Monitoring Pollution in Asia:

A UNU-Shimadzu partnership
For capacity building

UNITED NATIONS UNIVERSITY

SHIMADZU

Contents

Welcome Messages

I would like to express my appreciation to the Shimadzu Corporation for its continuing support of this important initiative. I also wish to take this opportunity to thank to the project participants for their contributions to the United Nations University (UNU) - Shimadzu project.

Environmental monitoring and governance is one of the strong thematic focuses of UNU. This UNU-Shimadzu Partnership has been one of the UNU's pioneering projects - exploring the synergies in a tripartite partnership between the UNU, the private sector, and partner scientific institutions in developing countries in Asia. While many multilateral environmental interventions tend to undervalue sustained local academic capacity development efforts, this project has successfully strengthened local academic capacities many of which are now recognized as expert resources at the national level.

The UNU is proud of what has been achieved through this type of research capacity enhancement. We believe that it has contributed to the strengthening of environmental research and education capacities in developing countries and has helped these countries to deal with crucial issues on the international environmental agenda.

Prof. Konrad Osterwalder
UNU Rector, UN Under Secretary General

I wish to express my sincere appreciation and respect for the United Nations University, its project members and its supporting staff for their 15 years of efforts and all of their achievements. The chemical substances do not have borders, and therefore, this project of global environmental monitoring since 1996 utilizing a network of major research institutes in Asia is of great significance. More importantly, all items monitored were substances of great concern at that time, e.g. both ambient and indoor aldehydes, endocrine disrupter, POPs beginning 9 years ago,and PCB in environmental water, the brominated flame retardant in the sediment for these 3 years. Since the Stockholm Convention, international cooperation has become increasingly important to widen the range of target substances and to conduct more detailed monitoring. At Shimadzu Corporation, we believe it is a great honor that we had been able to support this project and participate in activities for building the international monitoring network, and wish to fulfill our role as an analytical and measuring instrument manufacturer of ever-advancing analytical technologies.

Mr. Nakamoto Akira
President and Chief Executive Officer of Shimadzu Cooperation

Project Overview

Our waters contain a great variety of elements including those released from industrial and agricultural activity and urban waste. These pollutants, particularly Persistent Organic Pollutants, or POPs, can remain for a very long time and enter the food chain, posing a real risk to human and ecological health. In efforts to manage these pollutants in Asia, the United Nations University's Institute for Sustainability and Peace (ISP) and Shimadzu Corporation jointly established a capacity-building initiative that would provide developing Asian countries with the scientific knowledge and technology to monitor pollutants in the environment and better implement multilateral environmental agreements like the Stockholm Convention on POPs. From its modest beginnings, the project is now in its 15th year and about to complete its fifth phase. International symposiums and conferences, as well as specialized training seminars were held each year. Numerous environmental researchers have been trained for the latest scientific techniques; and an extensive network has been built connecting academia, the private sector and government together across the region, and internationally.

First Phase: 1996-1999

"Environmental Monitoring and Analysis in the East Asian Region"

In 1996, UNU signed a landmark agreement with Shimadzu Corporation to establish a three-year pilot project: 'Environmental Monitoring and Analysis in the East Asian Region'. The project was to involve 9 countries/territories in Asia (China, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan, Thailand, and Viet Nam), for the purpose of improving pollution monitoring in the region. Individual research laboratories were selected in each country and a National Project Coordinator (NPC) was designated. Each NPC was responsible for managing the project within its laboratory, interfacing with the local government and communicating with UNU.

In its first year, the primary emphasis of the project was on evaluating pesticide contamination in foods. Rice was selected as the representative crop due to its widespread use as a staple diet in East Asia. Additionally, soil samples were also analyzed to establish a correlation between soil and rice contamination. In the second year, the project's scope soon expanded to water contamination, collecting samples of tap water (and a few seawater samples) across East Asia to evaluate water quality levels in the region. The final year of the pilot project focused on monitoring air pollution, particularly on contaminants such as aldehydes and volatile organic compounds (VOCs).

Second Phase: 1999-2002

"Environmental Monitoring and Governance in the East Asian Coastal Hydrosphere"

Due to the success of the First Phase, UNU and Shimadzu agreed to continue the project, and established the Second Phase in 1999. In continuation of the previous (1996-99) project, the individual research laboratories in each country were maintained as partners and national implementation units. The countries involved were: China, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam.

This phase contained three major components:

(1) Environmental Monitoring and Governance - EDC Pollution in the East Asian Coastal Hydrosphere;

(2) Cooperative International Research Project on Marine and Coastal Environment; and

(3) Asia-Pacific Cooperation on Research and Conservation of Mangroves.

The three components were closely linked together and implemented with collaboration of the UNU network on coastal issues.

The first component: EDC Pollution in the East Asian Coastal Hydrosphere was managed with close cooperation and major funding from Shimadzu Corporation. The project involved collecting data on the presence of endocrine disruptor compounds (EDCs) in the coastal hydrosphere. This information was used to develop consistent and rational guidelines for coastal management programmes in East Asia.

During the first year of the project phase, participating organizations monitored DDT (Dichloro-Diphenyl-Trichloroethane) and its breakdown components. DDT was commonly used as a pesticide and insecticide worldwide; however, due to its toxicity and potential harm on ecology and human health, it was subsequently banned for agricultural use around the world under the Stockholm Convention. In this phase, several other pesticides were also reported. During the second year of the project, additional pollutants were included in the list of those monitored; these were primarily alkylphenols and bisphenol-A. In the third year, a new group comprising various phthalates was added.

Third Phase: 2002-2005

"Environmental Monitoring and Governance in the East Asian Hydrosphere"

2002 marked the beginning of the third phase of the joint UNU-Shimadzu initiative. The objective of the third phase was to build on previous efforts to develop scientific capacity-building in East Asia, particularly for chemical analysis of environmental pollutants such as Persistent Organic Pollutants (POPs). Project activities also contributed to Article 16 of the Stockholm Convention which articulates "using existing monitoring programmes and mechanisms to the extent possible and promoting harmonization of approaches". The following countries were involved: China, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. Individual research laboratories were maintained as partners and were provided with new gas chromatograph-mass spectrometer machines (GC/MS-QP2010) by Shimadzu. POPs used for pesticides and termiticides such as DDT, Heptachlor, Chlordane, Aldrin, and Dieldrin, in water and sediment samples were monitored during this phase.

Three international symposiums and four other events such as workshops and training sessions (totaling more than 950 participants) were held during the third phase. Participants were brought together to share new knowledge with other experts. The database, including the new data obtained in the third phase was be fully analyzed and reported across East Asia in international scientific and academic conferences.

Fourth Phase: 2005-2008

"Environmental Monitoring and Governance in the Asian Coastal Hydrosphere"

The fourth phase focused on monitoring POPs in various biota samples in Asian countries. POPs are bioaccumulative in nature; it travels long distances without breaking down and concentrates as it moves up the food chain, posing significant health threats to organisms which may ingest them. A good environmental indicator of the level of POP contamination in local waters is to collect biota samples from aqua-organisms. As such, project participants were given training on how to collect and measure the level of POPs in biota samples. This phase also sought to reach a consensus on the standardized use of GC/Q-MS machines and the standard operating procedures that should be widely recognized by the international scientific communities, based on the best available analytical technology for developing countries. During this phase, the project also welcomed two new member countries, India and Pakistan. Their entry certainly allowed us to broaden our knowledge on POPs environmental distributions in Asia.

Fifth Phase: 2008-2011

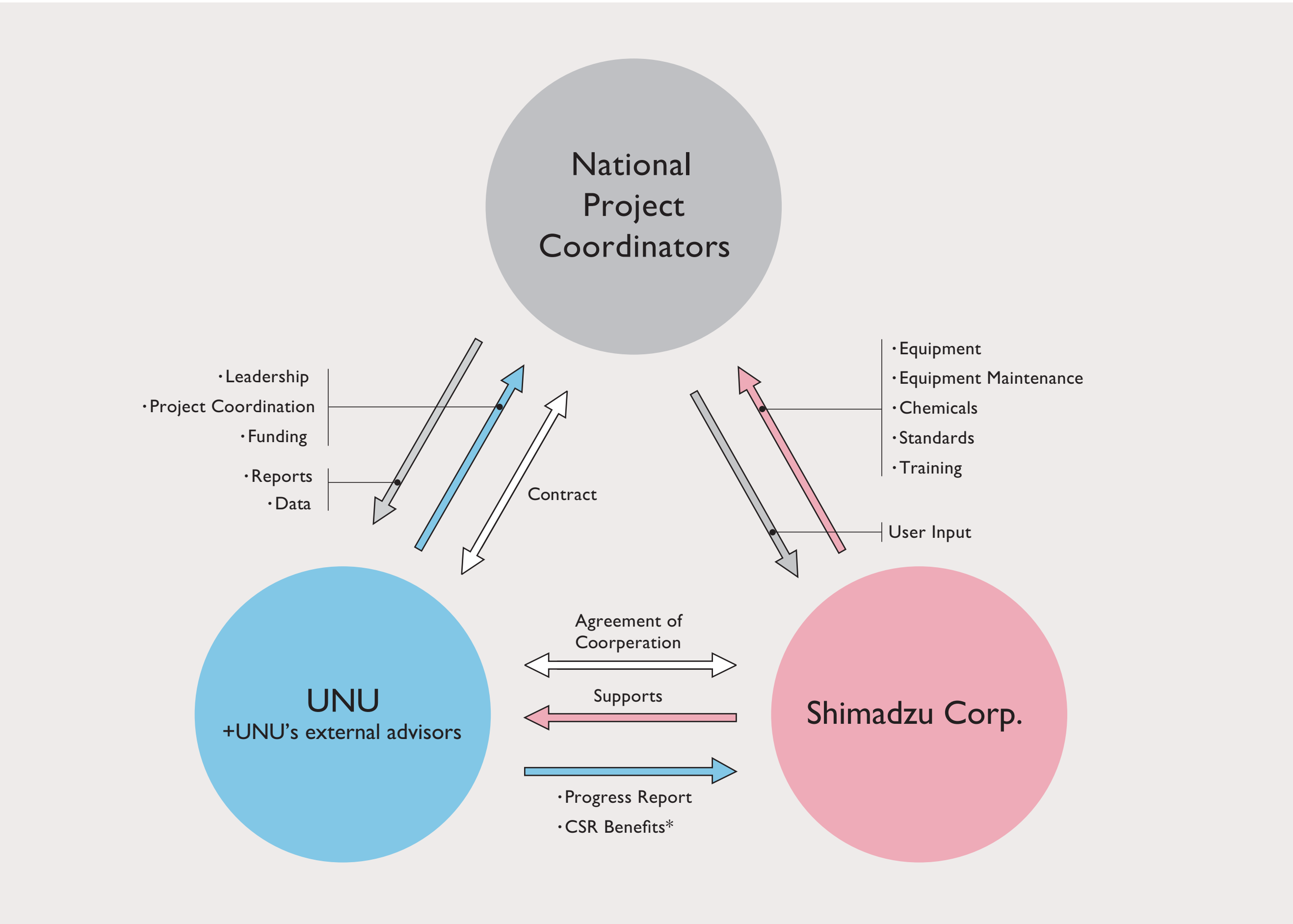
"Environmental Monitoring and Governance in the Asian Coastal Hydrosphere"

The fifth phase of this project focused on the monitoring of Polychlorinated Biphenyls (PCBs) and Polybrominated diphenylethers (PBDEs) in Asian countries. The Stockholm Convention has articulated that the use of PCB should be eliminated by 2025, and all liquids and equipments containing PCB over 0.005% should be treated in an environmentally sound waste management process by 2028. However, some National Implementation Plans submitted to the Stockholm Convention have no appropriate plans on identified PCB equipments in use as well as stockpiles. On the other hand, two commercial PBDEs have been listed as POPs in the COP4 of the Stockholm Convention in May 2009. PBDEs are widely used as flame retardants. Considering the great concerns on the PCBs and PBDEs, this fifth phase of the UNU-Shimadzu project strengthened the analytical capacities of PCBs and PBDEs for the Asian partners. Two training workshops and three international symposiums were held during this phase.

Project Scheme

UNU-ISP's partnership with Shimadzu Corporation is a dynamic relationship that has flourished for 15 years. Shimadzu is providing the comprehensive supports, laboratory equipment and training for the ten institutions nominated by the UNU-ISP under this project. The UNU-ISP is responsible for the overall execution of the project. Shimadzu Corporation has been an excellent and active project partner; collaborating on joint project design, implementation and evaluation, in addition to its resource contribution.

Figure 1: UNU-Shimadzu Partnership Scheme



* CSR Benefits
• Development of trust and goodwill
• Enhancing brand image,
• Improving risk management
• Attracting and retaining employees

Project Achievements

Since its inception in 1996, the project has helped participating countries develop their technical and technological capacity for chemical analysis. As such, some partner institutes have now become highly recognized as national expert resources and have participated in the Stockholm Convention mandated regional meetings.

The project has mobilized 18 gas chromatography/mass spectroscopy (GC/MS) equipments and operational budget. All the in-kind contributions provided by our co-managing partner, Shimadzu Corporation, have enabled the project partners to improve their analytical capability and to more focus on their monitoring activities.

International symposiums have been held every year in a project participating country to exchange the latest development of multilateral environmental agreement, disseminate the project outcomes, and interact with local researchers and policy makers.

The symposiums have provided opportunities for academic researchers, policy makers, industrial sectors, and general participants to learn the latest chemical analysis technologies and the related environmental policies. The project website itself reaches out to many people in developing countries with event information such as the UNU's general activities. More than 500 people have subscribed to the e-mail quarterly newsletter, and many of them have been reconnected with UNU in other events and through other networks.

Training workshops have been provided every year by Shimadzu Corporation to enhance the partner countries' monitoring capacity of various chemicals and POPs.

In total, more than 100 research staff from participating governmental institutions and universities in ten countries (China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Singapore, Thailand, and Viet Nam) have been trained on sample pre-treatment and data analysis using GC/MS for a wide variety of samples (water, biota, sediment, and food, fish, and air). Various target environmental pollutant chemicals have been analyzed ranging from Volatile Organic Compounds (VOCs) to Persistent Organic Compounds (POPs) as shown in Table 1.

Shimadzu Corporation also prepared analytical procedures and quality control indicators to suit the capacities and resources of the institutes participating in the monitoring projects. An inter-laboratory calibration study was conducted to check the project data variability.

Figure 2: Location of National Project Coordinators

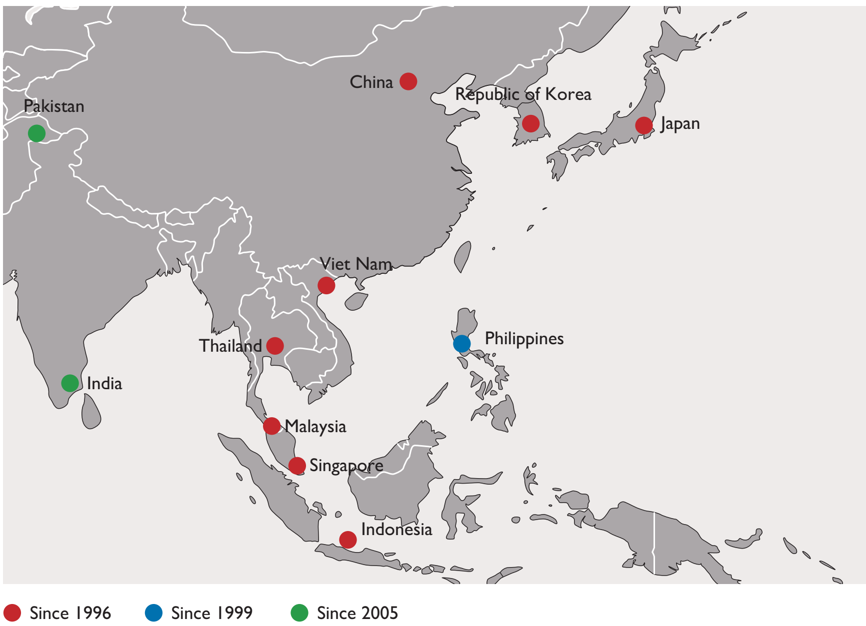


Table 1a. Target chemicals and media examined in this project during the previous phases (1996-2001)

	First Phase (1996-1998)					Second Phase (1999-2001)		
	1996	1997		1998		1999	2000	2001
	Pesticides	VOCs	TBTs	VOCs	Aldehydes	EDC-like Pesticides	EDC-like Phenols	EDC-like Phthalates
Target Media	Rice	Tap/River Water	Fish Scales	Indoor/Ambient Air	Indoor/Ambient Air	River Water	River Water	River Water
Target Chemicals	Malathion	1,1-Dichloroethylene	Tri Buthyl Tin	Trichloromethane	Formaldehyde	α -BHC	Bisphenol-A	Di methyl phthalate
	Chloryrifos	Dichloroethylene	Tri Phenyl Tin	1,1,1-Trichloromethane	Acetaldehyde	β -BHC	4-t-Butylphenol	Di ethyl phthalate
	p,p'-DDT	t-1,2,Dichloroethene		Terachloromethane		γ -BHC	4-n-Butylphenol	Di i-propyl phthalate
		c-1,2,Dichloroethene		Benzene		δ -BHC	4-n-Pentylphenol	Di allyl phthalate
		Trichloromethane		1,2-Dichloroethane		Aldrin	4-n-Hexylphenol	Di n-propyl phthalate
		1,1,1-Trichloroethane		Trichloroethene		Dieldrin	4-n-Heptylphnol	Di i-butyl phthalate
		Terachloromethane		1,2-Dichloropropane		p,p'-DDE	4-n-Octylphenol	Di-n-butyl Phthalate
		Benzene		Bromodichloromethane		Endrin	4-n-Octylphenol	Di-n-pentyly Phthalate
		1,2-Dichloroethane		c-1,3-Dichloropropene		p,p'-DDD	4-Nonylphenol	Butyl benzl phthalate
		Trichloroethene		Toluene		p,p'-DDT	2,4-Dichlorophenol	Di n-hexyl phthalate
		1,2-Dichloropropane		t-1,3-Dichloropropene			Pentachlorophenol	Di butoxy ethyl phthalate
		Bromodichloromethane		1,1,2-Trichloroethane				Di cycrohexyl phthalate
		c-1,3-Dichloropropene		Tetrachloroethene				Di phenyl phthalate
		Toluene		Dibromochloromethane				Di n-heptyl phthalate
		t-1,3-Dichloropropene		m,p-Xylene				Di 2-ethl hexyl phthalate
		1,1,2-Trichloroethane		o-Xylene				Di n-octyl phthalate
		Tetrachloroethene		Tribromomethane				Di2-ethyl hexl adipate
		Dibromochloromethane		p-Dichlorobenzene				
		m,p-Xylene						
		o-Xylene						
		Tribromomethane						
		p-Dichlorobenzene						
Surrogate			Tri Pentyl Tin				Bisphenol-Ad_{16}	Di n-pentyl phthalate-d_4
Internal Standards		p-Bromofluorobenzene	Tetra Butyl Tin		Diphenylamine	Phenanthrene-d_{16}	Naphthalene-d_8	Di n-butyl phthalate-d_4
						Pyrene-d_{10}	phenanthrene-d_{10}	Di 2-ethl hexyl phthalate-d_4
							pyrene-d_{10}	
Instruments	GCMS-QP5050A					GCMS-QP5050A		

Table 1b. Target chemicals and media examined in this project during the previous phases (2002-2011)

	Third Phase (2002-2004)			Fourth Phase (2005-2008)			Fifth Phase (2009-2011)	
	2002	2003	2004	2005/2006	2007	2008	2009	2010
	Pesticides POPs	Pesticides POPs	Pesticides POPs	Pesticides POPs	Pesticides POPs	Pesticides POPs	PCBs	PBDEs
Target Media	River Water	River Water/Sediment	River Water/Sediment	Shrimp	Fish	Squid	Shrimp	Sediment
Target Chemicals	Hexachlorobenzene	Hexachlorobenzene	Hexachlorobenzene	Hexachlorobenzene	Hexachlorobenzene	Hexachlorobenzene	Monochlorobiphenyl	2,4,4'-TriBDE
	Heptachor	Heptachor	Heptachor	Heptachor	Heptachor	Heptachor	Dichlorobiphenyl	2,2',4,4'-TetraBDE
	Ardrin	Ardrin	Ardrin	Ardrin	Ardrin	Ardrin	Trichlorobiphenyl	2,2',4,4',5-PentaBDE
	t-Chlordane	t-Chlordane	t-Chlordane	t-Chlordane	t-Chlordane	t-Chlordane	Tetrachlorobiphenyl	2,2',4,4',6-PentaBDE
	c-Chlordane	c-Chlordane	c-Chlordane	c-Chlordane	c-Chlordane	c-Chlordane	Pentachlorobiphenyl	2,2',4,4',5,5'-HexaBDE
	Dieldrin	Dieldrin	Dieldrin	Dieldrin	Dieldrin	Dieldrin	Hexachlorobiphenyl	2,2',4,4',5,6'-HexaBDE
	Endrin	Endrin	Endrin	Endrin	Endrin	Endrin	Octachlorobiphenyl	2,2',3,4,4',5',6-HeptaBDE
	p,p'-DDT	p,p'-DDT	p,p'-DDT	p,p'-DDT	p,p'-DDT	p,p'-DDT	Nonachlorobiphenyl	DecaBDE
						Lindane	Decachlorobiphenyl	
Surrogate	p,p'-DDT-$^{13}C_{12}$	p,p'-DDT-$^{13}C_{12}$	p,p'-DDT-$^{13}C_{12}$	p,p'-DDT-$^{13}C_{12}$	p,p'-DDT-$^{13}C_{12}$	p,p'-DDT-$^{13}C_{12}$	^{13}C-Labelled PCBs	^{13}C-Labelled BDEs
Internal Standards	Pyrene-d_{10}	Pyrene-d_{10}	Pyrene-d_{10}	Phenanthrene-d_{10}	Phenanthrene-d_{11}	Phenanthrene-d_{12}	Perylene-d_{12}	2,2',5,5'-TetraCB-$^{13}C_{12}$
				Crysene-d_{12}	Crysene-d_{13}	Crysene-d_{14}		2,2',3,4,4',5'-HexaCB-$^{13}C_{12}$
Instruments	CGCMS-QP2010			CGCMS-QP2010			CGCMS-QP2010	

Since the Stockholm Convention entered into force in 2004, expectations from this capacity development monitoring project have been increasing. Existing regional networks engaged in POPs monitoring like this UNU project could be important data sources on the global POPs levels. Some of the project's monitoring results as well as the quality assurance and quality control aspects of the project activities are briefly presented.

Quality assurance and quality control

To ensure the quality of the analytical activities, quality control indicators such as blank tests, injection repeatability tests and standard addition recovery tests were conducted by all project member laboratories as necessary, and DDT-$^{13}C_{12}$ recovery data have been collected for all samples with 70-130% as an acceptable range. During the 4th phase, one of the two internal standards, phenanthrene-d_{10} and chrysene-d_{12}, were chosen in quantifying each POPs chemical depending on its capillary column elution time. To determine instrument detection limits, an injection repeatability test was conducted with five to eight times injections as the recommended amount. The number of repetition determines the coefficient to use in calculating detection limits, this can be seen below. Instrument Detection Limit (IDL) = t (n-1, 0.01) x σ , where t (n-1, 0.01) is a value of t-distribution at σ = 0.01 for one tail. More details are described in the UNU Project Quality Assurance Document.

Monitoring results

The project monitoring data of chemical pollutants have been reported through symposiums, conferences, and scientific peer-reviewed journals. Due to some concerns on the data quality of the project data, domestic data comparisons have been mainly reported. In some countries, these monitoring activities have been regarded as, or incorporated into, national POPs monitoring plans.

Over the period of 15 years, more than 100 different compounds were measured in the 10 participating Asian countries and various POPs, including Organochlorine Pesticides (OCPs), Polychlorinated Biphenyls (PCBs) and Polybrominated diphenylethers (PBDEs), were analyzed. The project has monitored water, sediment, soil, shrimp, fish, and squid for POPs since the start of the third phase. Samples were collected at more than 800 sites in rivers, lakes, coastal waters and sediments throughout the 10 participating Asian countries, which provide a general overview of the POP levels in the region. In some countries such as Thailand, Philippines, Singapore, and Indonesia, samples were mostly collected from the same locations, providing useful inter-annual data comparisons. Countries which partially changed their sampling sites include Viet Nam, Korea and Malaysia, and those that change every year include China. Here, some POPs monitoring results in a selection of Asian countries are presented and discussed.

(1)OCPs

Most of the legacy POPs in the Stockholm Convention adopted in 2001 are OCPs, which have been widely and massively produced and used in Asia. OCP pollutions in the environment may caused potential risk to human and ecosystem in Asia. This project had focused on OCPs for almost ten years until the end of the fourth phase.

Among all samples, the most commonly detected OCPs were p,p'-DDT and its metabolites, p,p'-DDD and p,p'-DDE, followed by HCB, Lindane and cis- and trans-Chlordane. Specifically, in limnic sediment samples, p,p'-DDD, p,p'-DDE and HCB, have a detection frequency that exceeds 70%. In marine sediment Lindane, HCB and p,p'-DDD were recorded in more than 70% of the samples. In seawater, detection frequencies for cis-Chlordane, Heptachlor, Lindane, Dieldrin and p,p'-DDT ranged above 50% whereas in freshwater samples, the most common compounds, p,p'-DDT, Lindane, trans-Chlordane, and HCB, exceeded a detection frequency of only 30%.

Figure 3 shows OCPs concentrations in water bodies measured in 2002-2005 in Thailand. The sample sites were largely the same, and compound concentrations were found to be within the same range of orders of magnitude. The percentage of sample sites, where the substances have been detected, has been comparatively low and do not vary remarkably (0-24%).

Figure 3: OCPs levels in river / sea water sampled in Thailand (2002-2005) with the detection ratios indicated in %

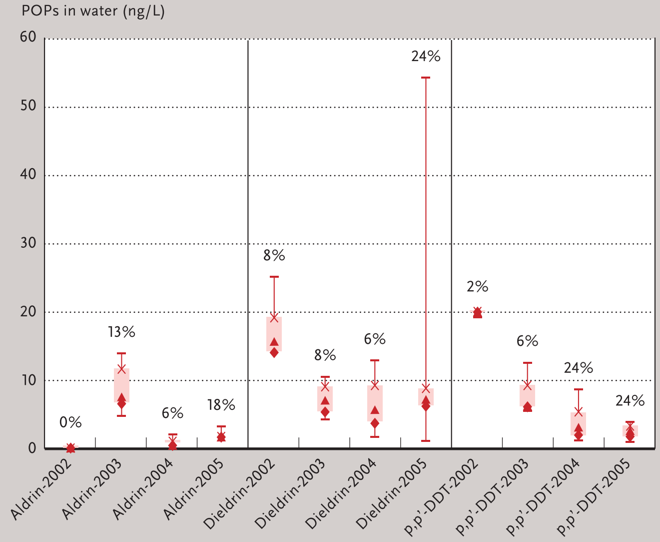


Figure 4: OCPs levels in river water sampled in China, 2003, with the detection ratios indicated in %

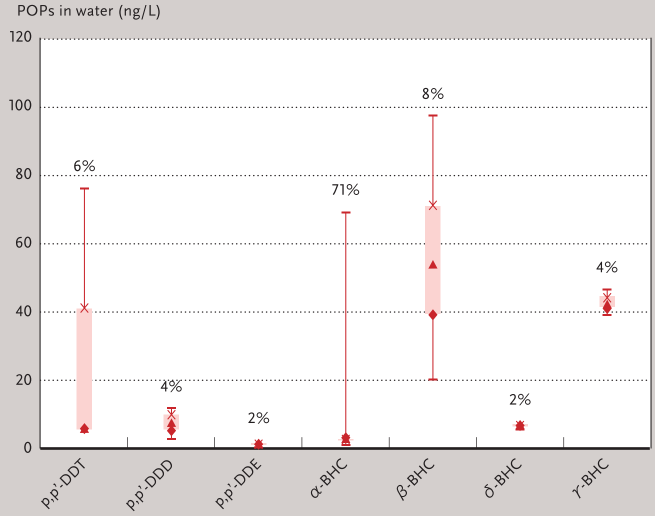


Figure 5: OCPs detected in fish sampled in Vietnam, 2007, with the detection ratios indicated in %

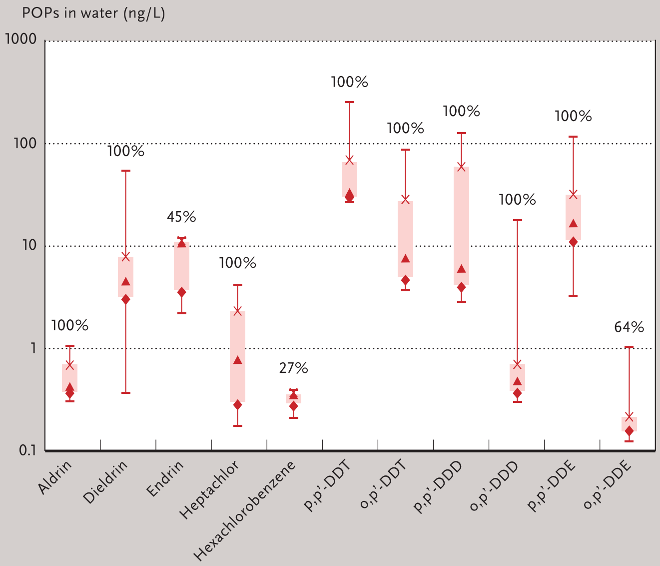


Figure 6: PBDE congeners in sediment samples from coastal areas of Singapore, 2010.

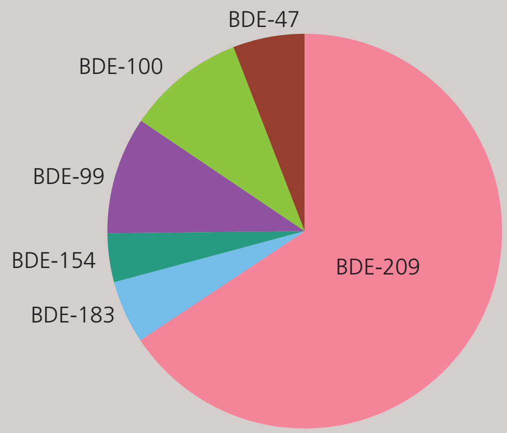


Figure 4 shows OCPs detected in river water samples in China, 2003. Among 11 compounds detected, α-HCH was common throughout the sampling sites, and the highest concentration measured for α-HCH was 98 ng/L. The environmental level is not statistically dependent on seasons but on water bodies (1-way-ANOVA (analysis of variance), $p<0.05$), and the samples from Haihe River showed higher concentrations than those in the Chaobai River and Miyun Reservoir.

In 2007, Ha Long Bay, Hai Phong Port, and Ba Lat Estuary in Viet Nam were selected as sampling locations. Ha Long Bay has very diverse ecosystems and is recognized as a UNESCO World Heritage site in Viet Nam. It provides a very important resource for tourism, aquaculture and commercial activities. Next to Ha Long Bay is Hai Phong Port, where industrial activities have occurred for more than one hundred years. These anthropogenic activities may have caused pollution of the local aquatic environment and of Ha Long Bay. Discharges from the port site may bring considerable load of contaminants such as OCPs to the coastal waters. Known as being one of the main regions in producing rice for domestic consumption and export, Thai Binh province annually uses a large quantity of pesticides and herbicides to protect crops from pest and weeds. Ba Lat Estuary is also the final repository which receives water from channels and streams, containing industrial and agricultural wastes from manufacturing and agricultural activities in Hanoi city and Thai Binh province. Fish species sampled in Viet Nam were Black porgy (Sparus macrocephalus), Yellowfin seabream (Sparus latus), and Waeigieu seaperch (Psammoperca). Among 11 fish samples analyzed, Mirex and cis-/trans-Chlordane were not detected at all. Other compounds detected are shown in Figure 5. Recent inputs of p,p'-DDT to the water bodies may be indicated by higher ratios of DDT/DDE than 0.5.

In 2008, Squid samples (Loliolus japonica) were taken from some cities, such as Dalian, Yantai and Qingdao, in China, and various OCPs in the body and liver were analyzed. However, only HCB and DDTs were detected. In Korea, common squid (Todarodes pacificus) was collected from South Sea (Chilchun-do, CP) and East Sea (Ulleung-do, UP). DDTs, HCHs, HCB and CHLs are detected in the liver tissue. Among these compounds, DDTs were the highest in both the regions, followed by HCHs and others. The highest levels were recorded for p,p'-DDD and p,p'-DDE in the Yellow Sea, indicating weathering and metabolism from the DDT input over a period of time. The p,p-DDT levels was the highest in Ulleung-do (UP) indicating a recent input of these pesticides in that region. In Philippines, sampling was performed during the dry season (May-June, 2008) and the rainy season (September, 2008). In general, OCPs were detected in liver and muscle tissues in all the squid samples collected during the dry season. β-HCH was detected in all liver and muscle samples. Other OCPs were detected in squid samples depending on the sampling site. OCPs were detected in most of the squid samples collected during the rainy season. β-HCH was detected in most liver samples and in all muscle samples.

(2)PCBs

PCBs were widely used as dielectric and coolant fluids, for example in transformers, capacitors, and electric motors. Due to their persistence in the environment, bioaccumulation, long range transportation potential and high toxicity, they are listed as POPs under Stockholm Convention. In 2009, PCBs in water samples were detected in the ten Asian partner countries. Here, the PCBs monitoring results in the partner countries are presented in Table 2.

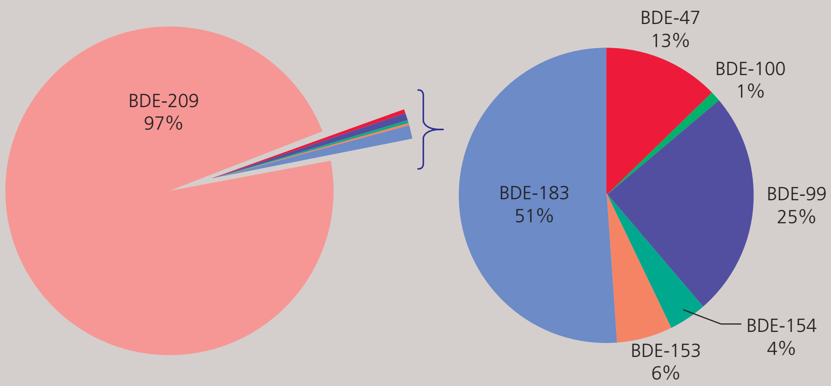
(3)PBDEs

PBDE are organobromine compounds that are used as flame retardants. PBDEs have been widely used in building materials, electronics, furnishings, motor vehicles, airplanes, plastics, polyurethane foams, and textiles. They are structurally akin to the PCBs. In 2009, PentaBDE and OctaBDE were listed as new POPs. DecaBDE (BDE-209) is still mass-produced in Asia, which can degrade to PentaBDE and OctaBDE. It is reported E-waste dismantling in some Asian countries have caused serious PBDE pollution. In 2010, PBDEs in sediments were analyzed in the ten Asian partner countries. Various PBDE congeners were detected in Asian countries, among them BDE-209 is usually the dominant congener (Figure 6 and 7 show the examples of Singapore and Korea).

Table 2 The summary of the PCBs monitoring results in the partner countries (2009)

Country	Results
China	PCBs concentrations were 1.22-16.8 ng/L in the Yangtze River Delta. Total PCBs concentration in Suzhou was higher than Wuxi, and the latter was higher than Nantong. The PCBs level in Beijing-Hangzhou Grand Canal was higher than Yangtze River. Trichlorobiphenyl and tetrachlorobiphenyl were the most predominant isomers.
India	The total PCBs levels were 0.56-1.72 ng/L in river water and 0.68-5.17 ng/L in sea water in Tamil Nadu. The total PCBs in the Vellar and Uppanar estuary were 0.56 and 1.23 ng/L, respectively. The order of PCBs levels in seawater was as follows: Chennai >Pondicherry >Tuticorin >Kanniyakumari.
Indonesia	Higher PCBs level was found in Jakarta (about 700 ng/L) than in Semarang and Surabaya (< 200 ng/L). The high PCBs levels were usually found in harbor or the industrial area.
Korea	The PCBs were almost undetectable in all the samples.
Pakistan	The total PCBs concentrations in the main rivers and Arabian Sea coast ranged from ND (not detected) to 8.75 ng/L.
Philippines	The total PCBs concentrations in Pasig River and Laguna Lake were respectively ND-12.87 ng/L and 1.25-12.63 ng/L in rainy season and dry season.
Singapore	PCBs were detected in seawater from all sampled locations. The mean total PCB concentrations were 0.67-28.65 ng/L. The highest concentrations of PCBs were detected at Lim Chu Kang, followed by Raffles Marina and Bedok Jetty.
Thailand	PCBs were not detected in water samples. The volume of 1 L is not enough for the analysis of relatively clean water samples in Thailand.
Vietnam	The PCBs concentrations in the rainy season and the dry season were respectively 37-88 ng/L and 16-58 ng/L in the Kim Nguu River, 19-53 ng/L and 8.8-35 ng/L in the Lu River, 37-74 ng/L and 18-40 ng/L in the Nhue River, 25-60 ng/L and 8.6-41 ng/L in the To Lich River, 19-66 ng/L and 9.4-41 ng/L in the Yen So lake.

Figure 7: PBDE congeners in sediment samples from coastal areas of Korea, 2010.



All the monitoring data and reports are put in a web database, which is shared among all the project partners. As one of the existing regional networks engaged in POPs monitoring, it provides an important data source on the Asian regional POPs levels which helps the effectiveness evaluation of the implementation of Stockholm Convention.

Stockholm Convention COP3 in 2007

Representing the UNU at the Third Meeting of the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants (POPs) in Senegal 2007, Dr. Fukuya Iino, UNU Academic Programme Officer, had an opportunity to make a statement on the potential for public-private sector partnerships in the field of environmental monitoring and governance in relation to the Project. Many positive comments were received about the unique achievement of this project, particularly by those who recognize the importance of creating the scientific infrastructure necessary to sustain national capacities for environmental governance in terms of POPs control. It is hoped that many partnership projects are replicated by learning from this pioneering endeavour. Collaborations with United Nations Industrial Development Organization (UNIDO) started through the networks extended at this COP3, and project development efforts with United Nations Institute for Training and Research (UNITAR) have been also made as well.

Stockholm Convention COP5 in 2011

United Nations University (UNU-ISP),in co-operation with the Secretariat of the Stockholm Convention on POPs held a side event titled "Stockholm at 10: achievement of 10 years of efforts to protect human health and the environment from POPs"at the Fifth Meeting of the Conference of the Parties to the Stockholm Convention on POPs (COP5) on 27th April 2011. Mr. Shinichi Arai, Senior Research Fellow of UNU-ISP made a presentation titled " A partnership for capacity building for POPs monitoring in Asia," in which he spoke of UNU activities including Environmental Monitoring and Governance in the Asian Coastal Hydrosphere Project which is sponsored and technically supported by Shimadzu Corporation (UNU-Shimadzu Project). He mentioned that since 1996 the project successfully helped Asian ten developing countries to build and enhance their own capacities of POPs monitoring and developed a broad POPs research network in Asia. He emphasized that cooperation between academia and industry is important for overcoming the challenges of POPs issues such as management of new POPs and a closely connected network for research in Asia. He also said that gap between science and policy should be resolved by, for example, more user-oriented assessments of POPs.

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Events Held Under the UNU Project

	Date	Events	Place	Theme
1995-1998	July 13, 1995	The first agreement between UNU and Shimadzu signed for 1996-1998		
	1996: Environmental Governance and Analytical Techniques: Food Pollution and Industrial Wastes			
	1 February 1996	International Symposium I	UNU, Tokyo	Food Pollution caused by Agricultural Chemicals
	2 February 1996	International Symposium II	UNU, Tokyo	Environmental Pollution caused by Industrial Wastes
	5 February 1996	Training Workshop (2 days)	NIES, Tsukuba	Residual pesticides in rice
	7 February 1996	Training Workshop (2 days)	Shimadzu CSC, Hadano, Japan	Operation of GCMS-QP5000
	1997: Environmental Governance and Analytical Techniques: Water Pollution and Water Quality Monitoring			
	21 February 1997	International Symposium I	UNU, Tokyo	Water Pollution and Water Quality Monitoring
	24 February 1997	International Symposium II	Singapore	Water Pollution and Water Quality Monitoring
	26 February 1997	Training Workshop (4 days)	Shimadzu Lab, Singapore	Matrix standard materials for water and fish
	1998: Environmental Governance and Analytical Techniques: Air Pollution and Air Quality Monitoring			
	13 February 1998	International Symposium	Kyoto International Conference Hall	Air Pollution and Air Quality Monitoring
	16 February 1998	Training Workshop (5 days)	Shimadzu CSC, Kyoto	Method of air monitoring using GCMS
1999-2001	1999-2001: Environmental Monitoring and Governance: EDC Pollution in the East Asian Coastal Hydrosphere			
	9 February 1999	International Symposium (2days)	UNU, Tokyo	Environmental Issues Related to EDC Pollution
	17 September 1999	The second agreement between UNU and Shimadzu signed for 1999-2001		
	21 February 2000	Training Workshop (6 days)	Tokyo and Otsuchi, Japan	Workshop on Marine Environment
	26 March 2000	Training Workshop (5 days)	Okinawa, Japan	Research for Conservation of Mangroves
	17 April 2000	International Symposium (2 days)	The University of Malaya, Malaysia	EDC in the East Asian Coastal Hydrosphere
	19 April 2000	Training Workshop (4 days)	The University of Malaya, Malaysia	Bisphenol A, alkylphenol in water
	3 December 2000	Training Workshop (6 days)	Otsuchi, Japan	Coastal Ecology, Nutrient Cycles and Pollution
	16 April 2001	International Symposium (2 days)	Seoul Natonal University, Korea	Industries and EDC Pollution
	19 April 2001	Training Workshop (4 days)	Shimadzu CSC, Hadano, Japan	Analytical methods for phthalates
	21 October 2001	Training Workshop (6 days)	Otsuchi, Japan	Coastal Ecosystems, Nutrient Cycles and Pollution
2002-2004	15 April 2002	International Symposium (2 days)	Hanoi, Vietnam	Tracing pollutants from agrochemical use
	8 July 2002	International Conference (3 days)	UNU, Tokyo	Conserving Our Coastal Environment
	15 July 2002	The third agreement between UNU and Shimadzu signed for 2002-2004		
	2002-2004: Environmental Monitoring and Governance in the East Asian Hydrosphere: Monitoring of POPs			
	26 January 2003	Training Workshop I (2 days)	K-JIST, Gwangju, Korea	Environmental Quality Guidelines and Capacity Development
	29 January 2003	Training Workshop II (3 days)	Shimadzu CSC, Hadano, Japan	Analytical Methods for POPs in Water
	1 September 2003	Training Workshop I (2 days)	UNU, Tokyo	Environmental Quality Guidelines and Monitoring
	3 September 2003	Training Workshop II (3 days)	Shimadzu CSC, Hadano, Japan	Analytical Method for POPs in Sediments
	11 February 2004	Training Workshop (7 days)	Iwate, Japan	Ecosystem Conservation in Coastal Areas
	24 May 2004	International Symposium (2 days)	Beijing, China	Impacts of POPs from Urban Areas
	3 November 2004	Training Workshop (6 days)	Otsuchi, Japan	Marine Ecosystems and Bio-logging Science

2005-2008	26 April 2005	International Symposium (2 days)	Bangkok, Thailand	Ecosystem Impacts of POPs
	21 September 2005	International Symposium (1 day)	UNU, Tokyo	Future Challenges in POPs Management
	October 21, 2005	The fourth agreement between UNU and Shimadzu signed for 2005-2008		
	2005-2008: Environmental Monitoring and Governance in the Asian Coastal Hydrosphere			
	24 October 2005	Training Workshop (7 days)	Otsuchi, Japan	Sustainable Management of Coastal and Marine Resources
	24 January 2006	Training Workshop (3 days)	Shimadzu CSC, Hadano, Japan	POPs Analysis in Aqua-organisms
	28 July 2006	International Conference (1 day)	UNU, Tokyo	Man and the Ocean
	7 November 2006	International Symposium (1 day)	Quezon, Philippines	POPs in Asia: Its Status and Future
	February - March 2007	Training Workshop Closed Event	Shimadzu CSC, Hadano, Japan	Analysis in Fish-species
	14 November 2007	International Symposium (1 day)	Jakarta, Indonesia	POPs: Global Transport, Best Environmental Practice, and Risk Perception
	17 March 2008	Training Workshop(3 days) Closed Event	Shimadzu CSC, Hadano, Japan	POPs Analysis in Squid
	14 November 2008	International Conference (1 day)	UNU, Tokyo	Roles of Academia and Private Sectors for the Stockholm Convention
	October 4, 2008	The fifth agreement between UNU and Shimadzu signed for 2009-2011		
2009-2011	2009-2011: Environmental Monitoring and Governance in the Asian Coastal Hydrosphere			
	23-25 March 2009	Training Workshop (3 days)	Shimadzu CSC, Kyoto, Japan	PCBs in the Environment
	23 January 2010	International Symposium (1 day)	Tiruchirappalli, India	Trace Organic Pollutants in the environment
	12-14 April 2010	Training Workshop (3 days)	Shimadzu CSC, Kyoto, Japan	Environmental analysis of PBDEs in the sediment
	11-22 October 2010	Training Workshop (12 days, Jointly held with AMETEC)	Geoje island, Korea	Passive Air Sampling: Long Range Transport of Pollutants
	9 March 2011	International Symposium (1 day)	Shanghai, China	Existing and Emerging Chemicals in the Environment
	27 April, 2011	Side event in the COP5 of Stockholm Convention (Jointly held)	Geneva, Switzerland	SSC Side event: Stockholm at 10
	25 October 2011	International Conference (1 day)	UNU, Tokyo	Past 10 Years and Future of Stockholm Convention on POPs




This booklet outlines the achievements of a UNU-Shimadzu partnership for capacity building on monitoring pollution in Asia, active from 1996-2011.

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