></p>	<ul style="list-style-type: none"> <li>• Ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 18 December 1995.</li> <li>• 1994, the first-ever inventory done covering five sectors: (i) energy, (ii) industry, (iii) agriculture, (iv) wastes, and (v) land use change and forestry (LUCF).</li> <li>• Policy and project activities focussed on the forestry and energy sectors, such as creation and management of 23 protected areas covering about 18% of the country's land area; establishment of various legal instruments related to forest management, waste management, air pollution control; current efforts to eliminate illegal logging and wildlife trade; and government efforts in promoting renewable energy development and cleaner and efficient energy technology (combined cycle gas turbine, hydropower, etc.).</li> <li>• Signed Instrument of Accession to the Kyoto Protocol on 04 July 2002.</li> <li>• The first <b>National Action Plan on Climate Change</b> has identified a number of existing or proposed government plans in agriculture, forestry, energy and transport, health, and coastal zone, into which climate change objectives can be integrated. In addition, several new climate change initiatives have been proposed which focus on improving local data, technical and institutional capacity, cleaner energy technology, awareness raising and vulnerability and adaptation assessment.</li> <li>• The first, 1998-2002, <b>National Environmental Action Plan</b> was prepared to guide the integration of environmental concerns into national and local development policies, economic decision making, and investment planning and focused on selected key areas such as forestry, fisheries, agriculture, conservation, energy development, and waste management.</li> <li>• Preparation of a <b>National Biodiversity Strategy and Action Plan</b> is at the final stage. The goal of the plan is "to use, protect and manage biodiversity for sustainable development in Cambodia". Cambodia has prepared a National Action Plan on Climate Change with a goal of supporting development priorities of the country and at the same time contributing to global efforts to address climate change concerns.</li> </ul>
<p><b>Indonesia</b></p>	<p><b>Energy</b></p> <ul style="list-style-type: none"> <li>• Gradual removal of energy market distortions, such as fuel and electricity subsidy.</li> <li>• Promote use and development of renewable energy, through incentives such as tax breaks for investors on the technology, encouraging research and so on.</li> <li>• Encourage public adoption of energy conservation and efficiency, by adopting techniques such as public campaigns, while at the same time using economic incentives to further promote energy efficiency products and energy conservation practices.</li> <li>• Promote clean and efficient energy use for industry and commercial sectors. Various technologies, for example, clean production, is available to help the industry and commercial sectors become more efficient.</li> <li>• Restructure the price for various energy sources according to the emission and externalities that the energy source emits.</li> </ul> <p><b>Transportation</b></p> <ul style="list-style-type: none"> <li>• Promote use of public transportation by increasing the capacity and comfort of the public transportation system in Indonesia. Also, a shift in the transportation policy towards use of electric trains.</li> </ul>

	<ul style="list-style-type: none"> <li>• Road pricing and area traffic control system (ATCS) for regularly congested areas, which will allow road users to realise the value of that public good.</li> <li>• Control vehicle emission and promote use of clean fuels through providing incentives for car users who would like to convert their cars to enable them to utilise better and cleaner fuel.</li> </ul> <p><b>Agriculture</b></p> <ul style="list-style-type: none"> <li>• Improving technology and information transfer to farmers in order to speed adaptation and innovation and adoption.</li> <li>• Strengthening research, development, and dissemination of sustainable agriculture practices.</li> <li>• Supporting research and technology that will ensure that the agricultural sector can deal successfully with the various challenges of the future.</li> <li>• Promote improved agricultural practices that emit the least amount of greenhouse gases.</li> <li>• Staple food diversification by promotion of non rice food sources.</li> <li>• Improve water management in rice production.</li> <li>• Regionalisation of agricultural research and development.</li> </ul> <p><b>Forestry</b></p> <ul style="list-style-type: none"> <li>• Improving forest policy and enforcement of stronger regulations in forest management.</li> <li>• Improving technology and information transfer in order to speed adaptation and innovation and adoption.</li> <li>• Strengthening research and development of sustainable forest management.</li> <li>• Review and revise present forest and land management policies to provide stronger and more accountable measures.</li> <li>• Prevent the occurrence of forest fires through better preparation, especially in the areas prone to forest fires.</li> <li>• Provide land grants to universities for forestry researches.</li> <li>• Support research and development of fast growing high quality forest trees.</li> <li>• Replenish the forests in the rural areas and replant trees in the urban areas.</li> <li>• Promote low impact logging practices.</li> </ul> <p><b>Wastes</b></p> <ul style="list-style-type: none"> <li>• Devise an integrated waste management scheme, especially for the urban areas, which are still rapidly developing more real estates.</li> <li>• Encourage and promote waste minimisation and clean production in the industry through research and public campaigns.</li> </ul> <p><b>Coastal Resources</b></p> <ul style="list-style-type: none"> <li>• Continue and develop the national marine resources evaluation and planning programme to include management issues and institutional support to assist the Provincial and District Bappedas to increase the level of community participation in the spatial planning process.</li> <li>• Continue the national surveying and mapping programme as well as develop the national geographic information system in which coastal area and small islands are put as priority.</li> <li>• Promote the coral reef rehabilitation planning and management, as well as mangrove rehabilitation and management programme to piloting community based management of coastal resources as a key initiative to implement coastal zone management plans under the 1992 Spatial Planning Act No. 24.</li> <li>• Continue promoting and strengthening water resources management with particular emphasis on national networking of hydrology</li> </ul>
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	<p>information system, which will link in with other natural resources information system.</p> <ul style="list-style-type: none"> <li>• Develop and integrate the nation wide tide gauge station network to enable sea level rise monitoring in the country for a long run period. Vertical datum definition study will be conducted with reference to an absolute International Terrestrial Reference Frame (ITRF) through an international co-operation in the Asia and Pacific region.</li> <li>• Prepare a <b>long-term adaptation strategy</b> for the possibilities of sea-level rise due to climate change in the various coastal areas.</li> </ul> <p><b>Public Health</b></p> <ul style="list-style-type: none"> <li>• Promote use of environmentally friendly fuels and healthy transportation system.</li> <li>• Promote healthy environment housing.</li> <li>• Prepare Environmental Impact Assessment (AMDAL) and its enforcement with attention to climate change impacts for all major development including health services.</li> <li>• Promote emergency response system for sporadic climate change disaster.</li> </ul> <p><b>International Cooperation</b></p> <p>Adaptation Policies:</p> <ul style="list-style-type: none"> <li>• Formulate the Clean Development Mechanism (CDM) to cover insurance policy for adaptation measures.</li> <li>• Under CDM, link the insurance mechanism with the level of global mitigation efforts.</li> </ul> <p>R&amp;D Policies:</p> <ul style="list-style-type: none"> <li>• Continue Cooperation in R&amp;D on Climate Change Science, Economics, and Policy with other countries.</li> <li>• Initiate R&amp;D on new and renewable energy.</li> <li>• Initiate South-South cooperation for R&amp;D.</li> </ul> <p>Mitigation Policies:</p> <ul style="list-style-type: none"> <li>• Follow the 'precautionary principles' to mitigate climate change.</li> <li>• Evaluate existing technology standards.</li> <li>• Enhance technology cooperation.</li> <li>• Identify voluntary measures that may be committed at the global levels.</li> </ul>
Malaysia	<p><b>Food Sufficiency</b></p> <ul style="list-style-type: none"> <li>• The Green Revolution has been revived as a strategy to increase food production.</li> <li>• A lot of emphasis under the Eighth and Ninth Malaysian Plans to develop areas for food production.</li> </ul> <p><b>Coastal Vulnerability Index (CVI)</b></p> <ul style="list-style-type: none"> <li>• A national mapping exercise to identify coastal areas that are susceptible to the impacts of sea level rise (SLR) has started. This involves the establishment of an index that integrates all relevant parameters to indicate the vulnerability of a locality to SLR.</li> <li>• A national coastal vulnerability index (CVI) formulated will be tested/applied in several pilot sites with widely varying characteristics.</li> <li>• Findings from the CVI study will identify highly vulnerable areas where development should be avoided. It will serve as a basis for recommending proactive adaptive measures to mitigate the impacts of SLR.</li> </ul>

	<p><b>Public Health Studies</b></p> <ul style="list-style-type: none"> <li>• No studies have so far equate diseases with effects of climate change although there were some that indicated good correlations with <i>El Nino</i> and <i>La Nina</i> effects. Studies are underway to establish the pattern of diseases that are endemic to the country or emerging and re-emerging diseases to establish possible statistical causal links between the diseases listed and climatic factors based on climatic data of the same time period.</li> </ul> <p><b>Mitigation Options to Reduce CO<sub>2</sub> Emissions</b></p> <p>Comparative Studies on Carbon Sequestration Potentials</p> <ul style="list-style-type: none"> <li>• Promote R&amp;D studies to elicit the extent of reforestation and afforestation activities on CO<sub>2</sub> in the atmosphere. The series of comparative studies included forest ecosystems and plantation forests with special reference to oil palm, rubber and <i>Acacia mangium</i>. The aim is to assess carbon dynamics in the two different forest ecosystems (primary and plantation) in order to determine the current and future carbon sequestration potentials in those ecosystems.</li> </ul> <p><b>Energy Efficiency in the Transport Sector</b></p> <ul style="list-style-type: none"> <li>• Promote use of public transportation by increasing the capacity and comfort of the public transportation system. In urban areas such as Kuala Lumpur, there is a shift towards the use of light rail transit.</li> <li>• Road pricing and area traffic control system (ATCS) control have been debated but not implemented as yet.</li> <li>• Control vehicle emissions through use of clean fuels (petrol has very low lead and sulphur content).</li> </ul> <p><b>Biomass Waste for Power Co-generation</b></p> <ul style="list-style-type: none"> <li>• Diverting unwanted agricultural residues to become energy resource supplements for use to reduce demand pressures on energy sources available in the country.</li> <li>• Move towards technologies that make use of agricultural residues as fuel to produce electricity in preference over more conventional diesel generators.</li> </ul> <p><b>Improving Energy Efficiency in the Industrial Sector</b></p> <ul style="list-style-type: none"> <li>• The legal framework under which the energy service business is organised is being reviewed to increase the level of participation of financial institutions in the energy business.</li> </ul> <p><b>Public Awareness Creation</b></p> <ul style="list-style-type: none"> <li>• Started strategies to increase public awareness and knowledge of climate change issues. The components include preparation of a handbook on climate change, holding follow-up seminars, local production of documentaries on effects of climatic change.</li> </ul>
Philippines	<p>The Philippines was among the first countries to embrace the sustainable development paradigm, adopting the Philippine Strategy for Sustainable Development (PSSD) in 1989. The PSSD comprises of a ten-pronged strategy, as follows:</p> <ul style="list-style-type: none"> <li>• Integration of environmental consideration in decision-making;</li> <li>• Proper pricing of natural resources;</li> <li>• Property rights reform;</li> <li>• Conservation of biodiversity;</li> <li>• Rehabilitation of degraded ecosystem(s);</li> <li>• Strengthening of residuals management;</li> <li>• Control of population growth and human resources development;</li> <li>• Inducing growth in rural areas;</li> </ul>

	<ul style="list-style-type: none"> <li>• Promotion of environmental education;</li> <li>• Strengthening citizens' participation.</li> </ul> <p>The Philippines has carried out a lot of research on climate-related issues, among the main ones are:</p> <ul style="list-style-type: none"> <li>• Epidemiological Study for Metro Manila Using Climatic Variability</li> <li>• Country Study to Address Climate Change Issues and Concerns</li> <li>• GHG emissions inventory</li> <li>• Vulnerability assessments and adaptation analysis on water resources, coastal resources and agriculture</li> <li>• Mitigation activities to reduce GHG emissions</li> <li>• An Investigation on Systems Responses to Sea Level Changes of Some Selected Locations in the Philippines</li> </ul> <p><b>On-Going Research</b></p> <ul style="list-style-type: none"> <li>• Development of a Climate Information, Monitoring and Prediction System (CLIMPS), being undertaken by PAGASA in collaboration with the Department of Agriculture (DA) and the Department of Environmental and Natural Resources (DENR). It will have the capability to predict and issue with sufficient lead-time, advisories on extreme climate events such as during episodes of El Niño and La Niña, as well as, seasonal to inter-annual climate forecasts.</li> <li>• Climatological Study on the Changes in the Tropical Cyclone Intensity in the Philippine Area of Responsibility</li> </ul> <p><b>Future Research</b></p> <ul style="list-style-type: none"> <li>• Forecasting of the UV Index in Four Regional Stations of the Philippines</li> <li>• Crop Yield Information in Selected Areas</li> <li>• Development of an Operational Agrometeorological Crop Monitoring and Weather-based Crop Production Forecasting</li> <li>• Feasibility Study on the Use of Passive Samplers for Background Monitoring of Gases</li> <li>• Vegetation and Soil Moisture Index Mapping using AATSR, ASAR and MWR Data from ENVISAT</li> <li>• Bio-climatic Mapping of the Philippines</li> </ul> <p><b>Training/workshops on Local Action Planning on Climate Change</b></p> <ul style="list-style-type: none"> <li>• A number of training/workshops on "Local Action Planning on Climate Change" was organised by the Institute for Climate, Energy and the Environment (ICEE) under the Enabling Activity Project in selected provinces in the country with the local government units and other stakeholders as participants. Areas covered include risk management resulting from climate change and sea level rise, coastal degradation and inundation. These are to create awareness among the various stakeholders in the areas to provide the necessary guidance in the formulation of local action plans on climate change.</li> </ul> <p><b>Promotion of energy efficiency and conservation</b></p> <p>The Department of Energy has undertaken a number of information campaigns, as follows:</p> <ul style="list-style-type: none"> <li>• The <i>Power Patrol Program</i> is an energy information awareness and education programme covering the residential, industrial, commercial and education sectors. It promotes efficiency in the electricity and gasoline fuel use of these sectors through the tri-media. The campaign has reached approximately 1 million households so far.</li> <li>• The <i>Road Transport Patrol Program</i> launched on 17 April 1998 focussed on information dissemination regarding proper operation and maintenance practices to reduce fuel consumption. The</li> </ul>
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	<p>programme is expected to contribute to a reduction in oil importation and environmental emissions as a result of the reduction in fuel consumption in the transport sector.</p> <p><b>The Buhay Recognition Awards for Greenhouse Gases Abatement</b> The <i>Buhay</i> Awards is part of the country's initiatives to promote and recognise voluntary efforts on GHG mitigation. The <i>Buhay</i> Awards for greenhouse gases abatement were presented for the first time in 1998.</p> <p><b>Climate Awareness Survey</b> The Philippines, in April 1998, through the Inter-Agency Committee on Climate Change Secretariat, conducted a survey on climate awareness in the various sectors. The survey was done in collaboration with and with support from the United Nations Environment Program (UNEP).</p>
Singapore	<p><b>Water Resources</b></p> <ul style="list-style-type: none"> <li>• Singapore's impounded reservoirs are designed to minimise the risk of seawater infiltration from a rise in sea level. Although Singapore is not self sufficient in fresh water, measures have been taken to ensure sufficient potable water to meet demands. These measures include desalination, water reuse and water conservation.</li> </ul> <p><b>Flooding</b></p> <ul style="list-style-type: none"> <li>• There is a system in place to monitor the storm-water drainage and flooding situation so that timely actions are taken to reduce the flooding impacts. Flood prevention and protection programmes are planned and implemented on an ongoing basis.</li> </ul> <p><b>Public Health Impact from Resurgence of Diseases</b></p> <ul style="list-style-type: none"> <li>• Singapore already has a vigorous system to control and manage communicable diseases and based on information so far, could easily adapt the system to respond to adverse health impacts caused by climate change.</li> </ul>
Thailand	<ul style="list-style-type: none"> <li>• Immediately following ratification of the UNFCCC, the Royal Thai Government set up a National Climate Change Committee (NCCC) and a Climate Change Expert Committee (CCEC) to prepare the country's response to climate change.</li> <li>• Climate change policies and issues have been integrated into economic and social development since the 7th National Economic and Social Development Plan (1992-1996). They have also been incorporated in environmental policies and plans of the country where appropriate. The following strategies for energy development were developed: <ul style="list-style-type: none"> <li>• Provide energy sufficient to meet increases in demand at reasonable prices while ensuring quality and security of supply.</li> <li>• Promote efficient and economic use of energy.</li> <li>• Promote competition in the energy supply industry and increase the private sector's role.</li> <li>• Prevent and mitigate environmental problems arising from energy development and utilisation, and improve the safety of energy-related activities.</li> <li>• Develop legislation related to energy and energy administration mechanisms.</li> <li>• Public Awareness: A programme to update local personnel on technical and political developments will be designed to keep the public constantly alert to climate change issues.</li> </ul> </li> </ul>
Viet Nam	Energy sector:

<ul style="list-style-type: none"> <li>• Efficient use of energy.</li> <li>• Effective and rational use of power resources, development and maximal utilisation of hydropower and gas.</li> <li>• Development of new and renewable energy.</li> <li>• Determination of environment standards, evaluation of environmental benefits and costs for energy projects.</li> </ul> <p><b>In agriculture:</b></p> <ul style="list-style-type: none"> <li>• Development and application of sustainable agricultural farming techniques to enhance the agricultural production and to mitigate GHG emissions.</li> <li>• Improvement of irrigation-drainage management in rice fields.</li> <li>• Strengthening the capacities of agriculture research institutions.</li> <li>• Researching on improving the crop and animal varieties.</li> </ul> <p><b>In forestry and land use change:</b></p> <ul style="list-style-type: none"> <li>• To promote the implementation of programmes to plant 5 million hectares of forest effectively.</li> <li>• To conserve and restore the existing forest, to minimise the exploitation of natural forest.</li> <li>• To stabilise the areal structure of forests, including 12 million hectares of natural forest and 3.5 million hectares of planted forest.</li> <li>• Forest fire prevention and preparedness.</li> <li>• To raise the living standard of the people in mountainous areas to assist in poverty alleviation, through development of appropriate land and forest allocation policies to local households for subsistence and marketing purposes.</li> <li>• The <b>National Environmental Protection Strategy</b> relates closely to activities on climate change such as, developing the plan for sustainable industrial development, rational resources utilisation, effective production and waste management; managing and controlling air, water and noise pollution in industrial enterprises; implementing clean production strategy; enhancing awareness in enterprises on requirement of minimisation and effective management of waste, and training on environment and climate change for managers.</li> <li>• Developing a plan for management of solid, dangerous waste storage and effective waste treatment system for all class I and class II cities and densely populated urban areas.</li> <li>• Ensuring waste collection from households and its effective treatment.</li> <li>• Preventing pollution from medium and small enterprises and from agricultural activities and husbandry.</li> <li>• Improving effectiveness of energy generation and utilisation.</li> <li>• Enhancing utilisation of clean energy consumption technology.</li> <li>• Conserving and utilising effectively land resources, avoiding from soil degradation.</li> <li>• Mitigating greenhouse gases emissions and ozone depletion substances.</li> <li>• Promoting forestation in watershed.</li> <li>• Increasing forestation and protecting degraded coastal forests, particularly, mangroves.</li> </ul>
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### Appendix 3: Further Questionnaire Responses Relating to Floods and Droughts

**Question 10a:** What approaches are taken nationally and internationally to identify the extent of flooding and its likelihood of occurrence?

Question 10a	Actions taken to identify the extent of flooding and its likelihood of occurrence	
Country	Nationally	Internationally
Brunei Darussalam	N/A	N/A
Cambodia	Ministry of Water Resources and Meteorology forecasts and publish seasonal flood forecasting during the wet season to the public; makes assessment and reports through National Cambodian Disaster Management.	N/A
Indonesia	Flood recording (flood records since the rainy season 2001/2002 up to 2003/4 are available) Flood and weather forecasting  The implementation of the comprehensive policy to mitigate the flood hazards are carried out in staging (step by step) depending on the availability of government budget. As has been identified, Indonesia has about 5,860 units of rivers, among them 600 rivers have the worst impact on social and economic conditions. To mitigate the flood hazard impact structurally on those 600 rivers about 30,000 km river training and 15,000 km dyke are required. However, the capacity of government in term of budget availability to develop river training and dyke <b>annually</b> is about 300 km and 150 km respectively, therefore it needs about 100 years to mitigate flood hazard structurally. In response to this problem, Government of Indonesia seeks and promotes a new approach that is an approach that promotes the resilience of community to live in harmony with flood such as <i>community service and empowerment of society</i> ; that consist of provision of early flood warning system and flood hazard mapping and risks guides, flood resistant building code, raising awareness, campaign, capacity building, education and training, etc. The resilience of community to flood programme is intended to abate the impact of flood for urban and sub-urban areas and rural areas as well. The targeted areas among others are JABODETABEK (Jakarta, Bogor, Depok, Tangerang dan Bekasi), Bandung, Semarang, Surabaya, Makassar, Denpasar, Padang, Medan, and Lampung and other cities that have flood prone areas.	N/A
Lao PDR	Flood forecasting by the Ministry of Agriculture and Forestry.	N/A
Malaysia	Flood forecasting (monitoring and modeling) Flood warning system	N/A
Myanmar	Townships and the Irrigation Departments are involved in flood control Department of Meteorology and Hydrology conducts weather forecasting and issues daily reports Preventive contingency plan	Cooperation with international organisations and neighbouring countries
Philippines	Flood assessment and reporting through National Disaster Coordinating Council Establishment of NDCC (regional, provincial, municipal and barangay levels) Conduct basin-wide studies	N/A
Singapore	Drainage Department, PUB, (Public Utilities Board) provide a first-rate drainage system to: Harness rainwater for Singapore's needs Keep Singapore flood free Protect the country against public health risks	N/A



Thailand	Installation of flood monitoring and advanced warning systems in the river basins at risk	N/A
Viet Nam	Statistics, frequencies, observation, measurement	N/A

**Question 10b:** What techniques whether planning or technological are used to prevent flooding?

Question 10b	Techniques used to prevent flooding	
Country	Plans	Technology
Brunei Darussalam	N/A	N/A
Cambodia	To prevent the damage that may occur as a result of floods, a strategic plan is being prepared to: <ul style="list-style-type: none"> <li>Control of floods and abatement/reduction of the effects thereof</li> <li>Improvement of weather forecast to ensure timely warning of natural occurrences</li> <li>Prevention of watershed degradation</li> <li>Continue to cooperate and exchange information with the other Mekong Basin countries in order to prevent the harmful effects of floods</li> <li>Construct Flood Emergency Centre in Phnom Penh Capital that is supported by MRC and provides flood preparedness programmes, information dissemination forecasting and warning system operating basin wide</li> </ul>	Construction of dams and dykes along the riverbanks of floodplain and drainages for protecting areas announcements of disaster likelihood in risk areas.
Indonesia	'Community service' and 'empowerment of society' approach by the Government to promote the 'resilience of community to live in harmony with flood'. These provides: early flood warning system, flood hazard mapping, risks guides, flood resistant building code, raising awareness, campaign, capacity building, education and training. Master plans for flood control infrastructures are completed, awaiting construction of the programme. Target areas: Jakarta, Bogor, Depok, Tangerang, Bekasi, Bandung, Semarang, Surabaya, Makassar, Denpasar, Padang, Medan. Landuse planning, integrated water resources management, provision of adequate urban-rural infrastructure and low price housing.	Indonesia has about 5860 rivers, with 600 of these impacting significantly on social and economic conditions. To mitigate the flood hazard on these 600 rivers requires about 30,000 km of river training and 15,000 km of dykes. However, the capacity of government to do this is about 300 km of river training and 150 km of dykes respectively. Therefore it will take about 100 years to mitigate the flood hazard structurally. In response to this, the Indonesian Government is focusing on flood warning systems, flood hazard mapping and risk guides, flood resistant building codes, awareness raising, capacity building and training.
Lao PDR	Strategy of disaster management (2003-2020) and 3 years Action Plan (2003-2005) of National Disaster Management Committee, 2003: Improve the drainage systems Issue regulation on landuse and land management Flood preparedness programmes: warning systems, conduct training on how to prevent flood, awareness through the media	N/A
Malaysia	Urban Stormwater Manual (planning and developmental approval control through the application of control at source) Started Integrated River Basin Management systems for the whole country.	N/A
Myanmar	In line with the guideline of the State Peace and Development Council, the National Disaster	Construction of storage dams upstream to prevent flooding

	Preparedness, Relief and Resettlement Committee has been set up.	Construction of dykes along the riverbanks of floodplain
Philippines	Information dissemination, forecasting and warning system, watershed management, evacuation system, basin-wide development, etc	Sabo Dam, revetment, retaining wall, dykes, consolidation dams, levee, spurdikes, flood control dam, retarding basins, etc
Singapore	To develop and evolve comprehensive drainage plans in tandem with landuse plans and developments Plan, design, and implement drainage schemes to prevent and alleviate flooding Maintain and safeguard the national network of drainage infrastructure and flood control facilities	N/A
Thailand	N/A	Construction of dykes for protecting risk areas. Announcement of disaster possibility in risk areas
Viet Nam	Structural and non-structural measures Measures differ according to regions Flood Control, co-existing with flood National Water Policy and Strategy	Planting of mangroves by the Red Cross since 1994 in Northern Viet Nam to act as buffers against the sea, reducing 1.5 m waves into harmless, centimetre-high ripples.

**Question 10c:** What measures are taken to mitigate societal and economic impacts of flooding?

Question 10c	Measures used to mitigate the social and economic impacts of flooding
Country	Social and Economic Aspects
Brunei Darussalam	N/A
Cambodia	National Cambodian Disaster Management Offices have been established at provincial level and with close linkages at National level. Emergency assistance unit (Red Cross) has also been established. Generally there has been structural improvement, the development of awareness programmes and an improvement in warning forecasts.
Indonesia	Search and rescue measures, evacuation, emergency supports such as temporary shelters, food supplies and medical services for disaster victims. Activated National Board for Coordination of Disaster Mitigation and Refuge Management at Central Level, and Provincial and District/City Task Force for Disaster Mitigation for Provincial and District/City levels. Reconstruction of public infrastructures and facilities Provision of budgets for emergency measures at national, provincial and district/city levels
Lao PDR	Setting up of Disaster management office in Districts and in the future, at village level Training course on Disaster Management at District Levels Improve data and information network Improve the weather forecast and disaster management systems Introducing a warning centre to distribute Disaster information Set up emergency help unit Coordinate with line agencies to cope with the flood
Malaysia	Preventive approach: disaster management (flood fighting and relief operation) Curative approach: flood mitigation programmes (construction of flood detention storages, dams, river canalization, flood by-pass, dykes)
Myanmar	In line with the guideline of the State Peace and Development Council, The National Disaster Preparedness, Relief and Resettlement Committee has been set up to: Create early warning systems Arrange contingency plans Manage donations Lead and guide the state and divisional committees Draw short and long term plans for prevention, relief and resettlements and create public education and awareness.
Philippines	Community development/redevelopment Livelihood programme

	Resettlement Lending mechanism Emergency loans
Singapore	PUB has an on-going drainage development programme to improve drains and canals to alleviate and prevent flooding Flood advisories are issued to residents/shop owners in low-lying areas to warn them of possible high tides Flood alerts are incorporated in weather advisory given to radio stations The public may call the 24-hr call centre, PUB-One for flood updates
Thailand	Announcement of disaster possibility, for evacuation The evacuation of people out of risk areas Awareness raising for preparedness of people in risk areas
Viet Nam	Time-shifting crops and change in the variety of crop Improve infrastructure Awareness programmes Improvement or warning forecasts

**Question 10d:** What approaches are taken nationally and internationally to identify the extent of drought and its likelihood of occurrence?

Question 10d	Approaches to identify the extent of drought and its likelihood of occurrence	
	Nationally	Internationally
Brunei Darussalam	N/A	N/A
Cambodia	Structural* and non-structural measures** and assessment of drought related damage.	N/A
Indonesia	Drought recording and forecasting and weather forecasting	N/A
Lao PDR	No data because drought is not severe	No data because drought is not severe
Malaysia	Drought forecasting and monitoring programme by the Department of Irrigation and Drainage (DID)	N/A
Myanmar	N/A	N/A
Philippines	Creation of El Nino Task Force (Inter-agency) Assessment of damages related to drought	N/A
Singapore	Not applicable	Not applicable
Thailand	Close monitoring of weather forecast worldwide, focusing on impact at country level Assessing its impact to certain areas of the country	N/A
Viet Nam	Structural* and non-structural measures** Improving the warning forecasts	N/A

\*Structural measures: building of infrastructure such as water diversion and delivery systems

\*\*Non-structural measures: policy reform, economic and related market based initiatives

**Question 10e:** What techniques whether planning or technological are used to prevent drought?

Question 10e	Techniques used to prevent drought	
Country	Plans	Technology
Brunei Darussalam	N/A	N/A
Cambodia	Long term and seasonal prediction of drought is provided to the public including close weather monitoring, especially world weather phenomena in relation to El Nino. Water conservation techniques are deployed and altering planting times and crop varieties to maximise seasonal weather/rainfall.	Seasonal and long term climate prediction. Expansion of irrigation schemes – mostly pumped irrigation for intervention during prolonged dry season.
Indonesia	Short-term: Change land-use practices, irrigation from reservoir and aquifers, relief programmes, protecting priority users. Long-term: changing crop types, building storage reservoirs, building security at local and family level.	Seasonal and long term climate prediction. Other measures include the construction of a multipurpose dam on the Cimanuk River, W. Java, and other small scale reservoirs (water ponds) on the north coast of Java to mitigate acute drought and flood problems.
Lao PDR	No data because drought is not severe	No data because drought is not severe
Malaysia	N/A	Construction of water impoundment storages, inter-basin water transfer (from water rich states), rainfall harvesting Groundwater withdrawal (within permissible limits)
Myanmar	Increasing the construction of impounding reservoirs in drought prone areas.	Pump irrigation at dry zones
Philippines	Implement projects related to El Nino programmes such as water supply, small water impounding dams, etc	N/A
Singapore	PUB is diversifying its water sources. There will be 4 water sources: <ul style="list-style-type: none"> <li>Local reservoir</li> <li>Water from Johor, Malaysia</li> <li>Desalination</li> <li>Reclaimed water</li> </ul>	N/A
Thailand	Plans to increase water sources from groundwater, portable water, rainwater harvesting.	N/A
Viet Nam	Time-shifting crops and change in the variety of crop Improve infrastructure Awareness programmes Improvement or warning forecasts	N/A

**Question 10f:** What measures are taken to mitigate societal and economic impacts of drought?

Question 10f	Measures used to mitigate the social and economic impacts of drought
Country	Social and Economic Aspects
Brunei Darussalam	N/A
Cambodia	Ministry of Water Resources and Meteorology provides warning through the national campaign for intervention in drought situations. Water conservation has been strengthened and water storage capacities have been improved. Altering planting times and crop varieties to

## WATER RESOURCE MANAGEMENT IN ASEAN MEMBER COUNTRIES

A QUESTIONNAIRE TO ASSIST IN ASSESSING CURRENT PRACTICE  
AND PRIORITIES FOR ACTION

	maximise seasonal weather/rainfall.
Indonesia	National campaign for drought mitigation such as water conservation, etc Provision of drinking water trucks for critical areas Distribution of movable pumps for communal water supply system and small scale irrigation systems
Lao PDR	Setting up of Disaster management office in districts and in the future, village levels Training course on Disaster Management at District Levels Improve data and information network Improve the weather forecast and disaster management systems Introducing a warning centre to distribute Disaster information Set up emergency help unit Coordinate with line agencies to cope with the drought
Malaysia	Flood risk mapping and warning (including advisory services) "Save water" campaigns Strict adherence to the planting schedule (paddy) Rescheduling of irrigation peak supply period and zoning for staggered supply or water rationing Real time drought forecasting is also used to change planting and/or rationing schedules
Myanmar	N/A
Philippines	Livelihood programmes Lending mechanism Emergency loans
Singapore	Public education and publicity programme to encourage public to conserve water.
Thailand	Detection of risk areas Advice to communities to store water during the rainy season Inspection and maintenance of infrastructure
Viet Nam	Structural and non-structural measures Improving the warning forecasts

*This questionnaire is being conducted to collate available information that will enable us to develop a coordinated ASEAN Strategic Plan of Action for implementing the Strategic Plan for Water Resources Management in the ASEAN member countries over the next five years. As stated in earlier communications please do not worry too much about spending large amounts of time collating every last piece of information that may be available. In the end the Strategic Plan of Action on Water Resources Management will be concentrating on developing the key actions for immediate implementation and the information gathered will be used in this general context.*

Name:  
Agency:  
Contact Details:  
Postal Address:  
Telephone:  
Mobile Telephone:  
E-mail:

**PLEASE NOTE!** Throughout this questionnaire there will be questions which may be well answered by a section in a document, a complete document or even a series of papers or publication. It is perfectly satisfactory for you to answer the question by referring us to that document. If this is the case it would be very helpful if you could refer us to the specific page numbers or document number. If documents are used in this way we would be very grateful if hard copies were sent to us at

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## AJ INTRODUCTION

Integrated Water Resources Management (IWRM) can mean different things to different people. It can vary from the provision of infrastructure of urban pipes, through to the management of forests on water supply catchments or the introduction of new water treatment technologies. When you consider the *Long Term Plan for Water Resources management in ASEAN member countries* could you identify for us all major government and non-government agencies, organisations, ministries or departments that could have a role in its implementation in your country or in your country in collaboration with a neighbour (a copy of this plan is attached)

Agency:  
Role in Long Term Plan:  
Contact Details:  
General Correspondence:  
For Questionnaire:

Have they been consulted in the answers to this questionnaire? [ ] Yes [ ] No

Agency:  
Role in Long Term Plan:  
Contact Details:  
General Correspondence:  
For Questionnaire:  
Have they been consulted in the answers to this questionnaire? [ ] Yes [ ] No

Agency:  
Role in Long Term Plan:  
Contact Details:  
General Correspondence:  
For Questionnaire:  
Have they been consulted in the answers to this questionnaire? [ ] Yes [ ] No

Agency:  
Role in Long Term Plan:  
Contact Details:  
General Correspondence:  
For Questionnaire:  
Have they been consulted in the answers to this questionnaire? [ ] Yes [ ] No

Agency:  
Role in Long Term Plan:  
Contact Details:  
General Correspondence:  
For Questionnaire:  
Have they been consulted in the answers to this questionnaire? [ ] Yes [ ] No

## B] MAJOR ISSUES AND PRINCIPLES

"What we must have in an action plan"

1. What are the three or four most important principles that guide IWRM in your country? Why do you regard these principles as important?

a.) Principle:

Reason:

b.) Principle:

Reason:

c.) Principle:

Reason:

d.) Principle:

Reason:

2. Please list the four most important or strategic issues for your country that relate to the Long Term Strategic Plan

1.

2.

3.

4.

## C] SUPPLY AND DEMAND

How much water do we have and how should we use it wisely?

3. Available Resources

a) What are the gross or total volumes of water supplies available in your country in either million cubic metres or cubic kilometres or any other unit? Please circle the unit used or describe any other unit you may prefer.

Surface Water	Million cubic metres Cubic kilometres Other Units
Groundwater	Million cubic metres Cubic kilometres Other Units

4. Demand Considerations

a) What are the current demands of differing sectors?

Industry:  
Mining:  
Agriculture/ Irrigation:  
Domestic Supply:  
Environmental Purposes:

b) What are the projected demands for the year 2025 given current water use patterns?

Industry:  
Mining:  
Agriculture/ Irrigation:  
Domestic Supply:  
Environmental Purposes:

c) When you consider the country overall (there is no need to get down to individual cities, towns or villages) are there currently any demographic groups (e.g. household type, female, urban, rural) or particular regions with lack of access to adequate **quantity** of water supply? [ ] Yes [ ] No

If YES Please describe the demographic groups or regions and any current plans to create supply.

d) How adequate are the supplies for each sector likely to be in the year 2025?

i). Industry    Plenty/Adequate/Inadequate

If Inadequate please outline reasons:

Does your country have any plans to assist supplementing supply in this situation?

ii). Mining      Plenty/Adequate/Inadequate

If Inadequate please outline reasons:

Does your country have any plans to assist supplementing supply in this situation?

iii) Agriculture/Irrigation    Plenty/Adequate/Inadequate

If Inadequate please outline reasons:

Does your country have any plans to assist in supplementing supply this situation?

iv) Domestic      Supply Plenty/Adequate/Inadequate

If Inadequate please outline reasons:

Does your country have any plans to assist supplementing supply in this situation?

(v) Environmental Purposes    Plenty/Adequate/Inadequate

If Inadequate please outline reasons:

Does your country have any plans to supplementing supply assist in this situation?

#### 5. Demand Management

a) Industry

Do you have a demand management programme for industry? [ ] Yes [ ] No  
If Y Please describe

How much do you think this programme will lessen or modify projected demand for this sector by the year 2025?

b) Mining

Do you have a demand management programme for mining? [ ] Yes [ ] No  
If Y Please describe

How much do you think this programme will lessen or modify projected demand for this sector by the year 2025?

c) Irrigation

Do you have a demand management programme for irrigation? [ ] Yes [ ] No  
If Y Please describe

How much do you think this programme will lessen or modify projected demand for this sector by the year 2025?

d) Domestic Supply

Do you have a demand management programme for domestic supply?  
[ ] Yes [ ] No If Y Please describe

How much do you think this programme will lessen or modify projected demand for this sector by the year 2025?

## D] WATER QUALITY AND SANITATION

*How do we maintain good quality drinking water, safe treatment and disposal of wastewater and maintain good health?*

### 6. Water Quality Issues

- a) At a national level are there currently groups with lack of access to adequate **quality** of water supply? [ ] Yes [ ] No

If YES Please describe the group and any current plans to create quality improvement supply?

- b) Are there any plans to introduce lesser water quality sources for alternative purposes?

- c) Is recycling of grey or blackwater (water in the sewer) being considered?

- d) Are there any programmes to improve water quality in the environment or within a reticulated water system? [ ] Yes [ ] No

If YES Please describe

- e) Are there water quality monitoring programmes in place [ ] Yes [ ] No  
If YES please describe

### 7. Sanitation

- a) What percentage of the population has access to sanitation? %

- b) For whom and where is sanitation lacking (e.g. you may consider a range of situations from individual buildings in major towns, through to communal systems in rural areas and so on)?

- c) Are any programmes in place to provide greater access to sanitation?  
[ ] Yes [ ] No If YES Please describe

### 8. Health and Water Management

- a) What are the key programmes your country has in place to counter water borne disease (whether carried by insects or water pollutants such as organic compounds, toxic plant growth or inorganic compounds such as those containing arsenic)?

- b) What are the priority areas for improvement or new programmes?

## EJ ALLOCATION

*How do we share water?*

### 9 Competition for resources

a) Do you see the user sectors (industry, mining, agriculture, domestic, and environment) as competing for water? [ ] Yes [ ] No

If Yes what are the major areas of competition between differing sectors (including the environment for water resources (both national and international)?

b) What mechanisms (including institutions and legislation) are in place to assist in achieving equitable allocation and water sharing (both national and international)?

c) If conflict occurs what means are used to manage or resolve it (both within and between nations)?

d) Are there any specific processes or mechanisms you would like to see put in place to deal with conflict?

e) Are specific allocations of water provided for environmental protection in your country? [ ] Yes [ ] No  
If Y please describe what water has been allocated and why?

- What are the three main factors impacting on the integrity/health/ ecological sustainability of aquatic ecosystems in your country?
- Does your country have any existing or planned legislation for protection of aquatic environments?

ASEAN countries are party to a number of agreements such as RAMSAR for wetlands? Please describe the international agreements that your country has:

## FJ EXTREME EVENTS

*How do we cope with too little and too much water?*

### 10. Managing Drought and Flood

a) What approaches are taken nationally and internationally to identify the extent of flooding and its likelihood of occurrence?

b) What techniques whether planning or technological are used to prevent flooding?

c) What measures are taken to mitigate the societal and economic impacts of flooding?

d) What approaches are taken nationally and internationally to identify the extent of drought and its likelihood of occurrence?

e) What techniques whether planning or technological are used to prevent drought?

f) What measures are taken to mitigate the societal and economic impacts of drought?



## G] SOCIETAL ISSUES AND CAPACITY BUILDING

*How do we create and build our community access and responsiveness to water resources?*

### 11. Community and Partnership Issues

- a) Are there programmes to encourage awareness of the wider societal and environmental benefits of water and water resource management issues?  
 Yes  No If YES Please describe
- b) Are there gender concerns in the provision of water supply and other water issues?  Yes  No If YES please describe
- c) Are there any current initiatives to try to overcome gender concerns?  
 Yes  No If YES please describe
- d) What provision for the individuals in the general community to become involved in IWRM is made?
- e) What provision is made for organised community (existing Non Government Organisations) or industry promotion groups (stakeholders) to become involved with IWRM?
- f) Is there a programme to enhance the capacity of individuals and groups to gain skills in becoming involved with IWRM?  Yes  No  
If YES please describe
- g) Are partnerships being created with private industry?  Yes  No  
If YES please describe.
- h) Who provides new information or research when it is required?

## H] GOVERNANCE

*How well do we organise ourselves to look after our water resources?*

12. Do current ways of governing or managing IWRM promote and achieve effective cooperation and collaboration between stakeholders in your country?  
 Yes  No If NO please explain

13. Are new ways of creating effective governance or management of IWRM being explored?  
 Yes  No If YES Please describe

14. Are whole of basin management organisations in existence for your key water resources?   
Yes  No If YES Please describe

15. Are international arrangements for governance in place to assist you with IWRM?   
Yes  No If YES Please describe

16. Are changes or improvements to these arrangements being considered?  
 Yes  No If YES Please describe

17. To achieve IWRM a number of general functions are required to be conducted by your institutions. These include planning, research, delivery of programmes, monitoring of the quantity and quality of water resources and ongoing overall evaluation as to how well IWRM is progressing.

a) Could you briefly describe the current approach to PLANNING in your country or refer us to appropriate documents?

Are there any key areas in terms of delivery of planning that you would like to see given more resources or skills? Why?

b) Could you briefly describe the current approach to IWRM related RESEARCH in your country or refer us to appropriate documents?

Are there any key areas in terms of doing research that you would like to see given more resources or skills? Why?

c) Could you briefly describe the current approach to PROGRAMME IMPLEMENTATION in your country or refer us to appropriate documents?

Are there any key areas in terms of implementation of programmes that you would like to see given more resources or skills? Why?

d) Could you briefly describe the current approach to WATER QUALITY AND QUANTITY MONITORING in your country or refer us to appropriate documents?

Are there any key areas in terms of implementing water quality and quantity monitoring that you would like to see given more resources or skills? Why?

e) Could you briefly describe the current approach to EVALUATION of progress in IWRM in your country or refer us to appropriate documents?

Are there any key areas in terms of implementing evaluation of progress in IWRM that you would like to see given more resources or skills? Why?

## I] PRIORITIES FOR ACTION

*What do we need to do first?*

18. Having considered your responses to this questionnaire –what are the five most urgent areas for inclusion in a Strategic Plan of Action over the next five years?

- 1.
- 2.
- 3.
- 4.
- 5.

19. Which of the issues in this questionnaire or outside would you like discussed at the workshop for the Strategic Plan of Action workshop later this year?

20. Are there any issues in relation to your national or international IWRM that you would like to bring to our attention?

## JJ REPORTS

21. Please list any existing reports that you have for your country which relate to the issues in this questionnaire.