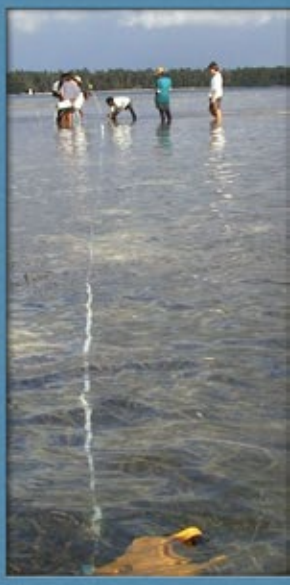
Bay of Bengal Large Marine Ecosystem Project



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NATIONAL REPORT OF MYANMAR

On the

Coastal Pollution Loading and Water Quality Criteria

(Land-based Sources of Marine Pollution)

Prepared

By

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Acronyms & Terms

AMEQC	ASEAN Marine Environmental Quality Criteria
ANZECC	Australia and New Zealand Environment and Conservation Council
As	Arsenic
ASEAN	Association of South East Asia Nations
AWGCME	ASEAN Working Group on Coastal and Marine Environment (TH)
BOBLME	Bay of Bengal Large Marine Ecosystem
BOB	Bay of Bengal
CCME	Canadian Council of Ministers of the Environment
Cd	Cadmium
DO	Dissolved Oxygen
COD	Chemical Oxygen Demand
EPA	Environment Protection Authority
EPD	Environmental Protection Department
FAO	United Nations Food and Agriculture Organization
GPA	United Nations Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
Hg	Mercury
IAEA	International Atomic Energy Agency
LME	Large Marine Ecosystem
NCEA	National Commission for Environmental Affairs
NEMA	National Environment Management Authority
NH_3-N	Ammonia Nitrogen
NO_2-N	Nitrite Nitrogen
Pb	Lead
POPs	Persistent Organic Pollutants
ppt	parts per thousand
ppm	parts per million
SFT	Statens forurensningstilsyn (Norwegian Pollution Control Authority)
TSS	Total Suspended Solids
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme

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Hopefully, this report could make a significant contribution to the BOBLME project, particularly Myanmar portion of coastal pollution loading and water quality criteria.

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Coastal Pollution Working Group (Myanmar)
BOBLME Project

Executive Summary

Myanmar, Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) project and lay the foundations for a coordinated programme of action designed to improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

The BOBLME is one of 64 large marine ecosystems (LMEs) recognized world-wide, some of which have recently become the subject of the development of an ecosystem approach focused on sustainable management of biomass yields. The BOBLME covers 3.8 million sq km of sea area and includes approximately ¼ of the world's human population.

To implement the BOBLME project, there are four **Components** which composed of 16 **Subcomponents**. A key area under Project **Component 4** deals with coastal pollution loading and water quality criteria, more specifically, the development of a regional collaborative approach to identifying important coastal water pollution issues and to develop remedial strategies (**Subcomponent 4.2**).

To fulfill it, studies on some physicochemical properties of sea water samples from coastal regions in Myanmar have been carried out in Analytical Chemistry Research Laboratory, Department of Chemistry, University of Yangon since June 2010. Totally 55 samples from Rakhine, Deltaic, Dawei and Myeik regions were collected with GIS positions. Physicochemical properties (chemical oxygen demand, total suspended solids, ammonia nitrogen, nitrite nitrogen, phosphate, chlorophyll *a*) and heavy metal (Pb, Cd, Hg) contents of the sea water samples were determined and compared with acceptable levels of international and ASEAN standards.

In the coastal regions of Myanmar, the sewage, excess nutrients from agriculture and aquaculture, chemical fertilizer residue, POPs from used pesticide residue and used household materials like plastic bags, medical wastes, excreted pharmaceuticals, etc. are main components of land-based source for coastal pollution.

The ammonia nitrogen and nitrite nitrogen concentrations are under the acceptable level of ASEAN and other countries. Average phosphate (inorganic phosphate or orthophosphate) concentrations of the sea water samples were 0.0244, 0.0305, 0.0265 and 0.0237 ppm in Rakhine, Deltaic, Dawei and Myeik regions, respectively. These values were

below the criteria value of ASEAN and other countries. Higher concentrations of phosphate were observed in the two samples related to mouth of Yangon River in Deltaic coastal zone and to Pandinin (near mouth of Dawei river). From these results, it can be deduced that the studied regions are not eutrophicated with nitrogen and phosphorus species. Median values of nitrogen and phosphorus were found in Deltaic and Dawei regions. This may be related with residual chemical fertilizer from land-based source. Among the samples, a highest total suspended solid (TSS) was found in the sample that is from mouth of Yangon river. Generally, TSS values are in the acceptable range. Higher COD values were found in two samples related to mouth of Yangon River and near Maungmagan.

There are no refineries along the coastal regions in Myanmar; however, one refinery is located near Yangon River close to the coastal region. Currently, eleven and nineteen offshore gas platforms in the Rakhine coast and Gulf of Mottama (Martaban) in the Deltaic coastal zone are operating, respectively and there is no oil platform in Myanmar coastal regions.

Lead (Pb) concentrations in the sea water samples are under the acceptable level except that the sample related to mouth of Yangon River. Average concentrations of mercury in sea water samples of Rakhine, Deltaic, Dawei and Myeik coastal zones were 1.03, 1.53, 1.39 and 1.07 ppb, respectively. The cadmium (Cd) contents of the most of the sea water samples were lower than ASEAN acceptable level of 10 ppb.

In the heavy metal studies on invertebrates, Hg, Pb, Cd and As (arsenic) concentrations in cuttlefish (*Sepia aculeata*), squid (*Loligo duvauceli*) and crab (*Scylla serrata*) samples were determined according to three sizes (small, medium and large). The cuttlefish and squid were caught in Taninthayi coastal zone and crabs were caught from Ayeyarwady Region. Samples were collected in summer (March), rainy season (July) and winter (December). Average concentrations of Hg, Cd, Pb and As in cuttlefish samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively. Average concentrations of Hg, Cd, Pb and As in the squid samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively. Average concentrations of Hg, Cd, Pb and As in the crab samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively.

In the heavy metal (Pb, Cd, Hg, As) studies on the three different fish species, yellow cat fish (*Pangasius pangasius*), giant sea perch (*Lates calcarifer*), and striped snake head (*Channa striata*) were caught from Dadaye Township in Ayeyarwady region in Deltaic coastal zone. Among the four metals, Pb was the highest concentration in all fish species. Concentrations of lead were in the range of 0.202 to 0.487 ppm for *Pangasius pangasius*,

0.157 to 0.298 ppm for *Lates calcarifer*, and 0.137 to 0.225 for Channa striata. The heavy metals in order of concentrations in these three fish species were Pb >As >Cd >Hg. All values are under the maximum permitted values of As (< 1.0 ppm), Cd (< 1.0 ppm), Pb (< 2.0 ppm) and Hg (< 0.5 ppm).

Myanmar has signed the United Nations Convention on the Law of the Sea in 1982. In 1988, Myanmar acceded to the International Convention for the Prevention of Pollution from Ship 1973 and the Protocol of 1978 (MARPOL 1973/78). Myanmar acceded to the Stockholm Convention on Persistent Organic Pollutants on 19-04-2004.

Myanmar Agenda 21 aims to address the following activities, to promote research and monitoring programmes, to develop and implement strategies for the sustainable use of marine resources, to strengthen legal and regulation framework, to enhance education and awareness campaign, to conserve marine biological diversity, to establish a coordinating mechanism and to promote coastal zone management and development.

Myanmar has a number of sectorial laws that are related to protecting and conservation of natural resources and control of pollution. They are the Factories Act 1951, the Forest Law 1992, the Pesticide Law 1990, the Myanmar Marine Law 1994, the Myanmar Pearl Law 1993 and the Water Power Act 1927. The Law Relating to Aquaculture 1989, The Law Relating to the Fishing Rights of Foreign Fishing Vessels 1989, the Myanmar Marine Fisheries Law 1990 and the Freshwater Fisheries Law 1991 are provided for further development of fisheries, preventing over fishing, safeguarding and protection of fishing grounds and management of fisheries. These laws prohibit fishing without license, causing water pollution, use of destructive fishing practices and promotion of sustainable use of fishery resources.

Research works related to BOBLME project are on-going process and technical (training/ fellowships/ partnerships) and materials supports from UN agencies (UNEP/GPA/IAEA) and other stakeholders are necessary to implement the work successfully. Also international collaboration among working groups, regional laboratories and BOBLME member countries are essential.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. The Bay of Bengal Coast of Myanmar

1.1 Bio-geographical Features

Myanmar is the largest country in mainland Southeast Asia comprising a land area of over 676,577 square kilometers and geographically located between 9°32' and 28°31' N latitude and 92°10' and 101°11' E longitude stretching over 2280 kilometers. It shares common maritime boundaries with Bangladesh in the north-east of the Bay of Bengal and with Thailand and India in the Andaman Sea which is a part of the Bay of Bengal. Myanmar continental shelf covers approximately 230,000 sqkm with a relatively wider portion in the central and southern parts. The Exclusive Economic Zone (EEZ) is about 486,000 sqkm. The coastal zones of Myanmar can be subdivided into three main areas, namely Rakhine Coast, Ayeyarwady Delta and Tanintharyi Coast. Many rivers flow into the coastal zones such as the "Mayu" and "Kaladan" rivers in the Rakhine Coastal area; the "Ayeyarwady", "Sittaung" and "Thanlwin" rivers in Delta coastal area and the "Yae", "Dawei", "Tanintharyi" and " Lenya" rivers in the Tanintharyi coastal area.

1.1.1 The Rakhine Coastal Zone

The Rakhine Coastal Zone is bounded by the Bay of Bengal in the west and has a total land area of 367,780 sqkm. The mountain ranges within the state, stretches from Bangladesh to the Chin State and slope downwards from north to south having average elevations of about 900 meter. The northern valley area is narrower than the southern valley; better known as the Sittwe valley is considerably wide. The Rakhine Coast stretches 740 km from the Naff River to Mawdin Point. The upper part of the coastline is shallow and deltaic. The southern part is more or less rocky. Continental shelf down to 200 – meter depth is narrow compared to other areas. Two big islands namely "Yan-bye Kyune"(Ramee Island) and "Man-aung Kyune" (Cheduba Island), exist near the Sittwe valley of the Rakhine coast.

The hydrographic condition of the Rakhine Coast is heavily influenced by the monsoon. During the rainy season, the surface waters are extensively mixed with freshwater poured down from runoffs by the rivers. The southward flow of diluted seawater reduces the salinity to 18 ppt in the near shore areas whereas in the dry season a northward flow of high salinity water 34 ppt was recorded. Indications of local upwelling were frequently recorded near Munn Aung Island during Northeast Winds. Organic production, including fish, is relatively higher during this upwelling period.

1.1.2 The Deltaic Coastal Zone

The Deltaic Coastal Zone consists of the entire river – mouth areas of three major rivers, Ayeyarwady, Sittaung and Thanlwin. Administratively, this coastal zone lies within Ayeyarwady Division, Yangon Division and Mon State. The Ayeyarwady Division lies at the central part of the coastal area comprising land area of 35,138 sqkm. It is bounded by the southern waters of the Andaman Sea of the BOB. Apart from the western part of the zone, which is adjacent to Rakhine Yoma, the region is a flat alluvial plain with a network of tributaries of the Ayeyarwady River. These rivers together with the Sittaung and Thanlwin deposited enormous quantities of sediments. The annual sediment discharge of the Ayeyarwady River has been estimated at 250 million tons. The delta is enlarging seaward at the rate of 5 km every hundred years and the seaward advance of the Gulf of Mottama at its 40 m depth contours is estimated at 55 km every hundred years.

The coastal area of Yangon Division remains highly important for Myanmar's port facilities. Thilawar port is crucial for the development of the nation's expanding trade under the market-oriented economic system. The total area of Yangon Division bounded by the Gulf of Mottama (Martaban) is about 10,172 sqkm.

The Mon State consisting of the smallest portion of the coastal area is also bounded by Gulf of Mottama (Martaban). The Thanlwin River originating in China opens into the Gulf in Mon State and "Balu-Kyune" (Giant Island) lies at its mouth. The total area of Mon State is about 12,297 sqkm.

1.1.3 The Tanintharyi Coastal Zone

The Tanintharyi Coastal area is the longest coastal zone of Myanmar and is bounded by Andaman Sea in the west. This coastal zone covers south of the Gulf of Mottama up to the mouth of Pakchan River. It also includes Myeik Archipelago and Andaman Sea. Myeik Archipelago extends from Mali Island to Similand Island and contains about 800 islands covering an area of about 34,340 sqkm and is lying up to 30 km off shore. Some islands also exist at the northern part of this coastal area. The length of the mainland coast is about 1,200 km. and the total land area is about 43,344 sqkm. The coastal plain is narrow and gradually rises towards the east to become the Tanintharyi Yoma with 2,073 meter high Myint Moe Let Khat Taung as the highest peak.

The vertical temperature distribution in sea waters showed a maximum at the surface layer and then decreased with depth. However, salinity increased gradually with

depth and below 130 meter became rather constant. The thermocline zone of the Tanintharyi coast was presented at 50 meter depth to 230 meter depth (Myint Pe, 2003).

1.2 Coastal Activities

Coastal and marine resources provide essential ecological, economic and social services in Myanmar. Coastal and marine waters serve as sinks for wastes from land-based sources, provide livelihood directly and indirectly to millions of people in Myanmar, provide food, maintain water cycles, regulate climatic conditions, and maintain the complex ecological balance of coastal and marine ecosystems.

Fishery resources in Myanmar's coastal areas are typical of Southeast Asia. There are large quantities of fish and shrimp in the EEZ which have been important export items. The unpolluted sea along the Rakhine and Tanintharyi coasts is ideal for pearl culture. The fishery sector is of major importance to Myanmar since most of the nutrients in the diet of the population come from fish. In Myanmar, marine fisheries are important for local consumption and export. Fish provides a relatively significant and healthy part of the diet. Currently, the average per capita consumption of fish in Myanmar is estimated about 21.04 kg. The fisheries resources of Myanmar can play a crucial role in the production of food, improvement of income and generating of employment. Its industries create direct benefit to over 2.0 million people (Myint Pe, 2003).

According to the survey conducted in the marine fisheries, it was noted about 1.0 million tons of pelagic fish and 0.75 million tons of demersal fish existed as biomass in Myanmar marine fishery waters. Out of the total biomass, 0.5 million tons of pelagic fish and 0.55 million tons of demersal fish (altogether 1.05 million tons) is marked as annual maximum sustainable yield (MSY) out of which 0.88 million tons were exploited during 1999-2000.

Since the data has been collected only from the landing, it has excluded discarded fish at sea and the catch by innumerable poaching vessels, thus the capture fisheries production in the marine area may have reached MSY.

The fishery sector in Myanmar is also the fourth largest exchange earner after agriculture, timber, and minerals. Shrimp is the most important fisheries export. Although no data is available with the breakdown of products, shrimp may account for nearly 50% of the total value of fishery export. According to Department of Fishery, the value of fisheries exports reached US $ 95 million during the April-May 1999-2000 against total exports of US $ 828 million. This is a result of increased harvesting of brackish water shrimp. Privatization

of processing plants and the marketing system has also been a major stimulating factor in seafood exports. Most of the products are exported through the port of Yangon (Tables 1 and 2**)**.

Table 1. Export earnings from fishery product

Sr. No.	Year	US $ (million)
1	1988-89	10.2
2	1989-90	15.4
3	1990-91	13.0
4	1991-92	22.5
5	1992-93	51.0
6	1993-94	68.4
7	1994-95	120.6
8	1995-96	113.7
9	1996-97	163.0
10	1997-98	167.1
11	1998-99	201.3
12	1999-2000	183.7
13	2000-2001	218.3
14	2001-2002	251.5
15	2002-2003	317.4
16	2003-2004	166.9
17	2004-2005	189.7
18	2005-2006	271.4
19	2006-2007	468.2
20	2007-2008	561.0
21	2008-2009	483.2
22	2009-2010	496.59

Source: Department of Fisheries

2. Overview of Sources of Pollution

2.1 Land-based **(Both point and non-point sources of pollution)**

Most municipalities, industries and agriculture in Myanmar discharge waste into nearby creeks or rivers and waterways and usually not directly into the sea. In Myanmar it is almost a custom to discharge all kinds of waste into the rivers. Besides, the gradual growth of industries, increased use of fertilizers and pesticides, urbanization and discharge of municipal waste are continuously polluting the river system. Moreover, the numerous rivers and their tributaries that criss-cross the country carry pollutants of the whole catchment area including upstream areas.

Table 2. Export of fish and fishery products

Year	Fish		Shrimp/Prawn		Others		Total	
	Ton	US $ (million)	Ton	US $ (million)	Ton	US $ (million)	Ton	US $ (million)
1989-90	7116.9	4.0	2131.6	11.3	25.4	0.1	99273.9	15.4
1990-91	11621.1	5.9	1273.0	7.0	1033.5	0.1	13927.6	13.0
1991-92	11032.0	5.7	2672.9	15.8	554.1	1.0	14259.0	22.5
1992-93	21053.0	12.9	5827.1	34.0	1607.5	4.1	28487.6	51.0
1993-94	12884.1	12.7	6195.0	45.1	4136.7	10.6	23215.8	68.4
1994-95	78590.0	35.3	7940.0	63.2	10210.0	22.1	96740.0	120.6
1995-96	34740.9	28.5	8814.5	72.4	10805.4	12.8	54360.8	113.7
1996-97	41068.3	45.9	12827.8	95.6	13504.7	21.5	67400.8	163.0
1997-98	45853.7	54.2	13467.2	91.9	14859.0	21.0	74179.9	167.1
1998-99	70906.4	70.2	13764.5	97.0	42202.9	34.1	126873.8	201.3
1999-00	72210.1	68.8	15536.0	90.7	28863.1	24.2	116609.2	183.7
2000-01	92302.2	80.8	19477.3	104.2	32844.3	33.3	144623.8	218.3
2001-02	138250.7	103.6	21453.9	94.4	41962.2	53.5	201666.8	251.5
2002-03	136036.2	143.2	22868.1	105.2	54095.3	69.0	212999.6	317.4
2003-04	5791.7	62.9	14930.3	79.7	8870.6	24.4	81716.5	166.9
2004-05	77162.9	79.9	18335.9	92.1	8036.1	17.8	103535.0	189.7
2005-06	125107.8	131.8	18941.1	89.1	45842.4	50.6	189891.3	271.4
2006-07	188424.5	201.3	23943.2	105.7	73057.5	97.2	285425.2	404.1
2007-08	239706.4	310.0	20315.2	105.5	83852.2	133.7	343873.8	549.1
2008-09	227290.9	269.4	18278.3	88.3	72021.8	121.1	317591.0	478.7

Source: Department of Fisheries

The Ayeyarwady River is one vital artery waterway of Myanmar and is navigable throughout the year. Many industrial zones are known to be situated along the banks of the Ayeyarwady River. Among these industries, some industrial plants in one way or other directly discharge their industrial effluents without any waste treatment into the Ayeyarwady River. It is obvious that the quality of this waterway will eventually become affected due to the extended discharge. Yangon, with a population of about 5-millions discharges its sewage and industrial waste into the Yangon River, which is a tributary of the Ayeyarwady. A similar condition can be found in the river mouth of Thanlwin, which is about 50 miles south of Mawlamyaing, the third largest city with population of 700,000. The city of Pathein, which is the fourth largest city also discharge its waste into the Nga-wun

River, a tributary of Ayeyarwady. Overall fertilizer use in 1996-97 was quite high in the Ayeyarwady, Yangon and Mon area, where rice is commercially grown. But use of fertilizer in Rakhine and Tanintharyi remained relatively less. The most common fertilizer currently utilized are Urea, Triple Super Phosphate, Muriate of Potash and compound fertilizer for paddy in a small extent. However, the use of gypsum about 2,800 MT, is only common in Mon State. In total, about 53,000 tons of Urea, 15,000 tons of TSP, 6,700 tons of Potash, and 8,500 tons of compound fertilizers were used in the coastal states and division.

In comparison with the sown area of crops, the use of pesticides is rather low due to lack of availability and partly due to low level of incidences of pest and disease in the coastal region. Pesticides are mainly used in Ayeyarwady Division, Yangon Division and Mon States as there are larger and more intensive cropping area than Rakhine State and Tanintharyi Division. For the year 1996-97 Mon State used some 45,000 liters and 13,033 kg of pesticides, while the Ayeyarwady coastal zone utilized a total of 12,555 liters and 5,226 kg of pesticides. On the other hand, Yangon Division used 350,000 liters and 92,100 kg of pesticides for the same period. Tanintharyi utilized the least amount, with a nominal use of 2,200 liters and about 600 kg of pesticides (Myint Pe, 2003).

In 2009-10, about 252698 ton of chemical fertilizers were imported. Local chemical plants produced about 0.1 million ton annually. About 4940 metric ton of pesticides were imported to Myanmar in 2009-10.

As the overall utilization of agrochemical in the coastal zones of Myanmar, particularly in the Rakhine State and Tanintharyi Division is minimal, there is no immediate threat to the fragile ecological conditions of these areas. But as agricultural production expands, the uses of agrochemicals are bound to increase in the near future. The increased utilization of agrochemicals could adversely affect land and water resources, environment and biodiversity, and merit serious consideration in use and methods of application. As such, Integrated Pest Management practices should be applied to the most possible extent in order to reduce number of applications and scale of chemical usage.

2.2 Marine-based Pollution

There are eight major ports in Myanmar coastal areas, namely Sittwe, Than Dwe, Kyauk Phyu, Yangon, Mawlamyaing, Dawei, Myeik and Kawthoung. Ports and shipping operations are inherently hazardous to the marine environment. Fortunately, there has been no significant pollution incident recorded at the major ports. Major marine sources of pollution include ship-borne pollution and land based pollution. Land-based pollutants

originate from municipal, agricultural and industrial activities. Hence, major land-based sources of pollution are domestic sewage, solid wastes, agricultural wastes, and industrial effluents and wastes.

2.3 Priority Categories of Parameters

Although the big cities like Yangon, Mandalay and Nay Pyi Taw have the good sanitation and cleaning systems operated by City Development Committee, most of the towns along the coastal regions of Myanmar discharge different kinds of wastes into nearby creeks or rivers and finally they are going into the coastal sea water. Due to relatively small numbers of factories existing in the coastal regions, especially in Rakhine and Myeik regions, industrial wastes entering into the coastal water are negligible. Therefore, major wastes are sewage, excess nutrients from agriculture and aquaculture, chemical fertilizer residue, POPs from used pesticide residue and used household materials like plastic bags, medical wastes, excreted pharmaceuticals, etc.

Since the population densities in Rakhine and Myeik coastal regions are relatively low and tourism in these regions is in an initial stage, the wastes are of limited level. They cannot give high pollution. Pollution hot spot was observed in river mouth of Yangon where more than 5 millions of people are living.

3. Existing Water and Sediment Quality Objectives and Targets

Since becoming a member of the ASEAN in 1997, Myanmar has developed a closer and greater contact with the other ASEAN member countries through participation in regional programmes and projects, conferences, meetings, forums, workshops and training courses on various dimensions including economic, social, cultural and environmental aspects.

The Hanoi Plan of Action (1999-2004) called for the development of a framework to improve regional coordination for the integrated protection and management of coastal zones, development of a regional action plan for the protection of the marine environment from land-based and sea-based activities, and promote regional coordination to protect Marine Heritage Parks and Reserves.

The Vientiane Action Programme 2004-2010 (VAP), adopted and endorsed by the ASEAN Leaders during the 10th ASEAN Summit in Vientiane, Lao PDR, in 2004, succeeded the Hanoi Plan of Action. The VAP describes the goals and strategies towards

realising the ASEAN Community, which comprises of three pillars, the ASEAN Security Community (ASCC), the ASEAN Economic Community and the ASEAN Socio-Cultural

Community. Environmental cooperation generally falls under the ASCC and one of the key strategic thrusts of the ASCC is to promote environmental sustainability through environmental and natural resource management. The specific programme area and measures in the VAP on coastal and marine environment are as follows:

Item 3.3.7 Coastal and Marine Environment

3.3.7.1 Enhance inter-agency and inter-sectoral coordination at the national, regional and international levels for achieving sustainable development of the ASEAN's coastal and marine environment.

3.3.7.2 Further expand and implement the ASEAN Marine Water Quality Criteria.

3.3.7.3 Implement the ASEAN Criteria for Marine Heritage Areas, and ASEAN Criteria for National Protected Areas to establish a representative network of protected areas to protect critical habitats

The ASEAN Ministers responsible for environment have adopted the following criteria:

- The Marine Water Quality Criteria for the ASEAN Region (AMEQC, 2000)
- The ASEAN Criteria for National Marine Protected Areas
- The ASEAN Criteria for Marine Heritage Areas

The Marine Water Quality Criteria sets values for an initial set of 17 parameters (Table 3) for the protection of aquatic life and human health, while the Criteria for National Marine Protected Areas and ASEAN Marine Heritage Areas contain criteria for designation and management of existing and new protected areas. These Criteria would ensure concerted national level action to protect the shared marine waters of ASEAN.

ASEAN recognizes the numerous activities undertaken by various organizations in the region and welcomes collaboration with these organizations to ensure coordinated approach for implementation and capacity building. In line with its mandate, ASEAN is well placed to facilitate and provide the forum for developing and implementing regional activities, and more importantly to ensure ownership and sustainability of these activities through the regional and national governmental institutions.

Table 3. Marine water quality criteria for the ASEAN Region (For aquatic life protection)

Parameter	Criteria values	Note
Ammonia (NH_3-N)	0.07ppm	
Cadmium	10 ppb	
Chromium (VI)	50 ppb	Criteria value proposed by CPMSII is 48 µg /L. The meeting recommended to adopt 50 µg /L, following the existing national standards of member countries
Copper	8 ppb	As the proposed value 2.9 µg /L is too stringent, the meeting agreed to use round-up value of 7.7 µg /L, the product of the lowest LOEC from a chronic study 77 µg /L for reproduction for Mysidopsis bahia and a safety factor of 0.1
Temperature	Increase not more than 20°C above the maximum ambient temperature	
Cyanide	7 ppb	
Dissolved oxygen	4 ppm	
Lead	8.5 ppb	
Mercury	0.16 ppb	
Nitrate (NO_3-N)	0.06 ppm	A single criteria value should be derived for nitrate and nitrite combined in future
Nitrite (NO_2-N)	0.055 ppm	
Oil and grease	0.14 ppm	Other related parameter, e.g. PAH, should be proposed in the future
Total phenol	0.12 ppm	
Phosphate (PO_4^{3-})	0.045 ppm (Coastal) 0.135 ppm (Estuarine)	
Tributyltin	10 ppm	
Total suspended solids	Permissible 10% maximum increase over seasonal average concentration	
For Human Health Protection		
Bacteria	100 faecal coliform/100 mL 35 enterococci/100 mL	Coastal water quality for recreational activities

4. The National Program - Coastal Ocean Monitoring and Prediction

4.1 Mapping Hotspots along the Coast

The industries, agriculture and municipalities in Myanmar discharge waste into nearby creeks and rivers waterways are usually not directly into the sea. Therefore, some rivers are polluted with residual fertilizers, pesticides and municipal waste. There may be

pollution hot spots at the coast near the major river mouths, especially, Yangon, Ayeyarwady, Sittaung, Thanlwin, Dawai river mouths. At present, seasonal monitoring of properties of water at the major river mouths has been carried out.

4.2 Time Series Analysis and Significant Findings

The Analytical Chemistry Research Laboratory (ACRL) has been carrying out the determination of properties of sea water along the coastal regions in Myanmar since 2010. Sampling sites were recorded using GIS system. Samplings have been carried out seasonally and annually for time series analysis. On-going research works are:

(i) determination of petroleum hydrocarbon residues in sediment samples

(ii) determination of particulate petroleum residue (tar ball) on beach

(iii) determination of polycyclic aromatic hydrocarbon (PAH) and persistent organic pollutants (POP) in sea water samples

(iv) determination of heavy metal contents in sea water and sediment samples

It can be expected that detailed assessment of sea water quality of Myanmar may be accomplished during coming years. Technical (training/ fellowships/ partnerships) and materials supports from UN agencies (UNEP/GPA/IAEA) and other stakeholders are necessary to implement the work successfully.

4.3 Role of Ministry of Environment and Ministry of Fisheries

In the long term-term interests of the State, the National Commission for Environmental Affairs (NCEA) has been formed under the Government Notification No. 7/90 since 14th February 1990. It has been constituted with the Minister for Foreign Affairs as chairman and members are Heads of Department from various government agencies. Under the commission, four specialized committees are formed. They are:

- Committee on Conservation of Natural Resources
- Committee on Control of Pollution
- Committee on Research, Education and Information and
- Committee on International Co-operation (Yin Yin Lay, 1995).

The National Environment Policy of Myanmar was adopted under the Government Notification No. 26/97 on 5th December 1994. The Policy calls for harmony and balance between environment and development through the integration of environmental considerations into the development process. National Environment Policy forms the basis for developing environmental strategies, environmental programme and plans.

At present, Myanmar's environmental management pattern is largely sectoral. For instance, the Ministry of Forestry is responsible for sustainable forest management including wildlife conservation, while the Ministry of Industry controls and regulates industrial activities and pollution. The Ministry of Health is responsible for environment-related issues. Conservation of marine and fresh water fishery resources is carried out by the Ministry of Livestock Breeding and Fisheries. The environmental issues relating to agriculture are directly administered by the Ministry of Agriculture. The Ministry of Energy aims to save non-renewable energy for future energy sufficiency, to promote efficient utilization of energy and to prevent deforestation caused by the excessive use of fuel wood and charcoal.

As for marine resources, the Marine Fisheries Law of 1990 and the Fishing Rights of Foreign Vessels Law of 1989 govern marine fisheries. These laws regulate and control fishing. They provide for the preservation and protection of the marine environment and its resources, and also for the prevention of marine pollution. Under these laws, fishing through the use of explosives, poisons, chemicals or other dangerous materials of like nature is prohibited.

4.4 National Laboratories

The ACRL of the Department of Chemistry, University of Yangon, Yangon, Myanmar is actively involved in many fields of research including analytical environmental studies. Hla Phone Aung studied the water environment of Hmyin (*Acetes* and mysids) in Kadonkani, Deltaic coastal zone, Ayeyarwady Division, Myanmar (Hla Phone Aung, 1986). Ye Myint Aung studied the water quality of Bago river near prawn hatchery in Tharkayta, Yangon (Ye Myint Aung, 1993). Win Aung performed the environmental assessment of Bago river (Win Aung, 1995).

Some research works were concerned with the analytical studies on marine invertebrates (Win Win Than, 2008 and 2009) and fishes (Khin Thida Kyaw, 2008). Studies have been conducted on fishes regarding safety and quality parameters, e.g. studies on biogenic amine histamine, putrescine and cadaverine in scombroid fish such as tuna and mackerel and non-scombroid fish (torpedo scad and hilsa shad) (Khin Lay Kyi, 2008). Mary studied the biological formaldehyde in lizard fish during frozen storage (Mary, 2008).

In relation with BOBLME project, studies on some physicochemical properties of sea water from coastal regions in Myanmar have been carried out in Analytical Chemistry Research Laboratory, Department of Chemistry, University of Yangon, Yangon,

Myanmar. The metal contents in sea water samples were determined using atomic absorption spectrophotometer in the Universities' Research Centre (URC), University of Yangon under The Ministry of Education and Analytical Laboratory Section under Department of Fisheries.

The Universities' Research Centre (URC) is a multi-disciplinary research laboratory established in 1985 to assist and foster research activities in Universities, Colleges and Institutes of higher education as well as to provide services to departments of industry, research organization, cooperative societies and enterprises.

The major objectives of the URC are: to provide research facilities and technical help for post-graduate (MSc and PhD) students, to foster and promote effective multi-disciplinary and inter-disciplinary research across the wide spectrum of science and technology, with strong emphasis on applied research essential in the economic development (*e.g.* in the exploration and exploitation of natural resources). The URC is equipped with modern research instruments such as AAS, GC-MS, ED-XRF, XRD, TG-DTA, FT-IR, FT-Raman, UV-visible spectrophotometer, etc.

5. Present Status of Marine Pollution: Contaminant Levels in Water, Sediments, Fish and other Biological Resources

5.1 Eutrophication and Nutrient Dynamics; Chlorophyll; Chemical Oxygen Demand; Suspended Substances

Totally 55 samples from Rakhine, Deltaic, Dawei and Myeik regions were collected with GIS positions (Figures 1-4). Table 4 mentions the sample stations, sampling location and sampling dates of sea water samples. All samples are surface sea water (5 m depth). Table 5 shows some physicochemical properties of the sea water samples.

Average concentrations of ammonia nitrogen in sea water samples from Rakhine, Deltaic, Dawei and Myeik regions were found to be 0.020, 0.039, 0.033 and 0.293 ppm, respectively. Average concentrations of nitrite nitrogen in sea water samples from in Rakhine, Deltaic, Dawei and Myeik regions were found to be 0.016, 0.039, 0.027 and 0.0245 ppm, respectively. Table 6 mentions the acceptable levels of different forms of nitrogen in marine water set by various countries. The ammonia nitrogen and nitrite nitrogen concentrations are under the acceptable level of ASEAN (Table 3) and other countries.

In water bodies, the phosphorus may be present in various forms. All forms of phosphorus are not readily available to plants. Total phosphorus is a measure of all forms of phosphorus (dissolved or suspended) found in water. The soluble reactive phosphorus is a

measure of orthophosphate (inorganic phosphate) that is the form directly taken up by plant cells. While monitoring the water bodies, the latter form of phosphorus would be of special significance to determine the stage of eutrophy and oligotrophy.

Average phosphate (inorganic phosphate or orthophosphate) concentrations of the sea water samples were 0.0244, 0.0305, 0.0265 and 0.0237 ppm in Rakhine, Deltaic and Dawei and Myeik regions, respectively. These values were below the criteria value of ASEAN and other countries (Table 7). Higher concentrations of phosphate were observed in sample no. (13) from Deltaic coastal zone and sample no. (32) from Dawei region. The sample no. (13) is from mouth of Yangon River and sample no. (32) is from *Pandinin* that is near to mouth of Dawei river.

Table 8 mentions the criteria for evaluating degree of nutrient over-enrichment. Table 9 summarizes the minimum and maximum concentrations of nitrogen, inorganic phosphorus and dissolved oxygen (DO) in the sea water samples. From these results, it can be deduced that the studied regions are not eutrophicated with nitrogen and phosphorus.

Median values of nitrogen and phosphorus were found in Deltaic and Dawei regions. This may be related with residual chemical fertilizer from land-based source.

Among the samples, highest total suspended solid (TSS) was found in sample no. (13) that is from mouth of Yangon River. Generally, TSS values are in the acceptable range. Table 10 shows the **s**ummary of the recommended water quality guidelines for total suspended substances.

There are three basic types of suspended substances: (i) phytoplankton, zooplankton and bacterial blooms, (ii) suspended organic and humic acids and (iii) suspension of silt and clay particles. Suspended substances can cause gill irritations and tissue damage, which increases the stress levels of aquatic animals. Cold water fish has been killed upon exposure for 3 to 4 weeks to 500 to 1000 ppm of suspended substances. Turbid waters can also shield food organisms and clog filters. The effect of suspended substances varies considerably between species; a level below 80 ppm for aquaculture species, levels below 80 ppm were quite innocuous for freshwater fish and a level below 80 ppm for freshwater aquaculture is recommend. However, some species (e.g. rainbow trout) require lower levels of suspended substances so a median level of <40 ppm is recommended as the guideline (Table 10). Marine species (e.g. snapper) are generally less tolerant, so the recommended guideline is <10 ppm based on the lowest species recommendation i.e. snapper. However, as

brackish water species (e.g. prawns and barramundi) can tolerate higher levels the recommended guideline for such waters is <75 ppm.

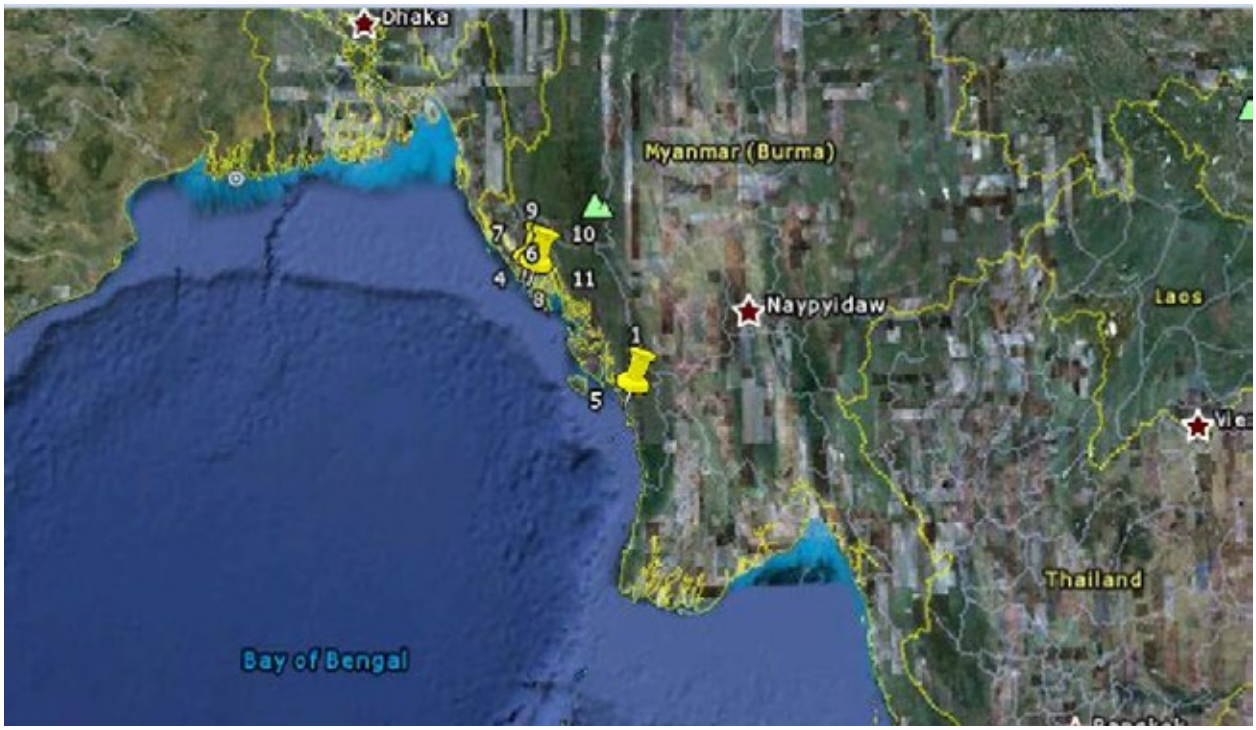


Figure 1 Sampling stations of sea water samples in Rakhine regions

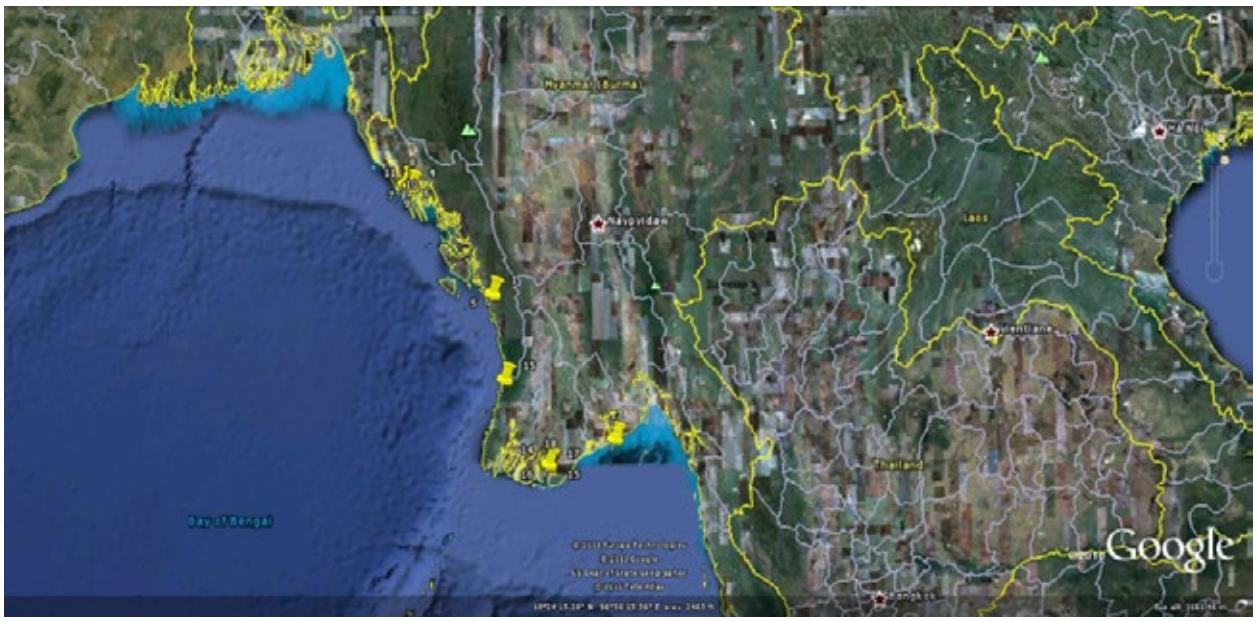


Figure 2 Sampling stations of sea water samples in Rakhine and Deltaic coastal regions

Figure 3 Sampling stations of sea water samples in Dawei regions

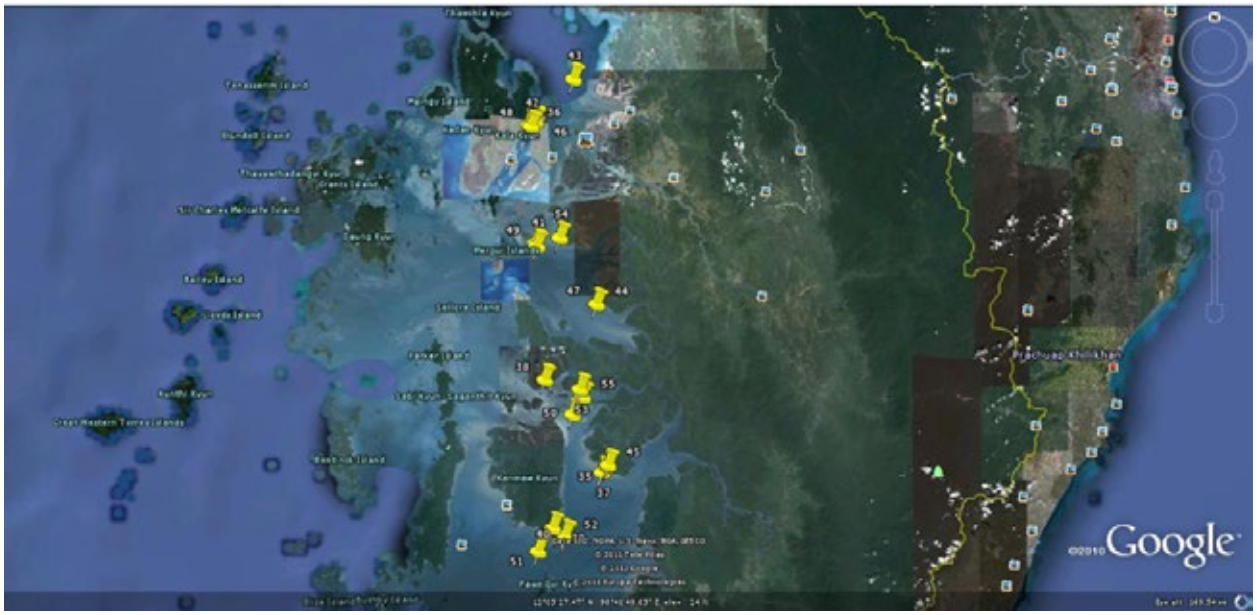


Figure 4 Sampling stations of sea water samples in Myeik Archipelago

Table 4. Sampling stations and sampling dates of sea water samples

Sample No.	Sampling station		Sampling date
	Longitude (E)	Latitude (N)	
Rakhine Coastal Zone			
1	94°17′26.5′′	18°28′3.1′′	19.7.10
2	92°47′13.6′′	20°9′48.8′′	29.7.10
3	92°47′58.4′′	20°9′37.1′′	29.7.10
4	92°54′3.9′′	20°6′42.9′′	29.7.10
5	94°17′26.3′′	18°28′2.7′′	19.8.10
6	92°48′7.7′′	20°9′20.2′′	23.8.10
7	92°53′17.3′′	20°7′1.6′′	25.8.10
8	92°54′0.9′′	20°6′48.7′′	25.8.10
9	92°48′21.3′′	20°9′18.3′′	3.1.11
10	92°53′28.9′′	20°6′55.6′′	4.1.11
11	92°54′2.5′′	20°6′48.5′′	4.1.11
12	92°17′24.8′′	18°28′14.8′′	7.1.11
Deltaic Coastal Zone			
13	96°17′42.0′′	16°13′42.0′′	27.7.10
14	95º13′9.6′′	15º50′18.8′′	31.10.10
15	95º13′15.5′′	15º49′7.8′′	31.10.10
16	95º13′17.1′′	15º48′56.0′′	31.10.10
17	95 º13′16.0′′	15º47′0.5′′	31.10.10
18	95º13′19.3′′	15º44′54.0′′	31.10.10
19	94°25′.826′′	16°57′.541′′	23.12.10
20	94°25′.596′′	16°57′.798′′	23.12.10
21	94°26′.170′′	16°58′.159′′	23.12.10
22	94°26′.161′′	16°58′.143′′	23.12.10
23	94°26′.879′′	16°58′.655′′	23.12.10
Tanintharyi Coastal Zone (i) Dawei Region			
24	97°56′13.6′′	14°9′14.5′′	15.8.10
25	97°58′34.1′′	14°11′12.4′′	15.8.10
26	98°40′9.2′′	11°40′9.2′′	15.8.10
27	97°57′46.5′′	14°6′28.9′′	16.8.10
28	98°43′12.8′′	11°57′11.4′′	16.8.10
29	98°36′7.2′′	11°46′9.2′′	16.8.10
30	98°29′34.8′′	11°51′29.8′′	17.8.10
31	98°30′49.8′′	11°31′50.8′′	17.8.10
32	98°38′14.5′′	11°44′36.3′′	18.8.10
33	98°28′24.6′′	12°54′9.1′′	18.8.10
34	98°43′12.8′′	11°5711.4′′	18.8.10

(ii) Myeik Archipelago			
35	98°54′28.9′′	12°27′49.1′′	18.8.10
36	98°27′13.2′′	12°26′32.5′′	18.8.10
37	98°37′24.0′′	11°51′41.5′′	19.8.10
38	98°33′36.4′′	12°21′49.1′′	20.8.10
39	98°30′33.9′′	11°31′45.6′′	20.8.10
40	97°55′15.1′′	13°51′10.1′′	3.9.10
41	97°55′04.7′′	14°11′37.8′′	3.9.10
42	98°27′34.1′′	12°26′22.1′′	28.10.10
43	98°35′29.2′′	12°32′49.5′′	28.10.10
44	98°36′41.1′′	12°2′11.2′′	28.10.10
45	98°43′13.4′′	11°40′20.0′′	1.1.11
46	98°28′12.8′′	12°27′2.4′′	2.1.11
47	98°36′33.6′′	12°2′14.6′′	3.1.11
48	98°27′13.4′′	12°26′32.2′′	3.1.11
49	98°28′12.9′′	12°10′30.5′′	4.1.11
50	98°33′19.5′′	11°47′13.6′′	5.1.11
51	98°48′31.8′′	11°28′34.7′′	6.1.11
52	98°38′21.4′′	11°44′28.9′′	15.1.11
53	98°34′21.9′′	11°50′39.4′′	15.1.11
54	98°41′33.6′′	12°11′14.6′′	16.1.11
55	98°43′46.1′′	11°57′36.9′′	17.1.11

Table 5. Some properties of the sea water samples

Sample No.	COD (ppm)	TSS (ppm)	NH_3-N (ppm)	NO_2-N (ppm)	Phosphate (ppm)	Chlorophyll *a* (mg/m^3)
Rakhine Coastal Zone						
1	0.346	5.40	0.011	0.013	0.0141	1.94
2	0.316	7.19	0.014	0.017	0.0214	2.14
3	0.353	6.18	0.018	0.018	0.0221	1.81
4	0.353	7.43	0.015	0.020	0.0345	2.31
5	0.311	5.14	0.027	0.014	0.0126	1.21
6	0.344	6.63	0.027	0.019	0.0270	1.52
7	0.357	6.69	0.022	0.014	0.0179	1.29
8	0.324	5.22	0.024	0.014	0.0211	1.42
9	0.287	7.14	0.018	0.022	0.0274	0.31
10	0.270	6.40	0.021	0.013	0.0379	0.14
11	0.241	6.04	0.014	0.013	0.0326	0.27
12	0.258	6.67	0.031	0.011	0.0251	0.09
Deltaic Coastal Zone						
13	2.852	9.57	0.074	0.055	0.0588	2.46
14	0.368	6.48	0.020	0.031	0.0286	1.36
15	0.736	6.77	0.015	0.043	0.0248	1.42
16	0.320	6.12	0.060	0.032	0.0158	0.96
17	0.368	6.72	0.045	0.032	0.0215	1.01
18	0.330	7.01	0.051	0.044	0.0229	1.79
19	0.310	7.84	0.056	0.031	0.0328	1.29
20	0.271	7.56	0.035	0.041	0.0310	1.01
21	0.278	8.23	0.045	0.041	0.0301	0.69
22	0.292	8.32	0.017	0.036	0.0351	1.37
23	0.261	8.11	0.015	0.040	0.0339	1.04
Tanintharyi Coastal Zone						
(i)Dawei Region						
24	0.356	7.44	0.043	0.031	0.0238	2.41
25	0.511	6.01	0.043	0.023	0.0279	2.01
26	0.447	7.95	0.026	0.021	0.0226	1.28
27	0.785	7.44	0.037	0.048	0.0177	2.26
28	0.736	7.01	0.027	0.020	0.0158	2.11
29	1.208	7.34	0.025	0.022	0.0256	1.89
30	0.544	7.07	0.032	0.020	0.0248	1.54
31	0.476	7.11	0.061	0.028	0.0267	1.79
32	0.431	8.12	0.021	0.036	0.0433	0.47
33	0.212	8.34	0.025	0.030	0.0288	0.34
34	0.503	8.49	0.028	0.019	0.0348	0.56

(ii) **Myeik Archepelago**						
35	0.464	6.48	0.028	0.021	0.0209	1.74
36	0.245	7.43	0.037	0.029	0.0217	1.54
37	0.311	6.63	0.030	0.012	0.0222	2.01
38	0.346	6.21	0.040	0.020	0.0219	1.77
39	0.404	6.04	0.042	0.023	0.0213	1.45
40	0.389	6.27	0.037	0.021	0.0231	1.38
41	0.115	6.24	0.028	0.033	0.0318	1.74
42	0.334	7.89	0.017	0.017	0.0203	1.77
43	0.216	6.23	0.024	0.014	0.0268	1.49
44	0.432	6.56	0.032	0.026	0.0200	1.80
45	0.467	5.81	0.033	0.020	0.0346	1.55
46	0.315	6.8	0.021	0.021	0.0201	1.79
47	0.236	6.37	0.016	0.040	0.0225	1.49
48	0.311	8.56	0.036	0.040	0.0330	0.14
49	0.204	7.09	0.041	0.028	0.0144	0.39
50	0.425	8.11	0.033	0.030	0.0265	0.77
51	0.362	7.54	0.029	0.021	0.0222	1.01
52	0.523	6.36	0.016	0.010	0.0121	0.84
53	0.301	7.11	0.034	0.030	0.0255	0.40
54	0.683	7.36	0.031	0.031	0.0280	0.21
55	0.445	6.49	0.011	0.035	0.0291	0.35

Table 6. Acceptable levels of different forms of nitrogen in marine water

Country	NH_3-N (ppm)	NO_2-N (ppm)	Reference
ASEAN	0.07	0.055	AMEQC(1999)
Australia, Canada	<0.01	<0.10	ANZECC(2000)
Hongkong	≤0.021	-	EPD
New Zealand	<0.01	<0.10	ANZECC(2000)
South Australia	0.05	-	EPA

Table 7. Acceptable levels of phosphate in marine water

Country	Marine (ppm)	Reference
Australia	<0.05 (PO_4^{3-})	ANZECC(2000)
ASEAN	0.045 (PO_4^{3-})	AMEQC(1999)
New Zealand	<0.05 (PO_4^{3-})	ANZECC(2000)
Norway	≤0.025 (P)	SFT
Philippines	Nil (as organophosphate)	DAO (1993-34)

Table 8. Criteria for evaluating degree of nutrient over-enrichment

Parameter	Low	Medium	High
N (ppm)	≤0.1	>0.1 - <1.0	≥1.0
P (ppm)	<0.01	>0.01 - <0.1	≥0.1
DO (ppm)	≤5	>2 - ≤ 5	0 - ≤ 2

Table 9. Minimum and maximum concentration of N and inorganic phosphorus and DO in the sea water samples

Parameter	R	Deltaic	Dawei	Myeik
P (ppm)	0.0042 – 0.0126	0.0052 – 0.0196	0.0052 – 0.0144	0.0040 – 0.0079
N (ppm)	0.022 – 0.053	0.046 – 0.129	0.041 – 0.1043	0.021 – 0.082
DO (ppm)	5.51 – 6.90	5.02 – 5.93	5.32 – 6.83	5.43 – 6.90

Table 10. Acceptable levels of total suspended solids for marine environment

Country	TSS (ppm)	Reference
ASEAN	≤10% (increase)*	AMWQC(1999)
Australia	<10	ANZECC(2000)
Canada	N.A	CCME(1994)
Hong Kong	<30 %	EPD(1998)
Kenya	30	NEMA
Malaysia	N.A	-
New Zealand	10	ANZECC(2000)
Philippines	≤ 30% (increase)	DAO (1990-34)
South Australia	10	EPA

*Permissible 10 % maximum increase over seasonal average concentration
N.A= not available

Chemical oxygen demand (COD), defined as the amount of oxygen needed to oxidize the dissolved and particulate matter in water, is a practical indicator of the concentration of organic matter and of water quality**.** Higher COD values were found in sample no (13) and (29) related to mouth of Yangon River and near Maungmagan, respectively.

5.2 Oil Pollution and Oil Spill, Refinery Waste Water and Offshore Operations; Ecological Impacts of Oil Pollution

Oil and grease residues are important contaminants of concern in the marine environment and were identified as a priority parameter for development of ASEAN marine water quality criteria (AMWQC) by the ASEAN Marine Environmental Quality Criteria -

Working Group (AMEQC-WG) as part of the ASEAN-Canada Cooperative Programme on Marine Science - Phase II (CPMS-II) (Tong, 1999). This prioritization was in consideration of its likely quantity and concentration of inputs, as well as its potential impact to marine ecosystems and to human health. Since inputs of oil and grease and their subsequent distribution in the marine environment tend to be as a group of components rather than a single chemical species, one practical approach was to develop AMWQC for oil and grease as a group parameter. Oil and grease normally consists of thousands of compounds, which can be present in varying proportions depending on the nature of the material, and it would not be feasible to develop criteria for each constituent and then derive an overall criterion for all the species combined into the form of oil and grease.

The main sources of oil pollution are: petroleum (crude oil) or its fractions originating from transportation (tanker operations, dry-docking, discharged oils, oil losses from tanker and other vessel accidents); land-based sources (e.g., municipal and industrial wastes, urban run-off, automotive sources); offshore production; and natural sources such as marine seeps and erosion of sediments. Additionally, oil gets deposited from incomplete combustion processes (motor vehicles, incineration and open burning) and refineries. The estimate for the amount of oil entering the world's marine environment is about 2.4 million tons per year, with yearly variations depending on the frequency of oil spills. Sources of oil pollution include natural seeps and anthropogenic sources such as discharges from storage facilities and refineries, discharges and deballasting activities from tankers and other vessels, accidental oil spills and pipeline ruptures. Other sources include river-borne discharges, industrial and municipal discharges and atmospheric deposition. Also of concern is the occurrence of illegal dumping operations.

Under normal operations, most cargo and oil/gas ports are not major sources of pollution. Only in fishing ports, where regulations on pollution control are difficult to implement on small boats, is oil pollution from fuel/lubrication oil dumping and bilge water discharge seen. Fishing ports exist in every coastal area and then usually near to major urban areas, thus making it difficult to separate the contribution from the two sources. There are probable over (23,000) fishing boats of various sizes registered and operating in Myanmar coastal waters. All of the discarded oil is believed to be discharged into the sea. In addition, leaks and spills of fuel (diesel) oil during filling and transfer occur but this cannot be estimated. Marine accidents, although still low in frequency, could release significant amounts of oil into sea. However, no data are currently being collected to accurately assess the impact of oil pollution on the marine and coastal environment and its living resources.

There are no refineries along the coastal regions in Myanmar; however, one refinery is located near Yangon River. The amount of oil residue released through operational activities into Yangon River may be probably very low. Now, determinations of seasonally variation of hydrocarbon residues around the refinery are being carried out.

Currently, eleven and nineteen offshore gas platforms in the Rakhine coast and Gulf of Mottama (Martaban) in the Deltaic coastal zone are operating, respectively and there is no oil platform in Myanmar coastal regions.

5.3 Heavy Metals and Persistent Organic Pollutants (POPs)

Heavy metal contaminations in the marine environment arise from a range of land and sea based activities, including the discharge of wastewater to the coastal environment, as a result of river-water inputs, or as deposition to the sea surface from the atmosphere. In addition, heavy metal contaminations in the marine environment can arise from human activities at sea such as oil exploration and extraction, accidents, or shipping. Cadmium, lead and mercury are found at low concentrations in the Earth's crust and occur naturally in seawater. Table 11 mentions the general acceptable levels of heavy metals for marine environment by different countries. It can be seen clearly that the levels are different from each other and there is no consensus. Table 12 shows the observed lead concentrations in sea water of ASEAN and other countries.

Table 11. General acceptable levels of heavy metals for marine environment

Country	Heavy metal content (ppb)			Reference
	Hg	Pb	Cd	
Australia	<1.0	< 1-7.0	< 0.5-5	ANZECC, 2000
ASEAN	0.16	8.5	10	AMEQC, 1999
India	1.0	1.0	1.0	
Kenya	5.0	10	10	EMCR, 2006
New Zealand	<1.0	< 1-7.0	< 0.5-5	ANZECC, 2000
Philippines	2.0	50	10	DAO 1990-34
United States	1.8	210	42	EPA

Table 13 shows the heavy metal (Pb, Cd and Hg) contents in the sea water samples. Average concentrations of lead (Pb) in sea water samples of Rakhine, Deltaic, Dawei and Myeik coastal zones were 4.48, 6.85, 7.55 and 5.50 ppb, respectively.

Table 12. Observed Lead concentrations in seawater in ASEAN and other countries

Location	Lead Concentration (ppb)	Reference
INDONESIA		
Segara Anakan, Central Java	5.7 -14.8	Romimohtarto *et al*., 1991
MALAYSIA		
East and west coast, Peninsular Malaysia	0.20 - 0.34	Ismail *et al*., 1995
Juru Estuary, Penang	2.0 - 2.8	Seng *et al*., 1987
Straits of Malacca	1.7 - 3	Shazili and Mohamed, 1990
SINGAPORE		
Straits of Johore/ Singapore	0.2 - 0.6	Singapore Ministry of
		Environment, 1993
Coastal sea water (filtered)	0.09 - 0.56	Ang *et al*., 1989
	0 - 40	Rahman *et al*., 1980
	1.6 - 3.1	Chai, 1975
Coastal waters	0.3 - 0.8	Tang *et al*., 1997
THAILAND		
Upper Gulf of Thailand	0.10 - 32.0	Suthanaruk *et al*., 1995
Upper Gulf of Thailand	0.13 - 12.18	Chumchuchan and Suthanaruk, 1997
Tapi River	0.042-0.479	Hungspreugs *et al*., 1991
Ban Don Bay	0.003-0.235	
Upper Gulf of Thailand	0.20 - 1.13 (wet season) 0.16 - 1.16 (dry season)	Hungspreugs *et al*., 1989
Lower Gulf of Thailand	0.01 - 0.06	Hungspreugs *et al*.,
Upper Gulf of Thailand	0.44 (wet season) 0.66 (dry season)	Hungspreugs, 1984
Gulf of Thailand	5.28 - 6.56	Siriruttanachai, 1980
VIETNAM		
Coastal waters	trace - 6.8	Nguyen *et al*., 1997
Coastal waters	1.0 - 5.1	Pham and Vo, 1997
OTHER COUNTRIES		
Scottish estuary, Scotland	0.006 - 0.16	Hall *et al*., 1996
Arabian Sea, Pakistan	0.019 - 0.189	Tariq *et al*., 1993
Alexandria region, Egypt	0.455 - 0.785	Abdel-Moati, 1991
Gove Harbour, Australia	0.15 - 2.87	Peerzada *et al*., 1990
Thames Estuary, UK	0.025 - 0.4	Harper, 1988

Source: Wong and Tan (AMEQC, 1999)

Lead concentrations in all sea water samples are under the acceptable level except that sample no (13) from mouth of Yangon River. The mercury (Hg) contents of the most of the sea water samples were higher than ASEAN acceptable level of 0.16 ppb. The cadmium (Cd) contents of the most of the sea water samples were lower than ASEAN

acceptable level of 10 ppb. Average concentrations of cadmium in sea water samples of Rakhine, Deltaic, Dawei and Myeik coastal zones were 1.67, 2.30, 2.16 and 1.83 ppb respectively.

Persistent organic pollutants (POPs) are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. They are used to control unwanted non-pathogenic organisms. Because of this, they have been observed to persist in the environment, to be capable of long-range transport, bioaccumulation in marine species and to have potential significant impacts on the marine environment. Many POPs are currently or were in the past used as pesticides. Others are used in industrial processes and in the production of a range of goods such as solvents, polyvinyl chloride, and pharmaceuticals. There are a few natural sources of POPs, but most POPs are created by humans in industrial processes, either intentionally or as byproducts.

Now, necessary standard chemicals and instruments are organized for the determinations of polycyclic aromatic hydrocarbon (PAH) and persistent organic pollutants (POP) in sea water samples by using spectrofluorometric technique.

5.4 General Status and Trends of Marine Pollution: Trend of Harmful Algal Blooms (HABs); Toxin-producing and Shellfish Poisoning; Pathogenic Microorganisms-viruses and Bacteria; the Health of Coastal Organisms

Fish and shellfish accumulate chemical residues from the environment in which they live. The extent of accumulation depends on various factors such as geographic location, species of fish, feeding pattern and solubility and persistence of the chemicals on the environment. The chemicals have an opportunity to become more concentrated through bioaccumulation.

Aquatic invertebrates appear to be excellent biological monitors of heavy metal pollution. They are more tolerant of metals than fish, they accumulate metals in relative proportion to the metal concentrations in the water, and they concentrate the metal by some predictable, reproducible factor.

Table 13. Heavy metal (Pb, Cd and Hg) concentrations in the sea water samples

Sample No.	Heavy metal contents (ppb)		
	Pb	Hg	Cd
Rakhine coastal zone			
1	2.6	ND	1.5

2	3.8	0.7	2.1
3	4.5	1.4	1.4
4	4.9	0.4	0.9
5	6.3	ND	1.6
6	4.8	1.1	2.7
7	1.1	1.4	1.4
8	4.9	0.9	0.9
9	7.1	1.1	2.6
10	1.4	1.2	1.8
11	7.1	1.1	1.3
12	5.3	1.1	1.8
Deltaic coastal zone			
13	9.4	1.8	1.5
14	5.3	1.1	3.7
15	6.5	1.6	2.4
16	5.4	2.1	1.7
17	4.2	1.3	6.1
18	7.2	1.1	2.4
19	7.4	1.5	1.2
20	7.1	1.7	1.4
21	7.9	1.2	1.7
22	8.1	1.7	1.8
23	6.9	1.7	1.4
Tanintharyi coastal zone			
(i) Dawei Region			
24	7.8	1.6	1.2
25	8.2	1.4	2.4
26	8.1	1.4	1.4
27	7.8	1.3	1.2
28	7.2	1.6	2.7
29	7.2	1.7	4.1
30	7.8	0.8	4.8
31	6.1	1.6	5.8
32	8.4	1.1	1.5
33	6.9	1.5	2.9
34	7.6	1.3	2.1
(ii) **Myeik Archipelago**			
Sample No.	**Pb**	**Hg**	**Cd**
35	7.1	1.1	1.3
36	6.9	1.1	1.4
37	7.4	1.2	1.1
38	5.4	0.5	1.2
39	5.4	1.4	1.4
40	3.9	0.8	2.4
41	7.6	0.5	2.8
42	7.0	1.5	2.5
43	7.4	1.3	1.2
44	5.4	1.3	5.7
45	4.7	0.9	1.4
46	2.5	1.5	1.1
47	4.7	1.1	2.1
48	3.8	1.6	2.1
49	1.1	ND	2.0
50	3.9	1.1	1.7
51	6.1	0.6	1.9
52	7.7	0.8	1.8
53	4.7	1.1	1.7
54	7.4	0.4	1.5
55	5.4	1.6	2.7

In the work of Kyaw Naing and coworkers (Win Win Than, 2009), toxic metal concentrations in cuttlefish (*Sepia aculeata*), squid (*Loligo duvauceli*) and crab (*Scylla serrata*) samples were determined according to three sizes (small, medium and large). The cuttlefish and squid were caught in Taninthayi coastal zone and crabs were caught from Ayeyarwady region in Deltaic coastal zone. Samples were collected in summer (March), rainy season (July) and winter (December). Total numbers of the samples were 81; 27 samples for three different sizes. The samples were immediately frozen (-25°C) on board in individual plastic bags.

Table 14 mentions the concentrations of Pb, Cd, Hg and As in the invertebrate samples. Average concentrations of Hg, Cd, Pb and As in cuttlefish samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively. Average concentrations of Hg, Cd, Pb and As in the squid samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively. Average concentrations of Hg, Cd, Pb and As in the crab samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively.

Mercury concentrations in cuttlefish and squid samples were about 4 times higher than that in crab sample. Similarly, cadmium and arsenic concentrations in cuttlefish, squid and crab samples were about 10 times and lead concentrations were about 6 times higher than those in crab samples. Cuttlefish and squid samples were accumulating large concentration of cadmium. All toxic metal concentrations in cuttlefish, squid and crab samples were lesser than maximum permitted levels (Hg < 0.5 ppm, Cd < 1.0 ppm, Pb < 2.0 ppm and As < 1.0 ppm) (MFRD, 1992).

Figure 5 shows the variation of toxic metal concentrations in the invertebrate samples with their sizes. In this case, three different sizes, small (<60 mm), medium (60 – 120 mm) and large (> 120 mm) were considered; for cuttlefish and squid are mantle length and for crab is carapace width. Increase of cadmium concentrations with the size was clear in the case of cuttlefish and squid. Lead and arsenic concentrations also increased with their sizes. For cuttlefish and squid samples, concentration order was Cd >Pb ~ As >Hg. For crab samples the order was Cd>Pb ~ Hg>As. Table 15 shows minimum, maximum and mean values of metals concentration in cuttlefish, squid and crab samples.

Coliform bacteria consist of several genera belonging to family *Enterobacteriaceae.* Fecal coliform which belongs to this group is found mostly in feces and intestinal tracts of humans and other warm blooded animals. It is not pathogenic; however, it is a good indicator of the presence of pathogenic bacteria.

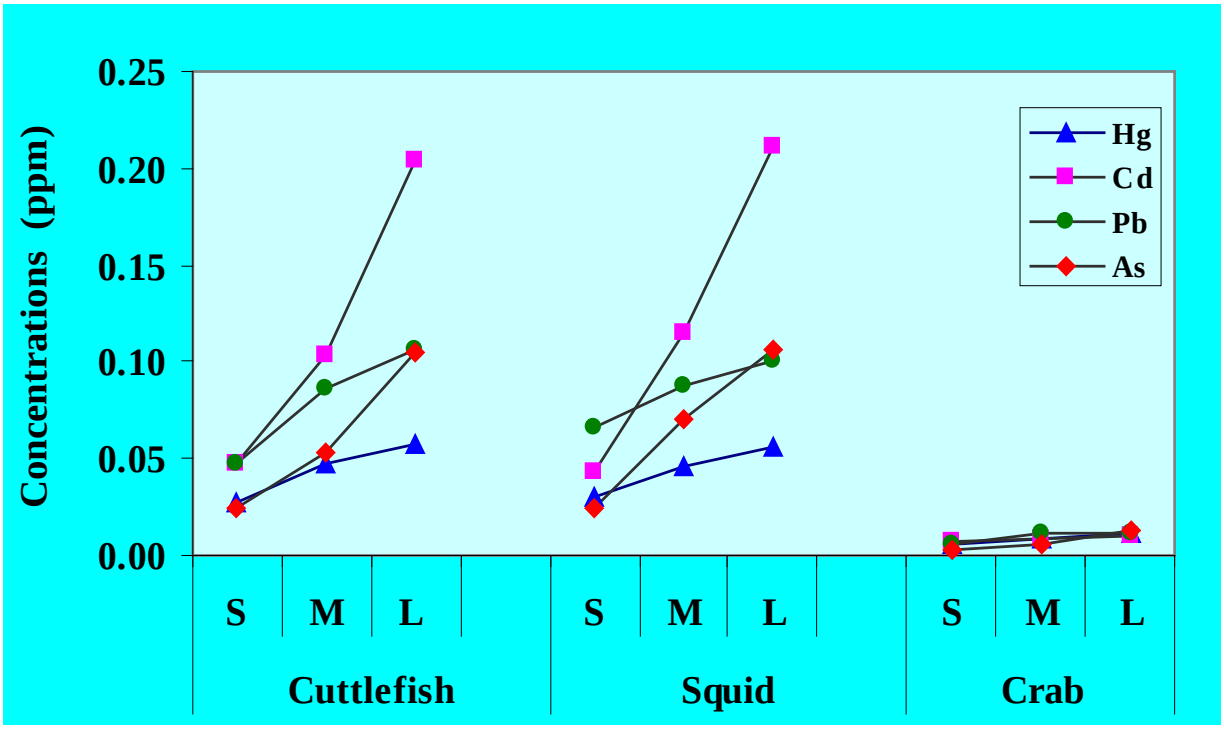
Table 14. Concentrations of Pb, Cd, Hg and As in the invertebrate samples

Samples	Metal	Hg (ppb)			Cd (ppb)			Pb (ppb)			As (ppb)		
	Size / Season	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Cuttlefish* (*Sepia aculeata*)	Summer	27.4	48.1	58.0	46.7	103.2	204.1	46.8	85.8	106.0	23.8	53.5	104.8
	Rainy	20.7	22.4	24.3	28.0	90.5	185.7	8.8	24.6	75.6	9.3	34.6	96.6
	Winter	20.8	45.7	55.2	32.1	95.0	185.8	14.3	20.9	18.3	18.8	40.2	103.1
Squid* (*Loligo duvauceli*)	Summer	30.3	46.0	56.3	42.5	114.7	211.9	65.5	87.7	100.8	24.5	71.0	105.8
	Rainy	27.1	28.8	44.8	24.5	103.3	162.0	15.4	22.7	62.1	11.6	41.5	85.8
	Winter	23.2	42.2	49.4	50.7	152.5	195.1	17.3	25.9	81.5	18.0	40.4	120.1
Crab# (*Scylla serrata*)	Summer	6.0	8.9	10.9	7.9	8.6	10.5	5.9	10.9	11.3	2.5	5.8	12.8
	Rainy	2.2	6.2	8.8	7.6	4.8	9.8	5.0	7.5	9.3	2.3	5.4	8.1
	Winter	4.3	6.3	9.5	7.7	8.6	11.6	5.7	7.9	10.5	2.3	5.3	8.9

Source: Win Win Than, 2008

The values are average values of three samples.
* Small = Mantle length of less than 80 mm
Medium = Mantle length of between 80 – 120 mm
Large = Mantle length of larger than 120 mm
# Small = Carapace width of less than 80 mm
Medium = Carapace width of between 80 – 120 mm
Large = Carapace width of larger than 120 mm

High levels of fecal coliform in the water may cause typhoid fever, hepatitis, gastroenteritis, dysentery and eat infection. Some factors which may affect the concentration of these bacteria are the presence of wastewater and septic system, animal wastes, run-off, high temperature and nutrient-rich water.



The values are average values of three samples.
For cuttlefish and squid
Small = Mantle length of less than 80 mm
Medium = Mantle length of between 80 – 120 mm
Large = Mantle length of larger than 120 mm
For crab
Small = Carapace width of less than 80 mm
Medium = Carapace width of between 80 – 120 mm
Large = Carapace width of larger than 120 mm

Figure 5 Variation of toxic metal concentrations in the invertebrate samples with their sizes

Microbiological assessments of the standard plate counts of cuttlefish and squid were 2.12×10^5, 1.13×10^5 and 1.30×10^5 CFU/g, respectively. These values were found to be lower than the allowed SPC limit of 10^6 CFU/g. The cuttlefish and squid samples contained bacterial counts (Coliforms, *Escherichia coli*) of 10 CFU/g and crab sample contained bacterial counts (Coliforms, *Escherichia coli*) of less than 10 CFU/g. The *Staphylococcus aureus* count was found to be less than 10 CFU/g each in cuttlefish, squid

and crab. The minimum allowed limit was 10 CFU/g for marine invertebrates, so these samples studied were fit for human consumption. Furthermore, *Salmonella* and *Vibrio cholerae* were not detected in these three types of marine invertebrates.

Table 15. Minimum, maximum and mean values of metal concentrations in cuttlefish, squid and crab samples

Samples	Metals	Min (ppm)	Max(ppm)	Mean (ppm) ± SD
Cuttlefish	Hg	0.0207	0.0581	0.0358 ± 0.0034
	Cd	0.0281	0.2041	0.1079 ± 0.0154
	Pb	0.0088	0.1061	0.0516 ± 0.0025
	As	0.0093	0.1048	0.0539 ± 0.0008
Squid	Hg	0.0271	0.0563	0.0387 ± 0.0026
	Cd	0.0245	0.2119	0.1175 ± 0.0225
	Pb	0.0154	0.1008	0.0532 ± 0.0021
	As	0.0116	0.1258	0.0599 ± 0.0053
Crab	Hg	0.0022	0.0162	0.0085 ± 0.0016
	Cd	0.0076	0.0105	0.0091 ± 0.0121
	Pb	0.0051	0.0131	0.0084 ± 0.0055
	As	0.0023	0.0128	0.0059 ± 0.0013

Source: Win Win Than, 2008

In the work of Khin Thida Kyaw 2009, three different fish species, *viz*., yellow cat fish (*Pangasius pangasius*), giant sea perch (*Lates calcarifer*), and striped snake head (*Channa striata*) were caught from Dadaye Township in Ayeyarwady region in Deltaic coastal zone. Their toxic metal concentrations with seasonality are shown in Table 16. In all fish samples, lead was the highest concentration in all fish species. Concentrations of lead were in the range of 0.202 to 0.487 ppm for *Pangasius pangasius*, 0.157 to 0.298 ppm for *Lates calcarifer*, and 0.137 to 0.225 ppm for *Channa striata*. The toxic metals in order of concentrations in these three fish species were lead >arsenic >cadmium >mercury. *Pangasius pangasius* accumulated higher concentrations of toxic metals since it is an omnivorous fish species, while snake head (*Channa striata*) accumulated lower concentration of toxic metals.

Table 16. Toxic metal (Pb, Cd, Hg and As) concentrations in the fish samples

Fish Samples	Summer Season (ppm)				Rainy Season (ppm)				Winter Season (ppm)			
	As	Cd	Pb	Hg	As	Cd	Pb	Hg	As	Cd	Pb	Hg
Yellow cat fish (*Pangasius pangasius*)	0.141	0.123	0.305	0.020	0.188	0.130	0.421	0.020	0.127	0.115	0.243	0.011
Giant sea perch (*Lates calcarifer*)	0.127	0.089	0.230	0.011	0.141	0.097	0.286	0.012	0.119	0.074	0.176	0.010
Striped snake head (*Channa striata*)	0.105	0.075	0.177	0.008	0.108	0.077	0.223	0.010	0.089	0.072	0.140	0.007

Source: Khin Thida Kyaw, 2008

Maximum permitted level
As – not more than 1.0 ppm
Cd – not more than 1.0 ppm
Pb – not more than 2.0 ppm
Hg – not more than 1.0 ppm (MFRD, 2005, Singapore)

6. Trans-boundary Coastal Pollution Issues and Concerns

In Myanmar, most factories neither produce toxic chemicals nor use them as raw materials in their manufacturing processes. Therefore marine pollution in Myanmar caused by industry has been minimal at present due to low level of industrialization and relatively small amount of chemical fertilizers and pesticides used in agriculture.

A few factories such as paper mills, leather factories and textile factories generate some industrial hazardous wastes. However, they do not exist near the coastal region. With the opening up of the economy since 1989, there is some apprehension that industries generating hazardous wastes may increase. Hazardous wastes and products may be accumulated.

The Myanmar Investment Commission in June 1994 notified that all permitted enterprises shall compulsory install sewage treatment plant, industrial waste water treatment plant and other pollution control procedures and abide with the sanitary and hygienic rules and regulations set by the authorities concerned.

Most municipalities and agriculture works in Myanmar discharge waste into nearby creeks or rivers and waterways and usually not directly into the sea. The waste may accumulate in the bottom of the river or go into the coastal region. Detailed discussion of trans-boundary coastal pollution issues were mentioned in the review of land-based sources of pollution to the coastal and marine environments in the BOBLME Region (Kaly, 2004).

7. International Instruments, Conventions, Protocols and Programs Adopted and Relevant to Coastal and Marine Pollution, and the Current Status of Their Implementation in the Country (Including projects and programs supported by bilateral and multilateral agencies/ institutions)

7.1 The Agenda 21(Chapter 17) of the UN Conference on Environment and Development calling for "the protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources", 1992

Myanmar is a party to the Convention on Biological Diversity, Convention on Climate Change, Vienna Convention for the Protection of the Ozone Layer and London

Amendment, Convention to Combat Desertification and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The Government of the Union of Myanmar adopted the National Environment Policy of Myanmar on 5 December 1994 with the aim to establish sound environment policies in the utilization of water, land, forests, mineral, marine resources and other natural resource in order to conserve the environment and prevent its degradation.

National Environment Policy of Myanmar

"*The wealth of a nation is its people, its cultural heritage, its environment and its natural resources. The objective of Myanmar's environment policy is aimed at achieving harmony and balance between these through the integration of environmental considerations into the development process to enhance the quality of life of all its citizens. Every nation has the sovereign right to utilize its natural resources in accordance with its environmental policies; but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interests of present and future generations. Environmental protection should always be the primary objective in seeking development* ".

Table 17 mentions the status regarding international conventions, agreements and conduct related to marine environment. In its moves towards establishing sound environmental management system, the National Commission for Environmental Affairs (NCEA) took the initiatives and drafted Myanmar Agenda 21 in collaboration with UN organizations. After three years of hard work and coordination among various ministries concerned and several national workshop and seminars, Myanmar Agenda 21 came out with full endorsement from the Government in June 1997 (Tee Tee Cho, 1997).

Myanmar Agenda 21 aims at strengthening and promoting systematic environmental management in the country. Myanmar Agenda 21 contains programmes and activities that will promote environmental protection and prevent environmental degradation. It has four main sections relating to sustainable use of natural resources, sustainable social development, sustainable economic development, and sustainable institutional development. The programmes are social, economic, institutional and infrastructural strengthening programmes as well as environmental protection and conservation programmes that will put the country onto the sustainable development path.

After adopting the National Environmental Policy of Myanmar, it is necessary to formulate a comprehensive national environmental law. Therefore the NCEA has drafted the Union of Myanmar Environmental Protection Law.

The NCEA acts as a focal point and as a coordinating body for environmental affairs; and to promote environmentally sound and sustainable development in Myanmar. The NCEA is comprised of a Chairman, a Secretary, a Joint Secretary and nineteen members who represent various ministries. Since 2004, NCEA has been relocated under the Ministry of Forestry from the Ministry of Foreign Affairs. The Chairman of the Commission is the Minister for Ministry of Forestry and the Secretary is the Director General of the Department of Planning and Statistics under the Ministry of Forestry. The Joint Secretary is the Director of NCEA.

Four specialized committees were formed under the Commission (Figure 6):

1. Committee on Conservation of Natural Resources;
2. Committee on Control of Pollution;
3. Committee on Research, Education and Information; and
4. Committee on International Cooperation.

The NCEA serves as a coordinating agency, collaborating closely with government departments in matters relating to the environment. It acts as the national focal point for environmental matters with other countries and international organizations.

The Commission's mandate includes:

1. To provide advice to the Cabinet on the formulation of environmental policies and seeks its approval
2. To issue guidelines for the implementation of environmental policies
3. To provide guidance and advice to the regulatory agencies on such matters as legislation, regulations and environmental standards
4. To formulate short, medium and long term environmental polices and strategies that take into account both the environmental needs and development requirements

The process of drafting national environmental law began in 1998 and the draft national environmental protection law was completed in 2000. However, the adoption of the law has been still pending. The regulations on Environmental Impact Assessment (EIA) as well as environmental standards are yet to be developed.

Table 17. Status regarding International Conventions, Agreements and Conduct related to Marine Environment

Sr. No.	Convention Date of Signature	Date of Ratification	Date of Membership	Date of Membership	Remarks
1	International Convention for Prevention of Pollution from Ships. London, 1973		Accession		Undertaken to give effect this convention under para 1&2 of Article 1 of the protocol of 1978
2	Protocol of 1978 relating to the international convention for the prevention of pollution from ships, London, 1973		Accession 4-8-1998		Except for Annexes III,IV and V of the convention
3	United Nations Convention on the Law of the Sea,Montago Bay, 1982	10-12-1982	Ratification 21-5-1996		
4	United Nations Framework Convention on Climate Change, New York, 1992	11-6-1992	Ratification 25-11-1994	22-2-1994	
5	Convention on Biological Diversity, Rio de Janeiro, 1992	11-6-1992	Ratification 25-11-1994		
6	Vienna Convention on the Protection of the Ozone layer, Montreal, 1987		Accession 24-11-1993	22-2-1994	
7	London amendment to the Montreal Protocol on substances that deplete the Ozone layer, London, 1990		Accession 24-11-1993	22-2-1994	
8	Convention on International Trade in Endangered Species of wild fauna and flora, Washington, 1973 and this convention as amended in Bonn, Germany, 1979		Accession 13-5-1997	11-9-1997	
9	Stockholm Convention on Persistent Organic Pollutant, 2001		Accession 19-4-2004		

NCEA also serves as the focal point for various international environmental conventions such as United Nations Framework Convention on Climate Change (UNFCCC), United Nations Convention on Biological Diversity (UNCBD), United Nations Convention to Combat Desertification (UNCCD), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Stockholm Convention on Persistent Organic Pollutants (POPs), Vienna Convention, Montreal Protocol and Kyoto Protocol.

In order to effectively and systematically carry out environmental conservation activities throughout the country, the Environmental Conservation Committee was formed on the 26th of March 2004 chaired by the Minister for the Ministry of Forestry with the Minister for the Ministry of Mines as Vice-Chairman. The Deputy Ministers of the line Ministries are members of the Committee. The Committee in cooperation with the ministries and departments concerned sees to the effective implementation of the activities and enforcement of existing laws, rules and regulations and to take effective actions on law offenders. The seven specialized task forces under the central committee are responsible for the implementation of environmental programmes and activities in the States & Regions, District, Township and Village Tract level. Environmental Conservation Committee reviews the progress of works at quarterly meetings and decides future activities**.**

Technical assistance from UNEP was obtained for Environmental Law and Policy. Environmental Management Training Workshops and National Environmental Seminars are frequently organized to disseminate environmental information and environmental management techniques. In February 1994, Myanmar hosted the ESCAP/UNEP Regional Seminar on People's Participation in Mangrove Rehabilitation and Management in Asia and the Pacific. In preparation for the 1995 State of the Environment report, Myanmar in July 1995, hosted the ESCAP "Regional Meeting on the State of the Environment in Asia and the Pacific".

The NCEA and the Hanns Seidel Foundation-HSF of Germany jointly organized the National Conference on Environmental Management in August 1995 to promote environmental education among the department personnel. Representatives attended the conference from foreign countries in addition to those of government departments in the country. Similarly, the Commission and the HSF jointly organized the National Conference on Environment, Cultural Heritage and Tourism in April 1996 and the National Workshop on Environmental Legislation organized by the National Commission for Environmental Affairs (NCEA) in cooperation with the United Nations Environment Programme (UNEP) and the Hanns Seidel Foundation was held in October 1998. The Commission and the Asia and the Pacific Regional Office of the UN Environment Programme jointly organized the National Workshop on Environmental Law in July 1996.

In June 1997, the Commission and the Economic and Social Commission for Asia and the Pacific jointly organized a National Seminar on Technology Transfer for Wastewater Treatment of Small and Medium Scale Industries (SMIs).

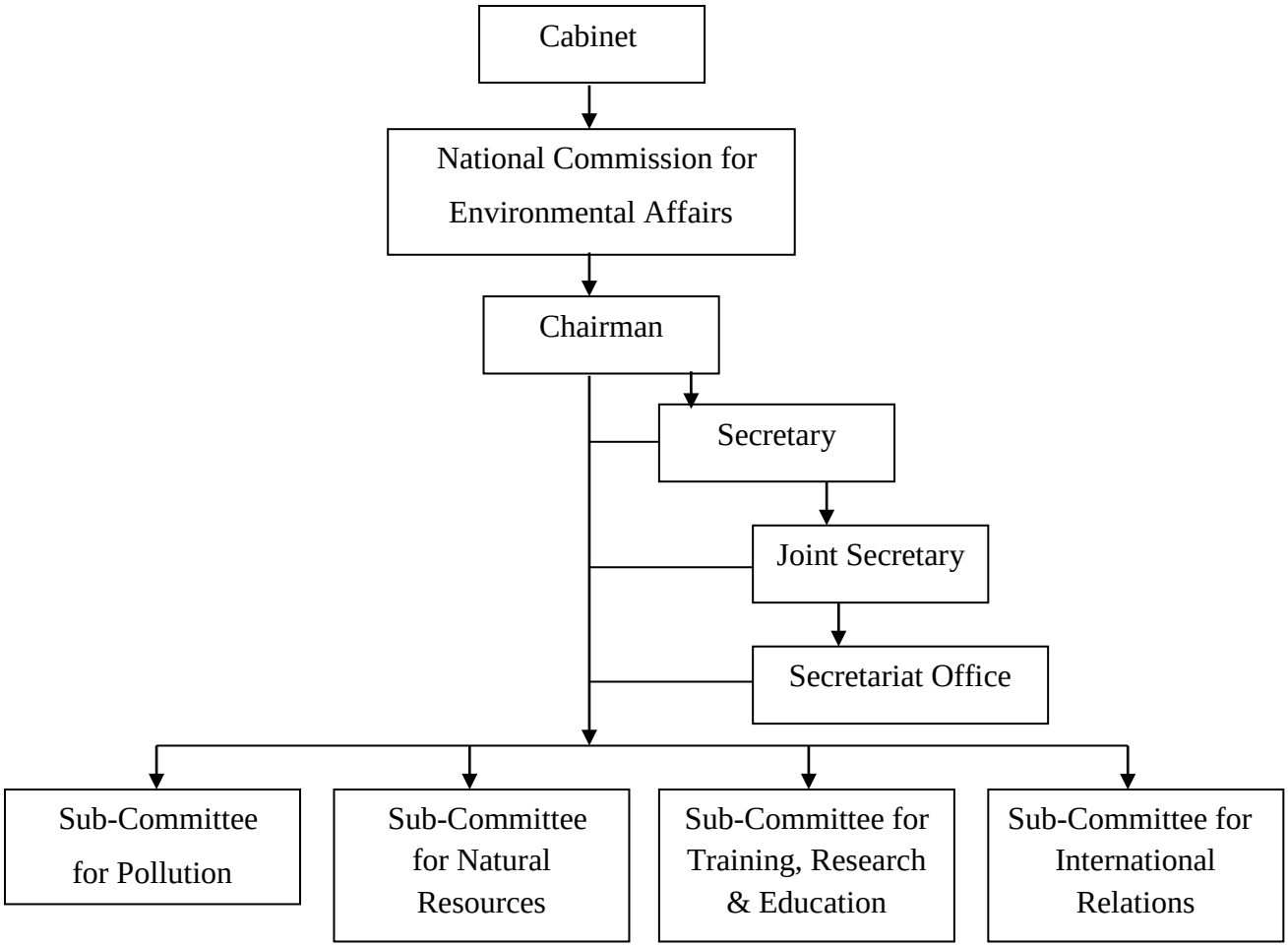


Figure 6. Organization structure of NCEA, NCEA (2000)

Private entrepreneurs were also invited to the Seminar. The ECOTONE VII Regional Seminar for South East and East Asia (Integrated Coastal Zone Management in Southeast and East Asia) organized by the National Commission for Environmental Affairs in cooperation with the Myanmar National Commission for UNESCO and the United Nations Educational Scientific and Culture Organization (UNESCO), was held in June 1998. The National Commission for Environmental Affairs and the Asian Development Bank jointly organized the First National Workshop on Strategic Environmental Framework for the Greater Mekong Sub region in May 1999, the Second National Workshop in September 2000 and the Third National Workshop in March 2001. The Second National Workshop on Environmental Legislation organized by the National Commission for Environmental Affairs in cooperation with the Hanns Seidel Foundation was held on 24-25 May 1999 in Yangon. A workshop on the preparation of the National Report on the Implementation of the United Nations Convention to Combat Desertification (UNCCD) was held on 15 June 2000.

To implement and achieve sustainable development objectives laid down by the Rio Agenda 21 and numerous international environmental conventions, regional environmental agreements and national sustainable development programmes, technical and financial resources are still necessary. In the past decade Myanmar received little or no assistance from multilateral institutions including the World Bank and Asian Development Bank and from the EU countries. In view of the ever-increasing demand and obligations from various environmental convention secretariats and other institutions, there is a need for more international cooperation and collaboration to enable Myanmar to undertake the obligations.

7.2 Global Programme of Action for the Protection of Marine Environment from Land-based Activities (GPA), 1995

Myanmar did not accede the GPA Programme.

7.3 Stockholm Convention on Persistent Organic Pollutants, 2001

Myanmar acceded to the Stockholm Convention on Persistent Organic Pollutants on 19-04-2004.

7.4 London Conventions 1972 and its 1996 Protocol

Myanmar did not accede the London Conventions 1972 and its 1996 Protocol.

7.5 MARPOL (International Convention for the Prevention of Pollution from Ships, 1973 and the Protocol of 1978)

Myanmar is the signatory of MARPOL since 04-08-1998. Myanmar port authority is responsible body for monitoring the ships for prevention of the pollution from ships.

8. Policy, Economic Instruments and Legal Mechanisms for Pollution Control

8.1 The Water (Prevention and Control of Pollution) Act and Rules

In Yangon (lower Myanmar), Nay Pyi Taw (Capital) and Mandalay (upper Myanmar), autonomous City Development Committees and their Pollution Control and Cleansing Departments (PCCDs) with a network of branches and sub-units are tasked with waste management within their municipal areas. In other parts of the country Township Development Committees under the Department for Development Affairs (DDA), Ministry of Progress of Border Area Development and National Races and Development Affairs (MPBND), manage municipal waste collection and disposal.

According to Myanmar Agenda-21, pollution control and cleansing rules had been drawn up by the Yangon City Development Committee (YCDC) in Myanmar. This rule has 25 sections and in cooperation and coordination with other governmental agencies, the disposal of industrial, chemical, toxic material and radioactive waste are identified and controlled. PCCD has prepared the bye law on pollution control and it includes the important section concerning with wastes management, such as prohibitions of collection, transportation, treatment and disposal of industrial and domestic waste and prevention of waste pollution due to improper disposal of industrial waste and prohibition of storage or transportation of toxic substances.

In 2003, 78.8 percent of the population had access to safe water while 76.1 percent had adequate excreta disposal facilities. In both instances, a higher percentage is found in the urban areas. Of the total solid waste volume generated, about 60.65 percent were collected in 2004 (WHO, 2004).

Several government and private laboratories are equipped to monitor various environmental quality parameters for drinking water and water resources. The Ministry of Health has planned to extend laboratory services to all states/regions and divisions to perform microbiological examination and chemical characterization of water. Health-care waste generated from hospitals and health institutions reached 228.125 tons in 2004. There is no information on the hazardous waste generation but since the level of industrialization of Myanmar is still low, it could be assumed that the volume is still limited. The National Poison Control Center was established by the Ministry of Health with the objective of protecting the people and the environment from toxic hazards.

As a part of the program of ASEAN Working Group on Environmentally Sustainable Cities (AWGESC), NCEA, YCDC and Mandalay City Development Committee (MCDC) have jointly formulated the future action to maintain clean land to safe-guard public health. Nay Pyi Taw, Yangon and Mandalay City Development Committees are performing the waste management within their municipal areas. In other part of the country, Department of Development Affairs (DDA) is a responsible one for managing municipal solid wastes in respective township. The related laws (Win Latt, 2000) are

1. The Development Committees Law, 1993
2. The Mandalay City Development Law, 1992
3. The City of Yangon Development Law. 1990 (Amended in 1995 and again in 1996)

4. The Underground Water Act, 1930
5. The Water Power Act, 1927
6. The City of Yangon Municipal Act, 1922
   (The Law Amending the City of Yangon Municipal Act, 1991)
7. The Yangon Water-Works Act, 1885

8.2 The Environment (Protection) Act and Rules

Since environmental law is not yet available in Myanmar sectoral laws relating to environment are regarded as environmental protection laws. However these laws in general do not possess holistic vision on environmental management thereby only emphasizing on specific issues of related sector. Therefore the effect of those laws on environmental protection is often indirect. For example, the City of Yangon Development Law (1990), the City of Yangon Municipal Act (1992) and the Development Committee Law (1993) contains provisions relating to water pollution. As the City of Yangon is located in the coastal zone prevention of pollution from the city is quite important for the sustainability of coastal marine ecosystems. In addition the Yangon Port Act (1905), the Canal Act (1905), the Embankment Act (1909) and the Ports Act (1908) provide for cleanness of inland waterways hence they prevent increasing pollution level in the estuary and marine areas. Prevention of mangrove deforestation can also be seen in the Salt Enterprise Law which prohibits production of salt by means of wood fire or charcoal and permits only solar salt. Similarly, the Factories Act has provisions whereby effective arrangement is required to be made in every factory for the disposal of wastes and effluence. Measures for the proper disposal of waste and effluence and in particular treatment of waste water from the textile and chemical plants have resolved much of the environmental pollution problem that would have adverse impact on the coastal marine ecosystems. Provisions of these environmental related laws control the land based pollution sources thereby protect coastal and marine ecosystems indirectly.

Laws related to coastal and marine environments are described in different sectoral laws under two ministries, the Ministry of Livestock and Fisheries and the Ministry of Forestry. For instance the Marine Fisheries Law (1990), the Freshwater Fisheries Law (1991), the Fishing Rights of Foreign Fishing Vessels Law (1989) and the Aquaculture Law (1989) prohibit causing water pollution harassing fishes and other marine organism and using explosive substances, poison chemicals and dangerous material in fishing. In addition the Territorial Sea and Maritime Zone Law (1977) provides measures for protection of marine

environment prevention and control of marine pollution. It also endorses conducting scientific research and management of the marine environment. The Pesticide Law (1990) prohibits the use of pesticides to catch or kill land or aquatic animals. The Pearl Law of 1995 protects and conserves water area of oyster fishing grounds from destruction and oyster from extinction.

In the fisheries sector while some of directives and regulations emphasize in assuring fisheries revenue, others prevent overfishing by declaring closed season and territories restriction of fishing gear etc., However those laws and regulations are weak in conservation measures including protection of aquatic resources habitat. Apart from the laws mentioned above there are also several directives from the ministry in protection of marine resources however those are more of ad hoc basis.

Appropriate law promulgated to protect some of coastal resources is the Forest Law of 1992 and the Protection of Wild Life and Wild Plants and Conservation of Natural Areas Law (1994). These laws are considered quite comprehensive in protection and management of mangrove forests as well as wildlife in Myanmar.

NCEA has drafted the Union of Myanmar Environmental Protection Law since 2000 and the law is in the process for Government's approval. At present, the environmental management pattern in Myanmar is largely sectoral with existing policies and regulations relating to environmental management being formulated and administered by sectoral ministries and departments concerned.

In summary, the Myanmar Laws relating to environment are;

1. The Territorial Sea and Maritime Zones Law, 1977
2. The Plant Pest Quarantine Law, 1993
3. The Pesticide Law, 1990
4. The Embankment Act, 1909
5. The Protection of Wild Life and Wild Plants and Conservation of Natural Areas Law, 1994
6. The Forest Law, 1992
7. The Myanmar Hotel and Tourism Law, 1993
8. The Private Industrial Enterprise Law, 1990
9. The Factories Act, 1951
10. The Oilfield (Workers and Welfare) Act, 1951
11. The Petroleum Act, 1934

12. The Oilfields Act, 1918
13. The Freshwater Fisheries Law, 1992
14. The Myanmar Marine Fisheries Law, 1990
    (The Law Amending the Myanmar Marine Fisheries Law, 1993)
15. The Law Relating to Aquaculture, 1989
16. The Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1989
    (The Law Amending the Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1993)
17. The Myanmar Gemstone Law, 1995
18. The Myanmar Pearl Law, 1995
19. The Myanmar Mines Law, 1994
20. The Salt Enterprise Law, 1992
21. The Land Acquisition (Mines) Act. 1885
22. The Ports Act, 1908
23. The Defile Traffic Act, 1907
24. The Yangon Port Act, 1905
25. The Canal Act, 1905

8.3 Water Quality Standards

Although no quantified national targets have been established for wastewater, the Government has launched the "Green and Clean City" campaign. The percentage of waste collected in Cities has improved and is comparable to, for instance, Hanoi but it lags significantly behind Bangkok (UNCED, 2002). The National Environmental Law has been drafted and is awaiting approval. This will allow NCEA to proceed with developing national ambient standards on air and water quality.

8.4 EIA/ SEA for Clearance and Approval of Projects that have Potential Impacts on the Water Quality and Coastal and Marine Environment in General

In Myanmar, Environmental Impact Assessment (EIA) is not an official requirement for clearance and approval of projects that have potential impacts on the water quality and coastal and marine environment. There is no formal requirement for environmental impact assessment (EIA) and strategic environmental assessment (SEA) in Myanmar. EIAs are conducted on an ad hoc basis for projects funded by international organizations and some foreign corporations. The need for EIA laws is recognized by the

Myanmar Agenda 21. However, presently the National Commission for Environmental Affairs (NCEA) does not have the authority to require the commissioning of EIAs.

The Myanmar Investment Commission (MIC) issued a notification in June 1994 to protect the environment while promoting investment in the country. This notification requires investors to install wastewater treatment facilities to prevent environmental pollution. Myanmar Port Authority prepared necessary rules and regulations for the protection of pollution in fresh and marine water environment.

8.5 Other Instruments and Key Sectoral Policies (e.g. Agricultural policy dealing with fertilizer and pesticide use and / or integrated pest management/organic farming, ICZM)

The pesticide consumption in Myanmar is very low compared to many neighboring countries. Every township in Myanmar has the township-officer appointed from Ministry of Agriculture and Irrigation. They educate the farmers for proper uses of chemical fertilizers and pesticides. The pesticides banned by Stockholm Convention on Persistent Organic Pollutants are not allowed to be imported to Myanmar. In Myanmar, import of the pesticides is controlled by Pesticide Registration Board under the Ministry of Agriculture and Irrigation. In the board, responsible officers from different ministries and Professors from Department of Chemistry in University of Yangon are the members of the Board. Only registered pesticides are allowed for import. As of now, more than 900 brands of pesticides have been registered.

The pesticide analytical laboratory under Myanmar Agricultural Services acts in cooperation with Yangon City Development Committee and the Ministry of Health to inspect the residue limit in fruits and from markets. The pesticide analytical laboratory arranges inspections of residual pesticide on food five times a year. In cooperation with agronomists from the Myanmar Agriculture Service, the laboratory provides educational programs once a year on the use of pesticides.

Organic farming in Myanmar is early stage and now expanding. Shops selling fruits and vegetables from the organic farms are increasingly popular.

8.6 Market-based Instrument-Environmental Levies, Taxes, Subsidies, Incentives, etc.

The local municipal authorities (PCCD) in each township collect taxes for water and cleaning to local residents and commercial enterprises. In Yangon, biggest city in Myanmar, eight task forces have been deployed throughout the city for regular checking of emission levels and waste disposal. Yangon City Development Committee has developed a surveillance system for monitoring waste disposal. Fines are levied on those who breach the established disposal restrictions.

The current national accounting system does not separately report environmental expenditure. Financial resources for environmental management are apportioned to sectoral ministries or agencies.

9. Institutional Mechanisms for Pollution Control and Enforcement of Existing Policies and Legislations

11.1 Pollution Control Board-at central, regional/state and local levels their mandates, operational structures and inter-linkages

In Myanmar, environmental management has been traditionally undertaken by line agencies within their respective mandates. In the most obvious example, the Ministry of Agriculture and the Ministry of Forestry are largely responsible for the management of "their" natural resources under agriculture and forestry development projects/programs. The mandates are sometimes combined: for instance, the Irrigation Department, Water Resource Utilization Department, Yangon/Mandalay City Development Committees, the Department of Development Affairs, and Environmental Sanitation Division under Department of Health share the responsibility for improving water supply in rural and urban areas. For the management of urban environment, the responsibilities have been allocated mainly to city/township Development Committees, Government Affairs Department, Department of Human Settlement and Housing Development, Department of Health, and Directorate of Industrial Supervision, and Inspection. Among the omissions is the assignment of responsibility for national air and water quality management. Until 1989, no governmental agency existed to oversee environmental matters. In 1989, the Ministry of Foreign Affairs (MOFA) began to assume authority over domestic environmental protection, while the Cabinet retained responsibility for international environmental matters. In 1990, the National

Commission for Environmental Affairs (NCEA) was created by MOFA to act as a central agency for environmental management. In 2005, NCEA was transferred under the stewardship of the Ministry of Forestry, with Minister of Forests assuming the NCEA chairperson role.

Creation of NCEA (Figure 6) was a significant step in the integration of environmental considerations into Myanmar's development planning process. NCEA's main mission is to ensure sustainable use of environmental resources and to promote environmentally sound practices in industry and in other economic activities. Its key functions are to:

(i) Formulate policies on natural resource management,

(ii) Prepare environmental legislation (standards and regulations) for pollution control, monitoring and enforcement,

(iii) Promote environmental awareness through public education and to liaise as necessary with international organizations in environmental matters.

NCEA is supported by sub-committees that oversee the management of several environment and related concerns viz., (a) pollution control, (b) natural resource conservation, (c) research, information and education, and (d) international cooperation.

Since its inception, NCEA has been able to accomplish a series of initiatives required for integration of environmental concerns into economic development. These include formulation of national environmental policy (1994) and development of 'Myanmar Agenda 21' as a framework for adopting multi-sectoral approaches to sustainable development. It also drafted the National Environmental Protection Law that is awaiting approval. All of these initiatives were taken in collaboration with other government and non-government organizations.

Pollution control committee was formed under Ministry of Science and Technology Development to monitor and regulate industrial pollution in urban environment at the operational level. As many institutions are involved in different or same aspects of environmental management, there are some overlaps, resource conflicts and instances of inconsistent approaches. There are the sub-committees that play a key role in achieving coordination at the central level. However, they are not very active and effective for the operations at the provincial and local levels. Local committees created until 2004 to coordinate natural resource management and land use have had no direct relationship to NCEA.

11.2 Who does quality control and who ensures enforcement of policies and legislations

Enforcement of standards and environmental quality is critical for the success of any environmental protection regime. Supplementary legislation on sectoral aspects of environmental management is necessary to bridge the gaps in the framework laws and to provide practical guidelines and criteria to the enforcement agencies. In addition Myanmar Agenda has stated that there is a need for new laws and mechanisms for enforcement and implementation in order to harmonize current environmental trends and conditions.

There is neither a specific enforcement body or coordination unit that has multidisciplinary approach for enforcement of coastal and marine pollution. In the absence of the national environmental law, coordination among stakeholders tends to be ad hoc and informal rather than structured and systematic. This also affects environmental information and data management. The way it is set up, NCEA does not have the authority to enforce coordination. It can facilitate and ensure that the concerned agencies are kept informed about each other's activities. However, separate indirect responsibility on protection and management of marine environment is scattered amongst different ministries. City/Town Development Committees and Myanmar Port Authority are also responsible for enforcement of environmental related laws.

12. Gaps

12.1 Information / Data

There are many research works to be carried out for fulfillment of the assessments of the sea water quality and biological assessments (harmful algal blooms, toxin producing and shellfish poisoning). To implement the project, international collaboration among working groups, regional laboratories and BOBLME member countries are important.

On-going research works are determinations of petroleum hydrocarbon residues in sediment, particulate petroleum residue (tar ball) on beach, polycyclic aromatic hydrocarbon (PAH) and persistent organic pollutants (POPs) in sea water and heavy metal contents in sea water and sediment samples.

12.2 Policies and Legislation

Inter-ministerial and departmental committees are set up as the need arises to address cross-sectoral environmental issues. The National Water Committee is one such example. It has also been formed to better address conflicts in water management and related

institutional issues. The Committee is tasked to establish a 'national water council' in future to implement Myanmar's Water Vision. In parallel to NCEA and PCCD/YCDC, another pollution control committee was formed under Ministry of Science and Technology Development to monitor and regulate industrial pollution in urban environment at the operational level.

As many institutions are involved in different or same aspects of environmental management, there are some overlaps, resource conflicts and instances of inconsistent approaches. Although NCEA has been playing a coordinating role, the process has not always been smooth. In the absence of the national environmental law, coordination among stakeholders tends to be ad hoc and informal rather than structured and systematic. This also affects environmental information and data management. The way it is set up, NCEA does not have the authority to enforce coordination. It can facilitate and ensure that the concerned agencies are kept informed about each other's activities. There are the sub-committees that play a key role in achieving coordination at the central level. However, they are not very active and effective for the operations at the provincial and local levels.

Local committees created until 2004 to coordinate natural resource management and land use have had no direct relationship to NCEA. The formation of the National Coordination Committee for Environment (NCCE) in 2004 with a structure of sub-committees was a set up in the direction of achieving both horizontal and vertical coordination. Ministerial agencies and local authorities are represented in the Committee. NCCE sub-committees have been set up based on the eco-region, including Northern Forest Region, Eastern Forest Region, Western Forest Region, Southern Forest Region, Ayeyarwaddy River Region, Chindwin River Region, Sittaung River Region, Thanlwin River Region, Central Plain Zone and Coastal Zone.

10.3 Implementation Issues (capacity constraints both human, technical/ infrastructure)

To implement the BOBLME work plan, members' countries, regional and international collaboration and coordination are essential. Materials and technical assistance from international organizations are required.

Official development assistance (ODA) to Myanmar is channeled almost exclusively toward humanitarian assistance. The non-availability of financial and technical resources is a key constraint to carry out the projects.

10.4 Report Card of Pollution Status to Public

TV and Radio commercials and interviews are most used for the promotion of environmental matters, to preserve the environment. Also, Posters and Slogans on environmental education are being distributed among popular place. Textbooks and readers contain material on the need to protect the environment and on the consequences of degraded environment. Youths and students participate en masse in the annual Tree Planting Week so that they come across nature not only in their books but also meet with and experience the joy and benefits of natural growth.

Newspapers, journals, radio and television are key sources of information pertaining to the management of environment. Popular opinions on environmental issues are often voiced in "People's voice" sections of local newspapers and journals.

The NCEA is promoting a campaign to enhance public awareness on environmental matters. Since 1993, nation-wide World Environment Day celebrations were held, aiming at involving local communities in the environmental conservation programmes. Till now, some studies about air pollution levels and suspended particulate matter in cities were carried out and reported to public media. Report cards of marine pollution status to public are still lacking.

13. Priority Actions and Remedial Measures Required at

11.1 National level

First of all, National Environmental Law should be approved. To enforce the National Environmental Law, a new department should be set up at ministry level.

A marine research centre should be established under the new department and required work plan should be laid down for pollution control of coastal regions. Three main tasks of the research centre are (i) organizing the scattered environmental-related data to national environmental database to which all stakeholders have access, (ii) enhancing the national and international partnerships on environmental-related matters, and (iii) continuous monitoring of sea water properties. In Myanmar, research facilities (materials and technology) are still necessary for the comprehensive assessment of sea water quality and biological assessment of marine environment. The government / ministry should provide the required facilities. Provision of research facilities will facilitate the mapping out of the pollution hot spots. After that remedial strategies for the pollution hot spots should be carried out.

The government empowers the local authorities to obey the National Environmental Law.

11.2 Regional/State Level

The main jobs at the regional level are to monitor the sea water properties in the coastal region and waste water from land-based source coming into the region, to mapping out of the pollution hot spots in the region and to carry out remedial strategies for the pollution hot spots.

To carry out the mentioned steps, international collaboration among working groups, regional laboratories and BOBLME member countries are important. Technical (training/ fellowships/ partnerships) and materials supports from UN agencies (UNEP/GPA/IAEA) and other stakeholders are necessary to implement the work plan effectively and efficiently.

11.3 Local level

Local authorities and NGOs educate the local people to systematic uses of chemical fertilizer, pesticides, home-made sewage treatment systems, better farming and aquaculture, and environmental education and awareness. NGOs should initiate the Integrated Coastal Zone Management projects in the coastal regions.

12. Summary and Conclusions

(i) In this report, background information about the bio-graphical features of Myanmar was summarized. Coastal regions of Myanmar are divided into three portions; the Rakhine, Deltaic and Tanintharyi (Dawei Region and Myeik Archipelago).

(ii) Major sources of pollution in the Myanmar coastal regions are probably the sewage, excess nutrients from agriculture and aquaculture, chemical fertilizer residue, POPs from used pesticide residue and used household materials like plastic bags, medical wastes, excreted pharmaceuticals, etc.

(iii) Totally 55 samples from Rakhine, Deltaic, Dawei and Myeik regions were collected with GIS positions. Physicochemical properties (chemical oxygen demand, total suspended solids, ammonia nitrogen, nitrite nitrogen, phosphate, chlorophyll *a*) and heavy metal (Pb, Cd, Hg) contents of the sea water samples were determined and compared with acceptable levels of international and ASEAN standards.

(iv) The ammonia nitrogen and nitrite nitrogen concentrations are under the acceptable level of ASEAN and other countries. Average phosphate (inorganic phosphate or

orthophosphate) concentrations of the sea water samples were 0.0244, 0.0305, 0.0265 and 0.0237 ppm in Rakhine, Deltaic and Dawei and Myeik regions, respectively. These values were below the criteria value of ASEAN and other countries. Higher concentrations of phosphate were observed in the two samples related to mouth of Yangon River in Deltaic coastal zone and to Pandinin (mouth of Dawei river).

(v) According to the results, it can be deduced that the studied regions are not eutrophicated with nitrogen and phosphorus. Median values of nitrogen and phosphorus were found in Deltaic and Dawei regions. This may be related with residual chemical fertilizer from land-based source.

(vi) Among the samples, the highest total suspended solid (TSS) was found in the sample that is from mouth of Yangon river. Generally, TSS values are in the acceptable range. Higher COD values were found in two samples related to mouth of Yangon River and near Maungmagan.

(vii) Currently, eleven and nineteen offshore gas platforms in the Rakhine coast and Gulf of Mottama (Martaban) in the Deltaic coastal zone are operating, respectively and there is no oil platform in Myanmar coastal regions.

(viii) Lead (Pb) concentrations in the sea water samples are under the acceptable level except that the sample related to mouth of Yangon River. Average concentrations of lead in sea water samples of Rakhine, Deltaic, Dawei and Myeik coastal zones were 4.48, 6.85, 7.55 and 5.50 ppb, respectively. Average concentrations of mercury in sea water samples of Rakhine, Deltaic, Dawei and Myeik coastal zones were 1.03, 1.53, 1.39 and 1.07 ppb, respectively. The cadmium (Cd) contents of the most of the sea water samples were lower than ASEAN acceptable level of 10 ppb. Average concentrations of cadmium in sea water samples of Rakhine, Deltaic, Dawei and Myeik coastal zones were 1.67, 2.30, 2.16 and 1.83 ppb, respectively.

(ix) According to data, heavy metal (Cd, Pb and Hg) concentrations in sea water samples are low in Rakhine, Dawei and Myeik coastal zones. Median concentrations are found in Deltaic coastal zone.

(x) Average concentrations of Hg, Cd, Pb and As in cuttlefish (*Sepia aculeata*) samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively. Average concentrations of Hg, Cd, Pb and As in the squid (*Loligo duvauceli*) samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively. Average concentrations of Hg, Cd, Pb and As in the crab (*Scylla serrata*) samples were 0.0358, 0.1079, 0.0516, 0.0539 ppm, respectively. All toxic metal

concentrations in cuttlefish, squid and crab samples were lesser than maximum permitted levels (Hg < 0.5 ppm, Cd < 1.0 ppm, Pb < 2.0 ppm and As < 1.0 ppm).

(xi) Microbiological assessments of the standard plate counts of cuttlefish and squid were $2.12x10^5$, $1.13x10^5$ and $1.30x10^5$ CFU/g, respectively. These values were found to be lower than the allowed SPC limit of 10^6 CFU/g. The cuttlefish and squid samples contained bacterial counts (Coliforms, *Escherichia coli*) of 10 CFU/g and crab sample contained bacterial counts (Coliforms, *Escherichia coli*) of less than 10 CFU/g. The *Staphylococcus aureus* count was found to be less than 10 CFU/g each in cuttlefish, squid and crab. The minimum allowed limit was 10 CFU/g for marine invertebrates, so these samples studied were fit for human consumption. Furthermore, *Salmonella* and *Vibrio cholerae* were not detected in these three types of marine invertebrates.

(xii) Among the four metals, lead was the highest concentration in all fish species. Concentrations of lead were in the range of 0.202 to 0.487 ppm for *Pangasius pangasius*, 0.157 to 0.298 ppm for *Lates calcarifer*, and 0.137 to 0.225 for Channa striata. The toxic metals in order of concentrations in these three fish species were lead >arsenic >cadmium >mercury. All values are under the maximum permitted values of As (< 1.0 ppm), Cd (< 1.0 ppm), Pb (< 2.0 ppm) and Hg (< 0.5 ppm).

(xiii) Myanmar has signed the United Nations Convention on the Law of the Sea in 1982. In 1988, Myanmar acceded to the International Convention for the Prevention of Pollution from Ship 1973 and the Protocol of 1978 (MARPOL 1973/78). Myanmar acceded to the Stockholm Convention on Persistent Organic Pollutants on 19-04-2004.

(xiv) Myanmar Agenda 21 aims to address the following activities, to promote research and monitoring programmes, to develop and implement strategies for the sustainable use of marine resources, to strengthen legal and regulation framework, to enhance education and awareness campaign, to conserve marine biological diversity, to establish a coordinating mechanism and to promote coastal zone management and development.

(xv) Myanmar has a number of sectorial laws that are related to protecting and conservation of natural resources and control of pollution. They are the Factories Act 1951, the Forest Law 1992, the Pesticide Law 1990, the Myanmar Marine Law 1994, the Myanmar Pearl Law 1993 and the Water Power Act 1927. The Law Relating to Aquaculture 1989, the Law Relating to the Fishing Rights of Foreign Fishing Vessels 1989, the Myanmar Marine Fisheries Law 1990 and the Freshwater Fisheries Law 1991 are provided for further development of fisheries, preventing over fishing, safeguarding and protection of fishing

grounds and management of fisheries. These laws prohibit fishing without license, causing water pollution, use of destructive fishing practices and promotion of sustainable use of fishery resources.

(xvi) Research works related to BOBLME project are on-going process and technical (training/ fellowships/ partnerships) and materials supports from UN agencies (UNEP/GPA/IAEA) and other stakeholders are necessary to implement the work successfully. Also international collaboration among working groups, regional laboratories and BOBLME members countries are essential.

REFERENCES

AMEQC, (2000), "Marine Water Quality Criteria for the ASEAN Region"

Hla Phone Aung, (1986), "Analytical Studies of the Water Environment of Hmyin (acetes and mysids)", MSc.Thesis, Department of Chemistry, University of Yangon Myanmar

Kaly, U.L., (2004), "Review of Land-based Sources of Pollution to the Coastal and Marine Environments in the BOBLME Region", BOBLME Project

Khin Lay Kyi, Kyaw Naing, Ni Ni Sein and Aung Myint, (2007), "Investigation on Changes of Histamine Content in Pyi-daw-tha (Toredo scad) Nga-tha-lauk (Hislsashad) by Colourimetric Technique", *Jour. Myan. Acad. Arts & Sc*., **V**, 1(A), p.123

Khin Thida Kyaw, (2008), "Analytical Studies on Toxic Metals (As, Cd, Pb and Hg) Concentrations in Nga-dan (*pangasius pangasius*), Ka-kadit (*lates calcarifer*) and Nga-yant (*channa striata*) Samples", PhD Thesis, Department of Chemistry, University of Yangon, Myanmar

Klontz, G.W., (1993), "Epidemiology in Stoskopf", M.K. (ed.) Fish Medicine. W.B. Saunders, Philadelphia, US

Mary, Kyaw Naing, Ni Ni Sein and Aung Myint, (2007), "Determination of Formaldehyde in Lizard Fish by 4-amino-3-hydrazino-5-mercapto-1,2,4-triazol (AHMT) Method", *Jour. Myan. Acad. Arts & Sc*., **V**, 1(B), 213

MFRD (Marine Fishery Research Department) (1992), "Laboratory Manual on Analytical Methods and Procedure for Fish and Fish Products, SEAFDEC", 2nd Ed, Singapore

Myint Pe, (2003), "National Report of Myanmar on the Sustainable Management of the Bay of Bengal Large Marine Ecosystem (BOBLME)", Department of Fisheries, Myanmar

National Commission for Environmental Affairs, "Myanmar National Environmental Performance Assessment (EPA) Report", Myanmar

Tee Tee Cho, (1997), "Environmental Law Developments in the Union of Myanmar", *Singapore Journal of International & Comparative Law*, **1**, 609-614

Tong, S.L., Goh, S.H., Rani Abdulah, A., Tahir, N.M. and Wang,C.W., (1999), "ASEAN Marine Water Quality Criteria for Oil and Grease", *ASEAN-Canada CPMS-II Cooperative Programme on Marine Science*

UNCED, (2002), "Country Profiles Series", Johannesburg Summit, Myanmar

WHO, (2004), "Environmental Health Country Profile", Myanmar

Win Aung, (1995), "Environmental Studies on Bago River Water, Bago", M Sc Thesis, Department of Chemistry, University of Yangon, Myanmar

Win Latt, (2000), "The Role of Myanmar's Environment Related Laws and Regulations in Protection and Management of Coastal Marine Ecosystems Issues and Needs", In International Symposium on Protection and Management of Coastal Marine Ecosystem

Win Win Than, Kyaw Naing and Aung Myint, (2009), "Chemical Composition of Some Toxic Metals in Marine Invertebrates during Three Seasons", *Jour. Myan. Acad. Arts & Sc.*, **VII**, No.1, p. 383

Win Win Than, (2008), "Study on Some Toxic Metals and Pathogenic Bacteria in Marine Invertebrates", PhD Thesis, Department of Chemistry, University of Yangon, Myanmar

Ye Myint Aung, (1993), "Water Analysis of Bago River near Prawn Hatchery (Thakayta)", M Sc Thesis, Department of Chemistry, University of Yangon, Myanmar

Yin Yin Lay, (1995), Myanmar Agenda 21

Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project and to lay the foundations for a coordinated programme of action designed to improve the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

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