Case Study
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Safety, Health, and Environmental Improvement Programs in a Rapidly Growing Port: Laem Chabang

By Mr. Buncha Apai, Administrator 13, Office of the Director General, Laem Chabang Port; and Mr. Thongchai Thammapredee, Director, Port Operations Division, Laem Chabang Port

gef
Global Environment Facility

UNDP
United Nations Development Programme

UNOPS
United Nations Office for Project Services

PEMSEA
Partnerships in Environmental Management for the Seas of East Asia

The Yeosu Project and Expo 2012 Yeosu Korea

KOICA
Korea International Cooperation Agency

Considered to be Thailand's most important deep sea port with a dominant share of 70 percent of the country's sea transport volume, Laem Chabang Port (LCP) brims with potential to be a truly world-class port. Under the supervision of the Port Authority of Thailand (PAT), the port's development has been fast-tracked to serve the fast-growing industries in Chonburi Province as part of the Eastern Seaboard Development Project. Since its inaugural operations in January 1991, the port has been providing services to meet its government mandate of sustaining economic growth by facilitating maritime transport and international trade.

Geographically advantaged to be situated in the crossroads of one of the fastest growing economic clusters in the world, Thailand's Ministry of Transport has adopted a policy to promote LCP as the main trading gateway of Indochina. As a main port of Thailand, it can support large-scale transportation of commodities in the region once some international mega-projects are completed in the near future, such as interconnecting routes to China and India, and trading routes in the Greater Mekong Subregion and the North-South Economic Corridor. In addition to these promising developments, the establishment of an ASEAN Economic Community also augurs well for the LCP.

LCP's operations are supported by adequate resources, modern infrastructure and spacious facilities. It has a backup area of around 1,014 ha being used as container yard, empty container depot, warehouses, pre-delivering yard for exporting new cars, cargo distribution area, etc. The port has likewise reclaimed land of approximately 386 ha that is now serving as terminal backup area for 11 container terminals, two multipurpose terminals, one RO/RO (roll on/roll off) terminal, one passenger and RO/RO terminal, one dry bulk terminal, and one general cargo and RO/RO terminal.

The port has been providing services to various types of commodities with its existing capacity as shown in **Table 1**.

The port has posted an impressive 11.64 percent growth rate in terms of containerized cargo handling, clearly showing its dramatic rise as one of the world's busiest ports (**Table 2**).

Table 1. Services provided to various types of commodities and capacities.

Terminal type	Wharf length	Capacity/year
Container	2,800 m	7.6 million TEU
Ro/Ro	1,315 m	2.0 million units
Dry bulk	450 m	1.1 million ton
General cargo	1,250 m	3.0 million ton
Passenger	365 m	70,000 DWT passenger ship

Table 2. Containerized cargo (million TEU).

	2008	2009	2010	2011
Unloaded	2.573	2.304	2.422	2.761
Loaded	2.646	2.308	2.623	2.875
Transshipment	0.021	0.009	0.023	0.047
Total	5.240	4.621	5.068	5.658
Percent Growth	12.91	-11.80	9.66	11.64

Table 3. LCP cargo traffic forecast.

	2012	2013	2014	2015
Container (million TEU)	5.992	6.483	6.991	7.519
Exported cars (million unit)	1.005	1.070	1.140	1.214
General cargo (million ton)	2.901	2.956	3.002	3.040
Bulk cargo (million)	0.551	0.561	0.570	0.577

One of the most important roles of LCP is to serve as a hub of Thailand manufactured cars for exports. The Thai government relies on LCP's role to realize its vision of becoming a "Detroit of Asia" and become the largest carmaker and exporting base in the region.

With LCP's stable performance, the anticipated volume for each type of cargo throughput in LCP in the next four years is shown in **Table 3**.

Challenges in Safety, Health, and Environment

Laem Chabang Port has encountered a number of challenges with regard to safety, health and environmental (SHE) concerns in the port. First, because LCP has been developed in a coastal area, it has experienced multi-resource conflicts among other coastal users. Furthermore, since the construction method of the port involved dredging, land reclamation and setting up of a long breakwater, shore erosion and sedimentation have occurred. In addition, LCP has been experiencing various problems that have challenged the port to come up with short-term and long-term solutions, including:

Environmental problems from massive traffic volume of container trucks

With an average volume of 6 million TEUs of container cargo per year, LCP inevitably faces the problem of massive traffic volume of container trucks, not just within the port area but also in all the roads connected to the port. For instance, traffic volume amounted to 4.549 million and 4.841 million trips in 2010 and 2011 respectively. The container trucks have brought air pollution, increasing accidents and economic loss (due to unnecessary fuel consumption during traffic congestion).

Waste management in the port

One of the environmental concerns that is being prioritized in LCP is the relatively poor waste management practices in the port and the volume of solid and hazardous wastes generated by the port's operations, as shown in **Table 4**.

The Engineering Division of LCP is responsible for collecting solid waste and transferring it to a landfill in Laem Chabang Municipality. Some hazardous wastes (contaminated fabric, contaminated container, fluorescent and material scrap) are also collected by the Engineering Division and taken to a central waste storage. Then a licensed private waste operator takes them to the landfill in Laem Chabang Municipality for disposal.

In terms of oily waste from ships, LCP's waste management program needs further improvements. There is no adequate central

Table 4. Volume of solid and hazardous wastes generated by LCP operations.

Solid waste	Total *(kg/year)*	Average *(kg/day)*
2007	552,000	1,430
2008	558,540	1,530
2009	569,000	1,559
2010	550,000	1,507

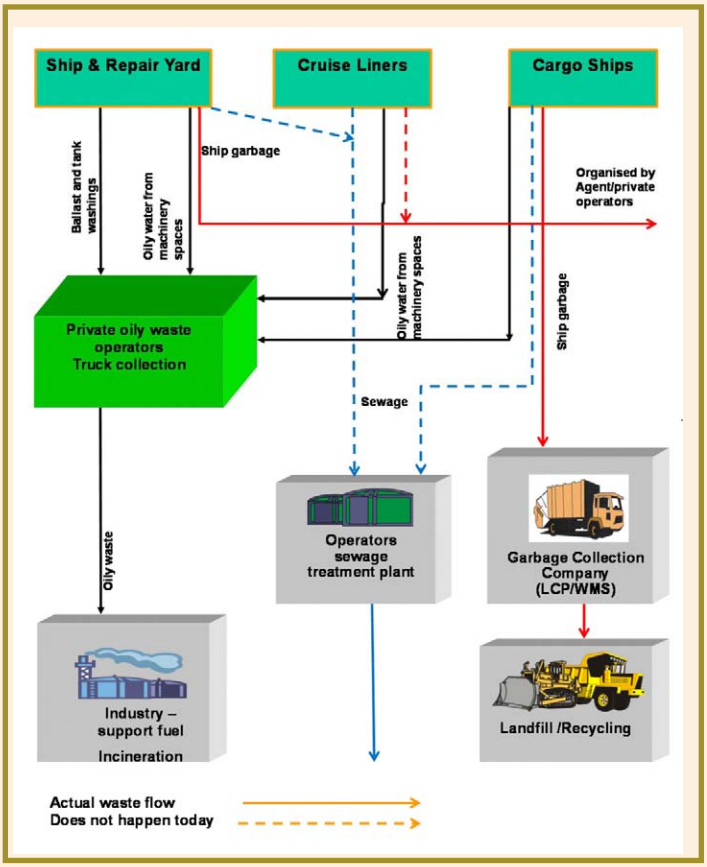
Hazardous waste	Total *(kg/year)*	Average *(kg/day)*
2007	53,840	148
2008	62,787	172
2009	n/a	123
2010	81,520	223

management, registration and notification for the collection of waste from the ships. The Marine Service Division is responsible for the collection of oily waste from ships while the Port Operation Division is responsible for oily waste from equipment and workshops in LCP. However, for regular operations, oily wastes are collected by licensed private waste collection operators and taken to treatment sites outside the port. In addition, sewage from ships is not being collected due to the relatively short time the ship stays in the port and sufficient holding tank capacity. The lack of clear procedures and regulations and the lack of transparency regarding fees and costs also add to the problem of collecting wastes from ships.

Figure 1 gives an overall view of the flow of ship waste in LCP.

With the aforementioned problems in ship waste collection and inadequate monitoring of waste handling procedures, LCP's waste management practices still needs a lot of improvement to better control health, safety and environmental aspects in the port.

Figure 1. Diagram of Laem Chabang Port's ship waste flow (2011).



Gas emission and energy consumption

Due to the increase in commercial activities of the port (posting an average annual growth rate of 5.6 percent in the volume of containerized cargo handled from 2008 to 2011) and the move towards more electrification of cargo handling equipment (to minimize air pollution from diesel fuels), energy use, particularly electric consumption, has been on an increasing trend. Electric power consumption in LCP from 2007 to 2010 is shown in the **Table 5**.

While it cannot be denied that LCP produces high volume of greenhouse gases (GHG) due to high electric consumption and the high level of fuel consumption by the millions of trucks and thousands of cargo vessels going in and out of the port, the port has been seeking measures and methods to decrease gas emission and adopt green energy in its operations to be more socially responsible and to contribute to mitigation of global warming.

Dangerous cargo management

LCP is strategically situated as a discharge point for imported materials that are transported to hundreds of factories, most of which are located in the eastern part of Thailand. At the same time, many types of dangerous cargo are also being loaded and transported to other countries using the port.

The volume of dangerous cargo (by IMO Class) LCP has handled from 2008 to 2011 is shown in **Table 6 and 7.**

While operating procedures for handling dangerous cargo within the port have been developed and implemented in accordance with IMO standards, LCP is still considered at high risk due to the sheer volume of inbound and outbound dangerous goods cargo it is handling every year (more than one million tons). In November 2009, for instance, a fire incident on a container filled with 9,142 kg of bleach powder was reported when it was stacked in a container terminal. The incident caused damages to the port's immediate environment and portrayed a negative image of the port.

With the high volume of dangerous cargo that LCP cannot just avoid or refuse to handle, it is imperative for the port to find more appropriate ways in managing dangerous cargo. This can also bring about more success in safety, health and environmental management in the port.

Port Security

LCP has been the focus of political protesters who wanted to interfere with port operations. Similar to other public enterprises, the port is sometimes vulnerable to these kinds of demonstrations. Furthermore, seaports are now known to be one of the places that are vulnerable to the risk of terrorism, involving, for example, destruction of property, port disruption and environmental damage to the country. This is one of the most important challenges to safety, health and environment, as well as security, that need to be addressed by LCP.

Experience in Adopting PSHEMS

Experience in the development, implementation and improvement of PSHEMS

The Port Authority of Thailand (PAT) agreed to accept technical assistance from the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) for the establishment and implementation of a Port Safety, Health, and Environmental Management System (PSHEMS) in LCP with the signing of a Memorandum of Agreement between the PAT and PEMSEA on October 7, 2008.

LCP was mainly responsible for facilitating the implementation of PSHEMS. A project team was established to coordinate and manage the activities programmed for PSHEMS development. PEMSEA, on

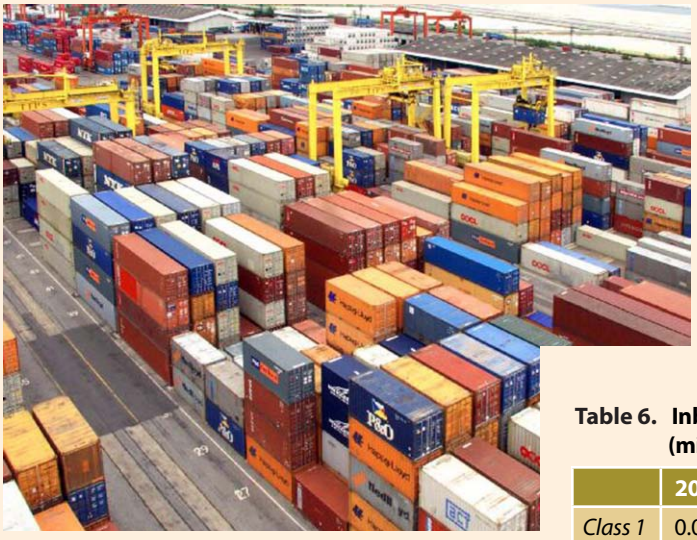


Table 5. LCP Electric power consumption from 2007–2010 .

	2007	2008	2009	2010
Electric power (million unit)	48.647	57.951	59.687	65.183
Growth (%)	-	19.13	3.00	9.21
Electric expense (million Baht)	135.32	156.76	186.27	195.39
Average (Baht/ unit)	2.78	2.71	3.12	3.00

Table 6. Inbound Dangerous Cargoes (million tons).

	2008	2009	2010	2011
Class 1	0.004	0.009	0.015	0.014
Class 2	0.041	0.031	0.040	0.047
Class 3	0.151	0.119	0.149	0.170
Class 4	0.062	0.025	0.033	0.046
Class 5	0.051	0.042	0.068	0.072
Class 6	0.052	0.037	0.050	0.064
Class 7	-	-	-	-
Class 8	0.111	0.088	0.115	0.140
Class 9	0.161	0.141	0.191	0.208
Total	0.637	0.497	0.665	0.765

Table 7. Outbound Dangerous Cargoes (million tons).

	2008	2009	2010	2011
Class 1	0.002	0.001	0.002	0.002
Class 2	0.045	0.036	0.036	0.050
Class 3	0.127	0.113	0.123	0.121
Class 4	0.016	0.014	0.033	0.033
Class 5	0.045	0.053	0.062	0.072
Class 6	0.015	0.011	0.009	0.016
Class 7	-	-	-	-
Class 8	0.092	0.075	0.090	0.109
Class 9	0.137	0.092	0.155	0.164
Total	0.481	0.398	0.512	0.571

the other hand, provided technical assistance through the facilitation of training workshops, review of documentation for planning, design and implementation of the PSHEM Code.

A series of trainings on PSHEMS were conducted by the PEMSEA Resource Facility (PRF) and participated in by relevant stakeholders such as the port officers, Customs, Marine Department, private terminal operators and DG warehouse operator at LCP. These trainings include:

- **Phase 1:**
  Understanding PSHEMS and conduct of hazard identification (October-December 2008)
- **Phase 2:**
  Documentation of the PSHEMS (January-February 2009)
- **Phase 3:**
  Implementing and Monitoring (March-August 2009)
- **Phase 4:**
  PSHEMS internal auditing (May-July 2009)
- **Phase 5:**
  Training and Conducting on continual improvement of the PSHEMS (July-November 2009)

With the PSHEMS documentation in place, the stage 1 audit was conducted by the PRF from August 30 to September 2, 2009. The PRF's stage 2 audit was conducted from November 2-6, 2009. Then, the Certificate of Recognition of PSHEMS was given to LCP on November 24, 2009 during the 3rd East Asian Seas Congress in Manila, Philippines.

Initially, there were some resistance from various departments in changing their own work processes. However, upon realizing the benefits of PSHEMS, and with the enthusiasm and teamwork displayed by the working team, the reluctance of these departments have been resolved. Eventually, they have gradually gone hand in hand with the working team in the development and implementation of PSHEMS.

The activities needed to develop the PSHEMS were carried out by the project team, which is made up of department managers who had to work extra hard to devote some of their time for PSHEMS development on top of their regular duties. In addition, the capability in understanding English by all the participants was also a factor in getting the most knowledge during training and workshop activities.

Nevertheless, the successful experience of developing PSHEMS as a part of the integrated management system of LCP, was made possible through the cooperation between the port and the port-related activities operators and related agencies, recognition on the importance of PSHEMS by the ports' executive officers and through the enthusiastic efforts and patience of the working team.

SHE Programs of LCP

Environmental Programs inside LCP

Sustainable Waste Management Program

In cooperation with the ASEAN Ports Association (APA) and PEMSEA, LCP has accepted technical assistance from the German International Cooperation (GIZ) for the implementation of the Sustainable Port Development in the ASEAN Region. The project's objectives are to improve the management of onshore waste generated on board ships and cargo residues, to avoid daily illegal operational spillages and discharges and to make the port modern and competitive. The project will cover discharges of solid, oily and toxic wastes and cargo residues from ships. The basic strategy is to reduce the volume of ship-generated waste into the sea by improving waste management, enhancing the availability and use of waste reception facilities and strengthening the enforcement regimes in the ports in accordance with the requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL73/78). The immediate outputs of the project were the development of port regulations on waste management and development of a Port Waste Management Manual.

The program commenced in November 2011 with an assessment of existing port waste management practices in the port. A review of national legislations concerning the port and related activities was likewise undertaken. An inventory of the type of waste accepted in Laem Chabang Port was also assessed. The results of these assessments revealed the following areas for improvement in LCP's waste management practices:

- There is no central management of waste handling within the port.
- No adequate central management, registration and notification of collection of ship waste.
- Unclear procedures and regulations regarding responsibilities on ship waste collection.
- Lack of transparency regarding fees and costs for some oily waste collection.
- Current fees for garbage collection do not reflect real cost.
- There are no economic incentives for ship's crew to deliver waste.
- Monitoring of waste handling procedures is inadequate.

In May 2012, the GIZ-supported project came up with a Port Waste Management Implementation Plan for LCP to be undertaken within a six-month duration.

Green Port Program

In 2010, Laem Chaebang Port initiated a Green Port program to address its carbon dioxide emissions. The port has decided to setup a Wind Farm Powerplant as a pilot project to increase the proportion of green energy to the port's total electricity consumption and thereby contribute to the curtailment of global warming. LCP hopes that the project will serve as a model project for other government agencies and private companies in Thailand, not only as a practical example of wind turbine farm development in Thailand but also as a good example of corporate social responsibility (CSR).

Upon the recommendation of LCP's project consultants from the Applied Research Center of Wind, Water and Solar Energy in the Faculty of Engineering of Rajamangala University of Technology Thanyaburito, 84 units of 18-m high wind turbines that have been researched and designed especially for ports will be installed in the first phase of the project. With a 10 kW/hr capacity, the combined power generation capacity of all 84 units is around 840 kW/hr. Interconnected by a grid inverter system, the wind turbine system is expected to generate electricity at an average of 2.5 million units/yr, which can also be expected to help decrease CO_2 emissions to the atmosphere by about 1.4 million tons CO_2/yr.

With an investment budget of Baht 135 million, the project is now under the process of installing the turbines in the port site. Although its capacity may be quite small compared to bigger wind turbines in other ports in Asia and Europe (e.g.,1,250 or 1,500 kW/hr/unit,) this project can realize the LCP's intention of initiating a green port program that is suited to the natural conditions around the port. The project is expected to be completed by August 2012. With funding of around Baht 165 million, the second phase of this project will focus on research on the best alternative way of green electric power generation, such as solar and wind energy. The research will also review both good and weak points that have occurred in the first phase to come up with a better design and a more suitable model for the second phase.

Low Carbon Port Program

Carbon dioxide and other GHG emissions in LCP comes from two major sources: from cargo handling equipment operated by terminal operators; and from ships calling the port. To address these problems, LCP's Low Carbon Port Program will encourage all private terminal operators in the port to switch from diesel fuel to electric power in operating cargo handling equipment. LCP will likewise apply more electric supply for ships berthing at the quay wall.

Some private terminal operators, such as the LCB Container Terminal 1 Ltd, have actually started to modify their heavy duty handling equipment (e.g., Rubber Tyre Gantry (RTG) crane) from using only diesel fuel to electrical power. After connecting the RTGs to the terminal electricity supply, it is expected that a reduction of about 1.80 ton of CO_2/yr will be achieved for the 20 RTGs in this terminal.

In addition, since March 2009, Hutchison Laem Chabang Terminal Co., Ltd. has also started installing about 12 units of electric RTGs in container terminals C1 and C2. It is now the policy of LCP that all new RTG installations will be electric-powered to support LCP's Green Port Program. In fact, some private terminal operators are already in the process of modifying their heavy duty handling equipment in line with this policy.

As for the electric supply for ships berthing at the quay wall, a feasibility study and engineering design for LCP's Phase III development will be undertaken and would involve the study and design for a "Cold Ironing System." Construction work for the development of LCP's Phase III is expected to start by the year 2013 or 2014. The project will embark on the development of an "innovative port", which aims to introduce "green port" improvements to the new terminal and

modify the old terminals to make them more environment-friendly.

Natural Resources Conservation

Situated in a coastal area of a Laem Chabang village, the port has a natural mangrove forest covering an area of about 4.5 ha that is teeming with fauna and flora species. To preserve its diversity, LCP, together with Laem Chabang Municipality and Kasetsart University, Sriracha campus, entered into a Memorandum of Understanding in the latter part of 2008 to collectively undertake activities that would preserve and rehabilitate the mangrove forest.

This natural resources preservation program has also encouraged people to participate in many activities together such as collecting garbage, surveying types and density of mangrove plantation, replanting of the destroyed areas of the forest, monitoring sea water quality, etc. Moreover, academic activities have been conducted to enhance knowledge about environment and natural resource preservation to the village people and school and university students around the port. Furthermore, the forest is used as a recreation site for the general public.

LCP has likewise undertaken other activities related to natural resource rehabilitation, such as planting trees within and around the port.

Port Air Emission Inventories Assessment

From September to December 2010, an air emission inventory was carried out in Bangkok Port under the the GIZ/ASEAN Sustainable Port Development in the ASEAN Region project. With the successful implementation of the project in Bangkok Port, the GIZ started to provide similar technical assistance to LCP in 2011, carrying out an air emission inventory within the port covering the following sources:

- Port direct sources including all air pollution emission sources directly under the control and operation of the port administration entity, port-owned vehicles, buildings (e.g., boilers, furnaces, etc.), port-owned and operated cargo handling equipment, as well as any other emissions sources that are owned and operated by the port administrative authority.
- Port indirect sources including port purchased electricity for port administration-owned buildings and operations (excluding "offsite" tenant power and energy purchases).
- Other port indirect sources including tenant operations, ships, trucks, cargo handling equipment, rail locomotives, harbor craft, tenant buildings, and port and tenant employees commuting in the port. In addition, onsite emissions included if possible.

Safety/Health Programs inside LCP

SHE Regulations Development Program

LCP, in cooperation with the GIZ project, has currently developed the Laem Chabang Port Ordinance (Port By-Laws) which also covers SHE regulations. A total of 11 meetings were held among port officers, terminal private operators, dangerous cargo warehouse operator, marine department and the GIZ project from December 2010 to November 2011. A draft of the Port By-Laws has now been completed covering port regulations on traffic management, port navigation, miscellaneous regulation, safety, dangerous goods, waste disposal and business statistics, and electronic data processing/data protection.

The draft port regulations will be submitted to the PAT's Director General in July 2012 and then to the PAT's Board of Commission in September 2012 for approval. The Port By-Laws should be one of the tools that can be used to more effectively control and manage SHE in the port in compliance with international regulations.

SHE Results delivery by the PSHEMS

SHE Regulations Development Program

Every year, LCP is implementing environmental quality monitoring within the port on the following parameters:

1. Ambient Air Quality (2 times/year) in 12 stations.
2. Noise Level (2 times/year) in 12 stations.
3. Wastewater from Water Treatment Plant (weekly) in 2 stations.
4. Seawater (4 times/year) in 11 stations.
5. Sediment in the Sea (2 times/year) in 11 stations.
6. Biological in the Sea (2 times/year) in 11 stations.
7. Coastal Change (1 time/year) in 9 stations.
8. Social and Economic (1 time/year) 4 stations.

Results of ambient air quality examined from 2008-2010 showed that total suspended particle, carbon monoxide, sulfur dioxide, total hydrocarbon and nitrogen dioxide in the port area and nearby communities are within the acceptable standards issued by the Department of Pollution Control, Ministry of Natural Resource and Environment. **Tables 8 and 9** show some examples of the air quality monitoring results.

With regard to seawater, biological and sediment monitoring, samples collected from 11 stations have shown that in spite of the fact that the port has been operating for more than 20 years already, environmental quality in the port is still in good condition (**Table 10**).

Moreover, noise level, socioeconomic and coastal line monitoring have also been examined regularly for the past several years. The results showed that noise level is within the limitation standard, while erosion and sedimentation are acceptable. On the other hand, the socioeconomic survey revealed that

Table 8. Air quality monitoring results on suspended particles.

Sampling Stations	Total Suspended Particulate *(mg/m³)*					
	1/51	2/51	1/52	2/52	1/53	2/53
Checking Gate (Station 1)	0.035-0.053	0.050-0.078	0.053-0.100	0.068-0.112	0.057-0.127	0.210-0.239
Checking Gate (Station 2)	0.118-0.157	0.044-0.115	0.031-0.041	0.039-0.069	0.026-0.072	0.036-0.062
Entrance of Leam Chabang Port	0.129-0.160	0.078-0.152	0.025-0.039	0.045-0.063	0.028-0.064	0.219-0.245
Laem Chabang Port Fire Protection Training Center	0.035-0.053	0.013-0.047	0.016-0.022	0.044-0.062	0.021-0.032	0.022-0.031
Technology Sriracha School	0.057-0.073	0.014-0.089	0.011-0.043	0.056-0.076	0.271-0.392	0.029-0.086
Tanaporn Witthaya School	0.020-0.042	0.013-0.037	0.029-0.033	0.021-0.056	0.019-0.030	0.032-0.041
Terminal A4	0.033-0.052	0.028-0.067	0.015-0.035	0.015-0.039	0.013-0.018	0.038-0.042
Terminal B4	0.020-0.042	0.177-0.323	0.037-0.069	0.058-0.207	0.075-0.133	0.091-0.226
College of Community Development	0.017-0.022	0.009-0.033	0.013-0.035	0.013-0.022	0.006-0.041	0.025-0.043
Terminal C3	0.025-0.029	0.020-0.029	0.025-0.049	0.016-0.027	0.014-0.034	0.042-0.098
Terminal C0	0.019-0.036	0.033-0.054	0.014-0.020	0.013-0.050	0.006-0.042	0.033-0.052
Standard	**0.033**					

the port activities have negatively impacted on the community around the port area mainly because of dust and massive traffic congestion. These adverse impacts are being taken into consideration by the port management to find areas for improvement and formulate appropriate action plans accordingly.

Table 9. Air quality monitoring results on carbon monoxide.

Sampling Stations	Carbon Monoxide *(ppm)*					
	1/51	2/51	1/52	2/52	1/53	2/53
Checking Gate (Station 1)	0.048-0.066	0.16-0.20	0.23-0.052	3.53-3.73	0.23-0.35	0.20-0.60
Checking Gate (Station 2)	0.18-0.21	0.47-0.69	0.26-0.73	3.04-3.23	0.12-0.41	0.19-0.49
Entrance of Leam Chabang Port	0.49-0.58	0.65-0.89	0.25-0.40	3.24-0.48	0.17-0.48	0.16-0.47
Laem Chabang Port Fire Protection Training Center	0.48-0.66	0.43-0.87	0.22-0.52	2.12-3.02	0.19-0.43	0.16-0.46
Technology Sriracha School	0.43-0.61	0.39-0.51	0.23-0.52	3.50-3.89	0.23-0.35	0.18-0.59
Tanaporn Witthaya School	0.36-0.44	0.74-0.82	0.27-0.44	2.21-3.32	0.16-0.36	0.18-0.52
Terminal A4	0.31-0.33	0.44-0.85	0.25-0.51	2.64-3.16	0.21-0.43	0.15-0.44
Terminal B4	0.36-0.44	0.52-0.80	0.28-0.35	3.17-5.77	0.18-0.46	0.17-0.57
Standard	**9**					

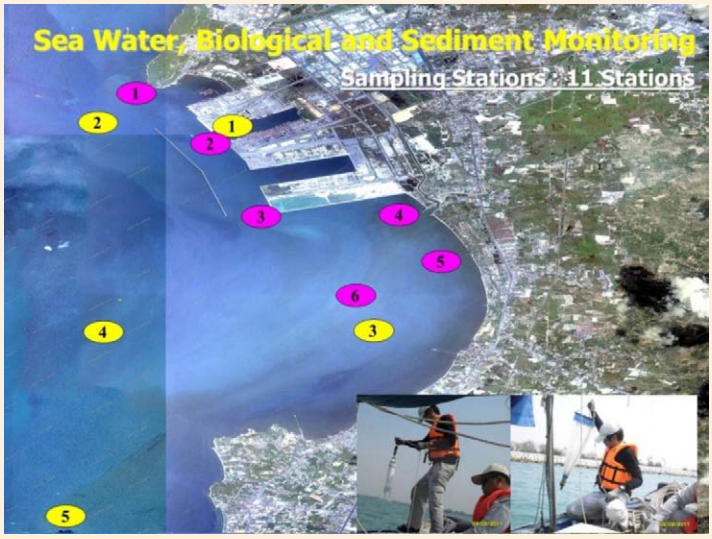


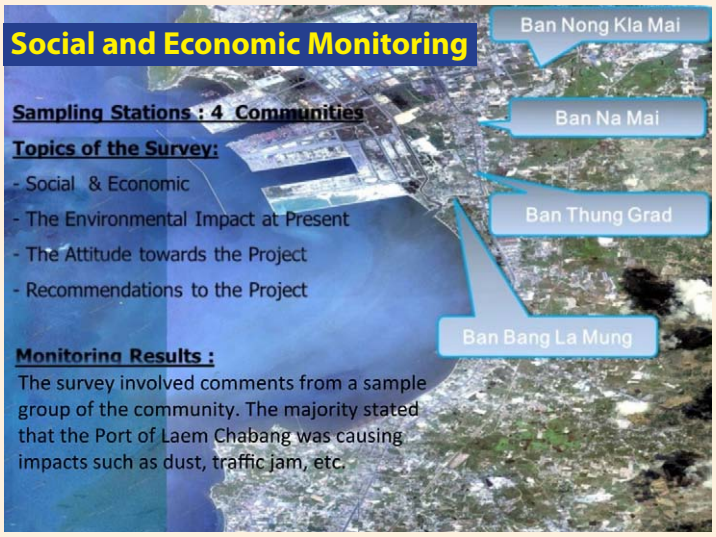
Table 10. Seawater quality analysis results from 2008-2011 (Laem Chabang Port Phase 2).

Sea Water Quality Analysis Results from 2008 - 2011							
Parameters	**Station 1**	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	***Standard***
Temperature (ºC)	28.4 - 32.6	28.6 - 33.2	26.9 - 33.4	27.0 - 33.4	29.6 - 33.7	27.1 - 33.0	-
Transparency (m.)	1.2 - 3.0	1.5 - 2.8	1.0 - 2.2	0.4 - 2.5	1.0 - 2.5	2.0 - 3.5	**N'**
Conductivity (µmhos/cm)	39,670 - 51,600	39,130 - 52,400	39,430 - 52,200	38,950 - 51,400	39,280 - 52,100	31,450 - 51,000	-
pH	7.88 - 8.19	7.96 - 8.20	7.89 - 8.24	7.88 - 8.23	7.97 - 8.31	7.94 - 8.31	**7.0 - 8.5**
Salinity (ppt)	27.8 - 35.2	27.3 - 35.1	28.3 - 35.4	28.0 - 34.1	26.3 - 35.0	28.5 - 34.0	**N**
SS (mg/L)	1.32 - 3.67	1.49 - 4.8	1.24 - 3.86	2.03 - 5.1	4.1 - 10.42	2.0 - 5.37	-
DO (mg/L)	6.6 - 9.0	6.4 - 8.3	7.0 - 8.0	6.4 - 8.0	6.4 - 8.0	6.7 - 8.0	**≥4**
BOD_5 (mg/L)	0.9 - 2.0	1.0 - 2.0	<1.0 - 2.0	<1.0 - 2.0	1.0 - 2.0	0.5 - 2.0	-
Grease and Oil (mg/L)	None to 0.7	None to 0.8	None to 0.6	None to 0.8	None to 0.8	None to 0.7	*
TCB (MPN/100 mL)	2 - 2,400	<1.8 to 4,900	<1.8 to 15	<1.8 to 15	<1.8 to 4,900	<1.8 to 9	**≤1,000**
Pb (µg/L)	<0.5 to 4.0	<0.5 to 3.0	<0.5 to 4.0	<0.5 to 3.0	<0.5 to 7.0	<0.5 to 5.0	**≤8.5**
Hg (µg/L)	<0.05 to <0.1	<0.05 to <0.1	<0.05 to <0.1	<0.05 to <0.1	<0.05 to <0.1	<0.05 to <0.1	**≤0.1**

Standard: Standard of Sea Water Quality (Class 5), Notification of National Environment Board, No. 27, 2006 (B.E. 2549)

Remarks: * = None visible Grease and Oil on water surface
N' = Not lower 10% than lowest turbidity of natural condition
N = Variation not exceed than 10% of lowest salinity

Legend: SS = suspended solids; DO = dissolved oxygen; BOD = biochemical oxygen demand; TCB = total coliform bacteria.



Lessons Learned

In the course of developing and implementing the PSHEMS, LCP has learned the following valuable lessons:

- It is important to have a dedicated working unit within the LCP organization that would oversee the development and implementation of PSHEMS. This requirement is essential in order to avoid the situation wherein no one wants to take responsibility and accountability on the activities required to develop and implement the PSHEMS.
- English proficiency plays a big role in the development and implementation of PSHEMS as it is a significant factor in the learning process of concerned personnel.
- Top management support is important for the sustainability of the PSHEMS.
- Trainings are very important to address the competency requirement of PSHEMS.
- Successive internal audits and management reviews are good in identifying areas for improvement.
- Technical assistance from a knowledgeable organization such as PEMSEA, significantly accelerates the pace of development and implementation of large projects like PSHEMS.

Conclusion

Since the adoption of PSHEMS as a part of the integrated management system of LCP, positive results have been generated. The port's safety and health conditions have been improved by regularly implementing and doing internal audits in order to better conform to the PSHEM Code. Moreover, environmental quality has been within the acceptable standards of related government agencies.

However, many aspects in relation to the PSHEMS such as the port regulations, air emission inventory, sustainable waste management system, green energy project, etc., are still under development. Hopefully, when these programs are already being fully implemented, more positive results from the PSHEMS initiative can be realized.

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For comments and suggestions, please contact:

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)

P.O. Box 2502, Quezon City 1165 Philippines
Tel.: (+63 2) 929 2992
Fax: (+63 2) 926 9712
Email: info@pemsea.org
www.pemsea.org