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REPORT 10 YEARS

IMPLEMENTING STOCKHOLM CONVENTION

On Persistent Organic Pollutants In Vietnam 2005 - 2015

Pollution Control Department, Vietnam Environment Administration
Ministry of Natural Resources and Environment
Vietnam Focal Point of Stockholm Convention on POPs

REPORT
10 YEARS OF IMPLEMENTING STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS IN VIETNAM 2005 - 2015

Hanoi - 2015

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ABBREVIATIONS

BAT and BEP	Best Available Techniques and Best Environmental Practices
CETASD	Research Centre for Environmental Technology and Sustainable Development
Decision No.184	Decision No.184/2006/QD-TTg dated 10 August 2006 on approving the Vietnam National Implementation Plan for the Stockholm Convention on POPs
EVN	Viet Nam Electricity
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
GEF/UNDP Project - Developing National Plan on POPs	Project of Development of National Implementation Plan for Vietnam in the Process of Accession, Implementation and Enforcement of the Newly-signed Stockholm Convention
GEF/UNDP Project - Dioxin Remediation	Project of Environmental Remediation of Dioxin Contaminated Hot Spots in Vietnam
GEF/UNDP Project - Management of POPs and hazardous chemicals	Project of Safe Management of POPs and Hazardous Chemicals in Vietnam
GEF/UNDP Project - POP Pesticides	Project of Building Capacity to Eliminate POP Pesticides Stockpiles in Vietnam
GEF/UNDP Project - Updating National Plan on POPs	Project of Updating the Vietnam National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants
GEF/UNEP Project - Asia POP Monitoring	Project of Implementation of the POPs Monitoring Plan in the Asian Region
GEF/UNIDO Project - Application of BAT/BEP	Project of Introduction of Best Available Techniques (BAT) and Best Environmental Pratices (BEP) to Demonstrate Reduction and Elimination of Unintentionally Produced Persistent Organic Pollutant (U-POPs) Releases from Industries in Vietnam

GEF/UNIDO Project - Application of BAT/BEP in health	Project of Demonstrating and Promoting Best Techniques and Practices for Reducing Healthcare Waste to Avoid Environmental Releases of Dioxins and Mercury
GEF/UNIDO Project - Application of BAT/BEP in Open Burning Activities	Project of Demonstration of BAT and BEP in Open Burning Activities in Response to the Stockholm Convention on POPs
GEF/WB Project - PCB	Project of PCB Management in Vietnam
MARD	Ministry of Agriculture and Rural Development
MOH	Ministry of Health
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MOST	The Ministry of Science and Technology
POPs	Persistent Organic Pollutants
Stockholm Convention	The Stockholm Convention on Persistent Organic Pollutants
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
U-POPs	Unintentionally Produced Persistent Organic Pollutants
USAID Project - Remediation of Dioxin in Da Nang	Project of Environmental Remediation of Dioxin Contamination at Da Nang Airport
VEA	Vietnam Environment Administration
WB	World Bank

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FOREWORD

We have been aware for several decades that besides the positive contributions chemicals also pose negative effects on the environment and human health. Among these chemicals Persistent Organic Pollutants (POPs) have been a primary concern. For example, chemicals such as DDT and PCB were great scientific achievements. However, these substances are now seen as hazardous chemical stockpiles, which need to be strictly controlled and eliminated. The Stockholm Convention on Persistent Organic Pollutants was signed in 2002 with the objective of mobilizing global efforts in order to manage and eliminate these chemicals and reduce emissions from them.

In the past, the environment and human health in Vietnam has suffered from negative impacts of hazardous pesticides, typically in areas contaminated by pesticide stockpiles or in "hot spots" with a high concentration of Agent Orange (AO)/dioxin. Nowadays, in the period of innovation and economic development, environmental pollution, including pollution caused by pesticide release, continues to be one of the most significant socio-economic issues that concerns the Government of Vietnam.

The Government of Vietnam has ratified the Stockholm Convention on POPs. The Government has also developed and promulgated Vietnam's implementation plan on the Stockholm Convention. The plan clearly indicates Vietnam's viewpoints and commitments to the international community on joint effort to safely manage POPs in order to protect the environment and community health. With the effort of the Government, organizations, experts and related individuals in Vietnam, as well as international cooperation, many programmes, projects and activities on management and remediation of POP contamination have been developed and implemented over the past 10 years.

The outcomes of POP management in Vietnam have been recognized by government agencies, organizations, individuals and the international community. Despite the low starting point due to the lack of POP status information and guiding policies, unclear legal regulations on POP management and low levels of community awareness of POP impacts, POP management in Vietnam has obtained remarkable achievements after 10 years of operation. This includes:

- Several key policies were promulgated in order to manage pesticide stockpiles and Polychlorinated Biphenyl (PCBs) in electrical equipment and to remedy pollution of Agent Orange/dioxin in the hot spots.
- A new series of regulations on preventing and controlling general chemicals pollution and POP management were developed and promulgated in the 2014 Environmental Protection Law and other related laws, decrees, circulars, technical norms, environmental standards and technical guidelines, as well as regulations on administrative sanctions on environmental infringement.
- Infrastructure and capacity on environmental analysis and monitoring and POP pollution remediation has been significantly strengthened, gradually

meeting the demands on pesticide management and remediation in Vietnam and Asia. A large volume of pesticides, oil with PCBs and soil contaminated with PCB and Dioxin/Furan has been handled and safely disposed.

- Many training and communication programmes on POP risks and dangers have been organized widely and effectively. Awareness and actions on POP safe management of authorized units at all levels and in the community have been significantly improved.

All achievements have contributed to the cause of environmental protection and sustainable development in Vietnam as well as to global environmental protection in many direct and indirect dimensions.

Looking back on the process of implementing the Stockholm Convention in Vietnam, we are thankful to the leaders who have led and laid the foundation for POP management and chemical control in Vietnam, such as Dr. Pham Khoi Nguyen, former Minister of the Ministry of Natural Resources and the Environment (MONRE), Dr. Tran Hong Ha, Deputy Minister of MONRE and the first national Director of the Global Environment Facility (GEF) and UN Development Programme (UNDP) project on the Vietnam Implementation Plan on the Stockholm Convention, Dr. Le Bich Thang, Dr. Tran The Loan, Associate Prof. Dr. Le Ke Son, and many other officers, experts and citizens. We would also like to recognize the strong support of the international community such as the UN Development Programme, the UN Industrial Development Organization, the UN Environment Programme and the World Bank.

POP chemicals still exit and the list of POPs that need to be managed under the Stockholm framework will be expanded, and the battle to protect the environment and human health is continuing. Therefore, the cooperation between Vietnam and the international community to safely manage POPs with the motto "prevention is better than cure" should be maintained and promoted.

This report was composed in order to synthesize outcomes, draw on experiences and orientate future activities with the consistent objective of effective implementation of the Stockholm Convention in order to protect the environment and human health from the potential risk caused by POPs. Many organizations, individuals and projects supported the report formulation. However, inevitable shortcomings still emerged during the process of developing the report. MONRE, the UN Development Programme and authors look forward to receiving valuable feedback from all readers in order to provide a better report in the next edition.

Sincerely yours,

Representative
Ministry of Natural Resources and Environment of Vietnam

Dr. Nguyen Van Tai
Director General,
Vietnam Environment Administration

Representative
The United Nations Development Programme

Louise Chamberlain
UNDP Country Director

SUMMARY

This report "10 years of implementing the Stockholm Convention on Persistent Organic Pollutants in Vietnam" is the result of activities implemented over the past 10 years (2005-2015), which has contributed to protecting the environment and human health from the dangerous impacts of POPs. The report includes the following sections:

Section I: General introduction of the Stockholm Convention

The Stockholm Convention was signed with the objectives to protect human health, biodiversity and the environment from the dangers and risks caused by POPs. Currently, the list of old and new POPs should be managed according to the regulations of the Stockholm Convention (including elimination, limit use and reduction of unintentional release). The list contains 23 groups of chemicals related to various sectors such as industry, agriculture, medical, production and waste management. Vietnam has deployed activities on safe management and disposal of POPs to implement commitments in the Stockholm Convention. For effective implementation of the Stockholm Convention, Vietnam has received strong support from international donors such as the Global Environment Facility (GEF), the UN Development Programme (UNDP), the UN Environment Programme (UNEP), the UN Industrial Development Organization (UNIDO) and the World Bank, which has created motivation and remarkable change on awareness, capacity and mechanisms to carry out activities on pollution management and control of POPs and hazardous chemicals. This has positively contributed to the protection of the environment and human health and sustainable development in Vietnam, as well as to global environmental protection.

Section II: Activities to implement the Stockholm Convention in Vietnam

In order to implement the Stockholm Convention, Vietnam Prime Minister promulgated Decision No. 184/2006/QD-TTg on safe management, reduction and elimination of POPs to meet the demand of the Stockholm Convention and the sustainable development target of Vietnam. Over the past years, 15 projects and programmes implemented by ministries and sectors have achieved remarkable results. Currently, Vietnam has updated Decision No. 184/2006/QD-TTg of Vietnam Prime Minister according to the request of the Stockholm Convention and implementation of environmental protection activities in Vietnam. The activities in recent years include:

- Assessment of POPs status;
- Development of POPs management policies and regulations;
- Strengthening of POPs management institutions;
- Strengthening of POPs monitoring capacity;
- Strengthening of remediation activities on POPs pollution;
- Community awareness raising on POPs;
- International workshops and meetings on POPs; and

- Research on old and new POPs in Vietnam.

Section III: Capacity mobilization to manage POPs in Vietnam

Vietnam received strong support from GEF via UNDP, UNIDO, UNEP and the World Bank, as well as other international organizations (including the Swiss Development & Cooperation Agency, the Japanese Ministry of Environment, Canada, the Czech Republic, the Ford Foundation and the Bill & Melinda Gates Foundation) in the GEF fourth and fifth cycles during 2004-2014. Additionally, Vietnam has mobilized reciprocal capital, material and personnel, in order to implement the activities and projects of GEF.

Section 4: Assessment of implementation of the Stockholm Convention in Vietnam

The implementation of the Stockholm Convention in Vietnam has achieved remarkable results over the last ten years (2005-2015). Awareness of ministries, sectors, localities and communities on POP risks and dangers has been promoted, mechanisms and policies on POP management have been developed, management capacity, implementation of monitoring activities, treatment, risk assessment due to POP pollution has been enhanced, the Convention coordination has been strengthened and the cooperation mechanism among ministries and sectors has been enhanced.

Section 5: International funded projects in Vietnam

For implementation of Stockholm Conventions on POPs and other related activities on environmentally sound management of POPs/PTS, Vietnam has received substantial technical and financial support from the international community, with the total funding for various projects reached over US$ 100 million, all are non-refundable ODA resources and of which more than US$ 20 million comes from GEF and US$ 80 million from the US and some other countries, particularly for Agent Orange/Dioxin remediation at hot spots. Co-financing funding mobiliazed from Government resources for the projects is also high, both in the form of in-kind, in-cash and manpower.

This report present general information on all projects implemented in Vietnam during the past time for sound management and treatment of POPs, which ultilized national resources as well as were supported by interntaional comminuties.

I. Introduction of the Stockholm Convention

I.1. The objective of the Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants was signed by the representatives of governments in Stockholm on 22 May 2001. The Socialist Republic of Vietnam ratified the Stockholm Convention on 22 July 2002, becoming the 14th Party of the Convention. So far there are 179 Parties to the Convention.

Stockholm Convention is a global legally binding instrument. Its objective is to protect human health, biodiversity and the natural habitat against the threat of hazardous waste such as POPs. The Stockholm Convention regulates the prohibition of production and use, reduction and final elimination of POPs created by human activities, and implementation of appropriate measures to continuously mitigate unintentional production of POPs from industrial and domestic activities or waste treatment. POPs have the following four characteristics: (i) persistence so they can persist in the environment for a long time, (ii) long-range transport, (iii) high bioaccumulation in the tissues of organisms, and (iv) toxicity. The Stockholm Convention on POPs divided POPs into three groups, including: (i) POPs that need to be removed in manufacture and use (Annex A); (ii) POPs that are limited in production and use (Annex B); and (iii) unintentionally produced persistent organic pollutants (Annex C).

Initially, the Stockholm Convention regulated the sound management, reduction and final elimination of 12 POPs, including Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, Polychlorinated Biphenyls; [1,l,l-trichloro-2,2-bis (4-chlorophenyl) ethane]; Polychlorinated dibenzo-p-dioxins and Polychlorinated dibenzofurans. In 2009, the Fourth Conference of the Parties of the Stockholm Convention decided to add nine new groups of POPs in annexes A, B and C of the Convention. This includes the chemicals in Annex A, a group of plant protection chemicals, including Lindane, Alpha hexachlorocyclohexane, Beta hexachlorocyclohexane, and Chlordecone; a group of industrial chemicals, including Hexabromobiphenyl, Pentachlorobenzene, Tetrabromodiphenyl ether, Pentabromodiphenyl ether, Hepta and Octabromodiphenyl ether; the chemicals in Annex B, including industrial chemical PFOS and PFOS-F and its salts, and perfluorooctane sulfonyl fluoride; and the chemical in Annex C: Pentachlorobenzene.

In 2011, the Fifth Conference of the Parties of the Stockholm Convention added Endosulfan and isomers to Annex A of the Convention.

In 2012, a meeting of the Persistent Organic Pollutants Review Committee proposed to the Conference of Parties to add Hexabromocyclododecane to Annex A as a chemical that needs to thoroughly removed, and this proposal was approved.

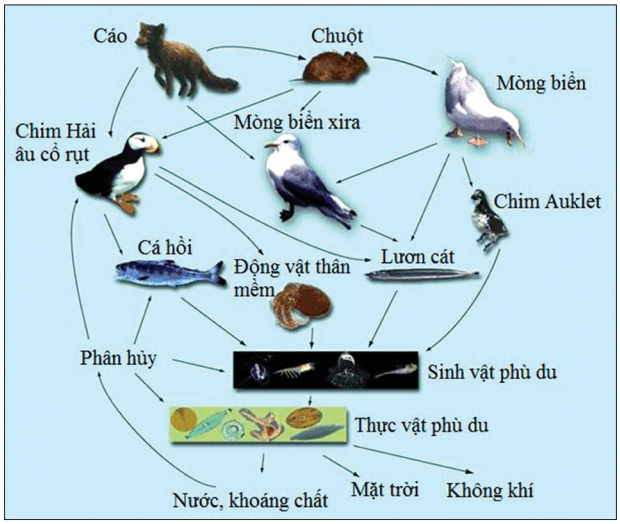

Figure I. 1: Example of POPs/PTS circulation and accumulation in the food chain

Basic information about POPs is presented in the following table:

Table I. 1: Persistent Organic Pollutants under the Stockholm Convention

No.	Name of chemicals	Annex
1	Aldrin	A
2	Chlordane	A
3	Chlordecone	A
4	Dieldrin	A
5	Endrin	A
6	Heptachlor	A
7	Hexabromobiphenyl (HBB)	A
8	Hexabromodiphenyl ether (hexa BDE) and Heptabromodiphenyl ether (hepta BDE)	A
9	Hexachlorobenzene (HCB)	A, C
10	Alpha hexachlorocyclohexane (Alpha HCH)	A
11	Beta hexachlorocyclohexane (Beta HCH)	A
12	Lindane	A
13	Mirex	A

14	Pentachlorobenzene ● ▲	A, C
15	Polychlorinated biphenyls (PCB) ▲	A, C
16	Endosulfan and isomers ●	A
17	Tetrabromodiphenyl ether (tetra BDE) ▲ and Pentabromodiphenyl ether (penta BDE)	A
18	Toxaphene ●	A
19	[1,l,l-trichloro-2,2-bis (4-chlorophenyl) ethane] (DDT) ●	B
20	Axit Perfluorooctane sulfonic (PFOS) and its salts, and per-fluorooctane sulfonyl fluoride (PFOS-F)	B
21	Polychlorinated dibenzo-p-dioxins (PCDD)	C
22	Polychlorinated dibenzofurans (PCDF)	C
23	Hexabromocyclododecane (HBCD or HBCDD) ▲	A

Note: ● Plant protection chemicals

▲ Industrial chemicals

Pollutants that need to removed in the production and use (Annex A) include 16 substances, primarily plant protection chemicals; POPs that are limited in production and use (Annex B) including DDT and PFOS; and unintentionally produced persistent organic pollutants (U-POPs) (Annex C), including Dioxin, Furan, HCB, PCB and Pentachlorobenzene.

The Stockholm Convention stipulates safety management at international scale of 23 POP groups, including hundreds of different pollutants in various sectors, such as plant protection chemicals and industrial chemicals unintentionally produced from production, trading and daily human activity. The list of POPs will continue to be revised.

I.2.Main content

The Stockholm Convention requests the Parties, as nations or regional economic integration organizations, to make efforts in sound management, reduction and final elimination of POPs in production and use. The main requirements of the Stockholm Convention are as follows:

a) Parties should apply effective measures to eliminate the intentional production and use of POPs; and manage and safely treat POP waste and stockpiles.

b) Eliminate the use of PCBs in equipment and PCBs in residual containers by 2025; and introduce environmentally sound management and treatment for

PCB fluids and equipment with concentrations of PCBs higher than 0.005 percent. This should be done as soon as possible, but in any case no later than 2028; and reports on progress are to be prepared every five years.

c) For unintentionally produced POPs: Parties are required to reduce and finally eliminate their releases; develop an implementation plan for the reduction of unintentional releases of Dioxins/Furans and other POPs within two years after the Convention entered into force; review strategies adopted in the implementation every five years; and apply best available technologies and best environmental practices in the reduction of unintentional production sources of POPs no later than four years after the Convention entered into force.

d) Development of National Implmentation Plan on POPs within two years after the Convention entered into force (17 May 2004) and submit it to the Conference of Parties for approval through the Secretariat. The National Implementation Plan should include specific action plans for reducing and eliminating POPs according to the requirements of the Convention. These plans should be integrated into policies for environmental protection and sustainable development of each country.

e) Report, information exchange and support among member states of the Stockholm Convention.

f) Support technology transfer of POPs pollution treatment.

g) Technical and financial assistance activities.

h) Other provisions for evaluating the Convention effectiveness, and adoption, approval and withdrawal from the Convention.

I.3.Vietnam's commitment to the Stockholm Convention

Vietnam signed the Stockholm Convention on 23 May 2001 and ratified it on 22 July 2002, officially becoming the 14th member to the Stockholm Convention. Being aware of serious environmental and health-related issues related to POPs, the Government of Vietnam has developed policies and implemented some specific actions, aimed at sound management of POPs.

In 1991, the Ministry of Agriculture and Food Industry (the precursor of the Ministry of Agriculture and Rural Development (MARD)) promulgated regulations on pesticide registration in Vietnam. MARD subsequently cooperated with line ministries and sectors in establishing the National Consultative Council on Pesticides. Based on advice from this Committee, MARD published a list of pesticides that are either allowed or prohibited for use in Vietnam. By 1992, most of the organochlorine pesticides (including a lot of chemicals in POP groups) and organophosphor pesticides with high toxicity and persistence had been prohibited.

In 1998, the Prime Minister issued Directive No. 29/1998/CT-TTg on enhancing the management of the use of pesticides and POPs, which stipulates the safe treatment and management of pesticides in POP and PCB groups, and the relevant responsibil-

ities of line ministries and sectors.

In 2000, the Ministry of Science, Technology and Environment cooperated with the Norwegian Agency for Development Cooperation (NORAD) in performing an inventory of pesticide stockpiles in Vietnam.

Subsequently, in 2002-2003 the Ministry of Natural Resources and the Environment (MONRE) cooperated with UNEP and the Swiss Development Cooperation Agency in demonstrating the application of POP inventory toolkits, through an initial inventory and assessment of PCBs and Dioxins/Furans release sources in Vietnam.

In 2000-2003 MONRE supported the implementation of some pilot projects on treating POPs and pesticide stockpile waste, such as a project on safe disposal in landfills in combination with bio-chemical treatment, a project on research and development of the technology for the disposal of POPs and hazardous waste at high temperature in specialized incinerators, and the incineration of pesticides in cement kilns.

In 2004, within the framework of the project "Development of National Implementation Plan for Vietnam in the Process of Accession, Implementation and Enforcement of the Newly-signed Stockholm Convention", funded by GEF/UNDP, the Environmental Protection Agency (the precursor of the Vietnam Environment Administration) and MONRE cooperated with domestic and foreign experts and local authorities in implementing an inventory and assessment of the POP status. This included a focus on the production, export-import, use, transport, storage and disposal of POP pesticides; the status of PCBs containing oils and equipment; unintentionally produced Dioxin/Furan sources; an overview of toxic chemically contaminated areas related to chemicals used by the American Army during the war in Vietnam; assessment of the POP monitoring and treatment infrastructure; and a review of the policy, legislative and institutional framework related to POP management. These POP assessments provided a basic picture of the current national status, management and treatment capacity on POPs, as well as the scientific base for the development of the national implementation plan for the Stockholm Convention.

Vietnam focal office for Stockholm Convention on POPs Designated by the Government to be the Vietnam focal point office for the Stockholm Convention and for the coordination of implementation activities in Vietnam, MONRE, in collaboration with other line ministries, sectors and localities, developed the National Implementation Plan and submitted it to the Prime Minister for approval.

With the support of the GEF/UNDP project – Development of National Plan on POPs, the Government developed and issued the Vietnam National Implementation Plan For the Stockholm Convention on POPs by Decision No. 184/2006/QD-TTg dated 10 August 2006[2]. The objective of this plan is to contribute to the global environmental protection of human health against the threat of persistent organic pollutants as that of the Stockholm Convention. Decision 84 also proposed a list of proposals, projects, tasks and priorities that are suitable with the circumstances and conditions of Vietnam, as well as a system of actions and solutions including policies, legislation, institutions, technology, finance, awareness raising and international integration in order to

gradually meet the requirements of the Stockholm Convention. The Vietnam National Implementation Plan for the Stockholm Convention has demonstrated the strong commitment of the Government on the sound management of POPs.

Decision No. 184 includes the following

a) Objectives of the National Implementation Plan:

- Develop and finalize policy, legislative and institutional frameworks for effective management of POPs in order to reduce and finally eliminate POPs;

- Strengthen technological and financial capacity and information management for the prevention, control and safe disposal of POPs;

- Control, treat and finally eliminate stockpiles of POP pesticides;

- Thoroughly treat sites contaminated with POP pesticides and Dioxin residue from toxic chemicals used by the American Army during the war in Vietnam;

- Reduce the release of PCBs into the environment, eliminate the use of PCBs in equipment by 2020 and safely dispose of PCBs by 2028;

- Continuously reduce the release of unintentionally produced POPs (Dioxins and Furans).

b) Principles for the National Implementation Plan:

- The core approach shall be "pollution prevention" with recognition of POPs as posing long-term potential hazards to human health and the environment;

- The management, reduction and elimination of POPs shall be implemented consistently, continuously and thoroughly;

- The activities of the NIP shall be feasible and in line with the objectives of the Vietnam National Strategy for Environmental Protection as well as the requirements of the Stockholm Convention;

- The NIP implementation shall ensure the cooperation, coordination, integration and participation of the government at all levels, as well as all economic sectors and the public;

- Action will be based on scientific evidence; making use of a combination of domestic and international resources and bringing into play internal strengths in combination with the use of international experience and assistance; and application of advanced, clean and environmentally friendly technologies for safety management, minimization and efficient treatment of POPs.

c) Activities and solutions for implementation:

- Finalize the organizational mechanism, policy and legislation to effectively manage, reduce and treat POPs;

- Strengthen the POP management capacity;

- Promote the survey, research and application of advanced and modern technological solutions for the sound management, reduction, disposal and elimination of POPs;

- Raise the awareness, roles and responsibilities of the Government at all levels and among the public on the sound management, reduction and elimination of POPs;

- Diversify investment sources; and

- Enhance international cooperation for the implementation of the Stockholm Convention.

The National Implementation Plan for the Stockholm Convention has proposed 15 prioritized programmes for implementation of the Convention.

In order to focus resources in line with prioritized objectives, the implementation of activities in Decision No. 184 on management, reduction and final elimination of POPs is classified in phases, including 2006-2010, 2010-2015 and 2015-2020. The implementation process for each stage is regularly monitored and sensibly adjusted by the national focal agency, based on the conditions and resources at that time.

I.4. The support of international donors for the implementation of the Stockholm Convention in Vietnam

POPs safety management has an international importance that benefits the global environment, contributes to the common goal of environmental protection and public health all over the world. Therefore, the implementation of the Stockholm Convention in Vietnam has also received a lot of attention and support from the international community.

GEF is the financial mechanism of the Stockholm Convention and initiated funding for POP projects from Cycle 4 (2006-2010) through, for example, UNDP, UNEP, UNIDO, the World Bank and other international organizations.

In order to mobilize international support for the implementation of the Stockholm Convention, VEA and MONRE has taken the initiative to build comprehensive programmes on POP management and has proposed specific projects to call for support from GEF and other donors. Recently, the VEA has coordinated with relevant agencies to organize several meetings and consultation conferences with donors such as the Food and Agriculture Organization (FAO), UNDP, UNEP, UNIDO, the World Health Organization, the World Bank, the Asian Development Bank and the Swiss Agency for Development and Cooperation (SDC) and the countries concerned to develop partnership programmes on POP management projects. The GEF national operational focal point has also actively supported POP projects through the National Dialogue Conference on GEF projects for programmes in the GEF 4, GEF 5 and GEF 6 cycle. Relevant agencies that are responsible for international cooperation, including the Department of International Cooperation under MONRE, the Ministry of Planning and Investment, the Ministry of Finance and the Department of International Relations under the Office of the Government, have also actively supported international cooperation activities, called for

funding and allocated resources to implement the Stockholm Convention in Vietnam.

With the initiative and coordination among agencies in the past few years, Vietnam has received considerable support from the international community to implement POP safety management. The number of POP projects that Vietnam has mobilized is quite diverse, including eight national GEF-funded projects, three regional GEF funded projects and a number of bilateral projects sponsored by different nations and organizations such as Switzerland, the Czech Republic, the United States, Canada, the Bill and Melinda Gates Foundation and the Ford Foundation. Based on the strategic direction of Decision No. 184 and a number of other policies on environmental protection, the POPs projects have been developed continuously to support one another in order to achieve the common goals.

Based on the general activities of the international community and the proactive and clear commitment of the Government in the field of POPs and chemical management, Vietnam has received 11 GEF-funded projects, including eight national GEF-funded projects, with a total cost of about US $20 million, and three regional GEF-funded projects with total funding of US $21 million. In terms of funding mobilization from GEF in the field of POP management, Vietnam ranks third in the world, after China and India. POP projects funded by GEF have been implemented in combination with co-financing from other donors or the Government, with a total budget 2-4 times higher than the GEF funding.

A lot of other international donors have funded directly or indirectly to implement POP pollution management, control and treatment in Vietnam. The total international funding for POP projects reached more than US $100 million.

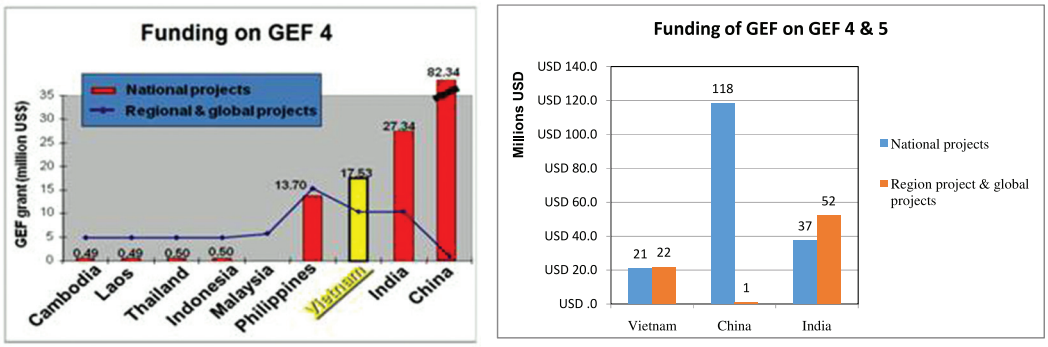

Figure I.2: GEF resource mobilization for POP management projects in Vietnam

In 2012, thanks to the success in raising GEF capital for Vietnam, the GEF Secretariat held a separate activity in Vietnam to evaluate the effectiveness of GEF resources for the implementation of activities supporting sustainable development and global environmental protection. Independent evaluation results from projects and the comprehensive consideration of the GEF Secretariat concurred that the projects and GEF resources have contributed to positive changes in the strategic planning, capacity

building and environmental protection in Vietnam, as well as to global environmental protection. The effectiveness of these projects is presented in specific activities such as technical capacity building, policy and legislation development, awareness raising about POPs and chemical pollution, promotion of environmental technology transfer, pollution treatment in hot spots and international integration support.

In general, amount of funding has shown considerable attention and support of international donors in the field of environmental management of POPs and chemicals. This funding, combined with technical assistance and other investments, has created motivation as well as significant changes in awareness, capacity and mechanisms to implement activities related to POP pollution management and control in particular and other hazardous chemicals in general, contributing positively to the environmental protection, health protection and sustainable development in Vietnam, as well as to global environmental protection.

II. Convention implementation activities in Vietnam

II.1. Implementation of the National Implementation Plan for the Stockholm Convention

Vietnam has developed Decision No. 184 with content on sound management of POPs and POP reduction and final elimination in order to be in line with the requirements of the Stockholm Convention and the sustainable development objectives of Vietnam. The National Implementation Plan for the Stockholm Convention is the basic policy of Vietnam in POP management, as well as a driving force and catalyst to promote the activities of hazardous waste pollution control and hazardous waste treatment.

Most of the tasks set out in 15 national priority programmes under Decision No. 184 have been implemented by various projects and programmes in many different ways and with diverse resources.

Basic information about the organization and resources for implementation of the projects is described in Table II.1.

Table II.1: Programmes within the framework of the National Implementation Plan of the Stockholm Convention

No.	Programmes	Domestic and international sources	Types and implementation progress
1	Development and finalization of policies, legislation and institutions for sound POP management	- State budget environmental protection expenditure - POP projects funded by GEF through UNDP, UNIDO and the World Bank	Completed (2009-2013) - Under implementation (2009-2015)

2	Sound management, disposal and phase-out of POP pesticide stockpiles	- State budget - environmental protection expenditure - GEF/UNDP - State budget for national target programme	Under implementation (2011-2015)
3	Thorough treatment of hot spots contaminated with Dioxins from toxic chemicals used by the American Army during the war in Vietnam	- GEF/UNDP - State budget - environmental protection expenditure - State budget – science and technology expenditure - State budget – economic/ basic investment expenditure - United States Agency for International Development - Ford Foundation - Czech Republic	Under implementation Under implementation; project on survey and assessment of Agent Orange/Dioxin contamination: GEF/UNDP project – Dioxin treatment; and environmental remediation project at Da Nang Airbase
4	Management of healthcare waste to reduce POPs and other toxic releases	- GEF/UNDP - GEF/WB - State budget of the Ministry of Health	- Participation in a global project on management of healthcare waste to reduce U-POPs and mercury - WB project on healthcare waste management
5	Thorough treatment of PCB and POP pesticides contaminated hot spots	- State budget for national target programme - State budget of MARD and MONRE and local budget	Ongoing activities of stockpile treatment and remediation combined with the activities of programme No.2 (on this Table)

6	Sound management, disposal and phase-out of PCBs and PCB-containing electrical equipment and industrial products	- GEF/WB - State budget – science and technology expenditure - Investments for laboratories	Under implementation, GEF/WB – PCB project from 2009-2015; scientific projects within the Department of Science and Technology
7	Development of technical capacity for POP monitoring and analysing facilities; establishment of a network of laboratories for analysing and assessing pollution and impacts of POPs on human health, biodiversity and the environment	- Bill & Melinda Gates Foundation - GEF/UNIDO - Japan - State budget (different sources) - Investment and upgrading laboratories of enterprises and the private sector - GEF/UNEP - GEF/WB	Under implementation through international projects; scientific projects within the Department of Science and Technology; investment resources for laboratory development of ministries, sectors and the private sector
8	Survey, research, support and management of the application of Best Available Techniques and Best Environmental Practices to reduce and finally eliminate the unintentional production of POPs from industrial and living activities	- GEF/UNIDO - State budget	- Completion of the GEF/UNIDO project Application of BAT/BEP in four industries (2009-2011) Under implementation of GEF/UNIDO project Application of BAT/BEP in open burning activities Under implementation of project on eco-industrial zone funded by GFF/UNIDO - Project on “Regional forum on BAT/BEP” In combination with a number of activities on cleaner production

9	Survey and study on the impacts of POP contaminated environment on public health	- State budget – science and technology expenditure for Agent Orange/ Dioxin projects and programmes - International cooperation on science and technology - GEF/UNDP project – Dioxin treatment - GEF/WB – PCB project	Through numerous scientific research projects Through the activities of assessment of the absorption and environmental risks related to POPs
10	Education, training and awareness raising on POP impacts	- State budget – environmental protection expenditure - GEF and other donors - Components on communication and awareness raising of many projects on POPs	Under implementation through numerous international projects
11	Enhancement of the technical and financial support for the implementation of the Stockholm Convention in Vietnam	- State budget – environmental protection expenditure - International cooperation activities	Under implementation through international cooperation activities, coordination and implementation of the Stockholm Convention and development of new projects
12	Strengthening capacity for managing and controlling the production, import-export, use and transport of prohibited chemicals in Vietnam	- GEF/WB - GEF/UNDP - Green Customs Initiative - State budget	Under implementation through international projects on POPs, Green Customs Initiative and a number of activities within the framework of the Basel Convention
13	Study and development of the emission and technological standards associated with POPs in line with development and integration needs	- GEF/WB - GEF/UNDP - State budget – scientific and technology expenditure	Integration in activities of projects: GEF/WB – PCB, GEF/UNDP – POP pesticides; GEF/UNDP – Dioxin treatment

14	Development of a national information system on POPs and promotion of stakeholder and public participation in the sound management of POPs	- GEF/WB - State budget	Integration in the activities of GEF/WB – PCB project, with the participation of a number of other projects on POPs (website: www.pops.org.vn)
15	Assessment of POP management in the whole country	- State budget – environmental protection expenditure - GEF-funded projects on POPs	Through the coordination and implementation of the Stockholm Convention and independent evaluation of projects

Although most of POP management activities have been implemented, some activities have not been implemented or not fully carried out. Therefore, it is essential for the National Implementation Plan for the Stockholm Convention in Vietnam to be implemented continuously and uniformly with a consistent roadmap to achieve the final goal, which is protecting human health and the global environment.

In 2009, 2011 and 2013 the Stockholm Convention added a number of new POPs to the list of chemicals that need to be managed and requested the Parties to periodically review, update information and improve management capacities on (old and new) POPs to implement activities most effectively. With the support of GEF and UNDP, the Ministry of Natural Resources and Environment is taking the lead, in collaboration with concerned ministries and agencies to update the National Implementation Plan for the Stockholm Convention. The new national plan is being developed with a focus on new POPs and old POPs inventory, and updating, assessment of the current national capacities for POP management, disposal and treatment, and determination of objectives, prioritized activities and plans for resource mobilization, and this plan will be submitted to the Government for approval.

The development and implementation of the updated national implementation plan for POP management is a new challenge but also an opportunity for Vietnam to review its management and control capacity on chemical pollution, and to compare it with other countries in order to develop policies and improve capacity building in environmental protection in line with current international trends.

II.2. The operation and performance of POP management in Vietnam

II.2.1. Assessment of the current status of POPs

So far, Vietnam has organized many activities related to conducting an inventory of POPs, including pesticides, PCBs from electrical equipment, several industrial POPs and U-POPs.

Doing an inventory of POPs requires highly advanced equipment and complex

techniques, due to the fact that POPs are released from various sources, reside in different environmental components and often exist at low concentrations. Some inventory activities apply the sampling, analytical and quantitative calculation methodology, while others apply the indirect inventory method following the inventory toolkit or the calculation formula that was introduced in the Stockholm Convention. Results from the inventory activities are very important preliminary information, forming the practical basis for the safe management of POPs and POP containing waste in Vietnam.

a) Inventory of the first 12 POPs

In recent years, a number of projects have investigated, surveyed and evaluated the inventory of POP pesticides storage and chemically contaminated areas in nationwide. The survey results showed that a significant number of contaminated areas exist due to many different causes such as residual chemicals from the war time, unsafe disposal of pesticides, buried chemicals, disposal of mixed waste and chemicals in dump areas, and storage of expired or confiscated chemicals.

The survey conducted in 2013 by the VEA in collaboration with localities, discovered thousands of areas that are contaminated by residual pesticides in provinces and cities, mainly in the north and north-central regions. Apart from some large chemical storage facilities and landfills considered as hot spots, most other contaminated spots are small and scattered across rural communes. The concentration of pesticides in soil at these spots usually ranges between 10-50 ppm. However, in some places it can go up to hundreds of ppm.

Figure II.1: Pesticides storage

Results of the survey also showed that the number of chemically contaminated areas increases with time and efforts spent on investigation and searching. In the period 2010-2014, through the implementation of the GEF/UNDP project on POP pesticides stockpiles, more than 400 new contaminated spots were discovered all over the country. Therefore, in future projects and activities for investigation, surveying and assessment of chemically contaminated areas will continue to be implemented in many parts of the country.

Figure II.2: Pesticide contaminated soil

As for an inventory of PCBs, several surveys have been conducted from 2004 to now. In the past, Vietnam did not produce but imported PCB equipment and possibly PCB containing oils such as oil for transformers, insulating oils and industrial oils (e.g. hydraulic oil, gas turbine oil, lubricants and plastic additives). As in many other countries, the PCBs were used as insulating fluids in oil-containing electrical equipment such as transformers and capacitors. Vietnam imported PCBs and equipment with PCBs quite early, starting in the late 1940s. However, Vietnam has implemented strict measures to control the import of PCB oils and PCB containing equipment since the 1980s, when many countries in the world began to realize the danger and toxicity of PCBs to humans and the environment and stopped their production.

Until 1998, Vietnam Electricity (EVN) has imported about 18,000 tons of insulating oils, which may contain amounts of PCB-containing oils. As Vietnam currently does not import PCB-containing oil or equipment, the main problem for the country now is to identify, manage and safely dispose in-use or discard PCB containing equipment, oil and waste containing PCBs.

Figure II. 3: Stored transformers after use

With support from the project GEF/WB - PCB management in Vietnam, during 2012-2014 the Industrial Safety Techniques and Environment Agency (ISEA) and EVN, under the Ministry of Industry and Trade, have chaired and coordinated with VEA and other stakeholders to conduct a PCB inventory throughout the country. In order to ensure its reliability, the inventory applied a sampling and analysis methodology on the actual concentrations of samples collected from field surveys. EVN collected and analysed nearly 50,000 samples of oils from electrical equipment and ISEA collected and analysed the PCB concentrations in nearly 9,000 samples taken from electrical equipment owned by non-EVN entities. Fast chlorine analytical results of transformer oils up to November 2014 showed that among more than 39,000 transformers, 401 machines were suspected to have PCB containing oil with concentrations exceeding the threshold allowed by the Stockholm Convention (i.e. 50 ppm). In particular, 112 machines had relatively high PCB concentrations that were above 200 ppm. Regarding the inventory of PCB outside the electricity sector (non-EVN), surveys at the end of 2014 showed that there were over 35,712 suspected PCB containing pieces of equipment and the project conducted an inventory of 9,000 machines and stored oils. The total estimation of non-EVN PCB contaminated oil is about 930 tons.

In Vietnam, many surveys and evaluation activities have been carried out in order to assess the contamination of Agent Orange/Dioxin used by the American Army during the Vietnam War. According to documents obtained by the Office of National Steering Committee 33, during the war, the American Army conducted 19,905 toxic chemical spraying missions covering an area of 2.6 million hectares that included 25,585 villages. The total amount of toxic chemicals used was approximately 76.9 million litres, of which Agent Orange chemicals accounted for 44 million litres. Some American scientists have estimated that 366 kg of dioxin were sprayed over the south of Vietnam.

For the last 15 years, the Ministry of Defence, in collaboration with local and international management authorities and researching institutes, has conducted numerous surveys and studies focusing on measurement of the Dioxin concentrations in soil and sediment at contaminated sites within the three airports of Bien Hoa, Da Nang and Phu Cat. Based on the data from these surveys, the GEF/UNDP project - Environmental Remediation of Dioxin-Contaminated Hot Spots implemented by Steering Committee 33 in coordination with the Ministry of Defence, has estimated the volume and weight of soil and sediment that needs to be remediated at Bien Hoa, Da Nang and Phu Cat (Table II.2). The volume of contaminated soil and sediment that needs to be remediated at Bien Hoa airport is 80,000 m^3 and at Da Nang airport it is 61,600 m^3. On-site thermal desorption technology is being implemented at a large scale at Da Nang airport. Mechano-chemical technology has also been tested at a smaller scale at Bien Hoa airport and has achieved positive results.

Table II.2: Estimated areas and volumes of soil and sediment that need to be remediated at three AO/Dioxin contaminated hot spots: Bien Hoa, Da Nang and Phu Cat airports

Airport	*Contaminated site*	*Estimated area and volume of soil and sediment to be remediated*	
Bien Hoa Airport	Zone Z1	40,000 m^2 ; depth: 1.2 - 1.4 m	
	Lake no. 1	10,000 m^2	
	Lake no. 2	20,000 m^2	
	Lake at Gate 2	10,000 m^2	
	Total area	80,000 m^2	
Da Nang Airport	Lotus Lake	85,400 m^2	22,800 m^3
	Storage area	16,200 m^2	8,900 m^3
	Mixing, loading, washing area	19,600 m^2	19,600 m^3
	Drainage area	35,600 m^2	8,500 m^3
	Eastern area of the airport	7,700 m^2	500 m^3
	Zone Pacer Ivy	3,200 m^2	1,400 m^3
	Total area/volume	167,700 m^2	61,600 m^3
Phu Cat Airport	Zone Z3	2,300 m^2	2,300 m^3
	Total area/volume	2,300 m^2	2,300 m^3

Assessment results of Dioxin contamination in the surveyed areas show that the effects of the environment withsuch as sunlight, heat, rain, flooding and microorganisms), the amount of dioxins in many sites has decreased to levels below the permissible risk threshold. Several studies have revealed that in many areas that were

sprayed with toxic chemicals in the past, dioxin levels have dropped to lower than the permissible maximum concentration or close to zero. In some areas such as Can Gio in south Vietnam, dioxin concentration in sediments are actually relatively low, down to the background level compared to some other areas in the north and central region, and much lower than that of the downtown area in Osaka, Japan [7] (Figure II.4).

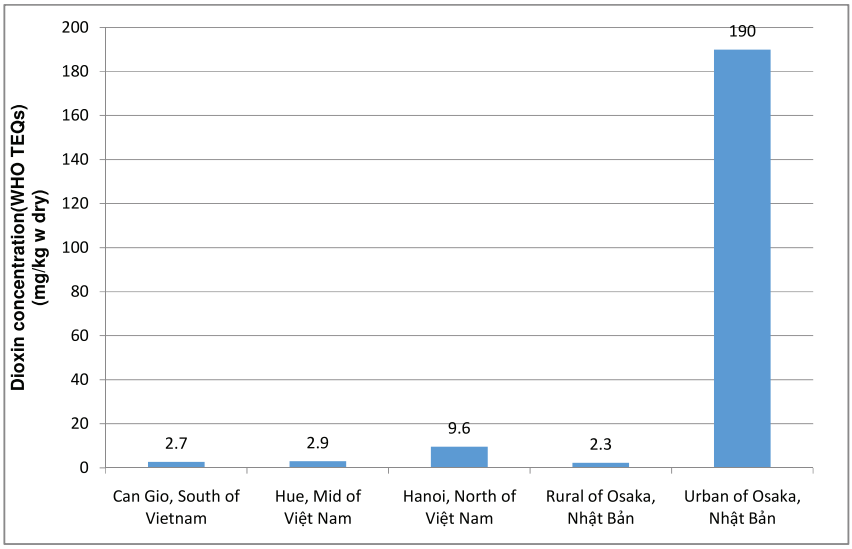

Figure II.4: The concentration of dioxin in sediments in Can Gio, south Vietnam (an area sprayed with toxic chemicals in the past) and in other areas in Vietnam and in Osaka, Japan. (Source cited: Kishida et al (2010). Chemosphere 78, 127-133 [7])

However, in heavily contaminated areas such as the three airports of Bien Hoa, Da Nang and Phu Cat, the Dioxin levels remain are very highly, as much as thousands of times the maximum permissible concentrations, and continue to affect the environment, eco-system and public health.

As for unintentional Dioxin produced by industrial processes, under the framework of a project funded by GEF via UNIDO, the Pollution Control Department of the VEA has carried out an emissions inventory, using a UNEP toolkit (Table II.3), for several industrial sectors that are potential Dioxin sources, including incinerators, metallurgy, cement, pulp and paper manufacturing, transportation and open burning activities. Results of the inventory conducted during 2013-2014 pointed out that incinerators, open burning and metallurgy are major Dioxin emission sources in Vietnam. The total amount of dioxin generated unintentionally by these six sectors was 568 g TEQ/year, of which waste incinerators accounted for the majority (465.5 g TEQ). In fact, several studies on dioxin emissions in Vietnamese industries using sampling and measuring methodology have demonstrated relatively high dioxin emission in some incinerators and nonferrous metallurgical facilities, as well as in open waste burning areas and in traditional craft villages.

Table II. 3: Inventory of unintentional Dioxin emissions by several industrial sectors

No	Sector	PCDD/PCDF emission (g TEQ/year)					Total
		Air	*Water*	*Soil*	*Residual*	*Ash*	
1	Incinerators	287.8				177.9	465.7
2	Ferrous and non-ferrous metallurgy	8.81	0	0	0	38.98	47.79
3	Cement production	17.89					17.89
4	Pulp and paper	0.006	0	0	0.657	5.33	6.47
5	Transportation	3.99	0	0	0	0	3.99
6	Open burning	24.3		0.87	0.37	1.11	26.6
	Total	**568**					

b) Inventory of new POPs

Vietnam's regulations have banned using of POP pesticides, including the initial POPs as well as POPs newly added to the list by the Stockholm Convention, such as Endosulfan. Some POPs for preventing diseases such as Lindan and Aldrin are no longer used in the medical sector in Vietnam. Thus, the inventory of new POP pesticides was mainly based on an assessment of the old storage areas, storage and burial zones of pesticides and expired chemicals in the medical sector.

Regarding new industrial POPs, data is limited and inadequate in Vietnam. This is also the main difficulty in managing them safely. Based on international literature and experience, as well as the guidance of the Stockholm Convention, the inventory of new POPs was conducted using the principle of life-cycle assessment, i.e. the inventory is divided into stages, from production, storage, transport, trade, use, until it expires and is discarded. For POPs that are no longer produced, their inventory process is divided into three main stages, including imported, used and stored, and turning into waste.

One of the most worrying industrial POPs is PBDE, a chemical commonly used as flame retardants in plastic, imitation leather or industrial textile. Under the framework of international projects supported by UNDP and UNIDO, the Pollution Control Department of the VEA has developed a methodology for the inventory and consequently conducted a preliminary inventory of PBDE contained in electronic devices, based on the life cycle of chemicals (Table II.4). Preliminary results point out that the electronics industry will be a potential PBDE emission source. In fact, there was a programme studying the PBDE contamination levels in areas where electronic waste was gathered and recycled. The results showed relatively high PBDE concentration in environmental samples such as air, sediment, dust and breast milk in these areas. Outcomes of research on PBDE and other new POPs are presented in Section II.3.

Table II. 4: Inventory of PBDE by stages of the life cycle in six types of electronic devices in Vietnam (2006). Unit: tons PBDE

Stage of life cycle	Television	Computer	Phone	Refrigerator	Air conditioner	Washing machine	Total
Used	83.60	6.91	0.03	4.61	0.22	2.32	**63.4**
Produced	71.70	2.55	0.00	3.61	0.13	1.62	**51.7**
Imported	26.30	6.01	0.03	2.03	0.25	0.78	**22.9**
Exported	14.30	1.67	0.01	1.03	0.16	0.08	**11.2**
Discarded	8.45	1.53	0.005	1.08	0.04	0.82	**7.74**

In the last five years, most studies on PBDE were carried out by institutes and scientific centres in universities, in collaboration with foreign research groups (e.g. from the US and Japan). The published results focused on typical subjects with high accumulation, such as household dust, soil, sediment and fish samples. The studied areas were mostly cities and electronic waste recycling zones and waste landfills. Meanwhile, similar research has been conducted in other countries of the world, particularly in Asia such as China, South Korea and Thailand. Data from this research has been a valuable reference source to initially assess the PBDE contamination levels in the environment in Vietnam.

Recently, VEA developed a methodology and technical guidance on PBDE inventory assessments, based on international reference materials and studies published by organizations such as UNIDO, the US Environmental Protection Agency and independent research groups. However, this approach of developing and applying technical guidance on a PBDE inventory needs to take into account the differences in conditions for application, management policies, and the level of science and technology development between countries. In Vietnam, several initial PBDE inventory activities have been conducted, mainly focused on finding PBDE in plastic materials and in waste recycling areas and landfills. The results will provide more data for an assessment of contamination levels and then for the implementation of management measures.

Through preliminary results achieved from research and a PBDE inventory at some hot spots, Vietnam is showing its efforts to meet the new requirements of the Stockholm Convention. Although insufficient and not specific, the data collected has covered all subjects relating to PBDE, such as plastic recycling, electronic waste, transportation, rubber, textiles and furniture. Based on that, environmental management authorities can perform the initial assessment on the volume and level of PBDE contamination and accumulation in the environment in Vietnam.

In environmental components such as dust, air, soil and sediment, the PBDE concentration equal the average levels of other countries in the world. Even in big cities like Hanoi and Ho Chi Minh City, the PBDE also remains at background levels. Research demonstrated that currently the emission of PBDE into the environment involves some

high-risk processes such as spontaneous plastic recycling activities from electrical and electronic waste at several villages and gathering, burying and processing of domestic and industrial waste at open landfills. In addition, the high PBDE concentration in contaminated areas led to the strong accumulation of harmful substances in living organisms, especially inaquatic organisms of the food chain, and consequently resulted in PBDE exposure.

According to the most recent study conducted in 2012-2013 [8], the PBDE concentration in dust samples in plastic recycling areas (Bui Dau and Trieu Khuc) are 6-37 times higher than that of Hanoi. However, they are considered as an average level compared to data in other international studies, and are much lower than the PBDE contamination levels in the UK and Thailand.

Similar to the case of PBDE, the data on PFOS in Vietnam, including studies by foreign scientists as well as collaborative research, is still limited. Currently, VEA has developed technical guidance on methodologies and has conducted a PFOS inventory in areas such as industrial processes; consumer markets; fire-fighting foam, aviation hydraulic fluids and insecticides; and waste, storage and contaminated sites. Several environmental experts have applied technical guidelines for Vietnam, together with the sampling and analysis of PFOS in different environments, such as water, sediment and product samples. According to the results, concentration of PFOA and PFOS found are relatively low. Many samples have been analysed but did not detect these pollutants. The Center for Environmental Technology and Sustainable Development (CETASD) of the University of Sciences, Hanoi National University, in collaboration with the United Nations University, also conducted research on the PFOS and PFOA concentration in surface water and waste water. Results revealed relatively low concentration compared to other countries in the region. For example, the PFOS and PFOA concentration in the mud samples are small, ranging from less than 10 ppb to 56 ppb as the highest (in the sample taken from a wastewater treatment tank of a plant that produces soap, washing powder and detergent).

As HBCDs were just added to Annex A of the Convention in 2013, research and policies on the management of HBCDs have not received much attention in Vietnam. However, since they are brominated flame-retardants and are popularly used in Vietnam, research on HBCDs as well as an inventory will also be conducted. Data on HBCDs is now very limited, mostly coming from published research by CETASD, in collaboration with the Centre for Marine Environmental Studies of Ehime University, Japan. The research has identified the HBCDs, PBDE and PCB contamination levels in four areas of northern Vietnam, including the urban and suburban areas of Hanoi and two electronic waste recycling areas in Trang Minh, Hai Phong and Bui Dau, Hung Yen [8]. Specifically, the HBCD concentration (median and concentration range) of dust in Hanoi (urban and suburban), and in Trang Minh, Bui Dau are: 7.4 (0.99 to 61); 8.7 (1.3 to 32); 29 (7.5 to 130) and 120 (5.4 to 400) ng/g, respectively. They are relatively low, compared to those in other countries such as Japan, Canada, USA and the UK. However, the concentration of HBCDs in dust in Bui Dau is much higher than other areas, showing the potential risk of HBCD emissions due to recycling activities

of electronic and plastic waste. On the other hand, HBCD was not found in many air samples. The only three sites where HBCD was found in the air are offices in Hanoi's urban area (6.6 pg/m^3), in Trang Minh recycling area (7.4 pg/m^3) and in Bui Dau (5.7 pg/m^3). In other words, air is not the typical accumulation environment of HBCDs as their concentration are very low and there is no significant difference between the HBCD concentration in the air in offices and that in electronic waste recycling areas.

In general, Vietnam has implemented activities such as inventories, studies on emissions, capacity building and risk assessments of the effect of new POPs on the environment and people's health (especially substances that are still in use in industrial processes and daily life). Results from the surveys show that in Vietnam there are a number of production activities that may cause the emission of new POPs (such as HBB, PBDE, PFOS and HBCD) into the environment at different levels and consequently pose a potential risk to the environment and human health. Some other new POPs were discovered in solid waste and sediment dust at noticeable levels, whereas in other environmental components they were only detected at low concentration, implying low risks on the environment and human health. However, the inventory scope of projects and surveys in recent years have been limited in time, studied sectors and the amount of samples. Therefore, in the future POP sampling and analysis under the framework of national and international joint programmes should be carried out continuously in order to provide a more accurate assessment. In addition, it is necessary to have closer coordination between the inventory and scientific research on potential POP emission sources. Work should be focused on expanding the scope of POP studies, monitoring POPs regularly, determining the emission factors and tracking changes over time of POPs in the environment. Based on that, the implementation of a POPs inventory, safety management as well as risk reduction will be more proactive and comprehensive.

II.2.2. Development of policies and regulations on POP management

As one of the first countries to sign and ratify the Stockholm Convention, the Vietnam Government has considered the reduction of POPs and eventually their elimination as one of its priorities to protect the environment and human health. Decision No. 184 was developed and issued quickly, demonstrating the commitment of Vietnam to implement the Stockholm Convention. In Decision 184 the highest priority is to establish a proper policy, legal and institutional system for the safe management and pollution control of POPs.

a) Development of policies and legislation for POPs management in the agricultural sector

Along with economic growth in general and the development of the agricultural sector in particular, pesticides are increasingly used, both in terms of volume and type. Many of them are hazardous chemicals that potentially harm human health and can have long-term consequences on the environment.

To prevent and eventually stop the illegal use of hazardous pesticides, smuggled and expired pesticides, the Government has assigned specific responsibilities to ministries

and other relevant agencies as follows:

- MARD: Annually issuing and distributing the list of permissible and prohibited pesticides; compiling and reporting to the Government on the management of pesticides in the country and data on prohibited pesticide stockpiles in provinces; coordinating with the Ministry of Industry, Ministry of Science and Technology and the Provincial People's Committees to manage, investigate and strictly supervise facilities that produce and trade permissible pesticides in accordance with the Ordinance on Plant Protection and Quarantine; enhancing inspections in all sectors and areas to timely identify and punish those who violate regulations on pesticides; and leading and collaborating with relevant ministries and sectors to investigate, supervise and promote the comprehensive collection of pesticide stockpiles for treatment and disposal, using appropriate hazardous waste treatment techniques and procedures without causing harm to the environment and human health.

- The Ministry of Industry and Trade (MOIT): Leading and collaborating with the Ministry of Science and Technology, People's Committees of provinces and cities directly under the Government to develop measures for management, investigation and supervision of import and export of pesticides in general and of prohibited pesticides in particular.

- The Ministry of Health: Responsible for the management, supervision and monitoring of the production, import, export, and use of chemicals, insecticides and disinfection products used in the healthcare sector; collaborating with the Ministry of Agriculture and Rural Development and other relevant ministries, sectors and localities in collecting, treating and disposing prohibited pesticides and insecticides; regularly updating the pesticides exposure and studying the impact of pesticides on human health in order to develop effective prevention and therapy measures.

- The Ministry of Science and Technology: Issuing standards, procedures and economic and technical thresholds for industries; and implementing studies, developing and guiding technical processes for treatment and disposal of prohibited pesticides and hazardous pesticides that are illegally imported into Vietnam.

- MONRE: Leading and collaborating with other relevant agencies and provincial People's Committees to develop treatment measures for hazardous chemical stockpiles whose origins are undefined and for confiscated hazardous chemical-containing products; leading and collaborating with the Ministry of Defence and other relevant agencies and provincial People's Committees to determine the sources and scope of the impact of hazardous chemical stockpiles from the war; developing and submitting the treatment plan to the Prime Minister for approval; evaluating the environmental pollution caused by the use of pesticides and assessing the concentration of hazardous pesticides and residual POPs in agricultural goods, food, soil and water and proposing the remedial measures. Recently, according to the Environmental Protection Law 2014, MONRE is responsible, in collaboration with MARD, for environmental protection activities related to pesticides and veterinary drugs.

According to the roles and responsibilities assigned by the Government, in recent

years, MARD has issued a series of legal documents for pesticides management as follows:

- Circular No. 03/2013/TT-BNNPTNT on 11 January 2013 on the management of pesticides (and many precedent Circulars and Decisions on pesticide portfolio and management);

- Circular No. 12/2010/TT-BNNPTNT on 11 March 2010 issued the supplemental list of permissible products for treatment and rehabilitation of the aquaculture environment;

- Circular No.77/2009/TT-BNNPTNT on 10 December 2009 on the state inspection of the quality of imported pesticides;

- Decision No. 97/2008/QĐ-BNN on 6 October 2008 issued regulations on the issuance of certificates of production, processing, bottling and packaging, and trading pesticides; and

- Technical regulations, Vietnamese standards and quality standards applied on pesticides, pesticide wholesale stores, and procedures for checking the use of pesticides on crops.

In 2013, MARD has taken the main responsibility for developing and submitting the Law on Plant Quarantine and Protection to the National Assembly for enactment, creating a more solid legal ground for safety management and contamination control of pesticides.

In sum, there are a lot of documents issued by MARD to control pesticides. In the list of permitted, limited-in-use and prohibited pesticides, all agricultural POPs are banned from use throughout the country. However, the management of several highly hazardous pesticides needs to be reviewed and controlled more strictly in the future.

In order to fulfil its task of environmental management regarding pesticides, including POPs, MONRE has also actively developed, issued and submitted for enactment a series of new policies and regulations in this field, especially to enhance the management of pollution caused by chemical stockpiles, including:

- Decision No. 1946/QD-TTg of the Prime Minister on 21 October 2010, on issuing the Treatment and Prevention Plan of environmental pollution caused by pesticide stockpiles throughout the country (Decision 1946). Decision 1946 is an important policy that has a strong impact and large influence at national scale on the management, improvement and treatment of environmental pollution in areas where chemicals have been present for a long time. MONRE was assigned to take the lead on monitoring and guiding the implementation of the Plan, in collaboration with other relevant ministries, agencies, and local authorities. To date, the list of contaminated sites of residual chemicals is continuously reviewed, evaluated and updated.

- Decision No. 2537/QĐ-BTNMT on 30 December 2010 issued the Implementation Programme of treatment and prevention of environmental pollution caused by pesticide stockpiles all over the country. The programme set out 13 prioritized tasks during the period 2010-2015, of which five tasks related to developing and completing the

mechanisms and policies on pollution mitigation and environmental improvement due to pesticide stockpiles.

- Decision No. 1206/QĐ-TTg of the Prime Minister on 2 September 2012 issued the national target programme on pollution mitigation and environmental improvement for the period 2012-2015. This is the first national target programme of the environmental sector and the implementation of this programme holds a critical significance for the treatment of POPs in particular and contaminated stockpiles in general, contributing to the implementation of Vietnam's commitments to the Stockholm Convention.

- Decision No 58/2008 /Q-ĐTTg of the Prime Minister on 29 April 2008 on targeted funding support of the state budget to comprehensively clean up and mitigate the pollution as well as to minimize the environmental degradation for several entities of the public sector; Decision 38/2011/QĐ-TTg dated 5 July 2011 by the Prime Minister amended and supplemented some articles of Decision No 58/2008/QĐ-TTg;

- Circular No. 43/2013/TT-BTNMT on 25 December 2013 of MONRE prescribing national clean-up standards for land contaminated by pesticides, with values differentiated on the basis of land use.

- Circular No. 33/2011/TT-BTNMT on 1 August 2011 of MONRE regulated technical procedures of soil environment monitoring;

Additionally, MONRE has issued several technical guidelines on the management of environmental pollution caused by POP pesticide stockpiles. Notably, there are three technical guidelines on the five-stage environmental pollution management of a contaminated areas, including preliminary investigation and assessments; insight investigation and assessment; planning for clean-up, rehabilitation and restoration of the environment; management and treatment of the contaminated area; and monitoring and taking care after pollution treatment.

MONRE has also cooperated with the Ministry of Science and Technology and relevant ministries and agencies to issue many standards and environmental technical regulations on waste water, emissions and soil, among which there are regulations on the total organic chlorine to control POP contamination. However, these standards and regulations are still insufficient, as they do not cover all the POPs as well as environmental components. Therefore, they need to be continuously reviewed and supplemented in order to meet the requirements of the Stockholm Convention on POP control.

Currently MARD is in charge of, in collaboration with MONRE, developing a joint circular on collection, transportation and disposal of pesticide packaging after use.

Being part of the Stockholm Convention has created an opportunity for awareness raising, knowledge expansion, technical and legal capacity enhancement, and national and international support for resource mobilization to develop and implement policies on management and remediation of residual POP pesticides and chemically contaminated areas. After 10 years of implementing the Stockholm Convention, the legal and policy framework on the management of POP pesticides and residual pollutants

has been gradually strengthened and improved. The implementation of these policies has significantly contributed to the thorough treatment of tens of thousands of tons of residual chemicals, limiting the pollution emissions and improving the environment of contaminated sites all over the country.

b) Development of legal and policy framework for PCB management

Vietnam was aware of hazards caused by PCB emissions to the environment and human health very early, thanks to scientific research of various research groups, including Prof. Pham Hung Viet and Prof. Nguyen Duc Hue from the Department of Chemistry, University of Hanoi (now Vietnam National University) since 1996. These studies, in collaboration with the United Nations University, have detected PCB in some samples of transformer oils and transformer substation areas in Vietnam.

Regarding policies, in 1998 the Prime Minister issued Directive 29/1998/CT-TTg on strengthening the management of the use of pesticides and POPs, which stipulates: "Prohibit the release of PCB containing oils and products into the environment, restrict and eventually prohibit the use of industrial PCB containing products. Strict controls are required to ensure that the release and transport of PCB containing products are pursuant to environmental clean-up and hazardous waste management regulations."

In 2006, in order to perform its obligations to the Stockholm Convention, Vietnam issued Decision No. 184 in which it committed to stop using PCB containing equipment in 2020 and to eventually destroy PCB containing material, equipment and waste in 2028. However, as policies and regulations on PCB management are vague and the policy enforcement capacity was limited, there were problems remaining in the management of PCBs during that period.

In later years, in order to enhance the safety management for PCBs and PCB containing equipment, materials and waste, many specific regulations, directly concerning PCBs have been developed and enacted. This includes the national technical regulations on the environment, including QCVN 07:2009/BTNMT on hazardous waste thresholds in which PCBs are classified as substances containing extremely hazardous components with a defined threshold of 5 ppm; QCVN 40:2011/BTNMT on industrial wastewater prescribes that the value for industrial wastewater of category A (released into other sources) is 0.003mg/l and 0.01mg/l; QCVN 41:2011/BTNMT on co-processing of hazardous waste in cement kilns limits the concentration of PCB in hazardous waste before loading into the cement co-processing at 500 ppm; regulations on PCB concentrations are also specified in QCVN 43:2012/BTNMT on sediment quality and in QCVN 56:2013/BTNMT on waste oil recycling. National standards on analysis procedures of PCBs in samples of different environmental components are also being developed.

Being aware of environmental pollution risks from PCBs in transformer oil and other electrical appliances, Vietnam Electricity the largest owner in Vietnam of electricity equipment also took initiatives to enact internal regulations and guiding documents for its members to strictly control the import of transformer oils as well as to check the PCB concentration of equipment before dismantling or disposal.

In 2014, the VEA issued a series of technical guidelines on the safety management of PCB containing materials and equipment in order to guide and support the implementation of PCB management throughout the country. These technical guidelines comprehensively and specifically addressed the PCB safety management for different subjects, i.e. from authorities to organizations or individuals that own PCB containing materials, equipment and waste. This includes guidelines on identification, management, repair, cleaning and loading of PCB containing equipment; guidelines to define and identify oils, equipment, materials and waste that contain PCBs; instructions for registration of PCB containing oils, equipment, materials and waste; instructions for packaging and labelling oils, equipment, materials and waste that contain PCBs; instructions for storing PCB containing oils, equipment, materials and waste; guidelines on transportation of oils, equipment, materials and waste that contain PCBs; guidelines on decontamination and treatment of PCB containing oils, equipment, materials and waste; guidelines on PCB inspection and examination; guidelines on developing the incident prevention and emergency response plan for facilities; and technical guidelines for prevention and response to PCB-related incidents.

MONRE is also considering the enactment of a Circular on management of PCBs and PCB-containing equipment, materials and waste with the general approach of managing PCBs according to the product life cycle. Some of the technical regulations relating to the management and treatment of PCBs continue to be supplemented. Besides, the Ministry of Industry and Trade is responsible for the development of the national plan on PCB management in order to ensure the safety management of PCBs in the future.

Hence, the policy and legal framework on PCB management has been gradually reviewed and enhanced to be more comprehensive, ensuring the safety management and treatment of PCB-containing materials, equipment and waste, protecting the environment and public health, and thereby fulfilling the commitment of the Government to the Stockholm Convention.

c) Development of policy and legal framework to control unintentionally produced and emitted POPs (Dioxin/Furan)

One of the POP groups that the Stockholm Convention required to be strictly controlled is unintentionally produced POPs (often referred to as U-POPs) derived from thermal processes or by-products and intermediate products of the production process of some certain types of chemicals and materials. These are also highly hazardous chemicals, such as Dioxin/Furan from waste incinerators, and their emission could cause significant unintended consequences. However, in Vietnam the awareness of hazards related to U-POPs is limited and is only acknowledged in several research groups specialized in environmental toxicology and monitoring.

After Vietnam participated in the implementation of the Stockholm Convention, many activities for conducting an inventory and monitoring and evaluation of U-POPs emissions from various sources have been carried out. The evaluation results of U-POPs emissions has been widely promulgated, resulting in changes in awareness of many groups, including environmental managers, organizations and individuals relating to emission sources such as steel, cement producers and waste treatment companies.

Based on that, a number of policies and regulations on emission control were issued including:

- QCVN 02:2008/MONRE - National Technical Regulations on emissions of medical solid waste incinerators, in which the total Dioxin/Furan emission threshold is regulated at 2.3 ng - TEQ/Nm^3;

- QCVN 30:2010/MONRE - National Technical Regulations on emissions of industrial waste incinerators, which regulates the total Dioxin/Furan emission threshold at 0.6 ng - TEQ/Nm^3;

- QCVN 41:2011/MONRE - National Technical Regulations on co-processing of hazardous waste in cement kilns, in which the maximum allowed level of total Dioxin/Furan emissions is 0.6 ng - TEQ/Nm^3;

- QCVN 45:2013/MONRE - National Technical Regulations on the permissible limits of dioxin in some soils, which stipulates the maximum allowed concentrations of dioxin in some soils.

- QCVN 51:2013/MONRE - National Technical Regulations on industrial emissions of steel production, which regulates the maximum permissible emission level of old steel incinerators is 0.6 ng - TEQ/Nm^3 and of new incinerators 0.1 ng - TEQ/Nm^3.

Steering Committee 33 of MONRE is also developing a number of environmental technical regulations on emissions from other industrial sources.

Recently, regulations and guidelines on the environmental monitoring of emissions from heating sources (e.g. incinerators of industrial, municipal and medical waste, steel or cement producing plants, boilers etc.) also pay more attention to the U-POPs (Dioxin/Furan) emissions criteria. VEA has developed a number of technical guidelines on U-POP emission control, including:

- Guidelines on the inventory, monitoring and supervision of POPs for sectors and localities;

- Instructions for the application of best available environmental methods and techniques to limit the unintentionally produced POPs from waste incinerators;

- Technical guidelines on the inventory and environmental risk assessment of some unintentionally produced POP emissions from industrial processes (applied for newly added U-POPs);

- Four technical guidelines on the application of best available techniques and best environmental practices (BAT/BEP) in four types of industrial activities, including waste incinerators, steel production, co-processing of waste in cement kilns and paper production;

- Developing methods to assess the cost-benefits of applying BAT/BEP to reduce U-POPs at the enterprise and sector level.

In addition, the Ministry of Health and Ministry of Labour, Invalids and Social Affairs

issued the Joint Circular No. 40/2011/TTLT BLĐTBXH-BYT on 28 December 2011. The joint circular defines hazardous working conditions and harmful jobs that are not allowed to employ female workers, women workers who are pregnant or who are raising children under 12 months. It also contained safety regulations on cases where a person is in contact with substances capable of causing cancer and some POPs like organic chlorine pesticides and Dioxin.

Thus, the new regulations and technical guidelines on the control of unintentionally produced Dioxin/Furan have contributed to awareness changes and operational adjustments of many relevant organizations and individuals, creating an important initial platform to control the contamination of Dioxin/Furan and other U-POPs. Together with the strengthening of technical capacity to monitor U-POP pollution, Dioxin/Furan contamination control activities are gradually updated in line with international trends and standards, contributing to public health protection as well as to sustainable development in Vietnam.

d) Development of the policy and legal framework on management of environmental contamination caused Agent Orange/Dioxin used by the American Army during the war in Vietnam

Pollution caused by Agent Orange/Dioxin in Vietnam is a problem rooted in the past, but which still has severe consequences for the environment and human health in Vietnam today. In order to mitigate the harmful impacts of Agent Orange/Dioxin in Vietnam, in 1999 the Government established Steering Committee 33, with standing office in MONRE. The function of Committee 33 is to advise the Prime Minister on direct remedial activities related to the consequences of toxic chemicals/Dioxin used by the American Army during the war in Vietnam.

The Government has developed and issued many policies to remediate the consequences of Agent Orange/Dioxin such as Decree No. 32/2007/NĐ-CP on 2 March 2007, which regulates the preferential treatment (subsidies and allowances) for people who have provided meritorious services, including those who were infected with toxic chemicals (Dioxin) in the war and their next of kin; Decision No 67/2004/QD-TTg on 27 April 2004 by the Prime Minister on the action plan phase 2004-2010 to remediate the consequences of toxic chemicals used by the American Army during the war in Vietnam; Decision No 09/2008/QD-BYT on 20 February 2008 of the Ministry of Health, which issued a list of diseases and disabilities, malformations and deformities related to exposure to toxic chemicals/Dioxin; and Decision No. 651/QD-TTg on 1 June 2012 of the Prime Minister, which approved the National Action Plan to overcome fundamental consequences of toxic chemicals used by the US in the Vietnam. This decision includes specific provisions on the treatment and control of emissions in Agent Orange/Dioxin contaminated hot spots.

During the period 2009-2013, the Office of Steering Committee 33 has taken the main responsibility to develop and submit for enactment three legal documents related to the management of Dioxin contamination in Vietnam, namely:

- TCVN 8183:2009 on Dioxin thresholds in soil and sediment, which regulates the

Dioxin threshold at 80 ng TEQ/kg by dry weight.

- QCVN 45:2012/BTNMT, national technical regulations on the permissible limits of dioxin concentration in several kinds of soils.

- TCVN 9737:2013 on limits of Dioxin in wastewater and emissions from processing of contamination caused by residual Dioxin, which regulates the Dioxin concentration threshold of emissions at 0.1 ng I-TEQ/Nm^3 and of wastewater at 10 pg I-TEQ.

On 8 June 2007, Committee 33 issued Directive No. 2174/BCĐ 33-VP on guidelines for developing the annual plan for 2008-2010 for consolidating the consequences of toxic chemicals. Currently, the Committee is chairing the implementation of some activities and scientific research to establish methodologies and regulations on environmental management and remediation in contaminated areas, while taking into account the purpose of land use.

Hence, activities under the implementation framework of the Stockholm Convention contributed to the formation of new policies and regulations on environmental management in Agent Orange/Dioxin-contaminated areas.

e) Developing policies and legislation on the management of new POPs

Currently, a number of new POPs are still being used in many production, trading and service sectors, posing a higher risk to the environment and human health as exposure to these chemicals is more frequent than to the old POPs. The safe management of new POPs remains a major challenge, not only for Vietnam but also for many other countries around the world.

Vietnam does not have any legal document directly related to management of new POPs in industrial sectors or for daily humam activities. However, Vietnam has several legal documents or guidelines that generally or indirectly include the management of new POPs, for example:

- In the 2007 Chemicals Law and some guiding decrees, several new POPs were included into the list of chemicals that are imported in limited quantity and traded conditionally, such as Hexaclobenzen and PCB.

- The Ministry of Industry and Trade developed and issued Circular No. 30/2011/TT-BCT on 10 August 2011 on the provisional regulation on permissible concentration limits of certain hazardous chemicals in electric and electrical products, which specifies that the threshold for PBBs and PBDEs is 0.1% of the weight.

As Vietnam has no direct, specific and feasible regulations to manage new POPs in the industry sector and daily humam activities, the inventory, risk assessment and safety management for these substances, therefore, is facing many difficulties.

Under the implementation framework of the project "Improving mechanisms, policies and regulations on the management of persistent organic pollutants", MONRE has developed, in collaboration with relevant agencies, organizations and individuals, new regulations on sound environmental management of hazardous industrial chemicals,

including new POPs. In order to gradually implement the controlling activities of these substances, in 2013 the VEA also developed and issued a number of relevant technical guidelines such as:

- Technical guidelines on emissions inventory and environmental protection of industrial processes using POPs;

- Technical guidelines on monitoring and evaluation of pollution and environmental risks and of some POPs stockpiles used in agriculture; and

- Technical guidelines on inventory, safety management and risk control of Perfluorooctane sulfonic acid, salts and Perfluorooctane sulfonyl fluoride (PFOS).

Furthermore, several regulations and activities on safety management and treatment of waste have also had a positive indirect impact on the mitigation of risks and hazards caused by new POPs. Examples of these regulations include programmes on electrical waste management, plastic recycling control and import waste control.

Thus, being aware of the risk to the environment and human health caused by POPs in particular and by hazardous chemicals in general, Vietnam authorities have developed and issued a number of policies, legislation and technical guidelines for safe management of POPs. The development of policies and regulations on this issue continue to receive attention and direction from many relevant authorities, organizations, individuals and the public. It is obvious that due to the participation in the Stockholm Convention and international technical and financial support, the development of a policy and legal framework on POP safety management in particular, and chemical contamination control in general, has become more visionary, comprehensive, effective and specific.

Along with the development and enactment of policies and legislation of government agencies, other organizations and individuals are also implementing many relevant projects and assignments, such as judicial reform activities (by for example the European Commission or the Asian Development Bank) related to the treatment of the consequences of pollution. These projects and activities have contributed significantly to policy development, supporting the practical implementation, enhancing law dissemination and training, and raising awareness. As a result, they helped to implement more effectively the goals of the Stockholm Convention.

II.2.3. Strengthening institutional management of POPs

a) Establishing a new organization with functions and duties related to safety management of POPs

In recent years, to meet the actual needs of environmental protection in general and managing toxic chemicals in particular MONRE has submitted to the Government for approval the establishment of several new units and has restructured the functions and responsibilities of VEA. Decision No. 25/2014/QĐ-TTg on 25 March 2014 regulates the functions, tasks, authority and organizational structure of the VEA, replacing Decision No 132/2008/QĐ-TTg of the Prime Minister on 30 September 2008.

The enactment of Decision No. 25/2014/QĐ-TTg is important for the effective implementation of Resolution No. 41-NQ/TW on 15 November 2004 of the Politburo on environmental protection in the period of accelerated industrialization and modernization and of Resolution No. 35/NQ-CP on 18 March 2013 on several pressing issues in environmental protection. Decision No 25/2014/QĐ-TTg also supplemented and clarified the function of "organizing the execution of environmental legislation in the country" to ensure its conformity with the provisions of Decree No. 36/2012/NĐ-CP, which defined the functions, tasks, authority and organizational structures of ministries and ministerial-level agencies, as well as Decree No. 21/2013/ND-CP that regulates the functions, tasks, authority and organizational structure of MONRE.

Regarding the control of chemical pollution in general and the safety management of POPs in particular, Decision No 25/2014/QĐ-TTg supplemented and clarified the mission of "Treatment and disposal of residual chemicals, waste and chemical containers" to comply with Clause 2, Article 25 and Article 64 of the 2007 Chemicals Law; supplemented regulations on environmental health; and clearly defined the function of VEA as the national focal agency for implementation of the Stockholm Convention on POPs, in accordance with the Government's commitment to the Stockholm Convention

Being aware of the importance of controlling chemical emissions, VEA has established the Division of Chemical Control and Environmental Incident Remediation, directly under the Pollution Control Department. This unit has the function of advising and assisting the director of the Pollution Control Department to perform the state management tasks of chemical emissions control, environmental incident prevention, response and remediation as stated in laws, and environmental health management at the national scale. It is also the standing unit for national and international communication and advises managers at all levels to coordinate the implementation of the Stockholm Convention in Vietnam.

b) Developing and strengthening the inter-sectoral coordination mechanism

Based on consensus among ministries and sectors, the Government issued Official Letter No. 1336/VPCP-KG on 23 March 2004, which assigned MONRE as the national focal agency that takes the lead and coordinates with relevant ministries, sectors and localities to implement the Stockholm Convention in Vietnam. Next, in Official Letter No. 7009/VPCP-KG on 24 December 2004, the Prime Minister approved the establishment of the National Steering Committee of the Stockholm Convention implementation in Vietnam. On 2 August 2005, the Minister of Natural Resources and the Environment issued Decision No. 1883/QĐ-BTNMT on the establishment of the National Steering Committee for the Stockholm Convention implementation. This decision also assigned the Deputy Minister of MONRE to be the chairman of the Steering Committee and persons from relevant ministries and sectors to be its members.

In Decision No. 184 the Prime Minister also defined clearly the tasks and coordination mechanisms between government agencies by different issues and by POP groups, in accordance with functions and responsibilities of each agency.

In recent years, the leading and active role of MONRE in assisting the Government to manage POP related activities has been clearly observed. Agencies under MONRE, especially the VEA, have taken the lead and collaborated with other relevant agencies, organizations and individuals to carry out multiple activities of POP management, such as developing and implementing legislation documents, technical capacity enhancement, raising awareness, supporting infrastructure development for POP pollution treatment, monitoring POP contamination, promoting the examination and development of a network of laboratories for the control of POPs and other hazardous chemicals, and issuing technical guidelines as well as training for their implementation.

Many other ministries also took the initiative and coordinated with MONRE to carry out tasks according to their assigned responsibilities such as management of PCBs (MOIT, EVN); management of POPs in medical waste (the Ministry of Health; management and mitigation of consequences caused by residual pesticides in the environment (MARD); performing activities related to the treatment of Agent Orange contamination in hot spots (Ministry of Defence); management and control of the import of products containing POPs or toxic chemicals (Ministry of Finance and the General Department of Customs); performing activities related to the mobilization and management of international funds (Ministry of Planning and Investment); approval and implementation of research projects on the application of advanced technologies in the management and treatment of POP pollution and jointly issuing several Vietnamese standards and technical regulations related to POPs (Ministry of Science and Technology).

The wide implementation of POP management activities at the national level has supported and promoted the coordination activities between central agencies and local authorities. Typical activities include conducting an inventory, assessment and treatment of residual chemically contaminated areas, inventory and management of PCBs and control of Dioxin/Furan emissions from incinerators.

However, several shortcomings exist in the inter-sectoral coordination, such as the overlapping of responsibilities between management agencies in environmental management related to chemicals and chemical safety control, including POPs used in different sectors. There is also a need to strengthen the coordination mechanisms between central and local authorities as well as between local authorities in the implementation of environmental management activities for POPs and hazardous chemicals. An orientation for the development of inter-sectoral and joint regulations on environmental protection against industrial chemicals, pesticides, veterinary drugs and medical waste management has been identified and is gradually being implemented. These are issues that relevant ministries and sectors will continue to resolve in the near future.

c) Training and enhancing the management capacity on POPs

Along with the development of policies, legislation and technical guidelines on POP management, many training activities and dissemination of relevant policies and information have also been conducted.

Figure II. 5: Inter-sectoral training for staff from environment, customs and environmental police departments

During the Stockholm Convention implementation process, capacity strengthening is considered an important activity to provide information, knowledge and connect stakeholders, as well as to involve communities in the safe management of POPs. This also supports the implementation of Decision No. 184 of the Government. As POPs are considered as typical hazardous chemicals, capacity strengthening on POP management will also help to improve the capacity for environmental management and waste management.

With support from projects such as the project GEF/WB - PCBs and the project GEF/UNDP - POP pesticides, VEA has organized training sessions for thousands of staff from departments of natural resources and environment, provincial environmental protection agencies, departments of industry and trade, police departments of fire fighting and prevention, general customs departments, provincial customs departments, customs agencies and market managers. Many companies, research institutes and individuals also attended the seminars and training programmes. The content and information in these workshops and training courses was related to the management practices of POPs and contributed to enhancing knowledge about environmental management in general. The training content has focused on:

- Transfer of technical knowledge and best and most suitable methods for POP management in the context of Vietnam, including defining, reviewing, sampling, analysing, waste processing, residual pollution remediation and risk management of POPs.

- Training on import/export control of POP-containing materials, aiming at raising awareness and enhancing capacity of customs officials to identify and prevent the entering of chemicals, materials, equipment or waste containing PCBs in Vietnam, as well as to prevent the export of these products to other countries that do not follow the

relevant regulations.

- Training on the prevention of and response to PCB related environmental incidents, focusing on capacity strengthening for staff from VEA, departments of natural resources and environment, provincial environmental protection agencies, police department fighting environmental crimes, police departments of fire fighting and prevention and several power companies, in order to prepare for and respond to PCB accidents or spills. The training activities also included information exchange and analysis of some specific topics and actual situations on the management of the use of hazardous chemical use and on the management of hazardous waste.

- Training on policies and regulations on POP management for staff from provincial departments of natural resources and environment, trade and industry, labour, invalids and social affairs, and customs, as well as EVN and other emission source owners.

The training materials, presentations and newsletters on POP management, as well as relevant project activities, are also publicly available and updated on the POP portal and individual websites of each project.

The general assessment of training activities and capacity enhancement for stakeholders showed clearly that thanks to significant resources invested by the state budget and international projects, training helped improve the qualifications of involved staff and contributed actively to the formulation and implementation of policies and regulations on safe management of POPs and environmental protection.

II.2.4. Strengthening the capacity for POP monitoring

II.2.4.1. Overview of monitoring POP contamination

Vietnam has officially been part of the Stockholm Convention since 2002. However, research and investigation on POP contamination in the environment at liminted areas has been carried out since the early 1990s. Major POP monitoring programmes in the early 1990s included assessments of Dioxin contamination in soil and sludge in Agent Orange/Dioxin contaminated areas (Committee 10-80 in cooperation with international researchers), monitoring programmes for organochlorine pesticides (POP pesticides) in biological samples, sludge and water at Ba Lat estuary (Hai Phong Institute of Oceanography and Nuclear Research Institute) and a monitoring programme for POP pesticides in water and sediment in urban areas (Chemistry Faculty, Hanoi University of Science). In general, monitoring activities during this period were fragmented, non-systematic and lacked quality control procedures (with the exception of cooperation studies in which analysis was performed in developed countries such as Japan and Canada).

International and national research shows that it is very important to achieve accurate and systematic monitoring data on POPs as well as other toxic chemicals for environmental protection, health care and socio-economic development. Monitoring of POPs in the environment is a skilled activity because POPs are widely distributed in almost all environmental components, bio-accumulate in a diverse way in food chains and have extremely low concentration (concentration is calculated in parts per million or

billion).

The purpose of POP monitoring activities is to achieve information on their levels in the environment, their accumulation in animals, food chains and ultimately in people who may be exposed to POPs due to their specific living habits. Based on this data management measures can be proposed, including:

- Contamination control and compliance assurance of technical standards and regulations in the environment;

- Assessment of contamination impacts on people and the environment; identify causes and relationship to contamination concentrations and impacts; research on possible links contamination and epidemiological data;

- Achievement of systematic data by conducting basic surveys (or regular measurements) on environmental quality and setting up a database for future use;

- Assurance of safety in using natural resources (air, water, soil, etc.) for economic purposes;

- Proposal for solutions in the case of high pollution levels.

To achieve these purposes, it is necessary to build up a systematic monitoring programme with reliable data. Over the past decades, VEA, together with functional organizations and individuals, has gradually improved the POP monitoring capacity and implemented these activities according to new principles, procedures and standards to obtain more comprehensive and reliable data on POP contamination.

POP monitoring activities in Vietnam have improved in terms of both data quality and monitoring scale since the early 2000s. Some national tasks, projects and studies supported by developed countries and international organizations have been conducted to support POP monitoring activities in Vietnam. However, these studies and monitoring programmes still lack continuity and connectivity. This has caused a data gap on POP emissions and discharges, as well as their occurrence and residue in the environment.

Nevertheless, some important data has been obtained in the POP monitoring programme in different environmental components.

a) POP monitoring in air, water, sediment and soil

Since the 1990s, studies on POPs in water and sediment in the north, middle and south of Vietnam have showed significantly higher DDT levels than those of other POPs. DDT, HCH and CHL have been detected at high levels in some areas in the delta areas of the Red River and the Duong River. Additionally, DDT was also detected in waste water collected in highly populated areas such as canals in Tu Liem district, Hanoi and Thi Nghe River, Ho Chi Minh City. Although analytical methods and sampling sites in the studies were different, the results showed two possibilities of DDT existence: the use of DDT had been prolonged in the north and south of Vietnam, and disposal of DDT in the past was done inadequately and thus DDT has leaked into the environment.

Some studies that analysed soil samples from the north and south of Vietnam revealed relatively high concentrations of PCBs at specific sites in Tay Ninh province, southern Vietnam, and the site of a former United States military base [9]. A study on PCB contamination conducted by the Chemistry Faculty, Hanoi University of Science, also detected PCB contamination in soil near transformer stations in Hanoi. Currently, a study on soil samples conducted in dumping sites in Hanoi and Ho Chi Minh City has shown that residue of DDT and PCB in these sites was higher than those in rice fields far from the dumping sites [10]. Residue of PCBs and POP pesticides detected at these sites may originate from the disposal of waste-containing residue of these compounds. In addition, PCB contamination has been observed in Vietnam since the 1990s because of disposal and replacement of old electric equipment imported from other countries such as the United States, France, the former Soviet Union and Eastern European countries.

During 2008-2012, in the framework of an environmental survey and assessment of POP pesticides contamination, VEA cooperated with international organizations for sampling and analysis of water and soil samples from various sites throughout the country. The results revealed nearly one thousand POP pesticides contaminated sites. Some of those sites were highly contaminated by DDT and 666 had levels up to hundreds of ppm in soil due to the inadequate disposal of such chemicals in the past.

Figure II.6: Training in ground water sampling for DDT analysis (Project GEF/UNDP - POP pesticides, 2014)

For POP monitoring in air, during 2009-2012 VEA, with support from the Ministry of Environment of Japan, implemented POP monitoring activities for ambient air in Tam Dao to monitor the concentration variation of some POPs in Vietnam and Southeast Asia. This was the first monitoring activity in Vietnam and Southeast Asia with a high sampling frequency to obtain consistent and continuous data. However, because of

the limit in budgets, this activity has been halted since 2013. Figure II.7 shows the concentration of some POPs in ambient air during 2009-2010. It can be seen that concentrations of HCBs in ambient air were highest, followed by DDTs and Chlordane [11]. In comparison with some studies conducted in Tam Dao during 2005-2007, concentration of DDTs in air slightly declined (82.40 pg/m^3 in 2005, 64.97 pg/m^3 in 2006, 22.7 pg/m^3 in 2010). Meanwhile the variation of HCB concentration in this period was not clear [11].

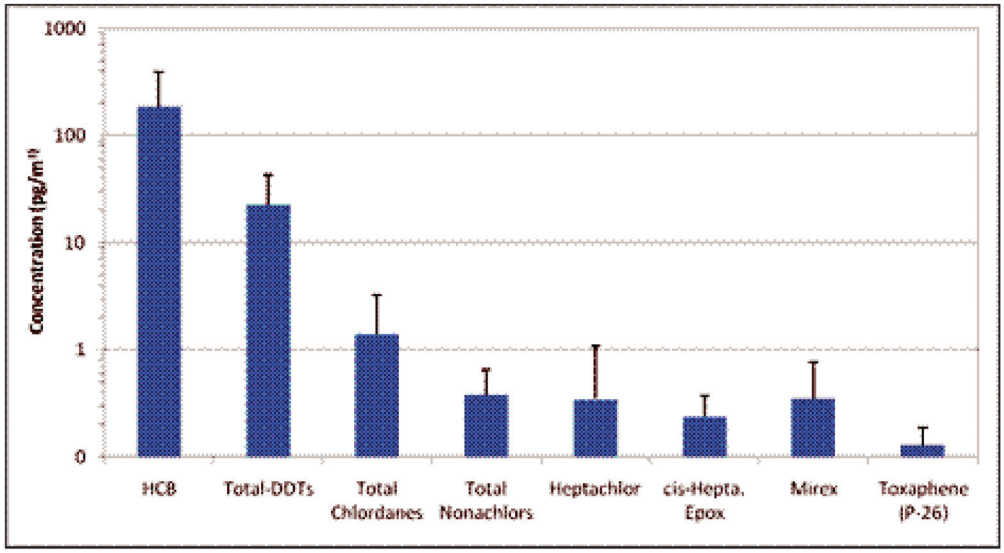

Figure II.7: Mean concentration of some POPs in ambient air in Tam Dao during 12 months (2009-2010)

For monitoring POP emissions from industries, VEA implemented an assessment for Dioxin/Furan emission from steel production and metallurgy activities in 2012 [12]. Results showed that concentrations of Dioxin were in the range from 0.033-0.837 ng TEQ/Nm^3. This was the first time such data was officially published in international journals and it has contributed to an estimation of the emission factor for Dioxin/Furan from industrial activities.

b) Monitoring the accumulation of POPs in animals

It is difficult to collect and analyse POPs in water samples because of their extremely low levels. Therefore, bivalves such as green mussels can be used as natural bioindicators for POP contamination in water. This approach has been implemented by a research group in Ehime University for many countries, including Vietnam. Green mussels collected in coastal areas in the north and middle of Vietnam had high concentration of DDT [13]. The concentration of DDT, HCH and PCB was relatively high in coastal areas near the Chinese border and decreased towards the southern coastline. The average concentration of PeCB and PBDEs (including tetra, penta, hexa and hepta-BDE), measured in ng/g in fish samples which collected at three study sites

is shown in Figure II.8. The PeCB was detected in fish samples taken at three study sites but the PeCB concentration is low (0.13 to 0.25 ng/g). Total concentration of PBDEs in fish samples taken in Phu Luu electronic waste recycling village is the highest (1.46 ng/g), followed by Nam Son landfill (0.99 ng/g) and Dong Anh automotive bus landfill (0.48 ng/g).

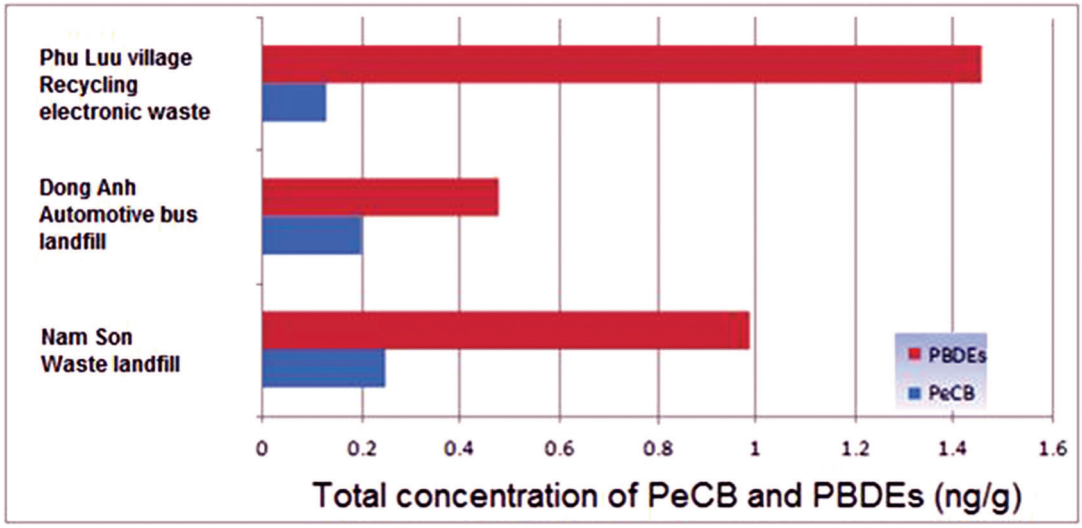

Figure II.8: Total concentration of PeCB and PBDEs in fish

The analysis of PBDEs in Pangasius hypophthalmus collected in Can Tho province [14] showed that the total concentration of PBDEs varied in the range of 0.12-3.7 ng/g lipid. Concentration of PBDEs were lower than those of DDTs in this sample (10-700 ng/g lipid).

c) Monitoring POP exposure in humans

Data on the status and occurrence of POP exposure in residential communities is limited. An early study published in 1989 [15] showed high concentration of DDT and HCH in breast milk samples collected in some areas in Ho Chi Minh City. Concentration of DDTs were higher than those of HCHs in both urban and rural areas, ranging from 10,500 to 12,000 ng/g lipid. However, concentrations of PCBs in these areas were relatively low in comparison with other countries.

Another comprehensive study conducted in 2001 in Hanoi and Ho Chi Minh City provided extensive data on POP exposure in humans [16]. Breast milk samples were collected from 96 nursing women living near dumping sites of solid waste in Hanoi and Ho Chi Minh City and analysed to determine concentration of PCBs, DDTs, HCHs, HCBs and CHLs. In general, concentration of these contaminants were similar in Hanoi and Ho Chi Minh City. Concentration of DDTs were highest, ranging from 1,500 to 2,300 ng/g lipid. Noticeably, concentration of HCHs in breast milk from Hanoi were

considerably higher than those in Ho Chi Minh City, implying that the HCHs accumulation in the north was higher than in the south. Perhaps the reason is that northern areas were affected more from sources of HCHs emitted in Asia and other countries. Additionally, the lower temperature in the north has raised the accumulation of HCHs in this region in comparison to the south.

Figure II.9: Training in PCB analysis

Studies on dioxin exposure in humans has focused mainly on hot spots of AO/Dioxin contamination, such as areas surrounding Bien Hoa, Da Nang and Phu Cat airbases. These studies focused on the contamination status and variation of dioxin in breast milk of nursing women in vicinity of the hot spots. The studies showed that concentration of dioxin in breast milk from women living in the area for a long time were 10-20 times higher than those from women living far from contaminated sites. An estimate of the daily dioxin intake for new-born babies through breast feeding showed that the daily intake levels exceeded the value recommended by the World Health Organization [17, 18].

d) Monitoring dioxin contamination in Vietnam

It is known that south Vietnam was seriously affected by Agent Orange/Dioxin (AO/Dioxin) used by the United States army during the war. Various studies on an assessment of Dioxin residues in the environment and people have been conducted in recent years, especially those dealing with dioxin in AO hot spots and their vicinity. In general, research shows that 2,3,7,8-TCDD is the most predominant congener in Dioxin originating from Agent Orange.

The assessment for residue levels and the contamination extent of dioxin in the environment in south Vietnam is focused on two areas: those that were sprayed by defoliants throughout the south (as large as 2.63 million hectares) and those that were used as military facilities for the defoliant spraying missions by aircrafts (military airbases and chemical warehouses).

To date, dioxin levels in soil, sediment, blood, breast milk, adipose tissue and foodstuff collected in sprayed areas are within an acceptable range, with the exception of watershed sites which are suspected to be reservoirs of the contaminants because of rainfall and flooding. Most studies report that dioxin concentrations in sludge and soil range from 10 to 100 ppt TEQ.

Four former US military airbases have high dioxin levels, and these are Bien Hoa, Da Nang, Phu Cat and A Luoi airbases. The AO/Dioxin contamination in these areas is complicated and different in scale. At Bien Hoa airbase contaminated sites spread across a large area in the north and southwest of the airbase. Of those, there are five sites with dioxin concentration above 1000 ppt TEQ, exceeding the national regulation for soil remediation. The total volume of the contaminated soil is up to 250,000 m^3. Currently, the Ministry of Defence has isolated the most contaminated sites of about 40,000 m^2 using secured landfill.

At Da Nang airbase there are three sites with dioxin concentration in soil samples exceeding the national threshold for necessary remediation. These sites are located at the north of the airbase with an area of about 88,000 m^2. The remediation activities for contaminated soil is ongoing because the sites are in Da Nang City and near residential communities.

At Phu Cat airbase the volume of contaminated soil is about 4000 m^2 and distributed in only one site. Currently, the contaminated soil in this airbase has been isolated to avoid spreading into the environment.

At A Luoi dioxin contamination is scattered and the levels are much lower than those in the other airbases. Most soil samples have dioxin concentrations ranging from 2 to 600 ppt TEQ and distributed in large areas. It is therefore not necessary to clean up the contaminated soil (concentration is below 1,000 ppt). However, because of the rapid growth in population, local communities are moving closer to the contaminated sites. It is therefore necessary to implement activities for environmental monitoring, localizing and remediating the contamination to ensure a suitable living environment for permanent habitat.

In addition to AO/Dioxin sources, industrial activities also contribute to Dioxin emission. Results of the GEF/UNIDO project for BAT/BEP application show that waste incineration, metallurgy and cement production account for the highest amount of dioxin generated. Recent research conducted in a Dioxin laboratory showed that concentrations of dioxin in stack gas collected in a steel production plant was in the range of 0.048-0.1666 ng TEQ/m^3 and those from a cement production plant in the range of 0.033-0.837 ng TEQ/m^3. This concentration range was similar to the results reported in Taiwan, Korea, Germany and Canada [12]. Moreover, current reports on the status of dioxin contamination in Vietnam confirm that waste incinerators are one of the main emission sources of Dioxin/Furan into the environment. It is therefore necessary to have strict management measures in future.

II.2.4.2. Proficiency test and assessment of laboratories

In order to reinforce the POP monitoring capacity of laboratories in Vietnam, activities for analytical training, assessment guiding and determination of laboratory capacities have been conducted. Among these, proficiency test, interlaboratory comparison and cross-check analysis is of particular importance.

In recent years, by participating in national and international projects, research institutes and laboratories in Vietnam have been equipped with modern instruments and improved their capacity in POP analysis, so proficiency testing and interlaboratory comparison are of more concern.

In 2009, in the framework of the project for strengthening the capacity of laboratories in POP analysis funded by GEF/UNEP, four organizations in Vietnam participated in the proficiency test organized by UNEP, including the Dioxin Laboratory, the Vietnam-Russia Tropical Centre, CETASD and the Institute of Marine Environment and Resources, Da Nang. Two of these laboratories participated in Dioxin/furan analysis and the others participated in analysing indicator PCBs in several samples (standard solution, sediment, fish and ash).

In 2012, UNEP organized the second proficiency test programme at a larger scale and added new POPs such as PBDE and PFOS. In this programme, the Dioxin Laboratory took part in PCDD/F and dl-PCB analysis in all samples provided, including breast milk and stack gas extract. The performance evaluation report provided by UNEP showed that most analytical results obtained in the Dioxin Laboratory were highly accurate.

In the framework of a collaborative project between Vietnam and the Czech Republic to overcome the consequences of herbicides/Dioxins in Vietnam, ALS Laboratories conducted an interlaboratory comparison to assess and strengthen the capacity of PCDD/F analysis for some laboratories in Vietnam during April 2014. The Dioxin Laboratory was the only one to participate and obtained results in the acceptable range. Indeed, these programmes help to assure the capacity of the Dioxin Laboratory in POP analysis, especially samples with a complicated matrix such as stack gas and breast milk.

For PCB analysis, in the framework of the project on PCB management funded by SDC and Project GEF/WB – PCB, VEA in cooperation with national and international laboratories organized an interlaboratory comparison for 40 laboratories in Vietnam. This programme has provided training for over 100 staff in PCB analysis using gas chromatography. There are six laboratories with the capacity for the analysis of PCBs in oil, sediment and non-porous solid surfaces. They now can provide services in PCB analysis.

Because of the requirements for modern instruments, professional knowledge and expensive operation expenditure, POP monitoring activities in Vietnam are limited. The capacity and quality of POP analysis of laboratories in Vietnam has however gradually improved to meet the analytical requirements. National laboratories for POP analysis have participated in proficiency testing and interlaboratory comparison in this field and achieved good results. Some laboratories are capable of providing services in analysing or training in POPs analysis and monitoring.

II.2.4.3. National and international training to strengthen the capacity for analysis

To achieve reliable data in POP monitoring activities, in addition to strengthening modern equipment, monitoring agencies need professional personnel who are trained competently in all stages of the monitoring procedure.

During 1990-2000, two major institutes provided training for POP analysis in Vietnam, the Research Centre for Environmental Technology and Sustainable Development (Vietnam National University, Hanoi) and the Institute for Environment and Resources (Vietnam National University, Ho Chi Minh City). These were also supported by a project of the Swiss Government on strengthening the capacity in environmental science and technology in Vietnam. International collaboration activities in these organizations have contributed to enhancing human resources in POP monitoring in Vietnam. Additionally, two other centres for chromatography training in Ha Noi and Ho Chi Minh City have provided knowledge and skills for laboratory staff on using chromatographies in the analysis of POPs and other toxic compounds.

Since the 2000s, a number of projects and international collaborative programmes have provided international training programmes for laboratory staff on POP monitoring. Important projects that have focused on strengthening the capacity of POP monitoring include a project for the establishment of a dioxin laboratory under MONRE; a project for strengthening the capacity for Dioxin and dl-PCB analysis in food (Ministry of Agricultural and Rural Development); a project for strengthening the capacity of the Vietnam-Russia Tropical Centre (Ministry of Defence); a GEF/UNIDO project on BAT/BEP application; a project for strengthening the capacity of the Institute of Environmental Technology, Vietnam Academy of Science and Technology funded by the Japan International Cooperation Agency; a GEF/WB project - PCB; a project on strengthening the capacity in dioxin monitoring in hot spots funded by the Czech Republic; and a collaborative programme between Japanese and Vietnamese universities. Of these, the projects for the establishment of a dioxin laboratory and the GEF/UNIDO BAT/BEP application project have pioneered strengthening the capacity for analysis and monitoring of PCDD/Fs and PCBs emitted from industrial activities as well as new POPs such as PBDE and PFOS. The Research Centre for Environmental Technology and Sustainable Development (Vietnam National University, Hanoi), the Chemistry Faculty, University of Science, and the Dioxin Laboratory have also improved their capacity in the analysis of new POPs such as PBDE and PFOS. Furthermore, in the framework of national POP inventory activities for industrial and trade sectors, VEA, in cooperation with national laboratories, has organized several training courses on identification and analysis of POPs and POPs related products. .

In addition, quality assurance and testing centres which belong to the Ministry of Science and Technology have also increased their capacity to meet higher requirements for POP analysis.

These training activities have contributed to improving the capacity of POP monitoring in Vietnam. The number of organizations with capacity for monitoring of POP pesticides has increased rapidly, recently reaching about 80-90. Of those, two organizations are certified to meet the requirements of ISO 17025 for the analysis of dioxin

and dl-PCBs and some laboratories are capable of determining PBDE and PFOS. However, standardization for analytical procedures and quality control for POP analysis, especially for new POPs, will be a challenge.

II.2.4.4. Establishment of the monitoring network

In 2009 VEA organized the workshop "Establishment of national network of experts in POP monitoring and management" in the framework of the project SDC - PCB. This was an important activity to support laboratories and experts in POP analysis. About 30 laboratories in Vietnam participated and agreed to join in the network and approved the workshop report. However, without mandatory regulations, lack of administration and connectivity and without annual workshops, there are only a few laboratories continuing to exchange information. In 2012-2014 in the framework of the project GEF/WB – PCB, VEA organized a training course for technical staff from 40 laboratories on PCB analysis and promoted activities in the POP monitoring network.

In Vietnam's system of environmental management agencies, there is an environmental monitoring network that includes centres for environmental monitoring belonging to provincial departments of natural resources and environment. This network has closer connectivity and more detailed tasks in network management, quality investigation and procedures for data reporting. The leading agency of the network is the Centre for Environmental Monitoring, VEA. Recently, with nearly 120 staff and modern equipment systems suitable to environmental monitoring, analysis and instrumental calibration, this centre has become the largest monitoring centre in Vietnam and assures the connectivity of agencies in the network. However, personnel qualifications and instruments in the different centres vary, and the number of centres with capacity in POP analysis is limited. In addition, because of lack of regulations and mandatory monitoring programmes for POPs, objectives and objects for environmental monitoring in different centres vary and there is no consistent data on monitoring POPs and other toxicants.

II.2.4.5. Providing POP monitoring services

In the mid-1990s, less than 10 organizations could provide analytical services and monitoring of POPs in the group of organochlorine PPCs and PCBs. Since 2004 the number of providers has increased to 90, of which some laboratories are capable of analysing samples with a complicated matrix such as ambient air and stack gas to determine complicated compounds such as dioxin and dl-PCBs. Some laboratories are certified to meet the requirements of ISO 17025 in the analysis of some POPs and of article No. 127/2014/NĐ-CP, issued in December 2014, on the organization of environmental monitoring services. These regulations contribute to bringing environmental monitoring activities in general, and POP monitoring activities in particular, into a system to obtain a reliable database for environmental management and inspection.

The list of POPs in the Stockholm Convention has recently expanded to 23 substances, including organic compounds containing bromine and fluorine. It is difficult to monitor these new chemical groups in the environment in Vietnam because of lack of technical capacity and legal basis. The number of agencies providing analytical

services is limited because the necessity for monitoring these compounds is low. Some agencies are capable of analysing new POPs, but only for research purposes. However, with experience in management and control of POP emissions, it is expected that the analysis and risk assessment capability will improve.

II.2.5. Strengthening the treatment of POP contamination

II.2.5.1. Review, assessment and testing of POP disposal technologies

Based on the results from investigations and an assessment of the current situation of POPs in Vietnam, the POP contamination that needs to be treated most consists of POP stockpiles in storage or dumping sites from the past, POP-contaminated soil, PCB-contaminated oil, equipment and materials, and Dioxin-contaminated soil at Dioxin/Agent Orange hot spots.

To strengthen the POP disposal capacity, MONRE has been collaborating with local and international institutions, experts, organizations and technology companies in order to review and evaluate various technologies, and the possibility of applying them in Vietnam. The technology review and assessment has been undertaken in different ways such as information collection, testing in laboratories, testing in practice and testing to evaluate and grant waste treatment licences. The technologies have been reviewed and assessed systematically and comprehensively, looking at efficiency, effectiveness and other requirements for technology, labour, safety and costs, so that proper technical solutions can be selected.

The technologies reviewed and assessed include the following:

- Incineration at high temperature
    + Large-scale fixed incinerator
    + Small-scale fixed incinerator
    + Mobile incinerator
- Co-processing
- Oxidation
    + Super-critical water oxidation
    + Advanced oxidation process (AOP)
    + TiO_2 enhanced photocatalysis (an AOP technology)
- Reduction destruction process
    + Gas phase chemical reduction
    + Based catalysed decomposition process
    + Solvated electron technology
    + Sodium reduction
- In-situ vitrification
    - Plasma arc

- Bioremediation

- Mechanochemical techniques

The review of various techniques reveals the potential for application for different waste as below:

Table II.5: Waste disposal technologies

Technology	Soil	Water	Mud, sediment	Oil, organic liquid	Electrical equipment
Incineration					
Fixed, mobile incinerator	x	x	x	x	x
Cement kiln	x	x	x	x	
Oxidation					
Super-critical water oxidation	x	x	x	x	x
Advanced oxidation process		x			
TiO2 enhanced photocatalysis	x	x	x		
Chemical Reduction					
Gas phase chemical reduction	x	x	x	x	x
Based catalysed decomposition Process	x	x	x	x	x
Solvated electron technology	x		x	x	x
Sodium reduction				x	x
In-situ vitrification	x				
Plasma arc	x	x	x	x	x
Bioremediation	x		x		
Mechanochemistry	x		x		

The results of the review, evaluation and experimentation of different techniques in Vietnam are briefly presented below. Some risks are also taken into account in the process of analysing, evaluating and testing each individual technology.

a) Co-processing in cement kiln

POP stockpiles, POP-containing waste and hazardous waste are put into cement kiln together with other materials and the co-processing take place. This is an alternative that ensures final disposal of POPs because the co-processing has very high temperature (> 1.800^{0}C), high thermal stability, alkaline environment, oxidation and long retention time. Co-processing requires proper technical specifications in order to avoid impacts to the cement production process. It also requires constant monitoring of emissions toward the environment.

Holcim Vietnam tested the co-processing of 40 tons of POP stockpiles in Kien Giang province in 2003 and the efficiency reached 99.999%. Regarding PCDD/Fs unintentionally generated through co-processing, the environmental monitoring results show that the samples of stack gas emission, ash and effluent are within the threshold of 0.1 ngTEQ/N m^3 in stack gas and 10 pg TEQ/L in effluent. Holcim Vietnam also successfully experimented the co-processing of two tons of high concentrated PCB-containing transformer oil in 2011. The destruction efficiency was high and stayed within the threshold for PCDD/Fs, which was 0.1 ng TEQ/N m^3 in emission.

Therefore, this technology has a high disposal efficiency, suitable for POP stockpiles like pesticides, PCB containing oil and is safe for the environment. For POP contamination, such as POP pesticides contaminated from several hundred to several thousand ppm, even though the disposal is efficient, there is a need to take into account the costs of collection, transportation and incineration on total waste volume. Up to now, there have been two cement companies in Vietnam that have been granted a license for co-processing of POP containing hazardous waste in cement kilns.

b) Incineration at high temperature

The disposal of POP pesticides in hazardous waste incinerators has been experimented at hazardous waste treatment units by using mobile or fixed two-stage incinerators. High POP destruction efficiency and short disposal time are two strengths of the incineration alternative. However, it requires very high temperature, leading to high consumption of thermal energy, which is the main factor pushing the costs higher. There might also be many kinds of POPs unintentionally generated and secondary pollution may occur if technical requirements for the incineration process and the treatment of emission, ash and effluent are not met.

The Centre for Technology and Environmental Treatment, under the High Command of Chemical (Ministry of Defence), has manufactured mobile incinerators for POP pesticides stockpile disposal since the late 1990s. POP pesticides in the form of powder or solution is initially treated by additives and catalysis, then combusted in two-stage incinerators at a temperature of 500- 600^{0}C (primary chamber) and 800-1,200^{0}C (secondary chamber). The emission from the combustion process is going through the process of raw dust filtration, membrane filtration in the cooling tower with the absorption solution before being discharged into the environment. Absorbent solution is used in a closed circulation cycle and is treated with carbon based catalysts. All of the ash is mixed with lime, disinfection substances and additional microbes and then carried for burial. The incinerators are mobile and are able to be carried to treat POPs on site, avoiding the transportation of POPs.

In order to strengthen the treatment of POP contamination by Incineration at high temperature, VEA has licensed treatment facility under Green Environment Production and Trade Services Co., Ltd. in Hai Duong use two stage incinerators to the disposal of POP pesticide.Recently, due to higher demand for waste treatment in Vietnam, many incinerators for domestic, industrial, hazardous and healthcare waste treatment have been manufactured with various capacities. They are equipped with relatively modern technology, the emission treated firstly by a solution and then adsorbed by

activated carbon so as to control the formation and discharge of PCDD/PCDF. Many companies have also imported incinerators of different kinds to supply to the market to treat the waste in Vietnam, particularly healthcare waste disposal.

Figure II.10: A hazardous waste incinerator made in Vietnam

In short, we can use the incineration technology to dispose POP contaminated waste and other waste in general. However, there are many potential risks that need to be closely managed in the process of combustion and treatment of emission, effluent and ash.

c) Thermal desorption

Recently, in order to dispose the Dioxin-contaminated soil at Da Nang airport, American specialists have tested and applied in-pile thermal desorption technology at the airport. Dioxin contaminated soil will be put into a furnace of 70 m width, 6 m height and 80 m length, which is firstly electrically heated at about 6 MW then increased to over 700^{0}C. Air is blown into the furnace in order to create negative pressure and the soil temperature can reach at least 335^{0}C. Pollutant-containing steam escaping from the soil, under the effect of negative pressure will be collected into wells, then transferred into the recovery system containing activated carbon. The activated carbon that has been used needs to be treated and disposed. Although the thermal desorption is usually classified as pre-treatment technology (according to the Council of Science and Technology of GEF and UNEP, 2011), Terra Term, one supplier of this technology, has revealed that the process has been upgraded to make sure the thermal desorption occurs at the same time with thermal decomposition when the dioxin-containing vapour goes through the high temperature area in the furnace.

This technology has been deployed by Terra Term to dispose of soil contaminated with Agent Orange/Dioxin at Da Nang airport. After treatment, the soil and residue will be analysed to ensure the fulfilment of Vietnam environmental standards. The environmental monitoring of PCDD/PCDF generated surrounding the disposal site has been also thoroughly undertaken by VEA.

d) Mechanochemistry

This technology is based on mechanical chemistry processes, where contaminated soil is crushed, screened to a size smaller than 10 mm and put into a rotary ball mill. The high speed collision of steel balls with contaminated soil may result in the dehalogenation of chlorinated organic molecules. The main parameters of the process are the loading speed, the rotation speed of the machine, the size and number of steel balls and the use of collaborating materials such as quartz sand. On handling mechanism, it is believed that the mechanochemical process relates to the formation of highly activated surface. Due to the collision and friction, the "triboplasma" (a plasma with radiation of electrons, ions, photons and charged particles) is created in some areas, forming free radicals that have high activation and react with surrounding compounds.

Radical Planet, a technology introduced by the company Planet Radical Research (Japan), also follows the same mechanochemical principles. The only difference is that the process is not continuous but by batch. The ball milling technology applying the mechanochemical process has been tested by the company Chemical Tribochem since the mid 1990s in Europe to dispose of PCB. EDL, a New Zealand-based company, has developed and registered the copyright for a continuous process to dispose contaminated soil based on this technology.

The ball mill technology was tested by EDL in Bien Hoa, Vietnam in the period from 30 July to 2 September 2012, under the supervision of the Project Management Committee of the GEF/UNDP – Disposal of Agent Orange/Dioxin project. The input materials were 150 tons of contaminated soil taken from the Bien Hoa airbase with contamination levels ranging from "high" (> 10,000 pg-TEQ/g), "average" (from 2,000 to 10,000 pg-TEQ/g) and "low" (<2,000 pg-TEQ/g). The test was divided into 42 times, in which specific parameters such as feeding speed, rotation speed and with/without additive quartz sand were closely monitored. The blended samples before and after running tests were sent to a laboratory for chemical analysis.

The results showed that this technology would be most effective for disposing soil contaminated at the level of "average". The maximum and average Dioxin reduction rates were 99.6% and 92.4% respectively, meeting the standard threshold of 1,000 ppt TEQ of Dioxin in soil according to TCVN 8183: 2009. Meanwhile, this technology is less effective for soil contaminated at the levels of "high" and "low".

In summary, this technology has the potential to be put into practice in some certain conditions. Notably, the development from the scale of testing to that of actual disposal will require close attention to many factors such as the concentration of pollutants, large volume of soil as input material, pre-processing methods, parameters, operating conditions and additional measures to restrict and control the secondary pollution like odour, dust, noise and solid waste generated from pre-treatment. It is also worth noting that the soil after treatment cannot be reused directly because the soil size is tiny and it is very sterile. The soil thus requires post-processing steps to be reused.

e) Chemical-based techniques

Halogen can be removed from POP molecules by chemical reactions using a reduction agent such as alkali hydroxide in mineral oil, sodium dispersed oil and new-born hydrogen atom,... This is the basic principle of the chemical-based technology for POP disposal.

A number of research studies on the potential of applying this technology in Vietnam have been conducted and published in Vietnam. The Institute of Chemistry and the Vietnam Academy of Science and Technology have researched and tested the Na-Tech technology, which uses sodium dispersed oil to dispose PCB containing transformer oil. The Vietnam Institute of Industrial Chemistry and the Vietnam National Chemical Corporation carried out a pilot model of 20 litres/batch to dispose PCB in transformer oil, in which the actors selected for PCB decomposition were NAOH solution with 30% concentration and Polypropylene glycol (PPG) M425. The Institute of Biotechnology of the Vietnam Academy of Science and Technology has studied the use of (Na + K) alloy at various ratios to react with benzophenone to create aryl ketyl compounds [(Ar)-, Me+], which can dispose PCB containing transformer oil.

Additionally, advanced oxidation techniques like using Fenton and Feroxon for POP oxidative decomposition have been researched by many Vietnam research organizations to dispose pesticide contaminated soil, water and packaging. However, these studies have only been limited within the scale of laboratories or small pilot tests on site, and have not met with technical requirements to be granted licenses of POP contamination disposal in Vietnam.

Chemical-based technology has been used to dispose POP stockpiles and PCB containing oil in many other countries such as the United States, Canada, the Netherlands, Germany, Japan, Korea and Australia, as well as the EU. In recent years, a number of international companies have introduced Vietnam to their technology, conducting market research and carrying out necessary legal procedures in order to be licensed to treat POP pesticides and PCB in Vietnam.

f) Bioremediation

This technique relies on living organisms (bacteria, fungi) to decompose pollutants to the concentration lower than permitting thresholds. In comparison with the above technologies, this technique has many advantages such as lower costs and final decomposition of pollutants without altering structures of the surroundings. However, the biggest drawback of this technology is that it can only treat pollutants with low concentration and the processing time is relatively long.

The Institute of Biotechnology, Vietnam Academy of Science and Technology, has conducted research on POP pilot treatment using bioremediation. The project "Decontamination of several chlorinated organic compounds by advanced chemical and bioremediation methods" (2007-2008) demonstrated ways to apply biological treatment by using aerobic and micro-aerobic bioreactors. The technological process was developed and tested on over 50 kg of herbicide/Dioxin contaminated soil, and the efficiency reached 44% after 17 weeks of processing.

In 2009, with financial support from the Ford Foundation, the Institute of Biotechnology, in collaboration with the United States Environmental Protection Agency, experimented disposing 2m^3 of Dioxin-contaminated soil, using 11 different treatment formulas at the former military base at Da Nang airport. The demonstration proved that the bioremediation of Dioxin by aerobic and anaerobic treatment (active landfilling) reached an average speed of 100 ppt or 100 pg TEQ per day. In the period of 2008-2011, in the framework of the project "Decontamination of Dioxin-contaminated soil at Bien Hoa airport by biodegradation methods", the Institute of Biotechnology collaborated with the High Command of Chemical and treated approximately 3,380 m^3 of soil contaminated with Dioxin-containing herbicides at Bien Hoa airport. The process used the technology "active landfilling" and used nanomaterials, extracellular enzymes and many tonnes of probiotics SLOW D (tablets), DHS 1 (powder) and DHS 2 (liquid), which were nutrients, pH modifiers and enhancers of POP water solubility.

In addition, studies by scientists from Germany, the USA, Japan, Australia and Taiwan also proved that biotechnology can be applied to dispose soil contaminated with POP-pesticides. However, the efficiency of Dioxin treatment has not been clear and convincing.

In brief, the review and evaluation of biotechnology applied to treat POP contaminated areas show that this is a potential technology, with a reasonable cost, especially for areas polluted at low level.

g) Plant-based disposal technique

This is a technology using plants for on-site disposing of pollutants in soil or sediment. Some plants can be used to expel heavy metals, pesticides, organic solvents, explosives, oil or organic materials containing aromatic rings from contaminated soil. The nature of this technique is quite complicated due to the relationship between the plant metabolism and useful microorganisms residing in the roots of the plant. The plant-based technique has been applied in many parts of the world, such as regions that need long-term environmental recovery. In Vietnam, there have been some initial research in a laboratory that uses plants to treat pollution.

h) Combined techniques

Original pesticide stockpiles and other waste (mainly pesticides or dioxin contaminated soil) can be disposed by combined techniques such as mechanical techniques together with chemical-based technology or incineration or other chemical, physical and biological techniques.

For example, the Center for Chemical Technology and Environment under the Vietnam Union of Science and Technology Associations has designed and developed, with funding from the Ford Foundation, the equipment for handling expired pesticide circulating water at the Green Environmental Station of Ben Luc, Long An province. The principle of the equipment is firstly to dilute the pesticides in water, then decompose them by advanced oxidation techniques using ozone/hyrdoperoxit, biodegrade them by the microorganisms fixed on the substrate, then absorb on activated carbon and the circulating water. This equipment has a processing capacity of 5-7 m^3 per

hour and is able to treat a pollutant concentration of 500-700 mg per litre. The advantage of this non-combustion method in comparison with using incinerators is that the processing cost of this technique is 50% cheaper. The model was accepted and met disposal requirements and put into operation in July 2006. However, due to insufficient waste inputs, and lack of funding and human resources this technique has not been applied regularly and widely.

For POP pesticides contaminated soil, because the volume of soil is usually large and scattered in warehouses or old pesticide dumping sites, the disposal methods are mainly on-site and combined by waste collection, chemical-based disposal, bioremediation, making concrete of the ground, building drain systems, activated carbon filter and creating walls to isolate the movement of contaminated water and soil to the surrounding environment. For example, pesticide contaminated soil has been treated in Nghe An and Thai Nguyen, using local materials and thereby having relatively low costs. The construction work was also simple, fitting with financial conditions in many localities of Vietnam. The main risks during and after the treatment process included the collection and transportation of POP waste to the disposal site, the risk of POP release to the air, and the ability to totally isolate the landfilling area of treated waste from the surrounding environment.

In addition, in order to ensure the effectiveness and affordability of the process, measures for mid-term and long-term management have been integrated into the final disposal.

Thus, along with the inventory, monitoring and evaluation of POP contamination, the demand for treatment of POP-containing waste, POP stockpiles or POP contaminated sites in Vietnam has increased rapidly. POP management projects in Vietnam have been implemented actively and effectively in the review of the technology, support of the pilot application, assessment of the technologies' effectiveness and efficiency, and promotion of technology transfer and application in practice. These activities have contributed to developing the environmental technology market, reducing costs and increasing the efficiency of POP disposal in particular and of environmental protection in general. In fact, for the past 10 years, technologies have been transferred and applied, and treated a large volume of POPs such as thousands of POP pesticides contaminated soil, Dioxin containing soil and PCB in transformer oil.

II.2.5.2. POP-pesticides treatment

The inventory and assessment of the current status of POP pesticides show that, in terms of legislation, the import and use of all types of POP pesticides are prohibited in Vietnam. However, there are still stockpiles from the past and there remain illegal imports, including POP and non-POP pesticides. Initial inventory results in 2008 found about 50 POP contaminated sites, storage areas and stockpiles. However, because of strengthened capacity and awareness of POP contamination, the inventory and reports of the following years have found a huge number of burial sites and old storage sites polluted with pesticides, including POP pesticides. The number of contamination points discovered is more than 1,000 and is still increasing. In some local areas, the collected pesticides, pesticide stockpiles and pesticide packaging have been stored and contained in conditions that are not environmentally safe, where pesticides

disperse into the environment, polluting the water and soil in the surrounding areas.

Therefore, the demand for POP-pesticide treatment is huge. Meanwhile, the requirements for POP pesticides stockpiles are increasingly complex, including the handling of POP pesticides in the storage areas and those dispersed into surrounding soil.

According to the Prime Minister's Decision 1946/QD-TTg dated 21 October 2010 approving the plan on treatment and prevention of environmental pollution caused by persistent organic pesticide stockpiles nationwide, MONRE should take lead and coordinate with relevant ministries and localities to investigate and provide guidance on the implementation of the plan. The plan's objective is to treat, rehabilitate and recover 240 sites polluted by pesticide stockpiles by 2015 in 15 provinces and cities, including Ha Giang, Tuyen Quang, Yen Bai, Thai Nguyen, Bac Giang, Bac Ninh, Lang Son, Hai Duong, Nam Dinh, Quang Ninh, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh and Quang Tri.

By 2015, ministries, sectors and localities have coordinated to treat 58 sites polluted by POP pesticides, of which the treatment of 27 sites has been completed and that of 31 other sites is ongoing. Of the 58 sites listed above, MONRE has ratified the GEF/UNDP - POP Pesticides Project, which treated nine contaminated sites in Thai Nguyen, Nghe An and Ha Tinh. In addition, MONRE financially supports 49 projects on treatment, pollution remediation and environmental improvement for sites contaminated with pesticide stockpiles in 12 provinces and cities, with a total budget of more than 240 billion VND.

Figure II.11: Treatment of POP pesticides stockpiles

Particularly in the period 2013-2014 and through the GEF/UNDP - POP Pesticides Project, VEA collected and disposed over 700 tons of POP-pesticide containing waste. POP containing waste was collected from burial areas and old pesticide storage areas, excavated, packed and transported to Holcim Vietnam for disposal

II.2.5.3. PCBs disposal

With the objective "Eliminating the use of PCB in equipment and machinery by 2020 and properly disposing PCB by 2028", in recent years, in order to ensure effective management of PCB-containing oil and equipment, MONRE has cooperated with relevant ministries and sectors to undertake multiple measures to eliminate PCB according to the roadmap committed to. In the framework of the GEF/WB – PCB Project, a national inventory of PCB in electrical equipment has been implemented.

To restrict the risk of PCB releasing into the environment, VEA has also supported several waste disposal companies to build warehouses for properly storing PCB-containing equipment and materials. Vietnam Electricity has also built a number of storehouses for PCB-containing materials, equipment and waste.

Figure II.12: Creating PCB waste storage in the form of containers

For PCB disposal, VEA has supported Holcim Vietnam to test technologies and evaluate the results of PCB containing oil treatment. In 2012, Holcim Vietnam was granted the license to transport and dispose hazardous waste (including PCB) by co-processing in cement. Holcim Vietnam contracted with some electrical companies and other organizations to dispose PCB-contaminated oil. As a result, about 50 tons of PCB-containing waste oil was safely disposed. Holcim Vietnam has also coordinated with the Dutch Orion company to introduce comprehensive solutions to treat PCB-contaminated equipment based on advanced and international standard technologies.

Figure II.13: Holcim Vietnam transported and treated PCB containing oil

The waste potentially contaminated with PCB such as oil, equipment, rags, gloves, containers and so on needs to be properly disposed. To provide the services of PCB treatment, disposers need to have technologies to decontaminate and treat PCB containing waste, meeting safety and environmental protection requirements. Recently, several local and foreign companies have been researching, introducing, registering their techniques and carrying out necessary legal procedures to supply the services for treating PCB containing materials, equipment and waste in Vietnam.

II.2.5.4. Disposal of Agent Orange/Dioxin

A pollution assessment of Agent Orange/Dioxin originating from the war shows that in some areas such as former US airports and military bases, Dioxin still remains at very dangerous levels of concentration. These areas are called “hot spots”. The common characteristic of these areas is that they had herbicide storages, where herbicides were pumped up to aircrafts for spraying and where aircrafts were washed when finished with the spraying job. These areas also contain herbicide containers. There are some areas contaminated with Agent Orange/Dioxin and where Dioxin concentration in the soil measured from several thousands to several hundred thousand ppt. In particular, there are places where Dioxin was absorbed 1.5 m into the ground at the concentration up to 1,000 ppt. The Government has therefore placed a very high priority on handling and isolating Dioxin sources in order to reduce their impact on human health and the environment.

Regarding pollution treatment in hot spots, the Ministry of Defence has completed 12 projects of investigation and evaluation of the pollution situation and adverse impacts, thereby developing the foundation to treat the toxic agent CS and Agent Orange/Dioxin. The research results have been used to carry out decontamination at three

Agent Orange/Dioxin hot spots at Bien Hoa, Phu Cat and Da Nang airports, and investigation of the pollution at four other airports, Tan Son Nhat, Tuy Hoa, Phan Rang and Nha Trang. Some initial measures for temporary prevention of the pollution sources at the above-mentioned three hot spots have been taken by the Ministry of Defence in order to limit the spread of dioxin into the environment.

In 2009 GEF/UNDP funcling the project "Environmental Remediation of Dioxin Contaminated Hot Spots in Vietnam" (Project GEF/UNDP - Agent Orange/Dioxin) with the aim to "minimize the devastation of toxic substances released from TCDD contaminated hot spots to ecosystems and human health". To accomplish this goal, authorities in Vietnam and experts came up with a two-stage process, including (1) isolate and prevent contaminated soil and sediment, and (2) remediate the three hot spots using appropriate measures. The selection of a Dioxin reduction technology depends on factors such as the development of the technology and the actual conditions in Vietnam, as there has been no international experience of disposal of contaminated soil/sediment with the amount and concentration like that in Vietnam's hot spots.

The project reviewed and evaluated techniques for Dioxin disposal, held trial treatment in practice and assessed the feasibility and efficiency of these technologies for Dioxin contaminated soil treatment, which included mechanochemistry (ball mill) and thermal desorption. At present, thermal desorption technology has been used to treat the Agent Orange/Dioxin contaminated soil at Da Nang airport, with technical and financial assistance from the United States Agency for International Development (USAID).

Also through this project the master plan for Dioxin treatment at Bien Hoa and Phu Cat airports has been elaborated and submitted to the Ministry of Defence, which is continuing discussions with the US partners to review and implement it in the near future.

Figure II.14: Dioxin treatment at Da Nang airport

Agent Orange/Dioxin contaminated hot spots are sources of POP release, posing high risks to the environment and human health in the region. Many activities to prevent the wide spread of these pollutants have therefore been implemented.

Through the treatment of Agent Orange/Dioxin contaminated hot spots, the experience in managing contaminated sites, technology assessment, process control, treatment of residual pollution on a large scale and environmental recovery will be valuable lessons for the environmental protection and sustainable development, not only for Vietnam but also many parts of the world.

II.2.5.5. Remediation of new POPs

From 2009 to 2013, the Stockholm Convention added 11 chemical groups to the list of POPs to be managed. In future, this list will continue to have new POPs added, making POP treatment and management increasingly challenging.

A notable feature of the new POPs is that, due to difficulties in finding alternatives, many substances are still being produced and used in many countries, such as brominated flame retardants in many electrical and electronic products, or PFOS used in the electronic and textile industry and fire retardant foam. Therefore, the safety management, pollution control and remediation of these substances will require new environmental management knowledge, such as controlling sources of materials and assessing and managing environmental risks based on the chemical life cycle or product life cycle. In addition, there is a need for further research on techniques to treat new POPs.

Vietnam is now conducting an extensive inventory of new POP chemicals and data on current use and release of new POPs is still very limited. Likewise, disposal techniques have also not been clearly defined yet. This will be one of the new challenges for environmental management in the near future.

Committing to the Stockholm Convention has created conditions for institutions, organizations and individuals in Vietnam to work with the international community to study, evaluate and apply the techniques of management and remediation of these substances. Priority activities will be management and treatment of electrical and electronic waste, recycling of materials with high risk of POP contamination such as plastics, ferrous metals and fireproof fabric, and pollution assessment and treatment in storage areas and areas of fire fighting training that uses PFOS containing fireproof foam.

II.2.6. Raising public awareness of POPs

Communication and public awareness raising is an important activity in the implementation of the Stockholm Convention in Vietnam, providing information related to POPs, particularly the impact of POPs on the environment and human health. Following the idea of "prevention is better than cure", communication activities therefore raise the awareness and change the behaviours of workers on safety practices, provide better knowledge to the public about the risks related to POPs and promote POP safety management activities of authorized agencies.

During implementation of the Stockholm Convention many activities related to communication, awareness raising and training have been carried out. The activities were implemented through different communication channels such as newspapers,

radio, television, printed materials (brochures, posters, manuals on frequently asked questions, quarterly newsletters etc.), electronic media, forums on social networks and Facebook. Other activities that are implemented include training for managers and employees exposed to POPs and information dissemination and training for journalists about the risks caused by POPs to the environment and human health.

II.2.6.1. Communication on the Stockholm Convention and POPs

Since the early 2000s when implementation of the Stockholm Convention in Vietnam started, assessment of public awareness on POPs has shown that in many places the awareness of the risks caused by POPs, including among environmental managers at government agencies or enterprises, is generally vague.

In fact, in many areas POPs are often used in agricultural and industrial activities and the contact and coexistence with POPs is still considered as normal. A survey and assessment of knowledge related to POPs confirmed that the implementation of the Stockholm Convention in Vietnam will encounter financial and technical difficulties, as well as difficulties in awareness. Therefore, environmental management authorities and many projects have defined that education and awareness raising on POPs is no less important than the safety management and treatment of these substances.

The analysis of activities and projects related to POPs in Vietnam during the period before the Stockholm Convention showed that there were a limited number of projects directly related to POPs, and most of them were short-term scientific studies. There were almost no activities related to education and awareness raising on POPs at a large scale. Therefore, during the development process of the National Implementation Plan of the Stockholm Convention (2004-2006) many national and international seminars and workshops to disseminate information have been held, contributing to the gradual change in awareness of officers from sectors at all levels and awareness of the public about the risks caused by POPs.

Decision No. 184 has identified the task of communication, education and awareness raising on POPs as mandatory and defined a programme on "Communications, education and raising awareness on the harmful impacts of POPs and other toxic chemicals for the period 2008-2010, with an orientation towards 2015". In 2007, VEA developed this programme in collaboration with the Environmental Protection Magazine and media experts from the Vietnam Union of Science and Technology. The objectives of this programme are communications, education and raising awareness about the harmful impacts of POPs and toxic chemicals, developing a system of materials, methods and models for communication to raise awareness about POPs during 2008-2010 and drawing lessons and orienting these activities to 2015.

Priority audience groups were identified and included: (1) environmental managers from ministries and sectors such as MONRE, MARD, MOIT, MOF, Ministry of Labour, Invalids and Social Affairs, Ministry of Defence and the Ministry of Public Security and from departments, institutes and centres under ministries; (2) environmental managers at local levels from provincial departments and districts; (3) officers in charge of environmental management from companies; (4) lecturers and students of universi-

ties and colleges, teachers and high school students; and (5) communities and public organizations, particularly women's organizations and communities in areas where POPs are used, stored or in regions that have POPs in the environment.

The programme also identified specific objectives, content and appropriate communication methods for each priority group.

The programme also analysed the legal basis, implementation principles and communication methods in different contexts in order to be able to choose and flexibly apply them in specific conditions or for specific subject groups. Examples of communication methods are direct communication, using mass media and communication via social networks.

Through the synthesis of information a message about POPs has been clearly stated, namely that the four characteristics of POPs are high toxicity, persistence, long-range transport and bioaccumulation and that POPs can cause a lot of negative consequences on the environment and human health at the global scale.

Figure II.15: Information exchange with journalists about PCBs and POPs

The development of the programme has helped to create changes in awareness about POPs, provided guidance for various communication activities for different groups of POPs and projects later on. The communication activities on POPs also helped to mobilize the participation of many different groups and move towards the common goal of environmental and health protection against the risks caused by POPs.

Another distinctive characteristic of the Stockholm Convention implementation in Vietnam is the active support of international organizations, providing financial, technical and human resources. Communication, education and awareness raising activities on

POPs have also received significant support.

II.2.6.2. Communication on POP pesticides

Many communication activities on environmental risks caused by POP pesticide stockpiles were carried out through the Project GEF/UNDP – POP Pesticides.

From 2011 to the end of 2013, the project GEF/UNDP - POP Pesticides organized 20 training courses to strengthen the capacity of staff from ministries, sectors and localities on management of pesticide contamination, management of empty pesticide packages and prevention of smuggling and illegal trading of expired pesticides. In 2014, the project provided training together with information exchange for officials at local levels from all over the country.

Figure II.16: Training on management of environmental pollution caused by POP pesticides in Nghe An (September 2014)

In coordination with other projects on POPs, the project GEF/UNDP - POP Pesticides also organized training for 250 officers (from customs, market management agencies, departments of natural resources and environment and departments of agriculture and rural development) and 400 relevant stakeholders (chemical traders and farmers) on the management of the life cycle of pesticides and related agricultural activities.

Regarding mass media, the project GEF/UNDP - POP Pesticides developed and launched the project website and completed four reports, six radio sessions, 12 printed articles and 12 online articles, printed media kits and conducted public consultations at two treatment points in Nghe An and Ha Tinh. The project also organized communication activities directly focusing on management officers and on a small number of stakeholders such as farmers and pesticide traders. Several non-governmental organizations in Vietnam under the IPEN group also carried out workshops

to introduce and disseminate information on the toxicity of pesticides in general and of POPs in particular, mainly to women.

Together with the activities of the GEF/UNDP project, the implementation of Decision No. 1946/QĐ-TTg dated 21 October 2010 on the issuance of the Treatment and Prevention Plan for environmental pollution caused by residual pesticides at the national scale also contributed significantly to awareness changes among authorities and residents on the environmental pollution problems caused by pesticide stockpiles. Ministries and local authorities have actively implemented programmes on investigation, survey and planning for the treatment and prevention of environmental pollution caused by residual pesticides. Several communication activities were carried out to raise public awareness and to provide knowledge of how to prevent the harmful impacts of the pollution, especially to vulnerable communities that live near contaminated areas.

Figure II.17: Consultation with the community and raising awareness of people in pesticide contaminated areas

In line with its management responsibility, MARD also organized training and dissemination activities about regulations on the use of pesticides and fertilizers, including POP pesticides, although the number of activities is still limited. MARD programmes have been conducted in more than 43 provinces and cities across the country. In 2009 and 2010, MARD held training classes on the safe and effective use of pesticides on rice for trainers from 12 provinces and cities in the Mekong River Delta. The educated trainers are 24 technical officers from companies and plant protection agencies under MARD.

In conclusion, the project GEF/UNDP - POP Pesticides and other national programmes on pesticide pollution management have developed and implemented a relatively effective communication plan, and have provided regular reports on project news and events as well as on related activities of the business sector and the community. Communication activities on pesticide management issues and areas of residual pesticide contamination have contributed to awareness raising and capacity strengthening of managers at all levels and supported people in contaminated

areas to adopt protective measures. However, in the future there should be more communication activities for public awareness raising, especially to communities around pesticide contaminated areas, helping them to understand about pesticides and how to avoid the exposure to hazardous chemicals.

II.2.6.3. Communication on PCBs

In Vietnam, for a long time, although there were several activities related to research, inventory and environmental monitoring of PCBs, the community and managers were generally not aware of all the risks related to these substances. As a result, the unsafe disposal of and exposure to PCBs still happens. Therefore, raising awareness about issues related to PCBs is necessary and a focus in many projects and assignments.

The project GEF/WB - PCBs and the project on PCB management in power systems funded by SDC both include communication activities on PCBs. These projects identified "the Campaign of Awareness Raising, Information and Communication on PCB" as one of the key activities under the capacity strengthening component. This campaign aims at promoting safe practices, improving risk management and reducing pollutants in the environment through the active involvement of different mass media. The specific objective of the campaign is to prove information about the hazards of PCBs as well as methods to minimize their environmental impacts, thereby improving the implementation duty of officers in charge of POP and PCB safety management, changing and enhancing positive behaviours of workers on PCB safety practices and bringing knowledge on PCB-related safety to the public.

To ensure the effectiveness of the communication, the campaign was carried out for a long period of four years and was divided into three phases, including: preparation (the first six months), implementation (the next 26 to 30 months) and supervision and maintenance (the last six months). Typical activities implemented as part of in this campaign consist of:

- Organizing five training courses and information exchanges on PCB/POP for nearly 300 journalists in the country in order to effectively disseminate information about the harmful impacts of PCBs and POP.

- Organizing three training courses, under the form of "training of trainers", on environmental communication methods for officers from provincial departments of natural resources and the environment, from police departments of environmental crime prevention and fighting, staff from environmental education and research centres and power companies. Over 325 people attended these courses. Subsequently, the project GEF/WB - PCB encouraged the implementation of communication activities by providing technical and financial support to organizations and individual "trainers" who were interested and wanted to conduct the communication on PCBs. A total of 35 enterprises participated, with the total number of trainees on PCB more than 1,300 people. In some cases, the training was implemented through videoconference. Such training of trainers and media support ensured that thousands of people received information directly, contributing positively to not only PCB/POP safety management in particular but also to environmental protection in general.

- Organizing four training activities to raise awareness and to identify the export/import of POPs for officers from the environmental management sector, market management, customs and environmental police, with the participation of nearly 400 people.

- Organizing many workshops to widely disseminate technical guidelines, and to collect suggestions for regulations on the management of PCB in legal documents.

Figure II. 18: Information exchange on PCB/POP and chemical pollution control with departments of natural resources and environment (Thanh Hoa, 2013)

- Organizing three workshops attended by hundreds of people, including environmental experts, researchers and teachers on environmental health and prevention, response and remediation of environmental incidents related to PCB in particular and hazardous chemicals in general.

- Regarding the mass media, the project GEF/WB - PCB collaborated with journalists to post information regularly in newspapers and magazines, supported the writing and publishing of 30 articles every month and four in-depth articles, and made sure that five news programmes were broadcast on the environment and development programme of VOV1 radio channel and VOV Transport radio channel, as well as five television reports on VTV and other TV channels and one TV advertisement message. To date, the information on PCB continues to be regularly disseminated through the Internet.

- Developing and operating the information portal of the Stockholm Convention (at pops.org.vn), which lists the websites of projects on PCBs and other projects on POPs, and provides information about policies, regulations and technical guidance on safety management of PCB and other relevant information on chemical pollution, environmental incidents and environmental health.

- The Campaign also published a collection of communication materials (leaflets, posters, questions and answer books, newsletters and CDs) as well as media reports to be widely disseminated all over the country.

The media campaign on PCBs has been organized professionally and systematically and has achieved encouraging results. Awareness and behaviours of the target audience groups have changed a lot, including managers at all levels as well as ordinary people. The number of news reports and information on PCB and environmental risks related to PCB has dramatically increased in recent years, in particular on online pages and websites, creating solid ground for community-based risk management in the future. These activities have resulted in the efficient dissemination of information, increasing the understanding of the impact and harmful consequences of PCBs and POPs to human health and the environment. The communication activities on PCBs helped mobilize the community to jointly reduce, limit and eventually eliminate the risks caused by POPs.

II.2.6.4. Communication on Agent Orange/Dioxin

Environmental pollution and the impacts on human health related to Agent Orange/Dioxin used by the American Army during the war in Vietnam is a big issue, both for the environment and society in Vietnam, and possibly for global environmental history. In the past few decades, many important policies have been or are being implemented to remedy the consequences caused by Agent Orange/Dioxin. In parallel, large communication programmes have been implemented to mobilize social resources and the contributions of national and international communities to ease the "Orange pain" and gradually overcome the consequences.

Aiming at the same objectives, the project GEF/UNDP - Dioxin Treatment also carried out a series of communication activities and education and awareness raising programmes for communities in areas surrounding the contaminated hot spots.

According to results of surveys conducted in the project preparation stage, although the proportion of people living in communities near the hot spots who know about Dioxin is relatively high, their understanding about Dioxin is still limited, especially about how Dioxin can enter the human body. While 97% of respondents said that Dioxin is a toxic chemical and is extremely hazardous to humans, only 69% know the Dioxin absorption sources to the human body and only 53% understand how it is absorbed. Therefore, in some areas local residents still keep on fishing and harvesting food from Dioxin contaminated ponds and lakes.

Steering Committee 33 together with the project GEF/UNDP - Dioxin Treatment have implemented educational programmes and communication to raise public awareness in areas surrounding the hot spot, and about 380 people have participated in the communication process. The project has handed out leaflets to households in four wards, Quang Vinh, Buu Long, Tan Phong and Trung Dung, which have approximately 3,800 residents. Also, local people are able to access posters displayed in public areas of the wards and to listen to information broadcast on local radio channels about the negative impacts of Dioxin and how to prevent Dioxin. Additionally, through lectures on civic education, biology, chemistry, geography and other information sources (such as posters, contact cards and calendars sent to schools), about 1,200 students at Hung Vuong School, Tran Hung Dao School and high schools in the four above-mentioned wards have been educated about the negative impacts of Dioxin

and how to prevent Dioxin exposure. Approximately 1,200 employees working at Bien Hoa airbase have also directly benefited from the communication activities of the project as they have access to its posters and leaflets. In addition, the project held a press conference with 34 journalists in order to expand communication with mass media.

Awareness raising activities of the Project GEF/UNDP - Dioxin Treatment have been organized in a comprehensive way and have contributed significantly to enhancing local people's knowledge about Dioxin as well as increasing the ratio of information from diverse sources.

II.2.6.5. Communication on the emissions of unintentionally produced POPs

One of the POP groups that the Stockholm Convention also requires to be managed and where emissions into the environment should be minimized is unintentionally produced and released POPs (U-POPs). These often come from heat-using sources in production activities such as manufacturing of cement, thermal power, boilers, waste disposal in incinerators or outdoor burning of waste, straw and thatch. International research has shown that these are significant sources of Dioxin/Furan that need to be considered and controlled. However, awareness about the hazards of U-POPs in Vietnam is still very limited, including that of environmental officers, businesses and communities.

In order to raise awareness about the risks to the environment and human health of Dioxin/Furan released from industrial activities, under the framework of the project GEF/UNIDO - Application of BAT/BEP, several communication activities on U-POPs have been carried out, including:

- Organising workshops on BAT/BEP and control of U-POP emissions, and advanced training workshop on sampling and monitoring of U-POPs;

- Collaborating with journalists to publish regular articles in the Journal of Industry and Trade and Journal of Environmental Protection;

- Supporting the development of a TV programme "Green Vietnam" broadcast on channel VTV2 to raise awareness about the risks caused by POPs, including emissions of Dioxin/Furan and to introduce the application of technology and environmental techniques to reduce the emissions from these substances; and

- Publishing bulletins to introduce information, activities and results of the project and publishing communication reports of the project to keep disseminating information widely to the public.

Through awareness raising activities of the project, the number of people who know about U-POPs and emissions control of U-POPs has increased remarkably, especially within enterprises of four sectors involved in the project, including steel manufacturing, cement production, waste treatment and paper production. There were also significant changes in awareness of state management authorities within environment, industry and trade about Dioxin/Furan released from industrial processes. In fact, thanks to these awareness changes, many other activities related to sampling, analysis, mon-

itoring and evaluation of Dioxin/Furan emissions from industrial sources have been implemented recently. Regulations on emission control and environmental standards on total Dioxin/Furan emissions have been developed, issued and gradually applied in practice, such as QCVN 20:2008/BTNMT, QCVN 30:2010/BTNMT, QCVN 41:2011/BTNMT and QCVN 51:2013/BTNMT.

Regarding the control of Dioxin/Furan in medical waste treatment, through the project "Management of medical waste to reduce emissions of U-POPs and mercury" funded by GEF/UNDP in a number of countries in Asia and Latin America (Project GEF/UNDP - Medical POPs), the Ministry of Health and MONRE have coordinated to organize extended national training programmes on management of medical waste, health and occupational safety. A survey conducted in 2004 by the Department of Preventive Health and Environment in Vietnam with 74 medical agencies and 1,509 medical personnel in three provinces and cities showed that only 69.5% of respondents have access to training programmes on occupational safety and environmental health. Therefore, communication activities of the project GEF/UNDP - Medical POPs has tried to broaden the training content and improve the ratio. Recently, the Ministry of Health also developed programmes, materials and organized training on medical waste management for lecturers and six groups of people, including (1) managers; (2) officers in charge of medical waste management; (3) medical personnel; (4) workers operating waste treatment systems; (5) persons in charge of collecting and transporting medical waste; and (6) officers working on medical environmental monitoring. Thanks to these activities issues of environmental risks and health relating to POPs and toxic chemicals have gradually become known to the healthcare sector. In particular, the project GEF/UNDP - Medical POPs has organized training to strengthen the capacity on medical waste management and developed and printed posters and CDs on classification and collection of medical waste for wide dissemination.

Figure II.19: Training on medical waste management to reduce emissions of U-POPs

In 2014, Steering Committee 33, with support from the project GEF/UNDP - Dioxin Treatment, conducted a study and compiled the report "Current Status of the Dioxin Environmental Contamination in Vietnam". This report includes basic informa-

tion about the characteristics of Dioxin and Dioxin emissions from waste and waste treatment, the paper and cement industry, metallurgy and brick production and initial research on the emission and Dioxin residue in soil, water and air in some areas of Vietnam. The report has received the attention of ministries, sectors and communities, thereby raising further the awareness of hazards caused by the release of U-POPs into the environment.

Thus, the implementation of projects under the framework of the Stockholm Convention has a significant impact on changing awareness about risks to the environment and human health caused by U-POPs, creating an important opportunity for emissions control in the coming time, following the international trend. However, it is also clear that the understanding among the general public and even among management authorities about U-POPs and measures to prevent U-POPs exposure is limited, due to limitations in funding and implementation time of projects and assignments. In the future, more projects and programmes on U-POPs are needed to disseminate more knowledge to the relevant authorities and the local community and to manage and mitigate the risks related to U-POPs.

II.2.6.6. Communication on the new POPs

For POPs that are newly added to the lists of substances to be managed, communication has been carried out through assignments on the implementation of POP management activities funded by the state budget and through the project GEF/UNDP - Updating NIP.

Currently, Vietnam is conducting an inventory for new POPs and therefore the data is limited and communication is difficult. However, with the motto "prevention is better than cure", communication on new POPs continues to be strengthened, especially for substances that are still being used in daily life such as PBDEs and PFOS. Experience gained from communication activities on POPs in recent years is being reviewed in order to promote communication efficiency. In addition, VEA is coordinating with related organizations and individuals to implement a number of integrated activities on safety management of the new POPs, chemical pollution control and environmental health.

In conclusion, it is clear that communication activities on POPs in the past 10 years through many different projects and assignments have brought remarkable results. There have been positive changes in awareness, consciousness, behaviour and the effective management of POPs. The supportive role of the Stockholm Convention on information, technology and financing through international projects has played an important role in this success.

II.2.7. Organization of international workshops and conferences on POPs

POPs are a global issue and there is therefore a need for international sharing and experience exchange in research, development, communication and practices of POPs management. In particular, workshops and conferences on POPs create good opportunities for different stakeholders to review the achievements obtained, raise awareness, disseminate knowledge, share collaboration opportunities and support

communication on POP. Below are examples of international workshops and conferences hosted by Vietnam or which Vietnam actively participated in, within the framework of the Stockholm Convention.

1 - Workshop on "Implementation of the Stockholm Convention – the international experiences" (Hanoi, 2005)

The Project GEF/UNDP – NIP Development was the initial project, laying the first bricks for the deployment of the Stockholm Convention in Vietnam. To exchange national and international information on POP management, the Vietnam Environmental Protection Agency (now the VEA) organized the workshop on "Implementation of the Stockholm Convention - the international experience" in August 2005 in Hanoi. Participants included representatives of environmental management agencies at local and central level in Vietnam, managers and environmental experts from the US Environmental Protection Agency, the Korea Ministry of Environment and Korea Institute of Environmental Research and the Philippines Environmental Protection Agency. A lot of information was presented and discussed at the workshop, such as POP analysis, review of the situation of commitments and implementation of the Stockholm Convention in the world, experience of implementing the Stockholm Convention in some countries, environmental licensing, remediation, new disposal techniques, environmental inspection, hazardous waste management in South Korea and the information system for waste management in South Korea. Importantly, this workshop provided an opportunity for participants to share experiences and contribute ideas for the National Action Plan for implementing the Stockholm Convention in Vietnam, which was later issued in 2006.

2 - Seminar on "Contamination of Dioxin and organic halogen substances from Agent Orange and unintentional emission sources" (Quang Ninh, 2010)

This seminar was organized with the support from the GEF/UNIDO Project – Application of BAT/BEP and the Project "Establishment of a Dioxin Laboratory" sponsored by the Bill and Melinda Gates Foundation and Atlantic Philanthropies. The seminar focused on exchanging experience of monitoring and pollution assessment of Dioxin/Furan emitted from residual pollution sources and other industrial sources. Many local scientists actively participated in and presented at the workshop, creating a platform for open discussion on difficult but important issues in POP contamination monitoring. The workshop included the participation of reputable scientists in the area of environmental monitoring and analysis such as Dr. Kannan (USA), Dr. Olep Parker (Germany) and Dr. Kino (Japan). This seminar was highly appreciated by experts and officials involved.

3 - Workshop on "Control of U-POP releases through application of BAT/BEP and experience of implementing GEF projects on POP in Vietnam" (Da Nang, 2011)

This workshop aimed at summarizing the activities of the GEF/UNIDO Project – Application of BAT/BEP, and connecting the project outcome with other POP management activities in Vietnam and globally, and networking among environmentalists,

environmental managers, experts and donors. The workshop received the attention and participation of representatives from the GEF Secretariat and many well-known scientists in the field of POP analysis, assessment and treatment from Germany, the USA, Japan, Hong Kong, Australia and Vietnam.

Figure II.20: International workshop on POP in Da Nang

The workshop received positive feedback from participants, created a forum for constructively exchanging information and opened up new cooperation opportunities for Vietnam to manage POPs, including new POPs that are difficult to control, such as PBDE in electronic waste.

4 - Workshop "Implementation of the plan on treatment and prevention of pollution caused by stockpile pesticides on national scale" (Nghe An, 2011)

To cope with the pollution caused by pesticide stockpiles, MONRE coordinated with relevant ministries, sectors and localities to build the plan on treatment and prevention of environmental pollution caused by pesticide stockpiles at the national scale. In this spirit, the workshop "Implementation of the plan on treatment and prevention of pollution caused by stockpile pesticides on national scale" was held in April 2011 in Nghe An province, the area with the largest number of pesticide stockpiles in the country. The workshop highlighted the determination to join hands to successfully implement Decision No 1946/QD-TTg. The workshop was also an opportunity to exchange and discuss the difficulties and obstacles in treating residual chemical contamination and finding possible solutions. It was also a forum for stakeholders, organizations, individuals and businesses to introduce technologies and discuss plans for proper pollution treatment.

This workshop emphasized the strong will of VEA, MONRE and localities in implementing the Prime Minister's Decision No 1946.

5 - Workshop on "Evaluation of the implementation and practical lessons learnt from activities and projects implementing the Stockholm Convention in Vietnam" (Hanoi, 2012)

As the national focal point of the Stockholm Convention in Vietnam, the VEA hosted the workshop "Evaluation of the implementation and practical lessons learnt from activities and projects implementing the Stockholm Convention in Vietnam" in July 2012 in Hanoi. The workshop was an opportunity to report and exchange information with GEF about the efficiency of POP projects financed by GEF in Vietnam. Information on the implementation, including achievements, difficulties and obstacles, of many projects funded by GEF in the field of POP management was presented and discussed at the workshop. Accordingly, GEF could evaluate the important role of GEF projects in supporting the development of policies on safety management of chemicals, chemical pollution control, environmental protection, health and safety, global integration and technology transfer, and at the same time recognize the contribution of these projects to the global environment in general.

6 - Workshop on "Sharing international experience and technologies for Dioxin/ POP assessment and treatment in Vietnam" (Da Nang, 2012)

With support from the GEF/UNDP Project – Dioxin Remediation, a technical international workshop was held in Da Nang in December 2012. The workshop aimed at sharing knowledge and experience in POP/Dioxin assessment and treatment.

The workshop shared diverse information resources and experience in research, assessment and remediation of Dioxin in Vietnam for the past 40 years. Again, managers, scientists and experts had the chance to gather to share knowledge, experiences and best practices for POP/Dioxin assessment and treatment in Vietnam. The workshop focused on three major issues including introducing different methods of assessing Dioxin and other pollutants, updating the development of technologies for POP/Dioxin disposal and comparing legal frameworks for Dioxin monitoring and control based on international perspectives. Also at this workshop many international delegates expressed their interests and shared experiences in reducing the negative impacts of Dioxin on the ecosystem, especially human health, and the effectiveness of the efforts to eliminate Dioxin hot spots in Vietnam.

7 - Annual Meeting of the forum of application of the best available techniques and the best environmental practices (BAT/BEP) in the East and Southeast Asia region (Khanh Hoa, 2012)

This international conference was held in December 2012 in Nha Trang, Khanh Hoa province, with financial support from the GEF/UNIDO Project - Forum of BAT/BEP for U-POPs reduction. The Council meetings are hosted annually by member countries in order to disseminate information and exchange experience in various areas among countries in the region about applying BAT/BEP and developing annual reports on the efficiency of BAT/BEP to reduce POPs released from industries specified in Appendix C of the Stockholm Convention. The participants were environmental officials from Cambodia, Indonesia, Laos, Thailand, China, Myanmar, Mongolia, Vietnam, UNIDO

and the Secretariat of the Stockholm Convention.

8 - "Vietnam theme" at international symposiums on Dioxin/POP

Historically, the discovery of environmental pollution caused by Agent Orange/Dioxin sprayed by the US during the war in Vietnam has attracted global interest. There is plenty of research conducted by local and international scientists about environmental pollution and the health effects of Agent Orange/Dioxin in Vietnam. To create a forum for sharing scientific information in this area, the Office of Steering Committee 33 has periodically organized a Vietnam theme in the framework of the Dioxin International Symposium. This international conference is held annually with the participation of hundreds of scientists around the world. The continuance of the Vietnam theme is one of Vietnam's efforts to promote research in the country. In recent years the Vietnam theme has been expanded to studies of other POPs such as PCB and Chlorinated Organic Pesticides. Vietnamese scientists have participated and presented the research results on PCB contamination, pesticides and new POP substances like PBDE in waste recycling. They also participated in the 35th Dioxin International Symposium in Brazil in August 2015.

9 - Support Vietnam officials and experts to participate in international workshops and convention meetings

Also in the framework of POP management projects, a number of officials and environmental experts from Vietnam have been supported to participate in the Conference of Parties (COP) of the Stockholm Convention and international scientific workshops such as the Dioxin & Halogen Conference in Australia, South Korea and Spain. Besides, a number of study tours to other countries and meetings for project development discussions have been sponsored by international projects and organizations.

In the context of limited budget in Vietnam, financing from international projects that supports the participation of officials and experts in international meetings and conferences plays an important role in ensuring Vietnam's involvement in the international integration process and broadens the outlook in the field of environmental protection. Officials and experts from Vietnam also took the initiative and actively shared and discussed their research results and project outcome at these international workshops. The image of Vietnam's institutions, officials and scientists has thereby been improved within the international community. The workshops have also made positive linkages between projects in Vietnam and other activities and projects of international organizations and other countries about POP management and chemical pollution control in general.

10 - Workshop on "Environmental Risk Assessment and Management of POP"

On the occasion of 10 years of implementation of the Stockholm Convention in Vietnam, MONRE in collaboration with the World Bank organized the "International Workshop on Environmental Risk Assessment and Management of POP." The objective of the workshop was to strengthen cooperation, information exchange and experience sharing among countries in the world about environmental risk assess-

ment of PCB/POP, and emission reduction and management of Persistent Organic Pollutants, including PCB, and other persistent toxic chemicals in order to support the implementation of the Stockholm Convention in Vietnam and in the world. The workshop was organized for the first time in 2015 and is expected to be organized annually in an effort to create an international-level scientific forum on POPs/hazardous chemicals in Vietnam.

Through exchanges and connections with other countries Vietnam has demonstrated its capability to properly manage POPs, from monitoring and risk assessment to contamination treatment. Accordingly, Vietnam has demonstrated its commitment to the Stockholm Convention and the goal of protecting human health and the environment in Vietnam and contributing to global environmental protection.

II.3. Scientific research activities on POP management

II.3.1. Research on POP pollution in Vietnam

Studies on POP pollution in the environment, animals and humans have received considerable attention in Vietnam since the 1990s. Studies during 1990-2010 have mainly focused on areas that have high population density and large industrial areas such as Hanoi and Ho Chi Minh City. Other studies have also been conducted in the Red River basin and the Mekong River basin, which are the main agricultural areas and granaries of Vietnam.

Since the 1990s, Japanese scientists [19] have conducted research on POPs in water, air, soil and sediment in a number of Asian countries, such as Japan, India, Vietnam, Thailand, Indonesia, Malaysia and the Philippines. The results of these studies have indicated that DDT and HCH pollution in the environment in Vietnam is relatively high when compared to developed countries like Japan and Australia. The presence of DDT in air, water and sediment samples from the north, central and south of Vietnam confirms that contamination levels of this chemical in the country are a result of using DDTs to protect crops in the past as well as from wiping out malaria.

Other research results in the following years [20,21] have shown a clear spatial distribution of DDTs in sediment along the coast from the Vietnam-China border to the Red River estuary (Figure II.21). However, the content of HCHs in Mong Cai (near China) is much higher than in other areas in the south, which implies that it could originate from China, which consumes most of the world's HCHs.

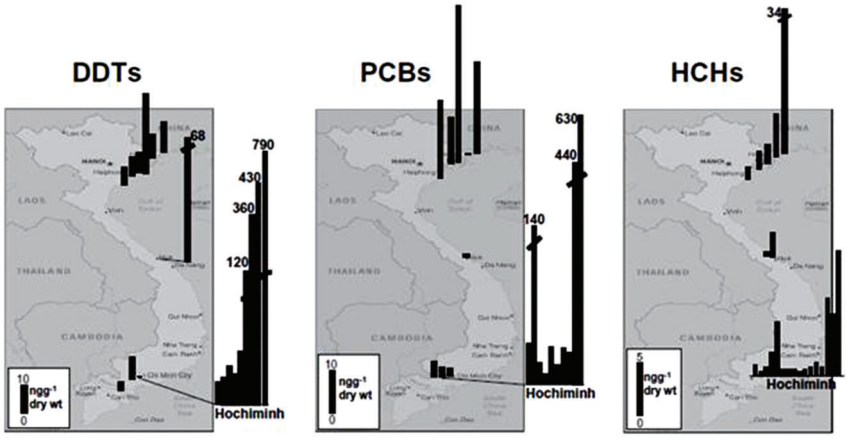

Figure II.21: Distribution of organochlorines in sediment in Vietnam

Studies on sediment in the river system of Ho Chi Minh City and the Saigon Dong Nai River basin have shown geographic dispersion [22,23]. The content of POPs (PCBs and DDTs) in sediment are highest in the urban river channels of Ho Chi Minh City, decrease when going down the river and are lowest in the estuary and coastal regions [24] (Figure II.22). These results have clarified that urban areas, industrial zones and residential activities are regarded as sources of POP contaminated sites [25].

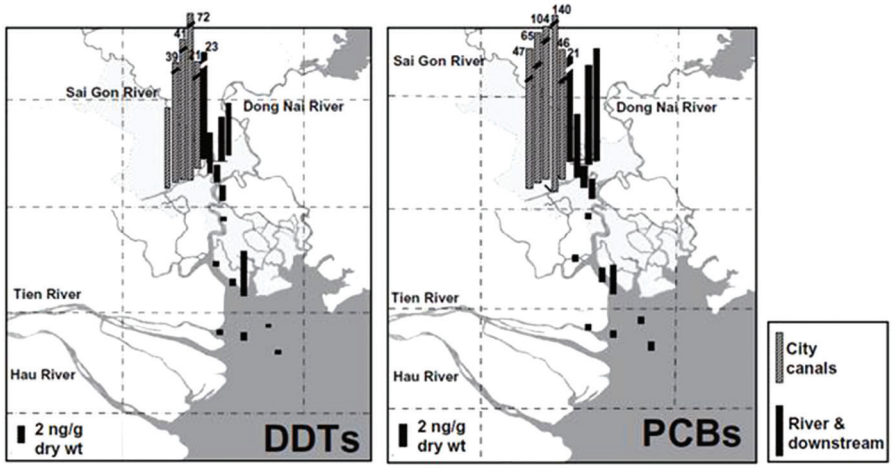

Figure II.22: Distribution of DDTs and PCBs in the Saigon Dong Nai River sediment, southern Vietnam

Another study was conducted in 2003-2004 in the Hau River basin, which is one of the two largest tributaries of the Mekong River and also the biggest granary of Vietnam. The results are consistent with previous studies, especially in the concentrations of DDTs and PCBs. The concentration of POPs from urban canals in residential areas decreases down to the lower section of the Hau River. The DDT content in urban areas

of Can Tho and Long Xuyen is 10-20 times higher when compared to the river's lower section. This is most likely from the use of DDTs for sanitary purposes and prevention of malaria rather than from agricultural activities [26,27].

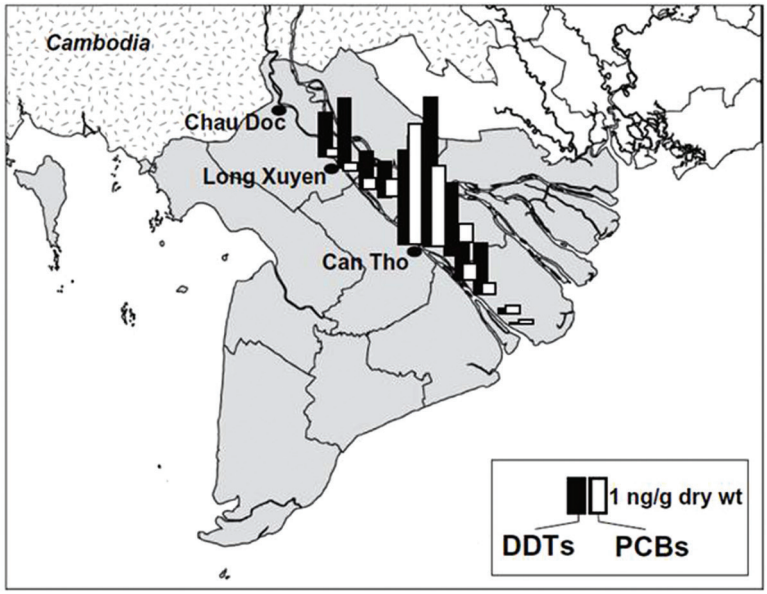

Figure II. 23: Distribution of PCB and DDT content in the Hau River sediment, southern Vietnam

Studies on POPs in soil samples in the northern and southern regions of Vietnam have pointed out that concentration of DDTs in rice fields is higher than in high grounds [28,29]. These results have also demonstrated that DDTs were used as insecticides to protect crops in the past. Meanwhile, in former military bases of the US Army in Tay Ninh, PCBs were found in soil with relatively high levels (92 ng/g). In landfills in Hanoi and Ho Chi Minh city (the two largest cities of Vietnam), research results have depicted that levels of PCBs and DDTs in landfill soil are much higher than in farmland [20].

When comparing the results from these studies with other countries in the Asia-Pacific region (Figure II.24), DDT pollution in the coastal regions of Vietnam is of concern, and this once again confirms the widespread use of DDTs in Vietnam in the past decades. PCB concentrations in water and sediment in the Mekong River estuary in southern Vietnam were relatively high when compared to other countries like India, Japan and Australia. Relatively high levels of PCBs in studies carried out in the early 1990s might originate from electronics imported from other developed countries (such as the former Soviet Union and USA) or from the equipment and weapons used during the Vietnam War.

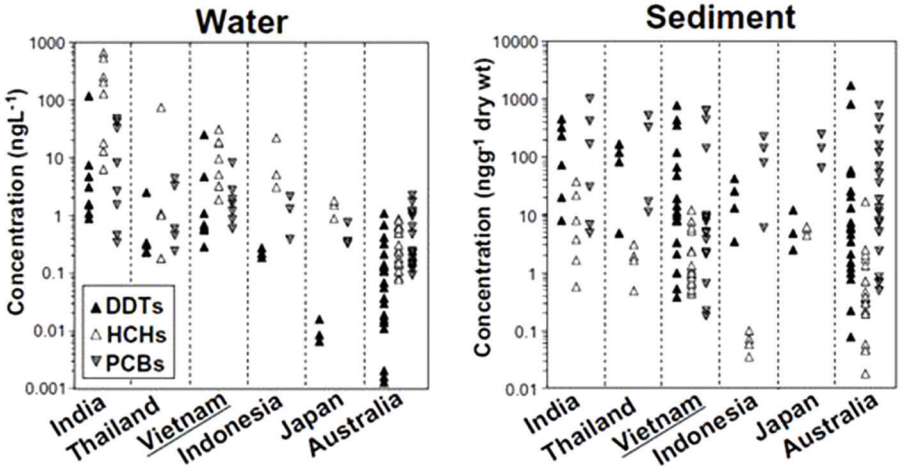

Figure II. 24: Comparison of concentrations of persistent organochlorines in water and sediment in Vietnam with other countries in the Asia-Pacific region

There is not much data on POP pollution in landfill soil in the world. The status of POP pollution in landfills in Vietnam compared to other countries in the world is depicted in Figure II.25 [28-34]. Generally, PCB levels found in landfill soil in Vietnam is higher than in industrialized countries like the US, Russia and Italy, which have higher levels of PCB contamination. These results have also shown that concentrations of DDT in landfill soil in Vietnam are comparable with those in agricultural land in the early 1990s of countries like Russia, Ireland and Slovakia, and higher than those in countries like Egypt and South Korea.

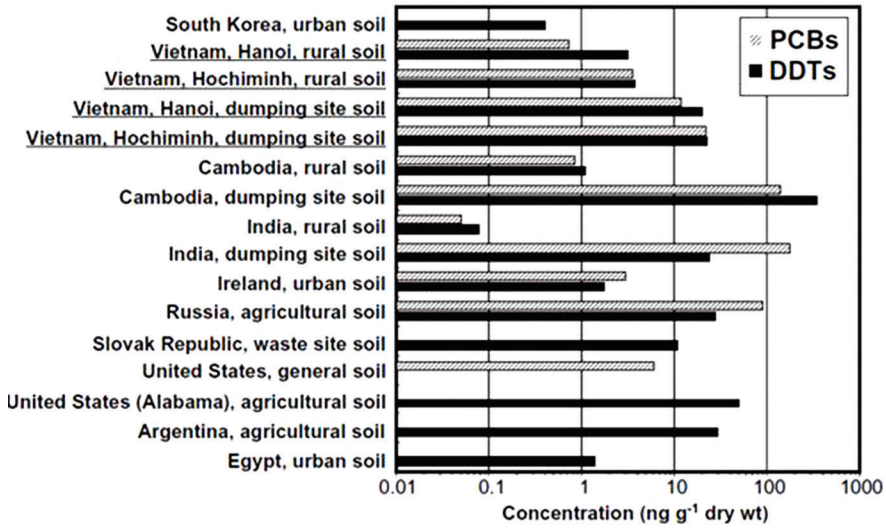

Figure II.25: Comparison of PCB and DDT concentrations in soil from different countries

A study by Japanese scientists on accumulation in biological samples such as fish, bivalves and birds from countries in the Asia-Pacific region, including Vietnam, has clarified the current pollution, distribution and identification of POP pollution sources [35]. The results showed that DDT concentration in fish was relatively high (Hanoi: 1,900 ng/g fat, the Red River estuary: 4,200 ng/g fat, Hue: 1,100 ng/g fat and Ho Chi Minh city: 1.100ng/g fat). These were similar to concentrations of PCBs in fish (Hanoi: 580 ng/g fat, 110 ng/g fat, Hue: 630 ng/g fat and Ho Chi Minh city: 950 ng/g fat). The mussel samples studied along the northern coast and the central coast also contain relatively high levels of DDTs, and show similar distribution of POPs as in sediment samples. In particular, the concentrations of PCBs, DDTs and HCHs are relatively high in areas near the Vietnam-China border and estuaries such as Hai Phong port (urban and industrial zones) or Thai Binh (granary of Vietnam), and tend to decrease along the southern coast.

In another study [36], concentrations of DDT have been found to be higher in non-migratory birds than in migratory birds in northern Vietnam (Figure II.26). These results clearly indicate that DDT pollution is quite common in the north of Vietnam. However, relatively high levels of HCHs in migratory birds suggest that the exposure to HCHs occurred at stop-overs during migration of birds in polluted areas such as India, South China and Japan. These countries act as potential sources of HCH pollution found in migratory birds intaked to their bodies in breeding season at the Baikal Lake area, Russia. A low level of PCBs in non-migratory birds and an equivalent level in migratory birds showed smaller sources of PCB pollution in northern Vietnam in the late 2000s. Thus, the POP accumulation pattern in birds depends on their migration activities and reflects the status of each pollutant. From this, researchers have proposed the use of birds as bio-indicators for monitoring POPs in the environment.

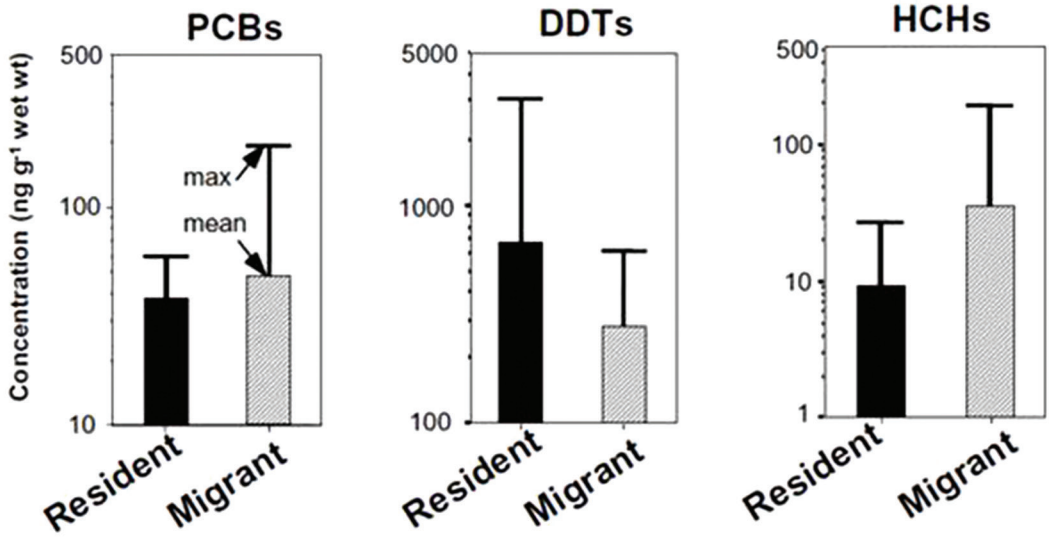

Figure II.26: Comparison of POP accumulation in migratory and non-migratory birds in Vietnam

According to the results of the bivalve monitoring programme in the Asia-Pacific region [37], POP concentrations in fish, bivalves and birds in Vietnam are lower than in southern China and Hong Kong, but higher than most other East Asian countries [38-44]. Meanwhile, the level of DDTs in fish in Vietnam is the highest when compared to other countries like India, Thailand, Indonesia and Australia.

In general, the distribution and pollution status of POPs in sediment and organisms are very similar at both the local and regional level. This may stem from the enhanced evaporation of POPs under the influence of hot air flows, which are characteristics of tropical ecosystems.

Studies on POP pollution in food in Vietnam have also been conducted since the early 1990s. DDTs were found in pork and chicken (190-5,100 ng/g fat), but concentrations of other POPs such as HCHs, CHLs, HCBs and PCBs are quite low [45]. Another study [46] conducted in 1990-1991 on various types of food such as rice, beans, oil, butter, animal fat, meat, fish and seafood in some areas like Hanoi, Tay Ninh and Ho Chi Minh city has detected relatively high levels of PCBs. These results are consistent with the PCB contamination status in soil in the areas. The high levels of DDTs in all these kinds of food, especially in animal oil and fat, indicate the use of DDTs at the time of the study. pp'-DDT accounts for the majority, approximately 50% of total DDT concentrations in rice, beans and oil. In 2003, scientists released a report stating very high contents of PCDD/Fs in food in Bien Hoa, where Agent Orange was sprayed during the war [47].

There are not many studies on POP pollution in humans in Vietnam. A preliminary study [15] has found very high DDT and HCH concentrations in breast milk in Ho Chi Minh city (10,500-12,000 ng/g fat). However, the PCB concentration in breast milk was relatively low when compared to other countries. Another study in 2001 has provided data on human exposure to POPs and a better understanding of the accumulation kinetics of PCBs and other organochlorines. The study was conducted on 96 breast-feeding mothers living in areas near landfills in Me Tri, Tu Liem in Hanoi and Vinh Loc, Dong Thanh in Ho Chi Minh city [16]. Generally, exposure to DDTs, HCBs, CHLs, and PCBs in these two groups in Hanoi and Ho Chi Minh city was comparable, while the content of HCHs in breast milk in Hanoi was significantly higher than in Ho Chi Minh city [16]. These results showed that the ground pollution level of HCHs in northern areas is higher than in the south.

Similar results of HCH pollution in sediment and bivalves along the coastal areas of northern Vietnam have also shown higher levels of HCHs near the border with China [19-21]. Earlier reports also showed similar geographic distribution of various types of environmental samples with HCH concentrations higher in Hanoi than in Ho Chi Minh city [8, 28, 35]. Aside from the migration impact from China, the world's biggest consumer of HCHs, the difference in climate between Hanoi and Ho Chi Minh city also results in the greater concentration of HCHs in Hanoi. The Mekong Delta region is characterized by a tropical climate with high temperatures and increased precipitation, leading to the enhanced evaporation of HCH isomers, and thus resulting in lower concentrations of these substances in environmental and human samples.

Similar to environmental samples, Vietnam is among the countries with the highest level of DDTs in humans when compared to other developed and developing countries. This raises concern about environmental quality and human health.

During the Vietnam war, a large amount of herbicides (Agent Orange) containing dioxin was sprayed over the south of Vietnam, leading to heavy dioxin pollution in the environment and food chain. During the past three decades, International scientists and Vietnamese colleagues have conducted many studies on dioxin contamination in southern Vietnam in sediment and food, especially biological samples from residents living near the hot spots of dioxin contamination. Generally, dioxin contamination by Agent Orange is characterized by 2,3,7,8-TCDD, which is the major pollutant in the composition of the herbicide 2,4,5-T, a component of Agent Orange. 2,3,7,8-TCDD is one of the most toxic compounds.

In order to assess the consequences of dioxin contamination in Vietnam War, the Ministry of Natural Resources and Environment is taking the lead in implementing the state-level program of scientific research and technology on “Research of remediation of long-term effects of Agent Orange/Dioxin used in the Vietnam war by the US on the environment and human health” (No. ST-33/11-15) in the period of 2011 - 2015 funded by the Government of Vietnam. The program includes 13 scientific projects implemented by Ministries: Defense, Health, Natural Resources and Environment, Vietnam Academy of Science and Technology, and some other agencies. The objective of the program is to assess the long-term consequences of toxic chemicals used by the US during the war on Vietnam environment and human health; to propose solutions on treatment, reduction, and solutions related to mechanisms and policies for victims of Agent Orange/Dioxin.

The highest concentration of PCDD/Fs in land of 2,200 pg/g dry weight was found when investigating soil, sediment and food samples at the A Luoi valley [48], which is a hot spot of Agent Orange contamination and also a former military base of the US Army. This concentration is much higher than the ground level of industrialized countries.

II.3.2. Research activities on new POPs

a) General introduction about research activities on new POPs

As mentioned earlier, new POP groups are continuously added to the management list of the Stockholm Convention throughout the COP meetings. In 2009, nine new POPs groups were added to the list, among which three groups relate to industrial activities, including (1) Tetrabrome diphenyl ether and Pentabrome diphenyl ether (POP-BDE) (Appendix A); (2) Hexabrome diphenyl ether and Heptabrome diphenyl ether (Appendix A); and (3) Perfluorooctane sulfonic acid, Perfluorooctane sulfonate and Perfluorooctane sulfonyl fluoride (Appendix B). Endosulfan and Hexabromocyclododecane were added in Appendix A of the Convention in 2011 and 2013 respectively.

Data on new POPs in Vietnam is scarce, which is the main obstacle for a sound management of these substances. Research on PBDE over the last five years has mostly have been conducted in research institutes and universities in cooperation

with international research groups in the US or Japan. Publications mainly focus on environmental samples which accumulate PBDE, such as indoor dust, soil, sediment and fish. Study areas have not been extended throughout the whole country but mostly concentrate on urban areas and several e-waste recycling sites and waste burial sites. In the meantime, research on PBDE has been conducted extensively in many other countries in the world, especially developing countries in Asia such as China, Korea and Thailand. Data taken from those investigations can be considered as valuable references to evaluate the PBDE pollution level in Vietnam in comparison with other countries in the region and in the world.

Scientific research activities on the inventory and evaluation of the current status of new POPs in industry in Vietnam is listed in Table II.6

Table II.6: Research activities on new POPs in Vietnam

No	Activities	Organisation	Research content
1	Pollutants monitoring programme using green mussels as biological indicators in the Asia-Pacific region. (Asia-Pacific Mussel Watch Programme)	- Ehime University, Japan - CETASD and Faculty of Chemistry, Hanoi University of Science, Hanoi National University	Evaluate the pollution level of POPs, including PBDE, using green mussels as biological indicators in Asia-Pacific countries, including Japan, Korea, China, Hong Kong, India, Cambodia, Indonesia, Malaysia, the Philippines and Vietnam
2	Programme Research Revolution 2002 (RR2002) funded by the Japan Society for the Promotion of Science	- Ehime University, Japan - CETASD and Faculty of Chemistry, Hanoi University of Science, Hanoi National University - University of Agriculture and Forestry, Ho Chi Minh City	Evaluate the pollution levels in the environment and exposure potential of toxic substances like POPs and heavy metals on humans in the Mekong delta region, including Vietnam

3	Project "Complete mechanisms, policies and legislation on the management of persistent organic pollutants"	- Pollution Control Department, VEA - Faculty of Chemistry, Hanoi University of Science, Hanoi National University - National Institute of Labour Protection, Vietnam General Confederation of Labour - Van Lang University, Ho Chi Minh City	- Conduct survey, analyse and write report on the results of POPs in industry and agriculture - Develop three technical guidance documents on POP inventory in industry and agriculture - Preliminary inventory and emission inventory of PBDE - Develop technical guidance on PFOS inventory - Preliminary inventory and emission inventory of PFOS in industry
4	Project "Evaluation of the emission and environmental pollution level of"	- National Foundation for Science and Technology Development - Faculty of Chemistry, Hanoi University of Science, Hanoi National University	- Develop analytical procedures to determine PBDE in emission sources and environmental and biological samples - Sample, analyse and evaluate the pollution level of PBDE in the environment - Calculate and assess the PBDE emission level
5	Project "Assessment of the pollution of traces of PBDE organic pollutants in surface sediment of rivers and lakes in Hanoi"	CETASD, Hanoi National University	- Develop analytical procedures to determine PBDE in surface sediment in rivers and lakes in Hanoi and Hung Yen - Evaluate the pollution level of PBDE in surface sediment in Hanoi and Hung Yen. Came to the conclusion that the recycling of e-waste has a potential risk to release PBDE.
6	Project "Study on the development of analytical procedure for determination of PBDE residue in fish samples using GC-MS in combination with SPE"	CETASD, Hanoi National University	- Develop analytical procedures to determine PBDE in fish samples taken from rivers and lakes in Hanoi - Evaluate the accumulation level of PBDE in fish taken from Nhue and To Lich rivers in Hanoi. Confirm the existence of PBDE in fish

7	Study on the distribution and accumulation level of PBDE in the river system in Hanoi	Dioxin Lab, Centre for Environmental Monitoring, VEA	- Develop analytical procedure to determine PBDE in sediment in river system in Hanoi - Evaluate the pollution level and distribution trend of PBDE in river sediment in Hanoi - The main emission source of PBDE has been defined as commercial penta-BDE and c-octa BDE
8	Evaluate the pollution level and distribution trend of PBDE in dust in working places	National working environment monitoring station, National Institute of Labour Protection, Vietnam General Confederation of Labour	- Develop analytical procedures to determine PBDE in house dust sample - Evaluate the pollution level and distribution pattern of PBDE in house dust in working places - Initially assess risk of PBDE on human health through dust inhalation
9	Research, assessment of POPs concentration stockpile in water, sediments of some estuaries in Quang Nam province and Da Nang city	Ha Noi University of Natural Resouces and Environment	- Process of the sample treatment and analysis for DDT, HCB, Lindan, PeCB, PBDEs and PCBs in water and sediments - Development of lectures on POPs in module on environmental toxicology
10	Other research	- Research institutes, research centres, universities and laboratories in Vietnam - Universities and research institutes in USA, Japan and Korea	- Evaluate the pollution level of new POPs in soil, sediment, water and air - Evaluate the accumulation level of new POPs in biological species of the food chain - Evaluate the exposure level of new POPs to human bodies - Detect the emission sources of new POPs and recommend processing methods

b) Research activities on polybrominated diphenyl ethers (PBDEs)

PBDEs belong to a group of brominated organic substances including 209 congeners that have been used and produced since 1970, mainly in the electric and electronic industries, transportation and textile industries as flame retardants. However, due to the dangerous effects of PBDE on the ecological system several PBDE congeners, including TetraBDE, PentaBDE, HexaBDE and HeptaBDE, were prohibited by the Stockholm Convention in 2009.

Vietnam has not yet conducted a comprehensive national inventory. Actions related to PBDE mainly comprise research on PBDE pollution levels in environmental and biological samples at several places that are considered to have a high level of PBDE emission. This research was carried out with the cooperation of research institutes inside and outside Vietnam within the last five years. In 2012, VEA, in the framework of project "Development of institutional mechanism, policies, legislation on the management of persistent organic pollutants", developed inventory guidance for new POPs, including PBDE.

Pollution level of PBDEs in the environment in Vietnam

PBDEs are present in the environment due to the production, use and discharge of PBDE-containing products, which are considered as emission sources of PBDE. Research in Sweden during 1979-1981 pointed out the existence of PBDE in several environmental objects. The existence and distribution trend of PBDE in dust, air, natural water, waste water, waste sludge, sediment, plants and organisms have been proved by numerous studies in different countries in recent decades. PBDE can enter and accumulate in the human body through three main routes, air inhalation, dust absorption and through the food chain, verified by the detection of PBDE in human blood, breast milk and hair.

PBDE concentration in emission sources

PBDEs have been used as flame retardant additives in numerous industrial products. Tens of thousands tons of PBDE have been consumed each year for the production of plastic, rubber and paint, followed by the production of electric and electronic products, transportation means, labour protection clothing, textiles and furniture. Nowadays, according to EU regulation as well Vietnam regulation, the maximum allowance concentration of PBDE in a product is 0.1% or 1,000 ppm.

Currently a database on PBDE concentration in emission sources in Vietnam is not available. In 2012, research groups from Hanoi National University and the National Institute of Labour Protection analysed the PBDE concentrations in several plastic samples. Despite the moderate number of samples, the research provided initial and reliable data for preliminary assessment of the PBDE level in plastic samples, which lies in a wide range from 20-55,790 ng/g [49]. Product plastic samples (separated from plastic parts of e-waste such as TVs, personal computers and electronic boards) have an average PBDE concentration of 43,500 ng/g, 1,000 times higher than the average concentration of PBDE in raw plastic of 40 ng/g. The concentrations of PBDE in both kinds of plastic, however, were still l0 to 50,000 times lower than the level required by

the Restriction of Hazardous Substances Directive 2002/95/EC (RoSH (1,000 ppm). The PBDE concentrations in plastic samples were the same level as plastic samples in the Japanese market in 2008 (two years after the RoSH decision) and much lower than in products in 2000. A compilation of investigations on PBDEs in plastic products in Vietnam and Asia is given in Figure II.27.

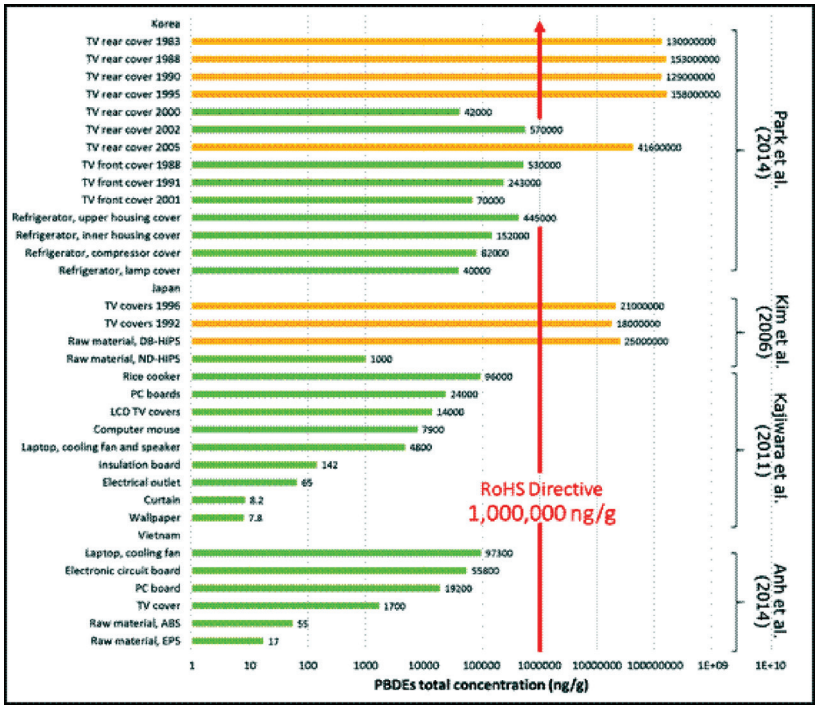

Figure II.27: PBDE concentrations in plastic products in Vietnam, Korea and Japan

The PBDE concentrations in plastic samples in Vietnam are compared with similar research in Japan and Korea [50-52]. The PBDE level in plastic samples in Vietnam was the same level to that of plastic products in the Japanese market, such as in personal computers, TVs, rice cookers, electric equipment, wall paper and curtains. Note that this research was conducted in 2008, when the RoSH decision had been effective for two years.

For products produced before 2000, especially in the case of TVs or HIPS plastic, PBDE concentrations are high, up to 14 to 145 times higher than the allowance level by the RoSh decision. Up to 2014, the RoSH decision, issued by European countries, is still an important regulation for other countries for the quality control of electric and electronic products that contain toxic substances, including PBDE.

Pollution level of PBDEs in air and dust

PBDEs can be emitted from PBDE containing sources into the air. Concentrations of PBDEs in the air largely depend on the sampling location, weather and temperature. PBDEs in air can travel a long distance or can be absorbed in suspended particle

phase, dust or fall down in soil. Dust is considered as the strongest accumulation environment of PBDE due to the high absorption ability. The PBDE concentrations in air and dust usually have usually been investigated at the same location to evaluate the emission level, exchange equilibrium and existence means of PBDE in these two environments. Inhalation of PBDE contaminated air and absorption of dust are the two main entrance routes of PBDE into the human body, hence the study of PBDE concentration and distribution in air and dust is important for the risk assessment of PBDE on human health.

In air, PBDEs have been usually investigated at different conditions such as indoor or outdoor sampling, different sampling times during the hot or cold season, and different sampling locations at urban, rural, metropolitan or industrial areas. Indoor air has been collected at different locations such as in houses, offices, stores and recycling sites. In general, the concentration of PBDE in outdoor air is much lower than in indoor air, while the PBDE concentration of indoor air is higher in offices than in houses or apartments. Usually, the level of PBDE pollution in rural areas is lower than in urban areas, and is highest at industrial zones, especially at e-waste recycling sites. The concentration of PBDE in air in the hot season is higher than in the cold season since the volatility of compounds increases with rising temperatures.

The concentration and distribution trend of PBDEs in air at two e-waste recycling sites at Trang Minh in Hai Phong, and Bui Dau in Hung Yen and at two reference sites in urban and suburban Hanoi have been investigated in 2008 [8]. According to this research, the average concentration of PBDE in air in suburban Hanoi is 4,6 pg/m^3 and in urban Hanoi it is 23 pg/m^3, 51 pg/m^3 and 58 pg/m^3 for streets and offices, respectively. The concentrations of PBDEs in air in family home that do not have e-waste recycling activities in Bui Dau and Trang Minh were 11 and 35 pg/m^3 respectively, the same level as urban Hanoi and significantly lower than families that have e-waste recycling activities (620 and 720 pg/m^3). Based on these results, we can preliminarily evaluate the pollution level of PBDE in air in Vietnam, and can also see the potential risk of plastic recycling activities on the release of PBDE into the environment.

The concentration of PBDE in air in Vietnam has been compared with other countries in the region and globally as demonstrated in Table II.7.

Table II.7: Pollution level of PBDEs in air in Vietnam, in comparison with other countries

No	Countries	Sampling areas	Concentrations (pg/m^3)	References
a. Indoor air				
1	America	House	760 (210 – 3,980)	Johnson et al. (2009)
2	China	House	628.3 (125.1 – 2,877)	Chen et al. (2008)

3	Norway	House	330 (72 – 1,400)	Thuresson et al. (2012)
4	Denmark	House	275 (107 – 953)	Vorkamp et al. (2011)
5	Vietnam	House, recycling places	11 and 35	Tue et al. (2013)
6	Australia	House	19 (0.5 – 179)	Toms et al. (2009)
7	Kuwait	House	8.2 (2.5 – 139)	Gevao et al. (2006)
8	Vietnam	House, working places	4.6	Tue et al. (2013)
b. Air at working place				
9	Norway	Office	4,000 (140 – 7,300)	Thuresson et al. (2012)
10	USA	Office	1,260 (21 – 17,200)	Batterman et al. (2010)
11	England	Office	1,082 (82 – 15,509)	Harrad et al. (2004)
12	Vietnam	E-waste recycling areas	620 and 720	Tue et al. (2013)
13	China	Office	518.3 (181.3 – 8,315)	Chen et al. (2008)
14	Canada	Office	140 (25 – 350)	Zhang et al. (2011)
15	Greece	Office	115 (19 – 10,848)	Mandalakis et al. (2008)
		Electronic shops	76 (29 - 139)	
16	Thailand	E-waste stores	52 (46 – 350)	Muenhor et al. (2010)
17	Australia	Office	18 (15 – 487)	Toms et al. (2009)
18	Kuwait	Office	8.6 (2 – 385)	Gevao et al. (2006)
c. Outdoor air				
19	China	Metropolitan, industrial zones	87.6 – 1,941	Chen et al. (2006)

20	France	Metropolitan, industrial zones	158 – 230	Castro et al. (2011)
21	USA	Metropolitan	65 – 135	Hoh et al. (2005)
22	Turkey	Industrial zones	117 ± 23	Cetin et al. (2008)
		Metropolitan	82 ± 28	
		Surburban	24 ± 10	
23	Vietnam	Metropolitan	23 and 51	Tue et al. (2013)
24	Thailand	E-waste recycling areas	45 (8 – 150)	Muenhor et al. (2010)
25	Greece	Metropolitan	26 (21 – 30)	Mandalakis et al. (2009)
		Suburban	15 (4 – 44)	
		Village	3 (2 – 11)	Lacovidou et al. (2009)
26	Australia	Metropolitan	1.7 et 6.8	Toms et al. (2009)
27	South Pole		0.67 – 2.98	Li et al. (2012)

As can be seen from the above table, the level of PBDE concentration in air in Vietnam lies in the middle range in comparison with other countries in the world. The concentrations of PBDE in indoor air in different countries in the world range from lower than 1 pg/m^3 up to about 4.000 pg/m^3. In Hanoi, suburban areas have pollution levels similar to the global ground level. Urban areas and rural reference areas with e-waste recycling activities have PBDE concentrations in air much higher than suburban areas. However, for families with e-waste recycling activities the concentration of PBDE in air is relatively high, about 10 times higher than at recycling sites in Thailand. This fact indicates that spontaneous e-waste recycling activities is one of the main PBDE emission sources into the air environment in Vietnam.

In dust, PBDEs present in air will be absorbed on dust, which is a highly PBDE-polluted environmental object. Numerous research studies on the pollution level and distribution trend of PBDEs in dust in different countries in the world have been published in scientific journals. However, in Vietnam research on this subject is limited and mainly focuses on several areas with high potential of PBDEs releasing, such as e-waste recycling villages and big metropolitan cities. PBDEs are absorbed on the dust layer that covers the surface of electric and electronic equipment or inside air conditioners. The larger the molecular mass of PBDE and the smaller the dust size, the stronger the PBDE absorption.

In 2012, a group of scientists at Hanoi University of Science, Hanoi National University and the National Institute of Labour Protection analysed PBDE in dust in two e-waste recycling villages in Trieu Khuc, Hanoi and Bui Dau, Hung Yen [49]. In 2008, dust samples from two e-waste recycling areas – Trang Minh in Hai Phong and Bui Dau in Hung Yen – and two reference areas in urban and suburban Hanoi were also collected for PBDE analysis [7]. The levels of PBDE accumulation in dust in Vietnam were compared with other countries in the world as illustrated in Fig. II.28.

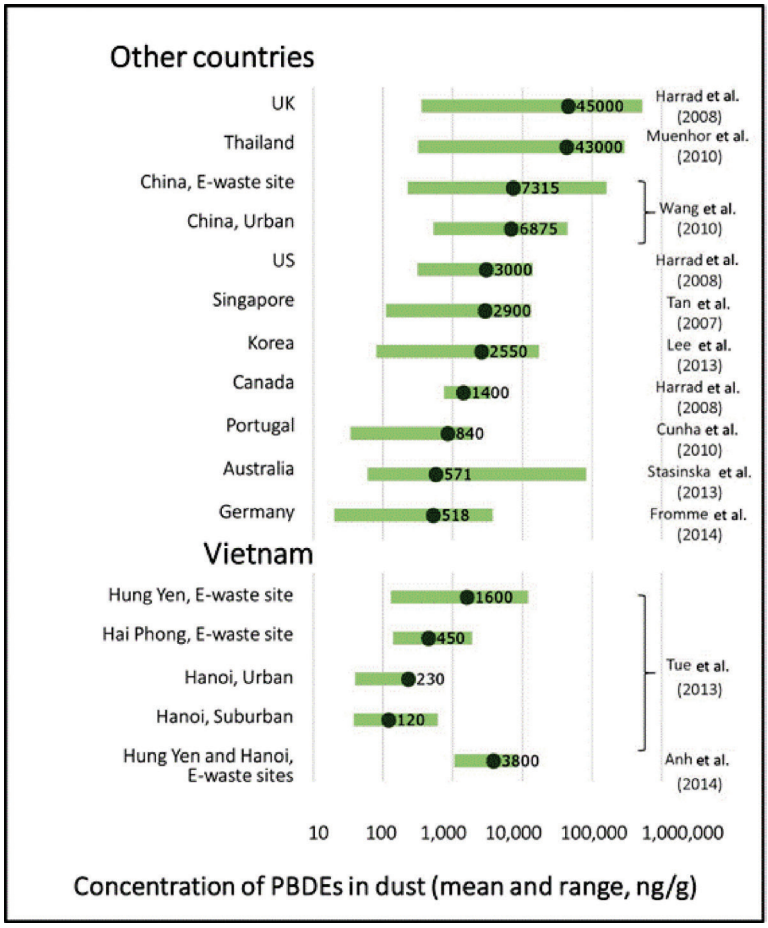

Figure II.28: Pollution level of PBDE in dust in Vietnam and other countries [5, 49, 70-76]

According to the data, the PBDE pollution level in dust in England is very high (with the average value of PBDE concentration of 45,000 ng/g and the highest PBDE concentration up to 520,000 ng/g). This concentration level is similar to the PBDE level in dust taken at electric and electronic stores in Thailand (average 43,000 ng/g). The PBDE concentration in dust collected in USA, Singapore, Korea and Canada is lower (from 1,400-3,000 ng/g). Dust samples taken indoor in Germany and Australia have the lowest PBDE level (about 500 ng/g). According to [8], PBDE concentration in dust taken from Hanoi and Trang Minh recycle sites is low, while for the recycle site in Bui

Dau it is average level. In Hanoi the concentration of PBDE in dust in urban areas is two times higher than in suburban areas. According to the newest research in 2012-2013 [49], the PBDE concentration in dust taken in Bui Dau and Trieu Khuc is about 6 to 37 times higher than in Hanoi, but still at an average level compared with other research and much lower than the high level in England and Thailand.

The concentration level and distribution trend of PBDE in air and dust are two important criteria for the evaluation of the PBDE pollution level in the environment, and a necessary parameter for risk assessment on human health. From the reported data it can be seen that the PBDE pollution in air and dust in Vietnam lies in the average level in comparison with other countries in the world. The significant high PBDE concentration in e-waste recycling villages in the northern part of Vietnam, if compared with the reference area, indicates that this recycling activity is the main emission source of PBDE into the environment. With the current amount of e-waste and the production yield of these recycling villages increasing over time, the loose management policy and inadequate awareness of environmental protection of residents living there may result in increased environmental pollution.

Pollution level of PBDE in soil and sediment

If air and indoor dust are considered as a direct receiving environment for PBDE, which can directly influence human health, soil and sediment are characteristic environments for the propagation of these substances. PBDE in these environments indirectly influences humans through the food chain, since the existence and accumulation of PBDEs in soil and sediment may affect the animal and plant system living there. Studies on the pollution level and distribution trend of PBDE in soil and sediment plays an important role, not only in the environmental aspect but also in providing information on emission inventory or studies on the existence and transportation of PBDE in the environment.

For soil, due to good absorption and high storage capacity, soil is a significant source for storing POP substances in general and PBDE in particular. PBDE can be absorbed on the surface of mineral or colloidal particles, especially mineral clay. The dissolution and mobility of PBDE in soil increases when soil contains soluble organic carbon such as sugar, amino acid or fatty acid. PBDE pollution levels in soil are an important criteria to evaluate the quality of the environment and assess the risk for humans via soil ingestion and dermal contact. The distribution trend of PBDE in soil depends on various factors such as the geological location, weather, pedological properties, human activities including industrial and agricultural production, and waste treatment activities.

In Vietnam, research on PBDE in soil is scares. However, the available data provides useful information to preliminarily evaluate the background concentration level and trace the potential pollution source. The concentration level and distribution of PBDE in soil at Thi Nai pond in the centre of Vietnam, located in a region with a number of economic, tourist and industrial production activities, has been studied [77]. The average value of PBDE concentration in soil taken around this pond was 1.4 pg/g dry wt (range: 0.21-4.02 pg/g dry wt).

Soil samples from open waste landfill sites in several Asian countries, such as India, Cambodia, Malaysia and Vietnam, have been collected by a Japanese research group from 1999-2007 to evaluate the pollution level of brominated flame retardants, including PBDE. Among the investigated countries, Vietnam has the highest concentration of PBDE in soil, with a mean value of 95 pg/g (from 1.2-430 pg/g) – about 400 times higher than the reference area and about 2 to 15 times higher than similar areas in other countries of the region [78]. However, if compared with other PBDE hot spots in southern China, the largest PBDE emission source until now is still e-waste recycling activities or e-waste burning.

The PBDE concentration levels in soil in Vietnam and other countries are presented in Fig. II.29 [77-83].

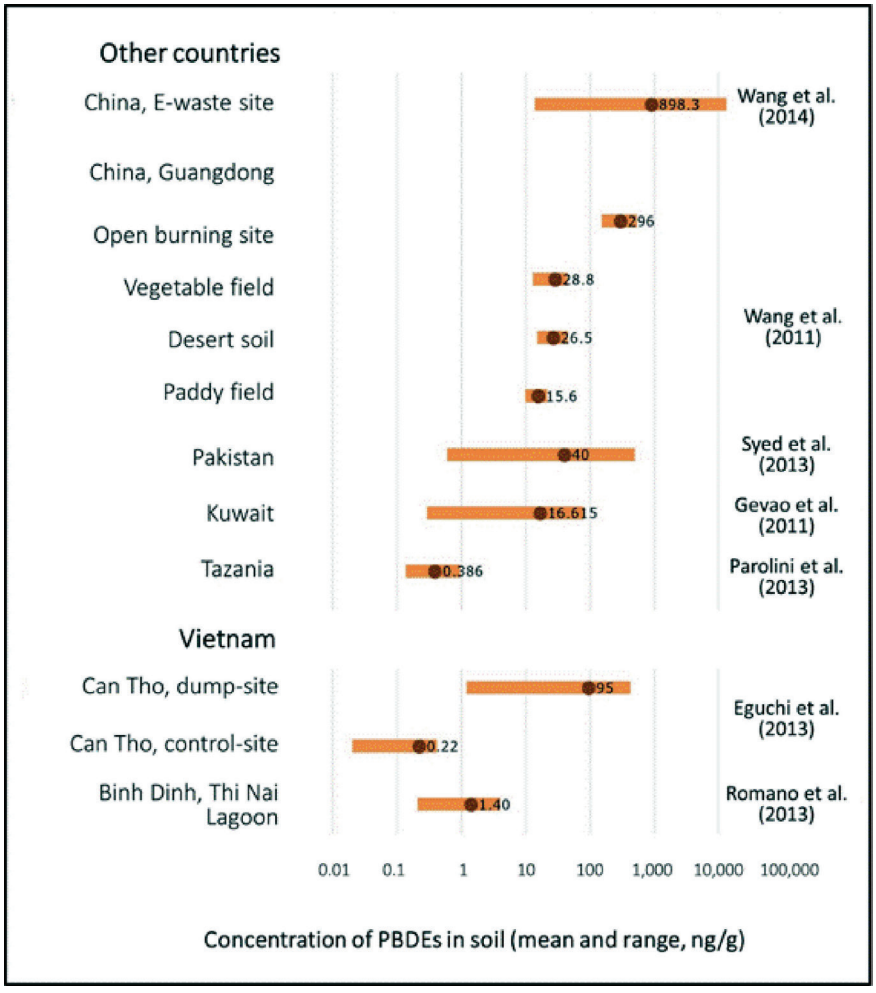

Figure II.29: Pollution level of PBDE in soil in Vietnam and other countries [77-83]

In Vietnam, the background level of PBDE is relatively low but the pollution of PBDE at waste landfill areas is significantly higher than in the reference area, and also higher than several other Asian and African countries. This reality indicates that the open and uncontrolled waste burial has a high risk of releasing PBDE into the environment because of the leaching of PBDE from e-waste, transportation means and discharged furniture.

For sediment, factors influencing the existence of PBDE in the equilibrium between water and sediment phases include the distribution of PBDE between the suspended particle phase and soluble phase, and hydrologic and geochemical properties of water such as turbidity, particle size distribution and organic carbon content in sediment. PBDEs are hydrophobic substances with very low water solubility. Hence, after being released in water they will be absorbed on organic matters, deposit and accumulate in sediment layers. Sediment is an important storage environment and also a secondary PBDE emission source that defines the existence manner, distribution and transportation trend of PBDE in the environment. PBDE-polluted sediment has negative impacts on bottom organisms, and if those organisms belong to the food chain they may become one of the PBDE exposure routes for human beings. Hence, research on PBDE in sediments has been conducted in many countries during the past decades.

The database on PBDE pollution in sediment in Vietnam is relatively sufficient compared to other environmental media, plus typical investigated areas have been selected for research, which has presented the distribution rules of PBDEs in sediment in Vietnam. In terms of the geological aspect, research has been carried out in the northern, central and southern regions, and ; in economic and social aspects, researches have been carried out in both agricultural and industrial zones, especially waste recycling sites. In general, in Vietnam the most likely PBDE polluted places are spontaneous e-waste recycling sites. Excluding the high pollution at recycling sites, other areas in Vietnam have a PBDE pollution level in sediment that is much lower than in Shinwa lake in Korea and Ravi lake in Pakistan, and is similar to other regions in Korea, Japan and China.

The PBDE levels in sediment in Vietnam and some other countries are represented in Fig. II.30 [77, 84-94].

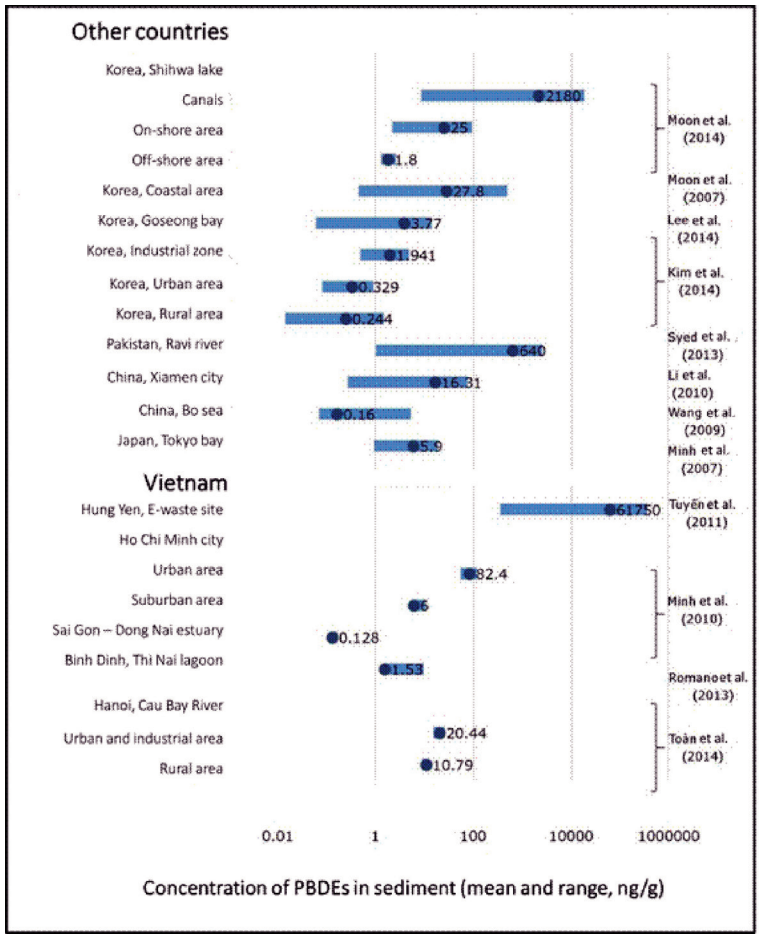

Figure II.30: The PBDE pollution levels in sediment in Vietnam and other countries [77, 84-93]

PBDE accumulation in biota

The PBDE concentration level in biota, especially aquabiota, provides useful information for the assessment of environmental pollution, as well as the risk assessment of PBDE exposure on the human body through the food chain. Since PBDEs are all hydrophobic and oleophilic, in a water environment they will absorb on the suspended phase, deposit and later bio-accumulate in fat tissues of animals. PBDEs have been detected in many kinds of animals, such as seagulls, seals, blue turtles, crabs and fish, especially bivalves. Bivalves have been considered as bio-indicators for environmental pollution globally, since they are widely distributed, adaptable to different environmental conditions and can easily be collected at all times of the year.

In the Asia-Pacific Mussel Watch Programme, green mussels (Perna viridis and Mytilus edulis) have been used as bio-indicators to indicate the accumulation level of POPs, including PBDE in coastal areas of ASEAN countries, such as Japan, Korea,

China, Hong Kong, India, Cambodia, Indonesia, Malaysia, the Philippines and Vietnam. A comparison of PBDE levels (ng/g fat) in mussels in Vietnam and other Asian countries is shown in Fig. II. 31 [94].

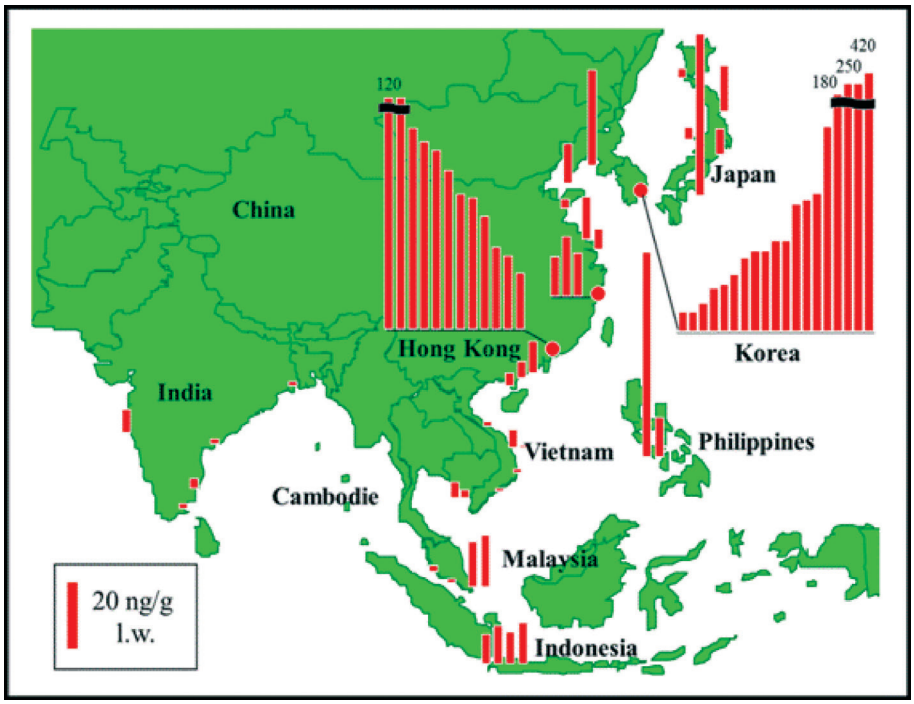

Figure II.31: PBDE accumulation level in mussels in Vietnam and other ASEAN countries [94]

According to this study, PBDEs have been detected in all mussel samples, showing widespread contamination of these chemicals in coastal areas of ASEAN countries. PBDE concentrations are distributed in a wide range, from 0.66-440 ng/g fat, depending on country and sampling location. In the marine environment, China, Hong Kong, Korea and the Philippines have a relatively high PBDE pollution level, Japan and Indonesia have an average level, while countries like Malaysia, Cambodia, India and Vietnam have the lowest level.

In Vietnam, green mussel samples collected in Hai Phong, Quang Binh, Thanh Hoa, Hue and Nha Trang have an average PBDE value of 2.0 ng/g lipid wt. and a concentration range of 0.66-5.4 ng/g lipid wt.

The accumulation of PBDE and other POPs in cat fish collected from Can Tho and Cao Lanh, Dong Thap province has been studied [14]. The average PBDE concentration (and range) in catfish taken from fish cultivation areas (reference area) and domestic waste landfill (potentially polluted area) is 0.77 (0.12-1.4) and 2.7 (1.4-3.7) ng/g fat. Results show that waste burial and processing activities have a high risk of releasing PBDE into environment, since the average PBDE concentration in fish collected at this area is three times higher than in the reference area. However, the

PBDE accumulation level in fish in the Mekong Delta region is still much lower than fish cultivated in the USA and the same level as fish collected from offshore areas in Indonesia and the Bengal gulf.

In research studies [14] and [94], next to PBDE other POPs such as PCB (old POPs characteristic of industrial activities) and DDT (characteristic of agricultural activities) have also been investigated. A comparison of the accumulation level of three POP groups, PBDE, PCB and DDT, in mussels and catfish is presented in Fig. II.32.

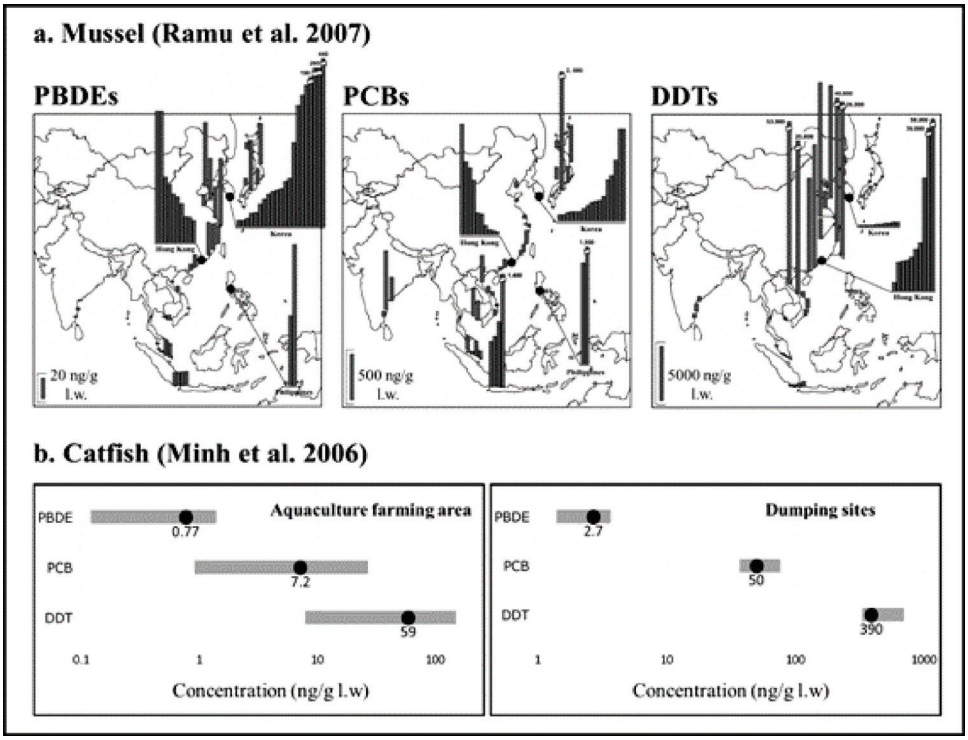

Figure II.32: Comparison of PBDEs, PCBs and DDTs in green mussels (a) and catfish (b) in Vietnam and other countries [94, 37]

Among the three POP groups, DDTs had the highest concentration, followed by PCBs and PBDE. DDTs and PCBs have been considered as the two main POP groups that cause serious environmental pollution. DDTs used to be imported and widely used in Vietnam from 1960-1990. Despite being banning since 1993, it is still a typical POP due to the high persistence in the environment. PCBs can travel from emission sources to a receiving environment such as air, water, soil, sediment and biota. The high concentration of PCBs in biological and environmental objects mainly relates to the use or discharge of electric equipment, oil and waste treatment.

Human exposure to PBDEs

Up to now, our knowledge of the toxicity of PBDEs is not enough to comprehensively evaluate their adverse effect on human health. The acute toxicity of PBDEs is rela-

tively low but PBDEs tend to bioaccumulate and cause long-term effect. The PBDE effect on humans and animals can be classified into six kinds that (1) influence the endocrine system, mainly the thyroid gland; (2) cause neural poisoning, (3) cause liver poisoning, (4) cause immunodeficiency, (5) influence reproductive ability and development; and (6) cause cancer.

Intakes of PBDEs into the human body take place by three main routes: (1) breathing polluted air, (2) absorbing polluted dust and (3) consuming food, especially fish and other seafood that accumulates PBDE in fat tissues. The congener ratio of PBDEs absorbed in each route depends on the existence form of PBDE in each environment. For example, light PBDEs such as DiBDEs are absorbed through breathing air, average PBDEs such as tetra, penta or hexaBDE are absorbed through food, while heavy PBDEs from octa to decaBDEs are absorbed through dust.

In Vietnam, the PBDE accumulation in the human body has not widely studied, partly because of the lack of advanced analytical techniques and difficulties in sample collection. A database on PBDE exposure on the human body in Vietnam is very scarce. Meanwhile, research worldwide in the last 30 years reveals a concern of scientists about the adverse effect of PBDEs on the human body. PBDEs have been detected in breast milk, serum, blood, fat tissue, liver tissue and hair. Especially the accumulation of PBDE in breast milk has attracted a lot of attention since breast milk contains a high fat content. The PBDE level in milk provides information not only to evaluate the PBDE exposure on the mother's body but also to assess the risk of breastfeeding children.

The accumulation of several POP groups including PBDE in breast milk in several areas in northern Vietnam, such as Dong Mai, Hung Yen (battery recycling villages), Bui Dau, Hung Yen (e-waste recycling villages), Trang Minh, Hai Phong (e-waste recycling villages) and Ha Noi (reference area) has been investigated [95]. According to this study, the PBDE concentration in breast milk of women working at e-waste recycling villages in Bui Dau has the highest mean value (84 ng/g fat) and range (20-250 ng/g fat), showing that recycling activities could pose the highest risk of PBDE exposure on the human body. PBDE concentrations in breast milk of other women living in the same area but not participating in recycling activity, as well as of women in other study areas, were about 30-150 times lower than the levels in breast milk of women directly involved in recycling activities.

The PBDE concentrations in breast milk in Vietnam were compared with other countries in the region and in the world. Range and mean (or median) values are presented in Table II.8 [95-106].

Table II.8: PBDE exposure level in breast milk in Vietnam in comparison with other countries

No	Countries	Sampling areas	Concentrations (ng/g t.l.fat)	References
1	Vietnam	Bui Dau, e-waste recycling	84 (20 – 250)	Tue et al. (2010)
		Bui Dau, other activities	3.2 (2.0 – 4.0)	
		Trang Minh	2.3 (0.55 – 13)	
		Dong Mai	0.73 (0.26 – 11)	
		Ha Noi, reference area	0.57 (0.24 – 0.8)	
2	USA		50.4	Ryan et al. (2006)
3	Canada	Ontario	48.3 (3.72 – 576)	Ryan et al. (2014)
4	China	Quanzou	11.4 (3.96 – 39.4)	Chen et al. (2014)
		Shanghai	8.6 (1.8 – 26.7)	Ma et al. (2012)
		Beijing	1.20 (0.68 – 3.07)	Li et al. (2008)
5	England	Newcastle	5.59 (1.28 – 22.0)	Bramwell et al. (2014)
6	Philippines		3.8	Malarvannan et al. (2009)
7	Spain	Catalonia, average	2.40 ± 1.67	Schuhmacher et al. (2007)
		Industrial zones	2.5	
		Metropolitan zones	2.2	
8	Indonesia		2.2 (0.49 – 3)	Sudaryanto et al. (2008)
9	Belgium		2.01	Colles et al. (2008)
10	Russia		0.96	Polder et al. (2008)

USA and Canada have the highest level of PBDE exposure in breast milk, about 50 ng/g lipid wt., followed by ASEAN countries like China (Quanzou and Shanghai) with a concentration of 10 g/g fat. Other ASEAN countries like the Philippines and Indonesia and European countries like Spain, Belgium and Russia have a relatively low PBDE concentration, about 5 ng/g fat. With an average concentration of 84 ng/g and the highest concentration of 250 ng/g, the e-waste recycling activity in Bui Dau has the

potential of creating a risk to the health of workers and their children.

Comments about research on PBDE in Vietnam

Based on available data on PBDE, the amount of PBDE, the environmental pollution level and accumulation level in Vietnam can be preliminarily evaluated. PBDE has been detected in several environmental samples, with the main emission source being electric and electronic equipment, transportation vehicles and home furniture. The concentration of PBDE is very low in raw plastic beads, much lower than the allowance level given by Circular No 30/201/TT-BCT of the Ministry of Trade for toxic chemicals in electric and electronic products and the RoHs decision for plastic waste. In environmental samples such as dust, air, soil and sediment, the concentrations of PBDE have an average value if compared with other countries in the world. Even in large metropolitan cities such as Hanoi and Ho Chi Minh City, the concentration of PBDE is still around the background level.

c) Research activities on hexabromcyclododecan (HBCD)

Hexabromocyclododecane (HBCD) is a group of brominated flame retardants, synthesized by the bromination of cyclododecatriene, including 3 g main congeners (included in more than 70% of commercial products). Similar to PBDEs, HBCDs are widely used in plastic and fibre materials to produce furniture, electronics and electric equipment. The materials that contain the largest amount of HBCD are two kinds of polystyrene, EPS and XPS. Heat insulation plates made from these plastics contain up to 0.5% HBCD. In 2001, the HBCD demand in the worldwide market was about 16,700 tons, of which 8% is for total brominated flame retardants. The popularity of HBCD in the market stands in third position, only after TBBPA and Deca-BDE. The two largest markets of HBCD consumption are China and EU countries.

HBCDs have been detected at a high level in the environment, animals and human bodies. Like other POPs, HBCDs have a high stability and high bio-accumulation ability, and hence can cause adverse effects on humans and animals. Even though knowledge about the toxicity of HBCD on the human body is not yet sufficient, available research reveals that HBCD can cause similar negative effects as DDTs and PCBs. This includes causing disorder in the gene recombination process and resulting in a number of diseases, including cancer. HBCD can have an effect on the development of the neural system of new-born babies, resulting in a distortion in behaviour, reflex or a decline in memory.

In October 2012, the POP Committee ratified the introduction of HBCD in Appendix A of the Stockholm Convention, with two special exemptions for EPS and XPS plastics. In May 2013, the final decision to add HBCD to the list of elimination compounds of the Stockholm Convention officially went to force. Up to now, HBCD is the newest POP group in the Stockholm Convention. A database, knowledge and management experience of these substances in Vietnam, as well as in other countries, is still limited.

Status of HBCD contamination in Vietnam

Global research on HBCD has been conducted in many environmental objects,

including air, dust, soil, sediment and mud, and biological objects such as fish, bivalve, bird tissue and eggs. In the human body, HBCDs have been detected in blood and breast milk.

In Vietnam, comprehensive research on the existence, concentration level, distribution trend and transportation means of HBCD in environmental, biological and human objects is not yet available. The main research has been done by a research group at CETASD, Hanoi University of Science, National University, in cooperation with the Centre for Marine Environmental Study at Ehime University in Japan. This research only focuses on the exposure of HBCDs on the human body through accumulation in breast milk and pollution in dust and air, the two environments that closely relate to the HBCD exposure route to the human body. The study areas are villages that have waste recycling activities, which are considered as a potential source for HBCD emission, and Hanoi, a typical urban area.

The pollution level of HBCD, together with PBDE and PCB, in urban and suburban Hanoi and two e-waste recycling sites at Trang Minh, Hai Phong and Bui Dau, Hung Yen has been investigated [8]. The concentration of HBCD (median and range) in dust in Hanoi (urban and suburban), Trang Minh and Bui Dau are 7.4 (0.99-61), 8.7 (1.3-32), 29 (7.5-130) and 120 (5.4-40) ng/g, respectively. In comparison with the concentration of HBCD in dust in other countries such as Japan, Canada, USA and England, the pollution level of these substances in Vietnam now is relatively low. However, the abnormally high concentration of HBCD in dust in Bui Dau shows the potential risk of releasing HBCD from e-waste recycling activities. For air samples, since air is not a characteristic absorption environment of HBCD, the concentration of HBCD is very low and not significantly different from air at offices and at e-waste recycling sites.

Another study [95] has determined the accumulation of several POP groups, including PBDE, PCB and HBCD, in breast milk in Hanoi and the three recycling sites of Trang Minh, Hai Phong (e-waste recycling), Dong Mai (battery recycling) and Bui Dau, Hung Yen (e-waste recycling). There is no significant difference between HBCD concentration in breast milk of women living in Hanoi, Dong Mai or Trang Minh and those who live in Bui Dau but do not participate in recycling activities, with concentrations of HBCD at 0.33, 0.42, 0.38 and 0.36 ng/g fat, respectively. Meanwhile, the concentration of HBCD (median and range) in breast milk of women participating in recycling activities is 2.0 (1.4-7.6) ng/g fat, about 5 to 6 times higher than in other study areas. Research on HBCD has usually been conducted together with other POP groups, especially with PBDE and PCB. A comparison of the accumulation of these three POP groups in dust and breast milk samples in Vietnam is presented in Fig. II.33 [8,95].

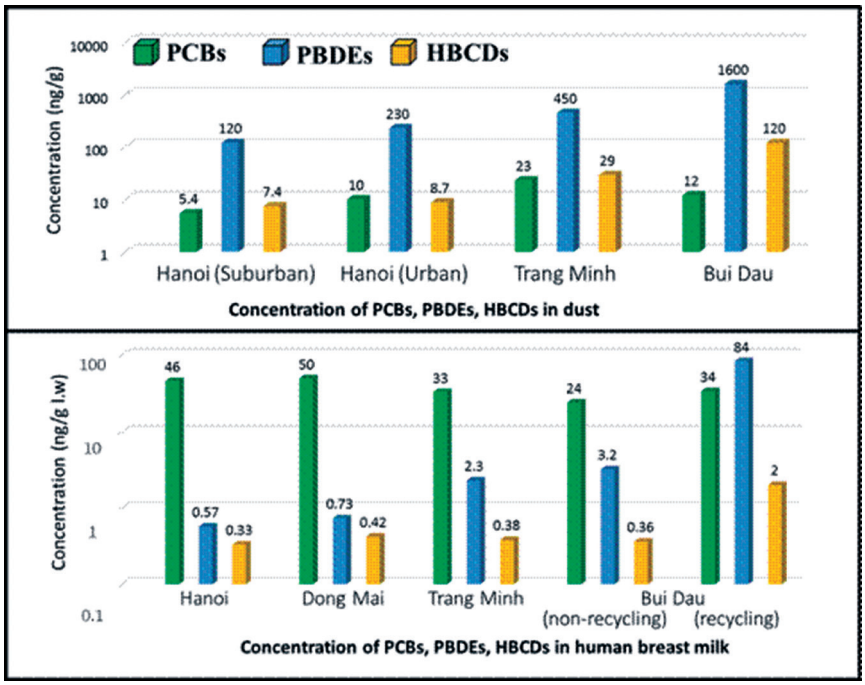

Figure II.33: Comparison of the accumulation of PCB, PBDE and HBCD in dust and breast milk at several places in Vietnam [8,95]

The relative accumulation level of the three POP groups is different from dust to breast milk samples. For dust samples, the concentration level of PBDE is significantly higher than the concentration of the other two groups. The concentration of HBCD is second highest and lowest is PCB concentration. At the e-waste recycling site in Bui Dau, the concentration of two brominated flame retardant groups is much higher than the concentration of PCD, showing that e-waste is the main emission source of PBDE and HBCD.

For breast milk samples, except the recycling site at Bui Dau, the rest of the study areas show the highest concentration of PCB, followed by PBDE and later HBCD in milk samples, which shows the high bio-accumulation of PCBs. For breast milk taken from women participating in e-waste recycling activity in Bui Dau, the PBDE concentration is 2.5 times higher than the PCB concentration, proving the high exposure level and high risk to human health of PBDE in this area.

Comments about research on HBCD in Vietnam

Research on the pollution status and distribution trend of HBCD in the environment in Vietnam is still incomplete. The limited database about the background level of HBCD in different environmental subjects and the accumulation level in humans and animal bodies makes it difficult to draw overall conclusions and make a profound assessment about these substances. However, based on the available data, the following remarks about HBCD in Vietnam can be given:

(1) The concentration of HBCD in the environment of Vietnam is still quite low in comparison with other countries in the world.

(2) Areas that can release HBCD into the environment include e-waste recycling sites and offices with a large amount of electrical and electronic equipment.

(3) HBCD has been detected in human bodies.

With this current status, we need to conduct more synchronized research on HBCD in Vietnam, as well to widen the objectives and scope of research and enhance the HBCD monitoring capacity at laboratories and analytical centres. Furthermore, it is necessary to develop a thorough inventory guidance for HBCD, based on international references in combination with real measurement data in Vietnam, to effectively support the emission inventory and risk assessment of HBCD, recommend a sound management plan, minimize the emissions and finally completely eliminate HBCD in Vietnam.

Introduction on PFOS and related compounds

PFOS and related compounds (PFC) belong to the group of perfluorinated chemicals in which all Hydrogen atoms are substituted by a Fluorine (F) atom. Apart from PFOS and PFOS-F, there are several groups of perfluorinated compounds such as Perfluoroalkyl sulfonate (PFAS), Perfluorocarboxylic acid (PFCA), Perfluorooctanoic acid (PFOA), Perfluoro telomerealkohol (FTOH) and Perfluorooctane sulfonamide (FOSA). PFC compounds are chemically inert, have low surface tensity, are stable under high temperature, and are widely used in various industrial sectors and purposes such as electroplating, mining, petroleum, foam, fire-fighting foam, hydraulic liquid and insecticides.

Despite having relatively high persistency and toxic responses, PFC's accumulation characteristics are somewhat different from those of classic POPs. They do not normally accumulate in lipid-rich tissues, but tend to bind to protein in blood and liver. PFCs have been reported to exert some reproductive adverse effects such as reducing sperm count and delaying pregnancy. Several investigations showed that prenatal exposure to PFCs may be linked to a foetal reduction in weight and size.

The Stockholm Convention amendment approved nine groups of new POPs in Annex 3 in August 2010. PFC compounds, including Perfluorooactane sulfonic acid, Perfluorooctane sulfonate and Perfluorooctane sulfonyl fluoride, were added to Annex B, which are the first industrial chemicals of this Annex. As a member of the Stockholm Convention, Vietnam has been implementing some preliminary research activities to evaluate the status of environmental contamination of PFCs and their potential emissions and sources.

Status of environmental contamination by PFOS and related compounds in Vietnam

PFOS and related compounds have recently been investigated extensively worldwide, and their accumulation has been reported in water, the particulate phase, airborne particulates, sediment, soil, animals and human beings. Unlike classic POPs,

PFCs are able to dissolve in water and this is among the most studied environmental media for these chemicals. During production, PFOSs release to the environment, with up to 80% of their emissions finally being deposited to the water phase. PFCs have been detected in water and sediment from most of the atmospheric and hydrospheric media, from rivers to open oceans, surface and groundwater, rain and storm run-off from both urbanized areas and polar regions of the globe. Monitoring investigations in the water environment can provide useful information on the transport and fate of PFCs in atmospheric and hydrospheric media. In Vietnam, the database on PFC contamination in the environment is still limited. Studies are often scattered, and most of them are focused on the occurrence of PFCs in the surface water environment. A few studies have been conducted on human exposure in breast milk and blood, within the framework of larger comprehensive investigations in countries such as Japan, Korea and China.

As for the water environment, PFC concentrations often ranged at the ppt or pg/L level, and this is one of the challenges in monitoring and conducting an inventory of these chemicals. A recent survey of PFOS and PFOA in water in six Asian countries, comprising Japan, China, Thailand, Malaysia, Singapore and Vietnam [107], showed that mean levels of PFOS and PFOA in water from Hanoi were 0.1 and 0.9 ng/L, respectively. These are markedly lower than those reported in Malaysia (7.1 ng/L), Thailand and Japan. PFCs for other studies [108, 109] demonstrated useful hints for tracing distribution and pollution trends and sources. PFC concentrations in surface water from different locations representing different source categories followed the increasing order of rural area < discharge point of municipal wastewater < heavy metal recycling from batteries < landfill dumping sites for municipal waste < obsolete e-waste recycling sites. Elevated levels were encountered at open landfill dumping sites and e-waste recycling villages, suggesting that these areas are potential sources of these PFC compounds.

Human exposure to PFOS was also reported in several studies. In Vietnam, breast milk of 40 women from Ho Chi Minh City was analysed for PFCs. PFOS levels ranged from 16.9-393 pg/ml, with a mean concentration of 75.8 pg/ml. The second rank was PFOA (ranging from 0.042-0.089 pg/ml). Other compounds such as PFHxS, PFNA, PFBS and PFHpA were presented at relatively low levels. In general, PFC levels in breast milk from Vietnam were in the lower range, comparable to Cambodia and India, and about 40-50% less than in the US, Germany and China. A compilation of PFOS in breast milk in Vietnam in comparison with other countries is given in Figure II.34.

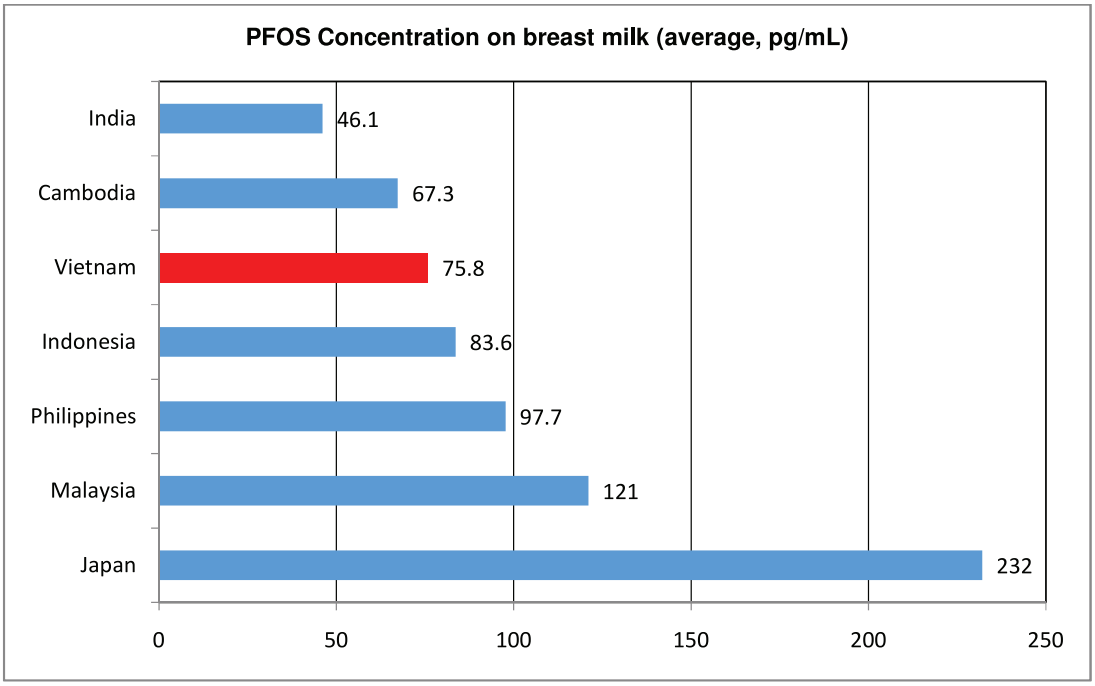

Figure II.34: Comparison of PFOS in breast milk in Vietnam and other countries

In human blood, PFOS levels found in Vietnamese women aged from 20-40 ranged from 1.89-14.6 ng/ml, and PFOA levels were < 0.2-1.57, with a mean of 0.575 ng/ml. PFOS concentrations in Vietnam were comparable to those in Japan (6.19 ng/ml) and lower than in Korea (8.43 ng/ml), while PFOA in Vietnam was markedly less than these two industrialized countries.

In Vietnam, the database on the concentration and distribution patterns of PFOS and PFC is very limited. Research only focuses on the aqueous environment and human bodies, which are typical for the existence and accumulation of PFOS. For other environmental media such as air, soil, sediment, dust and animal bodies, the database on PFOS concentrations is not yet available, which basically limits comprehensive knowledge of the existence and transportation of PFOS.

Based on the available database on PFOS concentration in surface water, the pollution level of PFOS in the aqueous environment in Vietnam can be considered very low, much lower if compared with other countries in the region. However, research also reveals several potential activities that release large amounts of PFC, including e-waste recycling at spontaneous craft villages and uncontrolled domestic waste burial. It is therefore important to plan a close management of activities that have a high risk for PFC emission as well to study, recommend and pilot sound management models and minimize the PFC emission in these places.

The exposure of PFC to human bodies in Vietnam is still low compared to other countries in the region and globally. However, the risk of PFC to human health cannot be

ignored. Further comprehensive studies are needed to provide an overall picture of environmental contamination and human exposure, and a risk assessment of these chemicals for the natural ecosystem and human health.

III. Resource mobilization for POP management in Vietnam

III.1. Internationally-funded projects in Vietnam

To implement the Stockholm Convention in Vietnam, the Government has developed and issued the National Plan, which was approved in Decision No. 184. The National Plan proposes schemes, projects and priority tasks that are based on the actual conditions in Vietnam. In the ten years from 2004 to 2014, Vietnam has actively mobilized both local and international resources to execute the proposed projects on POP management. The mobilization has been flexible, depending on different conditions in terms of areas, sectors, capital source and donors.

Figure III.1: MONRE has been working with other ministries, sectors and the GEF Secretariat on resource mobilization for Stockholm Convention implementation

The results of the resource mobilization from international sources are illustrated through typical projects in the table below.

Table III.1: List of internationally-financed projects on POP

No.	Name of project	Time	Funding source	Implementing agency
1	GEF/UNDP Project – NIP development	2004 - 2006	GEF	UNDP

2	Environmentally sound management and disposal of PCB in electrical systems – a pilot project for PCB-elimination in Vietnam	2007 - 2009	Swiss Agency for Development and Cooperation	CarboTech Company, Switzerland
3	Implementation of the POP monitoring plan in Asia	2007 - 2010	Japan's Ministry of Environment	JCES Center, Japan
4	GEF/UNIDO Project - BAT/BEP application	2009 - 2011	GEF	UNIDO
5	Demonstrating and promoting BAT/BEP for reducing healthcare waste to avoid environmental releases of dioxins and mercury	2009 - 2014	GEF	UNDP
6	GEF/UNDP – Dioxin remediation	2010 - 2014	GEF	UNDP
7	GEF/WB - PCB	2007 - 2008; 2010 - 2014	Canada, GEF	World Bank
8	GEF/UNDP – POP-pesticides	2009 - 2015	GEF	UNDP, FAO
9	Environmental remediation at Da Nang airport	2009 - 2016	The United States Agency for International Development (USAID)	American company
10	Strengthening the capacity of Dioxin monitoring at hot spots	2011	Czech Republic	MONRE
11	Evaluation of Dioxin contamination at hot spots	2006	Ford Foundation, Canada	Hatfield (Canada)
12	Development of MONRE dioxin laboratory belonging	2009 - 2014	The Bill & Melinda Gates Foundation and Atlantic Philanthropies	MONRE
13	GEF/UNDP Project – NIP update	2013 - 2015	GEF	UNDP

14	Safety management of POPs and toxic chemicals in Vietnam	2015 - 2018	GEF	UNDP
15	Implementation of POP monitoring plans in Asia	2015 - 2019	GEF	UNEP
16	Demonstration of best available techniques and best environmental practices for open incineration to implement the Stockholm Convention on POP	2015 –2020	GEF	UNIDO

III.2. State budget and other social resources

Along with the internationally-financed projects, the Government of Vietnam has mobilized from diverse sources within the country in order to contribute to the implementation of its commitments on POP safety management. The following are typical projects and tasks:

- Project "Education and awareness raising on POP"

- Project "Improving mechanisms, policies and laws on the management of persistent organic pollutants" (2009-2013)

- Task "Inventory and investigation of PCB contaminated sites"

-The national target programme on pollution remediation and environmental improvement

- Projects on decontamination and remediation of Dioxin hot spots

Being aware of the POP risks, as well as the opportunity to provide services on toxic chemicals monitoring and assessment, many laboratories have been increasing investment and capacity so as to be able to monitor and evaluate POP contamination. Some waste management companies have invested resources in research and applied POP storage techniques.

Vietnamese counterpart funding, in the form of in-kind and human resources, has also been mobilized in order to manage POPs in Vietnam.

IV. Review the implementation of the Stockholm Convention in Vietnam

It can be seen that for the last ten years (2004-2014) Vietnam has achieved many results in realizing its commitments to the Stockholm Convention on persistent organic pollutants (POP). Initially information and awareness on POP was only limited to a small group of scientists, and there were no management mechanisms for POPs. However, after 10 years multiple policies on POP management have been developed and submitted to the Government for approval and issuance, serving as background, guidance and orientation to promote the growth of other relevant POP management areas. On that basis, assigned ministries and sectors and concerned organizations

and individuals have jointly built the legislation and mechanisms for implementation and jointly deployed activities such as improving the infrastructure, pollution monitoring and treatment, raising awareness and changing behaviours related to POPs, chemicals and POP-like toxic waste.

Some specific evaluations are presented below:

IV.1. Development of legal and institutional framework

Based on the requirements of the Stockholm Convention and Vietnam's existing policy framework, a policy system has been built to guide and strengthen the management of each specific areas related to POP. In the context of the current legal and institutional system of Vietnam, policies on POP management have been developed according to specific areas, including pesticide management, management of PCB in electrical equipment, control of POP release in industrial sectors, awareness and restriction of U-POP release, and environmental remediation of Agent Orange/Dioxin used by US forces during the war in Vietnam.

These policies have been enacted in many different forms, such as being integrated in the National Assembly's resolution on chemical stockpiles or the Prime Minister's decisions promulgating national plans and strategies. These policies has served as the basis to assign responsibilities and guide relevant ministries, sectors and localities on implementation. Some ministry-level decisions have been developed and implemented such as MONRE's decision on implementing the national target programme and the plan on PCB management elaborated by the Ministry of Industry and Trade. In addition, different institutions also collaborate in deploying policies that have linked objectives and activities, for instance policies on cleaner production and applying BAT/BEP to restrict Dioxin/Furan release. It can be seen that with one National Assembly resolution, four Prime Minister decisions and a good number of ministry and sector level programmes, different areas of POP management have been covered in major policies.

In general, the issuance and implementation of these policies have significantly contributed to reducing POP contamination. Likewise, it has also created conditions for a positive change and improvement in awareness of ministries, sectors and communities towards further development and implementation of other important activities. For example, Decision No. 1946 can be considered as one of the important platforms to build the national target programme on environmental improvement of craft villages and sites contaminated by chemical stockpiles. This is the first ever national target programme in the field of the environment and has been allocated substantial funding, up to 2,500 billion Vietnam Dong (equivalent to US$ 125 million). Similarly, the decision promulgating the national programme on remediation of Dioxin contamination caused by the US armed forces during the Vietnam war is one of the significant bases for the Government to adopt the national-level Science and Technology Programme on Agent Orange/Dioxin remediation, to be financed with a total budget of 180 billion Vietnamese dong (equivalent to US $ 9 million).

Regarding the legal regulations, information from the Stockholm Convention, the

international experience and the actual needs for POP management have created important prerequisites for Vietnam to build new and practical policies to manage, control and reduce the pollution of these substances. As discussed above, within the legal framework of Vietnam, a series of circulars, technical regulations and environmental standards have been reviewed, supplemented or newly developed, step-by-step improving and completing the legal framework for POP management and hazardous chemical management in general. These policies are compatible with different management areas such as pesticides management, industrial chemicals management, emission control, environmental monitoring, pollution treatment and environmental health.

In addition, as POP substances have characteristics of both toxic chemicals and hazardous waste, and because POP substances are typical for stockpile pollution, the safety management of POPs has formed an important ground for strengthening and expanding environmental management of other areas such as chemical pollution control, stockpile management disposal, environmental risk management, prevention and remediation of environmental incidents, monitoring of toxic chemical pollution, environmental health and voluntary programmes on extended responsibility of producers. To some extent, the new aspects, concepts and knowledge mentioned above have been mainstreamed into the 2014 Law on Environmental Protection, and has created favourable conditions for further development of chemical pollution control and environmental protection in the future.

Regarding implementation mechanisms, the roles and responsibilities of ministries, sectors, organizations and individuals have been specified more clearly via the new policies and regulations mentioned above. On that basis, a more consistent cooperation mechanism has been built for POP management, chemical pollution control and environmental protection in general. In addition, the Steering Committee for the Stockholm Convention implementation has also been established with the participation of relevant ministries and sectors. Because the risk management of the 23 POP groups is a multi-sectoral issue and is hard to address by a single sector or industry, programmes and projects on POP management have accelerated inter-disciplinary and inter-regional collaboration to solve assigned tasks. This can be seen through joint activities between MONRE and MOIT to manage PCB, reduce U-POPs released from industrial activities, cooperation between MONRE and the Ministry of Health to control emissions of Dioxin/Furan from incinerators and manage environmental health, and between MONRE and MARD to manage and dispose of pesticide stockpiles, pesticide chemicals and collection of pesticide packaging after use.

In the framework of many programmes and projects on POP management, the activities on institutional strengthening have also been implemented through providing tens of thousands of participants from various sectors and areas with education and training on relevant policies and laws.

In short, the development of policies, legislation and institutional frameworks for implementation of the Stockholm Convention have created a fundamental and relatively consistent foundation for POP management. This only helps widen the vision

and ensure positive and long-term impacts of these policies and legal documents on environmental protection, particularly on chemical pollution control, but also becomes a catalyst for the completion of the legal framework on environmental protection in Vietnam.

IV.2. Technical capacity building

The results of POP monitoring and pollution treatment have shown that, in parallel with strengthening the legal system, activities on technical capacity building on POP management have also been carried out efficiently. Through international projects, a lot of training and education on pollution monitoring, risk management and POP stockpile treatment has been widely deployed across Vietnam.

From the perspective that the management of POPs requires understanding the context of import, production, use, storage, discarding and disposal of these substances in Vietnam, many institutions, organizations and individuals in Vietnam, with the strong support from international projects, have been involved in capacity building, inventory and investigation, and have reviewed the current situation of POPs in Vietnam. In the period 2004-2014, activities on inventory, monitoring and assessment of POP pollution have increased in terms of both quantity and quality, including an assessment of pesticide contamination, PCB in electrical equipment, unintentional release of Dioxin/Furan from industrial activities and pollution of Agent Orange/Dioxin used by the United States during the war. The results of the inventory, monitoring and assessment of pollution have shown a comprehensive picture of the current state of the environment and the high risks caused by POPs on the health of Vietnamese people. It is therefore crucial for Vietnam to have appropriate management measures.

Work by local and international scientists have detected the pollution caused by POP emissions into the environment in Vietnam, including in the environment of surface water, sediment, blood and breast milk. The concentration of pollutants in some places is remarkably high and worrying, and is similar to what is happening in many countries in the world.

The national capacity for POP analysis and disposal has also been periodically evaluated in order to determine and arrange solutions on investment, capacity building and support for the execution of related policies and regulations. The capacity of dozens of domestic laboratories has been evaluated, improved through training and recognized. More than 10 types of treatment technologies have been reviewed, of which some POP disposal techniques have been licensed to be applied in practice.

As POPs are difficult to detect and often pose risks even at low concentrations due to their high toxicity and biological accumulation, the capacity of pollution monitoring and analysis of these substances' traces and ultra trace has been paid special attention. In the past Vietnam had some labs with sufficient equipment for POP sampling and analysis. However, for a long time and for many different reasons their analytical quality has not been assured. In recent years, POP management projects have undertaken a series of investigations, assessments and training on POP sampling and analysis, including difficult sampling like POP in stack gas, baseline gas medium, the

atmosphere or in biological samples. The requirements for quality analysis have also contributed to boosting investments into laboratories, including financial support from international projects, the state budget and private investment.

Laboratories in Vietnam have been supported to establish and participate in a national network and connect with foreign laboratories for experience sharing and capacity building. Up to now, several laboratories have been equipped with modern analysers (such as GC/MS high resolution, HPLC/MS/MS, automatic purifying systems and stack gas sampling). Moreover, laboratory staff have also been trained on sampling and analysing processes, fulfilling both domestic and international requirements for analysing many POP groups. There have so far been at least six laboratories in Vietnam recognized for the quality of PCB analysis, two laboratories recognized for dioxin analysis and many others for analysis of environmental chemicals according to international standards. Some Vietnamese laboratories have been actively involved in regional and international programmes on POP monitoring and risk assessment, such as the dioxin laboratory of VEA, CETASD and the laboratory of the Vietnam-Russia Tropical Center.

For Dioxin/Furan generated from industrial sources, some of Vietnam's laboratories have recently become capable of sampling and analysing these substances and providing reliable results. An initial assessment of Dioxin/Furan emitted from industrial production and waste disposal has confirmed the hazards and risks caused by Dioxin/Furan emission into the environment. Thus, there is a need for tighter control of Dioxin/Furan releases in the near future.

At the same time, through POP monitoring and analysis projects Vietnam has attracted competent scientists from abroad to come to work in the country. Vietnam has also strengthened the cooperation with international experts and improved human resources working in this field.

Together with POP inventory and analysis, databases on POP management have been developed and put into practice, such as the information system for the management of PCB-containing materials, equipment and waste, the information system on POP-pesticide stockpile management, the Agent Orange/Dioxin pollution map and the hazardous waste registration system.

A series of detailed technical guidelines on management, storage, transportation, monitoring and treatment of POPs, such as pesticide stockpiles, PCB in transformer oil and U-POPs emission from households and industrial activities, have been elaborated by VEA. This helps increase the feasibility of POP management and simultaneously supports training and capacity building.

In brief, capacity building and assurance of the POPs analysis quality have contributed to a broader inventory and monitoring and pollution assessment, improved awareness of the POP status and POP risks to human health and the environment, and has thus contributed significantly to POP control and environmental protection in Vietnam. POP monitoring has also assisted the development and implementation of policies and legal documents in this area. All of these activities have contributed to protecting

human health, the environment and sustainable development in the country.

IV.3. Development of POP treatment infrastructure

The detection of contaminated sites of POP stockpiles or POP releases into the environment has increased the need for treatment of these substances. In the framework of POP management, many activities such as reviewing and evaluating POP treatment techniques have been carried out. The results of these activities have assisted Vietnam in making greater progress in acquiring knowledge, experience and technical infrastructure related to POP remediation and waste treatment. Some research reviewing and comparing various disposal technologies for PCB, pesticide and Agent Orange/Dioxin contaminated soil has been publicly disclosed, supporting the technology transfer. The analysis of costs, benefits and socio-economic impacts of POP treatment technologies has also been undertaken more comprehensively.

Along with technology research and assessment, the development, transfer and application of POP treatment technologies have also achieved results. To date, a number of disposal technologies have been licensed, such as combustion in high temperature incinerators, co-processing in cement kilns or thermal desorption technology for Dioxin contaminated soil disposal. Some other technologies are under trial to be transferred to Vietnam or applied in practice, for instance mechanochemistry by ball mills, chemical or biological techniques, or plasma arc.

The best available techniques and best environmental practices to reduce U-POP release from industrial activities have also been introduced and applied in practice such as fuel classification and waste selection before incineration, combustion parameter control and techniques combined with cleaner production technologies in the production process. Likewise, the solutions for PCB safe transportation and storage have also been studied and applied to reduce the risks of environmental pollution.

From these practical activities, the awareness and demand for POP pollution reduction have formed a market for POP treatment technologies in Vietnam. Activities like research, evaluation, transfer and application of technologies for POP treatment and chemical pollution treatment in general have increasingly been developed and promoted. As a result, some POP stockpiles have been directly eliminated and POP release has been reduced, as specified in the objectives of the Stockholm Convention.

IV.4. Awareness raising of the adverse impacts of POPs

After a decade of implementation of the Stockholm Convention in Vietnam many activities have directly and indirectly raised the awareness and changed behaviours on POP management. The awareness of POP risks on health and the environment has been considerably improved in both authorities and communities. Hundreds of articles have been published, many related TV and radio programmes have been broadcast, a lot of communication material has been provided to the public, and information related to POPs has been exchanged on social networks. The news and TV programmes about PCB in transformer oil, pesticide pollution, dioxin emissions from incinerators and harmful effects of Agent Orange/Dioxin have attracted a lot of

interest from the community. Decision No. 184 and subsequent programmes and projects were the first activities in Vietnam to mention and disseminate information of the risks caused by POPs, PCBs, pesticides and Dioxin in a systematic and effective manner. The valuable lessons learnt by other countries as well as the Stockholm Convention have also been shared with authorities and local communities to learn from and avoid the serious consequences caused by POP contamination.

In many cases, concerns and requests for action from the public have created pressure and have helped to speed up and increase the efficiency of POP management activities in Vietnam. The attitude and behaviours toward POP contamination of authorities from the central to local levels, non-governmental organizations and local communities have changed positively. Many tasks, projects and programmes related to POP management, such as toxic chemical monitoring, chemical emission inventory, risk exposure management, and residual chemical handling, have been set as priority activities in the field of environmental protection.

In addition, communication activities and awareness raising about POP has also created valuable experience and paved the way to continue other communication activities about chemical pollution control, risks and environmental protection in general.

Figure IV.1: Web portal on POP management in Vietnam

In addition, the change in awareness and behaviours in POP management coupled with the formation of the legal framework on POP management has also effectively supported the investigation, inspection and safety treatment of chemical pollution, including POPs, thereby promoting the management and proper handling undertaken by entities and individuals. For example, the treatment of pesticide stockpiles or PCB-containing waste has been accelerated recently. Furthermore, due to the interdisciplinary nature of POP management, the experience from domestic and international actors has strengthened the capacity of state management on the environment in general, in relevant areas such as customs, industrial sectors and health care. As the change in awareness is a continuing process, communication activities, particular-

ly the dissemination of information on environmental risks, need to be continued and maintained in the long term.

In short, the communication activities and awareness raising on POPs can be considered successful. It has helped to create a shift in perception and behaviours of many organizations and individuals, contributing significantly to improving policies, laws and institutions and promoting scientific and technical activities and increasing community involvement.

IV.5. Resource mobilization

Because it is hard to know right from the beginning the adverse impacts as well as the technical requirements, the mobilization of sufficient financial, technical and human resources is particularly crucial to implement POP management activities efficiently. This is especially true in the context of Vietnam, which has a limited budget for environmental protection.

POP management activities on a global scale, within the framework of the Stockholm Convention, have received considerable support from the international community. The total funding for POPs/chemicals from GEF is around US$ 2 billion. There are also other assistance resources coming from bilateral cooperation between countries. Vietnam has received substantial technical and financial support from the international community. The total funding for various projects has reached over US$ 100 million, of which more than US$ 20 million comes from GEF and US$ 80 million from the US and some other countries, particularly for Agent Orange/Dioxin remediation at hot spots. All the financial resources provided for POP management projects in Vietnam are non-refundable ODA and does therefore not cause a debt burden for future generations. Counterpart funding for projects is also high, both in the form of in-kind, in-cash and manpower.

The list of POP substances to be managed will continue to be expanded by the Stockholm Convention due to the actual requirements for health and environmental protection. It will therefore become increasingly challenging to manage POPs, especially for developing countries like Vietnam.

Following the international trend, non-refundable financial resources for environmental protection will decline significantly in the future. The strategies on international cooperation and resource mobilization therefore need to be reviewed and considered in the new context. The capacities acquired in recent years in Vietnam on POP management, particularly POP analysis, monitoring and communication, will assist Vietnam in actively promoting bilateral cooperation with other countries in the region and participating in the development and implementation of global projects on POPs designed by multilateral and international organizations. In the process of resource mobilization it is also important to consider integrating POP management as a catalyst to support other investments or loan projects in the environment field.

Obviously, strong international support coupled with the local resources mobilized within the country have positively transformed POP management and environmental

protection. In order to maintain this positive change, Vietnam needs sound policies, strategies and proper measures and mechanisms to preserve the outcomes obtained so far, and to maintain the motivation and continue efforts in the future.

POP substances and POP risks still exist in the life, therefore the Stockholm Convention on POPs will continue to be implemented. International cooperation and mobilization and exchange of resources are important factors ensuring the implementation of the Convention. The mobilization of resources from other sources, such as the state budget, loans for environmental protection and wider community participation will increasingly be part of maintaining and expanding POP management in particular, and protecting human health and the environment from toxic chemicals in general.

ANNEX
INTERNATIONAL FUNDED PROJECTS IN VIETNAM

1. Development of National Implementation Plan for Vietnam in the Process of Accession, Implementation and Enforcement of the Newly-signed Stockholm Convention

- Project scale: National
- Implementing agency: Vietnam Environmental Protection Agency, Ministry of Natural Resources and Environment
- Project duration: 2004-2006; Donor: GEF through UNDP
- Total project budget: US $500,000

Objective: Development and issuance of National Implementation Plan for Vietnam in the process of accession, implementation and enforcement of the Stockholm Convention on POPs according to requirements under Article 7 of the Convention.

- Main outcomes
  - Output 1: Mechanism to support the preparation and implementation of national plan is established;
  - Output 2: Mechanism to exchange local and international information is established;
  - Output 3: National Implementation Plan is approved; and
  - Output 4: Other outputs (inventory results, reports, assessment and technical guidelines).

2. Environmentally Sound Management and Decontamination of PCB in Electrical Systems – a Pilot Project for PCB Elimination in Vietnam

- Project scale: The project is piloted in some electricity establishments in Vietnam
- Implementing agency: Ministry of Natural Resources and Environment
- Coordinating agency: EVN
- Project duration: 2007-2009
- Donor: The Swiss Agency for Development and Cooperation (SDC)
- Total project budget: US $750,000
- Objective:

- *Overall objective:* Environmental decontamination of PCB contributing to the implementation of the Stockholm Convention.

- *Specific objectives:* Strengthen capacity in environmentally and technically sound management and decontamination of PCBs; define appropriate environmentally sound technologies and methods for final elimination of PCBs in Vietnam, which can be adapted and used in developing countries; and support the Government to develop and issue necessary policies for PCB elimination in Vietnam.

Main outcomes:

- Strengthening the capacity to analyze and identify PCB containing waste;

- Providing guidance for PCB inventory in transformer oil;

- Training on PCB safe management for concerned stakeholders;

- Contributing to building a project on PCB management in Vietnam.

3. Building capacity to eliminate POP pesticides stockpiles in Vietnam

- Project scale: National project, implemented on a national scale
- Implementing agency: MONRE
- Coordinating agencies: MARD, General Department of Customs
- Project duration: 2009-2015
- Donor: GEF through UNDP and FAO
- Total project budget: US $10,900,909, of which GEF US $4,300,800, UNDP US $110,000, FAO US $100,000 and the Government of Vietnam US $6,390,109
- Objective: Remove capacity barriers to the sustainable elimination of POP pesticides in Vietnam.
- Main outcomes of the project:

1. Improved capacity facilitates elimination of POP pesticide stockpiles

- Development of one data set on POP pesticide stockpile points including 557 POP pesticide pollution points, detailed survey in five areas (Cang Mountain - Thai Nguyen, Thach Luu District - Ha Tinh, Hon Tro, Mau 2, and Vuc Rong - Nghe An) and six other small points for environmental restoration
- Development of technical guidelines and managerial guidelines on POP waste management, POPs pesticide pollution points and technical guidelines on pesticide stockpile pollution control. Issuance of national technical standards on the threshold for POP pesticide stockpiles according to land use purpose, and support for the development and dissemination plan for treatment and prevention of environmental pollution due to pesticide stockpiles across the country (Decision No. 1946/QD-TTg dated 21 October 2010 by the Prime Minister).

2. All known stockpiles are destroyed and impacts on human health relieved

Elimination of pesticide and soil pollution in seven contaminated areas in Thai Nguyen, Nghe An and Ha Tinh by incineration in cement kilns. More than 700 tons of POP pesticide stockpiles is collected and treated. Moreover, the seven sites are cleaned and/or rehabilitated. Building of risk mitigation and environmental recovery construction at three sites (Mau 2, Thach Luu and and Hon Tro).

3. Improved chemicals management prevents import and use of POP pesticides

A compendium of legal documents and safety techniques for handling and storage of confiscated pesticides is developed and two pesticide storage sites in Lao Cai and Binh Thuan are upgraded. Three groups, including agricultural officials and pesticide traders, in five provinces (Thai Nguyen, Hai Duong, Bac Ninh, Hau Giang and Lam Dong) are trained and customs and other relevant agencies of 15 northern provinces are trained on the management of imported pesticides in Lao Cai province.

4. Introduction of Best Available Techniques (BAT) and Best Environmental Practicies (BEP) methodology to demonstrate reduction and elimination of releases from unintentionally produced persistent organic pollutants from industries in Vietnam

- Project scale: National project focusing on some industrial sectors
- Implementing agency: MONRE
- Coordinating agency: MOIT
- Project duration: 2009 - 2011
- Donor: GEF through UNIDO
- Total project budget: US $2,390,000, of which ODA is US $800,000 and the Government of Vietnam: US $1,550,000
- Overall objective: To establish the required human resources and infrastructure to implement the obligations of the Stockholm Convention in Article 5: "Measures to reduce and eliminate releases from unintentional production" and coordinate with national strategies for environmental protection and national strategies for industrial, sustainable and cleaner production, contributing in this way to human and environmental health.
- Main outcomes:

1. Capacity building of managerial and technical personnel with professional competencies in applying BAT/BEP in priority industrial source categories to reduce the release of U-POPs

Four pilot industrial sectors, including waste incineration, steel making and pulp and paper production industry using chlorine as bleaching agent and cement kilns for co-processing of hazardous waste, were selected for the assessment of application of BAT/BEP measures to reduce U-POP emissions. The project has developed a report on Dixon emission inventory in four industrial sectors in Vietnam, based on the UNEP Dixon/Furan inventory and calculation toolkit. The project has completed four technical guidelines on BAT/BEP application for the four above industries and has provided appropriate and feasible BAT/BEP solutions with the conditions of industries in Vietnam.

2. Coordination in the implementation of the Stockholm Convention action plans with cleaner production activities to enhance the efficiency in reducing, avoiding and eliminating U-POPs releases and reducing releases of other pollutants

Organizing general training course about BAT/BEP and U-POP monitoring for officers of VEA, Industrial Safety Techniques and Environment Agency and enterprises of selected industries, and disseminating information comparing and linking BAT/BEP application and cleaner production. Funding for 15 managerial and technical officers in short training courses in Japan, the UK and Australia (management, monitoring and treatment of chemically contaminated sites) and in USA (analysis of Dioxin and POPs), and proposing

energy efficient solutions for enterprises involved in the project, in order to incorporate knowledge, cleaner production solutions and BAT/BEP in the enterprises.

3. Capacity building for monitoring procedures for U-POP chemicals

- Organizing training on BAT/BEP application and U-POPs monitoring in four industries for 60 participants from enterprises, the department of natural resources and environment, the Ministry of Industry and Trade and VEA. Organizing in-depth training on BAT/BEP application and U-POP monitoring for managers, technicians and staff directly involved in the production process in the pilot enterprises. Dispatching officials and experts from the Dioxin Laboratory and VEA to attend training courses on U-POPs in USA, the UK and Germany;
- For the first time in Vietnam, ensuring the capacity and quality of dioxin/furan emission sampling collection in chimneys following international requirements and standards.

4. Cost-benefit estimation for implementation of BAT/BEP at enterprise and sector level:

Recommending measures to encourage the private sector to invest into BAT/BEP application via analysis of cost/benefit of BAT/BEP application in enterprises; supporting compliance of environmental regulations associated with measures to reduce U-POPs and other emissions; and leadership to increase responsibility of environmental/safety technique staff of the enterprises.

5. Establishment of South East Asian Air Monitoring Station

- Project scale: Some countries in East Asia and South East Asia
- Implementing agency: Ministry of the Environment, Government of Japan
- Project owner: VEA
- Coordinating agency: Environmental agencies of some countries in the region
- Project duration: 2007-2010
- Donor: Ministry of the Environment, Government of Japan
- Objective: Provide frequent and long-term monitoring data on the background level of POPs in air and contribute to the effectiveness evaluation of the Stockholm Convention, as well as support a capacity building programme on using GC/MS (high resolution) for POP analysis in laboratories of VEA.
- Main outcomes:
  - The project held 12 rounds of sampling and meteorological data collection at Tam Dao (every month) and provided nearly 60 gas samples for the Japanese side for analysis. The Dioxin laboratory funded Japanese experts to visit Vietnam in order to provide technical guidance and conduct fieldwork in Tam Dao;
  - Monitoring results were reported at a number of international conferences: 31th Dioxin Symposium in 2011; international workshop on POP monitoring in Northeast Asia held in Thailand in 2012, and an international conference on environmental chemistry held in Japan in 2012;
  - Following the results of phase 1, Vietnam and Japan have discussed and agreed to continue phase 2 of the project on POP monitoring in Tam Dao.

6. PCB Management in Vietnam

- Project scale: National level, statistical work is implemented in the whole country. A pilot on PCB management is carried out in Hanoi, Hai Phong, Quang Ninh, Hai Duong, Nam Dinh, Ho Chi Minh City, Dong Nai, Ba Ria - Vung Tau, Lam Dong, Can Tho and other provinces
- Project owner: VEA, Industrial Safety Techniques and Environment Agency, EVN
- Coordinating agency: Departments of Natural Resources and Environment and Departments of Industry and Trade, Customs and Police
- Project duration: 2010-2015
- Donor: GEF through the World Bank
- Total project budget: US $17,500,000, of which ODA: US $7,000,000 and co-financing: US $10,500,000
- Objective: Develop national capacity in Vietnam to manage all PCBs and on a pilot basis in selected provinces safely store significant amounts of PCBs in anticipation of future disposal.
- Main outcomes:

1. Development and completion of PCB management framework

- Draft regulation on "management of PCBs and PCB-containing equipment, materials and waste". Development of national plan and measures for capacity building on prevention, response and remediation of environmental incidents related to hazardous chemicals (PCBs/POPsP/PTS);
- Development of training materials and training plans for some selected local authorities as a demonstration on prevention and responses to environmental incidents related to PCBs, POPs and other toxic chemicals. Roles and responsibilities of government agencies in the process of control, inspection, monitoring and enforcement of PCBs management. Development and issuance of 10 technical guidelines on PCB management.

2. PCB inventory and management in electrical equipment

- Implementation of PCB inventory in EVN-units and non-EVN units in the whole country in the period of 2013-2015;
- Development of an information system of PCB containing materials, equipment and waste management.

3. Demonstration of PCB management:

- Fieldwork in nine non-EVN demonstration sites, development of PCB management plan for each site, assessment of the effectiveness of PCB management measures in the selected units, installation of oil recycling equipment and PCB test tool kit/analyser for storage sites to reduce PCB cross contamination;

- Infrastructure improvement and construction of PCB storage warehouse for six storing sites of waste treatment companies and one EVN storing site

4. Capacity building and awareness raising for the public

- Implementation of a series of activities, including technical seminars, awareness raising workshops, publications, radio and television programmes, information exchange on social networks, and development of a website on POPs and other websites on PCBs in order to provide information on policies, regulations, guidance and technical information on PCB and POP sound management;
- A basic change in awareness and behaviour of many concerned individuals and organizations on PCB management.

7. Environmental Remediation of Dioxin Contaminated Hot Spots in Vietnam

- Project scale: Some dioxin contaminated hot spots, including Bien Hoa airbase (Dong Nai province), Da Nang airbase (Da Nang city) and Phu Cat airbase (Binh Dinh province)
- Implementing agency: Ministry of Natural Resources and Environment;
- Project owner: Office of National Steering Committee 33
- Coordinating agencies: Ministry of Defence, Provincial People's Committees of Da Nang, Dong Nai and Binh Dinh
- Project duration: 2010-2014
- Donor: GEF through UNDP
- Total budget: US $ 76,377,550. Committed funding: US $37,312,550 of which GEF: US $ 4,977,000 and other sources: US $ 32,335,550
- Objective: "Minimise disruption of ecosystems and health risks for people from environmental releases of TCDD contaminated hot spots". This will contribute to the broader goal, which is "to overcome the consequences of toxic chemicals used in the war in Vietnam".
- Main outcomes:

1. Dioxin in core hot spot areas contained and remediated

- Containment/remediation targets and remediation action plans for each hot spot completed.
- *At Phu Cat airbase:*

  Contaminated area zoning, landfill design and construction of landfill construction has been completed, and tank installation and rehabilitation are being implemented. A long-term monitoring system (Czech Republic) is preparing to survey two areas for landfills. The monitoring plan at Phu Cat airbase has been handed over to the Ministry of Defence
- *At Bien Hoa airbase:*

  The master plan for dioxin remediation and the monitoring plan for Bien Hoa airbase has been handed over to the Ministry of Defence for implementation Completed additional assessment of dioxin contamination outside Bien Hoa airbase. The terrain in the polluted area is being surveyed, and a temporary isolation system is being installed at the airbase.

  Promising technologies have been shortlisted. Mechano-chemical destruction (ball mill) provided by the contractors has been tested. The results showed that this technology does not work well in arsenic contaminated soil. Therefore, it is necessary to have more information and conduct other tests on mechano-chemical technology and bioremediation technology to be able to choose the suitable technology for Dioxin and POP treatment. Tests of MCD technology by project partner EDL are being conducted together with biochemistry tests by the French partner and thermal desorption by the US partner.

- *At Da Nang airbase:*

  Thermal desorption technology has been selected for treatment of dioxin contaminated soil and sludge at Da Nang airbase. The construction of tanks for dioxin contaminated soil and a thermal desorption tube have been completed. Phase 1 will decontaminate 45,000 m^3 of dioxin contaminated soil and sediment and phase 2 will decontaminate 28,000 m^3 of soil and sediment. Under the plan, the treatment of dioxin contaminated soil at Da Nang airbase will be completed in 2016.

2. Strengthening national regulations and institutional capacities

- The Dioxin threshold in ambient air and waste water, especially for dioxin remediation facilities at hot spots, has been developed and issued (TCVN 9737:2013 - Dioxin discharge standards from treatment activities for dioxin contaminated sites).
- The first draft of a national report on a dioxin emission survey from industrial activities has been developed. A geographic information system (GIS) has been handed over to Office 33 to manage dioxin emission data from these sources.
- A training programme on ball mill technology has been developed and a training programme on long-term monitoring is being developed.
- Dissemination and awareness raising for citizens living in Bien Hoa city and for 1,200 staff working at Bien Hoa airport have been implemented. Documentation about AO and documentation for dissemination in related media has been developed.

8. Construction of a Dioxin Laboratory for the Ministry of Natural Resources and Environment

- Project scale: Dioxin Laboratory of Ministry of Natural Resources and Environment
- Project owner: VEA
- Coordinating agency: Office of National Steering Committee 33 and Ministry of Defence
- Project duration: 2009-2014
- Donor: Bill and Melinda Gates Foundation, Atlantic Philanthropies
- Total project budget: US $5,385,500 of which Bill and Melinda Gates Foundation: US $2,685,500 and Atlantic Philanthropies US $2,700,000 USD
- Objective: Construct an international standard environmental analysis laboratory that has importance in the Southeast Asian region on the study, analysis and assessment of AO/Dioxin pollution and POPs in the Stockholm Convention.
- Main outcomes:

1. Laboratory facilities:

- Equipped with modern and uniform analytical equipment, including HRMS, Tandem GC/MS-MS, LC/MS-MS, ICP - MS, devices for sample handling and storage, high volume air sampling device (US EPA TP - 9A), isokinetic sampling of chimney exhaust (US EPA M23), passive air sampling (PAS - PUF) and devices for soil and sampling.

2. Personnel:

- 15 trained officers, including eight officers who have been granted certificates for dioxin analysis

3. Activities:

- The laboratory has developed standardized processes for analysis of Dioxin/Furan and dl-PCBs in environmental samples (soil, water, sediment, air and factory emissions), samples from organisms and human biological products. The laboratory has been granted ISO 17025 certificate (VILAS: 545) on analysis of 17 Dioxin/Furan objects in water, soil, sludge, sediment and creatures. The laboratory has participated and achieved good results in the quality control programmes and annual cross-examination.
- The laboratory has been conducting many studies in hot spots in line with requirements of Agent Orange remediation. The laboratory has implemented the task on "Development of technical guidance on Dioxin emission monitoring in some typical industries" by VEA and provided services for Dioxin and Furan emission analysis from emissions from domestic and hazardous waste incineration. The laboratory has strengthened cooperation and training with foreign laboratories and has participated in international cooperation projects in related fields.

9. Demonstrating and Promoting Best Techniques and Practices for Reducing Healthcare Waste to Avoid Environmental Releases of Dioxins and Mercury

- Project scale: Hanoi, Ninh Binh
- Implementing agency: MONRE
- Coordinating agency: Ministry of Health
- Project duration: 2009-2012
- Donor: GEF through UNDP
- Total project budget: US $2,113,935 of which ODA: US $1,073,935 and the government: US $1,040,000
- Objectives:

Long-term objective: Protection of the global environment and public health by reducing releases of dioxins and mercury from healthcare waste. Reduction of barriers to implementation of the Stockholm Convention, SAICM and World Health Organization policies.

Short-term objective: Demonstration and promotion of best practices and techniques for healthcare waste management.

- Main outcomes:
  - Medical sharps waste management plan of Viet Duc University Hospital.
  - Medical waste management plan of Viet Duc University Hospital and Ninh Binh Provincial General Hospital;
  - Report on policy review related to medical waste and recommendations;
  - All non-mercury equipment provided to Ninh Binh General Hospital has been used;
  - The project has also provided one small autoclave in 2012 instead of the medical waste incinerator with a capacity of 1,300 kg/month;
  - Six training courses on medical waste management were organized for 251 participants from hospitals and local departments of health;
  - Investment and use of one autoclave for medical waste treatment.

10. Updating Vietnam National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants

- Project scale: National project
- Project duration: 2013-2015
- Donor: GEF through UNDP
- Objective: To implement obligations to the Stockholm Convention in Vietnam to manage, reduce and eliminate POP emissions affecting the environment and human life.
- Main outcomes:
  - Management and monitoring structure for the project activities is formulated and an inception report is produced;
  - POP inventory database and report on national capacity assessment on POP management, treatment and disposal are available;
  - Report on identification of priority activities and national targets for POP management in consultation with related stakeholders is produced;
  - NIP update is completed and approved by the Prime Minister.

11. Implementation of the POP Monitoring Plan in the Asian Region

- Project scale: Vietnam, Cambodia, Indonesia, Lao PDR, Mongolia and Thailand
- Implementing agency in Vietnam: MONRE
- Project duration: 2015-2019
- Donor: GEF through UNEP
- Total project budget: GEF: US $3,936,000, of which Vietnam: US $580,000; co-financing: US $11,870,000, of which Vietnam: US $1,855,000 (cash US $55,000 and in-kind US $1,800,000)
- Objective: To strengthen the capacity of countries in the Asian region for POP analysis as a basis for the implementation of pollution control measures to reduce and finally eliminate human exposure to POPs at national, regional and global levels.
- Expected outcomes:
  - Relevant stakeholders for project implementation in the Asian region are committed to carry out the agreed responsibilities;
  - Regional network and national capacity to carry out air and water sampling is enhanced in the Asian region, and high quality data is generated on the presence of initial and new POPs in the region;
  - Regional network and national capacity to carry out breast milk sampling is enhanced in the Asian region, and high quality data is generated on the presence of initial and new POPs in the region;
  - Accuracy of POP assessment in the Asian region is consolidated by performance evaluation of national laboratories, as well as by analysis of additional matrices of major national interest;
  - Contribution to regional report for the global monitoring plan is performed, and a roadmap for sustainable POP monitoring for the Asian region in a global context is developed.

12. Safe management of POPs and hazardous chemicals in Vietnam

- Project scale: National project
- Implementing agency: MONRE
- Coordinating agency: MOIT, Department of Natural Resources and Environment of Nghe An and Binh Duong provinces
- Project duration: 2015-2018
- Donor: GEF through UNEP
- Total project budget: GEF: US $2,550,000, JICA'S co-financing: US $3.000.000, Vietnam's co-financing: US $8.050.000
- Objective: The general objective of the project is to further minimize risks for the environment and human health by reducing emissions from POPs and hazardous chemicals.
- Expected activities:
  - Component 1: Development and implementation of policy frameworks on safe management of chemicals, including POPs and PTS;
  - Component 2: POPs and PTS monitoring and reporting;
  - Component 3: Management of POPs contaminated areas;
  - Component 4: Inventory of national baseline data on mercury and mercury emission reduction.

13. Demonstration of BAT and BEP in open burning activities in response to the Stockholm Convention on POPs

- Project scale: Vietnam, Cambodia, Lao PDR, Mongolia and the Philippines
- Implementing agency in Vietnam: MONRE
- Coordinating agency: Departments under MONRE, VEA
- Project duration: 2015-2018
- Donor: GEF through UNIDO
- Total project budget: GEF: US $7,560,000, of which Vietnam: US $1,512,000, co-financing: US $32.776.434, of which Vietnam: US $5,740,000 (cash US $200,000 and in-kind US $5,540,000)
- Objective: To achieve sustainable release reduction of U-POPs in the open burning sector through the introduction and implementation of BAT and BEP in selected demonstration sites, legislation improvement and institutional strengthening, regional cooperation and information exchange by all implementing agencies.
- Expected activities
  - Component 1: Capacity building of BAT/BEP application in open burning practices;
  - Component 2: Capacity building for human resources to carry out BAT/BEP implementation;
  - Component 3: BAT/BEP implementation in the selected demonstration sites;
  - Component 4: Improvement of knowledge and understanding on BAT/BEP and U-POP related risks concerning open burning activities;
  - Component 5: Project management and monitoring;

14. Environmental Remediation of Dioxin Contamination at Da Nang Airport

- Project scale: The project is implemented at Da Nang airport
- Project duration: 2009-2016
- Donor: The United States Agency for International Development (USAID)
- Total project budget: US $83,000,000
- Objective: To remediate an estimated 73,000 cubic meters of contaminated soil and sediment at Da Nang airport
- Main outcomes:
  - Environmental assessment to evaluate contamination level in soil and sediment at Da Nang airport was implemented;
  - Bilateral discussion to select pollution treatment measures for soil and sediment. In-situ thermal desorption was selected;
  - Technical workshops on in-situ thermal desorption/in-pile thermal desorption were held on 18 and 20 May 2010 (Hanoi and Da Nang);
  - Sampling, analysis and assessment of pollution levels;
  - Demining in the treatment area was implemented and submission of the Environmental Impact Assessmen (EIA) report, technology selection and project implementation plan were submitted to the Ministry of Natural Resources and Environment for consideration;
  - In-situ thermal desorption system of dioxin contaminated soil was installed including oil tanks and thermal desorption tubes;
  - The ongoing phase 1: transferring soil samples into and out of the treatment system, and monitoring soil samples before and after treatment to assess the treatment effectiveness for 45,000 m^3 of sediment and soil. After that phase 2 will be implemented with 28,000 m^3 of sediment and soil;
  - Rehabilitation.

15. Other local and international cooperation activities

15.1. Analysis and monitoring

Since the beginning of 1994, local organizations of science, technology, and training initiated to conduct research on POPs. The following organizations have conducted many studies and research on POPs:

- CETASD, Hanoi University of Science, Vietnam National University has conducted state-funded research as follows: “Research on residue and transportation of endocrine disruptors in some coastal areas of Vietnam", 2004-2006; “Development of concurrent sample collection and analysis of PCB compounds and organochlorine pesticides in sediment and biological samples at some typical points of the coastal zone in Vietnam”, 2005-2006; “Recreation of the pollution history of persistent organic pollutants (POP) at some typical points of the Tonkin Gulf by sediment column technique”, 2008-2010; “Simultaneous determination of residues of organochlorine compounds in shellfish by GCMS,” 2007; “Development of analytical method of organic trace pollution of Polybrominated diphenyl ethers (PBDE) in sediments and biological samples,” 2007; “Simultaneous determination of residues of organochlorine pesticides and PCBs in saltwater fish by GCMS,” 2008; “Research on analytical process of PBDE residues in fish samples using solid phase extraction and GCMS,” 2009; and “Assessment of trace pollution of PBDE chemicals in surface sediment of several canals and lakes in Hanoi,” 2010.

- Institute of Environment and Resources, Vietnam National University, Ho Chi Minh City has implemented a number of research studies as follows: “Research and development of POP analysis in compensation samples by GCMS – application for Thi Vai River pollution assessment,” 2006-2008; “Research and development of PBDE analysis method in sediment by GCMS - Application to assess PBDE contaminated status and origin of the canal system in Ho Chi Minh city,” 2011-2012; “Research and suggestion of possible solutions to mitigate the pollution impacts caused by Dioxin/Furan residue to ecosystems and public health at Bien Hoa airport.”

- Analysis Laboratory, Quality Assurance and Testing Centre 1, Directorate for Standards, Metrology and Quality conducted ministerial level research under the Ministry of Science and Technology on "Investigation of POP pollution in Hanoi".

- The Vietnam-Russia Tropical Centre has implemented the project "Assessment of dioxin storage sites in military airports used for dioxin storage during the war in Vietnam.”

In addition, a number of organization specialized in scientific, technological and service research have implemented studies on POP contamination assessment, including the Institute of Environmental Technology, Vietnam Academy of Science and Technology, the Institute for Environmental Science and Technology of Hanoi University of Technology, National Institute of Labour Protection, Center for Environmental Monitoring and Information, Centre for Education and Development of Chromatography, Center for Technology & Environment Treatment of the High Command of Chemistry, Quality Assurance and Testing Centre 3, Centre for Environmental Consultancy and Technology, Vietnam Institute of Industrial Chemistry and Military Institute of Forensic Medicine.

On the basis of funding for international cooperation, a number POP monitoring programmes have been implemented for many years, as follows:

- Sampling and analysis of residues of POPs (DDT, HCH, PCB, HCL and HCB) in mussels and fish in some coastal areas, as well as in migratory birds and resident birds in the Asia-Pacific, and studies on the determination of new POP contaminants, such as PBDE in handicraft villages, have been conducted by the Center for Marine Environmental Studies, Ehime University in cooperation with CETASD, Ha Noi University of Natural Sciences, Vietnam National University.

- Analysis and monitoring of the presence of organochlorine pesticides, PCBs and endocrine disruptors such as bisphenol A, pthalat and the new POPs, including PBDE, PFOS and PFOA, in water and sediment in a number of rivers and lakes in the north and centre of Vietnam, as well as in fish and crustaceans in the framework of the project "Monitoring and management of the coastal water environment in the south Asian region" since 1996 to date (executed by the United Nations University, Japan, with participation of 11 countries from East Asia, of which the Vietnamese representative is CETASD).

- Analysis and monitoring of the presence of POPs in the air and dust in Ba Vi implemented by CETASD in 2008-2010 in the framework of the project "Research on the transportation of persistent organic pollutants caused by human activities from continents to the North Pole", funded by the Department of Environment, Canada.

- Study of DDT and PCB residues in sediment and water in several canals in Hanoi and some northern coastal regions (1994-1999) conducted by the Vietnam Institute of Nuclear Energy, Quality Assurance and Testing Centre 1 (Directorate for Standards, Metrology and Quality, Ministry of Science and Technology), National Institute of Nuclear Power, Portugal, and the Marine Environmental Laboratory, University Monaco of Nuclear Energy. This project was developed by the International Atomic Energy Agency.

Surveys on the current state of infrastructure for POPs monitoring and treatment show that the number of laboratories for POP analysis in Vietnam is still limited and mainly concentrated in research institutes or universities. Some laboratories are under management of the Ministry of Agriculture and Rural Development, Ministry of Science and Technology and the Quality Assurance and Testing Centre. In addition, there are some private laboratories performing POP analysis.

15.2. Pollution treatment

To address environmental pollution and impacts on human health caused by POP pollution, in recent years scientists and officials in Vietnam have studied and proposed different POP treatment methods. On the basis of these studies, the Ministry of Natural Resources and Environment has issued regulations on safe disposal procedures for some hazardous chemicals, as well as coordinated with relevant ministries and sectors to conduct POP-related activities in order to provide solutions towards a sustainable environment.

15.3. Environmental management

Besides coordination activities, concerned ministries and sectors involved in the Stockholm Convention implementation have implemented specific activities related to POP management. This includes: MONRE has reviewed, assessed and supplemented existing regulations in Vietnam on POP management; the Ministry of Industry and Trade has issued appropriate implementation plans of decisions in manufacturing sectors, including regulations on the management of PCB transformer oils; the Ministry of Defence has taken the initiative and actively participated in the environmental remediation of dioxin contaminated hot spots caused by the war in Vietnam; MARD has regularly issued official regulations on pesticide management; and MOET has integrated POPs into several teaching programmes in schools.

It is clear that the perception and awareness of POPs and understanding of the Stockholm Convention has improved, especially for concerned authorities. The group of environmental management officials at ministerial level has the most comprehensive understanding of POPs (90% of participants know about POPs), followed by environmental management officers in departments (more than 50%). In addition, most members of the community are aware of the impact of POPs on human health and the environment.

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